Report to the Congress On Ocean Dumping Research

January through December 1977

August 1978

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

Report to the Congress On Ocean Dumping Research

January through December 1977

Submitted in compliance with Section 201,
Title II of the Marine Protection, Research,
and Sanctuaries Act of 1972
(Public Law 92-532)

August 1978

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary
United States. **National Oceanic and Atmospheric Administration**
Richard A. Frank, Administrator

THE SECRETARY OF COMMERCE
Washington, D.C. 20230

January 16, 1979

Dear Sirs:

It is my privilege to submit to the Congress this fifth annual report on ocean dumping.

Under Title II of the Marine Protection, Research, and Sanctuaries Act of 1972, the Congress assigned to the Department of Commerce a responsibility to initiate a program of monitoring and research to improve our understanding of the effects of dumping wastes into the ocean. This report is in response to Section 201 of the Act, which specifies that the Secretary shall report on the findings of such research to Congress at least once a year.

This report describes the ocean dumping investigations carried out by the National Oceanic and Atmospheric Administration during calendar year 1977. It focuses upon three major categories of pollutant materials: sewage sludge, industrial wastes, and dredged materials. Field and laboratory studies relating to these types of pollutants were completed during the year that apply to several marine areas. The effects of dumping industrial wastes into deep waters was investigated for a disposal site in the Gulf of Mexico and for a site in the Atlantic near New Jersey. The environmental effects of sewage sludge and dredged material disposal were studied in the region of the New York Bight.

Substantial progress was made during the year in furthering the general understanding of the basic environmental effects of dumping waste materials into the ocean. Substantial progress was also made in developing remote sensing techniques for monitoring dispersal patterns of dumped wastes. These advances were made through a series of field waste-tracking experiments performed in unison with laboratory studies of the chemical and physical nature and biological impacts of the same wastes.

The Department of Commerce will continue to fulfill its responsibilities under the law for carrying out research on the effects of ocean disposal of wastes. The work provides valuable and immediate support to regulatory agencies, and also improves our scientific understanding of the environmental implications of ocean dumping.

Sincerely,

Juanita M. Kreps

Secretary of Commerce

President of the Senate
Speaker of the House of Representatives

CONTENTS

ILLUSTRATIONS AND TABLES

CHAPTER I

INTRODUCTION

BACKGROUND

The Marine Protection, Research, and Sanctuaries Act (MPRSA) was enacted October 23, 1972. This legislation was the result of concern on the part of Congress, the Executive Branch, and public over the potential harmful effects of continuted unregulated ocean waste disposal. The problem of ocean dumping was reviewed by the Council on Environmental Quality (CEQ) in its 1970 report to the President on ocean dumping. The CEQ report recommended a comprehensive national policy on ocean dumping of wastes to end unregulated ocean dumping, and to prohibit ocean disposal of all materials harmful to the marine environment. Specific recommendations on the three major categories of dumped waste materials were as follows:

- Dredge material: "Ocean dumping of polluted dredge spoils should be phased out as soon as alternatives can be employed. In the interim, dumping should minimize ecological damage. The current policy of the Corps of Engineers on dredging highly polluted areas only when absolutely necessary should be continued, and even then, navigational benefits should be weighed carefully against damages."

- Sewage sludge: "Ocean dumping of undigested sewage sludge should be stopped as soon as possible and no new sources allowed. Ocean dumping of digested or other stabilized sludge should be phased out and no new sources allowed. In cases in which substantial facilities and/or significant commitments exist, continued ocean dumping may be necessary until alternatives can be developed and implemented. But continued dumping should be considered an interim measure."

- Industrial waste: "Ocean dumping of industrial wastes should be stopped as soon as possible. Ocean dumping of toxic wastes should be terminated immediately, except in those cases in which no alternative offers less harm to man or the environment."

Passage of the Marine Protection, Research, and Sanctuaries Act of 1972 committed the United States on a national basis for the first time to:

"... regulate the dumping of all types of materials into ocean waters and to prevent or strictly limit the dumping into ocean waters

of any material which would adversely affect human health, welfare or amenities, or marine environment, ecological systems, or economic potentialities."

AGENCY ROLES AND RESPONSIBILITIES

The Marine Protection, Research, and Sanctuaries Act of 1972 is organized into three titles. Title I deals with regulatory aspects of ocean dumping. The Act assigns regulatory authority and involvement to the Environmental Protection Agency (EPA), the Corps of Engineers (COE), and the Coast Guard (USCG). Title II of the Act deals principally with research aspects of ocean dumping that are needed to support the intent of the Act to limit ocean dumping of harmful materials. The research responsibilities described in Title II are to be coordinated by the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA), in consultation and coordination with other Federal agencies. Title III of the Act provides for the designation of marine sanctuaries. This Title is also administered by NOAA in consultation with other Federal departments and agencies.

Section 201 of Title II assigns responsibility to the Department of Commerce for a comprehensive and continuing program of monitoring and research regarding the effects of dumping material into ocean waters, coastal waters, and the Great Lakes. The legislation also directs that the Secretary of Commerce will provide to the Congress at least once a year the findings from the monitoring and research program.

SCOPE OF THE REPORT

This is the fifth annual report to Congress by the Department of Commerce pursuant to Section 201 of the legislation. In addition to the Title II research of NOAA, the first three Department of Commerce annual reports described research activities of EPA, COE, and USCG carried out in support of their respective regulatory responsibilities under Title I of MPRSA. Amending legislation in 1976 (P.L. 94-326) directed that those agencies submit to the Congress separate annual reports on their administration of Title I. This report, therefore, covers only NOAA research on ocean dumping during calendar year 1977.

