MESA Special Report

Long Island Beach Pollution: June 1976

Report coordinated by
National Oceanic and Atmospheric Administration
Marine EcoSystems Analysis (MESA)
New York Bight Project, Stony Brook, New York

R. Lawrence Swanson, Manager

With major contributions from
U.S. Environmental Protection Agency, Region II (EPA-RII)

Gerald M. Hansler, Regional Administrator

and
U.S. Coast Guard, 3rd District
Marine Environmental Protection Branch
Governors Island, New York

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U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary

National Oceanic and Atmospheric Administration
Robert M. White, Administrator

Environmental Research Laboratories
Wilmot Hess, Director

Boulder, Colorado

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402

Typical materials that washed up on Long Island south shore beaches during June 1976. (See sec. 2.1.)

Screened materials collected from effluent plume. (Passaic Valley Sewerage Commissioners' Plant. (See sec. 4.3.)

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ABBREVIATIONS

ALK	alkalinity
BOD	biochemical oxygen demand
BOD_5	biochemical oxygen demand, 5-day
cfs	cubic feet per second
COD	chemical oxygen demand
COE	Corps of Engineers
e.d.t.	eastern daylight time
EPA-RII	Environmental Protection Agency - Region II
F. Coli	fecal coliform
ft	feet
g	gram
gal	gallon
gpd	gallons per day
kn	knot
ℓ	liter
lb	pound
mbar	millibar
MBAS	methylene blue active substance, surfactant
MESA	Marine EcoSystems Analysis
mg	milligram
mgd	million gallons per day
mℓ	milliliter
MPN	Most Probable Number
NASA	National Aeronautics and Space Administration
NCC	National Climatic Center
NCDH	Nassau County Department of Health
NMFS	National Marine Fisheries Service
nmi	nautical mile
NWS	National Weather Service
NYDEC	New York State Department of Environmental Conservation
OCS	Outer Continental Shelf
O&G	oil and grease
ORG-N	organic nitrogen
ORTHO-P	ortho-phosphate
oz	ounce
ppm	parts per million
SCDEC	Suffolk County Department of Environmental Control
pt	pint
SS	suspended solids
STP	sewage treatment plant
T. Coli	total coliform
TKN	total Kjeldahl nitrogen
TOC	total organic carbon
TOTAL-N	total nitrogen
TOTAL-P	total phosphate
USCG	United States Coast Guard
USGS	United States Geological Survey

PREFACE

The concept of this report was developed at a meeting held at the MESA Office in Stony Brook, New York, on June 17, 1976, and attended by concerned Federal, State, and local agency personnel. That meeting was called to discuss the June pollution episode on Long Island ocean beaches and to initiate a coordinated Federal response to the problem. The report contains information from a wide range of sources, including Federal, State, and local governments, and the private sector. It was assembled at the MESA New York Bight Project's Stony Brook Office, with joint authorship. Major contributions and review were provided by the other Federal agencies involved.

The individuals listed below should receive credit for writing major portions of the text and for assembling all available data. It is the intent, wherever possible, to credit other specific sources, but this has not always been feasible due to the urgency of early publication. We regret any errors or omissions of this kind which may remain.

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EXECUTIVE SUMMARY

This report contains information on the nature and possible sources of floating trash and pollutants that were washed up in large quantities on most of Long Island's beaches during June 1976.

Section 1. Introduction.

The Introduction defines the general orientation of the report and describes the roles played by the Federal, State, and local agencies during the beach pollution event. It summarizes the chronology of events and observations; a detailed chronology of events and the field report summaries are in Appendix A and Appendix B.

Section 2. Scope of Problem: Characterization of Waste Materials and Public Health Considerations.

This section describes the waste materials identified on the beaches. These included tar and grease balls, sewage-related items (condom rings, tampon applicators, etc.), garbage (watermelon rinds, orange peels, chicken heads, etc.), trash (paper, plastic wrappers, straws, cups, etc.), and charred wood.

Laboratory analyses of the tar and grease balls revealed high concentrations of total and fecal coliform bacteria. Attempts to isolate enteric pathogenic bacteria, such as *Salmonella*, from the grease balls were unsuccessful, even though total and fecal coliform densities were in the millions per 100 grams of sample. Water samples collected during the peak of the beach contamination showed total coliform levels well within the New York State standard for swimming.

Section 3. Transport of Waste Materials to the Beaches.

This section analyzes historical surface wind data and the wind conditions during June 1976, examines surface drifter studies, and applies the U.S. Coast Guard and the Brookhaven National Laboratory surface transport models to events of June 1976. It is concluded that persistent southerly wind-driven transport was responsible for the stranding of the floatables. Southerly surface winds with about 8.0-kn velocities are not unusual for June over the Bight. Occasional departures of large-scale atmospheric pressure patterns (possibly once each year either in late spring or the summer months), such as that which occurred during the 15-day period between June 5 to 20, 1976, can increase the persistence and mean velocity of these winds. These winds drove the floatable load of the Bight northward onto the beaches of Long Island.

Drifter studies, as well as mathematical modeling, support these conclusions. Modeling studies using the U.S. Coast Guard model showed that if the material

were released in the area of the sewage sludge storage tank explosion near East Rockaway Inlet and in the area of the Hudson River pier fires there would be a high probability of its reaching the Long Island shoreline. The Brookhaven National Laboratory model indicated that floatable material in the Bight Apex from June 1 to 24, 1976, would be stranded on the southern shores of Long Island.

Section 4. The Possible Sources of Floatables.

This section gives a detailed summary of types, most likely sources, and estimated quantities of floatables that reached the New York Bight. The types and sources of floatables include trash, plastic and rubber objects, and grease from waste water and combined sewer outfall discharges; street litter from bays and minor estuaries; sewage, garbage, and oily wastes (petroleum products) from oil spills, commercial ships, and recreational boats; charred wood from pier fires; floatables in dumped sewage sludge and from the explosion of the Bay Park sewage storage tanks; solid wastes lost during transport to disposal locations or washed or blown away from land-fill sites; and oil and grease from industrial wastes. The Hudson/Raritan estuarine outflow is a major source of all the above floatables to the waters of the New York Bight.

It is estimated that waste water and combined sewer outfall discharges routinely contribute the largest amounts of floatable wastes to the Bight via the Hudson/Raritan estuary system. The above-average spring water flow from the Hudson River undoubtedly carried larger than normal amounts of these waste materials over a broad area of the Bight in 1976. Sewage, garbage, and oily wastes discharged from vessels, and other petroleum products from the large number of minor oil spills in the area (over 250 reported events in 1976) are another major source of floatables. During the June 1976 floatable pollution episode the materials released by the Bay Park sewage storage tank explosion could have contributed to the beach strandings of these materials. Investigations suggest that sewage sludge dumping has been a minor contributor to the floatables found on the beaches.

Section 5. Prevention of Future Similar Incidents.

This section discusses possible actions to reduce or to prevent floatable pollutants from reaching the Bight by eliminating these at their sources. This requires the collective action of concerned citizens and industry committed to minimizing pollution, and possibly financial incentives and governmental regulations. Technological improvement of waste management is another necessity, but it must be understood that these improvements would be less than 100% effective and would require substantial expenditures.

Section 6. Research Requirements.

This section identifies the "quantitative documentation of the sources of floatables" as the most urgent need. It is understood that effective corrective measures cannot take place until this research task is accomplished.

Additional research tasks identified would provide insight into the actual pollutant load present in the Bight, and would document its movement and seasonal variations. Research to obtain a realistic estimate of environmental damage and public health hazards, to improve waste handling technology improvement, and to develop more biodegradable materials for everyday use is also recommended.

Section 7. Summary and Conclusions.

This section summarizes the key events and recommendations of the report. The June event is not the first occurrence although this latest event was probably more extensive than earlier ones. There is no possibility of lessening the severity of such events in the immediate future. Control at the numerous sources of floatable material is the ultimate solution to the problem.

LONG ISLAND BEACH POLLUTION: JUNE 1976

1. INTRODUCTION

In June 1976 almost all of Long Island's major public ocean beaches were closed to swimmers for varying periods because of floating trash and pollutants. Waterborne debris has been a constant irritant to beach users in recent years, but the concentrations during June were the heaviest ever known. The unprecedented closings began with the restriction of 20 miles of Fire Island beaches on June 15, and most of Long Island's south shore beaches were closed during the third week of June. By July 1 these beaches were again open, but during the interval normal summer beach use decreased causing inconvenience and annoyance to prospective swimmers and economic loss to local business. Additional strandings have recurred, but on a lesser scale, and resulting closings have been comparatively brief.

Obviously, the polluting materials floated to shore from the New York Bight (fig. 1). This report summarizes information on the nature of these materials, their possible source(s), and the natural or man-related mechanisms which caused them to wash up on shore. Possible ways of preventing or minimizing future occurrences are also considered.

The report covers events shortly before and during June and mainly concerns June 9 to 25, 1976, when most of the problem developed. After June 25, conditions in the Bight changed to end the major episode. Minor recurrences have and are expected to appear intermittently, but the particular combination of circumstances causing the severity of this incident is not expected often.

The appearance of waste materials on Long Island beaches is not uncommon. For example, an EPA news release of June 21, 1974, cites many previous instances of tar and grease ball stranding and lists bacteriological sample analyses taken. A 1959 American Petroleum Institute (API) study reports on similar observations dating back to 1951, and varying concentrations of other waste materials observed in the current incident also have been routine beach problems for years.

1.1 Roles of Organizations

The MESA New York Bight Project is developing scientific and technical information for examination and review by other agencies and for the public. This information describes waste materials found on the beaches, and the water transport mechanism involved, and discusses sources potentially responsible for their presence in New York Bight waters. In addition, cruises were conducted to observe conditions in the Inner Bight and in the Bight Apex (adjacent to the Hudson/Raritan estuary-fig. 1) immediately following major influx of materials to the local beaches.

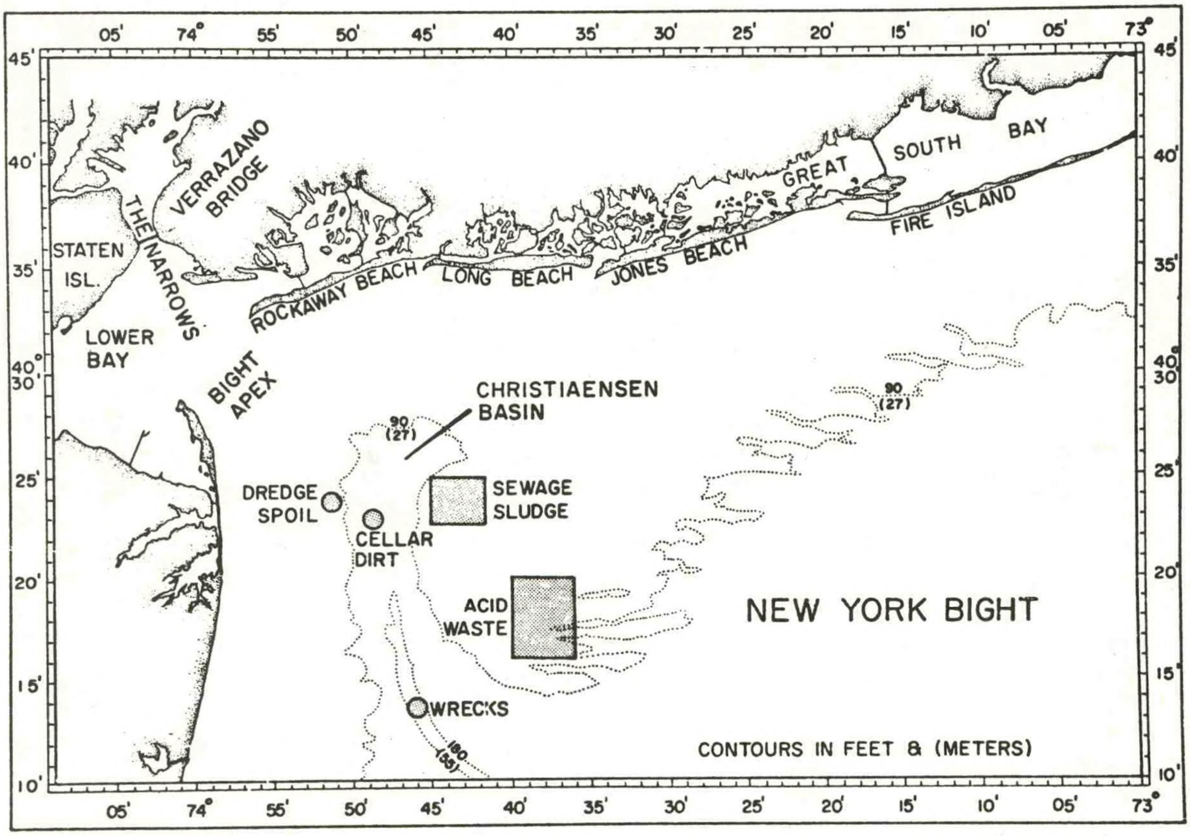


Figure 1. Major Dump Sites in the New York Bight.

EPA served as the coordinating agency for Federal activities and also provided field and laboratory expertise to identify the material and to assess environmental implications, particularly from a public health standpoint. EPA activity also involved beach and helicopter surveillance to determine the presence, types, and amounts of floatables on the beaches and in the water. Additional helicopter and boat excursions were made to collect water and sediment samples along the beaches and in the Bight. These as well as samples collected by other Federal, State, and local agencies were subjected to microbiological and chemical analysis by EPA.

The Coast Guard (USCG) supported studies throughout the incident. Manpower and marine and airborne transportation capabilities were used to assist the various Federal interagency activities. At the direction of the President, USCG personnel coordinated and supervised the Federal beach cleanup program, in addition to normal oil pollution responsibilities. The Federal Water Pollution Control Act (FWPCA) does not address cleanup of sewage-related materials or other debris, though it does charge the USCG with oil spill cleanup in coastal areas. With regard to this report, the USCG contributed available information on marine pollution and performed mathematical model analysis concerning the potential for movement of floatable materials (models developed and applied by USCG Research and Development Center, Groton, Connecticut).

The National Aeronautics and Space Administration (NASA) supplied LANDSAT satellite imagery of the Bight prior to, during, and subsequent to the episode, and color and color infrared photography of the beach areas. More intensive satellite surveillance of the Bight is being planned for the future.

The New York State Department of Environmental Conservation (NYDEC) coordinated State and local investigations and cleanup activities. NYDEC also analyzed beach waste samples and sampled the adjacent waters, with particular emphasis on shellfish producing areas. A clearing house for current information on beach conditions was set up and manned in part by NYDEC volunteers, and daily reports on beach conditions were made available to all callers.

1.2 General Observations and Chronology of Events

The beach pollution attracted much attention from local, State, and Federal governments and also from the information media. In general, the quality of media treatment was good. Officials were usually quoted correctly, and the complexities of the problem were appreciated. This is significant because the episode had an important effect on public perception of this problem.

The major events, observations, and responses relevant to this pollution episode are detailed chronologically in appendix A of this report. It is sufficient to summarize these here with a map of the general area (fig. 2) showing locations named.

In early May a medium oil spill in Upper New York Bay resulted in large quantities of black oil balls (tar balls) washing up on beaches from Jacob Riis Park to Fire Island. The Coast Guard immediately began observations and cleanup operations. Coast Guard analysis also confirmed the source of the pollution and used a New York Harbor spill forecast study to verify dispersal patterns.

While this initial pollution was cleaned up by the end of the month, other events occurred which combined to affect the situation in June. Throughout the latter part of May, the flow of the Hudson River remained far above normal. On May 26, a storage tank ruptured at Jersey City, New Jersey, and large quantities of oil were spilled into the Hackensack River and into the wetlands of the Hackensack Meadows. A week later, two sewage sludge storage tanks on Pearsalls Hassock exploded; 1 million gal of sewage sludge flowed into the water, and 1.1 million gal spilled onto the land. The next day, Coast Guard observers sighted material floating out to sea through East Rockaway Inlet.

On June 3 and 11, pier fires broke out at Weehawken, New Jersey, and Manhattan, New York, dumping tons of wreckage and debris into the water. Large amounts of this debris could not be recovered in cleanup operations because of the small size. And, finally, winds which had been variable became southerly in early June and continued to blow predominantly from this direction throughout most of the month. The cumulative effects of these diverse events would contribute substantially to the unusual pollution patterns of the following weeks.

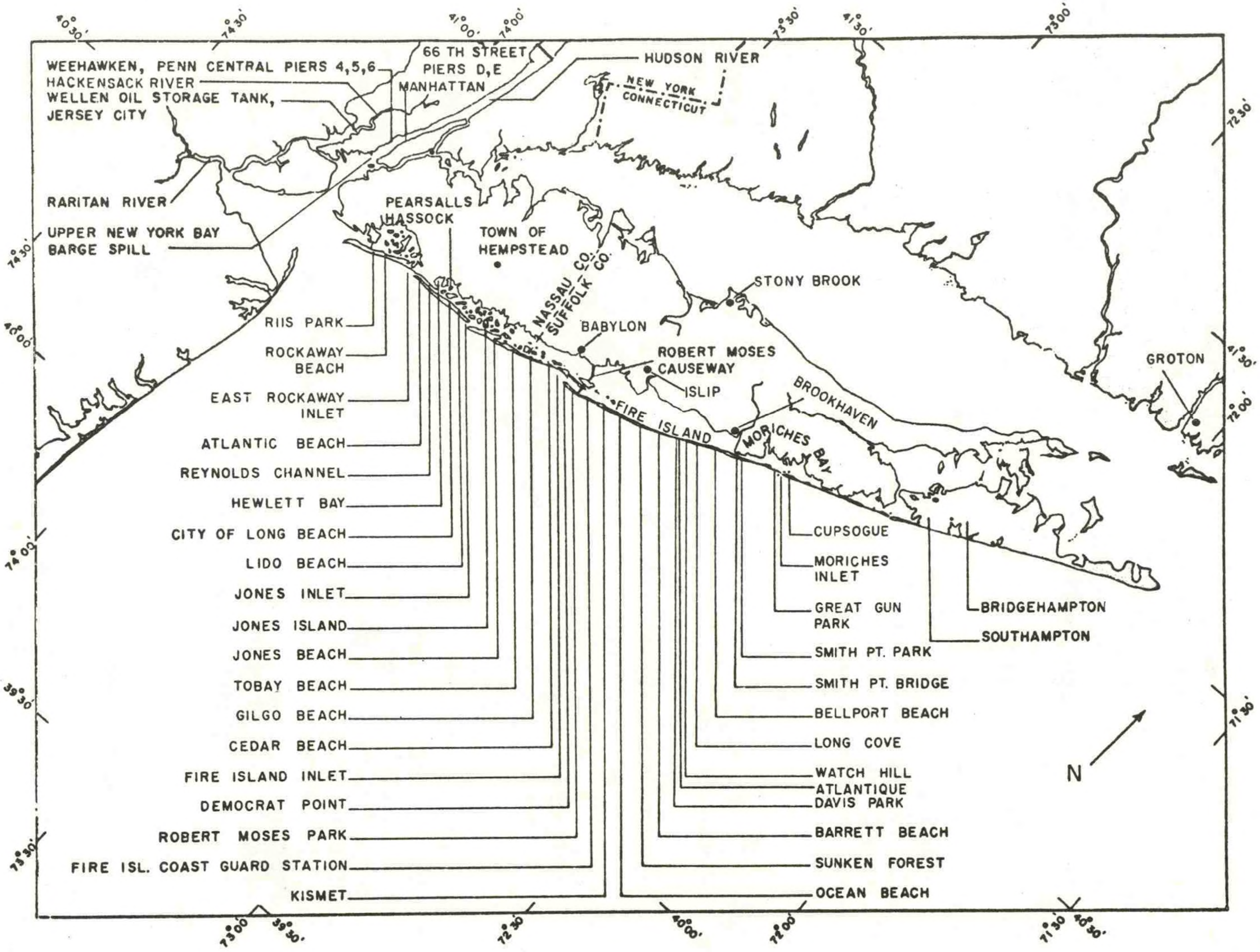


Figure 2. Location map.

At 1200 e.d.t. (all times in this report are given in eastern daylight time) on June 14, the Coast Guard station at Fire Island received a report of unusual amounts of floatables washing up on the Davis Park Beach. Coast Guard personnel found tar balls as large as 4 inches in diameter and grease balls ranging from 1 to 2 inches in diameter mixed with a variety of other debris along the high waterline on the beaches from Sunken Forest to Watch Hill. While the tar balls ended at Watch Hill, the grease balls and other debris extended east to the South Point Bridge. Fire Island Station observers requested that a Captain of the Port (N.Y. pollution investigator) evaluate the situation and send a helicopter to observe the sewage sludge dumpsite (fig. 2).

By the following day, large quantities of tar and grease balls were washing ashore along southern Fire Island. EPA-RII, the MESA New York Bight Project Office, and a number of State and local agencies joined with the Coast Guard to observe the situation and analyze water and pollutant samples. The same afternoon, the Suffolk County Department of Health recommended that all County beaches be closed to swimmers. The situation worsened the following day as Federal, State, and local officials continued their investigations. NYDEC closed shellfish waters from Moriches to Jones Inlet for seven days, and beaches from Gilgo Beach to Fire Island Inlet were closed the next morning.

On June 17 the MESA staff met with over 20 Federal, State, and local agencies to share data and preliminary findings, and investigations continued. While some beaches were reopened on the 18th, a new "wave" of pollutants began washing ashore on the 19th, and by late afternoon all beaches on Fire Island and in Babylon except for Smith Point Park were closed. The problem intensified during the next several days as beaches were closed all along the southern coast of Long Island, and on June 23, Governor Hugh Carey declared Nassau and Suffolk Counties a disaster area.

Officials continued to watch the situation carefully and soon reported that the water was returning to normal. Federal and State officials met on the 24th to coordinate cleanup activities and to further coordinate investigations. Two days later, President Gerald Ford assigned 100 Job Corps volunteers to clean up the beaches under Coast Guard supervision. This work began immediately and was completed by the end of the month. By July 1, observations indicated that beach conditions had returned to normal, and that this particular pollution experience was over. But important questions remained: what was responsible for the magnitude of this particular problem, what were its sources, and what caused pollutants to wash ashore? The balance of this report is concerned with these questions.

2. SCOPE OF PROBLEM: CHARACTERIZATION OF WASTE MATERIALS AND PUBLIC HEALTH CONSIDERATIONS

2.1 Characterization of Waste Materials

Reports from individuals and government agencies have described the waste materials polluting the beaches during this incident. The information ranged from brief telephone calls to detailed analyses and came from varied sources. (Several of the more specific reports are included in app. B.) Observations and analytical results of samples collected at different times and locations varied considerably, and different observers classified their observations or samples differently. The early reports suggesting a component of human feces or at least material of sewage-related origin led to official closings of the affected beaches. Closings were a precautionary step based on a perceived health threat, especially that of contracting viral hepatitis from contact with fecal materials or with contaminated water.

Closer examination has determined that these materials were not fecal matter per se but were "tar balls" or "grease balls" (aggregations of grease-like or oil-like substances from various sources produced by physicochemical processes). Some contained a petroleum fraction, and others did not. Their most common feature was high concentrations of both total coliform and fecal coliform bacteria, as revealed by standard test procedures. This finding suggests that some of the component material came from raw or inadequately treated sewage.

