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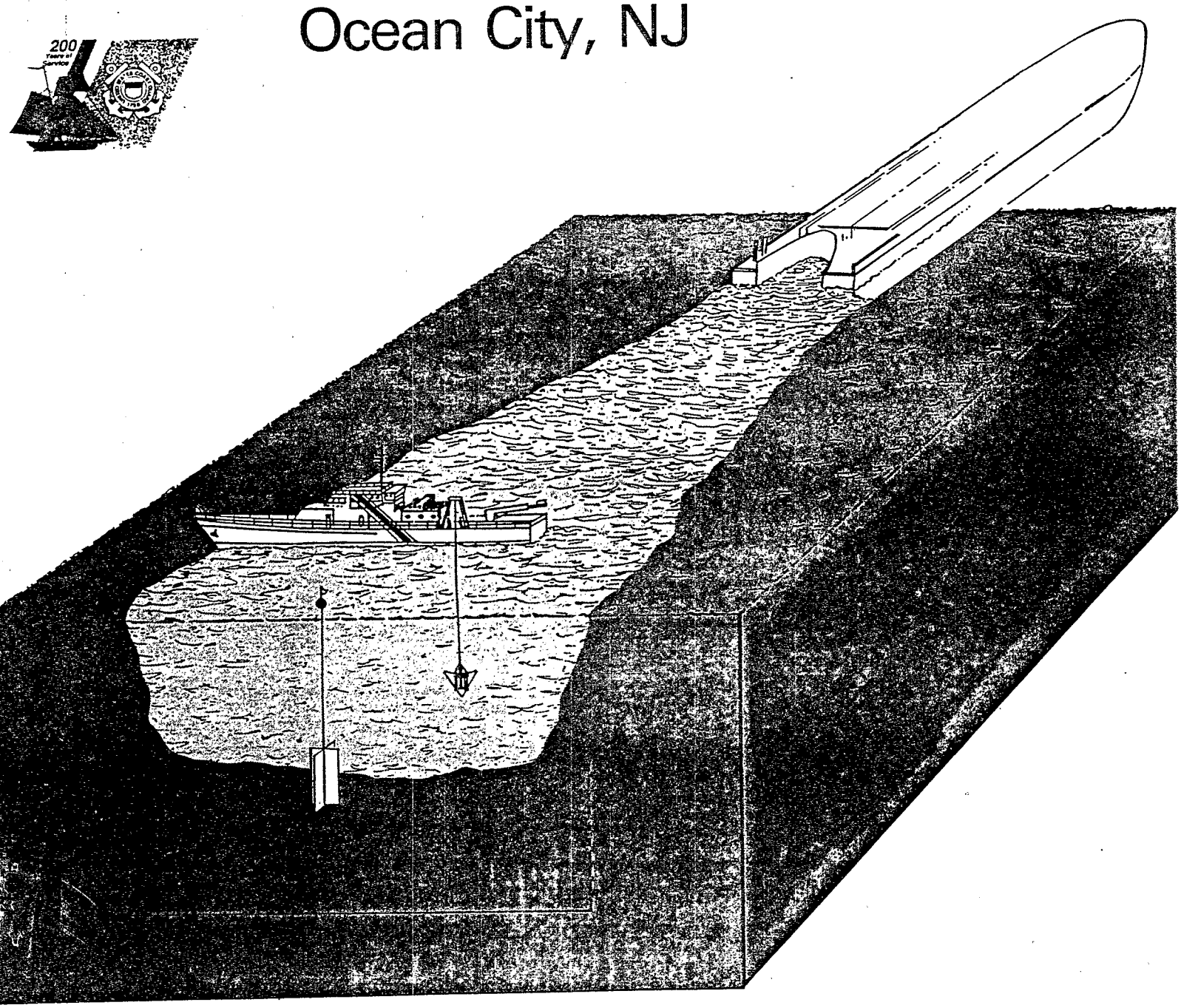
March 28—30, 1989
Ocean City, NJ



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PROCEEDINGS OF THE

OCEAN DUMPING WORKSHOP
106-MILE SITE

held

March 28 - 30, 1989

Ocean City, NJ

Conducted by

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Marine and Estuarine Protection
Washington, DC,

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Washington, DC,

and

UNITED STATES COAST GUARD
Washington, DC

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PREFACE

This report presents the organization, conduct, and results from a workshop convened by the U.S. Environmental Protection Agency (EPA), National Oceanic and Atmospheric Administration (NOAA), and United States Coast Guard (USCG) on ocean disposal of sewage sludge at the 106-Mile Deepwater Municipal Sludge Site (106-Mile Site). The document conveys the findings of the workshop. The materials presented here bring together the essence of the workshop findings and recommended strategies.

EPA and NOAA began developing a monitoring plan for the 106-Mile Site in late 1985. Between October 1985 and March 1988 iterative drafts of a monitoring plan and an implementation plan were developed and reviewed by EPA. In March 1988 a Draft Final Monitoring Plan and Draft Final Implementation Plan were accepted by EPA.

Using workshop findings and other information, EPA , NOAA, and USCG will develop a monitoring, research, and surveillance strategy for the 106-Mile Site and regions surrounding the site. The existing monitoring and implementation plans will be revised to reflect this strategy. A separate report describing the overall strategy for monitoring, research, and surveillance at the 106-Mile Site is being prepared. An independent report discussing the monitoring program for the Middle Atlantic Bight will also be prepared for submission to Congress in November 1989.

EXECUTIVE SUMMARY

Ocean dumping of sewage sludge has occurred in the inner New York Bight since 1924. Much of this disposal occurred at a location known as the 12-Mile Site. The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA, PL 92-532) was passed to regulate the disposal of wastes in the ocean. As amended, MPRSA is the primary legislative authority directly related to ocean dumping. Under MPRSA, the U.S. Environmental Protection Agency (EPA) is responsible for issuing permits for sewage sludge disposal and for managing and monitoring ocean disposal sites. Surveillance of operational aspects of the permit conditions and enforcement of permit conditions is a joint responsibility of EPA and the United States Coast Guard (USCG). MPRSA assigns the National Oceanic and Atmospheric Administration (NOAA) the responsibility for monitoring effects of wastes dumped into the ocean and continuing research programs on long-range effects of pollution and human-induced changes on the marine environment.

In 1984, EPA designated the 106-Mile Deepwater Municipal Sludge Site (106-Mile Site), located 120 nautical miles southeast of Ambrose Light, New York, and 115 nautical miles from the nearest coastline, as a replacement for the 12-Mile Site for disposal of municipal sewage sludge. Nine sewerage authorities from the New York City/Northern New Jersey area began dumping activities at this site in 1986. Since 1984, EPA has conducted eight surveys at and in the vicinity of the 106-Mile Site. In 1987 and 1988, NOAA conducted 13 biological survey cruises in the Mid-Atlantic Bight area that includes the 106-Mile Site.

Several recent marine pollution events focused the attention of many legislators, the news media, and the public on a potential relationship between environmental degradation and dumping activities at the 106-Mile Site. In response to public concern, Congress passed the Ocean Dumping Ban Act of 1988 (ODBA) to end ocean dumping of sewage sludge and industrial waste by December 31, 1991. ODBA also requires that EPA, in cooperation with NOAA, design by November 1989 a monitoring program for the region near the 106-Mile Site and including other disposal sites in the Middle Atlantic Bight such as the now abandoned 12-Mile Sewage Sludge Dump Site, the industrial waste sites, and other areas that may have been impacted by dumping. According to ODBA the monitoring program must include (1) sampling of an appropriate number of fish and shellfish species and other organisms to assess the effects of environmental conditions on living marine organisms in these areas; and (2) use of satellite and other advanced technologies in conducting the program.

EPA, NOAA, and USCG convened a workshop in Ocean City, New Jersey on March 28 - 30, 1989 to address concerns about potential effects on fisheries and human health risks resulting from disposal of sewage sludge at the 106-Mile Site, and to assist in the process of identifying critical monitoring, research, and surveillance needs relative to the 106-Mile Site. The goals of the workshop were (1) to assess what is known about the transport and fate of the sludge; (2) to assess potential impacts on living marine resources and on human health from disposal of sewage sludge at the 106-Mile Site; and (3) to develop recommendations for future research, monitoring, and surveillance activities at the 106-Mile Site and in surrounding areas potentially impacted by sludge disposal at the site. Workshop participants included representatives of Federal agencies and state governments, the scientific and technical community, citizen groups, congressional staffs, and sewerage authorities. Four management questions were addressed at the workshop:

1. What is the physical and chemical fate of the sewage sludge dumped at the 106-Mile Site?

2. What is the effect of the sludge dumping at the 106-Mile Site on living marine resources?

3. What is the effect of the sludge dumping at the 106-Mile Site on human health?

4. Are there changes in site designation, permits, or surveillance that can provide better protection of the environment, living marine resources, and human health?

The workshop participants assessed what is known about each of these questions; identified additional needs for monitoring, research, and surveillance at the 106-Mile Site; and made recommendations concerning strategies for conducting monitoring, research, and surveillance. Several general conclusions were reached regarding sludge transport, impacts of sludge disposal on living marine resources and public health, and management of the 106-Mile Site. These included the following:

- Based on existing studies, sewage sludge is unlikely to move onto the shelf or onto beaches nor is sludge disposal at the 106-Mile Site likely to affect the nearshore environment and beaches.
- Existing studies have found no measurable effects of sewage sludge dumping on living resources at the 106-Mile Site.
- Existing information does not support allegations that seafood from the Middle Atlantic Bight is unsafe for human consumption because of dumping at the 106-Mile Site.
- There is no evidence from existing studies that dumping of sewage sludge at the 106-Mile Site poses a threat to human health, either directly through recreational or other water-related activities or indirectly through the consumption of seafood.

With regard to the movement of sludge from the 106-Mile Site, the workshop recognized that the existing monitoring efforts at the 106-Mile Site should be expanded. Recommendations for continued monitoring included use of the following:

- Lagrangian drifter studies using satellite-tracked surface drifters to determine current movements.
- Real-time satellite imagery programs to evaluate shelf-front, Gulf Stream, and warm core ring dynamics.
- Eulerian current meter measurements to determine the transport vectors of sludge in the vicinity of the 106-Mile Site.
- Sediment trap studies to evaluate the settling of sludge from the surface ocean.
- Use of recently acquired physical oceanographic data and available circulation and sludge transport models to determine whether better predictions of sludge transport can be made.

The workshop also recommended that the relative contribution of all contaminant sources to the Middle Atlantic Bight be evaluated and ranked. Participants identified additional data needs relative to nearfield movement of sludge within the 106-Mile Site. These included developing information on the sludge settling behavior immediately after disposal and penetration through the pycnocline.

With regard to effects on living marine resources, the workshop recommended that monitoring and research be increased to determine the possible effects from sludge disposal at the 106-Mile Site on fish and shellfish. These recommendations included:

- Develop information on the exposure to and contaminant levels in less-well-characterized, resident pelagic species and vertically migrating fish in and near the 106-Mile Site.

- Develop information on the level of pathogens and contaminants in commercially important demersal fish (e.g., tilefish) and benthic organisms (e.g., lobster, red crabs, bivalves) inshore from the 106-Mile Site.

- Perform short-term toxicity testing near the 106-Mile Site using marine species from the vicinity of the 106-Mile Site when these tests are developed and have been verified.

- Evaluate the relationship between dumping and pathogens in marine organisms.

- Conduct studies of the benthic communities on the continental shelf and slope in the vicinity of the 106-Mile Site to determine potential alterations in community structure.

Preliminary conclusions from an inter-agency group studying chitinoclasia, or shellfish disease, were also presented to the participants. The conclusions indicate that chitinoclasia occurs naturally but the incidence may be increased under environmental stress. The workshop recommended that studies be implemented to determine the incidence and distribution of this disease and to determine the cause/effect relationship to pathogens and contaminants.

From the perspective of human health, several work groups recommended that the quality of commercially important fish and shellfish from the area of influence of the 106-Mile Site be monitored to assure the public that seafood remains safe for consumption. Studies recommended by the workshop include

- Increased monitoring for disease in fish and shellfish.

- Increased monitoring for toxic chemicals and pathogens in commercially important species.

- Definition, quantification, and communication to the public of the risks from direct and indirect exposure to sludge dumped at the 106-Mile Site.

- Evaluation of relative risks from other potential exposure pathways in the Middle Atlantic Bight.

The workshop also discussed EPA's tiered approach to monitoring the 106-Mile Site as presented in the EPA monitoring and implementation plans. Participants were informed that this approach provides a conceptual framework within which monitoring activities can be conducted in a cost-effective sequence. The plan allows monitoring to be conducted in a sequential or parallel manner, depending on the management questions being addressed, and as such is not a traditional sequential pass-fail decision-making tiered framework.

With respect to the site regulation, surveillance, and monitoring, the workshop participants found the tiered monitoring approach being used by EPA at the 106-Mile Site to be appropriate and adequate. However, the participants strongly recommended that implementation of farfield fate and long-term effects monitoring be accelerated. The workshop participants judged that conformance to regulatory criteria was good but noted that violations have occurred. This, combined with concerns of the fishing industry over out-of-site dumping, resulted in participants recommending that the operational effectiveness of the Ocean Dumping Surveillance System be improved.

A common theme in all work group deliberations was the need to continue efforts to reduce contaminant loads in sewage sludge through pre-treatment control programs.

The workshop recommended that results from recent and ongoing monitoring, research, and surveillance activities be summarized in both technical and public information documents. In addition, the participants recommended that additional procedures be implemented to keep the public aware and informed of activities and events both at the 106-Mile Site and Middle Atlantic Bight in general. Other general recommendations included (1) formation of a "blue ribbon" panel as a mechanism to enhance the participation of scientists and technical experts from the Federal government in the review of the monitoring, research, and surveillance activities at the 106-Mile Site and (2) integration of activities being conducted by the various Federal agencies currently involved with the 106-Mile Site to eliminate overlap and to optimize agency roles.

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1.0 INTRODUCTION

Ocean dumping of sewage sludge has occurred since 1924. The Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA, PL 92-532) was passed to regulate the disposal of wastes in the ocean. As amended, MPRSA is the primary legislative authority directly related to ocean dumping. It is commonly referenced as the Ocean Dumping Act, and is the domestic legislation implementing the London Dumping Convention. Under MPRSA, the U.S. Environmental Protection Agency (EPA) is assigned responsibility for issuing sewage sludge disposal permits and for managing the ocean disposal sites. Surveillance of operational aspects of the permit conditions and enforcement of permit conditions is a joint responsibility of EPA and the U.S. Coast Guard (USCG). MPRSA assigns the National Oceanic and Atmospheric Administration (NOAA) the responsibility for monitoring effects of wastes dumped into the ocean, and for continuing research programs on long-range effects of pollution and human-induced changes in the marine environment.

EPA designated the 106-Mile Deepwater Municipal Sludge Site (106-Mile Site) to receive municipal sewage sludge in 1984. The 106-Mile Site is located 120 nautical miles southeast of Ambrose Light, New York and 115 nautical miles from the nearest coastline. Nine sewerage authorities from the New York City/northern New Jersey area began dumping at the 106-Mile Site in 1986. Beginning in late 1985 and continuing through 1988, EPA developed and revised a draft monitoring plan for the 106-Mile Site to focus monitoring activities regarding the potential effects of sludge dumping on marine life and human health, and to gain information regarding continued site management and permitting activities. Since 1984, EPA has conducted eight surveys at and in the vicinity of the 106-Mile Site. Early surveys focused on collecting baseline information. Subsequent surveys assessed nearfield fate, short-term effects, and farfield fate of sewage sludge. In 1987 and 1988, NOAA conducted 13 biological survey cruises in the Mid-Atlantic Bight area that includes the 106-Mile Site. The surveys examined ichthyoplankton, zooplankton, pelagic juvenile bluefish, and bottom fish. During some of these cruises and during six other NOAA surveys to the area, measurements of oceanographic conditions and circulation were made in the area. In addition, sediment samples were taken during three of the NOAA surveys.

Several recent marine environmental events focused the attention of many legislators, the news media, and the public on an alleged relationship between environmental degradation and dumping activities at the 106-Mile Site. These events included decreases in offshore fisheries catches, dolphin kills, diseases in crabs and lobsters, and floating debris washing up on New York and New Jersey beaches. The perceived problem of seafood contamination led to a decrease in seafood sales. In response to public concern, Congress passed the Ocean Dumping Ban Act of 1988 (ODBA) to end ocean dumping of sewage sludge and industrial waste by 1991 or as soon after as possible. Any municipalities using the 106-Mile Site beyond the 1991 deadline will be required to pay substantial penalties. ODBA also requires the following:

- By November 1989, EPA, in cooperation with NOAA, must design a monitoring program for the 12-Mile Site, the 106-Mile Site, the industrial waste sites, and other areas that may be impacted by dumping. The monitoring program is to include (1) sampling of an appropriate number of fish and shellfish species and other organisms to assess the effects of environmental conditions on living marine organisms in these areas; and (2) use of satellite and other advanced technologies in conducting the monitoring program.

- The payment of fees and penalties, a portion of which will go to EPA and NOAA to conduct monitoring and research, and to the USCG to conduct surveillance operations.

- EPA is to prepare annual reports to Congress on the progress made in ending the dumping of sewage sludge and industrial waste.

- EPA is to prepare annual reports to Congress, in cooperation with NOAA, on the results of environmental monitoring.

- By May 1989, EPA in cooperation with the USCG, is to prepare a report regarding progress made using electronic surveillance equipment and other methods to detect dumping outside the 106-Mile Site.

In partial response to the ODBA requirements and consumer concern about the safety of seafood, EPA, NOAA, and USCG convened a workshop to address concerns about potential risks to fisheries and human health of disposing sewage sludge at the 106-Mile Site and to assist in the process of identifying critical monitoring, research, and surveillance needs relative to the 106-Mile Site. The workshop was held in Ocean City, New Jersey on March 28-30, 1989. To gain a broad understanding regarding the potential effects of municipal sludge disposal at the site, representatives from Federal agencies and state governments, the scientific and technical community, citizen groups, congressional staffs, and sewerage authorities were invited to participate in this workshop. Appendix A lists persons invited to the workshop. Approximately 100 persons attended the workshop.

The goals of the workshop were to (1) assess what is known about the transport and fate of sewage sludge; (2) to assess potential impacts on living marine resources and human health from disposal of sewage sludge at the 106-Mile Site; and (3) to develop recommendations for future research, monitoring, and surveillance at the 106-Mile Site.

During the workshop, participants

- Assessed available information concerning the site and dumping activities.

- Examined the potential effects on marine life and human health risks associated with sewage sludge dumping at the 106-Mile Site.

- Discussed whether changes in the existing monitoring, research, and surveillance efforts are needed in order to implement more effective approaches and techniques.

- Provided recommendations for modifying EPA's existing monitoring plan, and identified research and surveillance needs.

1.1 WORKSHOP ORGANIZATION, FOCUS, AND CONDUCT

1.1.1 Presentations

The workshop was convened by Tudor Davies of EPA, Charles N. Ehler of NOAA, and David L. Folsom of the USCG. In the first session of the workshop, participants were provided with background information on the history, use, and monitoring of the 106-Mile Site plus an understanding of the role of each Federal agency (Table 1). The remainder of the workshop focused on four management questions (Table 2) related to the monitoring plan for the 106-Mile Site and to a broader monitoring program for the Middle Atlantic Bight, including the New York Bight Apex, the

TABLE 1. LIST OF PRESENTATIONS AND PRESENTERS FOR THE 106-MILE SITE WORKSHOP, MARCH 28-30, 1989.

PRESENTER	TOPIC
Craig Vogt, EPA	Introduction of Workshop Staff and Organizers
Tudor Davies, EPA	Convenor
Charles N. Ehler, NOAA	Convenor
David L. Folsom, USCG	Convenor
John Everett, NOAA	Workshop objectives and related products
Richard Allen, AOFA	Perspectives on Ocean Dumping at the 106-Mile Site by Commercial and Recreational Fishermen
Boyce Miller, Oceanic Society	Perspective on Ocean Dumping at the 106-Mile Site by Environmental Groups
Darrell Brown, EPA	Legislation Concerning Dumping at the 106-Mile Site
Frank Csulak, EPA	Overview and History of Dumping at and Management and Surveilleance of the 106-Mile Site
Tom O'Connor, NOAA	Overview of Physical and Chemical Oceanography Related to the 106-Mile Site
John Pearce, NOAA	Overview of Living Marine Resources in the Middle Atlantic Bight
David Redford, EPA	Overview of the EPA 106-Mile Site Monitoring Plan
Frank Csulak, EPA	Recent Monitoring Results from the 106-Mile Site
Lee Follwein, USCG	Overview of Ocean Dumping Surveillance
Terry Whitledge, U. of Texas	Chairman, Question 1
Larry Swanson, State U. of New York, Stony Brook	Strategist, Question 1
Angela Cristini, Ramapo College of New Jersey	Chairman, Question 2
John Pearce, NOAA	Strategist, Question 2
Thomas Billy, NOAA	Chairman, Question 3
Robert Wetherell, FDA	Strategist, Question 3
Deny Bennet American Littoral Society	Chairman, Question 4
William Muir, EPA	Strategist, Question 4

TABLE 2. MANAGEMENT QUESTIONS ADDRESSED BY THE 106-MILE SITE WORKSHOP, MARCH 28-30, 1989.