CHAPTER II

NOAA OCEAN DUMPING RESEARCH - 1977

GULF OF MEXICO

BACKGROUND

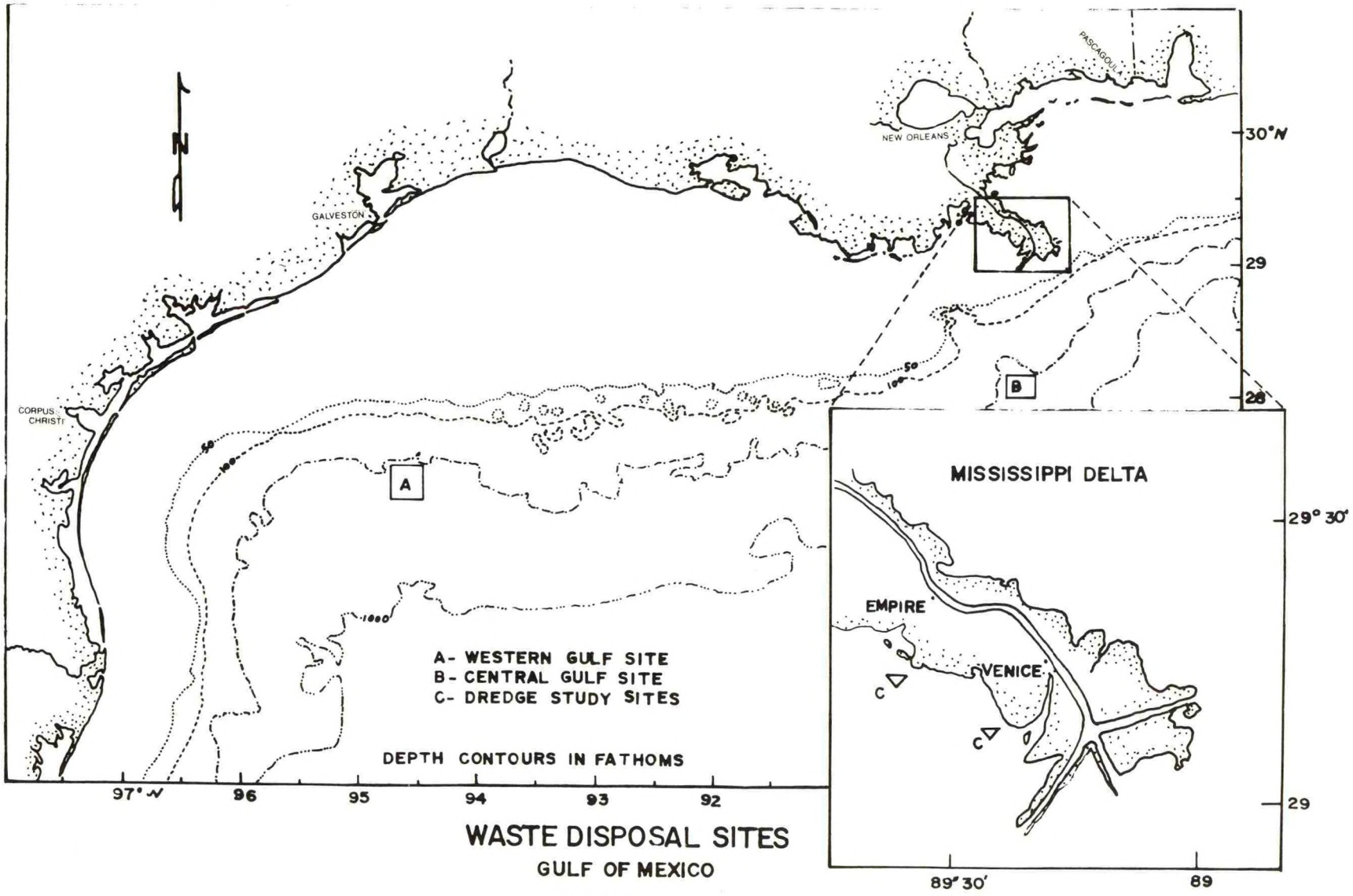
Two deepwater industrial waste dumping sites were utilized in the Gulf of Mexico during 1977. One is located at 28°05'N, 39°23.5'W, approximately 50 nautical miles (nmi) from Southwest Pass on the Mississippi Delta. The area lies in water ranging from 1,000 to 1,300 meters (m) deep, and has surface dimensions of about 10 x 13 nmi. The second site lies approximately 120 nmi south of Galveston, Texas at about 27°20'N, 94°36'W. Surface dimensions of this area are roughly 14 x 16 nmi, and the site measures from 900 to 1,400 m in depth. Exact locations of the sites are shown in figure 1.

The dumping site located immediately south of the Mississippi Delta (named the Central Gulf Site in figure 1) was used during 1977 by the Ethyl Corporation of Baton Rouge, Louisiana. The waste material discharged at the site was a highly reactive inorganic sludge consisting primarily of metallic sodium and calcium, sodium chloride, and sodium and calcium oxides. The wastes were sealed in metal drums before being transported to the disposal area, and barge loads of the drums were dumped at the sites about once every month to 6 weeks. The EPA permit regulating disposal of the Ethyl wastes allowed for up to 800 drums (of 200-liter capacity) of the sludge to be dumped at the site each month. The permit also specified that each drum be punctured thoroughly at the time of release to assure rapid neutralization of the contents by reaction with seawater. Since the drums contained substantial amounts of metallic sodium, reaction of the sludge in the ocean was highly explosive.

The dumping site south of Galveston (named the Western Gulf Site in figure 1) was used during 1977 exclusively by the Shell Chemical Company of Deer Park, Texas. The material dumped at the site was a biological sludge consisting of living and dead microorganisms (primarily bacteria and protozoas), and a large variety of organic compounds in suspension and solution. Since the sludge was produced by a biological waste water treatment system, however, the bulk of the material was water.

Barge loads of the Shell sludge were dumped at the Western Gulf Site at weekly intervals during most of 1977. The EPA permit regulating use of the site limited the rate of dumping to roughly 3,450 tons per week, and 50,000 tons per quarter.

The permits regulating use of these two industrial waste disposal sites were issued by the EPA Region VI Office in Dallas, Texas. Through the efforts of the Region VI Office together with cooperative efforts on the parts of the Shell Chemical Company and the Ethyl Corporation to



WASTE DISPOSAL SITES
GULF OF MEXICO

FIGURE 1

establish alternative waste disposal technologies, dumping at both sites discussed here ended during late 1977. In response to an EPA mandate to end dumping of industrial wastes into the Gulf, both Shell and Ethyl made land-based disposal methods operational during the year. Dumping at the Western Gulf Site ended during August, and dumping at the Central Gulf Site terminated during November.

The NOAA research effort applied during 1977 to ocean dumping in the Gulf of Mexico focused almost entirely upon the Shell Chemical Company biological sludge, and the Western Gulf Dumping Site where the Shell wastes were routinely discharged. Even though it was obvious early during the year that dumping of the Shell wastes would end in the near future, studying the Shell problem appeared justifiable for several reasons. First, virtually no scientific information exists concerning the environmental fates of biological sludges deposited in deep waters. Since this was the case, much of the basic information generated by the study would apply to similar dumping situations in other geographic regions, including the sewage sludge sites off the east coast. Second, a field study of disposal patterns and biological fates of the Shell wastes would provide a unique means of estimating fates and effects of industrial wastes dumped into the Gulf in years past. Virtually no information exists about this problem.

The resources available for studying industrial waste dumping in the Gulf during 1977 were applied to the Shell wastes and to the Western Gulf Dumping Site, rather than to the Ethyl wastes and the Central Gulf Dumping Site, for several other reasons. The physical and chemical nature of the Shell wastes closely resembled those of other materials, such as sewage sludge, which are dumped into other ocean areas. Those of the Ethyl wastes were unique for a waste discharged into the ocean. Because of their explosive nature in the presence of water, they were unsuitable for either field or laboratory biological tolerance studies. The Shell wastes, on the other hand, were well suited for biological and chemical investigation, both in the laboratory and at sea. It also would have been prohibitively hazardous to conduct field studies of the Ethyl wastes simply because of the violent and explosive nature of the dumping operation.

The chemical composition of the Ethyl wastes also indicated the material to have an extremely low potential for either short or long-term environmental damage in the ocean. Certain substances contained in the Shell wastes, on the other hand, appeared to have a potential capability to degrade environmental conditions appreciably in the ocean if allowed to reach even measurable concentrations.

STUDY PROGRAM

The study program applying to the Shell wastes and to the Western Gulf Dumping Site for 1977 took form early in the year, and became operational during May. The program had two major operational components.

One consisted of laboratory studies of the chemical characteristics and biological effects of the Shell wastes. The second consisted of a field study of the physical and chemical behavior of the wastes when they were dumped at sea at the disposal site.

The field study took place during July-August 1977 at the Western Gulf Dumping Site. During the exercise, NOAA-sponsored scientific parties aboard the NOAA Ship RESEARCHER and the U.S. Coast Guard vessel ACUSHNET performed a series of physical and chemical waste-track experiments, together with a group of site characterization studies. The studies were completed in a period of time during which a barge load of the Shell wastes were dumped at the site. The scientific group included personnel from the NOAA/NOS Ocean Dumping Program, the NOAA/Atlantic Oceanographic and Meteorological Laboratories in Miami, and from Texas A&M University, College Station. A group of scientists from the NASA Langley Research Center, Hampton, Virginia, also participated in the exercise. The NASA group contributed to the project by collecting aerial imagery of different types of the dumping procedure. The imagery was collected from an aircraft.

The laboratory component of the 1977 program was initiated during late May. The laboratory investigations applied to the Shell wastes included biological tolerance studies, physical and chemical waste characterization projects and analyses of the physical, chemical, and biological conditions of samples of contaminated waters collected at the dumping site during the field study. The laboratory studies were undertaken primarily by Texas A&M University and the University of Texas Marine Science Institute at Port Aransas.