This was not the first time that tar and grease balls had been identified on Long Island beaches. In 1974 considerable numbers of balls on Nassau County beaches were also found by EPA-RII to have high concentrations of coliform bacteria, but it is not known how frequently these incidents occur as they have not been widely publicized. In addition to the materials just described, beach accumulations included other sewage related items (condom rings, tampon applicators, etc.), garbage (watermelon rinds, orange peels, chicken heads, etc.), trash (paper, plastic wrappers, straws, cups, etc.), and charred wood. The only obvious common property of these waste materials and pollutants is that they float and presumably arrived on the beaches by surface drift from the adjacent waters of the Bight.

The enclosed reports (app. B) are essentially verbatim as submitted, and give a general impression of the nature and amounts of wastes observed. Locations can be found in fig. 2, and results of laboratory tests appear in the following section.

2.2 Laboratory Analysis Reports

1. <u>Long Island Beach Samples</u> (EPA-RII): An analysis of data relating to Long Island beach and water quality samples was completed by EPA-RII (unpublished data) and is summarized below.

Waste (Tar/Grease) Balls: Bacteriological tests revealed high concentrations of total and fecal coliform bacteria in most of the waste balls examined. These results are generally consistent with data from EPA tests of similar waste balls collected in previous years.

Chemical analysis of the above samples showed a wide variation in the ratio of hydrocarbon (petroleum) to nonhydrocarbon (nonpetroleum) material among the different samples. Median percent of nonpetroleum hydrocarbon content in the grease balls was 32. The percentages ranged from 14 to 52 for nonpetroleum hydrocarbon typical and all-inclusive of waste balls, and from 48 to 86 for petroleum hydrocarbon typical and all-inclusive of waste balls. Invariably, the darker waste balls gave the higher percentage of petroleum hydrocarbon while the lighter colored (white, gray, and light brown) balls showed the higher percentage of nonpetroleum hydrocarbons. The high petroleum hydrocarbon content suggests petroleum as a major source, but the presence of reasonably significant amounts of nonpetroleum hydrocarbons indicates that these waste balls are also aggregations of various substances not petroleum-related and probably originating in sewer systems. In fact, observations confirm that waste balls can be associated with raw or inadequately treated waste water discharges. Thus, these results and the observation that waste balls generally form around nuclei suggest that these balls formed either in the open waters or along the surf zone. However, not much is known about the formation mechanism.

Surf Samples: In all cases, data on water samples collected during the peak of the beach contamination showed total coliform levels well within the New York State standard for swimming (2,400 Most Probable Number [MPN] per 100 milliliters [mℓ]). Fecal coliform was also very low--in all cases less than 100 MPN per 100 mℓ and in most cases less than 10 MPN per 100 mℓ.

2. Hempstead Bay and Atlantic Ocean Samples (Nassau County Department of Health): An intensive sampling program began immediately following the sewage sludge tank explosion at Pearsalls Hassock on June 2. With the exception of June 3, coliform counts in Hempstead Bay were normal or lower than normal and well below State standards.

Sampling results from 26 routine monitoring points on the Bay and seven shoreline points were above normal levels only on June 3. At the 26 routine monitoring points on the Bay, total coliform levels were approximately five times higher than normal for May and June, and fecal coliform levels were approximately three times higher than normal. At the seven shoreline points the elevation of coliform levels was less--approximately 50 percent higher than normal.

Ocean beach sampling was also conducted on the five days following the explosion. Ocean beach coliform levels were approximately 100 percent higher than normal on June 3 but were normal or below normal on the following four days. Previous rainfall may have contributed to the elevated counts on June 3 (Nassau County Department of Health, unpublished report).

3. Hempstead Town Ocean Beach Samples (Department of Conservation and Waterways): None of the samples collected on June 16, 20, and 28, and tested by the Department for total coliform and fecal coliform content showed abnormally high bacterial counts. One sample of "solid floating material" (tentatively identified as tube-worm casings) gave an MPN of 1,300 total coliform per 100 mℓ and 220 MPN per 100 mℓ fecal coliform (Hempstead DCW, unpublished data).

4. Barrier Beach Samples (NYDEC-RI): Samples were taken along the outer barrier beaches in the vicinity of Fire Island between June 15 and 22. Analysis of all waste ball samples showed extremely high counts of both total and fecal coliforms. Water and beach sand samples were far below the State standard for total and fecal coliforms as were two surf clam samples (NYDEC, unpublished data). Bacteriological analyses of water samples from Fire Island Inlet, Moriches Inlet, Shinnecock Inlet, and adjacent bay areas were also normal.

2.3 Public Health Considerations

While floatable trash and garbage are an obvious aesthetic problem, their significance as a health problem is less clear. Concentrations of floatables on beaches are immediately obvious, and direct contact is easily avoided. Floatables in the water are often less obvious, and avoidance of direct contact with them is more difficult. A number of disease-causing microorganisms (pathogens) can be spread by warm-blooded animal excreta, and their possible presence in sewage-derived material can never be entirely excluded. Most experts believe, however, that there is little health risk represented by sewage which has transited a sufficient distance or time in seawater. Common-sense precautions should be exercised, however, regarding direct contact with such material, both on shore and in the water.

One aspect which may constitute a health hazard is the possibility of someone, possibly a small child, ingesting tar or grease ball material, or a swimmer inadvertently taking a small waste ball into his mouth. The strong odor and the other physical characteristics of these balls make this an unlikely problem, and no known cases of disease traceable to beach activities or swimming during the June episode have been reported (EPA-RII).

The most difficult problem is the determination of the health hazards of water polluted by finely dispersed floatables. The potential dangers of the water are determined by bacteriological testing of water samples.

The standard procedure for determining the safety of coastal marine waters for swimming is based on bacterial criteria. Disease-causing bacteria, viruses, and multicellular parasites are of paramount importance in this consideration; unfortunately, no single test exists to detect and quantify adequately the wide range of pathogens that might be present. The most reliable indicator is the fecal coliform group of bacteria which are direct evidence of contamination from warm-blooded animal waste. It is assumed that the potential for enteric disease increases as fecal coliform densities increase. Coliform measurements of the water at the Long Island beaches did not show unduly high densities of bacteria. In the few instances where coliform densities of individual water samples were higher than New York State standards for swimming, specific local circumstances were responsible (for example, samples taken near marinas). Aside from the floatable trash on the beaches, waters met standards for swimming during the entire period. The beaches were officially closed to swimming as a precautionary measure, pending results of bacterial analyses, because of the suspected origin of the trash.

The grease and tar balls were probably the most objectionable floating trash. Many of these contained extremely high densities of total and fecal coliform bacteria, the significance of which is not known. In the absence of corollary scientific data, expert opinion is that these bacteria were in an organic matrix conducive to multiplication. To the extent that such multiplication occurred, the high coliform densities in the balls may not have had their usual indicator significance. Reproduction of the coliforms says essentially nothing about the likelihood of pathogens being present and multiplying. Since pathogens have not been discovered in the balls, the high coliform numbers may mean little or nothing as an indicator of a health hazard. The balls have thus not been shown to constitute a health hazard for swimmers, and they are not regarded as such by most authorities. Until the question of the high coliform levels is resolved, significant numbers of tar and grease ball strandings must be a cause for concern. (See statement by G. M. Hansler, Regional Administrator, EPA-RII, before House Subcommittee Hearings held at Hempstead, N.Y., on July 24, 1976.)

Attempts to isolate enteric pathogenic bacteria such as *Salmonella* from grease balls were unsuccessful even though total and fecal coliform densities were in the million per 100 grams (g) of sample range. As a matter of interest, bottom sediment samples collected from the sewage sludge dump site over the past 2 years failed to yield positive *Salmonella* isolates even though fecal coliforms at times reached several thousand per 100 g of sample. Other water sample research data suggest, however, that some correlation does exist between *Salmonella* occurrences and fecal coliform levels. In one example, when the fecal coliform range was between 201 and 2,000 per 100 g of sample, *Salmonella* was found in from 30.2 to 44 percent of the water samples. Between 55.8 and 60 percent of the samples with fecal coliform counts exceeding 2,000 per 100 g of sample contained *Salmonella*, and when the fecal coliform density was over 3,500 per 100 g of sample, 89.5 percent of the samples were positive for *Salmonella* (EPA-RII).

A single water sample collected from the Narrows near the Verrazano Bridge (fig. 1) on June 29, 1976, contained 11,000 total coliforms, 640 fecal coliforms per 100 mℓ, and two strains of *Salmonella* (*Salmonella enteritidis* ser. *reading* and *Salmonella enteritidis* ser. *ohio*). The effects of over 250 million gal per day (mgd) of raw sewage injected upstream on a continuous basis and less than two hours transit time down the Narrows toward Lower New York Bay, account for these successful *Salmonella* isolations. Apparently, as transit time increases, *Salmonella* longevity decreases in seawater. Environmental factors such as dilution, sedimentation, predation, and toxicity account for their disappearance.

3. TRANSPORT OF WASTE MATERIALS TO THE BEACHES

Floatable waste on Long Island beaches suggests a surface transport mechanism. Movements of the ocean's surface layer, unlike those of deeper layers, are generally affected most rapidly and directly by local winds. Because water at different levels responds differently to the winds, waste floating at various depths is not transported in the same way. Bottom transport can even be offshore when surface transport is onshore. Generally, chemical and bacteriological analyses of the beach waters indicate that no significant amount of nonfloating waste was present. If nonfloating waste made up part of the original pollution, it was obviously segregated from the floating waste during the transport process.

Wind and surface drift data suggest a strong tendency for surface transport onto Long Island beaches immediately before and during the beach contamination episode. Primitive wind-driven, surface-trajectory models using contemporary wind data further support this hypothesis, as discussed in section 3.3.

3.1 Surface Wind Conditions Over the New York Bight June 1 to 21, 1976

Since wind is the major driving force for surface transport, it is logical to examine wind conditions over the Bight during this period. From June 9 through the end of the study period on June 21, a persistent south to southwesterly wind dominated the surface circulation with one brief interruption.

Since debris from the ocean surface began to appear on Long Island beaches several days after this wind flow began, several important questions are raised.

1. What is the normal wind pattern over the Bight during June?
2. What was the departure from normal, if any, during June 1976?
3. How significant was the departure, and can we expect to see it repeated? If so, how well can we predict the probability of recurrences?

Reliable answers to these questions are possible and are given in the following sections with supporting data. Conclusions about wind patterns do not, of course, lead directly to conclusions about possible future beach pollution episodes; other factors must always be considered. Nevertheless, this kind of information is an important part of any effort to understand why such episodes occur.

Surface winds in the Bight region are usually south to southwesterly during late spring and summer, but with many variations from the mean flow. Weak frontal zones cause wind shifts, and sea breezes further complicate matters. Fig. 3 shows the locations of 11 coastal and offshore observation points of the New York Bight with observed wind direction and speed on June 14, 1976, at 2000. All winds except those recorded at Sandy Hook were from the south to southwest at 10 to 20 knots (kn). The variation of surface winds over the 21-day study period is indicated in figs. 4 and 5. Observed winds at four sample stations (Ambrose Light, Data Buoy EB-34, Fire Island, and Atlantic City) are plotted, with fig. 4 showing the morning readings and fig. 5 the evening readings. The winds were somewhat variable until they became southerly late on June 9. (The only variation from this pattern occurred briefly on June 12 with the passage of a weak cold front.) This pattern was the same at all 11 observation stations. Although the winds were rather brisk at times (15 to 25 kn), the striking feature seen here was the persistence of southerly winds.

3.1.1 *Meteorological Significance of the June 1976 Wind Pattern*

Records of mean wind speed and direction for New York observation points are collected by the National Weather Service (NWS) and kept at the National Climatic Center (NCC). June data since 1941 show a mean southerly wind at 9.5 kn for La Guardia Airport (Queens), and a mean southwesterly wind at 6.9 kn for Central Park (Manhattan) (NCC, 1975). In addition, the U.S. Naval Weather Service has found that surface winds with a southerly component occurred in 56 percent of all observations taken in the Bight during June between 1912 and 1968.

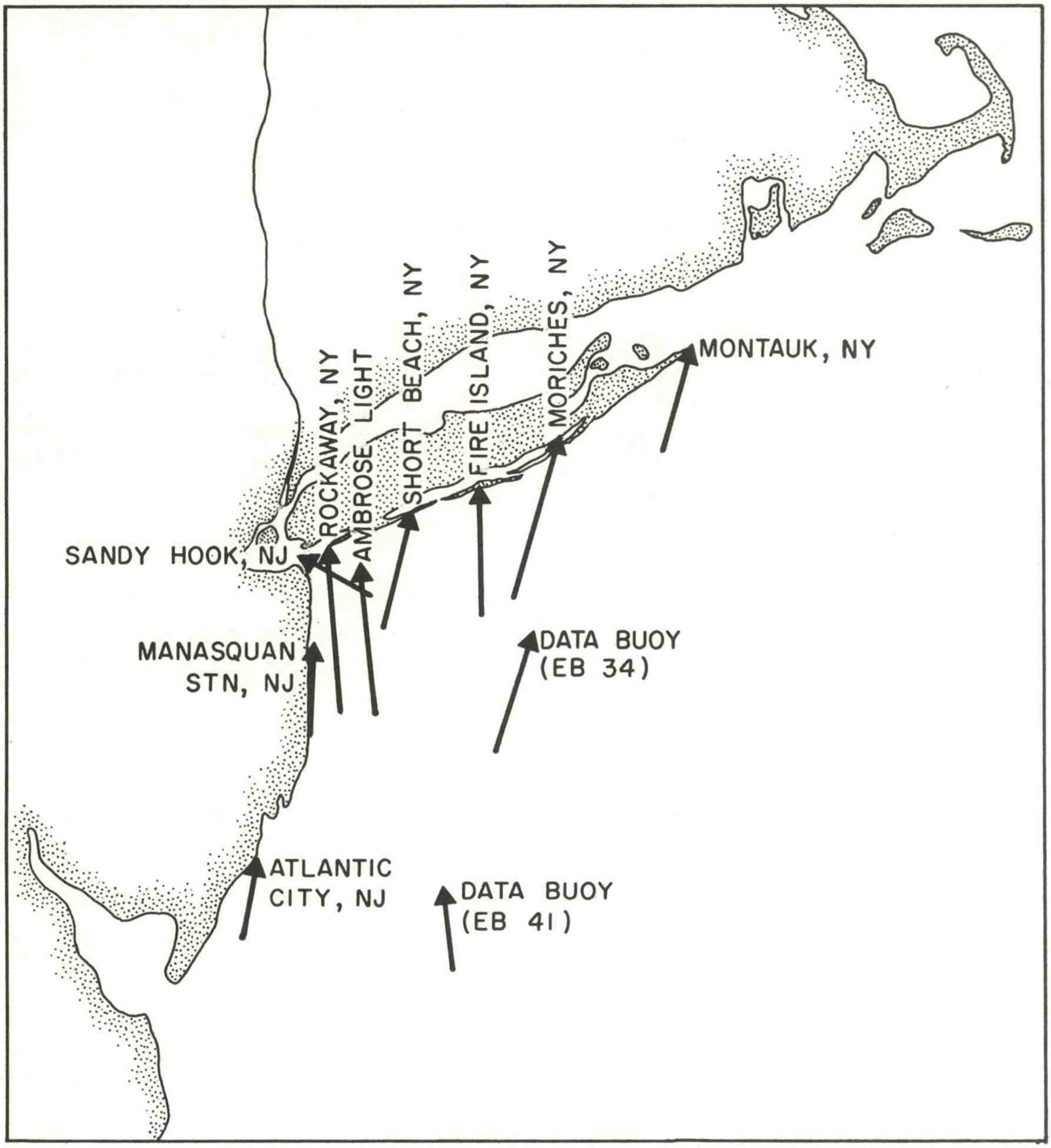


Figure 3. Coastal and offshore observation stations used in this study to analyze surface winds. Winds plotted are for June 14, 1976, at 2000 e.d.t. Wind speed is indicated by the length of the arrows (0.5 inch = 10 kn. EB = Environmental Buoy). Stations are at arrow points.

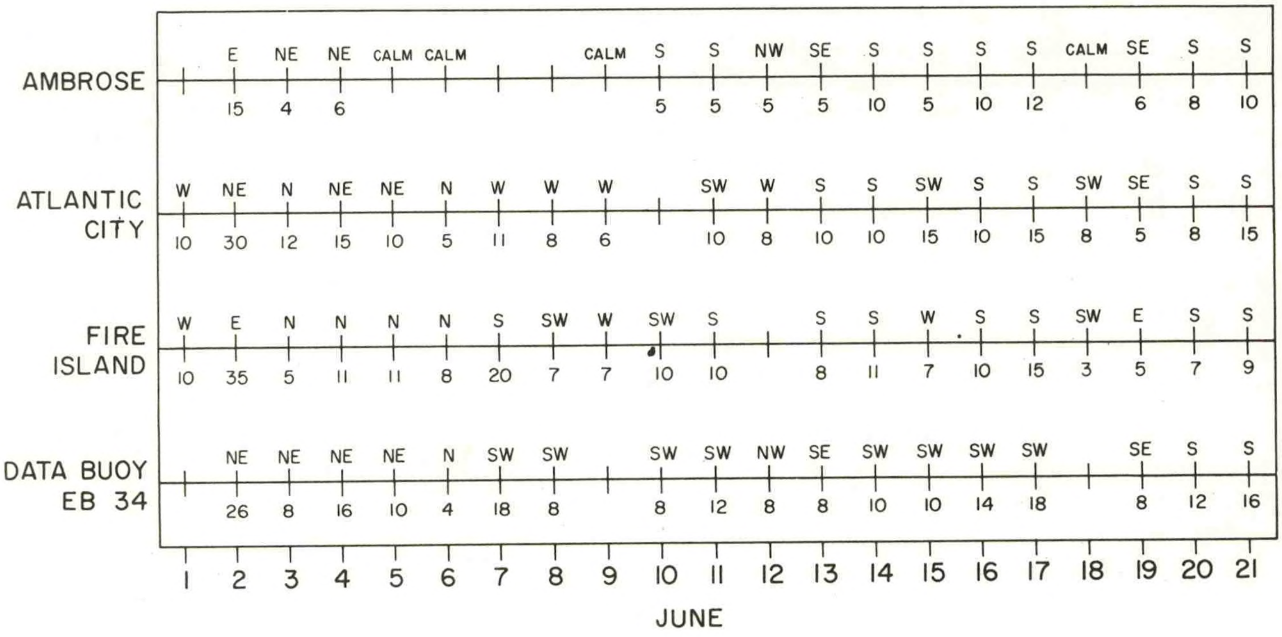


Figure 4. June 1976 - 0800 e.d.t. wind observations (speed in kn).

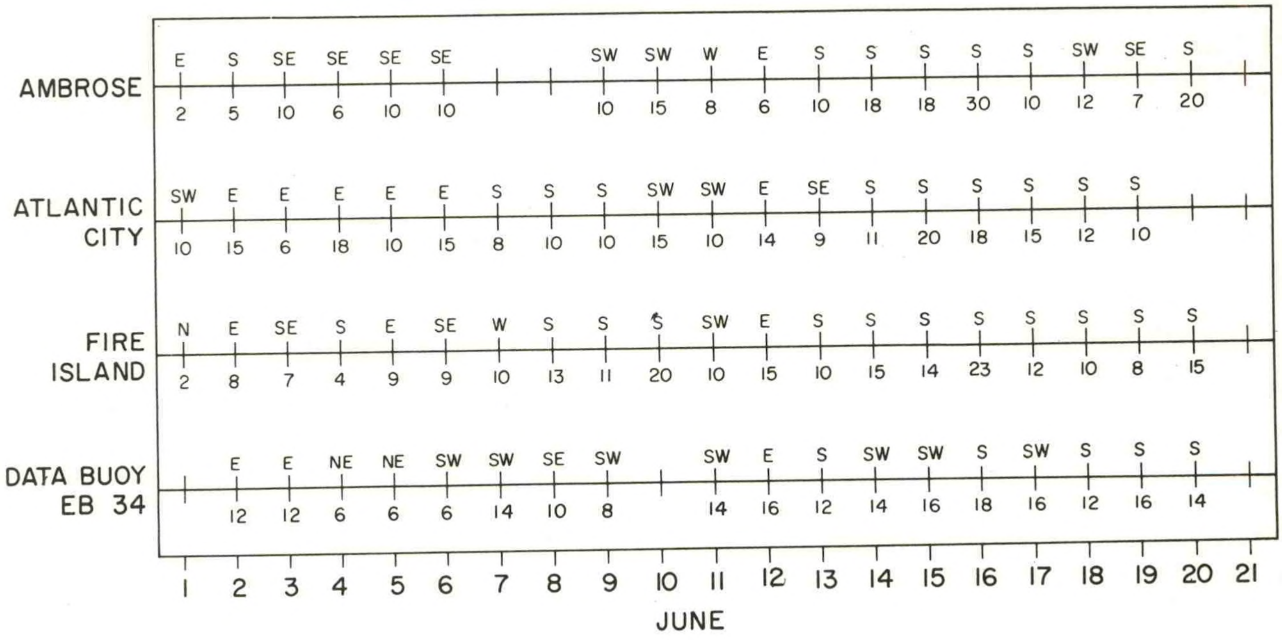


Figure 5. June 1976 - 2000 e.d.t. wind observations (speed in kn).

These summaries are correlated with the normal (mean) surface pressure pattern for June in fig. 6. Surface winds flow clockwise around the dominant high pressure system (located in the mid-Atlantic at latitude 30° N), but also have a slight tendency to blow toward lower pressure. Petterssen (1969) calculates this tendency to represent about a 20° angle to the lines of constant pressure. The normal pressure pattern for the Bight accounts for a dominant southwesterly wind (fig. 6).

While southerly winds are normal in the Bight during June, they were unusually persistent during June 1976. This can be seen by comparing mean surface pressure patterns for this month with patterns which are normal (composite mean) for many years. NWS's Long Range Prediction Group made this comparison with the normal pressure patterns for the period 1948 to 1970. Fig. 7 shows the computed mean sea level pressure for June 5 to 20, 1976, while fig. 8 shows the departure from the normal pattern for this period. This comparison reveals that the combined effects of unusually high surface pressure southeast of the Bight and unusually low pressure to the northwest increased the normal southerly wind flow by about 2.5 kn (fig. 8).

The decision to base the above statement on a 15-day period has statistical implications. If the real wind event of significance had a different time scale, the conclusion might be altered somewhat. However, this 15-day period was what researchers had to work with, and while more detailed examination of the data might better specify the exact nature of the departure, the conclusion is considered reasonable.

In summary, southerly surface winds with speeds of about 8.0 kn are normal for June over the Bight. For the 15-day period from June 5 to 20, 1976, analyses indicate that a departure from normal surface pressure patterns increased the persistence of southerly surface winds so that the mean speed during the period was about 2.5 kn (or 30 percent) greater than normal.

3.1.2 *Probability of a Recurrence of the Wind Event*

The probability of recurrence can be roughly estimated by reviewing previous mean pressure patterns and departures from normal. A review of 15-day periods during May, June, and July 1971 to 1975 (29 cases) indicates that similar departures occurred four times (July 13 to 28, 1975; May 28 to June 12, 1973; April 28 to May 13, 1973; and June 13 to 27, 1972). The analyses for July 13 to 28, 1975 (figs. 9 and 10) show a marked similarity to June 1976 and strongly indicate that such departures are not unusual and can be expected to recur, perhaps on average as often as once each year during the late spring and summer months. They are less likely in other months (especially winter) due to predominantly westerly to northwesterly winds (Weather Bureau, 1952).