1. What is the physical and chemical fate of the sewage sludge dumped at the 106-Mile Site?
2. What is the effect of the sludge dumping at the 106-Mile Site on living marine resources?
3. What is the effect of the sludge dumping at the 106-Mile Site on human health?
4. Are there changes in site designation, permits, or surveillance that can provide better protection of the environment, living marine resources, and human health?

industrial waste site, and other areas of potential influence from sewage sludge dumping. In addition, the participants addressed broader issues relative to the ocean dumping of sewage sludge, including (1) the potential for onshelf sediment and food-chain contamination, especially by pathogens, (2) the potential for long-term/farfield toxic effects in the deep water column, and (3) the need to define the contribution of 106-Mile Site dumping relative to other stresses to existing and potential problems in the New York Bight.

1.1.2 Management Questions

To address the four management questions (Table 2), a series of specific issues and questions was identified and made available to the participants in advance of the workshop (Battelle, 1989a). At the workshop, participants were organized into four work groups composed of representatives of the various agencies, scientific disciplines, and environmental groups. This organization maximized the opportunity for interaction between persons with various backgrounds and interests. Each work group was led by a chairperson who was assisted by a strategist and a rapporteur. The chairperson directed the activities of each work group, summarized known information about the various issues, and identified additional information needs relative to the management questions being addressed. The strategist was responsible for identifying monitoring, research, and surveillance strategies resulting from the discussions. Each work group addressed each of the four of the management questions.

The discussion of each management question was structured as follows: the questions and issues associated with each management question were presented by one of the work group chairpersons in a plenary session to the workshop participants; and the work groups were given a specific set of issues to address, along with the options of adding other issues or discussing issues assigned to other work groups. Discussions of each work group session focused on assessing the current level of understanding about the effects of dumping in relation to the workshop questions, and developing recommendations for inclusion in the comprehensive research, monitoring, and surveillance plan. After the group discussions were concluded, each work group chairperson presented summary findings of their work group to all of the participants. The session chairperson presenting the question then prepared a written summary of the results of discussions from the four work groups. These summaries are included in Appendix B. The strategists for all groups worked together to develop strategies for addressing the identified needs for each management question. On the last day of the workshop, each of the strategists presented summaries of the recommended strategies. These are included in Appendix C.

During the workshop, the physical oceanographers and modelers convened an independent session to elaborate on questions concerning the transport and fate of the sludge. A list of recommendations developed by this group is included as Appendix D.

Summaries of the presentations from the plenary session can be found in Part 2. The major findings of the workshop relative to the four management questions, plus workshop recommendations to include in a research, monitoring, and surveillance strategy for managing the 106-Mile Site, are presented in Parts 3 and 4. The interested reader will find different formats for the summary of the workshop discussions in the chairmen and strategists' reports that are included in the appendices. These various presentations which sometimes appear to be different, if not at odds, were used to develop the overall summaries that appear in the document. Part 3 of this document summarizes background data and information relative to the management questions plus additional information from the workshop. Section 3.1 (page 24), Section 3.2 (page 29, Section 3.3 (page 34), and Section 3.4 (page 37) address questions 1, 2, 3, and 4, respectively. Discussion of the monitoring needs and

strategies recommended for addressing these needs are presented in Part 4. Questions 1, 2, 3, and 4 are addressed in Section 4.1 (page 39), Section 4.2 (page 44), Section 4.3. (page 48), and Section 4.4 (page 57), respectively. The findings and recommendations will be used by EPA, NOAA, and USCG to jointly develop an overall strategy for monitoring, research, and surveillance in the Middle Atlantic Bight. This strategy will be incorporated into a comprehensive research, monitoring, and surveillance plan for the 106-Mile Site.

1.1.3 Key Technical Issues

Prior to the workshop, numerous questions relevant to the four management questions were raised. These questions, plus monitoring and management concerns identified by the convening agencies, were complied into a series of brief statements and were included in the background document sent to the workshop participants. These issues are summarized in Appendix E. Workshop participants were able to add to and discuss additional issues.

2.0 SUMMARY OF WORKSHOP PRESENTATIONS

2.1 LEGISLATION AND MONITORING, RESEARCH, AND SURVEILLANCE RESPONSIBILITIES

The MPRSA, P.L. 92-532 as amended, is the primary legislative authority regulating ocean dumping at the 106-Mile Site. It is commonly referred to as the Ocean Dumping Act and is the domestic legislation implementing the London Dumping Convention. The MPRSA has been amended several times in the years since it was originally passed, most recently by ODBA. The provisions of the ODBA are discussed in Section 2.1.3.

2.1.1 The Marine Protection, Research, and Sanctuaries Act of 1972

EPA and the U.S. Army Corps of Engineers (USACE) administer the permit programs under the MPRSA. EPA issues disposal permits for all materials except dredged material. The USACE issues all dredged material disposal permits. Surveillance and enforcement of permit conditions is the joint responsibility of EPA and USCG. EPA designates disposal sites and is responsible for site monitoring and management. USCG is assigned responsibility for surveillance to ensure that operational aspects of the permit conditions are met. NOAA is responsible for research programs on long-range effects of pollution and anthropogenic changes to the marine environment. The major sections of the ocean dumping regulations that administer the MPRSA are summarized below.

40 CFR Part 227 Criteria for Evaluation of Permit Applications for Ocean Dumping of Materials

This part of the ocean dumping regulations develops criteria for determining acceptability of materials, evaluating environmental impact, determining materials that are prohibited as other than trace contaminants, and developing limits for disposal rates and quantities.

40 CFR Part 228 Criteria for Management of Disposal Sites for Ocean Dumping

This section of the ocean dumping regulations deals with the selection, designation, and management of ocean disposal sites. Three functions address management: (1) site designation, (2) permit terms, and (3) site monitoring. These functions consist of conducting disposal site evaluation and designation studies, and recommending modifications in site use and/or designation (site designation); regulating times, rates, and methods of disposal, and quantities and types of materials that can be disposed (permitting); and developing and maintaining effective monitoring programs for dumpsites (site monitoring). The three management functions are interdependent and are intended to prevent unreasonable degradation of the marine environment resulting from ocean disposal of wastes.

2.1.2 Other Relevant Legislation

EPA has additional legislative authorities that relate to the oceans, sewage sludge, and hazardous and toxic substances. These include:

Federal Water Pollution Control Act (Clean Water Act) Amendments of 1972, and Water Quality Act of 1987 (Amends Clean Water Act)

Section 104n: EPA has the responsibility to conduct and promote studies of pollution in the estuaries and estuarine zones of the United States.

Section 301h: EPA may allow variances from secondary treatment for sewage discharges into marine waters, if the applicant for a variance satisfactorily demonstrates that the discharge meets certain criteria intended to protect the water and ecosystem.

Section 311: EPA has the responsibility to define the quantity of oil that may be harmful if released into navigable waters of the United States (up to 200 miles offshore). EPA has the responsibility to require certain onshore or offshore facilities to prepare and implement a Spill Prevention, Control, and Countermeasures Plan to prevent the unauthorized, unpermitted release of oil into navigable waters of the United States.

Section 312: EPA has the responsibility to promulgate standards of performance for marine sanitation devices.

Section 320: Establishes the National Estuary Program.

Section 403: EPA has the responsibility to evaluate the impact of pollutants on marine ecosystems prior to issuing National Pollutant Discharge Elimination System (NPDES) permits. The evaluations include such factors as pollutant dispersal and persistence, presence of fish spawning or nursery areas, and ecosystem diversity, productivity, and stability.

Section 404: The Secretary of the Army has the responsibility for issuing permits for the discharge of dredged or fill material into the navigable waters of the United States. The EPA Administrator is authorized to prohibit the specification of any defined area as a disposal site whenever he determines that the disposal of material into the area will have an unacceptable adverse impact on municipal water supplies, shellfish beds and fishery areas, or recreational areas.

Toxic Substances Control Act (TSCA)– This Act requires the EPA Administrator to maintain a current list of chemicals in use in the United States and to review any new chemical substances to protect public and environmental health from the adverse effects of chemical exposure. Based on this review, EPA may prohibit or condition the manufacture, distribution, and use of such chemical substances that, as determined by the agency, pose an unacceptable risk to health and the environment.

Federal Food, Drug, and Cosmetic Act– The purpose of this Act is to ensure that food is safe, pure, and wholesome; that human and animal drugs, biological products, and therapeutic devices are safe and effective; and that radiological products do not result in unnecessary exposure of humans to radiation.

Resource Conservation and Recovery Act (RCRA)–This Act requires complete tracking of hazardous waste from its origin to disposal. An enforcement mechanism ensures compliance with record-keeping procedures and that disposal of hazardous waste is accomplished without contamination of the environment.

Clean Air Act– The 1970 Amendments of the Clean Air Act authorize EPA to set National Ambient Air Quality Standards (NAAQS) to achieve protection of public health. The States are required to design, seek EPA approval for, and enforce state implementation plans (SIPS) to ensure attainment of the NAAQS. These amendments also require EPA to set National Emissions Standards for new stationary sources. With the 1977 Amendments, sanctions and implementation strategies were introduced for areas of non-attainment of the NAAQS. Prevention of Significant Deterioration (PSD) was introduced for attainment areas as a means of controlling emissions.

NOAA also has additional research responsibilities to protect the nation's oceans. Legislation that defines these responsibilities includes the following:

The National Ocean Pollution Planning Act of 1978–This Act assigns NOAA responsibility for establishing a coordinated program for ocean pollution research, development, and monitoring, and for preparing, every three years, a coordinated five-year Federal marine pollution, research, and monitoring plan. The plan, which includes identification of and recommendations for meeting research needs, is prepared by NOAA with the assistance of an interagency committee.

The Fish and Wildlife Act–This Act requires NOAA to manage, conserve, and protect fishery resources.

The Fish and Wildlife Coordination Act–This Act requires NOAA to conserve and enhance fish and wildlife and their habitats, and to investigate effects of pollutants on living resources.

The Magnuson Fishery Conservation and Management Act, as amended–This Act requires NOAA to conduct a comprehensive program of fishery research to determine impacts of pollution on marine resources and effects of habitat degradation on abundance and availability of fish.

The Marine Mammal Protection Act and Endangered Species Act–Under these Acts NOAA's stewardship responsibilities are extended to all living marine resources, and include designating and protecting their critical habitats.

2.1.3 Ocean Dumping Ban Act

During November 1988, the MPRSA was amended to require an end to ocean dumping of sewage sludge and industrial waste by December 31, 1991. The key provisions of ODBA include the following:

- No new dumpers of sewage sludge or industrial waste.
- No dumping of sewage sludge or industrial waste without a permit and compliance or enforcement agreement.
- Dumping fees imposed starting 270 days from enactment of the Act and continuing until December 1991.
- Financial penalties imposed for dumping after 1991.

Under ODBA sewage sludge dumping must be conducted under permits. Permits will authorize municipalities to dump sewage sludge in the ocean under specific dumping conditions that specify quantity of sewage sludge dumped, dilution and dumping rates, location of dumping and surveillance and monitoring activities. Consent decrees contain the municipal dumper's plans and schedules for implementing sludge disposal alternatives to ocean dumping. Compliance and enforcement agreements will also specify the financial and accounting arrangements for the municipal dumper's payment of fees. Every municipality that disposes of sludge by ocean dumping must pay a special fee, which will increase over time, for every dry ton of sewage sludge that is dumped into the ocean. The fees will be used as financial assurance that an alternative to ocean dumping is provided within a reasonable time period. EPA, NOAA, and USCG will each receive five dollars per dry ton from the fees paid to support monitoring, research, and surveillance activities. Part of the fees must be paid into a trust account, established by the dumper, set aside to hold the funds until needed to pay for development of an alternative waste management system. Other parts of the fees must be paid to EPA, to a State Clean Oceans Fund, and to a State's Water Pollution Control Revolving Loan Program. If the State has not created a Clean Oceans Fund or a Water Pollution Revolving Fund, that portion of the fees will be paid to EPA, to be held in escrow for up to one year. The fees may then either be paid to the State or placed in the U.S. Treasury. Fee payments are to be distributed by the EPA.

2.2. SURVEILLANCE OF DISPOSAL OPERATIONS

The Ocean Dumping Surveillance System (ODSS) is currently used to track disposal operations at the 106-Mile Site. Sixteen barges have been equipped with the ODSS. Only these barges are permitted to carry sludge to the 106-Mile Site. The ODSS allows tracking the position of the barge, and determination of the rate of sludge disposal (through pressure sensors located on each barge, and information on barge configuration and capacity). The ODSS design uses off-the-shelf components whenever feasible and has a design specification of 95 percent accuracy. This specification is judged sufficient to eliminate the need for ship riders. Data from the ODSS is transmitted via radio to a shorebased relay station located at the USCG Electronics Shop Group, Sandy Hook, NJ. From the relay station the data is transmitted to the USCG NY Operations Center, Governors Island, NY. USCG submits ODSS data to the EPA for review and regulatory actions.

Because the radio transmissions are line-of-site, USCG remains in direct contact with the barges for only two-thirds of the distance to the 106-Mile Site. Data from beyond the transmission range is stored onboard the ODSS. Once the barge returns to the communication range of the system, the stored data are sent to the base station. Present plans entail examining the possibility of using GEOSTAR to achieve continuous contact with the barges.

Operationally, ODSS data are available from approximately 50 percent of the barges going to the 106-Mile Site. Operational status of the ODSS is not known to the barge operators at any time. The data availability goal for the ODSS is 80 percent coverage of all barge transits to the 106-Mile Site. Because of recent concerns about sludge transfers from feeder barges to the ODSS-equipped barges within local harbors, EPA is installing seals on all valves on each barge and is instituting a sludge manifest system to track all sludge movement between the loading point and the 106-Mile Site.

2.3 HISTORICAL INFORMATION

2.3.1 106-Mile Site History and Related Issues

The area originally known as the 106-Mile Site was bounded by 38°40'00" to 39°00'00" north latitude and 72°00'00" to 72°30'00" west longitude. Approximately 500 square nautical miles in size, it was used from 1961 to 1963 as a site for disposal of chemical wastes. In 1965 the site was proposed by the U.S. Fish and Wildlife Service as an alternative to inland disposal, which might result in contamination of drinking water supplies. From 1961 to 1978, approximately 5.1 million metric tons of liquid chemical wastes, 102,000 metric tons of municipal sludge, and 287,000 metric tons of municipal sludge digester cleanout residue were disposed of at the site.

When ocean dumping came under EPA regulation in 1973, 66 permittees were dumping wastes at the site. By 1979, this number had decreased to four. During the same period, the amount of waste increased from 341,000 metric tons in 1973 to 797,000 metric tons in 1978.

From 1973 to 1978, approximately 287,000 metric tons of digester cleanout residues from the New York/New Jersey metropolitan area were dumped at the site. Municipal sludge disposal at the site was limited during this period. Between 1978 and 1979, only the city of Camden used the site for municipal sludge disposal.

In 1982, EPA published its intention to formally designate the site formally for disposal of industrial wastes and municipal sludge (47 FR 56663), and the site was proposed to receive sewage sludge for 5 years, pending environmental studies. However, concern that mixed dumping of industrial and municipal wastes would complicate monitoring efforts led to a decision by EPA to designate two smaller sites within the larger one. On May 4, 1984, the Deepwater Municipal Sludge Site (Figure 1) was designated (49 FR 19005). It is approximately 100 square nautical miles, with boundaries at 38°40'00" to 39°00'00" north latitude and 72°00'00" to 72°05'00" west longitude. The second site, designated on May 4, 1984, was to receive aqueous industrial wastes. This site has not been used since 1987 and is not further discussed in this document.

Designation of the Deepwater Municipal Sludge Site was linked to EPA's decision to end municipal sludge disposal at the 12-Mile Site, located within the New York Bight Apex. That site had been used for sludge disposal since 1924. It was given an interim designation for sludge disposal in 1973 and was formally approved for use in 1979. The interim designation of the 12-Mile Site expired in 1981. However, in accordance with a 1981 court order, the Site continued to be used pending an EPA decision on redesignation of the Site (City of New York v. EPA, 543 Supp. 1084).

EPA announced its intention to deny petitions to redesignate the 12-Mile Site concurrent with the formal designation of the 106-Mile Site for disposal of municipal sludge. The final decision to deny these petitions was published in 1985 (50 FR 14336). This action ended the court order allowing use of the 12-Mile Site and shifted disposal operations to the 106-Mile Site. All sewerage authorities using the 12-Mile Site at the time it was closed were allowed to shift operations to the 106-Mile Site.

Under the court order, EPA and the sewerage authorities involved negotiated a schedule to phase in operations at the 106-Mile Site. The phase-in was initiated on March 17, 1986, and completed on December 15, 1987. The nine sewerage authorities are

- Westchester County Department of Environmental Studies, New York
- Bergen County Utilities Authority, New Jersey

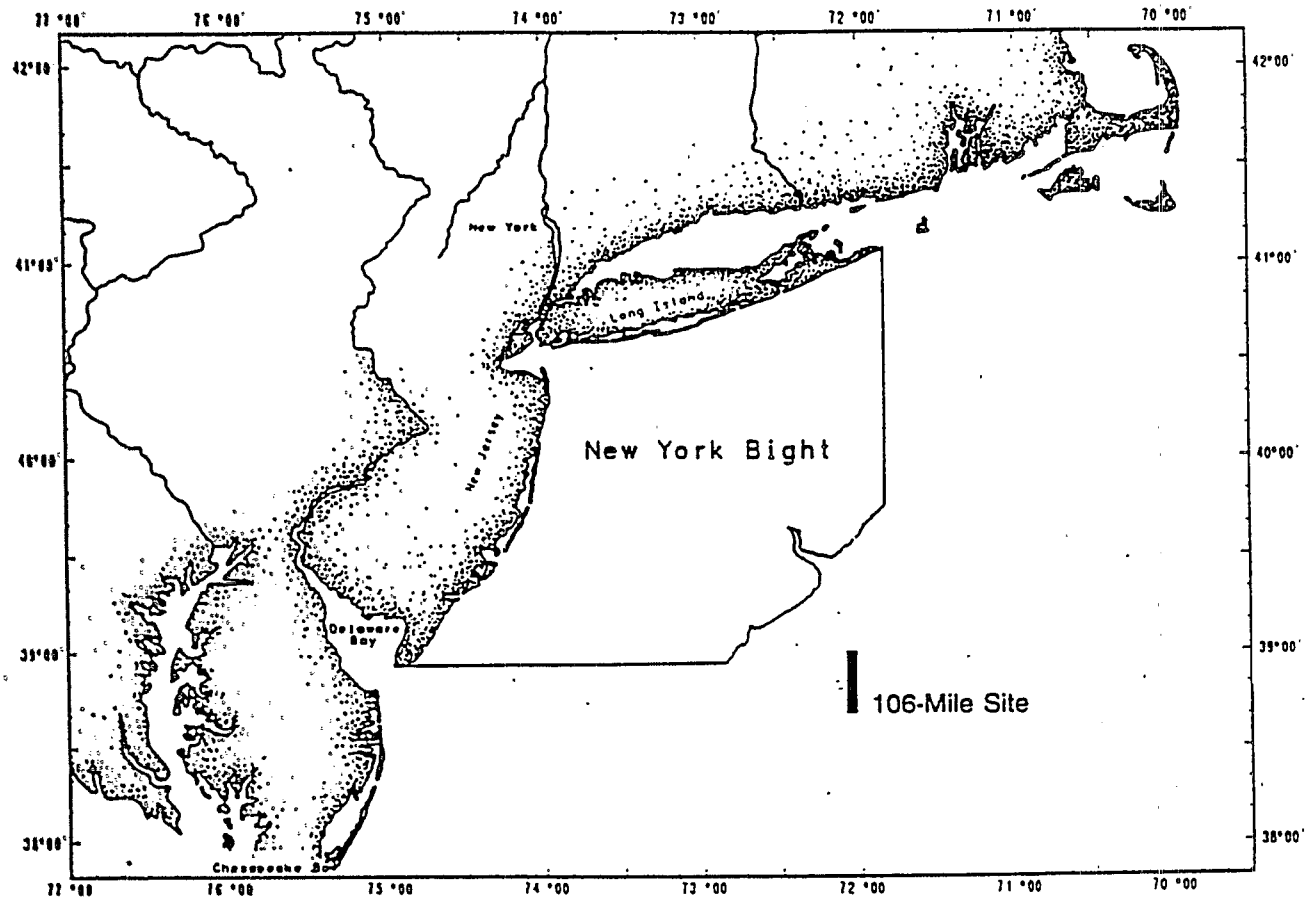

FIGURE 1. MIDDLE ATLANTIC BIGHT AREA SHOWING THE LOCATION OF THE 106-MILE SITE

- Joint Meeting of Essex and Union County, New Jersey
- Linden-Roselle Sewerage Authority, New Jersey
- Rahway Valley Sewerage Authority, New Jersey
- Middlesex County Utilities Authority, New Jersey
- Passaic Valley Sewerage Authority, New Jersey
- Nassau County Department of Public Works, New York
- New York City Department of Environmental Protection, New York.

It is now estimated that 8 million wet tons of sewage sludge are dumped at the 106-Mile Site annually.

