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PEMOTE SENSING OPERATIONS (MULTISPECTRAL SCANNER AND PHOTOGRAPHIC) IN THE NEW YORK BIGHT SEPTEMBER 22, 1975

BY

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Langley Research Center

February 1977

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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16. Abstract

Ocean dumping of waste materials is a significant environmental concern in the New York Bight. One of these wastes materials, sewage sludge, was monitored in a joint National Aeronautics and Space Administration/National Oceanic and Atmospheric Administration (NASA/NOAA) experiment conducted in the New York Bight on September 22, 1975. NASA remote sensing over controlled sewage sludge dumping included an 11-band multispectral scanner, five multispectral cameras and one mapping camera on the Johnson Space Center NP-3A aircraft. Concurrent in situ water samples were taken and acoustical measurements were made of the sewage sludge plumes during the experiment by NOAA. Data were obtained for sewage sludge plumes resulting from line (moving barge) and spot (stationary barge) dumps. Multiple aircraft overpasses were made to evaluate temporal effects on the plume signature.

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REMOTE SENSING OPERATIONS (MULTISPECTRAL SCANNER AND PHOTOGRAPHIC) IN THE NEW YORK BIGHT SEPTEMBER 22, 1975

By

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SUMMARY

A joint National Aeronautics and Space Administration/National Oceanic and Atmospheric Administration (NASA/NOAA) experiment was conducted in the New York Bight on September 22, 1975. Controlled sewage sludge dumping was monitored by an 11-band multispectral scanner, five multispectral cameras, and one mapping camera on the NASA Johnson Space Center (JSC) NP-3A aircraft. Data were obtained over sewage sludge plumes resulting from both moving barge and stationary (spot) sewage sludge dumps. Concurrent in situ water samples were taken and acoustical measurements were made of the sewage sludge plumes during the experiment by NOAA.

The purpose of this report is to describe the remote sensing experiment and document the operations performed by NASA in implementing the experiment. Brief descriptions of the test site, remote sensors, aircraft, and ship tracks are presented along with "quick look" photographic data.

INTRODUCTION

The New York Bight ocean area is one of the most abused bodies of water in the world. It is adjacent to one of the most densely populated and industrialized regions in the United States and because of its geographical location serves as a repository of man's wastes. Waste solids enter the Bight via inflowing rivers, land runoff, air fallout, sewage outfalls, and barge dumps. In the future, the environment of the Bight may be further compromised by new developments such as offshore nuclear powerplants, superports, deep-water terminals, and artificial islands. These activities, both present and planned, have caused increased concern to the public, the scientific community, and those who depend upon the Bight to make their living.

Accordingly, in 1974, NOAA initiated a 7-year New York Bight Marine Ecosystem Analysis (MESA) program to obtain environmental information. This effort in the New York Bight is the first of several MESA programs that are being planned by NOAA. The experiments represent a wide array of techniques and disciplines that reside within the laboratories of NOAA. The program is focused on providing information to better understand and minimize man's impact on the coastal zone. The initial step of a NOAA/NASA cooperative effort was implemented in the MESA Spring Experiment, April 7-17, 1975. The NASA operations relative to that experiment are reported in reference 1. The

present experiment, which was accomplished in the New York Bight on September 21-24, 1975, was a follow-on to the April 7-17, 1975, experiment. The NOAA ship, George B. Kelez, with onboard experimental acoustic equipment, monitored background and sewage sludge plume characteristics in the New York Bight, and served as a platform for water sampling. Remotely sensed data of sewage sludge plumes from moving and stationary barge dumps were collected from the NASA NP-3A aircraft platform. These data were collected by multispectral scanner (Modular Multispectral Scanner (M2S)), multispectral photography (Aerial Multispectral Photography System (AMPS)), and a mapping camera.

It is the purpose of this report to summarize the NASA remote sensing operations and present "quick look" photographic data from the New York Bight Fall Experiment of September 22, 1975.

TEST SITE

The area selected by NOAA for this joint NASA/NOAA experiment was the apex of the New York Bight as shown in figure 1. The New York Bight extends from Cape May, New Jersey, to Montauk Point, New York, and seaward to the edge of the continental shelf (200 m depth). The apex is bound on the north by Long Island, on the south by latitude meridian 40°10'N and on the east by longitude meridian 73°30'W. Presently, within the apex, sewage sludge is dumped in the Environmental Protection Agency (EPA) designated area about 18 km (9.7 n mi) south of Long Island, bounded by 73°41'30" to 73°45'0" west longitude and 40°22'30" to 40°25'0" north latitude. The remote-sensing experiment on September 22, 1975, was conducted over the sewage sludge dump area in the apex.