3.2 Surface Drift

Few measurements of surface currents in the Bight are available. Only in recent years have reliable methods been developed for measuring near-surface flows, and these were first applied in the Bight by MESA in the summer of 1974. Materials on or very near the surface, such as oils and other floatables, are not transported in the same way as materials "floating" deeper in

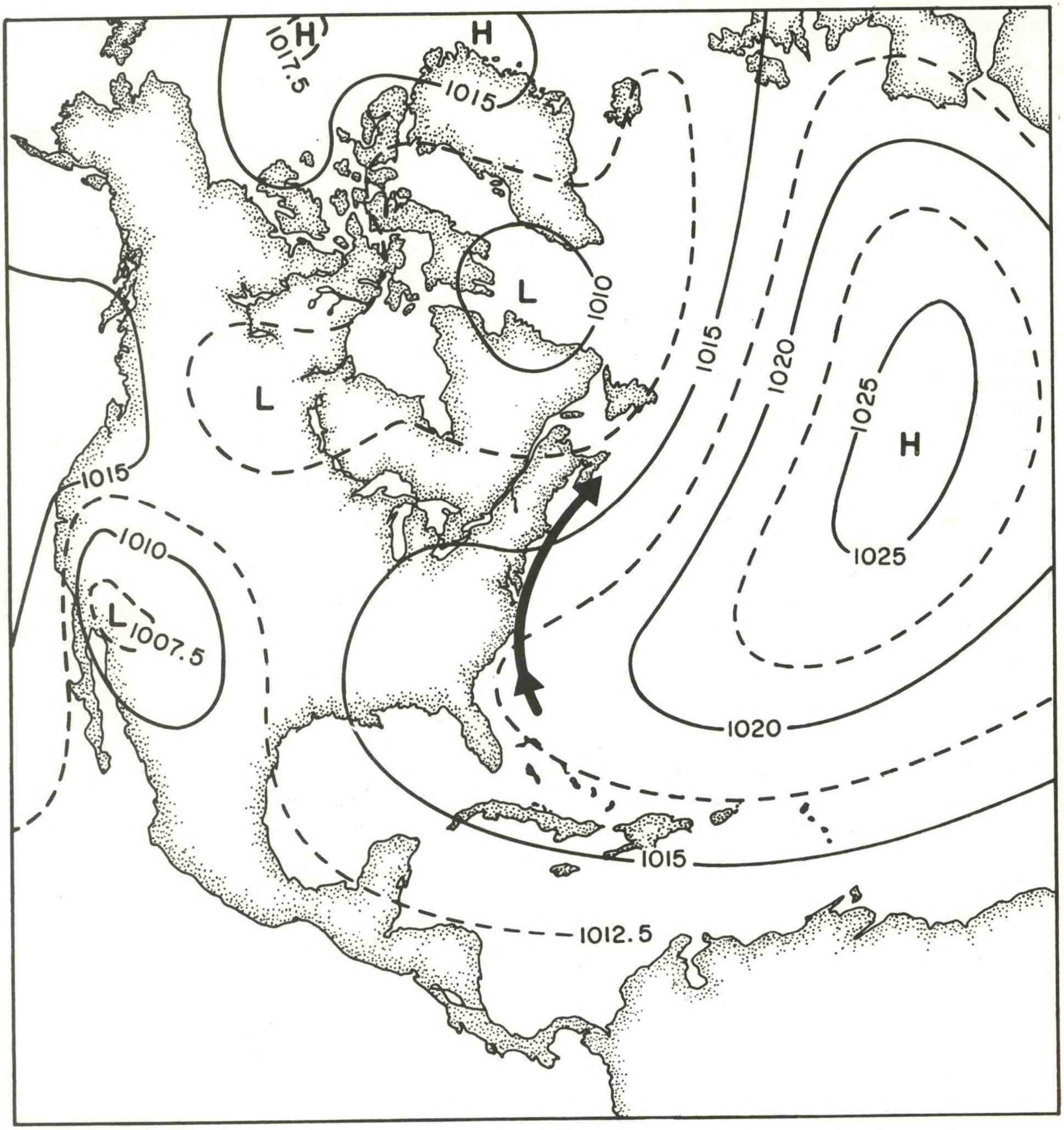


Figure 6. Normal (mean) sea level pressure (mbar = millibar) for June in the Northern Hemisphere. The expected normal wind flow for such a pressure pattern is shown with arrows. Source: Weather Bureau, 1952.

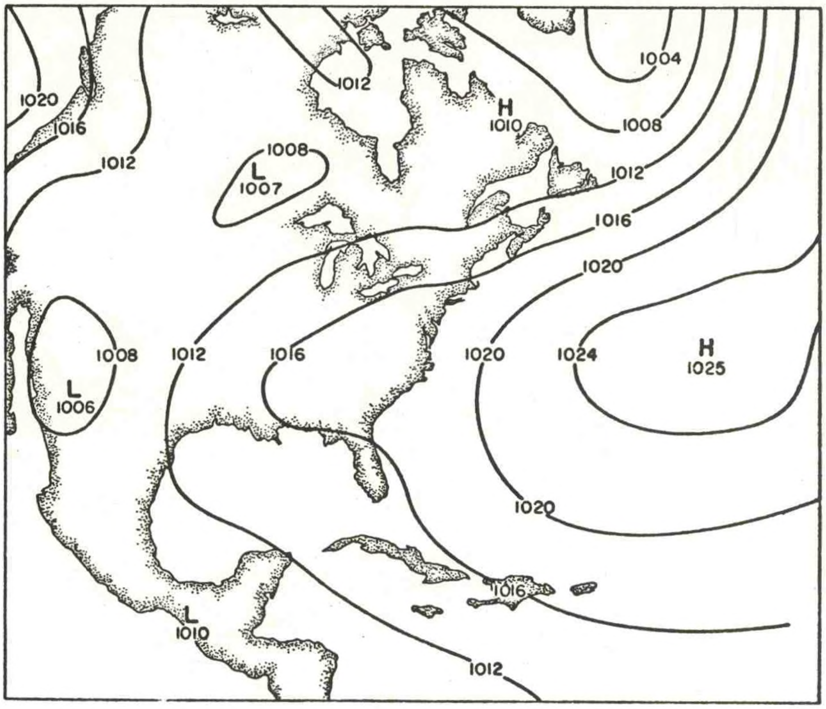


Figure 7. Fifteen-day mean sea level pressure (mbar) for June 5 to 20, 1976.

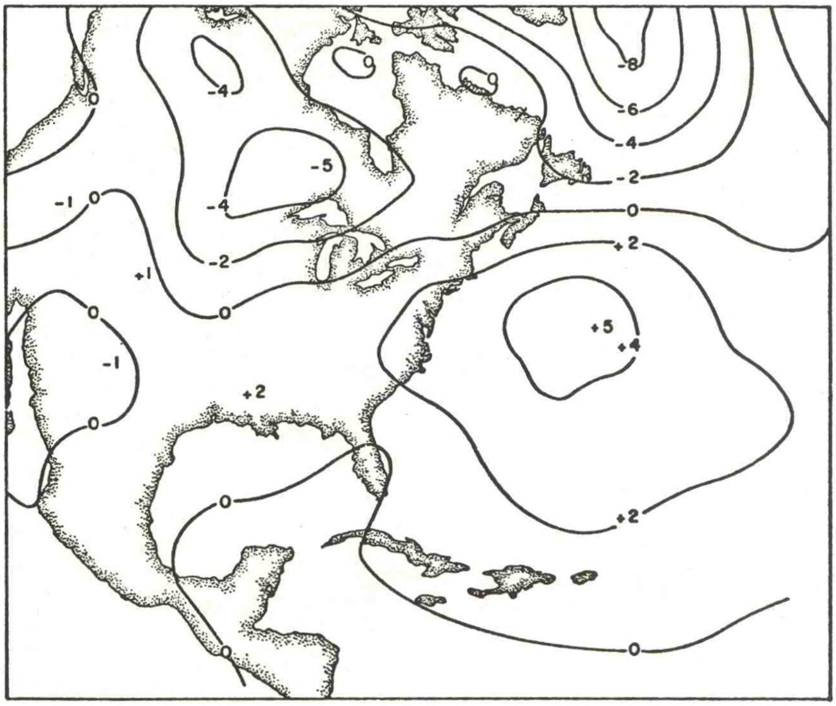


Figure 8. Fifteen-day mean sea level pressure departure from normal (mbar) for June 5 to 20, 1976.

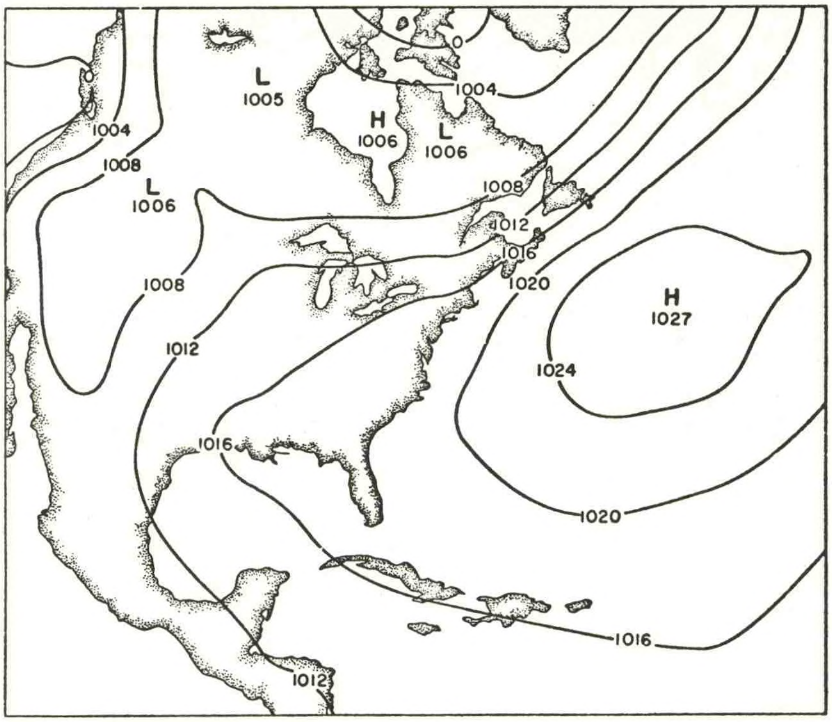


Figure 9. Fifteen-day mean sea level pressure (mbar) for July 13 to 28, 1975.

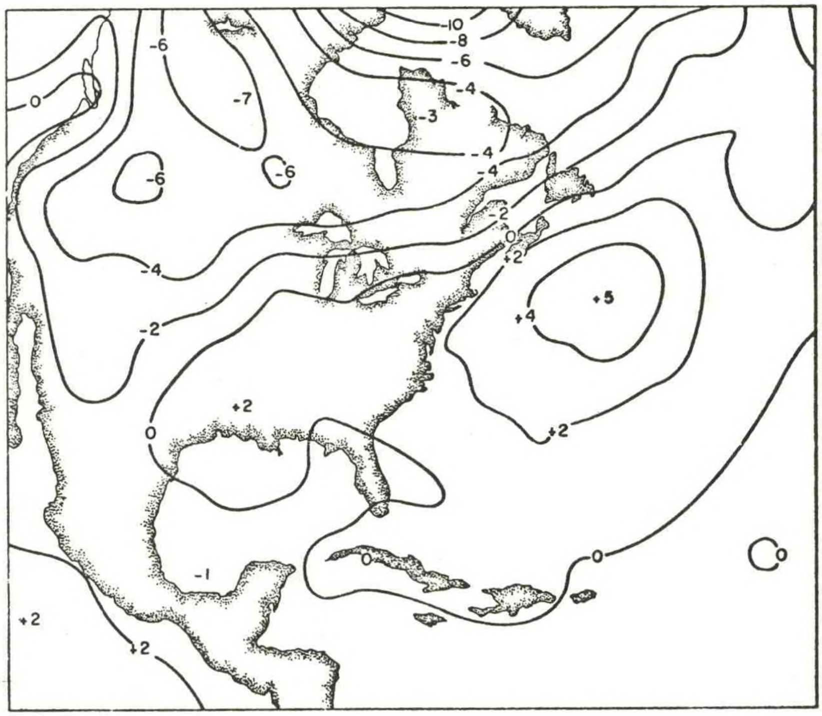


Figure 10. Fifteen-day mean sea level pressure departure from normal (mbar) for July 13 to 28, 1975.

the surface layer (Hardy et al., in press). Much of what is known about transport of floatables has to be inferred from passive "drifter" studies (the release and subsequent recovery of drifters). This information is limited, however, because often only the times and·locations of drifter release and recovery are known. The intervening transport path and time that drifters may lie immobile or unfound on shore are not known.

Several drifter studies have been conducted in the Bight in recent years. Probably the most widely known is that of Bumpus and Lauzier (1965) which dealt with Continental Shelf waters off the entire eastern North American coast. The National Marine Fisheries Service (NMFS) in 1969 conducted a study which covered only the Bight Apex (Charnell and Hansen, 1974). Then in 1974, Hardy et al. (1975 and in press) conducted two concurrent studies for MESA and the Nassau-Suffolk Regional Planning Board. All of these reports provide the most detailed spatial coverage yet available, and their findings are consistent.

Hardy et al. used specially designed drift cards, and release-recovery records were correlated with local weather observations. Although winds are the major driving force producing transport and dispersion of sea surface contaminants, secondary forces (tidal currents, estuarine discharges, and waves) which promote surface circulation can modify the influence of winds. A scheme for predicting surface transport and dispersion was developed to reflect direct wind effect and these secondary influences.

Without wind, the probability for floatables beaching diminishes with distance from shore and at some finite distance becomes essentially zero. On the other hand, there is some minimum distance from shore, probably less than 1/2 nautical mile (nmi), where floatables have almost 100 percent probability of beaching (a notable exception to this may occur near bays, estuaries, and inlets), but these limits are still imperfectly known. On Long Island's south shore, because of seasonal shifts in wind direction, landings are more probable in summer than in winter.

Hardy et al. developed a set of "strandograms" based on study results which allow transport-dispersion projection up to 10 days for five quadrant wind sectors between 068° and 270°, the southerly wind directions when most Long Island strandings occurred. Figs. 11 and 12 show strandograms for winds from south (158° to 202°) and southwest (203° to 247°) quadrants respectively, the prevalent directions during June 1976. Solid and dashed lines intersecting shore represent the western and eastern dispersion limits respectively, and the outer solid line the 10-day stranding limit for the study conditions. The dispersion cone reflects the fact that drifters (or units of any floatable material) released together usually reach shore at widely differing points. Dispersion cones for floatables initially located within the Hudson River plume and released when the winds were south to southwesterly are larger and are skewed more to the east than in the other three cases (not presented here).

Limited drifter studies were also conducted by the Nassau County Department of Health during the June beach episode. Ten surface drifters were released at the sewage sludge dump site on June 22, and five were recovered by July 26 at the following locations:

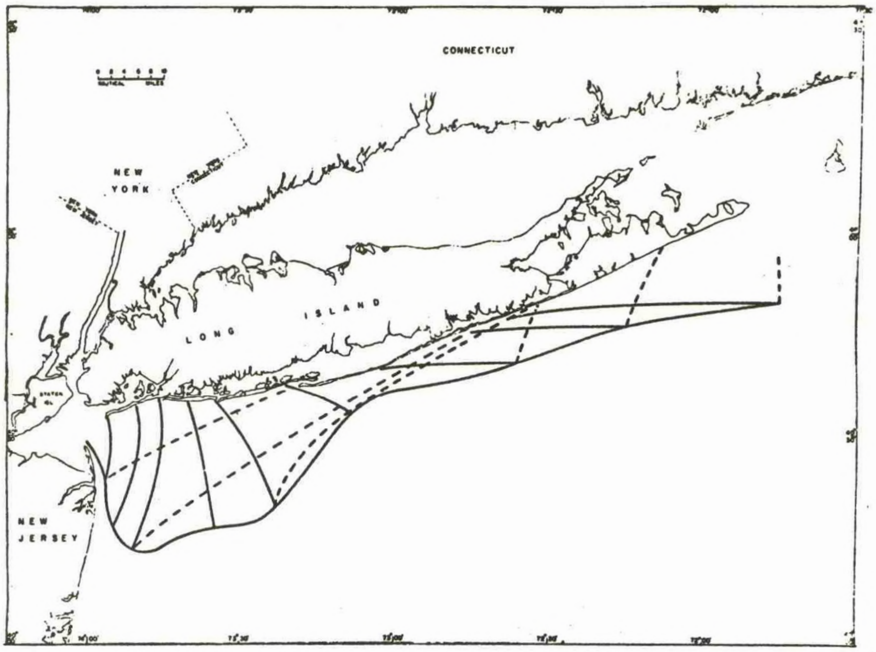


Figure 11. Strandogram 3 for southerly winds (158° to 202° true). 10-day stranding limit.

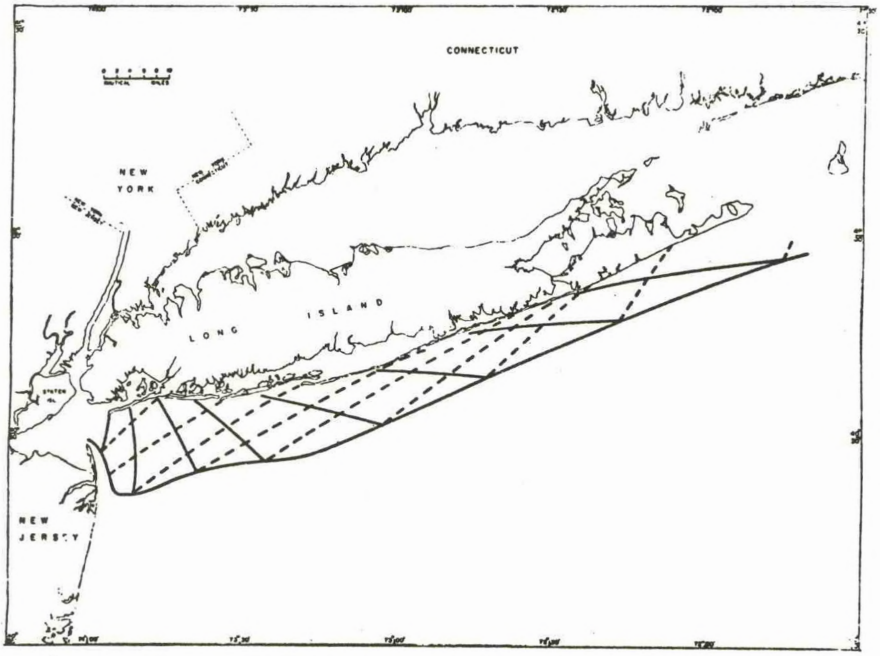


Figure 12. Strandogram 4 for southwesterly winds (203° to 247° true). 10-day stranding limit.

two on June 24 at West Gilgo Beach,
one on June 24 at Tobay Beach,
one on June 24 at Jones Beach Field Number 9,
one on June 25 at Jones Beach Central Mall.

Of another 25 drifter cards released at the dump site on June 25, only one was returned as of July 26, from Jones Beach Field Number 6 on June 28.

These observations confirm the conclusions of the Hardy et al. study. During the June 22 to 25 period, winds were still from a southwesterly direction. However, during the evening of June 25, winds became variable and then generally northerly, ending, at least temporarily, the transport potential toward shore.

3.3 Surface Transport Modeling

Computer models can be useful if based on sound and appropriate assumptions and properly applied. None have yet been developed specifically to study transport of ocean surface debris, but several can analyze and predict the transport of oil spills. Since oil in sea water moves similarly to other floatable material, these models can be relevant to the problem.

Two such models have been applied to the events of June 1976: a model of the Coast Guard's Research and Development Center and a model developed by Brookhaven National Laboratory for the Bight and applied under MESA contract. The results are limited because several of the forces moving the surface debris are not precisely quantified. In addition, each model is limited by the assumptions that enter into its construction. Nevertheless, the following information on the probability and location of surface drifting debris washing ashore can increase our intuitive and analytical understanding of the Long Island pollution problem.

3.3.1 *The U.S. Coast Guard Model*

This model uses a simple vector addition of the forces (including wind, tides, fresh water flow from the Hudson River, and surface currents) acting on floating material to predict their movements. Three test cases were studied. One dealt with the movement of material on June 3 from the vicinity of the sewage sludge storage tank explosion the previous day. The second and third were concerned with the movement of material (e.g., charred wood) following pier fires at Weehawken, N.J., and on the west side of Manhattan on June 3 and 11.

For the first test it was assumed, based on local observations, that part of the sewage sludge material (including floatables) flowed through East Rockaway Inlet at 0300, June 3. The predicted track (fig. 13) indicated a high possibility that material would reach the Long Island shoreline at several different locations, mainly because of the prevailing southerly winds from June 8 to 21.

The second test assumed that charred wood was located near the 66th Street pier in the Hudson River 0000 June 12. Again, a high possibility of impact along the Long Island coastline was found because of the wind pattern (fig. 14).

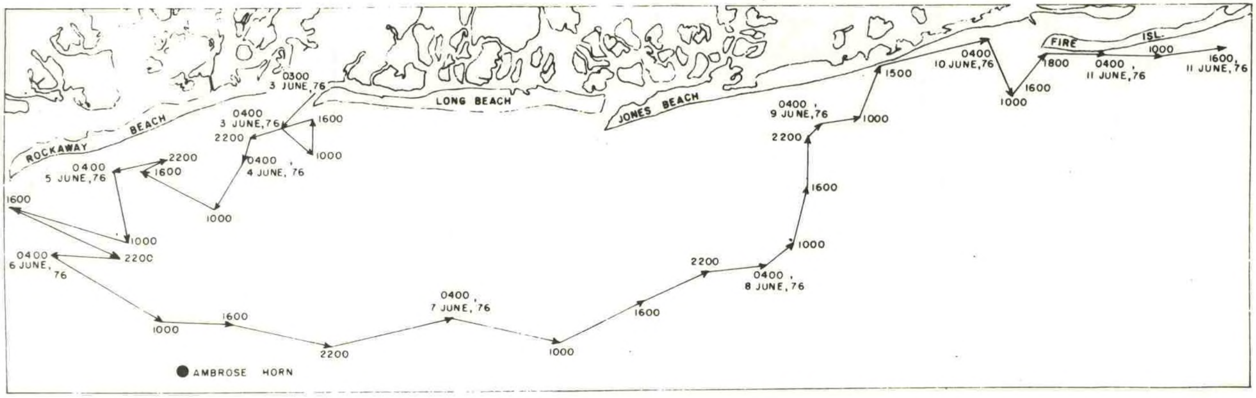


Figure 13. U.S. Coast Guard Model Test Case 1: predicted track for movement of floatable material originating from East Rockaway Inlet at 0300 e.d.t., June 3, 1976.