There were three major objectives to the work applied to the Shell wastes and to the Western Gulf dumping site during 1977. These are:

1. To determine the basic environmental characteristics of the sites.

2. To determine the magnitude of on-site environmental effects of dumping.

3. To determine where in the Gulf ecosystem the effects of dumping the Shell wastes are likely to appear, the general nature of the effects, and what means are available to measure the effects.

To achieve these objectives, the operational program for the Gulf for 1977 consisted of three basic thrusts, each of which had field and laboratory components.

1. Physical, chemical and biological site characterization studies.

2. Physical and chemical waste characterization studies, including on-site waste disposal studies.

3. Studies of both the immediate and long-term environmental fates and effects of the waste materials.

RESULTS

The results of the 1977 study program for the Gulf are near completion at this time, and will be published in a Site Assessment Report for the Western Gulf Site that will be released by NOAA/NOS before the end of 1978. A brief summary of the results is presented here, however, to reflect the major accomplishments of the 1977 program, it should be kept in mind that many of the data upon which this summary is based are still in preliminary form, and will not be available for general review until publication of the Site Assessment Report.

The biological waste tolerance studies undertaken during 1977 were completed mainly by a research group at the University of Texas Marine Science Institute. During these studies, organisms similar to the natural inhabitants of the Shell dumping site were exposed to weak dilutions of samples of the wastes taken directly from the Shell plant in Deer Park. The biological responses of the organisms to the wastes were measured in terms of changes in rates of basic biological processes such as metabolism, growth, and reproduction, and were interpreted by comparisons to measured rates of the same processes in organisms that were not exposed to the wastes. The test organisms included fish and a variety of marine algae and crustaceans.

The biological tolerance studies indicated that some types of living organisms exposed to weak concentrations of the Shell wastes do exhibit weak to moderate changes in rates of basic biological processes, but the degree to which the changes would affect populations of the organisms in nature appears to be difficult and perhaps impossible to estimate at this time. Since relatively few living organisms actually inhabit the dumping site, and since it was found during the field study that the wastes dumped at the site are diluted rapidly beyond measurable levels, it appears doubtful that the Shell wastes have had a significant effect upon environmental conditions at or adjacent to the site.

Chemical analyses of samples of the Shell wastes indicated the material to be similar both physically and chemically to sewage sludge. The wastes were found to consist primarily of organic materials, small amounts of minerals and metals, and small amounts of nutrients such as nitrogen and phosphorus. The wastes were not found to contain dangerous amounts of either natural or synthetic toxic substances. This suggests that extremely low concentrations of wastes probably do not cause a degradation of environmental quality in open ocean areas. Analyses of water samples gathered in the waste plume during the test dumping experiment indicate that local concentrations of the bioactive materials contained in the wastes do increase measurably following a dump, but that the concentrations return rapidly to ambient levels.

Waste dispersion studies were completed during the test dump in July-August using acoustical waste-tracking techniques, multispectral and photographic remote sensing techniques, and more routine physical oceanographic methods such as radar tracking of floating drogues deployed in the waste plume. The collective results of these efforts indicate that not only did the waste plume disperse rapidly, but also that the particulate materials contained in the sludge did not penetrate more than 30 or 40 meters into the water column. The materials did not seem to penetrate the seasonal thermocline (the temperature gradient separating cooler and heavier deep waters from warmer and ligher surface waters). Dilution of the wastes in the upper layers of the water mass at the site was still so great, however, that the plume was barely detectable within a day of the test dump.

As mentioned above, the NOAA/NOS studies initiated during 1977 relating to the Shell sludge and the Western Gulf Dumping Site will be completed during 1978, and a report summarizing the results of the effort will also be released during 1978. The studies making up the 1977 Gulf Program, together with names and affiliations of the principal investigators responsible for the work, are listed in table 1.

NEW YORK BIGHT

BACKGROUND

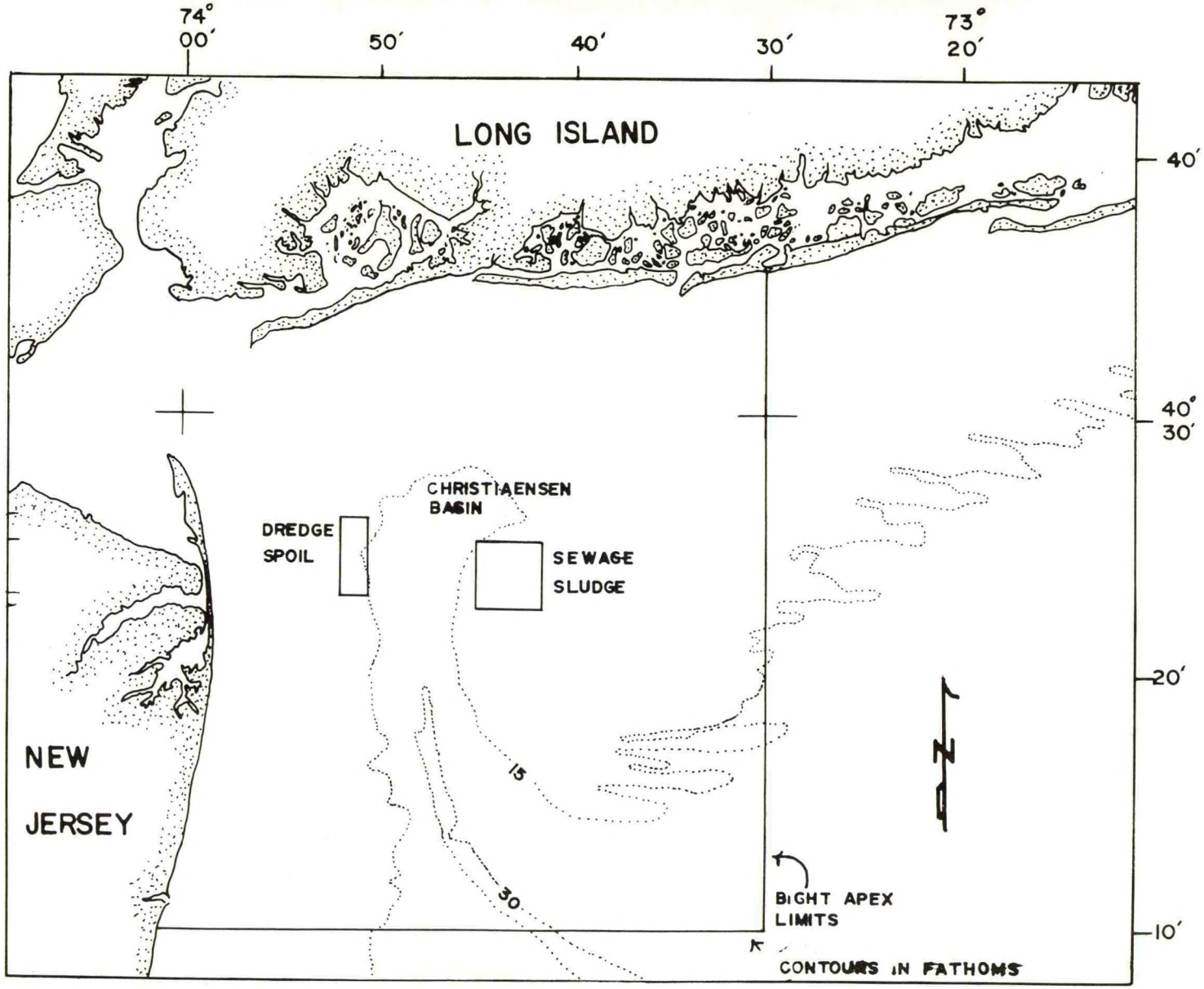
During 1977 there were no major pollution-related incidents in the New York Bight. As a result, efforts of the NOAA Marine EcoSystems Analysis (MESA) Project in the Bight were directed to accomplishing research and monitoring projected in the Project Development Plan, and expanded in detail in the Technical Development Plan for the Project. As in past years, substantial portions of Project research and monitoring were directed, both directly and indirectly, towards ocean dumping. This is best reflected in the fact that approximately 60 percent of the funds allotted to the Project for the year were applied to studying ocean dumping. Emphasis was placed on investigations related to dumping of dredge material and sewage sludge. The results of the efforts are summarized below, and locations of major study sites of the Project are given in figure 2.

