

**Report of Water Masses
Receiving Wastes from Ocean Dumping
at the 106-Mile Dumpsite
January 1, 1989 to December 31, 1989**

by

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ABSTRACT

The 106-Mile Dumpsite is a deep-ocean site located 106 miles southeast of New York that receives sewage-treatment sludge from several municipalities in New York and New Jersey. The site is occupied predominantly by slope water, however incursions of shelf water and warm core rings occur periodically. Satellite infrared data are used to determine which water masses are present at the time of each dump. Records of sewage sludge dumping at the site are obtained from the Environmental Protection Agency (EPA)

This report, the fourteenth in a series of annual summaries, correlates data regarding the volumes and dates of the dumps at the site with information on the water masses present at the time. A summary of the amounts of wastes received by each of the three principal water masses for 1989 is presented. In 1989, $1,749 \times 10^6$ gallons of sewage sludge was dumped at the 106-mile site. Approximately 81 percent (by volume) of the sludge was dumped in slope water, with the remainder being received by warm core rings (10 percent) and shelf water (9 percent).

Introduction

The 106-mile dumpsite is a deep ocean dumpsite bounded by $38^{\circ} 40'N$ to $39^{\circ} 00'N$ and $72^{\circ} 00'W$ to $72^{\circ} 30'W$. As a result of regulations imposed by the Environmental Protection Agency (EPA), the 106-mile site has been designated to receive all municipal sewage treatment sludge originally scheduled to be dumped at the 12-mile site (located in the New York Bight area, see Figure 1). EPA regulations provide for two new areas within the original 106-mile dumpsite for the dumping of sludge and industrial waste. The municipal sludge site is an area bounded by coordinates $38^{\circ} 40'N$ to $39^{\circ} 00'N$ and $72^{\circ} 00'W$ to $72^{\circ} 05'W$ (76.83 square nautical miles). Westward of that is the industrial waste site, a circular area with a six mile diameter and center coordinates of $38^{\circ} 45'N, 72^{\circ} 20'W$ (28.3 square nautical miles). (See Figure 1.)

Oceanographic conditions in the area of the 106-mile site are discussed by Ingham *et al.* (1977) in regard to shelf, slope and Gulf Stream waters. The site is occupied predominantly by slope water, but other water masses occupy the site periodically. Shelf water incursions into the region occur particularly in the spring, when fresh water runoff and

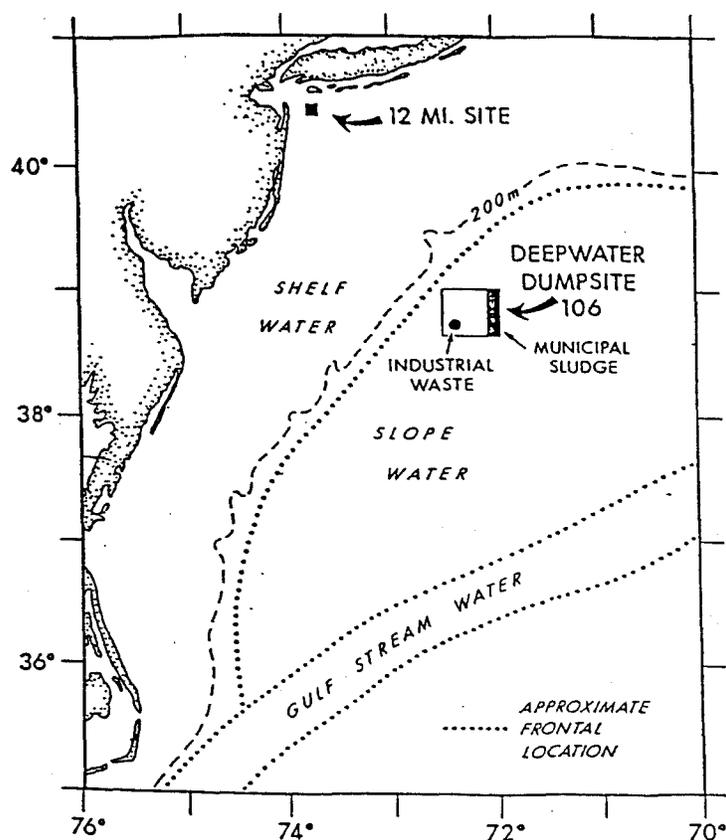


Figure 1. The 12- and 106-Mile Dumpsites in relation to the average locations of water masses in the New York Bight.