2.3.2 Overview of Physical and Chemical Oceanography Related to the 106-Mile Site

The 106-Mile Site and areas of potential impact have been studied during several recent programs (Table 3). The results of studies conducted through 1983 are summarized in Pearce et al. (1983). More recently, a summary of results from studies conducted in the vicinity of the 106-Mile Site has been compiled for EPA (Battelle, 1988b). The literature cited in these reports may be referenced for detailed discussions of the results from these studies.

The 106-Mile Site is located in a dispersive environment. Evidence from studies of acid iron waste disposal at the 106-Mile Site illustrates that dilution may be affected by the seasonal pycnocline and that once the rapid mixing caused by barge momentum stops, additional dilution resulting from oceanic processes is slow. Furthermore, the evidence from the acid iron waste studies indicated while long-term transport may be to the southwest, individual plumes will be transported from the site in all directions. Relative to the farfield distributions of the sludge, simple model calculations indicate that dilutions on the order of >500,000:1 will occur in the farfield. Because of this dilution, the sludge signal cannot be easily detected against the background concentrations in the surface waters of the ocean. Therefore, monitoring programs designed to detect the sludge in the farfield must focus on gradients emanating from the site and must use parameters that are characteristic of the sludges, if the sludge is to be successfully detected in the farfield. Calculations suggest that the flux of sludge to the sediments may be detected using sediment traps, if the rate of sludge settling is relatively high. However, the flux of contaminants to the sediments from the sludge disposal may be less than the background flux. The complexity of the ocean dynamics at the 106-Mile Site and many of the difficulties encountered in evaluating the fate of sludge disposed at the 106-Mile Site were highlighted during this presentation.

2.3.3 Overview of Living Marine Resources in the Middle Atlantic Bight

Information on living marine resources available through 1980 in the area potentially affected by the disposal of sewage sludge at the 106-Mile Site is summarized in Pearce et al. (1983). This report includes results from two NOAA programs, Marine Resources Monitoring Assessment and Prediction (MARMAP) and Northeast Monitoring Program (NEMP). The report includes information on nutrient distributions, dissolved oxygen concentrations, phytoplankton biomass and community structure,

TABLE 3. BACKGROUND SUMMARY OF STUDIES CONDUCTED IN THE VICINITY OF THE 106-MILE SITE.

Study	Sponsor	Prime Contractor	Study Dates
Mid-Atlantic Slope and Rise Physical Oceanography Study (MASAR)	DOI[a], MMS[b]	SAIC[c]	9/83-9/86
Shelf Edge Exchange Processes Program (SEEP)	DOE[d]	BNL[e], L-DGO[f]	1982-1992
Study of Biological Processes on the U.S. Mid-Atlantic Slope and Rise	DOI, MMS	Battelle	3/84-7/86
Analysis of Trace Metals in Bottom Sediments on the U.S. Mid-Atlantic Slope and Rise	DOI, MMS	USGS[g]	3/84-7/86
Study of Biological Processes on the U.S. North Atlantic Slope and Rise	DOI, MMS	Battelle	11/84-4/87
Analysis of Trace Metals in Bottom Sediments on the U.S. North Atlantic Slope and Rise	DOI, MMS	USGS	11/84-4/87
Four Studies of Baseline Conditions at the 106-Mile Site	EPA[h]	JRB[i] Battelle Battelle Battelle	7-8/84 8/85 2/86 8-9/86
Study of Baseline Conditions at the North Atlantic Incineration Site	EPA	Battelle	11/85

TABLE 3. Continued

Study	Sponsor	Prime Contractor	Study Dates
Current Meter Measurements at the 106-Mile Site in Support of Municipal Waste Disposal	EPA	Battelle, SAIC	9/86-4/87
Analysis of Circulation Characteristics in the Vicinity of Deepwater Dumpsite 106	NOAA[j]	EG&G	1968-1981
Warm-Core Ring Program	NFS	Various	1981-1982

[a]DOI = Department of Interior

[b]MMS = Minerals Management Service

[c]SAIC = Science Applications International Corporation

[d]DOE = Department of Energy

[e]BNL = Battelle Northwest Laboratories

[f]L-DGO = Lamont-Dougherty Geological Observatory

[g]USGS = United States Geological Survey

[h]EPA = Environmental Protection Agency

[i]JRB = JRB Associates

[j]NOAA = National Oceanic and Atmospheric Administration

zooplankton standing stock and species, fish eggs and larva, benthic fauna, fisheries stocks, marine mammals, and birds.

Few data are available from regions seaward of the shelf slope break. The majority of results discussed in Pearce et. al. (1983) is limited to areas landward of the shelf slope break. Thus, information on living marine resources from the immediate vicinity of the 106-Mile Site is limited, especially for commercially important species.

Commercially important species are not typically fished within the boundaries of the 106-Mile Site and the domestic fisheries do not normally extend beyond the shelf break. Fisheries of importance in the Middle Atlantic Bight include the yellow-tail flounder, red hake, Atlantic mackerel, spiny dogfish, tilefish, and shellfish (lobsters and red crab). Other species that may be found in the area include the loggerhead turtle and bottlenose dolphin. Landing statistics show a downward trend that predates the sludge disposal activities at the 106-Mile Site, for yellowfin, silver hake, and haddock. During this plenary presentation, data were presented that showed temporal variations in abundance of commercial stocks and variability in yearly landings, the cause of which is not known. Studies in the vicinity of the 106-Mile Site during the summer of 1989 include conduct of a midwater trawl reconnaissance survey in June 1989 to assess the feasibility of a myctophid sample collection program for determination of contaminant levels in these fish.

2.4 PERSPECTIVES OF OCEAN DUMPING, FISHING INDUSTRY, AND ENVIRONMENTAL GROUPS

Representatives from the recreational and commercial fisheries and from environmental groups were asked to present their perspectives on the ocean dumping of sewage sludge at the 106-Mile Site. Summaries of these presentations are provided below.

2.4.1 Commercial and Recreational Fisheries

In general, the fishing industry views ocean dumping as a threat to their livelihood. The threat stems from consumer perception that the quality of fish from the Middle Atlantic Bight is being degraded by ocean disposal of the sludge. These perceptions have negative economic impacts on the fisheries industry through reduced prices and sales volumes.

The major concerns of the fishing industry are the fate of the sludge in the ocean and adherence to regulations requiring disposal of sludge within the 106-Mile Site. A fishing industry representative stated "that the sludge must go somewhere in the ocean." That sludge transport vectors and fate are not known with confidence has increased the concern of the fishing industry relative to the impact of the sludge. This uncertainty contributes to the fishing industry's belief that sewage sludge disposal is bad for the ocean and not beneficial to the fishing industry.

2.4.2 Environmental Groups

Environmental groups are concerned over the use of monitoring data, contaminant accumulation in biological communities, parameters that should be included in the monitoring program, and permit conditions. These groups recognize the need for active use of monitoring data to manage the disposal operations and to modify government policies regarding the disposal of the sludge. Environmental groups do not want the monitoring data used only to document changes in the system. They believe that the environment at the 106-Mile Site is already stressed and therefore any

incremental changes in the system that may result from sludge disposal could lead to significant environmental impacts. Concern about the lack of pre-disposal baseline data for the ecosystem and marine resources was expressed.

Environmental groups suggest that additional biological measures be added to the monitoring plan so that changes at and near the 106-Mile Site can be documented. Suggested additional parameters include species diversity in the zooplankton and benthos, fish species, measures of reproduction, and concentrations of contaminants in tissues.

Regarding the permits for disposal of sludge at the 106-Mile Site, environmental groups recommend that the permits be creative to allow active regulation of the sludge disposal both with respect to dumping rates and loading at the disposal site. Creative options presented include (1) suspension or cancellation of dumping if significant effects are detected and (2) linking conditions for disposal to requirements for reducing toxic compounds in the sludge.

2.5 RECENT MONITORING RESULTS

The MPRSA and ocean dumping regulations require assessments of the effects of disposal of wastes at sea on public health and the marine environment before disposal sites can be selected, before permits to use the site are issued, and while a designated site is in use. Each of these management activities–site designation, permitting, and monitoring–are designed to ensure that unacceptable impacts do not result from disposal of wastes at sea. Monitoring programs conducted under the MPRSA and the ocean dumping regulations are designed (1) to verify compliance with conditions set to restrict disposal activities, and (2) to verify that compliance with permit conditions does in fact protect the environment. Beginning in late 1985, EPA began designing a monitoring program to meet these objectives for the 106-Mile Site. A brief description of the draft plan completed in March 1988 is provided below.

2.5.1 Overview of the EPA 106-Mile Site Monitoring Program

2.5.1.1 Development of the Monitoring Plan

EPA has developed a monitoring plan (Battelle, 1988b) and an implementation plan (Battelle, 1988c) as part of its monitoring program for the 106-Mile Site. Information on site and waste characteristics provide the framework for monitoring of the site. Development of the monitoring plan benefited from information on the physical, chemical, and biological conditions in the vicinity of the site available through the site designation process and additional baseline monitoring conducted by EPA and other Federal agencies (NOAA, 1977; Pearce, et al., 1983; EPA, 1980; Battelle, 1988a, 1988e). Because potential users of the site had previously disposed of sludge at the 12-Mile Site, information about the sludge to be disposed is also available (e.g., Santoro and Suszcowski, 1986). This information, plus more recent site characterization data, are being used to set permit conditions and to predict whether adverse impacts are likely to result from sludge disposal at the site.

The ocean dumping regulations define several specific areas of potential impact that must be addressed in any monitoring plan developed for ocean disposal sites. These include

- Impingement of sludge upon shorelines.
- Movement of sludge into marine sanctuaries or fishery areas.

- Accumulation of sludge components in marine organisms.
- Progressive changes in water quality related to sludge disposal.
- Progressive changes in sediment composition related to sludge disposal.
- Impacts on pollution-sensitive species or life-cycle stages as a result of sludge disposal.
- Impacts on endangered species as a result of sludge disposal.
- Progressive changes in biological communities as a result of sludge disposal.

In addition, the ocean dumping regulations require that permit conditions ensure that marine water quality criteria and toxicity-based limiting permissible concentrations are not exceeded in the site within 4 hours of disposal or outside the site at any time. These regulatory requirements were used to develop a series of predictions of potential impacts relative to the disposal of sludge at the 106-Mile Site (Figure 2). These predictions formed the basis for developing specific questions relating to compliance and impact assessment. After identifying specific questions, testable null hypotheses relating to compliance, fate, and effects of sewage sludge disposal at the 106-Mile Site were developed. The hypotheses were organized into logical categories or monitoring tiers. For the 106-Mile Site monitoring program, the null hypotheses were grouped into the following hierarchy of four tiers (Figure 3).

Tier 1--Sludge Characteristics and Disposal Operations

Tier 2--Nearfield Fate and Short-Term Effects

Tier 3--Farfield Fate

Tier 4--Long-Term Effects

The arrangement of monitoring tiers and hypotheses are used to direct the level of monitoring activity that is conducted. Within each tier, explicit objectives and endpoints guide the selection of monitoring activities. Data collected within each of the hierarchy of tiers form the foundation for the design and conduct of activities to be implemented in the next tier. The tier monitoring approach is not a decision-tier system that requires a pass-fail determination for conducting additional work under higher monitoring tiers. Although monitoring activities are generally implemented in a stepwise manner, testing of hypotheses in more than one tier may proceed concurrently, if required to address important questions. This approach ensures that necessary information for making decisions about continued monitoring or about site designation or permitting is gathered (Zeller and Wastler, 1986).

2.5.1.2 Use of Monitoring Results

Results from the 106-Mile Site monitoring program are intended to help EPA make decisions about issuing permits for site designation and continued monitoring. Because sludge disposal at the site began under court order, in advance of issuing permits, monitoring results are being used to set as well as to modify permit conditions. Information from Tier 1, Waste Characteristics and Disposal Operations, and Tier 2, Nearfield Fate and Short-Term Characteristics, is being used to revise and set

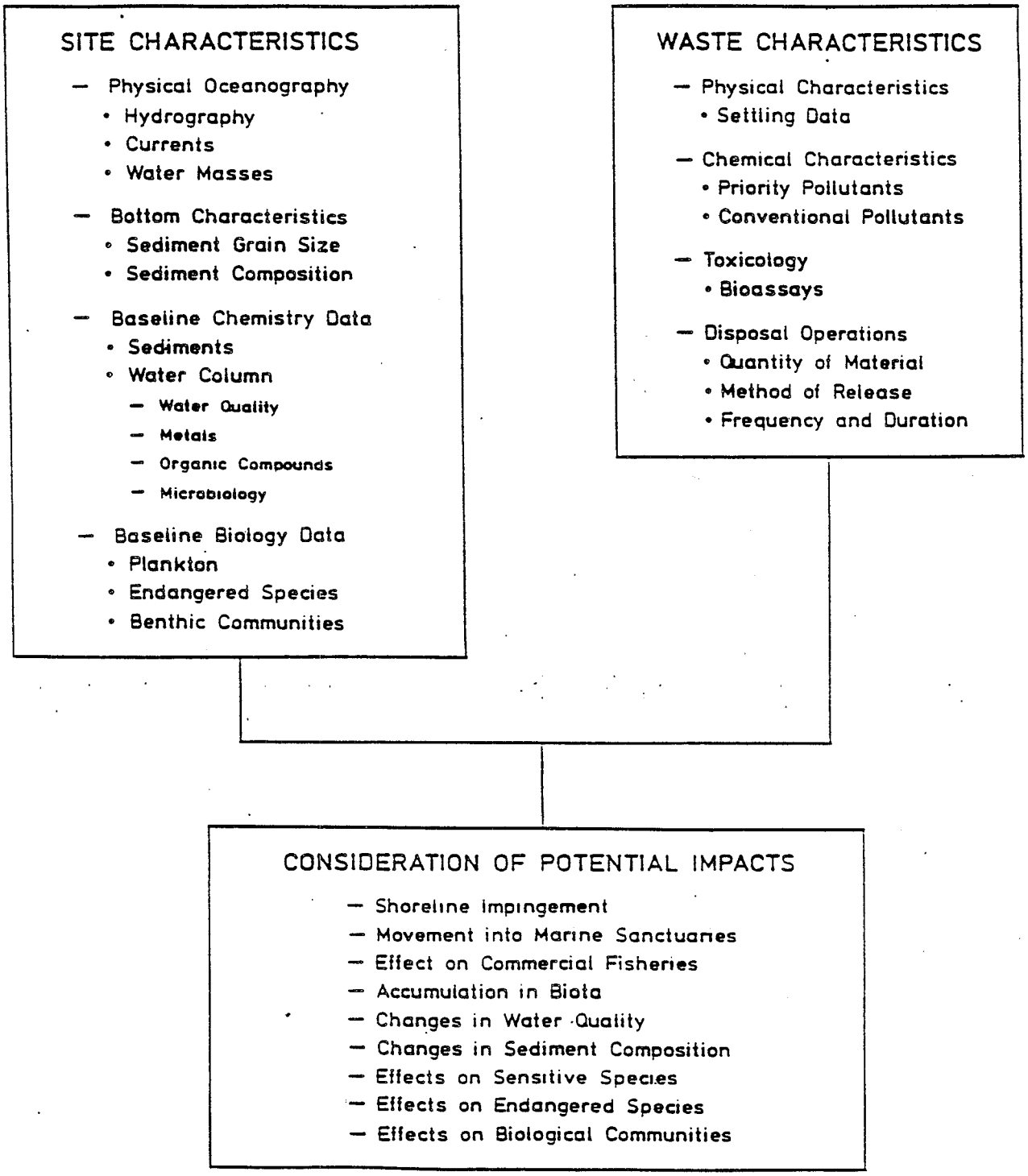

FIGURE 2. INFORMATION ON CHARACTERISTICS OF THE SITE AND OF THE SLUDGES WILL BE USED TO PREDICT POTENTIAL IMPACTS OF SLUDGE DISPOSAL AT THE SITE

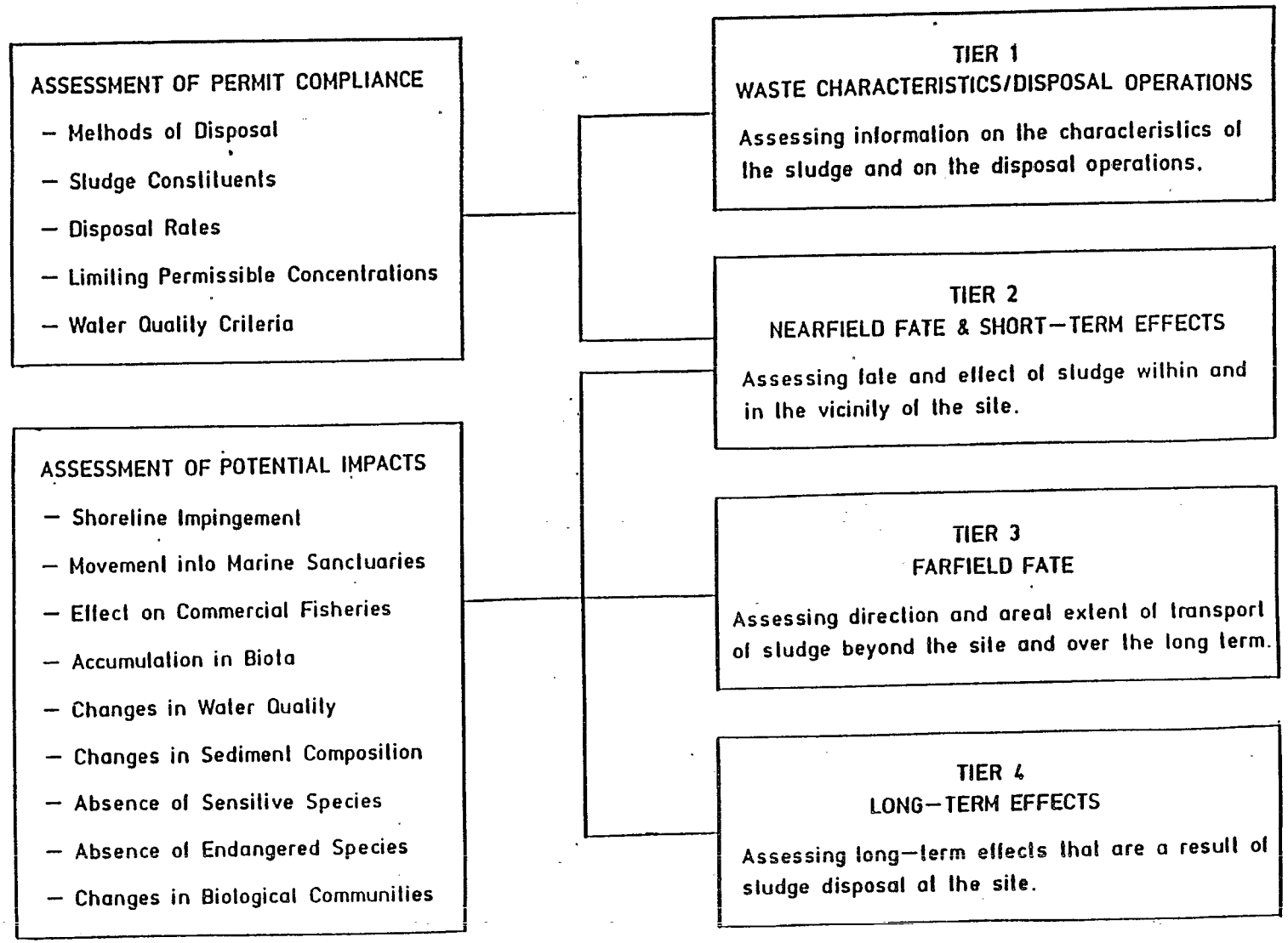

FIGURE 3. MONITORING TIERS ADDRESS PERMIT COMPLIANCE AND IMPACT ASSESSMENT

allowable dumping rates. Ongoing collection of information on waste characteristics will be used to update allowable dumping rates on a quarterly basis.

As monitoring results are generated, they become part of the body of information used to make site management decisions. Information on short-term effects from Tier 2 studies are used for determining whether adverse effects do result from sludge disposal at the site. Information from Tier 3 on the farfield transport and fate of sludge constituents allows estimation of the transport direction and areal distribution of sludge constituents. Conclusive information on long-term effects of sludge disposal may not be complete by 1991. Impacts that occur shoreward from the site will be difficult to separate from other pollutant inputs in this region of the ocean; impacts seaward of the continental shelf may prove difficult to measure. However, sufficient information will be available to support the site management decisions and to refine impact predictions made within the monitoring plan.

Monitoring results will also support decisions concerning continuation, modification, or termination of the monitoring program. Because of public concern, escalating importance of commercial interests, and expanding regional issues, modification of the 106-Mile Site monitoring program to include the interests of these groups is likely. Decisions regarding the direction, extent, and duration of the 106-Mile Site monitoring program will need to be assessed on a continuing basis.

2.5.2 Recent Results of the Monitoring Program

A number of reports discussing the results of the EPA monitoring program for the 106-Mile Site have been completed (Table 4). Summary discussions of the monitoring results were included in the 106-Mile Site Workshop background materials (Battelle, 1989a). A synopsis of the results, as they relate to monitoring, research, and surveillance for sewage sludge at the 106-Mile Site, is presented in the discussion of the four management questions addressed by the workshop.