NEW YORK BIGHT WATER QUALITY

During 1977 the MESA Project continued its assessment of New York Bight water quality. The major effort was a series of "Expanded (grid) Water Column Characterization (XWCC)" cruises. Five of the cruises, covering the station grid shown in figure 3, were conducted during the year. The cruises were held late during spring, summer, and early fall. One objective of the cruises was to examine changing concentrations of metals and other environmental anomalies which might have been caused by dumping. Careful examination of the XWCC data on metal distributions indicated high concentrations of dissolved manganese and

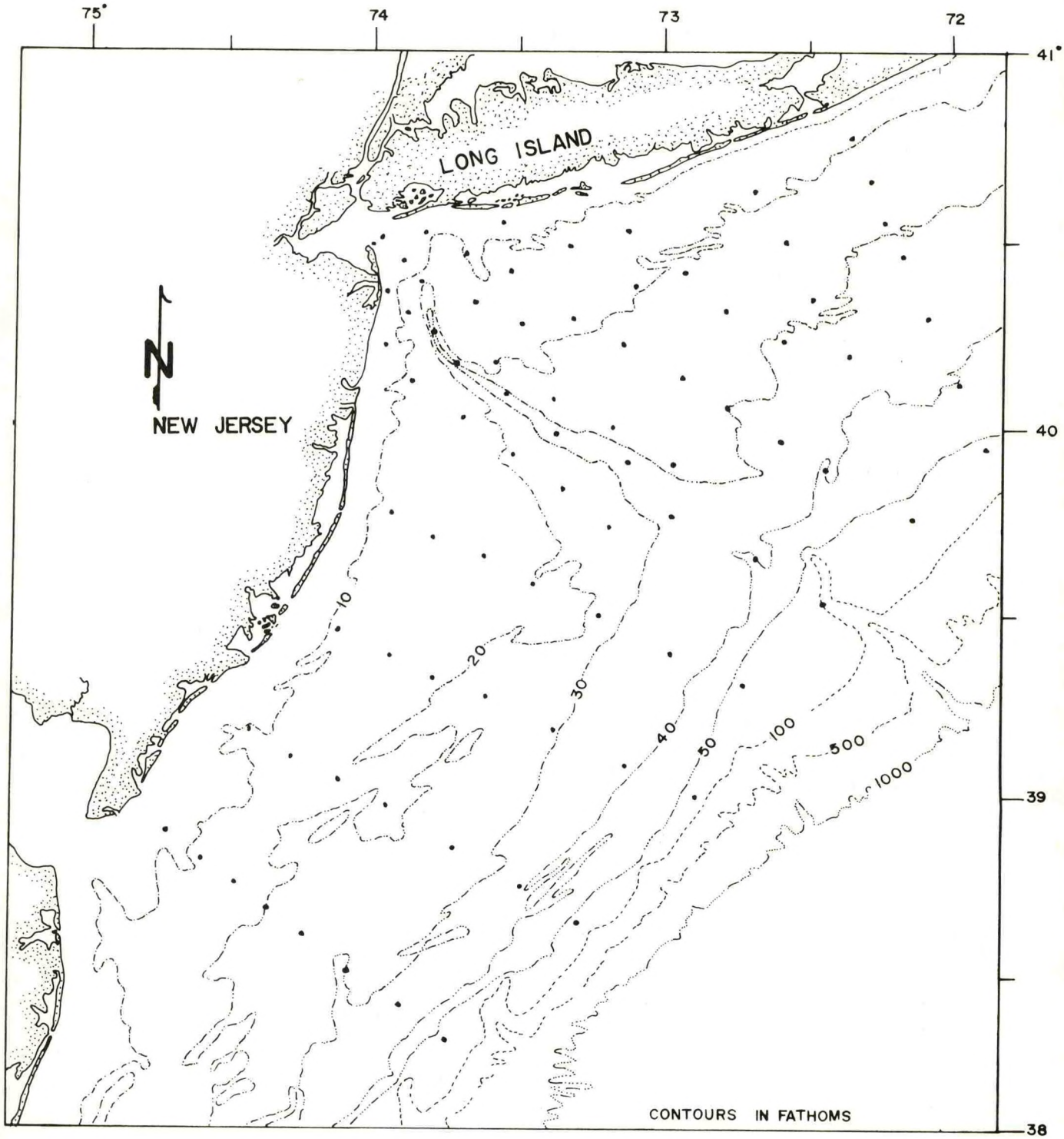
TABLE 1 LEAD PARTICIPANTS, GULF OF MEXICO
OCEAN DUMPING PROGRAM 1977

Principal Investigator(s)	Project
J.M. Brooks & W.M. Sackett, Dept. of Oceanography, Texas A&M University, College Station, TX 77843	Site Characterization and Dispersal Studies at Ocean Dumping Sites in the Gulf of Mexico
C.S. Giam & E.L. Atlas, Dept. of Chemistry, Texas A&M University	Trace Organic Analyses of Industrial Wastes and Gulf of Mexico Disposal Sites
Robert W. Johnson, NASA-Langley Research Center, Mail Stop 422, Hampton, VA 23665	Remote Sensing Studies During Test Dumps at Gulf of Mexico Disposal Sites
J.C.H. Mungall & T. Ichiye, Dept. of Oceanography, Texas A&M University	Gulf of Mexico Dumpsite Studies; Physical Oceanography
J.A.C. Nicol, University of Texas Marine Science Institute, Port Aransas, TX 78373	Biological Effects: Marine Invertebrates
P.L. Parker, University of Texas Marine Science Institute, Port Aranasa, TX 78373	Characterization and Transport Studies of Chemical Pollutants of Gulf Dumping Sites
B.J. Presley & J.H. Trefry, Dept. of Oceanography, Texas A&M University	Inorganic Geochemistry of Industrial Waste Materials and Gulf of Mexico Disposal Sites
J. Proni, NOAA/AOML, 15 Rickenbacker Causeway, Miami, FL 33149	Acoustical Waste Tracking Experiments at Gulf of Mexico Dumpsites
C. Van Baalen, University of Texas Marine Science Institute	Effects of Waste Materials on Growth of Representative Types of Microalgae
E. Wohlschlag, University of Texas Marine Science Institute	Sensitivity of Open Gulf Fishes to Ocean Dumping Wastes



DUMPSITE STUDY AREAS
IN THE
NEW YORK BIGHT

FIGURE 2



XWCC GRID STATIONS

FIGURE 3

cadmium in near-bottom waters at and near the dredged material dumpsite. Concentrations of other metals, such as iron, copper, and zinc were not found to be high in the same general area. The maximum manganese and cadmium levels observed at and near the study site, however, did not exceed the concentrations deemed hazardous in marine environments by the EPA 1976 Water Quality Criteria.