EXPERIMENTAL METHOD

Remote sensors that measure electromagnetic radiation in the visible and near-infrared (IR) wavelengths were flown over the test site. Remotely sensed data were collected during morning and afternoon missions. The NASA NP-3A aircraft flew at a nominal altitude of 3.0 km (10,000 ft.) and a groundspeed of 240 knots. Three onboard remote sensor systems were used: 1. an 11-band (10 bands in the visible and near IR and 1 thermal band) M2S multispectral scanner; 2. an AMPS multispectral camera bank (five simultaneously operated cameras collecting data in the visible and near IR wavelengths); and 3. a Zeiss mapping camera. Spectral and spatial characteristics of the remote sensors are listed in table I.

During the morning of September 22, 1975, two controlled sewage sludge dumps were made in the designated area shown in figure 1. The first dumping operation was from the moving barge Owl's Head, which made a "U" within the dump zone, the first leg being eastward along the northern boundary of the dump area. The second dump was a spot dump (from the stationary barge Little River) at approximately the center of the dump area, see figure 2.

Two ships were involved in monitoring the dumps and their plumes. The first of these ships was the NOAA vessel George B. Kelez (with the onboard acoustic equipment) which monitored the background prior to the dumps, then

followed in the wake zig-zagging through the plume of the sewage sludge dump originating from the moving barge, Owl's Head. The second ship was the State University of New York (SUNY) vessel, Onrust, which monitored the spot dump.

Surface water samples were taken on the Kelez to measure chlorophyll, suspended sediment, and particle size distributions in the plume and in the background water. An onboard Coulter Counter was used to determine particle size distributions. Water samples were filtered onboard for subsequent laboratory determinations of suspended sediment and chlorophyll a concentrations.

In addition to the two morning dumps described above, a third (spot) dump was made at 1500 hours, table II. No sea truth data were collected in the afternoon.

OPERATIONS

The NOAA ship, George B. Kelez, made a background survey of acoustic and physical water column characteristics in the sewage sludge dump area from 2200 hours (EDT), September 21, 1975, to 0900 hours, September 22, 1975. The sludge dumping area had been closed to all dumpers since 1200 hours, September 20, 1975, by the EPA to provide a relatively sludge-free background for the planned experiment. Five marker buoys were also implanted by the Kelez, four at each of the corners of the sludge dump area to guide the moving barge and the fifth at the center (where the spot dump was to take place). Chronological events during the experimental period are listed in table II and ship tracks (provided by NOAA) are shown in figure 2.

At 0900 hours, September 22, 1975, two sewage sludge barges departed from separate sewage treatment plants for the sludge dumping area. Sludge samples were taken by EPA for analysis. The first barge, Owl's Head, which made the moving dump, slowed to 2.5 m/sec as it entered the dump area. The barge was followed into the dump zone by the Kelez. Dumping started at about 1045 hours and the Kelez entered the plume about 8 minutes later at 1053 hours. Moving easterly along the northern boundary of the dump zone, the Owl's Head completed dumping at about 1111 hours. The Kelez followed the dumping barge until it made its southward turn, then the Kelez returned along the plume, crossing it a number of times. At 1145 hours, in anticipation of the aircraft flyover, surface water sampling was started, with samples taken in and out of the plume. Ten water samples were taken, five in the plume, five outside the plume, between 1145 hours and 1216 hours. All water samples taken by the Kelez were in or around the plume from the moving barge dump.

The second barge, Little River, went to the center of the dump zone and discharged its load in 5 minutes, from 1100 hours to 1105 hours. The SUNY vessel, Onrust, moved into the plume and remained at that station to take water samples (see fig. 2).

Remote sensing by the NP-3A aircraft started in the New York Bight area at 1000 hours on September 22, 1975, and continued to 1208 hours for the morning

mission (flight lines 1-7, fig. 3) and returned for an afternoon mission from 1435 to 1614 hours (flight line 7-15, fig. 3). In both missions, background as well as dump zone over-flights were completed. In the morning mission, seven remote sensing passes were made over the sewage sludge dump area, three prior to start of dumping and four during and after the dumping period. The four during and immediately after the dumping period were about 26 minutes, 1 hour, 1 hour and 17 minutes, and 1 hour and 23 minutes after start of the dump (recall that the dump took 26 minutes). The third overpass (line 6, run 1, table III) was essentially simultaneous with the water sampling. Aircraft flight lines over the experimental area are shown in figure 3 and times of overpasses listed in table III.