TABLE 4. SUMMARY OF REPORTS OF MONITORING STUDIES CONDUCTED UNDER THE EPA 106-MILE SITE MONITORING PROGRAM.

Battelle. 1988a. Final Report of Analytical Results of the 106-Mile Deepwater Sludge Dumpsite Survey-Summer 1986. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 1-31.

Battelle. 1988b. Final Report for Nearfield Monitoring of Sludge Plumes at the 106-Mile Deepwater Municipal Sludge Site: Results of a Survey Conducted August 31 through September 5, 1987. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 1-63.

Battelle. 1988c. Site Condition Report of Nearfield Fate Monitoring at the 106-Mile Deepwater Municipal Sludge Site: Winter 1988 Oceanographic Survey March 1-5, 1988. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 1-105.

Battelle. 1988d. Final Report of 106-Mile Deepwater Dumpsite Winter 1988 Survey. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 2-105.

Battelle. 1988e. Initial Survey Report of the Summer 1988 Oceanographic Survey to the 106-Mile Site September 10 to 20, 1988. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 1-118.

Battelle. 1988f. Final Survey Report of the Nearfield Fate Monitoring at the 106-Mile Deepwater Municipal Sludge Site: Winter 1988 Oceanographic Survey March 1 - March 5, 1988. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 1-105.

Battelle. 1987a. Analysis of Baseline Seawater and Sediment Samples from the 106-Mile Deepwater Municipal Sludge Site. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 21.

Battelle. 1987b. Evaluation of and Recommendations for Bioaccumulation Studies for the 106-Mile Deepwater Municipal Sludge Monitoring Program. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 47.

Battelle. 1987c. Strategy for Plume Tracking Methods at the 106-Mile Site. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 63.

TABLE 4. Continued

Battelle. 1987d. Analytical Procedures in Support of the 106-Mile Deepwater Municipal Sludge Site Monitoring Program. A quality assurance plan submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 21.

Battelle. 1987e. Final Report on Analytical Results of Samples Collected During the 1985 North Atlantic Incineration Site (NAIS) Survey. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 5.

Battelle. 1987f. Site Condition Report for Plume Tracking Survey for the 106-Mile Deepwater Municipal Sludge Site Monitoring Program in Support of the EPA 106-Mile Site Monitoring Program. August 29 - September 5, 1987. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 1-63.

Battelle. 1987g. Initial Survey Report for Plume Tracking Survey for the 106-Mile Deepwater Municipal Sludge Site in Support of the EPA 106-Mile Site Monitoring Program August 29-September 5, 1987. A report submitted to the U.S. Environmental Protection Agency under Contract No. 68-03-3319. Work Assignment 63.

3.0 DISCUSSION OF THE MANAGEMENT QUESTIONS

3.1 QUESTION 1: WHAT IS THE PHYSICAL AND CHEMICAL FATE OF THE SEWAGE SLUDGE DUMPED AT THE 106-MILE SITE?

Question 1 was concerned with the fate of the sludges disposed of at the 106-Mile Site. Background material for this question that was provided to the participants included information on sludge composition and characteristics, short-term behavior after disposal (0-24 hours), compliance with ocean dumping regulations, farfield fate, and sludge transport models.

3.1.1 Sludge Composition and Characteristics

Sludge characteristics data are reported to EPA quarterly by the municipal authorities. For most parameters, the characteristics are reported for whole sludge. Concentrations of selected parameters are reported for the liquid (dissolved) phase as it is defined in the regulations. Reporting requirements include concentrations of general sludge characteristics such as settleable solids, total solids, pH, ammonia, selected metals and organic compounds, and toxicity to representative marine organisms. State environmental protection agencies also require sewerage authorities to submit sludge characteristics data. Reporting requirements differ between the state and Federal agencies. Some results of sludge analysis are summarized below.

Summary of Results

- Conventional parameters, e.g., nutrients, solids content, pH

  Settleable solids as defined in the ocean dumping regulations are not present. This definition does not preclude the possibility of settling of the sludge particles in the ocean after disposal.

  Total suspended solids content varies with treatment process.

  Total suspended solids content varies with plant operations.

  Total solids concentrations range from 2 to 10 percent.

  Over time, the solids content of the sludge within a plant ranges over a factor of 2 to 5. An independent analysis conducted by EPA in August 1988 (Battelle, 1988f) found solids concentrations are within a factor of 2 to 5 of those reported to EPA by the municipal authorities.

- Metals

  Concentrations of metals depend on the industrial and domestic mix in the community served by the sewerage authority.

  Variability in metal concentrations across treatment plants is large.

  Within-plant variability is within a factor of 3 or less over an annual cycle.

Independent analysis conducted by EPA confirmed metal concentrations are within a factor of 2 to 5 of those reported to EPA.

More than 95 percent of the metals in the sewage sludge is associated with particles.

Partitioning of metals to the dissolved phase may occur after disposal.

- Organic compounds

  PCB concentrations in sludges are generally less than 25 ppb.

  Pesticide concentrations in sludges are generally less than 250 ppb.

  PCB and pesticide concentrations in the water column are at least 5 times less than marine chronic water quality criteria 4 hours after disposal.

The work groups concluded that composite sludge samples collected at the inlet of the feeder pipe to the barges will be representative of the sludge composition. However, participants felt that more extensive information is needed on the chemical and physical properties of sludge particles and on the behavior of pathogens in the sludge. Participants also felt that analytical procedures used for sludge analysis should be standardized to eliminate data variability and to enhance comparability among sewage treatment facilities. The independent sludge analyses conducted by EPA (Battelle, 1988f) were judged to be adequate confirmation of sludge composition.

Workshop participants also expressed a need for identification of a reliable tracer specific to the sludge dumped at the 106-Mile Site. Such tracers as tomato seeds or other large particles, while relatively unique to the sludge in the 106-Mile Site environs, may not effectively track the fate of sludge which has been shown to settle slowly at the 106-Mile Site. On the other hand, chemical tracers of sludge such as coprostanol may be difficult to accurately separate from background concentrations present in the receiving waters. Other sources of contamination (e.g., the Hudson-Raritan estuary, ocean-going vessels, other dumpsites on the continental shelf, and atmospheric inputs) contribute to pollution loading to the Middle Atlantic Bight. The participants, therefore, agreed that tracing the specific source of any contaminant in the region may be difficult.

3.1.2 Short-Term Behavior

For convenience, short-term has been defined as the 24-h time period after the initiation of disposal operations. Behavior of sludge in this time period involves initial dilution, settling, and usually movement beyond the disposal site boundary. The following summary results reflect data collected during EPA monitoring surveys conducted in 1987 and 1988:

- Initial dilution (at 15,500 gal/min)

  Dilution is 1000- to 2000-fold immediately in the wake of the barge.

  Dilution of sludge parcels during weak mixing conditions is as low as 4000:1 4 hours after disposal.

  Plume-averaged dilutions (based on plume dimensions and transmissometry data) exceed dilutions within parcels of seawater by 1 to 2 orders of magnitude 4 hours after dumping.

- Variations in dilution due to barge type, sludge characteristics, dumping method, and oceanographic conditions are not yet completely understood.

- Settling

  Laboratory studies suggest the bulk of the sludge particles will settle slowly (1 to 2 m per day); a small, unknown fraction of large particles may settle at ≈ 50 m per day.

  Field observations of sludge particle settling support laboratory findings of slow setting rates (<10 m/day).

  Field studies at the 106-Mile Site have not detected two particulate phases observed in laboratory studies.

  Settling below the pycnocline has not been detected in the nearfield within 8 h following dumping.

  Seasonal differences in sludge settling are not evident.

  Sludge settling rate depends on the dumping rate (e.g., flocculation).

  Freshwater content of sludge (90-95 percent) sometimes causes plumes to rise after discharge.

- Transport out of the site

  Near-surface currents have been observed to be highly variable in speed and direction.

  Plumes have been observed leaving the site in less than 4 h.

Workshop discussions provided the following insight concerning the short-term behavior of sludge:

Although field measurements at the 106-Mile Site indicate that in the near term, sludge particulates are confined to the mixed layer above the pycnocline, reports at the previously used 12-Mile Site suggest movement of the sludge to depths greater than 20 meters in short time periods.

Short-term nearfield current measurements plus broad-scale circulation patterns near the 106-Mile Site indicate that sludge disposed of at the site will be dispersed into the farfield even under calm conditions. Storms and other large-scale events occurring at the site may increase the dispersion. In either case, the dispersion will act to dilute sludge concentrations after disposal.

Advection events would rapidly displace a sludge plume, but may not increase the short-term mixing.

Certain physical features (e.g., pycnocline, fronts) of the water column at the 106-Mile Site tend to collect particulates.

Participants also questioned how interactions of sludge particles with seawater and biota in the area would affect settling and dispersal of the sludge.

3.1.3 Compliance with Ocean Dumping Regulations (at 15,500 gal/min)

Compliance with the ocean dumping regulations includes conduct of disposal operations within permit conditions and meeting the limiting permissible concentrations and water quality criteria after the 4-h initial mixing period.

Information available to the workshop participants included

- Chronic marine water quality criteria (WQC) and toxicity-based limiting permissible concentrations

  Rapid transport from the site can cause WQC to be exceeded at the site boundary.

  WQC can be exceeded after the 4-h initial mixing period.

  Copper and lead are the most likely toxic compounds to exceed WQC.

  Mercury concentrations can be within a factor of 2 to 3 of WQC 4 h after dumping.

  Some contaminants have been observed above background levels in the surface waters and at the pycnocline in the site.

  Dissolved oxygen and pH reductions in the sewage plumes are minimal and not biologically significant during the initial mixing period.

- Disposal operations

  Apparent short dumping (i.e., dumping outside the site) has been detected on two occasions during survey operations in the area.

  The ODSS is installed on 16 barges.

It was noted at the workshop that copper and lead are frequently associated with drinking water distribution systems. It was also pointed out that copper levels from this source may be controlled through pH adjustments in drinking water supplies. Further consideration of compliance with the ocean dumping regulations can be found in Section 3.4.

3.1.4 Farfield Fate

Farfield fate involves transport and fate of sludge more than 24 h after disposal and beyond the site boundary. Assessment of fate involves determination of both vertical and horizontal movement of the sludges. Movement of water masses and currents, and the density structure of the water column are considered. Results presented to the workshop participants included the following:

- Horizontal transport

  Although monthly or yearly averaged currents are toward the southwest, individual sludge plumes may be transported in any direction.

After dumping, sludge may recirculate through the site for days to months.

Slopewater intrusions can influence the transport of sludge.

Warm-core eddies may cause sludge to be transported toward the continental shelf; however, the volume of water involved in such movements is not well understood.

- Vertical transport

  Sludge settling rates are slow.

  Vertical transport is dominated by dispersive processes and hindered by the pycnocline.

- Ongoing activities

  A current-meter mooring was deployed at the 106-Mile Site on January 23, 1989 and is now acquiring real-time data on surface (30 m) currents.

  A near-surface satellite drifter program will be initiated by EPA in the summer of 1989 to collect farfield trajectory information. Continuation of this activity is proposed as a monitoring responsibility for those permitted to dispose sludge at the 106-Mile Site.

Work group discussions provided the following insight concerning the farfield movement of sludge. Some of this information results from preliminary interpretation of the four satellite-tracked drifters deployed at the 106-Mile Site in September 1988. Other information comes from ongoing programs conducted under NOAA funding.

- Deployment of four near-surface drifters has indicated a possible water flow from the 106-Mile Site toward the shelf break front (i.e., a possible convergence zone).

- One of the surface drifters looped back toward the continental shelf after reaching the Gulf Stream. This may indicate a large-scale gyre between the Gulf Stream and shelf waters.

- Observations from satellites and from the field have been coupled successfully with interactive modeling to predict the location and behavior of the Gulf Stream. The Navy GEOSAT satellite passes directly over the 106-Mile Site every 17 days and active microwave sensors can penetrate cloud cover.

- Two NOAA polar-orbiting satellites pass over the site twice each day, obtaining thermal and visible observations for routine, biweekly seasurface temperature, and Gulf Stream feature analyses.

Participants recognized the difficulty encountered in trying to detect and measure sludge components above background concentrations in the farfield. Several tracers for tracking the movement of sludge in the nearfield and farfield, including transmissometry, metals, dyes, drogues, and acoustics, were suggested by participants.

3.1.5 Models

Several existing transport models may be useful for evaluating the fate of sewage sludge disposed at the 106-Mile Site. Some of these models may also help determine exposure of living marine organisms to the sludges and aid in evaluating risks to living marine resources and human health. In addition, several circulation models for coastal regions off the U.S. coast and continental shelf, developed for MMS, may be useful in assessing regional movements. Sandia National Laboratory has also developed circulation models for this region of the ocean.

Generally, the workshop participants recognized that these mathematical models exist that they and can be useful tools for evaluating transport and fate of the sludge. The participants also recognized a need for improvements and validation of the models, and incorporation of recent data from the 106-Mile Site monitoring studies into existing models. No consensus on which model(s) were most appropriate was sought.

3.2 QUESTION 2: WHAT IS THE EFFECT OF SEWAGE SLUDGE DUMPING AT THE 106-MILE SITE ON LIVING MARINE RESOURCES?

Question 2 addressed the effect of sludge disposal at the 106-Mile Site on living marine resources. Background information for this question summarized the toxicological characteristics of the sludge, pathogen content of sludges, baseline data on living marine resources, short-term effects, and chronic exposure, bioaccumulation, and long-term effects. Also considered at the workshop was the design of the EPA monitoring plan (Battelle, 1988a) with respect to living marine resources. The summary background information and new information presented by participants is discussed below.

3.2.1 Characteristics of the Sewage Sludge

The sludge characteristics considered include the parameters that may affect living marine resources. They include tests of the toxicity of sludge to representative marine organisms and other more specific parameters. Sludge characteristics data are presently reported to EPA on a quarterly basis. Generally, the characteristics are reported for whole sludge. Information available to the participants prior to the workshop is summarized below.

- Toxicity

  Sludge toxicity varies among treatment plants.

  Within-plant toxicity varies over a factor of 2 to 5 during an annual cycle.

  The LC_{50} for mysid shrimp *Mysidopsis bahia* ranges from ≈ 0.1 to 3.0 percent whole sludge from the various treatment plants.

  Toxicity of sludge to mysid shrimp is greater than to the fish *Menidia* sp. and is least toxic to the diatom *Skeletonema costatum*.

Standard toxicity tests indicate sludge may be up to 10 times more toxic to indigenous zooplankton than to mysid shrimp.

Based on acute bioassay toxicity tests, dilutions required to meet limiting permissible concentrations at the 106-Mile Site range between 5,000 and 60,000:1.

Representatives of the sewerage authorities noted that results varied between analytical laboratories, confounding the ability to achieve standardized results.

- Pathogens

The pathogens found in sewage sludge are reviewed in "Development of a Quantitative Pathogen Risk Assessment Methodology for Ocean Disposal of Municipal Sludge" (EPA ECAO-CIN-493, May 1986) and "Pathogen Risk Assessment Feasibility Study" (EPA 600/S6-88/003). The summary below is from Fradkin et al. (In press). Their report indicated that the concentrations and types of pathogens in sludge from a given municipality depend on two principal factors: the incidence of infection within that municipality and the type of treatment sludge receives. Other major factors that influence the pathogen input to a waste water treatment plant include season, climate, population density, ratio of children to adults, and sanitation practices.

Municipal sludges can accumulate microorganisms capable of causing serious illness and mortality in man because enteric viruses bind strongly to particles. Viruses and other microorganisms may be concentrated in sludge during primary settling. The microorganisms that are accumulated in sludge and that can be pathogenic to man include bacteria, parasites (protozoans, helminths), fungi, and viruses. Representative pathogen species are generally tracked in waste streams due to lack of appropriate or simple measurement methods for all pathogens. Typical concentrations (numbers of pathogens per g dry weight) for secondary sludges are: viruses, $3x10^2$; bacteria, $2x10^2$ to $8x10^6$; and parasites, $1x10^1$ to $1x10^3$. Although more than 100 different viruses may be present in raw sewage, most knowledge on viruses pertains to those associated with gastroenteritis.

Bacterial pathogens in sewage may cause the following clinical illnesses: typhoid, paratyphoid, bacillary dysentery, gastroenteritis, cholera, and Weil's disease. Only four of the common protozoan species that may be found in sewage sludge are believed to be significant in disease transmission. All four cause mild diarrhea. Helminths, including nematodes (round worms) and cestodes (tapeworms), may occur in domestic sludges. Many of the common helminths are pathogenic to domestic animals, but not to humans. Finally, fungi including yeasts and filamentous molds found in municipal sludge may cause respiratory infections, candidiasis, subacute chronic meningitis, ringworm, athlete's foot, infection of hair follicles, and deep-tissue infections.

In general, the survival of pathogens in seawater and sediments is not well understood. However, pathogens that reach the sediments may survive for periods of months to years.

Specific studies of the pathogens in sewage sludge after disposal at the 106-Mile Site have not been routinely conducted. However, because Clostridium perfringens is considered a conservative tracer of pathogens and is relatively easy to measure on board survey vessels, it has been routinely measured on the EPA surveys of the site. Available data on C. perfringens concentrations in the sewage plumes from the site indicate that concentrations may not reach ambient concentrations in the 4-h initial dilution period.

3.2.2 Baseline Data on Living Marine Resources

The baseline data available from the 106-Mile Site and immediate environments are summarized in several reports listed in Table 3. Of primary interest to the 106-Mile Site are the results of the MMS program conducted during 1984-1986. This study represents the most complete set of benthic data in the vicinity of the 106-Mile Site prior to the initiation of sewage sludge disposal activities. Information on other marine resources is found in Pearce et al. (1983).

During the workshop, information was presented on studies conducted in the vicinity of the 106-Mile Site by the National Undersea Research Program (NURP) during the summer of 1988 (Appendix F). These studies were conducted in response to requests from the recreational and commercial fishing industries to address their concerns about decreasing fish and shellfish catches. Submersible survey activity was directed towards an overall assessment of the ecology of lobsters, crabs, lobes, flounders, and tilefish over a depth range of 200 to 1000 meters. The surveys were conducted in the general vicinity of Block-Hudson-Toms Canyons and the adjacent slope area between the Hudson Canyon and the 106-Mile Site.

A total of 16 dives was made in August and September 1988. Two submersibles (DELTA, JOHNSON-SEA-LINK) made 1 to 4 km transects over the ocean floor in areas specified by the fishing industry. These areas were located where evidence of sludge impact, as perceived by fishermen, might be found. Box cores, punch cores, video documentation of aerial-substrate associations, and visual observations were collected/made during each traverse.

In general, the dives showed the ocean floor megabenthic communities and their associated habitats to be quite normal (Dr. Richard Cooper, personal communication, 106-Mile Site Workshop, March 29, 1989). No obvious signs of sludge impact were observed or suggested from sample analyses or video examination. Lobsters and tilefish appeared in relatively low densities. The low population of lobsters may have been due to emigration, a result of behavior or avoidance of environmental contamination. Extensive fishing is probably the reason for the low numbers of tilefish observed. Hake, flounder, jonah crab, red crab, goosefish, squid, mud arenaceous, brittle starfish, redfish, black-bellied nosefish, ocean pout, and sculpins appeared in expected densities, and their behavior and habitat association seemed normal.

3.2.3 Short-Term Effects at the 106-Mile Site

Limited measurements of sludge toxicity are available from the field. Acute toxicity tests, using mysid shrimp and indigenous zooplankton, were conducted at sea on sewage plumes at the 106-Mile Site. The tests have shown no toxicity 4 h after disposal (Battelle, 1989b).

3.2.4 Chronic Exposure, Bioaccumulation, and Long-Term Effects

The only direct tests involving chronic exposure of organisms to sludge at the 106-Mile Site were conducted using a rapid-chronic toxicity test with sea urchin sperm. The preliminary results from this study indicate toxicity to the sea urchin sperm immediately after sludge disposal. The response of the organisms returned to predisposal levels within 4 h of disposal (Battelle, 1989b).

To date, short-term bioaccumulation studies proposed in the draft monitoring and implementation plans have not been conducted within the sewage sludge plumes at or near the 106-Mile Site. Contamination of samples during collection probably would preclude these measurements. Similarly, long-term effects studies, that link between biological effects and contaminant input at the 106-Mile Site or other sources to the region, have not been conducted. A preliminary long-term bioaccumulation study in red crabs and tilefish collected from canyon regions shoreward of the 106-Mile Site has been conducted (Dr. Larry Swanson, State University of New York, personal communication, 106-Mile Site Workshop, March 29, 1889). In this study, analysis of red crab digestive glands did not detect any anomalous concentrations of metals or selected organic contaminants.

At the workshop, several study designs for evaluating bioaccumulation in important commercial species were presented. These plans included additional studies during the summer of 1989 by NURP and by the Northeast Fisheries Center, National Marine Fisheries Service (NMFS). The projected NMFS studies include conducting a reconnaissance, mid-water trawl survey at four slope water stations from a point 180 km northeast to a point 180 km southwest of the 106-Mile Site (Robert Reid, National Marine Fisheries, Sandy Hook Laboratory, personal communication, March 29, 1989). As of preparation of this report, samples of myctophids have been collected from four stations and are in the process of analysis for selected contaminants. In addition, NURP is planning a survey of selected benthic stations in the vicinity of the 106-Mile Site. Included in the plans is collection of samples to evaluate community structure and bioaccumulation of contaminants in selected species.