The 1977 XWCC observations emphasized the period during which New York Bight waters are stratified. This is of particular interest because dissolved oxygen in the bottom waters, which are quite isolated from surface waters during periods of stratification, becomes depleted. As oxygen concentrations decrease, native organisms become stressed and in many cases die. Several possible causes of oxygen depletions in the New York Bight have been suggested, including introduction of dredged materials and sewage sludge by ocean dumping. An examination of the XWCC data on dissolved oxygen and nutrients has provided no evidence that ocean dumping of dredged material is a significant factor in generating depleted oxygen conditions in the Bight. Also, a joint effort was initiated during 1977 by MESA and the National Marine Fisheries Service to examine all available information pertaining to the severe oxygen depletion event off New Jersey in the summer of 1976. Preliminary results of the effort confirmed the findings mentioned above that dredged material dumping does not contribute significantly to oxygen depletion problems in the New York Bight.

DREDGED MATERIAL STUDIES

Another MESA-sponsored study related to dredged material dumping in the New York Bight was also completed during 1977. It was entitled, "A Preview of the Impact of Dredged Material Disposal in the New York Bight Apex, with Emphasis on Chemical Processes". The project assessed information available about the physical and chemical behavior of dredged materials in the ocean, and applied the findings to the question of possible effects of dumping dredged materials into the Bight. The major conclusions of the investigation are:

1. Ammonium iron concentrations in receiving waters during dumping may reach levels toxic to local organisms. Dilution below toxic levels is usually rapid, but ammonium pollution can be a problem in waters having a low oxygen content. This could lead to ecological problems in the New York Bight during summer when the area is stratified and oxygen concentrations drop to low levels in deeper waters.

2. A number of trace elements including chromium, iron cobalt, nickel, copper, silver, and lead tend to be present in high concentrations in sediments at and near the dredged material dumpsite. The environmental significance of such enrichment is not understood at present, but the metals in consideration are known to be toxic to organisms.

3. Dumped dredged materials are a major source of trace metals in the Bight. The biological implications of this, however, are not clear at this time.

4. Anoxic dredged materials dumped into the ocean can be a major source of highly toxic sulphur compounds. This may be an environmental problem in the Bight.

5. The physical processes controlling dispersion of dumped dredged material are poorly understood. It appears probable, however, that the contaminant-rich, fine-grained particles disperse faster and farther than do heavier natural sand and mineral grains, and because of this, significant amounts of contaminants may not remain in waste deposits at dumpsites.

6. Most dredged sediments dumped at the New York Bight disposal site remain within the site, but many fine materials appear to move away from the site. The amount are not certain.

7. Dredged material dumping has a negligible effect upon turbidity in the Bight.

As a result of these conclusions, new studies of dredged material dumping in the Bight are being initiated. The investigations are being directed towards:

1. Detailed examinations of the composition of dumped dredged materials in the New York Bight, with particular emphasis applied to metals and organic compounds.

2. Examination of physical and chemical processes occurring during dredged material dumping to assess the environmental fates of contaminants contained in dumped dredged materials.

3. Detailed studies of changes in dredged materials after deposition at the dumpsite to illustrate and measure release of contaminants from the materials.

The first and third efforts will be initiated during 1978; the second will be conducted during FY 1979.

SEWAGE SLUDGE STUDIES

The XWCC cruises were applied to sewage sludge studies as well as to the dredged material investigations. Results of the sewage sludge efforts indicated that the impacts of dumping of the wastes appear to be localized and temporary in the Bight and that water quality conditions in the vicinity of the dumping area returns to normal within hours of dumping events.

A MESA Special Report, "Long Island Beach Pollution: June 1976", was published in February 1977. The report contains information on the nature and sources of floating trash and pollutants that washed up in large quantities on Long Island beaches during June 1976. The wastes included garbage, trash, charred wood, oil, plastics, rubber, and grease.

Early reports during the incident suggested sewage sludge dumping to be the major source of the waste materials; however, the MESA study indicates that waste water and combined sewer outfall discharges into the Hudson-Raritan estuary contributed the largest amounts of the floating offal to the Bight area. The high spring flow from the Hudson River during 1976 apparently carried larger-than-normal amounts of the floating wastes into the Bight, and the wastes were subsequently transported to the beaches. Sewage, garbage, oily wastes discharged from vessels, and petroleum from minor oil spills in the area (over 250 reported events in 1976) also contributed to the floating wastes. The MESA Project found sewage sludge dumping to be a minor contribution, at most, to the 1976 beach fouling incident.

During late 1977 the MESA Project began developing mathematical models to predict nutrient and energy relationships between important living and nonliving components of the Bight environment. One model will assess carbon, oxygen, and nitrogen cycling and the degree of human impact on the cycling and on the local ecosystems. Another will examine effects of changes in the sources of organic compounds and nutrients to the system. The efforts place heavy emphasis upon sewage sludge and dredged materials as sources of nutrients, pollutants, and related substances. Results from the efforts will be published by 1980.

MESA-sponsored investigations during and prior to 1977 have shown that sewage sludge dumping is not the major source of contaminants in the New York Bight. Other MESA-sponsored research indicates that heavy metal ratios from sediments in the Bight can lend insight into the origin of metal contamination in the sediments.

During mid-1977, the MESA New York Bight Project made major contributions concerning New York Bight water quality to an ad hoc Interagency Advisory Committee. The Committee met about one a month, and considered seasonal environmental conditions in the Bight and human influences on the conditions, particularly the relation to ocean dumping of sewage sludge. Matters of concern were oxygen depletion, algal blooms, floating wastes, and general environmental degradation. The Committee included representatives of 14 Federal, State, and local government agencies. Several cooperative study endeavors which included the MESA New York Bight Project and the National Marine Fisheries Service, Sandy Hook Laboratory, resulted from the group's deliberations. As a result of the meetings, special telephones were designated for round-the-clock reportings of observations of unusual conditions which could warn of New York Bight environmental problems. The ad hoc Interagency Advisory was a superb example of a cooperative working arrangement between Federal, State, and local agencies.

In recent years, the MESA Project has sponsored a number of attempts to characterize the effects of ocean dumping on New York Bight sediments. Results from the most recent of these, completed in 1977, addresses polychlorinated biphenyls (PCBs) and DDTs. Both materials are quite toxic. PCBs and DDTs are highly concentrated in sediments around the sewage sludge dumping site (the Christiaensen Basin)in figure 2. There appears to be little or no transport of PCBs from the Christiaensen Basin. Dumping of sewage sludge is the major source of these toxic compounds in Bight sediments. The DDT compounds have been used for many years as insecticides, and the PCB compounds have been used for some time as an insulating substance by electric power companies. The high variability in the PCB composition of sewage sludge is also reflected in Bight sediments. This probably indicates that almost all types of PCBs in sewage sludge settle to the bottom soon after dumping. Data on DDT similarly indicates that sewage sludge dumping is the major source of these compounds to Bight sediments.

Another document released by MESA during 1977, "Steroids as Sewage-Specific Indicators in New York Bight Sediments", reports that coprostanol, a hormone-like compound unique to human wastes, may be a good indicator of sewage contamination in the Bight, as well as in other bodies of water. The study is based upon chemical comparisons of the coprostanol content of sediments from several highly polluted and relatively unpolluted areas of the Bight. Another preliminary conclusion of this research is that nearshore Bight sediments are contaminated to some degree with sewage-derived material. The contamination could come from many sources, one of which is ocean dumping of sewage sludge.

A sewage Sludge Tracking Acoustics Experiment (STAX) was conducted in the Apex of the New York Bight during July 1976, immediately after a sewage sludge dump had occurred. The primary objective of the experiment was to examine the chemical and physical characteristics of the dumped sewage sludge, as a function of time. During the experiment, water samples for analysis of dissolved and particulate metals, nutrients, bulk organic properties, and trace organic compounds were collected, in conjunction with acoustical measurements of the physical characteristics of the dispersing waste plume. The bulk organic properties and total suspended loads of the plume offered a good estimate of total material introduced to the water column by the dump. Trace organic compounds were useful to indicate the nature or source of the wastes. The major STAX findings are most impressive, and will be published during 1978. Preliminary results of the experiment include:

1. Coprostanol, the human fecal steroid present in low natural concentrations in ocean waters, appears unique to human wastes. It may provide a new means for tracing movements of human wastes in nature, and a new means for identifying organic environmental contamination of human origin.