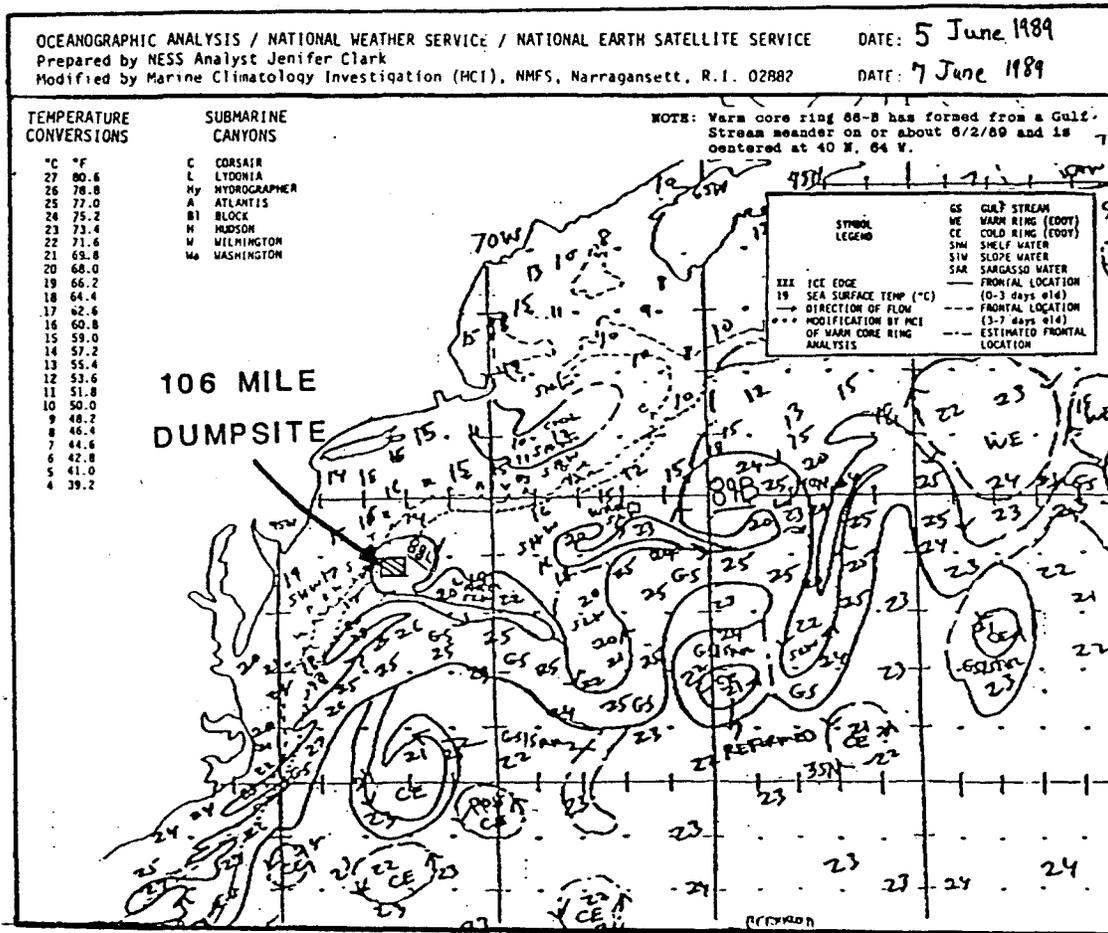


Figure 2. Modified Oceanographic Analysis chart showing sea surface conditions and location of 106-Mile Dumpsite. Prepared by the National Ocean Service on 5 June 1989 and modified by NOAA/NMFS Marine Climatology Investigation on 7 June 1989.

increased wind forcing causes offshore movement of the shelf/slope front (Hilland and Armstrong 1980). At other times shelf water is drawn into the dumpsite as an entrainment feature of a warm core ring. Warm core Gulf Stream rings may traverse the region from northeast to southwest, bringing strong currents and Gulf Stream or Sargasso Sea water to the site. Northward meandering of the Gulf Stream also causes Gulf Stream water to move into the dumpsite region, although this phenomenon is rare. Figure 1 shows the dumpsite's location in relation to the "average" locations of the water masses in the northwest Atlantic Ocean. Figure 2 is a chart of the actual conditions that existed at a particular time (5 June 1989), illustrating that

conditions in this region are very complex and dynamic in contrast to "average conditions" illustrated in Figure 1.