In the afternoon, starting at 1435 hours (table II), the NP-3A aircraft returned to the sewage sludge dump zone for additional remote sensing measurements. Three passes were made over the dump area; the first at about 1500 hours (or just prior to the third sewage sludge dump (a spot dump) of the day), and the second and third aircraft overpasses about 45 minutes later, table III. Chronologically, these were about 4 hours after the moving and stationary barge dumps in the morning. These data may provide information on the persistence of sludge plumes by the two dumping methods. No water sampling data collections were planned for the afternoon period; however, acoustic data from the water column were collected essentially continuously during both the morning and afternoon remote sensing missions.

PHOTOGRAPH OF SEWAGE SLUDGE PLUMES

A photograph taken with the Zeiss mapping camera on line 6, run 1 at 1159 hours over the dump area, shows the plumes from the moving barge and stationary barge (fig. 4) about 1 hour after the dumps were made. Note the higher spectral persistence of the spot dump compared to the moving dump. Also note the lower persistence of the latter portion of the moving dump plume. In this picture, the Kelez had returned to the starting end of the dump (see ship location at 1159 hrs., fig. 2) and was in the middle of the water sampling, table II. Also visible in the photograph is the SUNY vessel at approximately the center of the spot dump.

CONCLUDING REMARKS

NASA aircraft, with onboard remote sensors, were operated in conjunction with controlled sewage sludge dumps in the New York Bight on September 22, 1975. Multispectral scanner and photographic data collection overpasses were made within an hour after moving and stationary barge sewage sludge dumps. Surface water samples were taken by NOAA and SUNY to measure chlorophyll a, suspended sediment, and particle size distributions in and around the plumes that resulted from the morning dumps. Aircraft overpasses were also made about 4 hours after the morning sewage sludge dumps and may provide data to evaluate plume persistence of the two procedures; moving barge and stationary (spot) dumps. During the morning and afternoon remote sensing data collection missions, acoustic data were obtained by NOAA in and around the sewage sludge plumes.

"Quick look" aerial photography indicates sewage sludge plumes may be detected and mapped by remote sensing techniques. Subsequent analysis of the M2S digital data and AMPS photography products should give additional information on the spectral and dispersion characteristics of sewage sludge plumes.

REFERENCES

1. Usry, J. W.; and Hall, J. B., Jr.: National Aeronautics and Space Administration Operations - Remote Sensing Experiments in the New York Bight, April 7-17, 1975. NASA TMX-72802, 1975.

TABLE I.- SPECTRAL AND SPATIAL CHARACTERISTICS OF REMOTE SENSORS

(AT 3.0 km ALTITUDE)

I Modular Multispectral Scanner (M2S)

Band	Band width
1	380 - 440 nm
2	440 - 490 nm
3	495 - 535 nm
4	540 - 580 nm
5	580 - 620 nm
6	620 - 660 nm
7	660 - 700 nm
8	700 - 740 nm
9	760 - 860 nm
10	970 - 1060 nm
Thermal	8000 - 13,000 nm
Scan width, m	8500
Resolution, m	8

II AMPS Cameras

Camera Station	Spectral Range	Film	Resolution, m	Foot Print, m
1	700 - 800 nm	2424 (IR)	.7	1240 x 1240
2	800 - 900 nm	2424 (IR)	.7	"
4	400 - 500 nm	50022 (B&W)	.3	"
5	600 - 700 nm	50022 (B&W)	.3	"
6	500 - 600 nm	50022 (B&W)	.3	"

III Zeiss Mapping Camera

Spectral Range	Film	Resolution, m	Foot Print, m
300 - 700 nm	2402 (B&W)	1.3	4550 x 4550

TABLE II.- CHRONOLOGICAL EVENTS ON SEPTEMBER 22, 1975, DURING NOAA/NASA/MESA NEW YORK BIGHT FALL EXPERIMENT

Time (EDT)	Research Ships		NASA Aircraft	Dump type Sludge Barges		
	NOAA Ship Kelez	SUNY Ship Onrust	NP-3A	Moving(line) Owl's Head	Spot Little River	Spot (unknown)
1000	Acoustic monitoring		Start morning mission			
1045				Start dump		
1053	Enter line dump plume					
1100					Start dump	
1105					End dump	
1110		Into spot dump plume				
1111				End dump		
1145	Start water sampling					
1208			End Morning mission			
1216	End water sampling					
1243	Leave plume					
1300	Through spot dump plume					
1435			Start afternoon mission			
1500	Acoustic monitoring					Start dump
1505						End dump
1614			End Afternoon mission			

TABLE III.- AIRCRAFT MISSION TIMES OVER NEW YORK BIGHT

1. Morning Mission

Line	Run	Time, EDT Start	Time, EDT Stop	
1	1	0959	1003	*
2	1	1011	1013	*
3	1	1023	1029	
2	2	1035	1039	*
4	1	1054	1101	
2	3	1109	1111	*
5	1	1125	1133	
2	4	1143	1145	*
6	1	1156	1202	*
7	1	1205	1208	*