2. Heavy particles contained in sludge descend directly to the ocean floor when dumped. Lighter particles tend to remain suspended in the water.

3. Dumped sewage sludge mixes rapidly with seawater in the surface waters. The material sinks rapidly.

4. Particulate material from sewage sludge spreads horizontally along density layers in stratified waters. The particles penetrate the density layers slowly.

DEEPWATER DUMPSITE 106

BACKGROUND

Deepwater Dumpsite 106 (DWD-106) is a 500 square mile area located between 70°00 - 72°30'W and 38°40 - 39°00'N (figure 4). It lies in deep water (1,750 to 2,700m) and is 106 miles southeast of New York's Ambrose Light and about 90 miles east of Cape Henlopen, Delaware. During 1977 it was used for the EPA regulated disposal of 824,000 wet tons of waste. With the exception of 53,000 tons of sewage sludge from Camden, New Jersey, the materials dumped at DWD-106 were industrial wastes.

Table 2 lists the waste sources and volumes dumped during 1977. Total imput more than doubled in 1977 because of the addition of waste from duPont's titanium dioxide plant in Edge Moor, Delaware. The highly acidic solution of iron and other metals from this plant had previously been dumped at a site much closer to shore. Three major dumpers: duPont-Edge Moor, duPont-Grasselli, and American Cyanamid contributed 82 percent of the total input. In past years, the volume of highly alkaline waste from the production of anisole and dimethylhydroxylamine at the duPont-Grasselli plant in Linden, New Jersey, has exceeded that of the relatively high organic chemical containing waste generated by a variety processes within the American Cyanamid Warner's plant, also in Linden. During 1977 duPont-Grasselli production was much less than expected and its waste input exceeded by American Cyanamid. NOAA's efforts in regard to DWD-106 have centered almost exclusively on these three waste sources.

The objective of NOAA DWD-106 investigation is to identify effects dumping is having upon marine organisms and upon human use of marine resources. This goal is being addressed through studies of waste dispersion, chemical interactions of waste with seawater, biological effects of waste upon fish eggs and other organisms collected at and near DWD-106, and waste toxicity towards test organisms under laboratory conditions. A report is now being prepared within NOAA to summarize the results of these studies. The document will be released in the near future. It will contain a number of individual presentations by the scientists from NOAA and elsewhere who have contributed to the DWD-106 study. Table 3 is a listing of projects and principal investigators for fiscal year 1977.

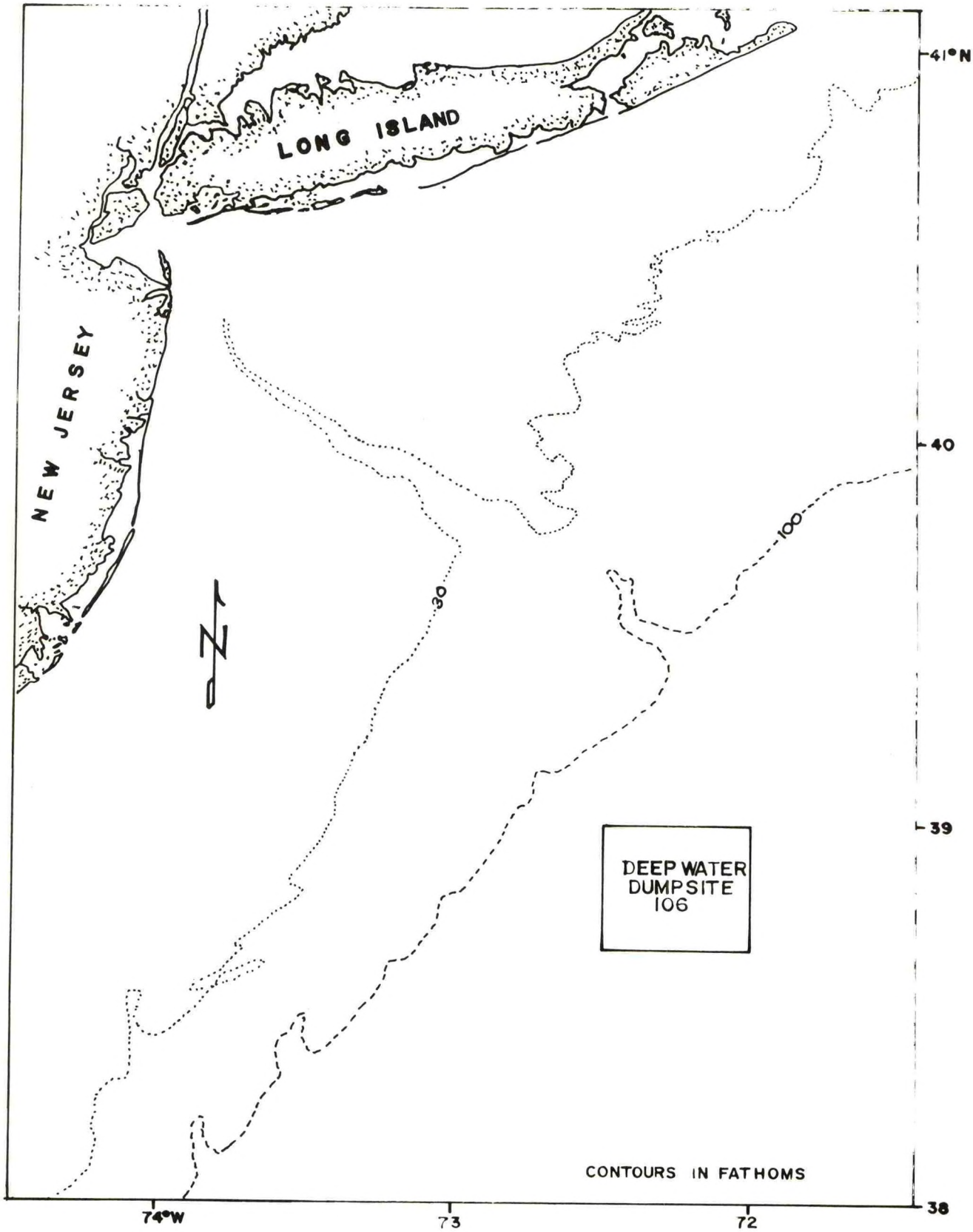

LONG ISLAND
NEW JERSEY
30
100
DEEP WATER
DUMPSITE
106
CONTOURS IN FATHOMS
41°N
40
39
38
74°W
73
72

FIGURE 4

TABLE 2

WASTE INPUTS TO DWD-106

Source	1976 Wet tons (thousands)	1977 Wet tons (thousands)	1977 Gallons[2] (thousands)	1978[1] Wet tons (thousands)
duPont-Edge Moor	--[3]	418	(100)	440
duPont-Grasselli	180	118	(28)	325
American Cyanamid	131	143	(34)	170
Modern Trans.[4]	69	91	(22)	100
Camden, NJ	--[3]	53	(13)	25[5]
General Marine[4]	5	1	--	0
Total	385	824	197	1060

[1]The 1978 column lists maximum allowed inputs. Actual inputs will not necessarily be as large.

[2]The 1977 input as given in terms of gallons as well as wet tons to indicate the size of liquid volumes being dumped. The conversion is inexact since it assumes all wastes to have a specific gravity of 1.0. Actual specific gravities vary from 1.02 to 1.16

[3]In 1978 and during previous years the duPont-Edge Moor and Camden, New Jersey wastes were dumped over the continental shelf, not at DWD-106.