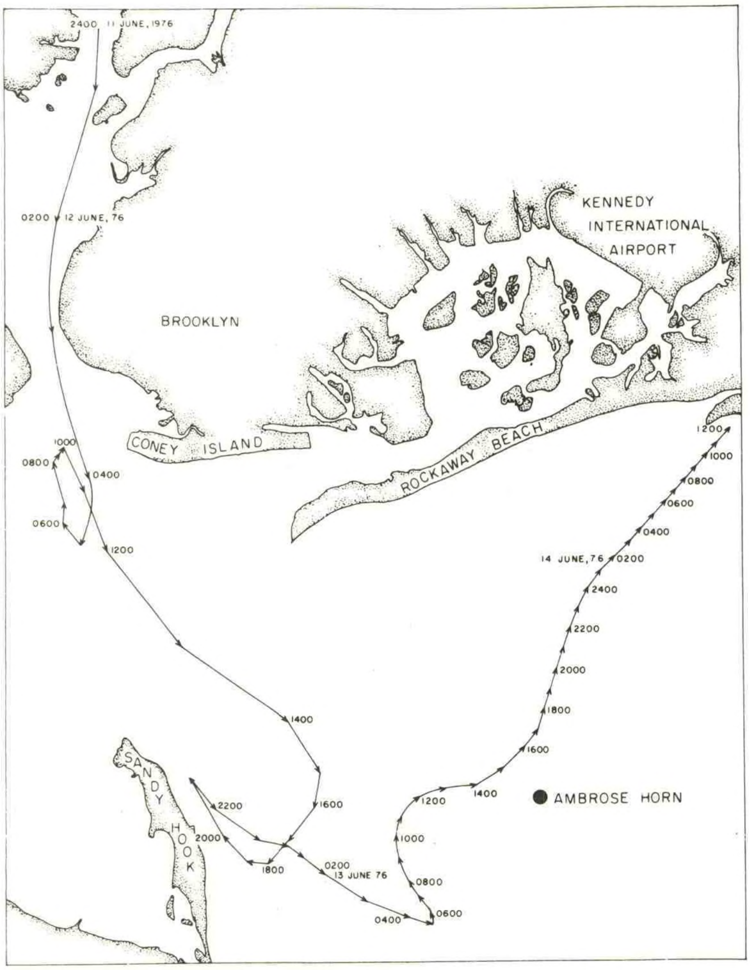


Figure 14. U.S. Coast Guard Model Test Case 2: predicted track for movement of floatable material originating from the 66th Street Pier in the Hudson River at 2400 e.d.t., June 11, 1976.

Two model runs were conducted for the third test case: the first assumed that material entered the waters off the piers at 0400 June 4 and the second at 0600 June 6. The model again predicted similar trajectories and that landings would occur on Nassau County beaches within four days in both situations.

3.3.2 *The Brookhaven National Laboratory Model*

This is basically a one-layer vertically integrated model that computes currents using the topography of the area and the observed winds as the driving force. It assumes that the water surface (and floating material) moves as a vector sum of the vertically integrated current and 3 percent of the wind velocity. The effects of waves, tides, and estuarine discharges are not included.

The method of calculation was to scatter 45 hypothetical continuous sources of material south of Long Island, down the New Jersey shore, and in the Bight Apex adjacent to the Hudson/Raritan estuary. The hypothetical particles were tagged and their movements were simulated every four hours from June 1 through June 28. This resulted in a data base of 7,560 particles for which trajectories and resulting locations were computed. A "hit" was counted if a particle came within 1.25 miles of the shore; the particle was then frozen at that location. (The possibility that particles might float along the shore was not considered.) To simulate the effect of the Hudson River plume, particles were not allowed to impact the New Jersey shore within 25 miles of Sandy Hook, as a boundary condition. Although the model assumes no prior knowledge of the existence of floatables derived from specific sources in the environment at any given time, the selection of the 45 test locations was made to test several hypotheses regarding the fate of assumed floatables in the vicinity of the sewage sludge dump site; the fate of floatables possibly escaping into the ocean through East Rockaway or Jones Inlets as a result of the June 2 explosion; the fate of floatables carried by the Hudson River plume; and the fate of floatables dumped by ships along the major traffic lanes.

The analysis of results is summarized in fig. 15 and indicates that anything floating in the shaded area from June 1 to 24, regardless of original source, would have stranded on Long Island. The times shown are hours from 0000 June 1.

All test particles released from the afternoon of June 2 through June 23 in the vicinity of the sewage sludge dump site (which may also come under the influence of the Hudson River plume) landed on the south shore of Long Island from East Rockaway Inlet to Watch Hill. Material released on June 3 landed on shore from Sailors Haven to a point 18.75 miles east on June 10 and 11. Material released from June 4 to 7 arrived earlier, mostly before June 9, and tended to concentrate near Sailors Haven. Material released from June 11 to 17 landed on Jones Beach within one to two days. Material released after this landed from East Rockaway Inlet to Fire Island Inlet within one to three days. For the entire period about 40 percent of the floating material released near the sewage sludge dump site reached Fire Island.

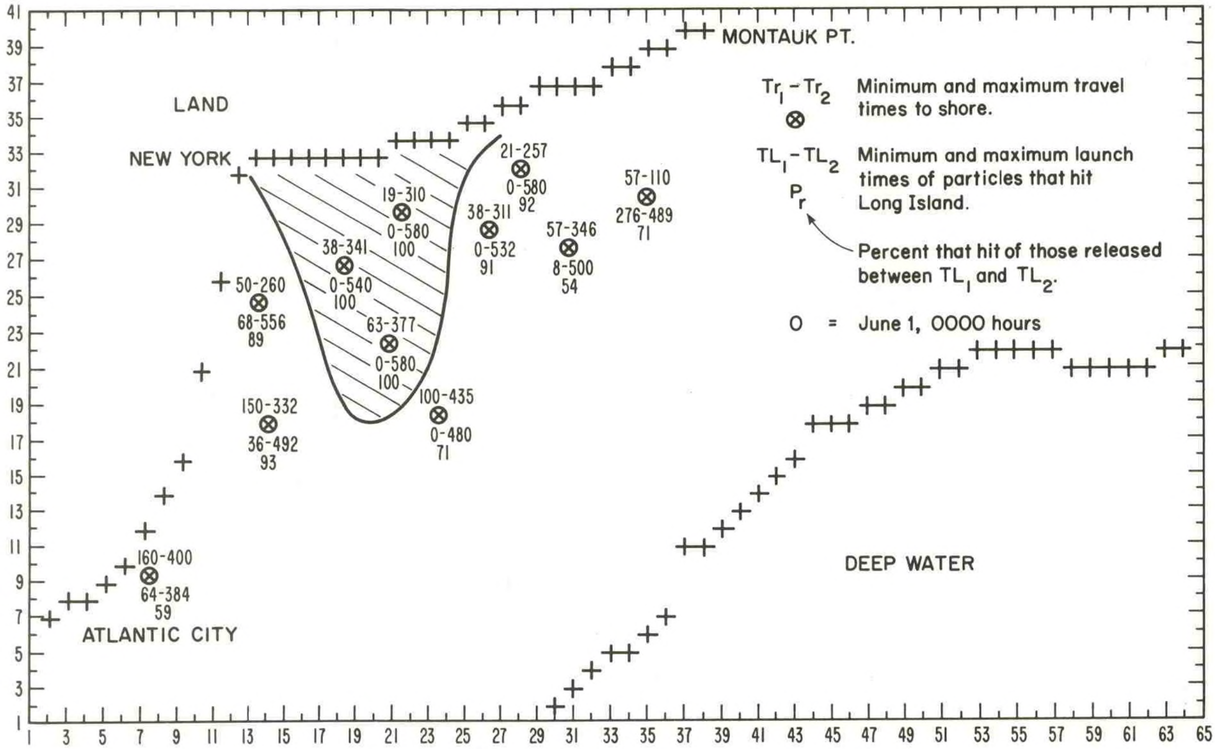


Figure 15. Brookhaven Model: a statistical summary of all trajectories for 11 of the 45 release points. Time is in hours for 0000 e.d.t. June 1. The code is at the upper right.

To simulate material originating near the sewage sludge storage tank explosion, releases were made at 20 points in a 115-square mile area near East Rockaway and Jones Inlets. All the particles released on June 3 and 4 ended up scattered along Fire Island in about a week. For example, all particles from a release point 4.3 miles southwest of East Rockaway Inlet landed within 9.3 miles of Sailors Haven on June 9 and 10. The path was not direct, however. The particles first floated west and then down the New Jersey coast joining with the "Hudson River plume particles" for a couple of days. The combined particles then turned, taking five or six days to reach Fire Island after the winds became predominantly south to southwesterly.

In summary, examination of wind records and surface drifter studies indicates a strong surface transport tendency from the Inner Bight to Long Island beaches before and during the June contamination period. Primitive wind-driven surface trajectory models using contemporary wind data yield similar results. This supports the hypothesis that waste materials reached the beaches from the surface of the Bight. The following section will consider how these materials may have accumulated in the Bight in the first place.

4. POSSIBLE SOURCES OF FLOATABLES

The previous information on surface drift suggests that beach pollutants came from surface accumulation in the Bight, but where did this accumulation originate? Generally speaking, it is not possible to identify specific sources for individual items in the stranded waste materials. Nevertheless, there are identifiable major sources for several categories of waste found, and it can be concluded that these sources contribute to beach pollution to the extent that they contribute floatable material to the Bight.

4.1 Outflow from the Hudson/Raritan Estuary

The Hudson/Raritan estuarine system significantly affects the circulation and distribution of water-quality properties in the Bight, particularly in the adjacent Bight Apex, by inputs of fresh water principally from the Hudson River. The influences are imperfectly understood, but general or qualitative statements can be made (Charnell and Hansen, 1974). Even under normal conditions, large amounts of contaminants are carried into the Bight by the Hudson/Raritan flow (Mueller et al., 1976), and several unusual events within the estuary increased these amounts just before the pollution incident.

One of these was a very high flow or discharge rate for the Hudson River. This discharge provided a mechanism for distributing an augmented floatable load over a large area of the Bight which was transported to shore by wind during June (see secs. 3.2 and 3.3.). Fig. 16 compares the Hudson River mean discharge rate at Green Island near Troy, N.Y., for the period May 1 through June 30, 1976 (U.S. Geological Survey [USGS] Albany, personal communication), with the 1946 to 1976 mean. Historical data going back to 1946 (USGS 1960, 1964, 1970; Water Supply Papers, 1968 to 1976) are also summarized in table 1 as monthly mean discharge rates for May and June with estimates of the Hudson River discharge at the Battery (V. Gravloe, USGS/Albany, personal communication). The Green Island rate is not the total fresh water discharge into the Bight; however, it is approximately 70 percent of the flow of the Hudson at the Battery, which represents approximately 90 percent of the Bight input, with the Raritan and other river basins contributing the rest.

This spring's discharge rates were above normal. May's discharge rate (31.8 x 10^3 cubic feet per second [cfs]) has been exceeded only four times in the last 30 years (table 1), and that month's peak daily discharge rate (71.9 x 10^3 cfs on May 20, 1976) has been exceeded only once (94.5 x 10^3 cfs in 1972) during the last 16 years. Flow remained very high from May 19 until the end of the month. The May discharge was perhaps more typical of April (with a long-term discharge rate of 31.5 x 10^3 cfs); the June mean rate (15.2 x 10^3 cfs), on the other hand, was not too unusual though still higher than normal.

Mueller et al. (1976) show that the Hudson/Raritan estuarine system is the most significant source of wastes into the Bight. These authors do not, however, report floatables separately from nonfloating contaminants. Studies conducted in the Bight Apex, most recently by NOAA/NMFS in 1969 (Charnell and Hansen, 1974), and by MESA since 1973 (Hazelworth et al., 1974, 1975a, 1975b), show that it is quasi-estuarine. A fresh water plume extends well out into the Bight, overriding and gradually mixing with its saltier waters. Most

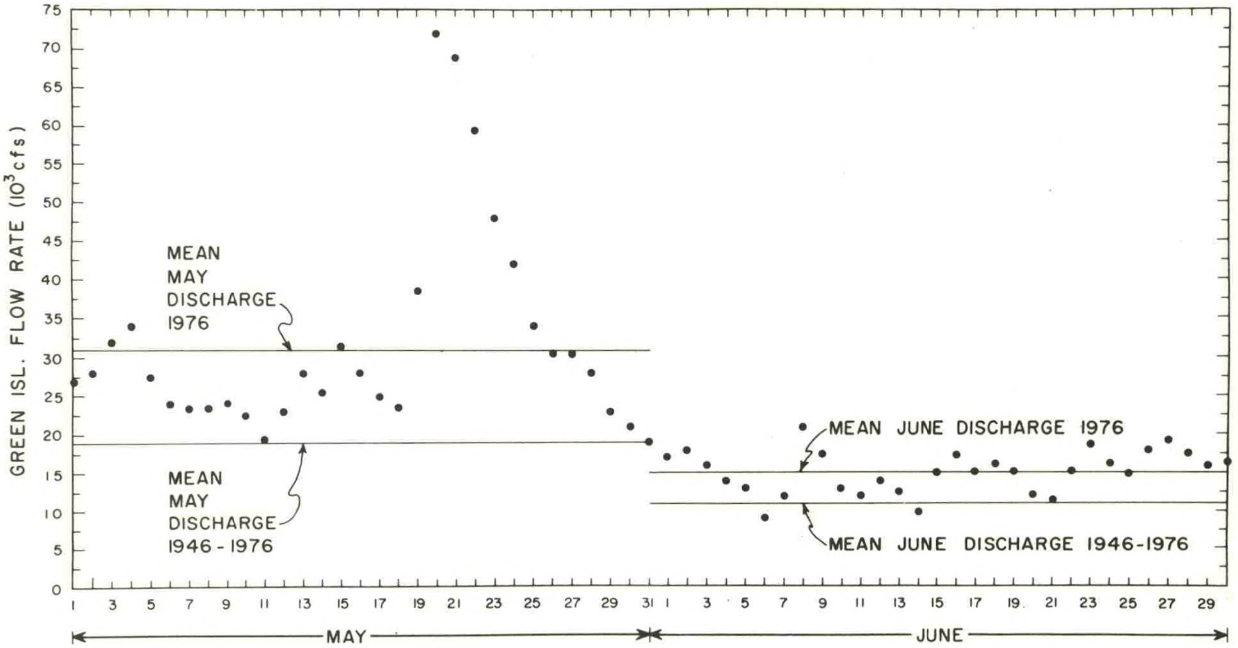


Figure 16. Hudson River discharge. Data from USGS.

waste is carried by the fresher waters; floatables ride with the main surface flow in the absence of winds. At the mixing boundaries of the plume, suspended materials (nonfloating waste) are dispersed or settle out of the plume when the flow can no longer sustain them. (Quite often there is an accumulation of this debris along the plume's boundaries.) Floatables do not sink; thus, their dispersion is often greater than that of the suspended materials.

The plume normally flows along the New Jersey coast in the western Apex (west of the Christiaensen Basin and Hudson Shelf Valley). However, when river runoff is high, it can spread into the eastern Apex, significantly to the east and south. The plume covered almost the entire Apex on April 7, 1973, after a Hudson River flow on the five preceding days greater than 45 x 10^3 cfs. Also, the plume was seen by surface isohaline contours to extend east and south of Ambrose Light during a survey conducted in April 1969. Before this, Green Island discharge rates were gaged at over 30 x 10^3 cfs for 18 days (Charnell and Hansen, 1974).

To establish the plume position (as indicated by suspended sediment load) during this spring, NASA/Langley was requested to review all remote sensed imagery for May and June. LANDSAT coverage for May 6, 15, 24, and June 2, 11, 20, 29 was surveyed, and low-altitude color and color infrared coverage from a special flight on June 23 of the Hudson transect and Long Island beaches was obtained. Unfortunately, plume features could not be distinguished because of cloud cover.

Table 1. Monthly Average Hudson River Discharge Rates (10^3 cfs)

	Estimated at BATTERY, N.Y. (10^3 cfs)		Gaged at GREEN ISLAND, N.Y. (10^3 cfs)	
YEAR	May	June	May	June
1946	----	----	18.3	15.8
1947	51.4	32.0	35.6	26.6
1948	31.9	21.9	19.6	12.2
1949	17.2	6.4	10.0	4.65
1950	21.9	15.4	14.2	8.0
1951	15.2	10.3	11.2	7.5
1952	35.6	29.5	22.0	14.4
1953	47.4	8.8	32.9	6.1
1954	38.9	17.4	25.6	14.3
1955	14.5	10.8	9.7	8.3
1956	34.5	17.1	23.5	13.1
1957	14.6	6.8	10.1	5.4
1958	29.0	12.3	15.8	9.3
1959	16.4	8.7	12.0	6.3
1960	19.7	15.1	14.3	10.6
1961	29.5	19.1	17.4	13.1
1962	18.2	6.1	14.8	4.8
1963	18.4	8.2	14.8	6.1
1964	13.2	5.3	9.4	3.8
1965	11.2	4.3	8.3	3.6
1966	22.7	10.5	18.4	8.2
1967	26.6	10.7	17.0	6.2
1968	28.8	30.3	18.5	15.7
1969	26.6	13.1	20.9	10.0
1970	18.9	8.5	14.6	6.4
1971	44.8	10.4	35.2	7.3
1972	54.3	53.8	40.5	29.6
1973	43.9	22.4	27.6	13.0
1974	30.6	12.0	23.0	8.8
1975	----	----	20.0	13.0
1976	----	----	31.8	15.2
TOTAL	755.6	416.7	607.0	327.5
MEAN	27.98	15.43	19.58	10.53

In summary, floatables from the estuarine system were widely distributed over the Apex because of high river flow in late May. Wind over the Bight initially promoted further dispersion of floatables to sea and on about June 9 became persistently southwesterly to provide the transport mechanism to wash the floating trash up on the Long Island shore.

4.2 Waste Water Discharges

Large volumes of municipal and industrial waste water reach the Bight daily (Mueller et al., 1976). Some discharges are made directly to Bight waters through ocean outfalls and barging operations, but most come from pipes leading into the New York Harbor complex (including Passaic, Raritan, Newark, and other bays) which eventually reach the Bight with flow from the Hudson/Raritan estuarine system. Additional contributions come from outfalls in coastal tributaries and embayments along the New Jersey and Long Island shores.

Estimates of total mass loads of pollution in the Bight (Mueller et al., 1976) are reproduced in tables 2, 3, and 4. With the possible exception of oil and grease, these pollutants did not directly contribute to the problem on Long Island. With this exception, the categories in the estimation do not separate floatables from total pollutant loads. However, observations made by EPA-RII on or about June 30 show that floatables in noticeable quantities are present in New York Harbor and thus demonstrate a potential source of floatables to the Bight.

The major sources of waste water discharges are municipal sewage treatment systems. A summary tabulation of such plants located in the New York Harbor complex and vicinity (New Jersey shore to Barnegat Inlet, south shore of Long Island, New York and New Jersey south of the Westchester-Rockland County lines) is given in Mueller et al. (1976). These authors estimate that these sewage systems account for 5 percent (2,670 mgd) of the total flow to the Bight (53.4×10^3 mgd). EPA-RII estimates that during May and June 1976, the average flow from municipal plants was 2,414 mgd, of which 428 mgd was discharged without treatment (table 5). Mueller et al. (1976) estimate that municipal discharges contribute 22 percent or 191 metric tons daily of the oil and grease input to Bight waters. (Not all oil and grease pollutants from these sources remain in the water surface; however, a sizeable fraction is emulsified and dispersed through the receiving water column. A significant, though unquantified, amount does float and undoubtedly contributed to the quantity of grease/tar balls found on the beaches.)

To determine if other floatable waste found on the beaches could have come from municipal outfalls, the operations of sewage treatment plants should be reviewed. Inflow from sewer mains is a mixture of liquids (99 percent water), suspended particulates, floatables, and large debris. The large debris is first removed on trash racks or bar screens and is generally incinerated or buried. Some plants grind up this material and reintroduce it to the waste stream for further treatment.

Next, suspended particulates and floatables which have passed through the screens are removed. The heavier particles, such as sand and grit are

Table 2. Total Mass Loads into the New York Bight

		Percentage contribution by location			
		Coastal Zone*			
Parameter	Mass load metric tons/day	Direct Bight	Transect	New Jersey	Long Island
FLOW, cfs	82,700	59	36	4	1
SS	24,000	68	31	0.6	0.1
ALK	5,100	1	96	2	1
BOD_5	2,100	30	67	3	0.5
COD	10,000	42	48	9	0.5
TOC	2,600	37	58	4	0.6
MBAS	59		95	4	0.5
O&G	870	38	53	9	0.6
NH_3-N	210	28	67	3	2
ORG-N	190	27	68	3	2
TKN	400	27	68	3	2
NO_2+NO_3-N	120	33	55	10	2
TOTAL-N	520	29	65	4	2
ORTHO-P	51	1	91	3	5
TOTAL-P	138	51	45	2	2
Cd	2.4	84	15	0.5	0.07
Cr	5.0	51	44	0.6	4
Cu	13.8	54	45	0.9	0.2
Fe	230	82	16	2	0.2
Hg	0.30	9	85	6	0.6
Pb	12.7	53	46	0.5	0.2
Zn	33	47	52	1	0.3
F. Coli[a] winter	5.6×17^7	<0.01	100	0.2	<0.001
summer	4.9×10^7	<0.01	100	0.2	<0.001
T. Coli[a] winter	21×10^7	<0.01	100	0.1	<0.001
summer	11×10^7	<0.01	100	0.2	<0.001

a. Coliform load [=] 10^{10} org/day

*See fig. 17 for illustration of the zones

Source: Mueller et al., 1976

removed in grit chambers. Treatment in primary settling tanks further removes suspended and floatable materials. Through this primary treatment process, about 35 percent of the suspended material and 60 percent of the BOD (biochemical oxygen demand) are removed. The floatables which pass through the screens are removed by a skimming process in the primary tanks. These "skimmings" -- scum, oil and grease, plastics, rubber, etc., -- are generally buried, incinerated, removed to sludge digesters, or placed in untreated, sludge storage tanks with the sludge. (See table 6 for a list of disposal methods used at major New York area treatment plants.)

Table 3. Total New York Bight Loads by Source

	Percentage contribution						
	Direct Bight		Coastal Zone*				
			Wastewater		Runoff		
Parameter	Barge	Atmospheric	Municipal	Industrial	Gaged†	Urban	Groundwater
FLOW	0.02	59	5	0.4	33	2	0.4
SS	63	5	4	0.2	16	12	Nil
ALK	1	Nil	35	0.3	59	5	0.03
BOD_5	21	9	48	2	11	9	0.01
COD	32	10	35	1	13	9	0.01
TOC	25	12	29	1	18	15	0.02
MBAS			86		5	9	0.05
O&G	38		22	0.7	16	23	
NH_3-N	24	4	55	3	10	4	0.04
ORG-N	19	9	45	2	21	5	0.02
TKN	21	6	51	2	15	5	0.02
NO_2+NO_3-N	0.07	33	6	0.3	60	0.6	0.7
TOTAL-N	16	13	40	2	25	4	0.2
ORTHO-P		1	72		18	9	Nil
TOTAL-P	50	0.7	35	1	9	4	Nil
Cd	82	2	5	0.6	5	5	0.001
Cr	50	1	22	0.8	10	16	Nil
Cu	51	3	11	9	10	16	0.006
Fe	79	3	5	0.5	6	6	0.01
Hg	9		71	2	13	5	
Pb	44	9	19	3	6	19	0.004
Zn	29	18	8	2	21	22	0.009
F.Coli-winter	<0.01	Nil	87	0.2	0.01	13	Nil
summer	<0.01	Nil	85	0.2	0.01	15	Nil
T.Coli-winter	<0.01	Nil	91	0.1	0.05	9	Nil
summer	<0.01	Nil	84	0.2	0.1	16	Nil

*See figure 17 for illustration of the zones.
†Gaged runoff for streams above tidal influence.
Source: Mueller et al., 1976.