OCEAN DUMPING AT THE 106-MILE SITE

This report concerns all ocean dumping that took place at the 106-mile site from January 1 to December 31, 1989 and is the fourteenth in a series of annual summary reports. The purpose of this report is to correlate the water masses present (shelf, slope, warm core ring, and Gulf Stream waters) with the time and location of disposals, in order to identify which masses received the dumped material.

No industrial waste was dumped at the 106-mile site in 1989. EPA has plans to rescind designation of the industrial waste site in 1990. Municipal sludge dumping at the site began in March 1986 and increased throughout 1987, with the 12-mile dumpsite completely phased out in December, 1987. The New Jersey and New York municipalities, previously authorized to dump at the 12-mile site, are routing all sewage sludge to the 106-mile site.

Methods

The process of describing the location of water masses with respect to the dates of ocean dumping at the 106-mile site was divided into three steps: 1) the water mass present at the dumpsite was determined for each day of the year; 2) the amount of sludge dumped each day was calculated; and 3) dumping amounts were correlated with the receiving water masses and annual totals were calculated for amounts of sludge dumped into each water mass. Methods used in these steps are described below.

The primary method of determining which water mass was present at the site on any given day uses high resolution (1 km) digital data collected by the Advanced Very High Resolution Radiometer (AVHRR) sensor onboard the NOAA-series of polar-orbiting satellites. As described by Barton (1987), the data are received by telecommunication links at the University of Rhode Island Oceanographic Remote Sensing Laboratory and are atmospherically and geographically corrected and enhanced to identify thermal features. The final product is a 512 X 512 pixel sea-surface temperature (SST) image, which can be displayed on a video display screen.

Every SST image was visually inspected to determine the water masses present at the dumpsite for each day of the year. Whenever the area of the dumpsite was clear of clouds, a direct observation was made of the water

mass present. This method provided water mass determinations for 58 percent of the days in 1989.

Whenever periods of cloudy weather obscured the satellite image of the sea surface, weekly Oceanographic Analysis Charts prepared and issued by the NOAA National Ocean Service were used to provide indirect determination of the water masses present at the dumpsite, as described by Bisagni (1985) (see Figure 2). While these charts were at a much lower spatial and temporal resolution than the digital imagery, they provided an acceptable approximation of water mass locations during a cloudy period, because the charts were made using all available satellite and ship data and estimates of movements during the time period. The dumpsite location was drawn on a transparent overlay and placed on each chart so the water mass present at the site could be noted. This method provided observations for an additional 29 percent of the days in 1989.

Water mass determinations for the remaining days (13 percent) were made using a combination of the two methods described above. This combination was appropriate for days when the dumpsite was cloud covered but the surrounding areas were relatively clear. Both methods were also used when a given day was cloudy but the days before and after were clear enough to interpolate between good images. In these cases, the estimates from the imagery were confirmed by the charts for the same time period.

Two trips were made to EPA, Region II, in New York City to examine and compile dumping records. The dumping amounts were taken from the Ocean Dumping Notification Forms submitted by the dumpers. All values were converted to units of gallons and were totaled for each day.

Finally, the amount of sludge dumped each day was correlated to the water mass present for that day. Then, the total amounts dumped and percentage dumped into each water mass were calculated. Also, the per-

centage of days that the site was occupied by each of the three water masses was calculated and compared to long-term means.

RESULTS AND DISCUSSION

A total of $1,749 \times 10^6$ gallons (7.48×10^6 tons) of sewage sludge was dumped in the site in 1989.¹ Approximately 81 percent of the sludge (by volume) was received by slope water, 10 percent by warm core ring/Gulf Stream water, and 9 percent by shelf water.

Disposal amounts and receiving water masses are listed in Tables 1 and 2. Table 1 lists the dates of sludge disposals, the receiving water mass, and the approximate volumes of sludge material that each water mass received. Table 2 includes the total amounts and percentages by volume of sludge and by number of dumps that each water mass received. Table 3 lists the number and annual percentage of days that each water mass was present in the site.