[4]Modern Transportation and General Marine are concerns which dump waste at DWD-106 for a variety of individual industrial waste producers. The inputs of each individual are small, none exceeding 40,000 wet tons.

TABLE 3 DWD-106 FY 1977 PROJECTS

Investigator	Institution*	Title
Marshall H. Orr	WHOI	Acoustic Monitoring of the Dynamics of Industrial Waste Disposal at DWD-106
Ralph F. Vaccaro	WHOI	The Environmental Response of Marine Bacteria to Waste Disposal Activities at Deep Water Dumpsite 106
Lynda S. Murphy	WHOI	The Effect of Pollutants on Marine Phytoplankton at Deep Water Dumpsite 106
Dana R. Kester	URI	Chemical Studies Associated with Acidic Iron Wastes and the Field Program at Deep Water Dumpsite 106
Arlene C. Longwell	NEFC	Mutagenics of Fish Eggs from Deep Water Dumpsite 106
Aaron Rosenfield	NEFC	Pathobiology of Macroplankton from Deep Water Dumpsite 106
Merton C. Ingham	AEG	Physical Oceanography of Deep Water Dumpsite 106

*WHOI - Woods Hole Oceanographic Institution
URI - University of Rhode Island
NEFC - NOAA/National Marine Fisheries Service, Northeast Fisheries Center
AEG-NOAA/National Marine Fisheries Service, Atlantic Environmental Group

FIELD INVESTIGATIONS

DISPERSION

Dispersion studies have been made for both duPont wastes, American Cynamid waste, and Camden sewage sludge. For industrial wastes, there is a rapid initial dilution as materials flow from a moving barge. After approximately 5 hours, however, a plateau concentration is reached which persists for about a day. After this one day, there must be a slow further dilution, but little data for so long a post-dump period has been obtained. Using the plateau values, it is concluded that the maximum concentrations which do persist are about 5, 50, and 400 parts per million for the duPont-Edge Moor, duPont-Grasselli, and American Cyanamid wastes, respectively. Work is in progress to determine the factors that are responsible for this range in mixing behavior. One factor which obviously affects these concentrations is dumping rate. At the time of the American Cyanamid waste dispersion study, it was dumped at a much faster rate than it is presently dumped. Therefore, it is probably more diluted now in the ocean than it was in the past. Data on sewage sludge is not adequate to define its dilution history.

Both duPont wastes form particles upon mixing with seawater, sewage sludge inherently contains particulate material. These wastes were followed in the ocean by using acoustic devices to locate the particles. The technique has shown that wastes form thin layers along density gradients rather than mixing uniformly with seawater. The sharpest of these gradients are the seasonal thermocline at 15 to 40m from May through October and the permanent thermocline at 100 to 150m at all times. Industrial waste dumped in the summer has rarely been seen to penetrate the seasonal thermocline. It was under such conditions that the above indicated dilution factors were determined. Recent work under winter conditions indicate the industrial waste to descend to the permanent thermocline and presumably dilutions are greater than during summer. Sewage sludge was seen too, in part, penetrating the seasonal, but not the permanent thermocline.

There have been infrequent indications on the acoustic record that waste particles along a density gradient suddenly descend to greater depths in small surges. In essence, though, waste remains in the upper part of the water column. For this reason, wastes are not likely to accumulate at DWD-106. They pass from the area in water masses moving through the site. Organisms most likely to be affected by waste are those living in the upper waters.

Dispersion studies indicate that since, except for sewage sludge, these dumps occur over long and more or less circular tracks, each dump leaves a long rather narrow strip of contamination. These strips will move with the currents which on the average are towards the southwest. As the water moves, it mixes with coastal water on the west or Gulf Stream water on the east. In this process of water-mass mixing, waste

is further diluted beyond the levels reached in the dumpsite and, thus, probably becomes undetectable at some distance away from DWD-106. Two of the major forthcoming tasks of the program are to find evidence of wastes or waste effects southwest of DWD-106 and to better characterize movements of water through the site.

CHEMISTRY

The chemical form a contaminant assumes in the ocean plays a major role in determing its effect on biota. Particle information in the cases of duPont wastes implies the availability of surfaces upon which trace elements can be adsorbed. Particle ingestion, then, by an organism represents a greatly enhanced intake of potentially toxic material. The particles have been shown to concentrate lead and cadmium. Field data on duPont-Edge Moor waste indicate the particles to be accumulating not only lead and cadmium from the waste but that from ambient seawater. Copper, on the other hand, has not been seen to be adsorbed to so great an extent implying that it is tied into organic molecules in the waste and unavailable for adsorption. The organic compounds which are significant in the cases of duPont-Grasselli and American Cyanamid wastes have not yet been investigated.

FIELD BIOLOGY

During 1976 a study was made of changes in primary productivity, chlorophyl levels, and other indications of phytoplankton activity before and after a dump of American Cyanamid waste. There were decreases in all parameters, but they could not be attributed to dumping because between the two sets of measurements the water mass had changed. As discussed in NOAA's 1977 Dumpsite Report, DWD-106, is alternatively occupied by shelf water, slope water, Gulf Stream water or Sargasso seawater, the latter two being present when the dumpsite is traversed by a warm core Gulf Stream eddy. This complex oceanography imposes a great variability on plankton abundance at any given location. A greater variation, even than that which exists due to the patchiness of plankton distributions is a single water mass.

Most biological work is done, therefore, under laboratory conditions, but two field studies were initiated in 1977. Developing fish eggs were examined for chromosomal damage and larger organisms were examined for tissue damage. Although both studies suffered from small sample sizes, there was an increase in moribundity of eggs collected in a plume of duPont-Edge Moor waste. The degree of damage decreased as the plume aged and was diluted over a 10-hour period.

Examinations of a variety of jellyfish-like organisms revealed increases in cell abnormalities and necrosis (tissue death) in duPont-Edge Moor plume. These observations were also made on samples collected while the plume was "young" and undergoing its initial fast dilution.

Field studies such as these are continuing and, in addition, plankton tows are planned where special "clean" nets will yield samples suitable for chemical analysis. Accumulation of waste by biota could be a significant contribution to the spread of contamination through the ocean or through the food chain.

LABORATORY STUDIES

While field data is necessary to demonstrate any ongoing biological effect of waste disposal, the sparsity and patchiness of samples is a formidable barrier to unequivocal results. Work under controlled conditions yields data on what the effects in the ocean could be and allows for better design of field experiments.

Effects of duPont-Grasselli waste in the concentrations ranging from 20 to 10,000 ppm and effects of American Cyanamid waste in the concentration range of 2,000 to 30,000 ppp were measured on marine bacteria. The rate of bacterial activity decreased by one-half at concentrations of 3,300 and 28,000 ppm for duPont-Grasselli and American Cyanamid wastes respectively. At the lower levels tested the wastes were periodically stimulative to marine bacteria.

This suggests that the concentrations of waste found in the field would not affect local bacterial populations. In fact, no effects could be found. Measurements of bacterial activity were the same within the dumpsite during test dumps as outside the site. While bacteria could be isolated which were persistant to American Cyanamid waste, there was no evidence that such species dominated the bacterial population with DWD-106.

Experiments with the phytoplankton species Thalassiosira pseudonanna showed that clones of the species taken from coastal waters were more tolerant of duPont-Grasselli waste than were clones of the same species taken from the open water. This suggests that phytoplankton found at DWD-106 are more susceptible to contaminant inputs than those near shore. It was demonstrated that duPont-Grasselli waste at a concentration of 1,000 ppm decreases the growth rate of ocean clones of T. pseudonanna by 25 percent. Since this is about 10 times the observed persistent maximum concentration of the waste at the site, it is not clear if any significant effect upon phytoplankton populations at DWD-106 is expected.