Biological processes, which constitute secondary treatment, utilize microbes to remove organic and inorganic matter from wastewater by converting these components into a biomass that eventually takes the form of a sludge. This sludge, and solids removed in primary treatment, are anaerobically digested to further stabilize the organic material and remove gases. Following the digestion, the remaining wastewater is introduced in the effluent stream which is discharged into the receiving water body. The combined primary and secondary treatment processes result in about 85 percent removal of suspended material and BOD.

Table 4. Total Barge Dump Mass Loads

Parameter	Load, metric tons/day	Percentage: Dredge spoils	Sewage sludge	Acid waste	Chemical waste	Rubble
V, $10^6 yd^3/yr$	21.7[c]	53	26	15	3	3
SS	15,000	86	3	0.7	0.05	11
ALK	45		71		29	
BOD_5	430	49	46		5	
COD	3,200	65	34	0.1	1	
TOC	660	82	17		1	
MBAS[d]						
O & G	330	92	7		0.9	
NH_3-N	50	74[a]	20	0.04	6	
Org-N	35	74[a]	20		6	
TKN	85	74	20		6	
NO_2+NO_3-N	0.086		53		47	
Total N	85	74	20		6	
Ortho P[d]						
Total P	69	92	7	0.3	0.8	
Cd	2.0	98	2	0.1	0.06	
Cr	2.5	93	3	4	0.1	
Cu	7.1	89	10	0.7	0.07	
Fe[b]	180					
Hg	0.026	50	50	0.04	0.7	
Pb	5.6	85	13	3	0.03	
Zn	9.3	78	19	2	0.7	
F.Coli, 10^{12} org/day	36					
T.Coli, 10^{12} org/day	82[e]					

a. Using sewage sludge TKN ratio.

b. From average Fe/Cu ratio for raw and digested sludge of 25, Mueller (1972).

c. 18.6 cfs.

d. Assumed negligible.

e. Assumed = F.Coli/0.44 from typical municipal wastewater concentration.

Source: Mueller et al., 1976.

Table 5. May Through Mid-June 1976 Discharge Summary

Barnegat Light, N.J., to Montauk Point, N.Y.

Treatment Mode	New Jersey		New York City		Long Island		Total	
	Average Flow (mgd)	Design Flow (mgd)	Average Flow (mgd)	Design Flow (mgd)	Average Flow (mgd)	Design Flow (mgd)	Average Flow (mgd)	Design Flow (mgd)
Raw	-	-	428	-	-	-	428	-
Primary	532	531	223	-	-	-	755	531
Primary & Flocculation	85.7	78.0	-	-	-	-	85.7	78.0
Biological Treatment	20.5	27.9	1038	1575	87	124	1145.5	1726.9
(Modified Aeration)*	-	-	(661)	(580)	-	-	(661)	(580)
TOTAL	638	637	1689	1575	87	124	2414.2	2335.9

*Modified Aeration data included in "Biological Treatment"
Source: EPA-RII

Table 6. Disposition of Screenings/Skimmings by Sewage Treatment Plants in the New York-New Jersey Metropolitan Area

Sewage Treatment Plant	Screenings	Skimmings
Bergen County	Landfill	Landfill
Glen Cove	Landfill	Landfill
Joint Meeting	Landfill	Storage Tanks
Linden-Roselle	Shredder	None
Long Beach	Shredder	Landfill
Middlesex County	Landfill	Landfill
Middletown	Landfill	Landfill
Nassau County	Shredder	Digester
New York City	Landfill	Digester/Landfill
Passaic Valley	Landfill	None
Westchester County	Landfill	Digester
West Long Beach	Landfill	Digester

Source: EPA-RII July 6, 1976. Data gathered through telephone inquiries to subject treatment plants. Only those plants currently holding ocean dumping permits were polled.

While almost all floatable waste is removed in a well-run secondary treatment plant, most plants in the New York area are not fully secondary, and they are not all well-run. Untreated discharges also occur routinely from some areas and during repair or construction activities. During May and June 1976, 428 mgd of raw sewage were discharged (table 5). These included 200 mgd from western Manhattan and 50 mgd from the Red Hook section of Brooklyn. The remaining 178 mgd resulted from plant breakdown or construction. Discharges from many plants in New Jersey are also insuffiently treated. For example, the Passaic Valley Sewerage Commissioners' Plant routinely treats sewage volumes well in excess of its design capacity, and the treatment is considerably below accepted standards.

The quantity of screenings (and skimmings) in an average waste water stream was estimated at 5 to 30 ft^3 per million gal in 1935 (Metcalf and Eddy, Inc., 1972). Using this value and the estimated flow of raw sewage going into the Hudson River during May and June, 2,140 to 12,840 ft^3 of floatables per day would flow into the Bight from raw discharges alone. This estimate is probably low since the proportionate volume of screenings has probably increased considerably since the Metcalf and Eddy estimates were made.

It is not fully understood how waste balls form, but oil and grease from municipal sewage plants are probably an important source. Recent studies of oil and grease found in raw, primary, and secondary effluents are summarized in table 7.

Table 7. Distribution of Oil and Grease Contributions Among Types of Sewage Treatment

Treatment Type	Oil & Grease (mg/ℓ)
None	70
Primary	35
Secondary	15

Source: EPA-RII

Based on these values, it is estimated that between 300,000 and 400,000 lb per day of oil and grease from sewage plants may be discharged through the Hudson/Raritan estuarine system (EPA-RII).

4.3 Combined Sewer Outfalls

In most major urban areas in the United States, including the New York-New Jersey metropolitan area, storm runoff systems and sewer systems are combined for historic and economic reasons. Whenever storm runoff and sewage flow exceed sewerline and/or treatment plant capacity, the overflow automatically bypasses the plant through specially designed overflow points and is discharged untreated. It is estimated that any rainfall in excess of 0.04 inch in the metropolitan area leads to the dumping of untreated waste. During May and June, rainfall exceeded 0.04 inch at the Central Park New York City Weather Station on 19 days (NWS). The number and locations of sewer outfalls in the metropolitan area are given in table 8.

Mueller et al. (1976) estimate that 2 percent of the total flow in the Bight results from urban runoff, including combined sewer discharge. Urban runoff during wet weather also contains trash, grit, and oil from streets (Colston, 1974; Pitt and Amy, 1973). This street runoff combines with sewage during storms and flows untreated into the Hudson/Raritan estuarine system. Only one treatment plant in New York City, the Spring Creek Combined Sewer Overflow Retention Facility, has provision for limited storage and chlorination of sewer overflows for subsequent delivery to treatment facilities.

Mytelka et al. (1973) studied these overflows at an outfall pipe in the Newtown Creek Treatment Plant. During an unusually heavy storm in June 1972, the authors reported that bypassed flow through one sewerline was 361.94 mgd, compared to a normal dry weather flow of 45.24 mgd. Under these conditions, 87.5 percent of the sewage flowed untreated into the water. Oil and grease flow was estimated at 180,000 lb in four hours, more than six times the normal daily amount. The maximum concentration of oil and grease observed during the four-hour storm was 4,300 mg/ℓ which can be compared with values in Mytelka et al. (1973, table 15). The total amount of untreated floatable waste overflowing into the water has not been documented, but observations by EPA and NOAA scientists indicate that it is substantial.

Table 8. Combined Sewer Outfalls

Treatment Plant	Number of Outfalls
New York City	
Port Richmond	30
Jamaica	4
Wards Island	71
Spring Creek	1
Bowery Bay	41
Owls Head	20
Oakwood Beach	6
Coney Island	3
Hunts Point	24
Newtown Creek	74
26th Ward	2
Rockaway	28
Tallman Island	20
North River	44
Red Hook	33
New Jersey	
Carteret	2
North Bergen - Northern	2
- Central	6
- Woodcliff	2
Luider	4
Elizabeth	40
Edgewater	11
Rahway Valley	4
Hoboken	7
Jersey City - East Side	19
- West Side	13
Passaic Valley	74
West New York	1
Middlesex County	6
Bayonne	21
Long Island	0

4.4 Outflow from Bays and Estuaries

No quantitative information on floatables reaching ocean waters via tidal flow or wind drift through inlets penetrating the barrier beach is available. Yet some floatable contribution from the bays is inevitable, and this is significant in the case of the Bay Park explosion because floatables released to Hewlett Bay may have reached the ocean (sec. 4.9). However, even if this source is excluded, routine contributions do occur.

The most identifiable item coming from the bays is marine vegetation. Dead stalks of the wetland reed *Phragmites communis* are familiar to all Long Island beach users. Seasonally, salt marsh cordgrass, *Spartina alterniflora*, breaks loose and is carried out by high tides, often to strand on beaches. Other plant debris, like marine algae and seaweed, is similarly deposited, especially in spring. Large crops of eelgrass, *Zostera marina*, grow on the shallow expanses of south shore bays and, at times, eelgrass drift dominates the debris line of bay beaches. Much of it eventually reaches ocean waters and sometimes ocean beaches.

More objectionable is trash from small boats and from land runoff after rains. The total amount of normal suburban street litter can be substantial. Sewer plant effluents also are released into the bays in some cases, though normal treatment can remove most floatables. Charred wood from beach fires also adds to the trash reaching the outer beaches.

4.5 Commercial Ships and Recreational Boats

Waste disposal from vessels and small boats is of growing concern. Such wastes include sewage, litter and trash of all kinds, garbage, and oil and oily wastes. A distinct parallel exists between these and the floatables found on Long Island beaches.

Ships at sea have traditionally disposed waste directly over the side. In international waters this is not illegal, although it is forbidden in U.S. waters (3 nmi limit). The Intergovernmental Maritime Consultive Organization, to which the United States belongs, recommended in 1973 broadening control of vessel discharges to include all oils, sewage, garbage, and noxious substances carried in bulk or in dangerous packages. Nevertheless, the practice is still common, especially in an area having heavy ship traffic like the Bight. In 1972, over 9,000 vessels arrived at the Port of New York with 33,716 vessel movements through the Ambrose and Sandy Hook Channel systems (Hammon, 1976). It was estimated that in 1975 vessel traffic would generate 3,930,000 gal per day (gpd) of oily wastes in New York Harbor. In the early 1970's, seven facilities existed in the Harbor that could handle nearly 5 million gal per year of oily waste (Hammon, 1976), a very small percentage of the amount generated.

When conditions are right, floatable fractions of wastes from ships will reach Long Island beaches (sec. 3). Few data are available on sewage generation rates on vessels. These are dependent on type of toilet fixtures, size of crew, and type of vessel. Some ships have treatment or retention capability, and others do not. It has been estimated that these rates for commercial craft range from 30 to 100 gpd per person, so a vessel with a crew of 35 might generate 1,050 to 3,500 gpd (W. Librizzi, EPA-RII, personal communication).

Garbage and refuse generation includes wet garbage (food wastes from galleys and dining rooms), domestic-type trash generated in crew member staterooms, and nondomestic wastes associated with vessel operations (cardboard boxes, cleaning rags, office paper, etc.). Estimates of these for an ocean-going vessel with a crew of 40 approximate

1. wet garbage, 140 lb per day;
2. domestic-type trash, 28 lb per day;
3. nondomestic trash, 10 to 15 lb per day (W. Librizzi, EPA-RII, personal communication).

These do not differ greatly from estimates of ship-generated garbage and refuse for inland vessels (Great Lakes) of 6.5 lb per crew member per day.

The large and growing number of pleasure boats must be considered a major source of floatables. The Coast Guard estimates that 9 million recreational boats used American navigable waters in 1974, outnumbering commercial and Federal vessels by 80 to 1. Carls (in press) estimates 8 million boating days per year in New Jersey. In New York there are some 400,000 registered motor boats and an estimated 150,000 unregistered small craft and unpowered sailboats (fresh-water as well as salt). While New York and Federal laws prohibit dumping trash in the water, the Coast Guard estimates that 1 lb of paper, cans, and bottles, and ½ lb of garbage are discarded by each boater each boating day (USCG Public Affairs Office, WEP 3/1); much of this is obviously thrown overboard.

It has been assumed that recreational boating traffic in the Bight is about equally distributed between New York and New Jersey registry, and roughly 20 percent of total boating days of each state are estimated to occur there. This could mean that nearly 2,500 tons of litter are annually dumped in the Bight from this source. Most of this dumping occurs during the active boating season between Memorial and Labor Days when litter is most visible on beaches and is most likely to be washed ashore.

For all kinds of craft (passenger, merchant, military, commercial fishing vessels, and recreational boats), the National Academy of Sciences (1975) estimates that 6.2×10^6 tons of litter are discarded per year in marine waters. Considering population density and industrial and commercial activity of the region, a significant part of this annual burden can be assigned to the Bight.

4.6 Pier Fires

Charred wood, probably from pier fires in New York Harbor, was distinguishable early in the Long Island pollution episode. The large amounts and relatively uniform distribution over a wide area argued against local beach fire origins, and many small bits of wood from the pier fires were known to have drifted into the Bight (sec. 1.2).

Laboratory analysis (U.S. Forest Service) of beach samples indicated the wood could have been used in pier construction. Although no precise identifications were obtained, it may be concluded that some of the driftwood came from pier fires. This is important because it indicates that some of the beach trash came from the Hudson/Raritan estuarine system via Bight waters, and other floatables could have come by the same route.

Pier fires are not the only or even necessarily the major source of charred wood to the Bight and beaches. Solid waste handling is an important source, and is so far completely unquantified (sec. 4.10). Logs, branches, and lumber in river flow are another source, though the quantity is also unknown. The only actual figures for New York Harbor give total amounts of driftwood collected there in recent years by the U.S. Army Corps of Engineers (COE) (table 9), but only pieces large enough to constitute a navigation hazard were picked up. The percentage of this wood attributable to pier and waterfront fires is termed "substantial."

4.7 Ocean Dumping

The sewage sludge dump site, where sewage sludge and small amounts of cesspool wastes are routinely disposed (fig. 17), has become a major environmental concern. It has been closely examined over the past several years and is discussed in considerable detail in two MESA studies (1975a, 1975b) and in Mueller et al. (1976). Recently, EPA completed a Draft Environmental Impact Statement (1976) on the possibility of relocating it farther out on the Continental Shelf.

It is generally concluded that sewage sludge contributes a relatively small quantity of the total contaminant load in the Bight. For this reason and because no public health problem has been associated with sewage sludge dumping, EPA recommended not moving the site. Instead, EPA is committed to phasing out ocean dumping of sewage sludge by December 1981 and is instituting an expanded monitoring program in the interim.

However, the topic of this report is not sewage sludge itself but any floatable material associated with sewage sludge and other dumping operations. Of primary concern are grease, small plastic and rubber objects, cigarette butts, and cellulose fibers. A preliminary assessment of the floatables problem was presented in a MESA study (1976a):

> While the floatable fraction of dumped sewage sludge has not yet been measured in the field, readily perceptible quantities of oils, greases, and artifacts remain at the surface after sewage sludge dumping. These materials are a deterrent to recreational boating, fishing, and other uses of Bight waters. It is possible that some portion of the floatables could be washed up on bathing beaches of Long Island and New Jersey, although this has not been demonstrated.
>
> Dumping at one of the alternative areas would result in the same quantity of floatable material per unit of dumped sludge. Although offshore dumping would move floatable materials to less densely travelled areas, and might diminish any portion now reaching bathing beaches, it would contribute to the degradation of relatively pristine waters while only minimally improving surface water quality of the Inner Bight. As with other forms of sewage sluge contamination, the quantities of sewage sludge floatables are probably far outweighed by inputs of floatables from the Hudson Estuary, other runoff, wastewater outfalls directly to the Bight, and vessel wastes.

Table 9. U.S. Army Corps of Engineers New York Harbor Driftwood Removal Program

Fiscal Year (July 1 to June 30)	Volume Removed (ft^3)
1976	557,463
1975	459,166
1974	566,000
1973	526,000
1972	510,000
1971	453,000
1970	390,000
1969	360,000
1968	480,000
1967	490,000

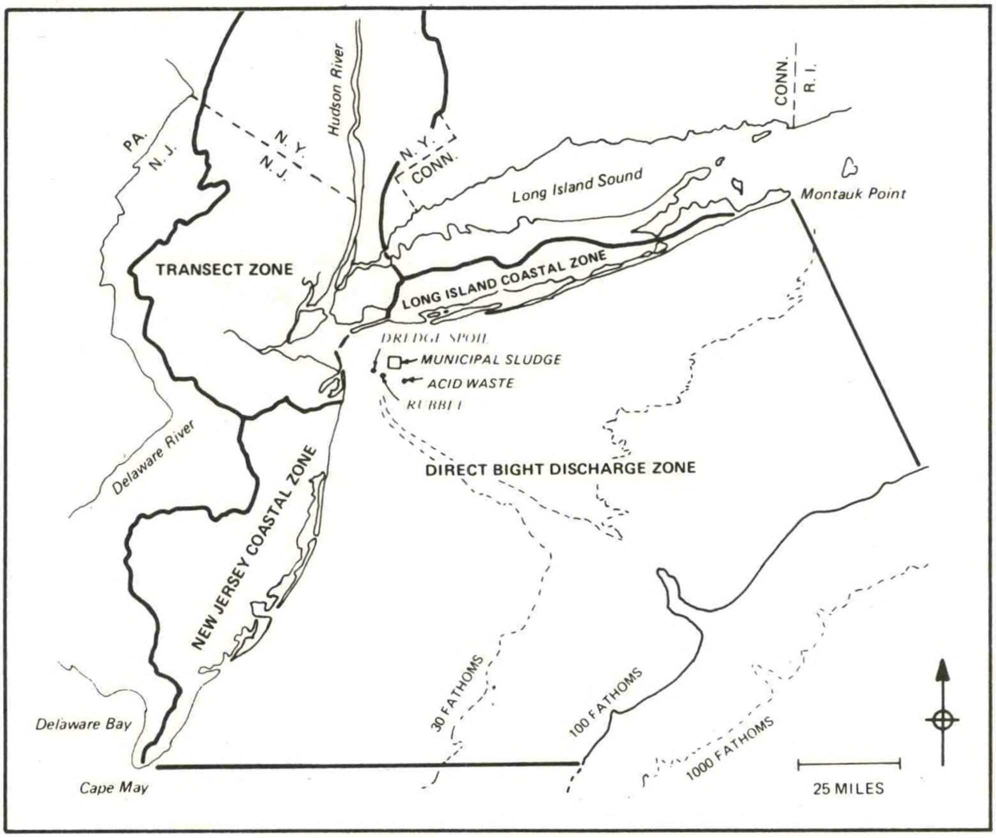


Figure 17. Geographical zones in the New York Bight.

With reference to oil and grease, this problem can be examined in greater detail (table 10). Oil and grease in Bight waters come from ocean dumping, the waters that drain through the Sandy Hook-Rockaway Point transect (called the transect zone), the waters which drain directly or indirectly from the New Jersey coast (called the New Jersey Coastal Zone), and the waters which drain directly or indirectly from the Long Island coast (called the Long Island Coastal Zone) (fig. 17).

Oil and grease in sewage sludge and dredge material dumping are generally associated with particulate material and are probably not all available as floatables. Compared to the total amount of oil and grease entering the Bight, the amount from sewage sludge dumping is small. Even if all the oil and grease from sewage sludge dumping were considered available as floatables, it would constitute only 2.6 percent of the total supply to the Bight. If none of the oil and grease in dredge spoil were considered available, the maximum contribution by sewage sludge would increase to only 4 percent.

The only floatable waste material found on the beaches that could be identified easily was one type of tampon applicator. A rough estimate of the number of these at the sewage sludge dump site can be compared with the number estimated to have been washed ashore from the Bight in general.

The number of applicators transported daily to the dump site is estimated from the population of the metropolitan region serviced by the site, from limited marketing statistics (New York Times, June 23, 1976) regarding daily use of the applicator, and from an estimate of the percentage of the applicators that are put into sewer systems. Since an overall efficiency of 95 percent is assumed for removing floatables at sewage treatment plants,

Table 10. Oil and Grease Contributed to the Bight

SOURCE	AMOUNT (metric tons/day)	PROPORTION INCLUDING DREDGE MATERIAL (percent)	PROPORTION EXCLUDING DREDGE MATERIAL (percent)
Ocean Dumping:			
Dredge Material	304*	35.0	----
Sewage Sludge	23*	2.6	4.0
Ocean Discharge:			
Transect Zone	460	53.0	81.6
New Jersey Coastal Zone	76	8.8	13.5
Long Island Coastal Zone	5	0.6	0.9
TOTALS	868	100.0	100.0

*Oil and grease are only partly available as floatables.
Source: Mueller et al., 1976.

theoretically less than 1,000 applicators reach the sewage sludge dump site daily. (This assumed efficiency is probably low but allows computation of the maximum possible effect from sewage sludge dumping. The resultant number should be used only in the context of the relative importance of sewage sludge as a contributor of floatable materials. In practice, floatables occur only in sewage sludge derived from treatment plants feeding skimmings to digesters or storage tanks. Since only about 50 percent of the plants in the area use these systems [P. Anderson, EPA-RII, personal communication], and since most of the sewage sludge is pumped from the bottom of the tanks, the total floatable load entering the Bight via ocean dumping should be considerably less than that estimated above.)

The residence time for Bight Apex waters is 7 to 10 days (Segar et al., 1975), and minimum transit time for floatables from the dump site to the Long Island beaches is about three days. Thus, from June 9, when southerly winds began, to June 15, when the applicators were counted on the beaches, a maximum of 13 days accumulation could have been available for washing ashore.

Previous research using surface drifters at the dump site under similar wind conditions indicates that 20 percent reached the beaches within 20 days. These landings are adjusted upward to 28.6 percent because only 70 percent of drifters deliberately located on beaches in another test were recovered.

There were then, hypothetically, a maximum of 13,000 applicators available from the dump site, of which some 3,700 (28.6 percent) would be expected to be found on the beaches by June 15. However, there were an estimated 17,000 on Fire Island alone (app. B) and there may have been as many as 30,000 on the beaches from East Rockaway Inlet to Moriches Inlet.

Thus, 4 percent of the grease and oil, and 12 percent of the plastic tampon applicators may have come from the dump site. These figures may be high; further research is needed. However, these percentages generally agree with estimated pollution in the Bight caused by other specific materials from the dump site. At the dumpsite during and immediately after the dumping process, few tampon applicators were observed. It can be concluded that the dump site was probably a minor source (less than 12 percent) of the floatable waste materials on the beaches. (A possible exception to this conclusion involves the effect of shipping Bay Park cleanup material to the dump site. See sec. 4.9.)

4.8 Oil Spills

Not all waste balls contained petroleum (sec. 2.2), but most included petroleum-related substances derived from spills, bilge cleanings, tanker ballast water, motor boat discharges, sewage discharges, etc. By the time these materials reach shore, they frequently are mixed with garbage and sewer greases. Such substances tend to combine through an unknown mechanism with kitchen oils, greases, and artifacts into "grease balls" (EPA, 1973, p. 257).

Much study has focused on the contribution of oily substances from vessels. It has been estimated that of 2.2 million tons of oil discharged into the water in 1969, 47 percent was attributed to normal ship operation and 9 percent to ship accidents (Revelle et al., 1972). If it is assumed that 300,000 tons of oil enter Bight waters each year, as many as 140,000 tons may be accounted for by "normal" ship operations.

Oily wastes (water plus waste oil) produced by individual ships have been estimated as follows:

1. ballast water--5,500 barrels per voyage for dry cargo ships; 30 percent of the amount carried by tankers.
2. bilge water--400 gpd for vessels built before 1953; 400 gpd for post-1953 irregular trade vessels; 265 gpd for post-1953 liners and tankers; 100 gpd for post-1970 liners and tankers (EPA-RII).