3.2.5 Shell Disease

The findings of an EPA-sponsored work group established to review and evaluate the data on the status of disease and mortality in commercially important shellfish were summarized during the presentation on living marine resources. The presentation (EPA and NOAA, 1989) appears in Appendix G. Principle findings included the following:

- Shell disease is a natural phenomenon in crustaceans but it may occur with higher prevalence and greater severity in polluted areas. Shell disease represents a stage in the natural relationship between crustaceans and chitin-utilizing bacteria and fungi. The balance between metabolic processes associated with new shell formation and infection by microbes capable of utilizing chitin may be disturbed by environmental changes affecting normal shell formation or favoring the growth of chitin-utilizing microbes. Such disturbances can be consequences of pollution.

- Some evidence exists for an association of shell disease with habitat degradation. Prevalence of disease has been found to be high in crustaceans from polluted sites. Patterns show trends similar to those of the black-gill syndrome, which is also a statistically associated with pollution. Experimental exposures of crustaceans to sediments contaminated with heavy metals, biocides, petroleum, and petroleum derivatives can result in the appearance of the black-gill syndrome, often accompanied by shell disease.

- The work group analyses suggest that prevalence of less than 5 percent may represent expected background levels of shell disease in inshore populations, probably related to mechanical damage or wound healing. Prevalence of over 15 percent, as noted in some inshore samples of lobsters and rock crabs, may reflect pollution-related disease superimposed on the natural occurrence of shell disease.

- Shell disease occurs in deepwater crustacean populations, including those in shelf canyons, but data are limited and there is no conclusive evidence that would associate shell disease in such populations with pollution of offshore habitats.

- Mortalities from shell disease have been observed, occasionally at high levels, in laboratory-held and impounded crustacean populations. Destruction of gills and adhesions of the exoskeleton which prevent molting have been considered to be responsible factors, as have secondary systemic infections that develop after perforation of the chitinous integument. There is no specific evidence, however, that would link crustacean population fluctuations in the New York Bight with the presence or severity of shell disease. Shell disease may predispose crustaceans to mortality, but there is currently no available method to separate disease-caused mortality from that caused by other influences. Additionally, there are no discernible trends in either lobster or crab abundance in the Middle Atlantic Bight in the past decade. If anything, there seems to be a slow increase in lobster abundance inshore and offshore.

The work group surmised that shell disease may be a perceived problem with respect to the crab and lobster catch because the marketability of diseased crab and lobsters may be affected. However, the group indicated there is no conclusive evidence now available to associate shell disease in offshore populations with sludge dumping activities at the 106-Mile Site.

3.2.6 EPA Monitoring Plan—Biological Effects

The EPA monitoring plan contains components to evaluate short- and long-term biological effects in the water column and the sediments in and near the 106-Mile Site. Measurements will include evaluation of changes in the phytoplankton community in the area; and measurements of bioaccumulation by commercially important species found in and near the site; measurements of benthic community structure; and analysis of sensitive lifecycle stages of fishes. One work group found that not enough consideration was given to monitoring the 106-Mile Site for biological baselines prior to the start of dumping. In general, sludge-associated changes to the living marine resources at the 106-Mile Site will be difficult to detect.

3.3 QUESTION 3: WHAT IS THE EFFECT OF SLUDGE DUMPING AT THE 106-MILE SITE ON HUMAN HEALTH?

Question 3 addressed the effects of sludge disposal at the 106-Mile Site on human health. Three areas were considered: the potential for human exposure to pathogens through direct or indirect pathways; the potential for effects from exposure to toxic chemicals; and evaluation of risk to human health from the activities at the 106-Mile Site. Background data as related to the 106-Mile Site are limited. A recapitulation of the literature on the exposure and effects of pathogens and toxic chemicals on human health was not attempted for the background materials. Thus, participants were required to depend on their own experience and expertise to address this question.

At the workshop, a new Federal study to provide more extensive inspection of all seafood, whether imported or of domestic origin, was reported. This study, authorized by Congress, is to provide better information on seafood safety and other concerns. Under this legislation, a comprehensive review of seafood safety is being conducted by NOAA, in cooperation with the Food and Drug Administration (FDA) and U.S. Department of Agriculture (USDA). This study, called the National Seafood Surveillance Project, is underway. An interim report to Congress is due in October 1989 and the final report to Congress is scheduled for January 1991.

The considerations of the participants with respect to sludge disposal and human health risks are summarized below.

3.3.1 Potential for Direct Human Exposure

Persons who may have a direct exposure to the pathogens and toxic materials in sludge dumped at the 106-Mile Site include the haulers/dumpers, commercial and recreational fishermen, crews of passing vessels, and swimmers in the vicinity of the 106-Mile Site. The workshop participants discussed the following information:

- Epidemiologists usually can attribute a viral infection to contact with another infected person, and not to water or aerosol exposure. However, other exposure pathways cannot be ruled out.
- Swimming is not the only route by which pathogens can infect humans; inhalation of aerosols during dumping may expose humans to the pathogens.
- Viruses, bacteria, protozoans, and parasites are present in sludge.
- Viruses cannot survive in open seawater for long periods unless they are associated with sediments.
- Technologies for measuring viruses are very new. Methods for detecting viruses in water require filtration of hundreds of gallons of water.
- Material dumped at the 106-Mile Site may come in contact with humans through mechanisms such as dumping operations, swimming, inhalation of aerosols, and fishing activities (e.g., a fisherman may come in contact with sludge in water in the vicinity of the site).

- No studies have been conducted on the group of people (barge workers, researchers) with the highest potential for exposure at the site. Studies of workers within sewage treatment plants have been conducted.

- The ability to differentiate between effects of sludge dumped at the 106-Mile Site and effects of nearshore influences (CSOs) is limited.

- Unlike viruses, bacteria can grow in water if sufficient nutrients are available.

- Bacteria can transfer drug resistance through reproduction.

- The risk of direct exposure to general human health is minimal:

  The risk of exposure to pathogens at the 106-Mile Site is low, and is not sufficient to warrant extensive application of limited resource dollars at this time.

  Potential for effects from direct exposure to toxic chemicals is less than that from pathogens.

The work groups concluded that available data indicate there is no evidence of human health problems associated with direct contact with sewage sludge disposal at the 106-Mile Site.

3.3.2 Potential for Indirect Human Exposure

During discussion of the potential for indirect exposure to pathogens and toxic chemicals through consumption of fish and shellfish, participants were informed that FDA considers three factors in determining indirect exposure: contamination level, toxicity, and relative level of consumption. There are no regulations for pathogens in fish. FDA does apply action levels or tolerance levels for certain contaminants in fish and shellfish.

The results of the discussions of indirect exposure included the following:

- Shellfish from the 106-Mile Site are not consumed by humans, primarily because no shell fishing occurs at the site. Scallops are caught in the area of potential influence of the 106-Mile Site but these organisms are usually not eaten raw.

- Thorough cooking of fish and shellfish kills pathogens.

- The heat and pressure treatment processes for sludge used by one sewerage authority using the 106-Mile Site kills pathogens. Storage of sludge for several days will kill pathogens.

- An indirect risk of exposure through the consumption of fish and shellfish is a remote possibility if seafoods are not thoroughly cooked.

The discussions concluded that there is no plausible likelihood that seafood is unsafe to consume because of dumping at the 106-Mile Site.

3.3.3 Harvested Resources of Concern

This topic, not considered in the background materials, was added at the workshop by the session chairman. Discussions of this information provided the following understanding:

- Fish species harvested on the continental slope and shelf near the 106-Mile Site represent an extremely small fraction of the total U.S. supply of commercial fish. About 56 percent of seafood consumed in the United States is imported (NOAA, 1989).

- Lobsters annually migrate in an inshore, offshore direction. Generally, lobsters with evidence of shell disease are less likely to be placed on the market, lessening human health concerns. An additional market factor may be the procedure of removing claws or tails and selling the meat as "shack lobster."

- Generally crabs are fished at the heads of canyons from depths no greater than 400 m. These locations are well inshore of the 106-Mile Site.

- Tuna are migratory and are generally fished off the shelf break. They are generally not found closer to shore than the 50 fathom (100 m) isobath. Also, tuna are known to be very temperature sensitive. Thus, changes in temperature in the ocean may influence the locations where tuna are found.

- Tilefish are not migratory. They are found primarily near the heads of submarine canyons in the 120 to 250 m depth range. Tilefish tend to remain within several hundred meters in large grottos excavated from the sediments. If the tilefish habitats were located down-current of the 106-Mile Site, these grottos could serve as natural sediment traps. Thus, these individuals may be candidates for exposure to contamination. However, mixing of new and old material in the burrows will complicate the interpretation of results. No more than 20 percent of the tilefish population north of Cape Hatteras is found in the area that may potentially be impacted by disposal activities at the 106-Mile Site. However, because of the proximity of other potential contaminant sources (disposal areas in the New York Bight and in the upper Hudson Canyon) in the vicinity of the tilefish habitat, assignment of cause and effect to the 106-Mile Site may be difficult.

- Recently, squid caught off the northeastern United States have been in demand for human consumption. The market is primarily for foreign consumption, but the domestic demand is growing.

- Like the tuna, shark and swordfish show migratory patterns that encompass large areas and may be found in the vicinity of the 106-Mile Site. Exposure of these species to sludge disposed at the 106-Mile Site may be limited. Therefore, sources of any contamination found in these animals cannot be traced effectively.

3.3.4 Conclusions Based Upon Available Information

It is extremely difficult to determine whether any contamination in commercially important fish and shellfish organisms results directly from the dumping activities at the 106-Mile Site. The workshop concluded that no evidence exists to indicate that ocean dumping at 106-Mile Site poses a threat to human health.

3.4 QUESTION 4: ARE THERE CHANGES IN SITE DESIGNATION, PERMITS, OR SURVEILLANCE THAT CAN PROVIDE BETTER PROTECTION OF THE ENVIRONMENT, LIVING MARINE RESOURCES AND HUMAN HEALTH?

Question 4 addressed the management of the 106-Mile Site. Topics considered in the background document included conformation to regulatory requirements, monitoring, site designation, and management tools/methods for site evaluation.

3.4.1 Regulatory Requirements

The regulatory requirements for management of the 106-Mile Site are based on protecting the marine environment. The regulations provide two mechanisms for managing the disposal site: (1) permits and the conditions listed therein and (2) site selection and designation.

Monitoring of sludge disposal operations at the 106-Mile Site has shown that disposal usually occurs within the site and at the prescribed disposal rate. Out-of-site dumping has been observed on two occasions and disposal above the court-ordered rate has been detected once. Numerous administrative violations, such as dumping less than one-half mile from the previous disposal plume and crossing of plumes, have been noted within the site. Of the sewage plumes monitored, approximately 50 percent have had at least one contaminant that exceeded WQC when the sludge plume moved outside the site boundary. As a result, EPA has proposed lowering the disposal rates at the 106-Mile Site to ensure that disposal operations conform to the requirements of the MPRSA.

The workshop participants judged that conformation to regulatory criteria was good, but noted that violations have occurred during dumping operations. Several workshop participants observed that neither the site configuration nor the areal extent of the site could be changed because the length of time required to make changes to the site and that this action is unlikely to be undertaken by EPA prior to December 31, 1991.

Workshop participants recommended that the operational effectiveness of the ODSS be improved. Participants believed that the ODSS should be able to track all barges at all times, even in the event of a barge breaking loose from its tow.

3.4.2 Site Monitoring

The EPA 106-Mile Site monitoring plan consists of two documents: the monitoring plan (Battelle, 1988a) and an implementation plan (Battelle, 1988c). A third document, the permittee monitoring requirements (Battelle, 1989c), describes the proposed monitoring requirements to be undertaken by those with permits to dispose sludge at the 106-Mile Site. The participants generally supported the tiered approach to monitoring, but supported the acceleration of the implementation of Tier 3 (Farfield Fate) and Tier 4 (Long-term Effects). The participants indicated farfield, long-term research should be based on science, not on public perceptions of the problem.

The workshop deliberations resulted in a series of recommendations for monitoring the 106-Mile Site. These are

- Monitoring should consider two issues: biological impacts and habitat modification. The habitats to be monitored should be surface waters, the pycnocline, and the bottom.

- The trajectories of the particulate matter in sludge as it moves away from the disposal site should be monitored to predict locations for observing potential effects of the sludge.
- Nutrient loading and its effect on plankton and potential to allow pathogen survival, both within the site and outside the site boundaries should be monitored.
- Bioaccumulation of contaminants in important species should be monitored.
- Dumpers should be encouraged to reduce toxicity from sludge to gain the benefit of faster dumping rates and alternative disposal options. EPA should consider seeking regular decreases in toxic chemicals in sludges each year so that loadings of toxic compounds at the 106-Mile Site decrease.
- Monitoring of indices of finfish and shellfish disorders was considered important.
- The monitoring plan should undergo peer review.

3.4.3 Site Designation

The consensus of most participants was that, if EPA were to expand the site, expansion must be in an offshore direction. The workshop concluded that the data, needed to decide on expansion of the size of the present 106-Mile Site, are not likely to become available in time for full notice, comment, and preparation of supporting documentation.

3.4.4 Management Tools/Methods for Site Evaluation

Workshop discussions provided several recommendations relative to the available tools for site management. These included changing dumping rates; site designation or dedesignation; and improved pretreatment. The recommendations for site evaluation included the following:

- Routine monitoring of the site perimeter for toxicity and contaminants.
- Review and comment on proposed permits by all agencies and special interest groups.
- Enhancement of Federal coordination through formation of a Blue Ribbon Panel of scientists to review the plans for monitoring, research, and surveillance and to adjust future activities in relation to the data generated by the monitoring program.
- Development of monitoring plans that include costs on a priority basis.
- Use of ships of opportunity, including fishing vessels, as platforms for sample collection or for release of drifters.

4.0 IDENTIFIED NEEDS AND RECOMMENDED STRATEGIES

Each work group was asked to identify monitoring, research, and surveillance needs for the 106-Mile Site. From these discussions, the work group strategists identified and proposed strategies for addressing the needs. This section presents the needs identified by the workshop and the proposed strategies for addressing these needs. The information in this section is organized according to the major issues identified in the background document supplied to the participants (Appendix E).

4.1 QUESTION 1: WHAT IS THE PHYSICAL AND CHEMICAL FATE OF THE SEWAGE SLUDGE DUMPED AT THE 106-MILE SITE?

4.1.1 Sludge Composition and Characteristics

This section lists information needs identified by the workshop regarding sludge composition and characteristics and the recommended strategies for addressing these needs.

4.1.1.1 Data/Information Needs

The workshop participants determined that standardized analytical methods for sludge were necessary. Standardization will increase the comparability of data from all sewerage authorities and improve the reliability of the bioassay tests.

In addition, the participants expressed the need to

- Determine the physical characteristics of sludge particles, particularly their size distribution and density by size class.
- Determine the long-term variability of the physical and chemical composition of sludge.

Participants also determined that previously reported sludge characteristics data should be examined to determine whether relationships among the chemical, physical and biological (toxicological) properties of the sludge and long-term effects can be found.

4.1.1.2 Recommended Strategies for Addressing Sludge Composition and Characteristics Needs

The following strategies were recommended:

- Select and require standardized analytical and sampling procedures for sludge analyses including better quality control and quality assurance on bioassays.
- Select analytical parameters that reflect potential for biological impacts (including pathogens) and that are useful for tracing and modeling.

- Conduct research on the physical and chemical partitioning of sludge particles in marine systems to improve understanding of fate caused by physical/chemical/biological processes.

- Conduct physical/chemical partitioning studies in seawater.

4.1.2 Short-Term Behavior

This section discusses strategies for addressing the identified needs for evaluating short-term behavior of the sludge.

4.1.2.1 Information Needs

The participants determined that a better understanding of dispersion of sludge at the 106-Mile Site is needed, including data on the vertical distribution and transport of sludge particles in sludge plumes. Participants identified the need for further information on the interactions between sludge and seawater, e.g., flocculation or absorption, as they relate to settling at the time of discharge. These data are needed to better understand the potential for transport of sludge below the seasonal pycnocline. Participants also felt that state-of-the-art acoustic techniques (especially the newer digital technology) could be used to define subpycnocline distributions.

The following areas were also identified as important for evaluating the short-term behavior of the sludge:

- Determination of sludge characteristics that could be used as tracers.

- Determination of bioaccumulation in zooplankton and phytoplankton within the sludge field.

- Determination of the uses for bioaccumulation data as indicators of contamination of habitats.

4.1.2.2 Recommended Strategies for Addressing the Short-Term Fate Needs

The workshop recommended several strategies to address these needs:

- Acoustical sludge tracking studies to supplement transmissometer studies to define and quantify partitioning, particularly around the pycnocline.

- Use of neutrally buoyant acoustically tracked drifters to evaluate subsurface sludge movement.

- Evaluation of xylem trachea, plant seeds (e.g., tomato seeds), and coprostanol as tracers of the sludge.

4.1.3 Farfield Fate

This section considers the strategies recommended for addressing the identified needs for assessing the farfield fate of the sludge.

4.1.3.1 Information Needs

The participants recommended that the following additional information on the transport of sludge in the upper mixed layer of the ocean be collected to help determine the farfield fate of the sludge:

- Evaluating the vertical transport of the sludge away from the 106-Mile Site.
- Obtaining additional current flow and velocity information by a coordinated effort using Lagrangian surface drifters and Eulerian measurements coordinated with satellite imagery.
- Determining sludge transport below the seasonal pycnocline.

The participants believed that physical oceanographic measurements should be coordinated with other measurements being made at and near the 106-Mile Site.

Construction of a mass balance for contaminants entering the inner New York Bight and off-shelf areas was recommended. This need requires evaluation of all sources of contaminants to the Middle Atlantic Bight, including atmospheric deposition.

4.1.3.2 Strategy for Addressing the Farfield Fate Needs

The recommended strategies for addressing the farfield fate of the sludge included design of the following field programs:

- Determination of ocean currents and circulation using an Eulerian current meter program and Lagrangian drifters. The minimum recommended study period for this program was one year. To provide statistical coverage for the time scales of events occurring in the region, weekly measurements were recommended. These data would help address questions concerning (1) gyres (warm core eddies) and oceanographic recirculation and (2) convergence zones.
- Integration of real-time remote sensing data (on the Gulf Stream, warm-core eddies, etc.) into the analysis of water movement.
- Design and implementation of a sediment trap study to measure settling of sludge particles or sludge tracers. Horizontal and vertical placement of the sediment traps was considered important, particularly with respect to the position of the pycnocline.
- Analysis of microorganisms as well as contaminants of concern.

In addition, the workshop recommended that the strategy for evaluating farfield fate include determining gradients in contaminants both along and toward the continental shelf. A mass balance for contaminants entering the Middle Atlantic Bight would estimate mass loadings from sources that may influence the 106-Mile Site, e.g., inner shelf vs. outer shelf vs. offshelf. The sources recommended for inclusion in this evaluation included the Hudson River plume, Delaware Bay plume,

New York Bight Apex sources (disposal sites and coastal discharges), atmospheric inputs, and disposal at the 106-Mile Site.

Also recommended was an assessment of the variability in water column chemical baseline data in the vicinity of the 106-Mile Site.

Finally, it was recommended that a review article on the status of knowledge of the physical oceanography at and near the 106-Mile Site be prepared as part of the process of evaluating the farfield fate monitoring program. This report would be the equivalent of the 1983 NOAA 106-Mile Site Characterization Update (NOAA, 1983).

4.1.3.3 Public Communication

The workshop recommended that communications with the public concerning the fate and effect of the dumped sewage sludge be improved. Critical to this effort was the identification of the most appropriate communication mechanisms.

4.1.4 Models

This section considers the needs and strategies for predicting sludge fate using models.

4.1.4.1 Information Needs

The workshop recommended that the available circulation and transport models be examined in more detail and that an appropriate field validation program be designed. The workshop identified the need for

- Modification of circulation and particle transport models of slope/shelf interactions as necessary to include mean flow, seasonal changes, and events caused by such factors as storms and warm-core eddies.
- Development of models that address the role of the pycnocline as a barrier to particle settling and as a surface for lateral spreading of the sludge.

4.1.4.2 Strategy for Addressing the Modeling Needs

The recommended strategy was to incorporate new and existing data in nearfield models to enhance existing monitoring strategies. Existing farfield data and models should be evaluated to determine their effectiveness and applicability to the 106-Mile Site. Changes to models should be made if necessary to improve their predictability for sludge transport. Extensive modeling efforts were not recommended until evaluations of existing models could be completed and the necessity for additional modeling determined.

4.1.5 General Strategies

Several general strategies were recommended as a result of the workshop discussions. These included the following:

- Preparation of a synthesis report integrating existing data and biological, chemical, and physical studies to assess ecological and public health effects.
- Establishment of a blue ribbon panel, including representatives of the public, to assess the research, monitoring, and surveillance program and redirect it if necessary.