Work with phytoplankton has expanded to include oceanic clones of other species and at lower concentrations of wastes. Also, while initially it seemed prudent to avoid particulate waste in laboratory experiments, it is the case that particles form at the barge ports as waste enters seawater and persist thereafter. So, to make laboratory experiments more like the field situation, the particles will be included. Finally, experiments have been initiated using open ocean zooplankton species and developing fish eggs.

CHAPTER III

NEW INITIATIVES

GULF OF MEXICO DREDGED MATERIAL SITES

Plans were formulated in the fall of 1977 to begin studies of dredge disposal sites outside the New York Bight during 1978.

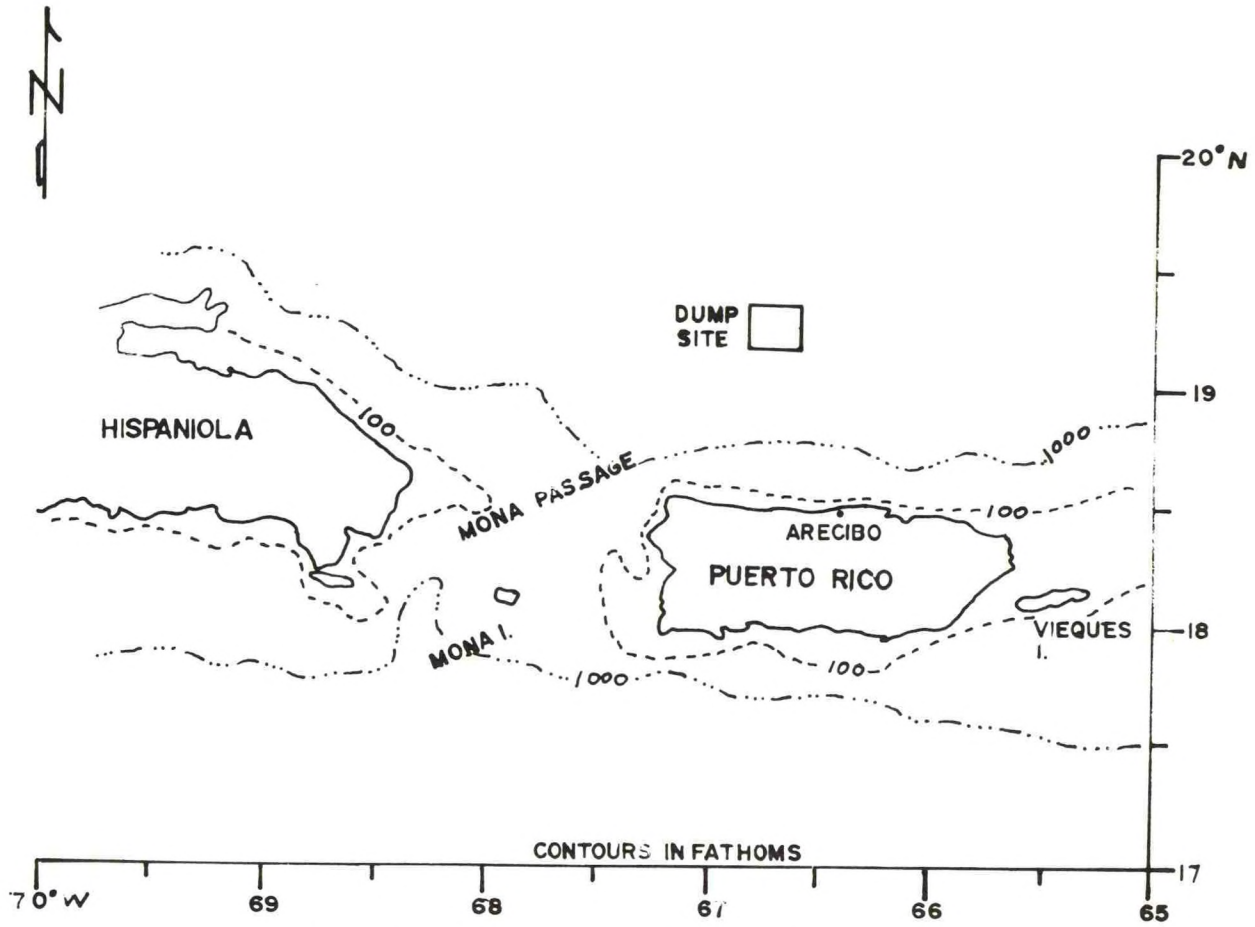
In cooperation with the Corps of Engineers, two potential dredged material sites located near Southwest Pass of the Mississippi Delta were identified for study. Locations of the sites are shown in figure 1. Studies of the sites will begin in the spring of 1978. These sites are important economically because two natural resource industries, shrimping and oystering, make heavy use of the vicinity. An environmental assessment of each site will be made prior to dredging. Financial support for the project will be provided by the New Orleans Corps of Engineers Office and the NOAA Ocean Dumping Program Office.

The first year's efforts will be to describe the chemical, physical, biological, and geological characteristics of the study areas that will be dredged in the future. Levels of trace metals will be determined for sediments to be dredged as well as for tentative disposal sites. Liquid, suspended particulate, and solid phase bioassays will be conducted to determine if the sites are suitable for dredging and dumping operations. This project will test and evaluate the methods of the EPA/COE Manual for ecological evaluation of proposed discharge of dredged material into ocean waters.

Major efforts are also planned for these two sites during FY 1979. The efforts will be multidisciplinary. Biological and chemical studies will include development of monitoring techniques, community bioassays, and physiological and behaviorial processes in fishes and invertebrates. Physical studies will include current dynamics, dredge sediment transport, and acoustical tracking of the dredged material to identify the driving mechanisms that control current movements and characteristics. This will generate basic information above movements and dispersion of the dredged materials dumped in the region.

PUERTO RICO DUMPSITE STUDIES

The Puerto Rico dumpsite, shown in figure 5, is a chemical waste dumpsite. The materials dumped there are primarily wastes resulting from pharmceutical production. The amount of waste discarded is approximately 530,000 wet tons per year. The dumping takes place from towed barges about 10 times per month. Each dump is about 700,000 gallons; the rate of dumping is 39,000 gallons per mile with the barge moving at about 3 to 4 knots.



PUERTO RICO DUMP SITE

FIGURE 5

The Puerto Rico dumpsite was established in 1972 as an interim disposal location pending completion of the Barceloneta Regional Wastewater Treatment System, presently scheduled for November 1979. It is located 42nmi north of the Arecibo Harbor, Puerto Rico, between latitudes 19°10'N - 19°20'N, and longitudes of 66°35'W - 66°50'W. The dumpsite is 140nmi^2 and over 6,000m deep. It is located over the Puerto Rico Trench in Antilles Current.

Two comprehensive field studies are planned for 1978. The overall technical approach will follow the patterns set in the Gulf of Mexico studies and now being followed in DWD-106. Cruises will take place in February and November 1978, and key waste characterization and effect studies will be carried out in the laboratory.

DEVELOPMENT OF INTERAGENCY AGREEMENTS

Under the Marine Protection, Research, and Sanctuaries Act, the Environmental Protection Agency (EPA), the Corps of Engineers (COE), the U.S. Coast Guard (USCG), and the National Oceanic and Atmospheric Administration (NOAA), all have responsibilities regarding permit approval, monitoring, and research of ocean disposal sites. Due to the interaction of the federal agencies, EPA and NOAA already entered into an interagency agreement in 1975. Other interagency agreements were initiated between NOAA and COE, and NOAA and USCG in August 1977. The interagency agreement between NOAA and COE concerns cooperative evaluations of ocean disposal of dredged materials. The agreement between NOAA and USCG will establish a comprehensive program of monitoring and research for implementing Title II, Section 201, of the MPRSA. Both agreements were in draft status by December 1977, and are now being reviewed by the agencies.