Severe oil pollution of beaches is generally attributed to major spills. None were reported during the June episode, though two significant spills occurred earlier and could have contributed to the problem (sec. 1.2).

The Coast Guard reported a 315 percent increase in oil spills in New York and New Jersey waters for the first 6 months of 1976 compared with the same period in 1975. This increase was greatly affected by a massive 2.5 million gal spill following an explosion and fire at the Bush Terminal in January 1976. This particular spill was only one of 105 reported spills in New York waters, and 141 were reported for New Jersey waters. The Coast Guard was unable to estimate the number of spills that went undetected (Newark Star-Ledger, August 4, 1976).

A considerable amount of information on the eventual fate of spilled oil is available. For example, Dennis (1959) reported that "oil tends to sink as cooler temperatures are reached"; therefore, beach pollution, as well as other effects on living organisms, may be worse in summer.

Dennis also found that the New Jersey coast from Atlantic City northward to Asbury Park had a heavier and more constant level of oil pollution than any other stretch of coast north of Florida. The average amount of oil measured was 1.3 lb per 100 ft. Since the Hudson/Raritan estuary discharge normally follows the New Jersey coast, conditions in June which directed the plume eastward (sec. 3) could have resulted in the oil's reaching Long Island instead. In this regard, application of the Coast Guard model for surface transport to the May 8 oil spill in New York Harbor predicted oil would reach Long Island under then-existing conditions and further indicated that wind rather than current would determine distribution of spill residue. These findings corroborate earlier discussions on the mechanisms by which floatables may have been transported to Long Island beaches.

4.9 Bay Park Sewage Sludge Storage Tanks

The explosion of two sewage sludge storage tanks on Pearsalls Hassock in Hempstead Bay is another contributor of floatable material to the Bight and ultimately to the beaches.

On June 2 at about 2000 e.d.t. (Coast Guard reports), the northern tank containing stored sewage sludge exploded, spilling half its contents into the water and the other half onto the Hassock. The southern tank also ruptured, allowing about half of its sludge to escape. In all, approximately 1 million gal were lost to the marine environment (M. Foster, Nassau County Department of Public Works).

Containment and initial cleanup began as soon as equipment could be gathered, about 10 hours later. Dredging operations were carried out from June 11 through July 28. The bottom was dredged 20 ft below the tank, and 26,250,000 gal of material were removed (Nassau County Department Public Works).

Examinations by NOAA, EPA, NYDEC, and Nassau County Department of Health have verified that the cleanup was effective. Nevertheless, several questions should be answered to assess the effect of this event on beach pollution:

1. Was the debris confined and cleaned up so that no significant quantities of material escaped to Hempstead Bay waters?
2. Ten hours passed before an oil retention boom to contain floating debris could be put in place. During this interval there was one ebb of the tidal current from the Bay. Was this sufficient to allow sludge and floatable material to escape into the Bight?
3. What was the composition of the material in the tank, and did it include floatables?
4. How long had it been since the tanks were cleaned and grease and floatables removed?
5. Could the tanks have contained enough grease and tampon applicators to account for the quantities of these materials arriving on the beaches?
6. If floatables did not escape and were cleaned up with the sludge, how was this material eventually disposed of?
7. Has the efficiency of removing floatables at the Bay Park and Cedar Creek plants been high enough to ensure that floatables were not transported to the sewage sludge dump site by barges after the explosion?

The sewage sludge tanks were located along East Rockaway Channel, a spur off the main channel in Hempstead Bay (fig. 18). An unknown quantity of the tank contents reached the Bay as a result of the explosion and was distributed by the ebbing tidal current (sec. 1.2). The Nassau County Department of Health has mapped the distribution of sludge (fig. 19) in sediment samples from East Rockaway Channel including microscopic organisms, artifacts (seeds and hair), xylem tracheids (a plant cellulose), and filter fly wings (the wings of flies found in substantial quantities around the screens of sewage treatment plants). Six days after the explosion, these covered almost the entire width of the Channel adjacent to the tanks. Since the heaviest concentration of sludge covered nearly two-thirds of the Channel width, floatables in the tanks would also be widely dispersed across the Channel and subject to distribution by the tidal current.

Fig. 20 represents tide and tidal current predictions for East Rockaway Inlet, Jones Inlet, and Long Beach, respectively the eastern and western extremes and midpoint of Reynolds Channel. Comparison of these data suggests

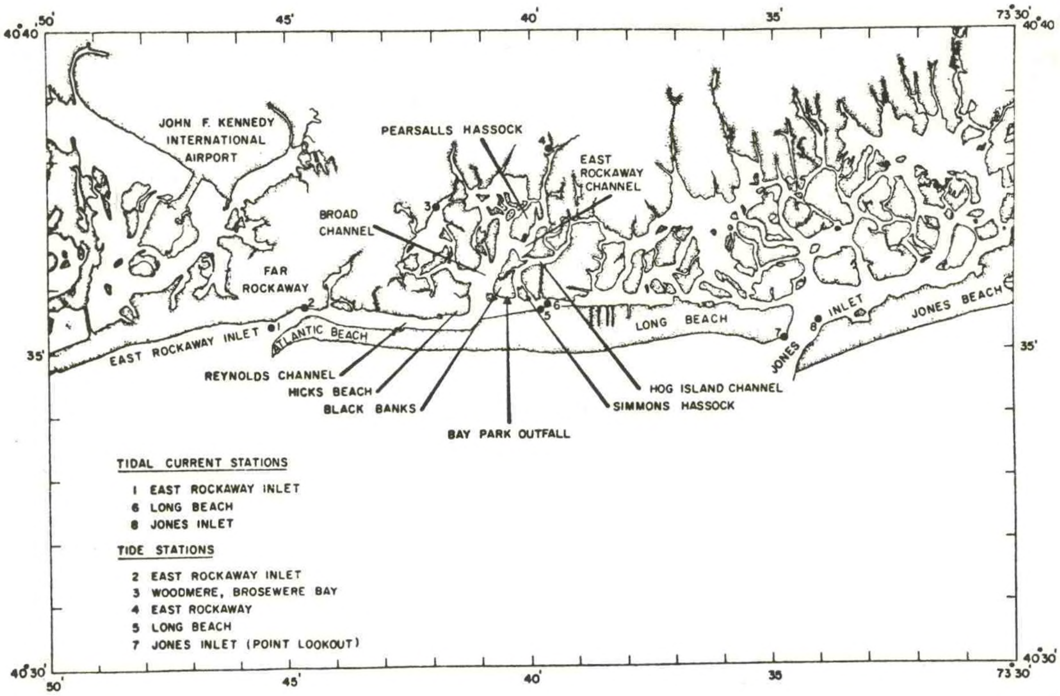
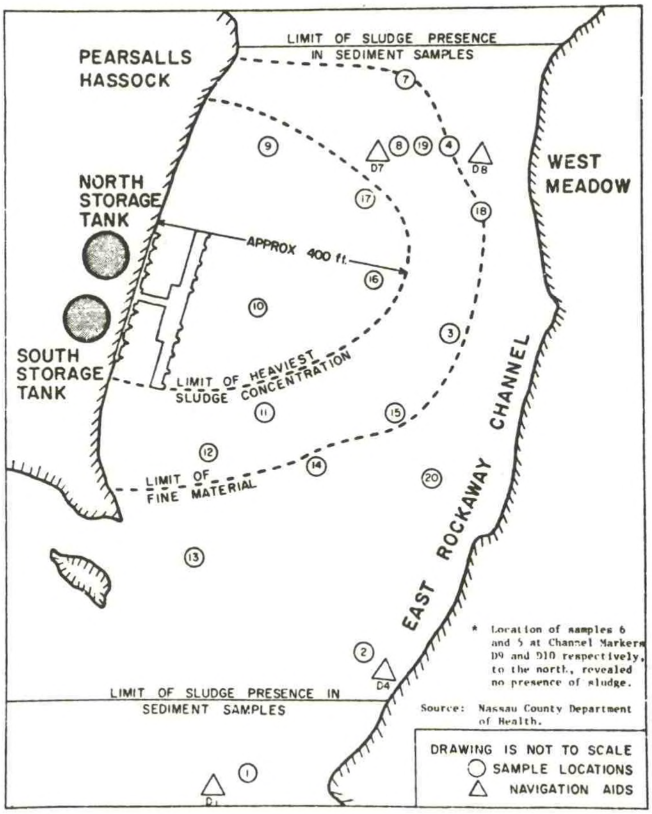


Figure 18. Location map: Bay Park vicinity.



* Location of samples 6 and 5 at Channel Markers D9 and D10 respectively, to the north, revealed no presence of sludge.

Source: Nassau County Department of Health.

Figure 19. Sludge distribution from Bay Park explosion.

that most of the tidal exchange from Pearsalls Hassock and Hewlett Bay takes place through East Rockaway Inlet rather than Jones Inlet. Low predicted current velocities at the Long Beach station support this view. Thus, floating debris from the tank explosion probably reached the ocean through East Rockaway Inlet rather than Jones Inlet.

A Coast Guard observer reported large amounts of sewage sludge in East Rockaway Channel, Broad Channel, and near Pearsalls Hassock shortly after the explosion. Another Coast Guard observer saw some sewage sludge on the shores near Long Beach High School, in Hog Island Channel, and in Reynolds Channel "moving west with the tide." By 0200 June 3, he observed some floating material passing the Coast Guard Station at East Rockaway Inlet, and by 0800, small amounts of surface debris were found between Pearsalls Hassock and East Rockaway Inlet.

The Nassau County Department of Health took samples for total coliform, fecal coliform, and dissolved oxygen measurements in Hempstead Bay and along Atlantic Beach, Long Beach, and Jones Beach (NCDH, unpublished report) during the five days following the explosion. With the exception of the first day, coliform counts were normal or lower than normal. Likewise, sampling results from 26 routine monitoring points in the Bay and seven shoreline points were above normal levels only on the day following the explosion. On that day, total coliform levels were approximately five times higher than normal for May and June, and fecal coliform levels were approximately three times higher than normal at the 26 points in the Bay. At the seven shoreline points, the elevation of coliform levels was only about 50 percent higher than normal.

Sampling at ocean beaches during these five days found coliform levels approximately 100 percent higher than normal on June 3 but below normal on the other days. Rains of 0.5 inch and 0.1 inch on June 1 and 2 probably contributed to the high coliform levels in the June 3 samples. While the percentage increase was higher for ocean beaches than for bay beaches, the actual bacterial concentrations were still very low and in nearly all cases within New York State standards.

Dissolved oxygen levels in Hempstead Bay decreased slightly from normal values during this time. On June 3, dissolved oxygen concentrations (average level 5.8 parts per million [ppm]) were approximately 2 ppm below average levels measured for the entire Bay between 1971 and 1975 (7.7 ppm). Dissolved oxygen concentrations increased to average values of 6.8 to 7.0 ppm between June 4 and 7. (All dissolved oxygen levels were measured at 5 ft depth.)

In summary, there is indication that material from the Bay Park explosion escaped and was carried by a tide as far as East Rockaway Inlet. This is supported by water quality data. Within less than a day, coliform counts increased and dissolved oxygen decreased.

From the best information available (NOAA, 1976a, 1976b), tidal ebb began about two hours after high water at Long Beach in Hempstead Bay on the days in question. High water occurred between 2100 and midnight at the Hassock, and an ebb current persisted through the night. It can thus be concluded that material from the explosion escaped before containment efforts began.

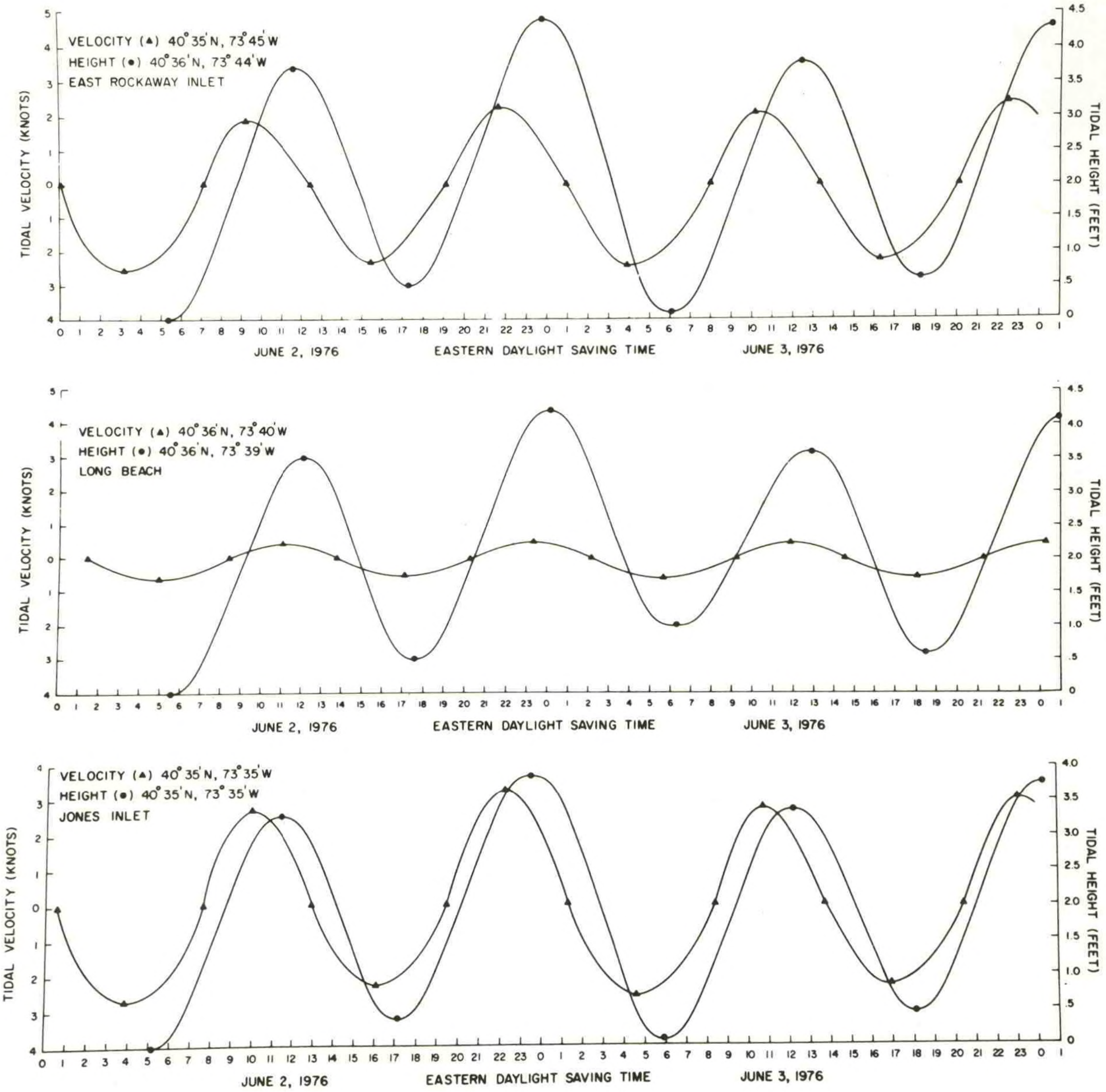


Figure 20. Tide and tidal current predictions for East Rockaway Inlet, Long Beach, and Jones Inlet. Source: NOAA, 1976a, 1976b.

The composition of material in the tanks has still not been ascertained. The efficiency of removing floatables before storage is also not known, although plant inspections suggest that it was high. (In addition, an intermediate set of storage tanks served as a filter for floatable material before shipment to Pearsalls Hassock.) However, the Nassau County Department of Public Works reported that these tanks had not been cleaned since their construction in 1964. So, even if the efficiency was high, it is still possible that a substantial quantity of floatables (grease, plastic, cigarette filters, cigar holders, etc.) had accumulated by gravity segregation and was released into the water.

To assess further the relevance of the explosion, an estimate was made of the number of one brand of tampon applicators that would have accumulated in the tanks before the explosion. This specific applicator was chosen because of its easy identification on the beaches. The estimate is based on population statistics, the amount of sludge generated by the Bay Park plant, rough estimates of marketing statistics (New York Times, June 23, 1976), and quantities improperly disposed through sewer systems. The efficiency for skimming operations in the Bay Park system was estimated at 95 percent.

Calculations based on these estimates give a daily rate of approximately 70 applicators going into the tanks. These applicators could have accumulated at the surface layer of the tanks and might not have been removed when the sludge vessels were gravity fed from the bottom. (Grease balls, if present in the tanks, may also have accumulated in the surface layer.) These applicators have been marketed for 1 to 2 years, and approximately 25,000 could have accumulated over a 12-month period.

One measure of the significance of the contribution of the plastic floatables from the explosion can be estimated by quantifying the amounts of these materials found along the beaches in Hempstead Bay. While little unusual litter was noted shortly after the explosion, most inhabited areas along Reynolds Channel are not conducive to trapping debris. The wetlands, largely covered by *Spartina alterniflora*, do provide potential traps, and on July 1 two MESA teams inspected five wetland areas in Hempstead Bay looking for material that could have drifted from the explosion site en route to the ocean. The areas surveyed (fig. 18) were Black Banks (northeast corner and south shore), Simmons Hassock (east shore), Hicks Beach, and East Channel Island (south shore). Two teams of two individuals each spent ½ hour at each location. The teams were able to cover areas between the low waterline and extreme high waterline over approximately 0.3 nmi. The type and quantities of material found at each site are summarized in table 11. Generally the areas inspected could be described as follows:

Black Banks (northeast corner) -- moderately impacted, probably littered by debris from tank explosion;
Black Banks (south shore) -- seriously degraded, sewage derived material;
Simmons Hassock (east shore) -- moderately impacted, mostly trash;
East Channel Island (south shore) -- relatively pristine;
Hicks Beach -- moderately impacted, mostly trash.

During the month between the explosion and the inspection, there was one spring tide, and a second inspection of Black Banks (south shore) on July 9 following a second spring tide indicated that the area first classified as seriously impacted was by then quite clean. Thus, the wetlands could have trapped material from the explosion and then have been cleansed by succeeding high tides. The lack of extensive material on July 1 does not, therefore, indicate that there was no contribution of floatables by the explosion.

Table 11. Materials Noted at Locations Surrounding Explosion Site, July 1, 1976

CATEGORIES	Hicks Beach	Simmons Hassock East Shore	East Channel	Black Banks S. Shore	Black Banks N.E.Tip
Styrofoam, Plastic cups	many	4	5	2	-
Beer cans and bottles	14	9	1	many	1
Cigar tips	5	8	6	5	15
Cigarette filters	18	24	72	many	65
Styrofoam pieces	-	many	-	many	-
Blue sanitary napkin liners	17	8	6	53	26
Straws	5	15	19	18	20
Horseshoe crab shells	21	-	-	-	2
Small plastics	many	many	many	many	24
Broken glass	much	-	-	some	-
Tar	6 pieces (one was 2 by 1 ft)	-	-	-	-
Pink tampon applicators	-	1	1	8	8
White tampon applicators	-	1	-	1	-
Condoms	-	-	-	3	2 intact
Grease balls	-	some	6	extreme	42
Bad Smell	-	-	-	yes	-

On the other hand, the polluted area on the south shore of Black Banks is close to the Bay Park sewer outfall (approximately 0.08 nmi), and this outfall could have been the source of the contamination. However, authorities doubt that the size and quantities of floatables found could have come through the effluent pipe, and brief observations at the outfall did not reveal any noticeable discharge of floatables. (In addition, this outfall is screened to remove plastic and rubber materials.)

Based on the information available, the explosion contributed floatable material to the Bight which washed ashore later in June. However, it cannot be proved if large quantities were contributed, and the theory that this was a major contributor to pollution is neither supported nor refuted.

Even if floatables did not escape from the immediate area of the tanks, they could have been cleaned up along with the sludge and transported to the sewage sludge dump site. If this occurred, floatables not ordinarily present at the site could have been transported to shore. Not enough information exists on the material collected in the cleanup to support or disprove this.

4.10 Solid Waste Disposal Practices

Almost nothing is known about the possibility of land-disposed solid wastes reaching the Bight. The map of New York City's waste disposal facility locations (fig. 21) shows only the potential for spills along water routes. Major spills have not occurred within recent years (EPA-RII), but no data exist on the frequency of minor spills. Nevertheless, these probably occur routinely. The City annually transfers 3.1 million tons of garbage and refuse from a number of collection points to the Fresh Kills landfill on Staten Island. Both EPA and the Corps of Engineers have frequently noted that trash, paper, and other debris are blown from the barges into the water. The City has attempted to minimize this by loading wet material on the top of barges, and, in addition, a specially built craft called the *Water Witch* retrieves refuse at Fresh Kills by skimming the water surface to catch

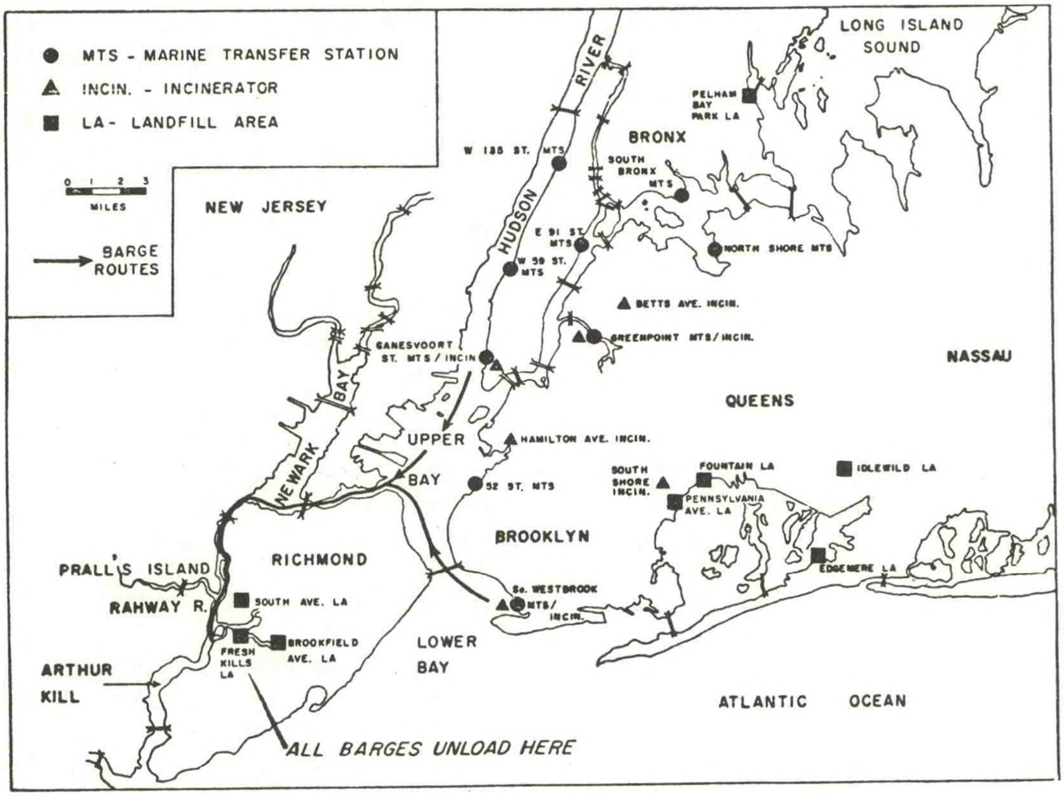


Figure 21. Solid waste handling facilities: New York City.

floating debris with a screen scoop. But in spite of these precautions, lighter trash items, like paper and plastics are probably blown off barges and away from transfer points. Printed items found on beaches suggest this origin.