4.2 QUESTION 2: WHAT IS THE EFFECT OF SEWAGE SLUDGE DUMPING AT THE 106-MILE SITE ON LIVING MARINE RESOURCES?

This section lists information needed about sludge composition and characteristics, and the strategies recommended for addressing these needs.

4.2.1 Characteristics of Sewage Sludge

Information needed about characteristics of sewage sludge, including toxicity and pathogens, is discussed in this section.

4.2.1.1 Toxicity Tests

The participants recommended that research associated with the toxicity tests used to characterize the sludges include species indigenous to the 106-Mile Site and that population response models be developed. A review of the reliability of the laboratories conducting the toxicity testing was suggested. Concern was also expressed about the implicit assumption that negative toxicity results are equated with no effects.

4.2.1.2 Pathogens

The workshop recommended that additional information on effects of pathogens on marine mammals and birds be collected. Also recommended were laboratory studies to

- Determine the relationship between dumping and pathogens in marine organisms.
- Determine the effects of sludge on potency of certain bacteria.
- Postulate relationships between bacteria in sludges causing illness and disease in marine organisms.
- Investigate survival of pathogens associated with sewage sludge after various disinfection techniques.

Finally, the workshop recommended increased monitoring for diseases in marine fishes and invertebrates at and in the vicinity the 106-Mile Site.

4.2.2 Baseline Data on Living Resources

The workshop recommended that more research be conducted on both the shallow and deep benthic communities that may be impacted by the disposal of sludge at the 106-Mile Site. A time-series study of the benthic communities should be initiated. This study should obtain appropriate samples to determine whether the organisms have been exposed to sludge and, if so, the degree of exposure.

Additional studies of the following living resources were recommended:

- Characterize finfish populations.
- Increase evaluation of pelagic species, i.e., squids.
- Investigate possible behavior modifications in species that swim near and around plumes.
- Increase site-specific egg and larval fish studies.

Development of information on commercial fish landings of catches from the vicinity of the 106-Mile Site was also believed important to the assessment of effects from the sludge dumping.

4.2.3 Short-Term Effects

The workshop recommended that information on resident, and vertically migrating species (i.e., lantern fish, hatchet fish) be developed. Data on populations and contaminant burden in the organisms should be collected. Also recommended was routine performance of toxicity tests in the water column in plumes and at the perimeters of the site.

4.2.4 Chronic Exposure, Bioaccumulation, and Long-Term Effects

The deliberations of the workshop made clear the need for better characterization of the sludges and measures of contaminant bioaccumulation in resource species. These measurements were deemed necessary to help allay public misperceptions and wariness about fish/seafood consumption.

4.2.5 The EPA Monitoring Plan

Recommendations regarding the EPA monitoring plan were primarily to accelerate the implementation of the long-term effects studies planned (Battelle, 1988c). The workshop recommended that existing monitoring information be presented to the scientific community and to the public to make clear the status of the environment at the 106-Mile Site. The workshop recommended that a group of experts be established to review details of present and future monitoring plans and make recommendations regarding monitoring activities.

4.2.6 Living Marine Resources

This section describes the strategies recommended by the workshop for addressing the need to monitor and research living marine resources near the 106-Mile Site.

4.2.6.1 Farfield Effects

Strategies for determining farfield effects were diverse and included studies of bioaccumulation, disease, community structure as well as toxicity testing. Recommended bioaccumulation studies

included use of modeling and hydrographic measurements as well as results from sediment traps to design and implement collections of key target organisms for bioaccumulation and long-term effects research and monitoring. As part of the overall strategy for studying the living marine resources in areas potentially affected by the disposal of sludge at the 106-Mile Site, the workshop recommended using commercial and recreational fishing vessels to supplement Federal survey activities whenever possible.

- Bioaccumulation

  For bioaccumulation studies, removal of appropriate organs for autopsy and contaminant analyses was recommended. The suggested target species included myctophids (lantern fish) and other vertically migrating species as well as midwater species such as squid (Loligo), demersal fish, and shellfish. As part of these studies, examination of the organisms and selected organs for disease was strongly recommended.

- Shell disease

  Recommended shell disease studies included a census of shellfish for incidence and distribution of disease. Organisms should be collected at the 106-Mile Site and in areas (midshelf and canyons, plus outershelf and continental slope) potentially affected by dumping at the 106-Mile Site. The strategists recommended that these studies be coordinated with sediment trap data. In addition, it was recommended that the organisms, material in the sediment traps, and the sludges be analyzed for pathogens, especially Vibrio, thought to be causative agents for chitinoclasia and finrot.

- Population dynamics and community structure

  Collection of time-series data on the benthic community (including commercial species, e.g., lobsters, red crabs, bivalves) and demersal fishes, (e.g., tilefish, Antimora) was recommended so that a baseline could be established for evaluating changes in these populations. This strategy requires that data be collected and arrayed to allow modeling of population dynamics essential to hazard assessments per EPA protocols (i.e., waste characterization, habitat characterization, etc.).

- Toxicity

  The workshop concluded that toxicity testing should include indigenous species from the vicinity of the 106-Mile Site (mid-water and vertical migrators). The data were recommended to "calibrate" or relate existing toxicity tests to biological effects. In situ tests were also recommended. Toxicity testing in waste plumes and at stations located at edge of plumes and at the boundary of the disposal site were recommended.

In addition, a research strategy, using laboratory and field research to evaluate the effects of dumping on the function of immunological systems, was recommended.

4.2.6.2 Public Education

As recommended in the strategies for monitoring the fate of the sludge dumped at the 106-Mile Site, the strategy for studying the living marine resources included a recommendation that a definitive "lay language" report on existing studies and historical modeling activities be prepared. In addition, the strategists recommended preparation of a definitive interpretative "lay language" report of our present understanding of the effects of ocean dumping at 106-Mile Site on living marine resources.

Use of existing data and generic information should be included. The emphasis of the report should be potential effects on the quality of living marine resources for human consumption.

4.2.6.3 Short-Term Effects

The recommended strategy for evaluating short-term effects included continued studies in the nearfield for short-term effects. Implementation of additional verification procedures were suggested, if the survey(s) show any short-term impacts from ocean dumping of the sludge. If verification studies show definitive effects, the workshop recommended that steps be initiated to relocate the 106-Mile Site further offshore (i.e., in Gulf Stream or beyond).

4.2.6.4 Oversight of Monitoring and Research Activities

The primary strategy developed by the workshop addressing monitoring and research activities was establishment of a permanent "Blue Ribbon Committee" of experts. This committee would

- Review any monitoring plan developed by the concerned Federal and state agencies.
- Review ongoing monitoring results, make recommendations for adjustments to the monitoring program, provide for rapid responses to sudden events, and establish procedures to evaluate the efficiency of monitoring and enforcement of dumping protocols and regulations.

It was recommended that the committee be empowered to add members (based on their interests in living marine resources) or to call upon other experts to testify, draft white papers, or evaluate findings of any monitoring and research conducted.

4.3 QUESTION 3: WHAT IS THE EFFECT OF SLUDGE DUMPING AT THE 106-MILE SITE ON HUMAN HEALTH?

4.3.1 Potential for Direct Human Exposure

4.3.1.1 Information Needs

The following information needs were identified for evaluating human health impact:

- Definition of the terms risk, relative risk, and perceived risk
- Development of an actual risk number applicable to the 106-Mile Site rather than depending on terminology that indicates the risk is minimal. The strategists recommended that the number be developed from existing literature. Before proceeding with the evaluation, the research money required to derive this number should be determined.
- Preparation of a definitive statement on public health risks to lessen public concerns about sludge dumping at the 106-Mile Site. The public must be informed of the differences between various contaminant sources in the Middle Atlantic Bight and risks to the public associated with each source.

The workshop suggested that agencies acknowledge to the public that, while they should have concerns about bathing water quality, problems are less likely to result from the activity at the 106-Mile Site, and more likely to result from other sources (i.e., shoreline activities).

4.3.1.2 Direct Exposure Information Needs

Two strategies were recommended to address data needs for human exposure:

1) Incorporation into a physical oceanography study, the mechanisms necessary to determine frequency of exposure of sludge components on the shoreline.
2) Development and implementation of a coastal monitoring program to assess effects of discharges from outfalls and CSOs, and to compare these effects to those from sludge disposal at the 106-Mile Site.

4.3.2 Potential for Indirect Human Exposure

4.3.2.1 Information Needs

To address public perceptions and concerns, there is an immediate need for an analysis of indirect human exposure from sludge disposed of at the 106-Mile Site. This would include analysis of exposure pathways for edible seafood from the Middle Atlantic Bight for chemicals, e.g., heavy metals, toxic chemicals, and pathogens.

4.3.2.2 Indirect Exposure Needs

The strategy recommended for addressing these needs includes analysis of chemical contaminants in musculature tissues of commercially important fishes from near the 106-Mile Site. The data will be used to determine if chemical contaminants have accumulated in the tissues.

Station locations should be based on past monitoring activities and be arrayed along gradients extending from the 106-Mile Site towards canyons and across the continental shelf. The gradient approach was recommended to establish traceability and relevancy between dumping at the 106-Mile Site and nearfield survey results.

4.3.2.3 Consumer Concerns

Because consumer concerns are great, the strategists recommended a mechanism to address issues or events as they occur. The workshop believed this mechanism should anticipate potential issues and help develop appropriate responses, in addition to providing a means for conveying information to consumers in a timely manner. As part of this mechanism, a plan should be developed to ensure that, as events occur, facts are ascertained from appropriate authorities, not from media or other second-hand sources.

The strategists for this question also recommended establishment of a Blue Ribbon Committee to review the monitoring, research, and surveillance activities at the 106-Mile Site and to assist in the release of information to the public. Formation of this panel should include a mechanism to involve the participation of scientists and technical experts, industry and consumer representatives, and Federal managers.

Finally, a strategy for reducing (removing) contaminants of concern (i.e., Cu, Pb, organic toxins) through pre-treatment mechanisms was recommended. It was recommended that this strategy include a public education program that addresses sludge, not only as an ocean issue, but as a societal issue. This program should encompass comparisons of the relative risks associated with currently available alternatives for sludge disposal, i.e., landfilling, composting, incineration, etc.

4.4 QUESTION 4: ARE THERE CHANGES IN SITE DESIGNATION, PERMITS, OR SURVEILLANCE THAT CAN PROVIDE BETTER PROTECTION OF THE ENVIRONMENT, LIVING MARINE RESOURCES, AND HUMAN HEALTH?

During the workshop, specific needs were not identified for this question. Rather, a series of recommendations resulted from the workshop deliberations and are discussed in this section.

4.4.1 Recommendations for Regulatory Issues

The workshop recommended development of consistent analytical procedures for toxicity tests required by the regulations, including quality assurance plans. Also, the workshop believed incorporation of offshore organisms into the toxicity test procedures was vital.

4.4.2 Recommendations for Surveillance

Recommendations for site surveillance focused on improvement to the ODSS system to provide more timely and accurate information on dumping activities and to make this information readily accessible to the public. The workshop recommended the system provide sufficient redundancy to assure, as a minimum, 95 percent effectiveness instead of the 80 percent as proposed by the USCG.

4.4.3 Recommendations for Monitoring

Several recommended strategies for monitoring were developed by the workshop. These included:

- Development of physical transport models for mixing and movement of material from the 106-Mile Site, with emphasis on determining the ultimate fate of the sludge.
- Implementation of the farfield monitoring studies simultaneously with Tier 1 and 2 studies of the EPA Monitoring Plan to address immediate public concerns.
- Development of a formal clearing house for the research and monitoring currently being conducted on 106-Mile Site and outer shelf area.
- Reassessment of the nearfield 4-hour mixing period for the 106-Mile Site. This was recommended as a specific research effort. The workshop believed studies should include several dumping and mixing scenarios.
- Setting aside of separate funds (possibly as a separate escrow account) for a long-term monitoring program to evaluate site recovery once disposal operations cease.

4.4.4 Recommendations for Site Designation

The process of designating disposal sites requires long time frames. Thus, the workshop believed designation of a new disposal site would not make effective use of Federal monies. ODBA has provided for the end to ocean dumping. The workshop recommended that the sewerage authorities

using 106-Mile Site be required to implement extensive pretreatment to reduce waste toxicity. Assessment of the site configuration was briefly considered, with support for enlargement of the site in the seaward direction, should EPA determine that such reconfigurations were necessary.

4.4.5 Recommendations for Management Tools/Methods for Site Evaluation

The workshop recommended the following for management of the site:

- Integrate the Federal agency programs currently involved with the 106-Mile Site to eliminate overlap and optimize agency functions.
- Establish a Blue Ribbon Panel to assess effectiveness of the monitoring programs.
- Develop mechanisms to coordinate policy and management activities within the Federal and state agencies, and to provide for adequate public involvement.
- After developing the optimum monitoring program for near and farfield assessments, prioritize and implement recommendations as funding levels allow. Provide feedback to Congress as needed.

4.5 FUTURE DIRECTIONS

The 106-Mile Site workshop was a major step toward developing a comprehensive research, monitoring, and surveillance plan for the 106-Mile Site. During the summer of 1989, EPA, NOAA, and the USCG will use the recommendations from this workshop plus other information to formulate a research, monitoring, and surveillance strategy for the 106-Mile Site and areas of potential impact from the sludge disposal operations. This strategy will form the basis of memorandum of understanding (MOUs) between these agencies regarding future studies and monitoring of the 106-Mile Site. Based on the strategy and MOUs, these agencies will modify the existing EPA monitoring and implementation plans to reflect the present needs in this important region of the ocean. The revised monitoring plan is due in November 1989. Many of the recommendations from the workshop have already entered the planning or implementation stage. The products of this workshop were key toward continuing the monitoring evaluation of the impact of sewage sludge disposal at the 106-Mile Site on the marine ecosystems, important fisheries, and for addressing human perceptions and concerns for the coastal waters.

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APPENDIX A.

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APPENDIX B.

REPORTS OF WORKGROUP CHAIRPERSONS

CHAIRPERSONS REPORT–QUESTION 1

QUESTION 1–WHAT IS THE PHYSICAL AND CHEMICAL FATE OF THE MATERIAL DUMPED AT THE 106-MILE SITE?

1. **Physical and chemical characteristics of sludge**

   What we know (this is in addition to results listed in text on Pages 4-2 through 4-9)

   A. Composite samples taken at the inlet on feeder barges are probably good indicators of sludge composition and retain the ability to also track the sludge to its source. The independent checks confirm the sludge composition adequately (within a factor of 2-5).

   B. Pretreatment can probably be used to reduce the concentration of some toxic constituents in the sludge.

   C. Some metals and toxicity are the parameters that exceed Marine Water Quality Criteria (MWQC).

   What we need to know

   A. Standardized chemical analytical methods are needed for sludge so that data from all plants in NY and NJ are comparable.

   B. What are the physical characteristics of sludge particles, particularly their size distribution and density by size class over an extended period of time?

   C. What is the long-term variability of the chemical composition of sludge?

   D. Dispersion of sludge in marine waters is not adequately known.

   E. What additional information can be learned from previous studies about the chemical and physical properties of sludge on its biological and long-term effects.

   F. Could compaction of sludge and the discharge of solid material that will sink rapidly to the bottom be an alternate strategy in deep waters like the 106-Mile Site?

2. **What are the water current regimes at the site?**

   What we know

   A. Near-surface drifter deployments (4 in September 1988) have indicated a possible water flow from the 106-Mile Site toward the shelf break front (i.e., a possible convergence zone).

   B. One of the surface drifters looped back toward the shelf and may be an indicator of a large-scale gyre between the Gulf Stream and shelf waters.

C. Observations from Navy GEOSAT satellite and from the field have been coupled successfully with interactive modeling to predict the location and behavior of the Gulf Stream. The Navy GEOSTAT satellite passes directly over the 106-Mile Site every 17 days and the active microwave sensor can penetrate cloud cover.

D. Advection events would rapidly displace a sludge plume, but may not increase the short-term mixing. Under normal conditions the ocean is a dispersive environment.

E. The pycnocline is at 10-20 m depth in summer, but in winter it will be considerably deeper.

F. Freshwater content (90-95 percent) of sludge sometimes causes plumes to rise after sewage disposal.

What we need to know

A. More complete velocity studies with Lagrangian surface drifters to obtain flow and coupled with Eulerian measurements for velocities. Deployment of surface drifters weekly for a year would cover the appropriate time scale of events (wind-induced, rings) and would be statistically significant in addressing the question of (1) gyres and recirculation and (2) convergence zones.

B. Data on vertical transport of sludge particles are critical and should be obtained.

C. Neutrally buoyant acoustically tracked drifters would be an expensive, but very appropriate instrument to better understand where sludge may be transported below the seasonal pycnocline.

D. More detailed examination of the available circulation and passive transport models is needed in addition to the design an appropriate field validation program.

3. What do the sludges do at the site?

What we know

Field measurements indicate sludge particulates at the 106-Mile Site are confined to the upper mixed layer above the pycnocline. Some reports at the 12-Mile Dump Site indicated bottom deposition occurring in short time periods. The ocean is a dispersive environment even under calm conditions at the 106-Mile Site and becomes even move dispersive under normal and stormy conditions. There are some physical features (pycnocline, fronts) that tend to collect particulates.

What we need to know

A. We need to know about the interactions of sludge with seawater and biota at the time of discharge, e.g., flocculation or absorption that would affect settling.

B. Can moored and free-floating sediment traps be deployed in concert with physical oceanographic instrumentation to better define movement of sludge particles? Initial installations should be in the nearfield with later deployments in the downstream farfield.

C. What other instrumentation in addition to those determined can be used to detect sludge particulates and follow their distribution? Possible instruments include acoustic techniques and in situ undulating particulate (plankton) samples.

D. Can organisms, such as salps, whose feeding mode concentrates small particles, be utilized to collect samples for detecting the presence of sludge materials?

E. What constituents of sludge can be used as tracers (xylem trachea, coprostanol) of sludge on the bottom?

4. **Are there adequate mathematical models of water circulation?**

What we know

Mathematical models exist but improvements and validation are needed.

What we need to know

A. A need exists for circulation and particle transport models of slope/shelf interactions in response to mean flow, seasonal changes, and events caused by such factors as storms and warm-core rings.

B. Models are needed to address the question of the pycnocline as a barrier to particle settling and interactions of particle fields with bioaccumulations.

5. What techniques are being used to track sludge?

What we know

A. Nearfield plume monitoring is adequate and should continue, but should break sludge into subfields.

B. Sludge is difficult to detect above background, especially in particulate matter in the farfield.

What we need to know

A. Can weekly drogues be deployed and remote sensing from satellites be used to define sludge transport in the upper mixed layer?

B. What acoustic techniques (especially the new technology) can be used to define subpycnocline distributions?

C. The vertical distribution of the particle plumes is needed.

D. Bioaccumulation of sludge particles needs more study to examine its use as an indicator of the presence of sludge.

E. Use submersible and microtopography technology to sample sediments that are impossible to collect from surface ships.

F. What active and passive optical techniques can be used to follow sludge particles?

G. Phytoplankton and zooplankton in the sludge field should be studied with respect to bioaccumulation.

6. Can physical data serve as a surrogate measurement for sludge movement?

What we know

Possible surrogate measurements are transmissometry, metals, dyes, drogues, and acoustics.

What we need to know

A. Emphasis needs to be placed on vertical measurements.

B. There is a need to better interface physical oceanographic measurements with other measurements being taken at the 106-Mile Site.

7. Can sludges from the 106-Mile Site be accurately detected to affirm or deny their influence on shoreline, beaches, or natural resources?

What we know

No additional needs were identified by the workshop.

What we need to know

A. Study benthic organisms (tilefish, red crabs, and other long-term residents).

B. Deploy sediment traps.

C. Construct a mass balance for the inner Bight and offshelf areas.

D. Other sludge tracers (silver, cellulose, plant products?).

8. What are the relative amounts of other sources of pollutants to the Bight?

What we know (in tentative ranked order)

A. Hudson-Raritan Estuary

B. Delaware Estuary

C. NY Bight Apex (12-Mile Site, acid waste site, cellar dump site)

D. 106-Mile Site

E. Outfalls

F. Atmosphere

9. **What is the magnitude of atmospheric deposition in the Bight at the 106-Mile Site?**

What we know

Atmospheric deposition can be a potential source of some contaminants (e.g., chlorinated hydrocarbons, etc.)

What we need to know

Atmospheric deposition should be studied with regard to relative magnitude and effects compared to sludge disposal rates.

CHAIRPERSONS REPORT-QUESTION 2

QUESTION 2: WHAT IS THE EFFECT OF SEWAGE SLUDGE DUMPING AT THE 106-MILE SITE ON LIVING MARINE RESOURCES?

1. Characteristics of sewage sludge

1.1 Toxicity Tests

What is known (pg. 4-10 in the background document)

What we need to know

A. Expand the toxicity tests to include species indigenous to the 106-Mile Site.

B. Develop population response models.

C. Review the reliability of labs doing the toxicity testing.

Concern was expressed about the implicit assumption that negative toxicity results equat with no effects in the ocean.