Comparison of the percentage of volume and number of dumps (Table 2) with the percentage of days each water mass occupied the site (Table 3) indicates that the dumping was evenly distributed throughout the year. Slope water occupied the site more in 1989 (80 percent) than the long-term mean (66.6 percent) for the period from October 1976 through September 1985 as calculated by Bisagni (1985). Shelf water occupied the site less in 1989 (9 percent) than the long-term mean (18.5 percent) while the percentage of time warm core rings were present in 1989 (11 percent) was only slightly less than the long-term mean (12.1 percent).

¹ The EPA estimated that 8.6×10^6 tons was dumped in 1989 (personal communication, Larry Visconti, EPA) based on the waste generators' quarterly reports. This estimate was higher than the total calculated in this report using the dumpers' data. However, the differences were distributed throughout the year; therefore, any errors introduced should not affect the percentages given here.

ACKNOWLEDGEMENTS

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Satellite image processing was performed at the University of Rhode Island Oceanographic Remote Sensing Laboratory, Narragansett RI, using software developed by O. Brown, R. Evans, J. Brown and A. Li at the University of Miami, Miami FL.

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Table 1. Volume and range of dates of sewage sludge discharged and receiving water mass from January 1 to December 31, 1989

| Range of Dates Month/Day/Year | Volume Discharged | | Receiving Water Mass |
|----------------------------------|-------------------------|--------------------|-------------------------|
| | 10 ⁶ gallons | (wet tons) | |
| 01/01/89 - 01/18/89 | 93.915 | (401,346) | Slope water |
| 01/20/89 - 01/23/89 | 15.301 | (65,389) | " |
| 01/31/89 | 11.771 | (50,303) | " |
| 02/12/89 - 02/13/89 | 11.316 | (48,359) | " |
| 02/25/89 - 04/16/89 | 195.505 | (835,492) | " |
| 04/19/89 - 05/17/89 | 127.125 | (543,269) | " |
| 05/22/89 - 05/26/89 | 22.973 | (98,175) | " |
| 06/17/89 - 08/21/89 | 345.036 | (1,474,513) | " |
| 08/31/89 - 11/26/89 | 484.956 | (2,072,462) | " |
| 12/05/89 - 12/31/89 | 117.685 | (502,927) | " |
| Total | = 1,425.583 | (6,092,235) | |
| 01/19/89 | 6.441 | (27,526) | Shelf water |
| 01/24/89 - 01/26/89 | 13.606 | (58,145) | " |
| 02/08/89 - 02/11/89 | 14.157 | (60,500) | " |
| 02/14/89 - 02/24/89 | 37.246 | (159,171) | " |
| 04/17/89 - 04/18/89 | 12.180 | (52,051) | " |
| 05/18/89 - 05/21/89 | 26.318 | (112,470) | " |
| 08/22/89 - 08/30/89 | 42.696 | (182,462) | " |
| Total | = 152.644 | (652,325) | |
| 01/27/89 - 01/30/89 | 18.436 | (78,786) | Warm core rings |
| 02/01/89 - 02/07/89 | 27.741 | (118,551) | " |
| 05/27/89 - 06/16/89 | 94.207 | (402,594) | " |
| 11/27/89 - 12/04/89 | 30.676 | (131,094) | " |
| Total | = 171.060 | (731,025) | |

Table 2. Amount and percentage of volume of sewage sludge dumped and number of dumps made into each water mass for the period of January 1 through December 31, 1989

| Water Mass Type | Volume | (%) | No. of Dumps (%) | |
|-----------------|--|---------|--------------------|---------|
| Slope water | 1,425.6 X 10 ⁶ | (81.5%) | 443 | (81.1%) |
| Shelf water | 152.6 X 10 ⁶ | (08.7%) | 48 | (08.8%) |
| Warm core ring | 171.1 X 10 ⁶ | (09.8%) | 55 | (10.1%) |
| Total | = 1,749.3 X 10⁶ gals | | Total = 546 | |

Table 3. Number of days and percentage of days each water mass occupied the dumpsite in 1989 and long-term mean percentages taken from Bisagni (1985)

| Water Mass | 1989 | | Long Term Mean ¹ |
|----------------|-------------|-----|-----------------------------|
| | No. of days | (%) | |
| Slope | 291 | 80% | 66.6% |
| Shelf water | 34 | 09% | 18.5% |
| Warm core ring | 40 | 11% | 12.1% |

¹ Remaining 2.8% either Gulf Stream or unknown due to lack of clear imagery.