Trash from the landfills themselves, at the enormous Fresh Kills site and smaller ones elsewhere in the metropolitan area, undoubtedly blows or washes into the water where it is unlikely to be recovered. (This does not imply criticism of these facilities. It simply reflects the inevitability of this and emphasizes one reason for finding more environmentally sound ways to handle solid wastes.)

Among the barge dump sites in the Inner Bight (fig. 17) is one for construction rubble. Approximately 1 million yd^3 of material such as sand, gravel, rock, and concrete were dumped there in 1975. Floatable trash is not permitted at this site, but such things as paper, packing cases, timber, and plastics were undoubtedly present.

In summary, solid wastes undoubtedly reach the Bight, perhaps in quantity, but amounts cannot even be estimated.

4.11 Industrial Activities

Mueller and Anderson (in press) conclude that "The major portion of industrial wastes ... is discharged to New York Bight receiving waters through ... municipal primary treatment plants." Such waste constitutes a significant portion of the effluent burden discussed in section 4.2 and may be more important than its actual volume suggests because of its high suspended and soluble load of pollutants. Industrial waste waters also tend to fluctuate in both volume and composition, lowering qualities of plant treatment and effluent.

While industrial waste has a great effect on Bight water quality, only a small fraction of this waste floats, and most of this is oil and grease. Fig. 22 shows the volumes of chemical and acid wastes, the two major kinds of industrial wastes dumped directly in the Bight. (The chemical dump site is just outside Bight limits at the edge of the continental shelf. See fig. 17.) Data published by Mueller et al. (1976) show no floatables going to the acid dump site, but amounts of oil and grease dumped at the chemical site vary by industry. In some cases these are significant; the authors estimated that three metric tons of oil and grease were dumped there daily in 1973. However, these materials resulted primarily from oil company discharges (P. Anderson, EPA-RII, personal communication) that were phased out in 1975.

The concentrated industrial zones in and around New York City might also be important contributors of special kinds of floatable wastes--damaged or unwanted objects, packing materials, etc. Many of the plastic artifacts found on the beaches may have come from this source, but there is no evidence to prove this.

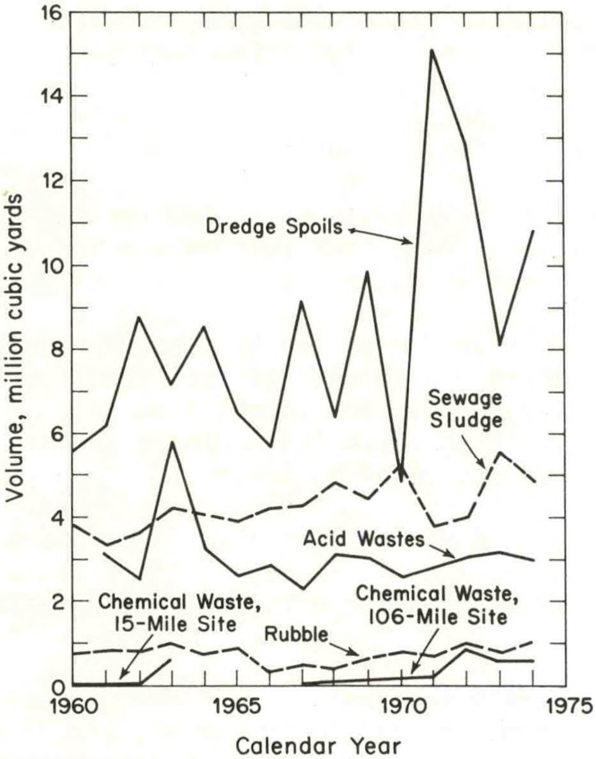


Figure 22. Volumes of wastes barged to New York Bight 1960 to 1974. Source: Mueller et al., 1976.

At present there is no reason to believe that industrial waste disposal makes any major contribution to floatables in the Bight. Undoubtedly, industry contributes through routine disposal channels--sewers, solid waste, etc.--with the other sectors.

5. FUTURE PREVENTION OF SIMILAR INCIDENTS

The recent pollution episode was unusually severe, and similar events will undoubtedly occur again.

Natural mechanisms such as river runoff and wind cannot be controlled. While population increase for the region may be minimal, the availability and use of many potential floatable wastes, especially nondegradable materials such as plastics, will continue to rise. Thus, the best hope is to reduce the severity of new beach occurrences through reducing sources and through technological improvements in methods for removing floatables from contributing systems.

5.1 Source Problems

Nondegradable plastic floatables are a major problem (Colton et al., 1974), and these are being created at a much faster rate than the environment can assimilate. Control is essential but only possible by realizing that they are a national problem, not only a pollution problem but also a serious drain on our energy resources.

Reduction of plastic pollutants can come from the following:

1. Individuals--a clean environment must start with each individual, since waste management cannot depend entirely on Government.
2. Industry--industry must be more responsible for creating more environmentally sound products and fewer resultant wastes.
3. Legislation--since efforts by the above will not be 100 percent effective, Government will have to become more responsible for controlling supply or usage of certain materials.

Public education must create a better understanding of the long-range results of sewer disposal of floatable plastic wastes. Even with optimal functioning, treatment plants cannot remove all floatables, and runoff from rain causes large quantities of untreated effluent to reach the marine environment. Only the individual can control this source of pollution.

Street litter represents a similar problem. Anything floatable discarded on the streets will be carried into storm sewers when it rains, if it is small enough. Only the individual or better street cleaning efforts can eliminate or reduce this source.

Industry must also become more environmentally responsible. It must reevaluate its use of disposable containers and nonbiodegradable materials and find ways to recycle as many floatables (especially plastics) as possible. Waste disposal practices must be based on environmental concerns rather than only on costs and convenience. More extensive use of financial incentives could help accomplish these changes, and it might also be useful to treat the industry-consumer chain as a single system.

Oil and grease waste could be substantially reduced by specific practices such as recycling service station drain oils and cooking oils and greases by commercial establishments and individuals. No apparent technical barriers to this exist, but financial incentive is lacking. (See Maltezou, 1974 and 1976, for detailed discussion.)

Wastes from ships and boats can be better controlled by laws and, more importantly, through individual and corporate responsibility. Because surveillance and enforcement of laws are difficult, the individual has to become more environmentally conscious.

Oil spill prevention technology is an active field, and work in this area must continue. Spills from onshore facilities can be reduced significantly by application of spill prevention and operations. Both EPA and the Coast Guard are developing programs to deal with such events. Once effective, these programs should reduce the number and impact severity of local oil spills.

On the northeast coast, possible exploitation of Outer Continental Shelf (OCS) oil and gas deposits and/or increased imports could negate any improved spill control methods. To what extent Bight spill frequency and intensity will be influenced by OCS oil drilling is still unknown.

5.2 Waste Management Technology

Technological improvements in waste management represent perhaps the least efficient solution to this problem. Additional costs, sometimes very large ones, are required to remove materials that should never have entered the sewage system in the first place. But while the cost is high, this approach has to be pursued and major efforts are underway to accomplish needed improvements. Several that are most relevant to the recent beach litter problem include the following:

1. Sewage treatment plants are being upgraded and expanded under EPA direction and with partial Federal, State, and local funding. Progress in this area and in eliminating combined sewer overflows wherever possible is the most important way to improve waste treatment systems and reduce the Bight floatable input. Methods to control existing overflow systems better are also being investigated. Under consideration are physicochemical pretreatment, underwater storage, storm standby tanks, high rate dual media filtration, microstraining, and dissolved air floatation. The proper design, instrumentation, operation, and maintenance of overflow regulators may also reduce the amount of pollutants during storm periods. The EPA-funded Spring Creek Combined Sewer Overflow Retention Facility in Brooklyn is an example of the type of system being developed.

2. More efficient removal of litter and floatable debris from streets and other paved areas would reduce the load entering the combined sewer system during runoff. This matter should be considered by the Areawide Waste Treatment Management Plan (Section 208 Study).

3. Solid waste handling practices must be improved. Present initiatives toward recycling and the use of wastes as an energy source are promising and should be continued and expanded. Improvements to operational procedures can also reduce the amounts of solid waste lost to the environment. For example, the barging of solid waste in New York Harbor could be improved by reduced loads per barge, higher freeboards, and routine deployment of netting to hold refuse in place more effectively. The various municipalities in the metropolitan area should all upgrade operation and planning of solid waste disposal and recognize that this is a regional problem.

4. Big-city harbor cleanup programs should be improved. Many larger items found on the polluted Long Island beaches had escaped routine screening. The practicality of removing smaller items directly from the water is debatable because the money required to do this could perhaps be better expended in other ways. A more comprehensive cleanup program of wood debris is beginning in New York Harbor. Wood is one of the less objectionable beach pollutants (though a possible hazard to small boat operators), and harbor cleanup activities have been based mainly on safe navigation considerations in the past. However, a more comprehensive cleanup program is presently being undertaken by the Corps of Engineers.

5. Improved sewage treatment plant (STP) operation and planning can reduce the discharge of floatable wastes. For example, skimmed materials should not be reintroduced to effluent or sludge even after grinding and screening. Similarly, a more effective means for removing oil and grease from STP effluents should also be developed.

The means of disposing STP products, especially the quantities anticipated after the completion of new STP's, is being reevaluated. Alternatives to the ocean dumping of sewage sludge are being sought and all dumping will be phased out by December 1981. Currently, a comprehensive study of land-based alternatives for sludge disposal is being undertaken by the Interstate Sanitation Commission (ISC). This study is expected to outline a regional sewage sludge waste management plan.

Sewage treatment considerations must recognize that some pollutants are more objectionable than others. The most undesirable materials washing up on the beaches from this perspective were probably the sewage-related items (grease balls and plastic artifacts), with tar balls and garbage forming a close second. Sewage treatment practices should reflect priorities based on these evaluations as well as quantitative considerations.

In summary, factors determining the extent to which Bight floatables reach Long Island beaches are mainly weather-related. As noted in section 3, the combination of wind and river discharge believed primarily responsible for the June 1976 episode was unusual. Several factors--the high Hudson/Raritan estuarine flow, strong persistent southwesterly winds, and to an unknown extent the sewage sludge tank explosion and other accidents--combined to create a unique situation. The frequency of recurrence is not predictable, but other combinations of these same factors will appear in future summers. Beach pollution incidents will recur, but they can be less severe with better control of sources and with improved waste management practices, especially in the urban perimeter of the Bight.

6. RESEARCH REQUIREMENTS

This report describes available information on the Long Island beach pollution events and apparent causes of their occurrence. Based on what has been found on the beaches, and on what is known about present waste handling and disposal technology in and around the New York-New Jersey metropolitan area, recurrences are considered inevitable in the near future. The severity of the most recent floatable pollution event suggests that there is need to reduce the magnitude and impact of the floatables and, ultimately, to eliminate them. The most important task toward this end requires the quantitative documentation of the sources of the floatables. This would enable the major contributors of floatable pollutants to realize that a serious problem exists and would allow for the reduction of pollutant releases either through voluntary action or regulation. To determine the resources needed for research and control, and to assign organizational responsibilities to deal with the floatable pollutant problem, three basic issues must be resolved:

1. What environmental and/or economic damages are caused by floatable pollutants in the beach zone besides aesthetic ones?
2. Do floatable pollutants impact the marine ecosystem and if so, to what extent?
3. Do they represent a health hazard and if so, to what extent?

Because a wide variety of floatable pollutants exist in the Bight (plastic cups, oil slicks, grease balls, etc.), answers to these questions require the separation and better identification of the pollutants causing particular problems. Research needs to accomplish these may be classified in the following categories:

1. Identification of floatable pollutant types, relative frequency of occurrence, and sources
2. Assessment of the Bight pollutant load
3. Development of better floatable transport models
4. Assessment of environmental and public health effects
5. Development of corrective measures

The first two categories require an extensive sampling program of pollutants along Long Island beaches and in Bight waters. To obtain quantitative data, a systematic sampling program should be developed. The most important information this program should provide is an assessment of possible sources, entry points, and areas of egress.

The New York Bight Project has been funding circulation studies of Bight waters, including tidal and meteorological forces. These studies will continue, and a circulation model will be developed. To understand the actual movement of floatables in response to weather, currents, river flow conditions, and boundary and mixing conditions, additional data are needed; it should also be determined how the various categories of floatables respond to these motivating forces.

The environmental impact of petroleum hydrocarbons and other floatable chemicals (tar, grease, etc.) has to be established. More intensive sampling of polluted waters and surface slicks for pathogens (bacteria and viruses) at the beaches and in aerosols carried over the beaches from the surf zone is also needed. Similar studies should be performed on grease and tar balls that have been found to contain fecal coliform levels.

The research areas discussed so far would provide insight as to the sources, variation, and types of floatables in the Bight and may lead to prediction of floatables reaching the beaches in different seasons and under different meteorological conditions. They would also allow a realistic estimate of environmental damage and public health hazard.

The last research area is concerned with improved waste handling technologies, including effluent overflow, urban runoff, landfill practices and sanitation. Also, this area should involve the development of biodegradable materials to replace the plastics now widely used.

7. SUMMARY AND CONCLUSIONS

From June 14 to 21, 1976, south shore Long Island beaches were inundated by a variety of floating litter. Floatables dispersed over 7,500 nmi^2 in the New York Bight, mostly to the south and west of Long Island, were driven ashore by southerly winds. Floatable material may even have come from southern New Jersey, Delaware, and Maryland. Any material that entered the Bight during the 12-day period of persistent southerly winds (June 9 to 21) probably contributed to the deposit on the beaches, depending on when and where it was introduced.

Many types of floatable material were deposited, including garbage, trash, charred wood, oil, plastics, rubber, and grease. The last three are normally associated with sewage treatment facilities. There was no confirmation of early reports claiming the presence of raw human feces on the beaches. Tar and grease balls generally exhibited extremely high fecal coliform counts. This fact strongly suggested a sewage origin for at least a part of the substances comprising the grease balls, although surface runoff in urban areas also can produce extremely high coliform counts. Water quality at the beaches was carefully tested and generally remained well within established standards for swimming. Although several individual samples exceeded the standard, average values were within acceptable limits.

In apparently every instance, beaches were initially closed for aesthetic reasons and/or as precautionary measures to allow time to test water quality. The apparent sewage-related nature of the beach debris suggested some deterioration of water quality, but test results did not verify this concern. Since analysis of tar and grease balls revealed high fecal coliform counts, authorities kept beaches closed until cleanup was accomplished.

No source can be identified as the single major contributor of floatables. Waste materials deposited on the beaches could have come from any of the drainage systems, or from various sources normally feeding the Bight. Once they reached Bight waters, further transport, whether to the beaches or elsewhere, depended on wind and current conditions. During this period, surface transport was mainly toward the Long Island beaches.

The unusually high May runoff of the Hudson River (and possibly other rivers as well) probably flushed more material than usual from the Hudson/ Raritan estuary. The discharge plume from this estuary normally moves south along the New Jersey coast. In this instance, however, it appears to have expanded to the east. This shift, combined with high flow, probably provided a greater than normal supply of floatable material to the northeast portion of the Bight near the beaches. There was also an unusually large transport of floatables from the southern Bight toward Long Island during this period.

Strong, persistent southerly winds were primarily responsible for pushing and holding the estuarine plume north and east of its usual path and for driving surface waters toward Long Island. These conditions, increased runoff and intense persistent southerly winds, combined with spring tides (maximum about June 12) to transport a large and continued supply of floatables to the beaches.

Many sources feed floatables to the Bight. The Hudson/Raritan estuarine system is the largest contributor because of the size, number, and variety of the waste discharges entering it. Many discharges (untreated, treated, and combined sewer overflows) carry large quantities of the kinds of floatables found on the beaches but lack adequate screening. Because of these discharges, the entire estuary serves as a source to the Bight Apex, where river waters and their contaminant loads are dispersed according to the prevailing oceanographic regime. Although other sources have been identified, practically all the debris found on the beaches can be associated with the Hudson/ Raritan estuary. The charred wood could have come from pier fires; garbage and trash could have come from landfills, vessel discharges, transfer operations, and urban runoff; sewer-related items could have come from raw or treated sewage discharges. The quantities involved in all these discharges and/or handling operations are enormous and cannot be disregarded. Sewage treatment plants in the area bypassed raw or partially treated sewage to the estuary. For example, the Port Richmond plant bypassed approximately 10 mgd, with its associated load of grease and other floatables, during the period in question because of construction-related disruptions.

The sewage sludge dump site and the area contaminated by the Bay Park storage tank explosion have been examined to assess their importance as contributors to the beach problem. Although both were possible sources of floatables, their contributions were relatively minor as were the contributions of other relatively small sources such as the Long Island coast and recreational and commercial boating operations.

The June event is not the first such occurrence recorded. This particular instance was probably more extensive than those in the past, although such a distinction cannot be quantified.

The findings of this report clearly indicate the impossibility of preventing or even lessening the severity of similar incidents until the floatable sources are identified and their input rates significantly reduced. In the short term, there is no technological solution to the problem of floatables on New York metropolitan area beaches. The oceanographic regime of the Bight will periodically affect beach stranding of its floatable load, and no quantitative prediction of the frequency or severity can be given at this time. There are, however, a number of actions which can be taken to reduce significantly the threat of recurrence by attempting to reduce the sources of floatables. These include the following:

1. Establishing a sense of individual and collective responsibility for proper waste disposal

2. Upgrading combined sewer systems
3. Eliminating raw sewage discharges
4. Removing grease and oil from treated effluents
5. Screening raw sewage discharges to remove floatables
6. Optimizing operation of combined sewer systems, by real-time control of valves to minimize bypass during rains
7. Improving solid waste handling procedures, waste handling on boats and vessels, and trash pickup at sources such as pier fires
8. Eliminating the ocean dumping of sewage sludge, and continuing intensifying present efforts to prevent and/or contain oil spills
9. Developing alternatives to throwaway and nonbiodegradable products
10. Recycling used plastic products, perhaps through legislative or financial incentives
11. Reducing industrial discharges of floatable pollutants such as oils and greases
12. Making a regional commitment to improve water quality in the Hudson/Raritan estuarine system

Until these recommendations become realities, beach administrators must be prepared to clean their beaches periodically. This situation is far from ideal, but it is a necessary part of beach management until more lasting changes become operative. The public and waste-handling agencies must play a more responsible role in limiting pollution at its sources.

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APPENDIX A

Chronology of Relevant Events, Observations, Responses

It is useful to detail some of the major events, observations, and responses associated with the pollution event. This listing is far from complete but is thought to be accurate. The approach does not directly follow the development of any one problem or investigation but instead is chronological. Refer to the map of the general area (fig. 2) to find the principal locations named. Times are given in terms of the 24-hr clock, eastern daylight time (e.d.t.), and the reporting agency is noted after most summaries.

Following are general observations and chronology of events as reported:

May 8, 1976 - A fuel barge ran aground and spilled 700 gal of Number 6 oil into Upper New York Bay. None was recovered, and Coast Guard helicopter observations were unable to detect to where the oil had dispersed. Coast Guard investigators believed that the oil sank, since water temperatures were cold enough to make the oil denser than water (U.S. Coast Guard).

May 10 - By late afternoon large quantities of black oil balls (tar balls) ranging from pea- to grapefruit-size began washing up on beaches from Jacob Riis Park (Rockaway Beach) to Fire Island (Bellport Beach) in concentrations estimated from 1 gal per 75 ft to 1 gal per 750 ft. The Coast Guard ordered immediate cleanup and helicopter flights over the area. These flights, however, could not locate the oil on beaches because the tar balls became covered with sand shortly after washing ashore. After notifying appropriate Federal, State, and local agencies, the Coast Guard instituted beach walking of both Fire Island and Rockaway. (Tar ball samples collected by NYDEC were transmitted to EPA for analysis.)

Oil tankers near the Long Island shore were boarded by the Coast Guard, and samples of their Number 6 oil were sent to the Coast Guard R&D Center in Groton, Connecticut, for analysis. The Center was able to match the tar ball samples to the May 8 spill and began a spill forecast study using the model developed for New York Harbor. This indicated that oil on the Harbor's surface could come ashore on the beach areas mentioned above with the winds and currents existing at the time (U.S. Coast Guard).

May 20 - The flow of the Hudson River, as gaged at Green Island north of Albany, reached a peak of 71.9×10^3 cfs. This level had been exceeded only once in the last 16 years and river flow remained above normal until the end of the month (U.S. Geological Survey).

May 26 - An oil-storage tank ruptured at Jersey City, New Jersey, and 3 million gal of Number 6 oil were spilled. Approximately 150,000 gal reached the Hackensack River, and even after recovery a large amount remained trapped in the wetlands of the Hackensack Meadows. Wetland cleanup involved the cutting and removal of oil-soaked vegetation (EPA-RII).

May 28 - Cleanup of the New York beaches was completed (U.S. Coast Guard).

June 2 - At 2000 e.d.t., two sewage sludge storage tanks containing 2.7 million gal of digested sludge exploded on Pearsalls Hassock. (See section 4.9.) One million gal flowed into the water, 0.6 million gal were contained in the southern tank, and 1.1 million gal spilled onto the Hassock surface (Nassau County Department of Public Works).

June 3 - At about 0200, the Coast Guard observed material floating out to sea through East Rockaway Inlet.

June 3 to June 6 - Fires broke out at Weehawken, New Jersey, on three piers. Much of the resulting water-borne debris was not collected by the Corps of Engineers (COE) vessel *Driftmaster* since pieces were smaller than the 6-inch mesh of the net used in cleanup operations. Debris collected on nearby beaches at low tide, but much more drifted away again with succeeding high tides (Corps of Engineers).

June 9 - Winds, which had been variable, shifted to a southerly direction. Predominantly southerly winds continued until June 26, at times becoming rather brisk (15 to 25 kn).

June 11 - At 1400, two piers in Manhattan, New York, caught fire. This fire was soon extinguished, but damage was extensive. COE trash boats collected 2½ tons of wreckage and debris, but once again, much material could not be recovered because of its small size (Corps of Engineers).

A routine Coast Guard helicopter flight over the sewage sludge dump site did not report any unusual occurrences.

June 14 - The initial report of unusual amounts of floatables washing up on Long Island beaches was made at 1200. (Some debris was noticed on Fire Island beaches on June 12, but the significance of these observations was not recognized until larger amounts of pollution were reported.) The Coast Guard station at Fire Island received a call from a Brookhaven maintenance foreman reporting a tar-like substance on the beach of Davis Park, on the southern shore of Fire Island. Coast Guard personnel investigated and observed scattered tar balls as large as 4 inches in diameter, and grease balls having the appearance of feces and varying from 1 to 2 inches in diameter, mixed with a variety of other debris along the high waterline on the beaches from Sunken Forest to Watch Hill. While the tar ball distribution ended at Watch Hill, the grease balls and other debris extended east to the Smith Point Bridge. The Coast Guard requested that a state pollution investigator evaluate the situation and sent a helicopter over the area for observation.

In the afternoon, a routine Coast Guard helicopter flight passed over the sewage sludge dump site twice and again did not report any unusual occurrences.