1.2 Pathogens

What is known (pg. 4-11, 4-12)

What we need to know

A. Additional information on effects of pathogens on marine mammals and birds.

B. Increased monitoring for diseases in marine fish and invertebrates in and around the 106-Mile Site.

C. Laboratory studies:

a. Relationship between dumping–Vibrios are stress in marine organisms.

b. Effects of sludge on lethal concentrations of certain bacteria.

c. Relationship between bacteria in sludges and disease in marine organisms.

D. What are the pathogens associated with sewage sludge that are present even after disinfection?

2. Baseline data on living resources

What is known

Several new studies were identified.

What we need to know

A. More work on both shallower and deeper benthic communities–time series to include sediment traps studies and data.

B. Characterization of less well-known fishes.

C. Enhance work on pelagic species, i.e. squids.

D. Work on possible behavior modifications in species swimming around plumes.

E. Enhance site specific larval fish studies, i.e., icthyoplankton

F. Additional information needed on commercial fish landings of catches near the 106-Mile Site.

3. Short-term effects

What is know (pg 4-13)

What we need to know

A. Look at resident and vertically migrating species (i.e., lantern fish, hatchet fish).

B. Perform toxicity tests at the perimeters (boundaries) of the site and plumes.

4. Chronic exposure, bioaccumulation and long-term effects

What is known (pg 4-13, 4-14)

What we need to know

A. Better characterization of sludges and their chemistry.

B. Identify "markers" in sludge for bioaccumulation and effects.

C. Establish a sampling program:

for:
- a. vertically migrating fishes.
- b. benthic fish and shellfish studies correlated with sediment trap data
- c. mid-water organisms, i.e., squid?

measure:
- a. bioaccumulation
- b. patent external disease symptoms
- c. microscopic indications of disease

D. Measurements of bioaccumulation should be used to allay public misperceptions and wariness about fish/seafood consumption.

5. EPA monitoring plan

What is known

Not enough consideration given to monitoring prior to dumping started--detection of changes are therefore difficult.

What we need to know

A. Existing information should be packaged and presented to scientific community and public to present clear picture at 106 situation.

B. Create a (small) group of experts that will be mandated to review details of present and future monitoring plans and make recommendations.

C. Continue monitoring of deep-sea community and key target species.

CHAIRPERSONS REPORT–QUESTION 3

QUESTION 3: WHAT IS THE EFFECT ON HUMAN HEALTH OF DUMPING AT THE 106-MILE SITE?

Introduction

With the passage of the Ocean Dumping Ban Act of 1988, it is essential that we step back to reevaluate the public health risks associated with dumping sludge at the 106-Mile Site. Congress declared in the original legislation that..."it is the policy of the United States to regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters of an material which would adversely affect human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities". This reevaluation will permit both an assessment based upon what is known at this point and form the basis for recommending further research as part of the monitoring requirements of the 1988 legislation.

The public is becoming increasingly concerned about the safety of seafood and the inadequacy of government inspection efforts. There are a number of reasons, not the least of which are consumer perceptions about ocean dumping and pollution. These perceptions are developed from a wide variety of sources and represent a wide spectrum of understanding including the effects of dumping sludge at the 106-Mile Site. US consumers have been bombarded with information, frequently incomplete or inaccurate, about the risks of consuming fish and shellfish. Concerns have also been expressed about reported increased frequency of chitinoclasia in several species of shellfish, beach closures, medical wastes washing up on beaches and recent whale and dolphin die offs along the Atlantic coast.

These concerns and perceptions about seafood safety have not been limited to the US, there are several examples of serious questions being raised or restrictions imposed on US exports of fishery products.

All this has led groups like Public Voice to call for new legislation to authorize more extensive inspection of all seafoods, whether imported or of domestic origin. Congress, to get a better handle on the problems with seafood safety and other concerns, authorized and funded a comprehensive review of this issue by NOAA, in cooperation with FDA and USDA. This study, called the National Seafood Surveillance Project, is well under way and an interim report to Congress is due in October, 1989. The final report to Congress is scheduled for January, 1991. This workshop is both timely and essential to providing a clear understanding of current knowledge about public health risks associated with ocean dumping, particularly at the 106-Mile Site, and the identification of further research needs. In addition, it will provide new insight in terms of public understanding and perception as a basis for informing and educating the public. In examining the public health concerns, the workshop participants were encouraged to consider the information and issues from two viewpoints, first as a public health official and second as a consumer.

Potential for Direct Human Exposure

The possibilities for direct exposure to the pathogens and toxic materials in sludge being dumped at the 106-Mile Site include the haulers/dumpers, commercial and recreational fisherman, crews of passing vessels, and swimmers.

What is known

- Summer in 1987 reported many cases of gastroenteritis, lesions, in New Jersey swimmers.

- Presence of warm-core eddy brought water to within five miles of the shore–highly unusual.

- Epidemiologists will usually attribute a viral infection to contact with another infected person, and not to water or aerosol exposure. Until some investigation is done, risks cannot be ruled out.

- Viruses are present in sludge.

- Viruses cannot survive in open seawater for long unless they are associated with sediments.

- Technology involving viruses are very new–i.e., methods for detecting viruses in sediments, hundreds of gallons of water must be filtered to detect viruses.

- Material dumped at the 106-Mile Site could have come in contact with humans through mechanisms such as

  - actual dumping
  - swimming
  - aerosol
  - Fishing (i.e. in the site, fisherman touches sludge in water)

- No studies have been made on the group that has potential for exposure at the site: barge workers, fisherman, researches.

- We do not have the technology to differentiate between effects of sludge dumped at the 106-Mile Site and effects of shore influences (CSOs).

- Given nutrients, bacteria can grow in water, unlike viruses. Bacteria can transfer drug resistance through reproduction.

- Risk to general heath is minimal.

- Greatest risk is at the site, but no suitable host is present at the site.

- Chances of exposure to pathogens at the Site are low, and not enough to warrant research.

- Swimming is not the only route by which pathogens can infect humans–inhalation of aerosols during dumping (oral, through eyes).

- Potential for effects from exposure to toxic chemicals.

  -Direct contact with toxic chemicals is even less likely than pathogens.

Needs

- Define: Risk, Relative risk, and Perceived risk

  We need a risk number. Do you spend research money to come up with this number?

  If a number can be reached by analyzing the existing literature, this is preferred over just saying that the risk is minimal.

- Definitive statement on public health risks–

  The public is confused. The public needs to be informed of the differences between various sources and their risks.

- Need to acknowledge to the public that they should have concerns about bathing water quality. Inform the public that the issue is less likely to be the 106-Mile Site, and more likely from other sources (i.e., shoreline activities).

Conclusions based upon available information

- Pathogens and toxics in sludges dumped at the 106-Mile Site carry no appreciable risk to public health through direct exposure.

Potential for Indirect Human Exposure

- What is potential for indirect human exposure?

  A. Pathogens
  B. Toxic Chemicals

- FDA considers:

  -contamination level
  -toxicity
  -relative level of consumption

- Pathogens–no shellfish from the 106-Mile Site are consumed by humans. No regulations on fish–only levels in shellfish.

- Do not know of any impact on human health. Cooking kills pathogens.

- Scallops are in the 106-Mile Site area of influence, but not eaten raw.

- Some dumpers kill pathogens with heat, also storage for several days will kill pathogens.

- Yet, potential is there for incremental increase in background.

  evidence is in liver, not in muscle. May not relate directly to the 106-Mile Site, but any in toxic levels in seawater potential.

- Medical waste–is going out illegally–not on barges. Different issue.

- Risk is greater than direct because foods are not always cooked thoroughly–i.e. crabs cooked only until they turn pink.

- If the sludge disposed at the 106-Mile Site reaches shore, we should worry about all viruses because you would have the combination of high risk (pathogens) and many hosts (swimmers). It will be up to the physical oceanographers to tell us probabilities of onshore impacts.

Needs

- We recommend immediate analysis to satisfy public perception? Yes.

  -UNJ already has data for nearshore–should utilize.

  1. What species?–decide in further discussions.

  2. What chemical?–pick those most likely suspect.

- Now broader than the 106-Mile Site–look for everything–sample edible seafood from Mid-Atlantic Bight, and analyze for sludge components and other chemicals. (Heavy metals, toxic chemicals, and other potential health hazards).

  Use existing data on fish.

  Use standard list of metals and organics. Don't rely on covariance.

- Recommend that some type of analyses be conducted on fish and shellfish as part of the monitoring program.

- More species should be collected and analyzed for presence of toxic levels of pathogens, metals, and organics.

Conclusions based upon available information

- There is no information to suggest that seafood is unsafe because of dumping at the 106-Mile Site.

Harvested resources of concern

- Species harvested from near the 106-Mile Site represent an extremely small fraction of the U.S. supply. About 65% of seafood consumed is imported.

- Hudson-Raritan Estuary Basin Coastal NY and NJ–major sources of pollutants in NY Bight

Did 12-Mile Site have public health risks?

areas were closed to commercial shellfish (825 km^2) and no immediate plans to reopen these beds in the near future.

- Lobster

  Extensive migrations annually (esp. 1-2 lb. size) inshore–offshore, canyon–canyon.

  Potential vectors of contaminants.

  Market discrimination against lobsters with shell disease therefore human health concerns are lessened because people won't buy scarred lobsters.

  Often claws or tails are pulled off and sold as lobster meat (rather than whole lobster)–"shacked lobster."

  Shell disease more inshore problem than offshore–problem may be more subtle.

  Interaction with red crab during inshore–offshore migration (predator/prey interface).

  Generally no deeper than 400m (at heads of canyons).

No evidence of contamination directly from the 106-Mile Site–it would be extremely difficult to determine yes or no.

- Tuna

  Tuna are very sensitive species, generally are not found closer than 50 fathom bath (very temperature sensitive)

- Tilefish–tend to be less migratory

  If in downcurrent, primary candidate for contamination.

  Range is within several hundred meters in grottos.

  Move tons of sediment yearly during normal behaviors.

  Piscaries (young tilefish, redfish, small lobsters eaten).

  400 ft to 800 ft range–not near 106-Mile Site proper.

  Grottos prime area for trapping sediments.

  Highly contaminated gradient moving into Hudson Canyon from 12-Mile dumpsite (as far as 25 nmi into canyon from 12-Mile Site).

Test tilefish in area of slope break vs. tilefish in Georges Bank--if both have same levels, can be concluded there's no contamination (body burdens within background).

In this area, no more than 20% of population north of Cape Hatteras is found in the area under discussion and may potentially be impacted.

- Squid (Illex)-US production is primary bait (low human health concern)-pelagic Shark, Swordfish, Tuna-large migratory patterns
- Tilefish metals, PCBs content from Georges Bank area is available
- Tunas fished off shelf break

Conclusions based upon available information

There has been no evidence that ocean dumping at the 106-Mile Site poses a threat to human health. All other vectors of exposure to disease are extremely low.

Other concerns and needs

- The monitoring to date has triggered several new regulations and permits.
    1. Regulate dumping on site.
    2. Rates of dumping.
    3. Better control of sludge content
- Lack of up-to-date consumption information. Need to monitor.
- Encourage public to participate.

CHAIRPERSONS REPORT–QUESTION 4

QUESTION 4: ARE THERE CHANGES IN SITE DESIGNATION OR PERMIT CONDITIONS THAT CAN PROVIDE EVEN BETTER PROTECTION OF THE ENVIRONMENT, LIVING MARINE RESOURCES, OR HUMAN HEALTH?

A. Regulatory Issues

Generally, conformation to regulatory criteria were judged to be good, noting, however, that violations have occurred in dumping too close to previous plumes and the fact that half the plumes monitored have at least one contaminant that exceeds EPA chronic water quality criteria when crossing the site boundary.

It was agreed that neither the site configuration nor the areal extent of the site should be changed. Also, it would take a number of years to make such changes and EPA will probably not take that approach.

It was understood that the ODSS is being improved. It should be to be able to trace all barges all the time, even if they break loose. Also, there was support for using XBTs from barges.

B. Monitoring Issues

1. The tiered approach to monitoring is supported, but Tiers 3 and 4 should be pressed now; no need to wait for Tiers 1 and 2 to be completed.

2. Monitoring should consider two things: bioaccumulation and habitat destruction. The habitats to be monitored should be: ocean surface, at the pycnocline, and on the bottom.

3. Monitoring's first priority should be a determination of the trajectories of particulate matter off site.

4. Nutrient loading should be monitored, especially for its effect on plankton and on increase in pathogens, both on and off site.

5. The four-hour test for toxicity should be revisited. Dumpers should be encouraged to remove toxicity from sludge to benefit from faster dumping rates. And, should not EPA consider seeking regular decreases in toxics in sludges each year so that loadings of toxics at 106-Mile Site decrease.

6. There is not (and should be) farfield, long-term research based on science, not on public perceptions of the problem; the monitoring plan needs to be peer reviewed.

C. Site designation issues

1. There are relatively few data to permit a decision to be made as to whether or not to expand the size of the present 106-Mile Site.

Need: Increased pre-treatment to allow contaminant reduction in waste so that dumping can occur within the presently defined 106-Mile Site.

2. If EPA decides to expand the 106-Mile Site, the consensus was to expand in an offshore direction.

3. Any expansion or redesignation would require the full legal process, including an EIS.

D. **Management Tools/Methods for Site Evaluation**

1. The frequency of sludge characteristics monitoring is proposed to be monthly with quarterly analysis of data to develop average composition characteristics of sludges.

   Recommendation: There should be routine monitoring of the site perimeter. All agencies and interest groups should carefully review and comment on proposed permits.

2. At present, there are two monitoring cruises per year, one summer, one winter, measuring plume dispersion, compliance with water quality criteria (WQC) after four hours, and field toxicity.

   bioassay, core sampling

   Recommendation: Need to tighten up coordination regarding policy direction as well as the already conducted work of one Blue Ribbon Panel of scientists.

3. EPA site monitoring budget is $1.1 million; one cruise and data work up costs $450,000.

   Recommendation: Responsible agencies should develop monitoring plan for what is needed including costs. Then, apply available funds to the highest priority needs.

   Recommendation: Further explore ships of opportunity, including fishing vessels, as platforms for sample collection.

APPENDIX C.

REPORTS OF WORKGROUP STRATEGISTS

STRATEGISTS REPORT--QUESTION 1

WHAT IS THE PHYSICAL AND CHEMICAL FATE OF THE MATERIAL DUMPED AT THE SITE?

1. **What are the physical and chemical characteristics of the sludges?**

   a. Select standardized analytical and sampling procedures for sludge analyses to provide comparable information among dumpers.

      Select analytical parameters that reflect potential for biological impacts (including pathogens) and that are useful for modeling and tracking purposes.

   b. Conduct research on physical and chemical partitioning of sludge particles in marine systems to improve understanding of fate (caused by physical/chemical/biological processes).

   c. Conduct physical/chemical partitioning studies using seawater flow tanks (using up-to-date sludges).

2. **What are the water current regimes at the site?**

   a. Design and implement an Eulerian current measurement program coupled with a Lagrangian drifter experiment. Lagrangian drifters should be released on a weekly basis over a period of one year. Sludge vessels could deploy drogues. See Q# 1-3 also.

   b. Integrate real time remote sensing data (Gulf Stream, warm core rings, etc.) into the analysis of Q# 1-1 above.

3. **What do the sludges do at the site?**

   a. Design and implement a sediment trap study to measure settling of sludge particles or sludge tracers. Horizontal and vertical placement important--particularly with regard to the location of the pycnocline. Consider floating and fixed traps. As a beginning, a trap should be fixed directly below the pycnocline for a point dump.

      Analyze collected materials for micro organisms as well as contaminants of concern.

   b. Conduct acoustical sludge tracking studies to supplement transmissometer studies to better define and quantify partitioning particularly around the pycnocline.

4. **Are there any adequate mathematical models available to estimate where, how long, and in what concentration constituents of the sludges are transported?**

   * a. Implement the use of existing data in near field models to help develop appropriate monitoring strategies.

   * b. Assess existing far field models for effectiveness and applicability to the 106-Mile dumpsite.

5. What techniques are being used to track the sludges now?

See Question Q# 1-3-b.

6. To what extent can easy-to-obtain and inexpensive physical data serve as a surrogate measurement for movement of the whole sludge? Is there a chemical that meets these requirements?

a. Continue to develop unique characteristics of whole sludge.

* b. Prepare a review article on the status of knowledge of the physical oceanography at and near the 106-Mile Site. Use this to help design measurement program in Q 1-2-a.

7. Can those 106-Mile Site sludges be detected accurately enough at a distance to affirm or deny their influence on shorelines, beaches, or natural resource areas?

* a. Scientific community must communicate with the public concerning the fate and effect of the dumped sewage sludge. Use the Sea Grant public outreach program.

8. What are the relative amounts of other sources of sewage sludge to the Bight?

* a. Conduct estimates of mass balance loadings which influence the 106-Mile Site. Inner shelf vs. outer shelf vs. offshelf. Quantify sources including Hudson Plume, Delaware Plume, Apex Sources, coastal discharges, atmospheric inputs, 106. See Hydroqual Study (1989) conducted as part of the NY Bight Restoration Plan.

* b. Prepare an assessment of the water column chemical baseline data in the vicinity of the 106-Mile Site to determine variability and to be used in development of the monitoring program.

c. Develop techniques for determining contaminant gradients along and toward the shelf. Consider

1. Sediment traps (Q# 1-3-a).
2. Biomonitoring of tilefish–a good long term resident population biomonitoring of red crab and lobster

9. What is the magnitude and effect of atmospheric deposition of contaminants in the Bight? Does it reach the 106-Mile Site?

* a. Consider conducting research to determine estimates of atmospheric loading on and off the shelf. This may be extremely expensive and not the best use of resources. Review data available from Bermuda as a beginning.

GENERAL

* a. Write synthesis report integrating existing data and the biological, chemical, physical studies to assess ecological and public health effects.

b. EPA should establish an advisory committee to monitor the research, monitoring, and surveillance program. Include public etc.

*These topics relate to use and assessments of existing data. These are probably high priority, first order task for EPA and NOAA to undertake with the initial funds derived from fees for dumping at 106.

STRATEGISTS REPORT–QUESTION 2: EFFECTS ON LMRs

1. Using previous modeling, modeling data, and hydrographic measurements, as well as analyses (chemical, microbiology, etc.) from sediment traps, design and implement collections of key target organisms for bioaccumulation and short-term effects research and monitoring:

   1.1 Appropriate organs are removed from target species for contaminant analyses and autopsy, seeking evidence for patent disease and relationships of these and other abnormalities to wastes and contaminants dumped at the 106-Mile Site.

   1.2 The foregoing would include a census of chitinoclasia (incidence and distribution) at 106 and areas (midshelf and canyons) potentially affected by dumping at the 106-Mile Site.

   1.3 Data from aforementioned census to be analyzed and correlated with sediment trap data collected concomitant with census.

   1.4 Target species biota, sediment trap matter, and dumped wastes studied for pathogens, especially Vibrio, and other micoorganisms know to be involved for chitinoclasia and finrot.

   1.5 Foregoing efforts and short-term monitoring to be expedited during expanded "assessment cruises" to include the 106-Mile Site area with analyses of myctophids (lantern fish) and other vertically migrating species as well as midwater species such as squid (Loligo).

   Moreover, commercial and recreational fishing vessels will be used for correlative activities during assessment intercruise periods.

   1.6 Benthic (lobsters, red crabs, bivalves) and demersal (tile fish, Antimora) species, and communities, will be used in establishing a time-series baseline for monitoring.

   1.7 Species from 106-Mile Site (mid-water and vertical migrators) will be used to "calibrate" existing toxicity tests for biological effects; in situ bioassays will be performed.

   1.8 Foregoing studies to be accomplished so that data will be collected and arrayed in a manner which will allow their use in modeling of population dynamics essential to hazard assessments per US EPA protocols (i.e., wastes characterization, habitat characterization, etc.).

   1.9 Laboratory and field research to be done on effects of dumping (and associated wastes), or stress, on function of immunological systems, as a bioassay tool.

   1.10 Item 1.9 and other bioassays of toxic effects to be performed in waste plumes and at stations located at borders of plumes and the disposal site.

2. A definitive report on the usefulness of existing physical studies and historical modeling activities to be prepared in "lay language".

3. A definitive interpretative report of our present understanding of the effects of ocean dumping at 106 on LMRs, using existing data, generic information and reports, and publish characterizations, emphasizing effects and the potential for dumping to affect their wholesomeness for human consumption, to be prepared in clear, concise "lay language".

4. If survey(s) of short-term effects shows impacts by ocean dumped materials, then immediately implement verification procedures, and take steps to relocate site 106 to preselected further offshore site (i.e., in Gulf Stream or beyond).

5. A permanent "Blue Ribbon Committee" of "experts" should be established to

   5.1 review any monitoring plan developed by the concerned federal and state agencies, and

   5.2 to review ongoing monitoring results, make recommendations for adjustments to the program, provide for "red flag" responses to sudden events, and establish evaluation procedures in regard to the efficiency of monitoring and enforcement of dumping protocols and regulations.

   5.3 This "Blue Ribbon Committee" will be empowered to add members (based on their interests in LMRs) or call upon other experts to testify, draft white papers, or evaluate findings forthcoming from monitoring and research commissioned by the concerned agency.

STRATEGISTS REPORT–QUESTION 3

EFFECT OF SLUDGE DUMPING AT 106-MILE SITE ON HUMAN HEALTH

Potential for Direct Human Exposure

1. Incorporate in a physical oceanography study (See Questions 1 and 2) mechanisms to measure frequency of exposure of sludge components on the shoreline, i.e., quantify dilutions and dispersions.