June 15 - The National Park Service informed NYDEC-RI that tar and grease balls were washing ashore along southern Fire Island. Suffolk County Department of Environmental Control (SCDEC) and Long Island State Park Commission investigated and made arrangements with EPA to analyze samples. The Suffolk County Department of Health said that local jurisdictions had successfully coped with previous similar events.

At 1410, a Coast Guard Pollution Investigation Team joined the National Park Service Police to observe the beaches. No tar balls were found between Fire Island station and Barrett Beach, although much debris, especially charred wood, seaweed, and what appeared to be untreated sewage, occurred at the high waterline. At Barrett Beach, minor concentrations of tar-like balls up to 1 inch in diameter were present. A sample taken from this beach was found to have minimal petroleum content.

At Davis Park, to the east, a slightly greater concentration of tar balls up to 2 inches in diameter was found scattered among the debris. Two samples were analyzed, but only one contained petroleum. The team continued east along the beach and beyond Long Cove; no more oil or tar balls were found, though large amounts of debris were present. Because of this, the investigators concluded that there was not sufficient oil to warrant a cleanup using the oil pollution contingency fund under Section 311 of PL-92-500.

At 1500, the MESA New York Bight Project Office became aware of the problem and toured Fire Island beaches from Smith Point Park to Davis Park between 1800 and 1930 with the Suffolk County Department of Parks, Recreation, and Conservation. (App. B-1 describes in detail materials found on the beaches.)

The same afternoon, the Suffolk County Department of Health requested that the County Parks Department close beaches to swimmers, pending analyses of water samples and waste balls.

June 16 - A Coast Guard vessel surveyed sewage sludge and nearby dump sites and did not report any unusual occurrences. An investigation from Jones Beach to Robert Moses Bridge and from Democrat Point to Kismet was undertaken separately by two Coast Guard teams in response to reports of additional debris washing ashore. No oil or debris were found in the Jones Beach area, and no oil or tar balls were found from Gilgo Beach to Democrat Point, although slight debris occurred in the west and progressively increased toward the east.

Between 1215 and 1600, MESA investigators and EPA-RII officials toured beaches from Robert Moses State Park to Davis Park, finding much debris and large numbers of "weathered" condom rings and plastic artifacts (see app. B). SCDEC reported that these wastes appeared to be sewage-related. NYDEC requested SCDEC and Nassau County Department of Health to check on the possibility of treatment plant bypasses or malfunctions and prohibited fishing from Moriches to Jones Inlets for seven days. EPA-RII also checked into bypassing and/or malfunctions in the entire metropolitan area.

The Suffolk County Department of Health reported similar materials coming up on the beaches as far west as Cedar Beach.

An EPA-RII observer rode on the tug *Gulf Duke* pulling the barge *Lisa* filled with sewage sludge from the Passaic Valley Sewage Commissioners' STP in Newark, New Jersey, to the sewage sludge dump site (fig. 1). No floatables were observed during dumping.

Scattered reports of materials on the beaches from Cupsogue to Southampton were reported to the Suffolk County Department of Health. In the afternoon

NYDEC personnel inspected the extreme eastern end of Fire Island (Smith Point Park, Great Gun Park) using a four-wheel-drive vehicle. Moriches Inlet area was also sampled, because of concern for shellfish waters in Moriches Bay, and was found to be clean. The ocean shoreline showed no grease or tar balls, only light plastic artifacts and heavy trash accumulations. It was impossible to determine whether the source of the trash was ships or beach traffic.

June 17 - At 0900, a helicopter flew from Gilgo Beach to 3 miles west of Moriches Inlet. No oil or tar balls were seen from the surf line to ½ mile offshore, though debris was noted. While spot checks of the north shore of Fire Island revealed no pollution, beaches from Gilgo Beach to Fire Island Inlet were closed at 1030.

At 1300, the MESA New York Bight Project Office staff met with more than 20 Federal, State, County, and, local agencies, to share data and preliminary findings. No one present at this meeting reported finding raw fecal material on any of the beaches.

June 18 - *Newsday* reported materials washing up on Atlantic and Lido Beaches.

Water samples analyzed for bacterial content by EPA-RII and Suffolk County Department of Health showed that the ocean surf was safe for swimming (2,400 total coliforms per 100 mℓ), and beaches were reopened at noon except for Davis and Robert Moses Parks.

June 19 - A second "wave" of material began washing ashore. By late afternoon, all Fire Island beaches and town of Babylon beaches, except Smith Point Park, were closed.

June 20 - MESA and NYDEC officials investigated Cedar Beach and Robert Moses Park, finding materials similar to those seen previously.

The Coast Guard learned that Tobay Beach was closed at 1050 by the town of South Oyster Bay due to "sewage." At 1115, a Coast Guard Group Rockaway investigator collected debris at Tobay Beach for analysis. He found that the shore was clear to the west end of Jones Beach where there was some debris. He also discovered patches of brown foam at the surf and took a water sample for analysis, but no oil was found.

June 21 - *Newsday* reported that Jones Beach was closed due to "sewage."

June 22 - Nassau County Department of Health ordered the closing of all County and Long Beach beaches to swimmers, pending water sample analyses.

MESA toured Nassau County beaches, finding waste balls with very high coliform counts (Nassau County Department of Health) (see app. B3). Jones Beach was strewn with litter and trash, including some items of possible ship origin (i.e., bearing European labels).

Charred wood was collected by the Coast Guard from several beaches to determine if it came from earlier pier fires, but this determination could not be made. Coast Guard investigators toured the area from Cedar Beach to Ocean Beach, finding no waste material. They did discover some litter and small shrimp-like animals that washed up from Robert Moses Park to Ocean Beach. A helicopter reported concentrations of debris near East Rockaway Inlet and Moriches Inlet.

June 22 to 29 - Town of Islip personnel surveyed their beaches and listed materials found (see app. B-4).

June 23 - The Coast Guard received reports of "sludge" and garbage in the water and along the beach at Bridgehampton and Southampton and dispatched an oil response team at about 1300. They reported the water free of debris but found the beach littered with sewage and garbage. EPA-RII observed the western areas of Fire Island by helicopter and noted large quantities of wood and seaweed. National Park Service personnel were observed cleaning up the closed beaches. NASA collected color and color infrared photography of the area.

Governor Hugh Carey declared Nassau and Suffolk Counties a disaster area and requested Federal assistance in beach cleanup.

In the late afternoon, the Coast Guard Air Station at Brooklyn made an overflight of area dump sites (fig. 1) and beaches with EPA-RII observers aboard and saw no debris or discoloration of the water. However, large amounts of fresh algae or seaweed were observed on beaches and in the surf from Atlantic Beach to Lido Beach.

June 24 - EPA-RII and NYDEC officials met at Stony Brook to share information and discuss probable causes. It was announced that Governor Carey had designated the NYDEC to coordinate State beach cleanup activities and to serve as a clearing house for information. Vice President Nelson Rockefeller flew over some local beaches.

June 25 - MESA scientists towed neuston nets in the Bight Apex but obtained no floatables. Local Federal representatives toured the beaches with members of the President's Domestic Council and Congressional representatives.

June 26 - President Gerald Ford assigned 100 Job Corps volunteers to help clean beaches under Coast Guard supervision; however, no direct Federal funding was made available.

June 28 - At 1300, Job Corps workers began cleaning up Jones Beach and Fire Island. Presidential Advisor George Humphreys visited this area. Beach debris was considered light, but by the end of the day four truckloads of debris had been removed (U.S. Coast Guard). A helicopter overflight by Coast Guard and EPA-RII did not observe floating materials in the waters adjacent to the beaches.

June 29 - The work force was divided into three groups, two assigned to Fire Island and one to Jones Island. Twenty-seven truckloads of debris were removed.

Riis Park was closed to swimming and fishing at 1600 after sewage and other debris were observed on the incoming tide. MESA and EPA-RII investigated, but nothing significant was found.

July 1 - Jones Beach Park and Robert Moses State Park were surveyed, and small amounts of debris were removed from the former. Both park superintendents felt the situation had returned to normal.

June 30 - Twenty-eight truckloads of debris were removed.

APPENDIX B

Field Reports

1. Observations at Fire Island (MESA New York Bight Project).

Based on tours of Fire Island beaches between Smith Point Park and Davis Park from about 1800 to 1930 on June 15 with Suffolk County Parks, Recreation and Conservation Commissioner John D. Chester and Park Supervisor Schyler "Bud" Corwin, and between 1215 and 1600 from Robert Moses State Park to Davis Park with William Librizzi, Director of EPA-RII's Surveillance and Analysis Division. General observations from these two tours are combined.

Most stretches of the beaches were littered with natural and waste material along a swath about 1 to 8 ft wide, parallel to the beach. This swath was the apparent maximum of the preceding tide and wash line and contained seaweed, driftwood, small (about 1 to 8 inches) pieces of burned wood, considerable trash, and flattened "balls" of waste material. The amount of natural and waste material was greater on June 15 than on June 16. No other parts of the beaches or the waters appeared to contain these materials. The burned wood appeared to be fresh and in greater quantity than could be accounted for by recent fires on the beaches. Wood was free of growths and materials that would have adhered had it been in the water for weeks to months. Wood was found all along the swath and was not distributed as if it were from local beach fires.

The waste materials were almost all of a floatable nature, and plastics far exceeded all other materials in amount except wood. They included the following:

(a) Plastic tampon applicators. These were the most obvious type of debris. Linear concentrations on June 16 were about one per 10 ft of beach. No cardboard applicators were seen.

(b) The ring portions of decomposed condoms. These were found in numbers about five to ten times greater than the plastic tampon applicators. In some cases, portions of the sheath were attached, but only in a few cases were intact condoms found.

(c) Thin pieces of plastic sheeting of various colors. The pieces were generally 2 to 6 inches long, almost always about 1 inch wide, and somewhat shredded at the edges.

(d) Large numbers of plastic straws. Many had one end shaped like a spoon.

(e) Broken pieces of Styrofoam cups. Some of these pieces appeared to be more weathered than others.

(f) Small- to medium-sized plastic bottle caps. Only a few large ones were seen. Most had diameters of about ½ to 1 inch and were filled with what appeared to be a more gelatinous version of the waste balls described below. None were observed to have a cardboard insert.

(g) Irregular pieces of fine-pore, man-made sponges.

(h) Corks.

(i) Small plastic toys and household wares, generally intact.

(j) Plastic cigar tips and the plastic portions of cigarette filter tips. Only a few decomposed cigarette filters were seen.

(k) Other plastic materials. These were in very minor concentrations, compared with those listed above.

Contrary to verbal and press reports, no disposable diapers, sanitary napkins, or tampons were observed.

The somewhat flattened balls of waste material generally ranged in size from small peas to baseballs. A few were larger. In general, the larger the balls, the more flattened they were. These balls had the following characteristics:

(a) Outside colors included light tan, medium brown, green, khaki, blue, and medium gray. Some balls with a dark gray or black outside color were also observed.

(b) The lighter outside colors were generally seen in the smaller balls, and the darker outside colors were generally seen in the larger balls.

(c) The outside appearance was generally mottled and similar in texture to papier-mâché.

(d) Inside colors were generally medium to dark gray and black, with oblate spheroids of a white to clear material interspersed. These interspersed materials were more solid if white, and more gelatinous if clear, and looked like congealed household grease or oil.

(e) The inside appearance also was generally mottled, and similar in texture to papier-mâché. However, when spread out in a thin layer on a board, the materials joined in a homogeneous, smooth, single layer, generally dark gray to black.

(f) The balls did not smell like fecal material when opened, but more like a mixture of grease, oil, and tar. Approximately 30 were opened on July 15 and approximately 20 on July 16. One ball, more cylindrical in shape than most, had an odor of dog feces when opened and was brown.

(g) Foreign substances (generally pieces of plastic) formed the nucleus around which about 75 percent of the balls were formed. In nearly all of the larger balls, the nucleus was a plastic tampon applicator.

2. Observations on the Hempstead Town Beach Front (Department of Conservation and Waterways).

The first accumulation of sewage appeared on the beach front from Point Lookout to Atlantic Beach on June 15 and June 16, 1976.

The materials observed in varying concentrations included grease, fat and tar balls, fine fatty slicks, contraceptive devices, filter tips from cigarettes and cigars, seeds, chopped garbage, tampon applicators, and plastic strips from minipads. A great deal of garbage and trash had been caught up with the normal accumulation of seaweed. Burned wood was also noted.

Visual observations of barrier beach front were made on June 16 during sampling of surf zone seawater for bacteria content from Point Lookout to west Atlantic Beach. The following comments were recorded:

Point Lookout Civic Beach. No visible accumulation of sewage-related debris.

Town Park Pt. Lookout. Slight accumulation of fine fat particles. Occasional appearance of contraceptive devices, tampon applicators, garbage, grease balls.

Nassau County Beach. Accumulation of above items increasing in concentration.

Lido Town Park - Lido Beach District. Heavy accumulation of grease and fat in the form of ½ to 2 inch balls. Few oil balls, but heavy concentrations of garbage and STP artifacts (contraceptive devices, tampon applicators, fat, filter tips, seeds) were mixed with sea lettuce and marsh grass from the bay (deposited by outgoing tide). Sewage material was caught up in sea cabbage and washed ashore by tides.

East Atlantic Beach. Material was similar to Lido Beach in concentration and type. Park personnel had raked up debris.

Atlantic Beach Hotel. Greater concentration than east Atlantic Beach; also contained accumulations of grease, fat, and tar balls. Massive amount of winter debris on upper beach.

Town Park Atlantic Beach Club. Completely cleaned off and no visible signs of sewage material.

West of Town Beach - Silver Point. Heavy accumulation of grease, fat, and tar balls. Large amounts of trash and garbage.

3. Report of Beach Inspections at Nassau County (S. Chanesman, MESA New York Bight Project).

Arrived at Jones Beach 0620 on June 22, 1976. Requested assistance from Dick Brady, Superintendent of Parks for Jones Beach. He provided a four-wheel-drive vehicle and driver, Richard Soper, Supervisor of Parks. We covered approximately 14 miles of beach, from east of Gilgo Beach to the west end of Jones Beach. Gilgo Beach and Tobay Beach were very clean with only one waste ball found. No tampon applicators were seen; however, there were some blue plastic strips (later confirmed to be sanitary napkin liners) on the beaches.

As we moved west, materials increased. By the time we reached Jones Beach, many blue plastic strips, condom rings--some with rubber portions--and waste balls that smelled like sewage were seen. The beaches at West End One and Two were the worst seen. The waste balls were larger (about fist size) and of a harder, crumbly, clay-like material. There were also softer, green-grey lenticular-shaped waste materials. These appeared very fresh, smelled like treated sewage, and were not weathered. Cardboard items were numerous. These included egg cartons, milk containers, and seafood-labeled waxed-paper boxes. There were many plastic items that could be ships' trash, including a Greek dairy food seal and a package of Polish potato noodles. There were many condom rings, plastic sanitary napkin strips, and some tampon applicators. Some of the more unusual things were 20 chicken heads and entrails (indicative of short-term transport) and a note in a sealed bottle that had been set adrift off the Delmarva Peninsula in mid-May.

Samples were collected and delivered to EPA-RII for analysis. These were found to be very different (especially in odor) from the types of material found on the Suffolk County beaches.

Pearsalls Hassock was toured next, and a sludge sample was obtained from the south tank for analysis. There were very few tampon applicators on the Hassock, but some shredded blue plastic strips were noticed. EPA-RII and New York City EPA were given portions of the sample.

4. Town of Islip Beaches (Dr. Malcom Hair, Marine Resource Consultant to the Town of Islip, N.Y.).

Samples were taken at times and places indicated below:

Atlantique beach - June 22, 1976 - Station 15

- Small pellets
- Pieces of Styrofoam cups
- Bandages
- Pieces of egg cartons
- Blue plastic strips from disposable diapers and sanitary napkins
- One can of Trotter and Co. semi-fluid Petrolatum cablejoint and terminal filling compound No. 10007
- Light bulbs

Atlantique beach - June 22, 1976 - Station 16

Same as above except for Petrolatum
Large amount of dead amphipods on trash line
One carton Bremerland Volkmilch pasteuris 0.5 ℓ Frischware
One bottle Grauhor tafelwasser Harzer Grauhof-Brunnen 0.7 ℓ
A number of Tropicana orange juice containers with June expiration dates
Clinton Orange Drink - 1 qt No. 25
Bread wrappers
Box pretzels
Soda cans

Saltaire - June 22, 1976 - Station 200

Large amount of amphipods on trash line with large amount of baby crab legs
Large amount small pellets
Large amount blue plastic strips, one per yd
Large amount Styrofoam packing material
Large amount plastic bandages
Large amount disposable diaper linings
Large amount eel grass
Pieces of egg cartons
One bottle P. Bokma Distillers, Holland

Saltaire - June 22, 1976 - Station 201

Very large amount plastic bandages
Large amount condoms
Large amount blue plastic strips, one to two per yd
Large amount pellets
Large amount eel grass

Saltaire - June 22, 1976 - Station 202

The backing of a plastic strip from a label gun - the name printed out was Kenny Deluca.
Small localized patch of charcoal with no evidence of pellets--located above the trash lines.
On the trash line:
  Large amount amphipods
  Large amount plastic bandages
  Large amount blue plastic strips
  Large amount eel grass
  Large amount pellets
One-half inch mussel with dried animal inside
Dead ribbed mussel
Yellow plastic straps
Cigarette filters
<u>Fucus</u> (seaweed)
S-shaped Styrofoam packing

Area of largest amount of trash and pellets on beaches:

Saltaire - June 22, 1976 - Station 203

- Blue plastic strips from sanitary napkins
- Pieces of egg carton
- Large amount of plastic bandages
- Large amount of pellets
- Large amount of disposable diaper linings
- Large amount of Styrofoam packing
- Large amount of crab parts and amphipods with pellets mixed in
- Large amount condoms
- Large amount eel grass

Saltaire - June 22, 1976 - Station 204

- Same as above
- No pellets in new trash line

Saltaire - June 22, 1976 - Station 205

- Same plus ribbed mussel

Fairhaven - June 24, 1976 - Station 207

- Large amount crabs
- Moderate amount of blue plastic strips
- Large amount sunflower, watermelon seeds
- Large amount cigar tips
- Large amount of plastic bandages
- Moderate amount of pea-size pellets
- Moderate amount of S-shaped Styrofoam packing
- Moderate amount of arthropods (crustaceans)
- Moderate amount of egg cartons

Fairhaven - June 24, 1976 - Station 208

- 1972 prescription, Aug. 2, 1972:
  - 6 oz bottle, Selsun,
  - Colonial Garden Pharmacy,
  - Fort Lauderdale, Florida,
  - Live barnacles inside
- Blue plastic strips
- Small cork parts
- Medium amount pea-size pellets
- Medium amount ladybugs
- Medium amount watermelon seeds
- Medium amount egg cartons
- Large amount arthropods--middle area no plastic
- Small amount of pellets (3 inches wide)
- Egg crates
- Fresh oil
- Crab parts

Fairhaven - June 24, 1976 - Station 209

- Blue plastic strips
- Medium amount pea-size ¼ inch pellets
- Plastic bandages
- Few small crab carapaces
- Shredded plastic
- Garbage bags
- Ribbed mussel
- Middle area: medium amount of arthropods
  - blue plastic and diapers
  - large amount arthropods
  - diapers, plastic bandages
  - fresh oil (small drops, not weathered)

Fairhaven - June 24, 1976 - Station 210

- Blue plastic strips
- Plastic bandages
- Moderate amount of pea-sized pellets
- Disposable diapers
- Few crab parts
- Eel grass
- Middle Area: blue plastic strips
  - large amount of arthropods
  - small amount of small crab corpses

Fairhaven - June 24, 1976 - Stations 210-211

- Moderate amount of crab parts, arthropods
- No plastics
- Diapers
- Plastic bandages
- Fresh oil drops
- Window 12 to 15 ft wide
- Pebble-sized pellets
- Plastic strips
- Condoms
- S-shaped Styrofoam
- Middle area: moderate amount of arthropods and crab parts
  - no plastics
  - oil drops
- Milk carton: 1 pt, June 14 expiration, Newark, New Jersey
- Window 6 to 12 ft wide
- Oil drops

Robins Beach - June 29, 1976 - Stations 30-35

Underdeveloped tract--no vegetation. Dunes absent on some areas. Main crossover--vehicular. Medium vegetation on top of dunes. Heavy vegetation behind dunes. Old broken snow fence, absent in some spots. Evidence of scraps on certain areas. Still worst parts of beach.

Ocean Beach - June 29, 1976 - Station 300

Blue strips
Small amount of pea-sized pellets
Plastic bandages

Ocean Beach - June 29, 1976 - Station 301

Very moderate amount small pellets
Blue strips

Ocean Beach - June 28, 1976 - Station 302

Remnants from spill (blue strips and disposable diapers) are at foot of dune--deposited at high tide.

Ocean Beach - June 28, 1976 - Station 306

Blue plastic strips

5. Jones and Fire Island Beaches (U.S. Coast Guard).

Observations of material removed from Long Island beaches during cleanup on June 28 to July 1, 1976:

Itemized Materials	Percentages of Total Observed (by volume)		
	Jones Beach	Fire Island	
		Robert Moses State Park	Kismet to Watch Hill
Wood*	95	80	60
Seaweed	04	17	10
Beach litter **		03	20
Sewage related debris	01		09
Tar balls			01
Fecal material	00	00	00***

* Includes dunnage, driftwood, burned timbers, burned bits.

** Includes soda and beer cans and bottles, Styrofoam cups, drinking straws and paper articles.

*** Includes above high water mark, 12 fresh feces were noted, 20 to 30 dogs (leashed and unleashed) were observed on the same stretch during this time.

6. Summary of Beach Observations (NYDEC).

On June 16, at approximately ¼ mile west of Smith Point Park (Fire Island), D. Beranek found grease and tar ball samples approximately every 20 ft. There were not many loose artifacts; most were contained in grease or oil balls.

SCDEC official W. Roberts felt this material was sewage-related, based on his inspection of roughly the western half of Fire Island and the finding of numerous floating plastics (tampon applicators, condoms, straws, cigarette filter tips, cigar tips, etc.). Material was heaviest west of Davis Park. One feces sample was also found, but age and origin unknown. Cleanup could be handled locally.

In afternoon, D. Beranek and A. Yerman (NYDEC) inspected extreme eastern end of Fire Island (Smith Point Park, Great Gun Park), since SCDEC, EPA-RII, and MESA were investigating the remainder. Observed and sampled Moriches Inlet area at request of J. Redman (NYDEC) because of concern for shell-fish waters in Moriches Bay. Inlet area observed to be clean. Ocean shoreline showed no grease or tar balls and light amount of plastic artifacts east of third cut, but heavy trash. Difficult to determine whether source of trash was from ships or beach traffic.

Plastic artifacts and charred wood were more dense west of third cut, with tampon applicators averaging one every 10 ft. Noted absence of condoms which had been reported elsewhere. Limited evidence of grease and tar balls. Two potato-sized tar balls were largest of few found in area west of third cut in short stretches surveyed. Interview with National Park Service Ranger indicated that the worst accumulation of materials was near Davis Park.

On June 21, A. Yerman inspected Fire Island from Smith Point County Park to Robert Moses State Park with W. Roberts and E. Kock (SCDEC). Debris appeared to be similar to that which had washed ashore previously. Many important swimming areas had already been cleaned of debris. Samples of marine organisms (perhaps sand lice), which were found at the waterline all along the Island, and fresh oil globules found at high water mark were transmitted to EPA-RII for analysis. Except for sand lice, waterline appeared clear.

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