2. Develop and implement a coastal monitoring program for impact of discharges from outfalls and CSOs, relative to the 106-Mile Site sludge, etc.

Potential for Indirect Human Exposure

1. Per Item 1.1 of Strategies, Question 2, samples are collected during assessment cruises, fish musculature tissues are autopsied for chemical analyses to determine if contaminants have accumulated in commercially important fishes from the 106-Mile Site.

2. Fish from middle Atlantic Bight (stations selected based on past monitoring endeavors) collected for analysis for contaminants:

   2.1 Fishes with high and moderate levels of lipids are analyzed for organic and inorganic xenobiotics.

   2.2 Stations arrayed along gradients extending from 106-Mile Site up canyons and across the shelf used to establish relevancy of 106-Mile Site data and effects of 106-Mile Site per se.

What are the harvested resources of concern

1. See 4 below.

What are the consumer concerns

1. Establish a mechanism that will address issues or events as they occur; anticipates potential issues and develops appropriate responses; provides the means for getting such information to consumers (public) in a timely manner. (See Question 2 - #5).

2. Develop plan that will ensure that when events occur the facts are ascertained directly, not from media or other second hand sources.

3. Incorporate in the operation of a Blue Ribbon Committee, a mechanism (Question 2 - #5) that ensures the participation of scientists and technical expertise as well as industry and consumer representatives in the review of the monitoring and surveillance activities on the 106-Mile Site before the reports on such activities are released to the public.

4. New or renewal permits should include requirements for further pre-treatment mechanisms to reduce (remove) contaminants of concern (i.e., Cu, Pb, organic toxins).

5. Develop a public education program that addresses the issues of sludge, not as an ocean issue, but as a societal issue which encompasses a comparison of the relative risks associated with currently available alternatives, i.e., landfill, composting, incineration.

STRATEGISTS REPORT–QUESTION 4

ARE THERE CHANGES IN THE SITE DESIGNATION, PERMITS, OR SURVEILLANCE THAT CAN PROVIDE EVEN BETTER PROTECTION OF THE ENVIRONMENT, LIVING MARINE RESOURCES ON HUMAN HEALTH?

A. Regulatory Issues

1. Develop better analytical procedures for bioassays, including QA/QC, that would attempt to assess the true toxicity of wastes. Also, incorporation of deep sea organisms into the bioassay procedures is vital.

2. The ODSS system must be improved to give timely and accurate information on dumping. This information must be accessible to the public. The system must provide redundancy to assure as a minimum 95% coverage instead of the 80% as proposed.

3. The long-term monitoring program must include separate funds to be set aside for site recovery, possibly as a separate escrow account.

B. Monitoring Issues

1. The nearfield four hour mixing zone formulation must be reassessed as a specific research effort. Design and implement a detailed study utilizing a number of different dumping and mixing scenarios.

2. As stated previously, the first priority is to develop the physical transport models for mixing and movement of material from the site with emphasis on the ultimate fate of the material.

3. Implement the farfield monitoring studies simultaneously with the Tier 1 and 2 studies.

4. Develop a formalized clearing house on research currently being conducted on 106-Mile Site and outer shelf area.

5. Require that each barge going to the 106-Mile Site have a separate tracking device attached.

C. Site Designation Issues

1. Due to the size limitation of the Site, require permittees to immediately implement extensive pretreatment in order to reduce waste toxicity.

2. Assess the site configuration as part of the redesignation process. Conduct nearfield sampling to determine best site configurations.

D. Management Tools/Methods for Site Evaluation

1. Integrate the Federal Agency Programs currently involved in any fashion with the 106-Mile Site including fisheries, physical oceanography, etc., to eliminate overlap and optimize agency functions.

2. As suggested previously, establish a Blue Ribbon Panel to assess effectiveness of the monitoring programs.

3. Must have better coordination of policy and management within the federal and state agencies and have adequate public involvement.

4. Develop the optimum monitoring program for near and farfield assessments, prioritize and implement as dollars allow and as a feedback to Congress as needed.

APPENDIX D.

RECOMMENDATIONS OF PHYSICAL OCEANOGRAPHIC AND MODELER SUBWORKING GROUP

RECOMMENDATIONS FOR PHYSICAL OCEANOGRAPHIC MEASUREMENTS

Tier 2

- Maintain current meter mooring at 106-Mile Site to develop statistics on near-surface currents and horizontal transport of sludge out of the site. Consider addition of near-surface transmissometry, salinity and temperature sensors, and current meters to mooring.

- Conduct profiling operations within additional sludge plumes to determine the immediate settling characteristics of sludge. Transmissometers and/or digital, acoustic profiling systems should be used to resolve vertical settling behavior and direct water sampling for post-survey laboratory analysis of particle size distributions.

- Laboratory studies of sludge settling in seawater flocculation can be simulated.

- If future models require accurate statistics on near-surface current shear at the site, a moored, upward-looking acoustic doppler current profiler would be most useful. Costs for this system are high, but NOAA/NOS may be able to provide equipment/technology.

Tier 3

- A Lagrangian drifter program is highly recommended for determining the pathways of sludge transport from the 106-Mile Site. One surface drifter should be released per week at the site for a period of one year. Drifter's should be tracked by ARGOS satellite for a minimum of four months each.

- High-resolution surface thermal images of the 106-Mile Site and adjacent regions should be obtained from AVHRR sensors on NOAA satellites. One to two images should be processed per week for the duration of the Lagrangian drifter program. NOAA satellite processing facilities in Maryland and Narragansett should be considered as sources of images.

- An array of moored, sub-surface sediment traps should be deployed to determine whether sludge particles are deposited on the seafloor at the 106-Mile Site or further inshore. An array of eight measurement sites with three traps per mooring would provide adequate horizontal and vertical resolution.

- A farfield water column survey should be conducted in summer to obtain water samples from the vertical particle maximum in the pycnocline. Trace metals analyses of collected particles should distinguish sludge accumulation from natural particulates.

- Subsurface thermal data obtained from XBT (expendable bathythermograph) profile measurements between the 106-Mile Site and the Continental Shelf would provide useful data on water mass boundaries and processes affecting sludge transport. Measurements could be conducted from sludge barges or ships-of-opportunity associated with on-going NOAA programs.

- Accurate, three-dimensional models of the circulation within the slope sea region (including the 106-Mile Site) do not exist, nor could they be developed and validated

in time to be of use to the 106-Mile Site program. It is recommended that the field results from the physical measurements programs be used to test and validate existing models of farfield sludge transport.

APPENDIX E.
TABLES - ISSUES IDENTIFIED FOR DISCUSSION

TABLE E-1. ISSUES IDENTIFIED FOR DISCUSSION PRIOR TO THE 106-MILE SITE WORKSHOP. QUESTION 1: WHAT IS THE PHYSICAL AND CHEMICAL FATE OF THE MATERIAL DUMPED AT THE SITE?

AREA	ISSUES
SLUDGE COMPOSITION AND CHARACTERISTICS	Parameters to include in permittee monitoring requirements.
	Data quality requirements.
	Sludge phases that must be monitored.
	Sampling and reporting frequency.
	Inconsistencies between measurements by the ocean dumping regulations and those accepted in the water quality criteria documents.
SHORT-TERM BEHAVIOR	Resolution of all factors that significantly affect the rate of sludge dilution/settling.
	Adequacy of the field methods to detect sludge settling.
	Appropriate laboratory methods for assessing sludge settling and their applicability to the 106-Mile Site.
COMPLIANCE	Significance of exceeding WQC in the nearfield.
	Operation and effectiveness of the ODSS.
	Buildup of contaminants in the pycnocline.
	Application of WQC at a point versus an average duration.

TABLE E-1. Continued

AREA	ISSUES
FARFIELD FATE	Likely transport pathways for sludge leaving the site.
	Importance of the pycnocline as a barrier to sludge transport.
	Frequency of recirculation through the site.
	Frequency of on-shelf transport and duration of events.
	Likelihood of sludge reaching the continental shelf.
	Likely depositional sites for the sludge.
	Suitable field methods for measuring the transport and deposition of sludge.
	Spatial scales and sampling frequency to employ to detect long-term changes in contaminant concentrations outside of the site.
	Importance of biotransport processes.
MODELS	Identification of the appropriate transport model.
	Identification of the appropriate exposure and effects assessment model.
	Data required to validate models.
	Design of field programs to validate models.

TABLE E-2. ISSUES IDENTIFIED FOR DISCUSSION PRIOR TO THE 106-MILE SITE WORKSHOP. QUESTION 2: WHAT IS THE EFFECT OF THE SLUDGE DUMPING AT THE 106-MILE SITE ON LIVING MARINE RESOURCES?

AREA	ISSUES
CHARACTERISTICS OF SEWAGE SLUDGE	
TOXICITY TESTS	Relevance of toxicity tests to long-term protection of living marine resources.
	Appropriateness of the test species used for toxicity testing.
	Relationship between these toxicity tests and potential impacts at the 106-Mile Site.
	Limitations of toxicity tests.
PATHOGENS	Understanding the survival rates of sludge bound-pathogens during storage and transport.
	Understanding of survival of sludge-bound pathogens in seawater and sediments.
	Adequacy of C. perfringens to represent other pathogen survival and transport (i.e., adequacy as pathogen surrogate).
	Improvements to and standardization of methodologies for tracking pathogens.
	Transport of pathogens onshore and into sediment.
	Transfer of pathogens into living marine resources.
	Effects of pathogens on living marine resources.
	Understanding of environmental significance of multiple pathogens (pathogen synergy).

TABLE E-2. Continued

AREA	ISSUES
BASELINE DATA ON LIVING RESOURCES	Sufficiency of baseline data to assess changes in the communities in the area and outside of the site in response to sludge disposal.
	Type and level of monitoring required to determine community changes in the water and sediments in the area.
	Most effective region to focus monitoring/research money.
SHORT-TERM EFFECTS	
ACUTE TOXICITY TESTS	Approriateness of these tests.
	Extrapolation of these results to other populations.
	Ecological significance of short-term effects.
	Toxicity during stagnant periods.
CHRONIC EXPOSURE	
BIOACCUMULATION	Occurrence of bioaccumulation of sludge-derived contaminants.
	Effectiveness of bioaccumulation studies in linking cause and effect.
	Linkage of bioaccumulation to 106-Mile Site and other activities.
LONG-TERM EFFECTS	Identification of potential effects that may result from sludge disposal activities.
	Relative importance of 106-Mile Site to other sources in region.
	Linkage between sludge disposal at the 106-Mile Site and decline in shellfish and fish catch from adjacent canyon areas.

TABLE E-2. Continued

AREA	ISSUES
	Linkage between present sludge disposal at the 106-Mile Site and declining fish stocks in the entire New York Bight/Mid-Atlantic Bight.
	Relationship of reported chitinoclasia outbreak to sludge disposal at the 106-Mile Site.
	Occurrence of ecosystem effects/alteration.
EPA MONITORING PLAN	
	Appropriateness of the communities targeted for evaluation.
	Practicality of measuring significant changes in these communities and relating them to the sludge disposal activity.

TABLE E-3. ISSUES IDENTIFIED FOR DISCUSSION PRIOR TO THE 106-MILE SITE WORKSHOP. QUESTION 3: WHAT IS THE EFFECT OF THE SLUDGE DUMPING AT THE 106-MILE SITE ON HUMAN HEALTH?

AREA	ISSUES
HUMAN HEALTH PROBLEMS ASSOCIATED WITH SLUDGE DUMPING	
•	**Potential for human exposure to pathogens, direct and indirect.**
	Transport to recreational areas in quantities sufficient to cause risk from direct exposure.
	Transport and transfer of pathogens into living resources.
	Direct exposure to pathogens through commercial and recreational fishing and shellfishing.
	Indirect exposure to pathogens through ingestion of contaminated fish or shellfish.
	Linkage between sludge disposal at 106-Mile Site and direct and indirect exposure to pathogens.
	Risk to human health from ingestion of organisms exhibiting signs of chitinoclasia.
	Transfer of critical information to public.
•	**Potential for effects from exposure to toxic chemicals.**
	Transport/exposure of contaminants to living resources.
	Occurrence of bioaccumulation/biomagnification of sludge contaminants.
	Risk to human health from bioaccumulation of toxic chemicals by important commercial fish.
	Relative importance of 106-Mile Site versus other sources in the New York Bight region.
	Linkage of bioaccumulation to 106-Mile Site activities.
•	**Risk evaluation to human health from activities at the 106-Mile Site.**
	Level of effort required.
	Models to apply (pathogen versus toxic chemicals).

TABLE E-4. ISSUES IDENTIFIED FOR DISCUSSION OF QUESTION 4 PRIOR TO THE 106-MILE SITE WORKSHOP. QUESTION 4: ARE THERE CHANGES IN THE SITE DESIGNATION, PERMITS, OR SURVEILLANCE THAT CAN PROVIDE EVEN BETTER PROTECTION OF THE ENVIRONMENT, LIVING MARINE RESOURCES, OR HUMAN HEALTH?

AREA	ISSUES
REGULATORY ISSUES; CONFORMATION TO REGULATORY CRITERIA	
	Appropriateness of site configuration.
	Appropriateness of areal extent of the site.
	Appropriateness of disposal rates for the site.
	Appropriateness of permit conditions for protecting living resources.
	Appropriateness of the permit conditions for protecting human health.
	Appropriateness of marine water quality criteria at the site.
	Effectiveness of the Ocean Dumping Surveillance System.
	Restrictions on dumping during stagnant conditions or periods of northerly flows.
MONITORING ISSUES	
	Implementation of the tiered monitoring approach.
	Adequacy of nearfield data.
	Appropriateness of the farfield monitoring design.
	Relationship between 106-Mile Site monitoring plan and regional monitoring/research needs.
SITE DESIGNATION ISSUES	
	Adequacy of monitoring information to redesignate, dedesignate, or alter the site.
	Need for a supplemental Environmental Impact Statement.

TABLE E-4. Continued

AREA	ISSUES
MANAGEMENT TOOLS/METHODS FOR SITE EVALUATION	
• Nearfield monitoring and effects.	
	Level of nearfield monitoring necessary to ensure permit compliance.
	Level of monitoring necessary to evaluate short-term effects.
• Farfield transport.	
	Design of appropriate farfield transport studies for the 106-Mile Site.
	Design of effective long-term effects program.
	Integration of regional monitoring and research programs.
	Definition of agency responsibility for regional monitoring.
	Design of regional monitoring plan/program.

APPENDIX F.

SUMMARY OF NATIONAL UNDERSEA RESEARCH PROGRAM RESEARCH ACTIVITIES

National Undersea Research Program (NURP), University of Connecticut at Avery Point (UCAP) Research on Ocean Dumping/Site 106.

Dr. Richard Cooper–March 29, 1989

PROGRAM SUMMARY/RATIONALE

In 1988, NURP-UCAP responded to direct requests from the recreational and commercial fishing industries to address their concerns about decreasing fish/shellfish catches coincident with sewage sludge dumping at the 106-Mile Site. NURP responded by diverting ship and submersible time to the general vicinity of Block-Hudson-Toms Canyons and the adjacent slope area between Hudson and the 106-Mile Site. Specifically, research submersible time was directed towards an overall assessment of the ecology of lobsters, crabs, lobes, flounders, and tilefish over a depth range of 200 to 1000 meters.

Two submersibles (DELTA, JOHNSON-SEA-LINK) made 1 to 4 km transects over the ocean floor in industry specified areas where evidence (perceived by fisherman) of sludge impact was observed. Using this scenario our diving activities in 1988 were directed towards the "worst case scenario". Box cores, punch cores, video documentation of aerial-substrate associations and visual observations were made/collected during each traverse accomplished. A total of 16 dives was made in August and September.

In general, the ocean floor megabenthic communities and their associated habitats appeared to be quite normal. No obvious signs of sludge impact were observed or suggested from sample analyses or video examination. Lobsters and tilefish appeared in relatively low densities. In the case of lobsters the low population level may have been a direct result of emigration, a result of rational behavior or avoidance to environmental contamination. In regard to tilefish, extensive fishing pressure is probably the cause for the few tilefish seen.

Hake, flounder, jonah crab, red crab, goosefish, squid, mud arenaceous, brittle starfish, redfish, black bellied nosefish, ocean pout, and sculpins appeared in expected densities and their behavior and habitat association seemed normal.

Plans for 1989 are as follows:

I. Alvin will be used at the 106-Mile Site to study the bio-geochemistry of the sediment water interface, to judge whether sludge materials reach the bottom and the likely impact, if any, on the benthos. Cruise date will be in late September. Sediment and animal samples will be collected for contaminant analyses. Video documentation will record species abundance and community structure of the megabenthos; bottom currents and suspended sediment samples will be obtained by an array deployed by Alvin. Colonization experiments are also planned using sludge which will be carried to the bottom.

II. The Johnson-Sea-Link will be used along parallel transects (600 ft., 3000 ft.) running ENE and SW of Hudson Canyon for distances through and beyond the hypothetical zone of potential impacts ("Jelly Bean" zone). Box cores, punch cores, video, 35mm and visual observations will be made at specific intervals/locations along these transects. Surface sediment and archival tissue samples will be analyzed for trace metals, PCBs, etc. We will be looking for gradients in contaminant levels moving away (ENE, SE) from the Hudson Canyon. As with the Alvin cruise to the

106-Mile Site, very precisely collected "fluff" layer samples will be taken and analyzed for recently settled sludge material.

The program is supported by NOAA's Office of Undersea Research. 1989 level of funding for Alvin and JSL combined (dive operations) is approximate $387,000. Another $200,000 is expected to support the science, i.e., sample analyses, current measurements, sediment trap operations, Sea Beam profiling etc.

APPENDIX G.

SUMMARY OF CHITINOCLASIA WORKGROUP PRESENTATION

NOTES ON SHELLFISH DISEASE WORKING GROUP FINDINGS

Dr. Carl Sindermann

The Working Group met in November and December 1988, and again in January and February 1989 to review and analyze published and unpublished data on the status of disease and mortality in commercially important crustacean resources, including those from areas beyond the New York Bight. In February, an additional meeting was convened by New Jersey Sea Grant to gain information from commercial fisherman and representatives of other organizations.

Data on crustaceans from the continental shelf break and the 106-Mile Site were found to be extremely limited. Nevertheless, in order to assess the possible impacts of pollution on commercial species, the Working Group reviewed the available data on lobster, red crab, rock crab, Jonah crab, and blue crab regardless of the geographic source of the data.

Despite the scarcity of information on crustacean health in offshore waters, some tentative conclusions were reached and recommendations proposed.

Principle findings of the study are the following:

1. Shell disease is a natural phenomenon in crustaceans but it may occur with higher prevalence and greater severity in polluted areas. Shell disease represents a stage in the natural relationship between crustaceans and chitin-utilizing bacteria and fungi. The balance between metabolic processes associated with new shell formation, and infection by microbes capable of utilizing chitin, may be disturbed by environmental changes affecting normal shell formation or favoring the growth of chitin-utilizing microbes. Such disturbances can be consequences of pollution.

2. Some evidence exists for an association of shell disease with habitat degradation. Prevalence has been found to be high in crustaceans from polluted sites; prevalence shows trends similar to those of the black-gill syndrome, which also has a statistical association with extent of pollution. Experimental exposures of crustaceans to contaminated sediments, heavy metals, biocides, petroleum, and petroleum derivatives can result in the appearance of the black-gill syndrome, often accompanied by shell disease.

3. Our analyses suggest that prevalences of less than 5 percent may represent expected background levels of shell disease in inshore populations, probably related to mechanical damage or wound healing. Prevalences of over 15 percent, as noted in some inshore samples of lobsters and rock crabs, may reflect pollution-related disease superimposed on the natural occurrence of shell disease.

4. Shell disease occurs in deepwater crustacean populations, including those in shelf canyons, but data are limited, and there is no conclusive evidence that would associate shell disease in such populations with pollution of offshore habitats.

5. Mortalities from shell disease have been observed, occasionally at high levels, in laboratory-held and impounded crustacean populations. Destruction of gills and adhesions of the exoskeleton which prevent molting have been considered to be responsible factors, as have secondary systemic infections which develop after perforation of the chitinous integument. There is no specific evidence, however, that would link crustacean population fluctuations in the New York Bight with the

presence or severity of shell disease. Shell disease may predispose crustaceans to mortality, but there is no currently available method to separate disease-caused mortality from that caused by other influences. Additionally, there are no discernible trends in either lobster or crab abundance in the Middle Atlantic Bight in the past decade; if anything, there seems to be a slow increase in lobster abundance inshore and offshore.

Concerning the situation in the vicinity of the 106-Mile Site, shell disease may be a problem insofar as the marketability of diseased crab and lobsters is concerned. However, there is no conclusive evidence available now to associate shell disease in offshore populations with sludge dumping activities at the 106-Mile Site.

Shell disease in crustaceans, therefore, resembles fin-rot disease in finfish—a natural phenomenon exacerbated by stressors found in degraded habitats. The consequences are the inability to maintain an intact integument as a defense against invasion by facultative microorganisms. The results of this are gross abnormalities that we recognize as "disease."