2. Afternoon Mission

Line	Run	Time, EDT Start	Time, EDT Stop	
7	1	1435	1443	
8	1	1446	1453	
9	1	1445	1502	*
10	1	1505	1513	
11	1	1520	1525	
12	1	1528	1535	
13	1	1538	1545	*
14	1	1549	1556	*
15	1	1558	1605	
10	2	1607	1614	

* Aircraft passes over sewage sludge dump area

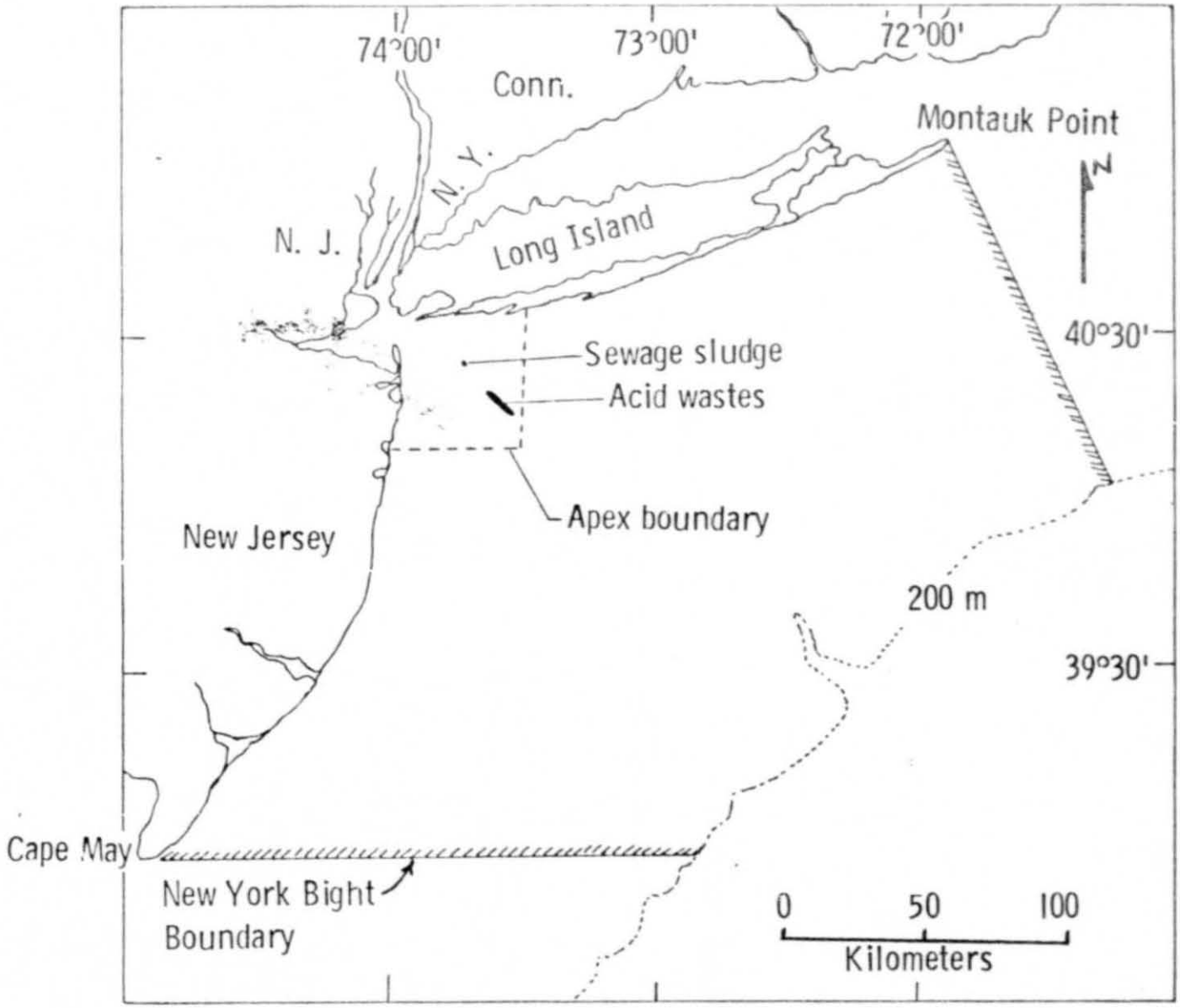

Figure 1.- MESA Defined New York Bight and Apex. (taken from reference 1)

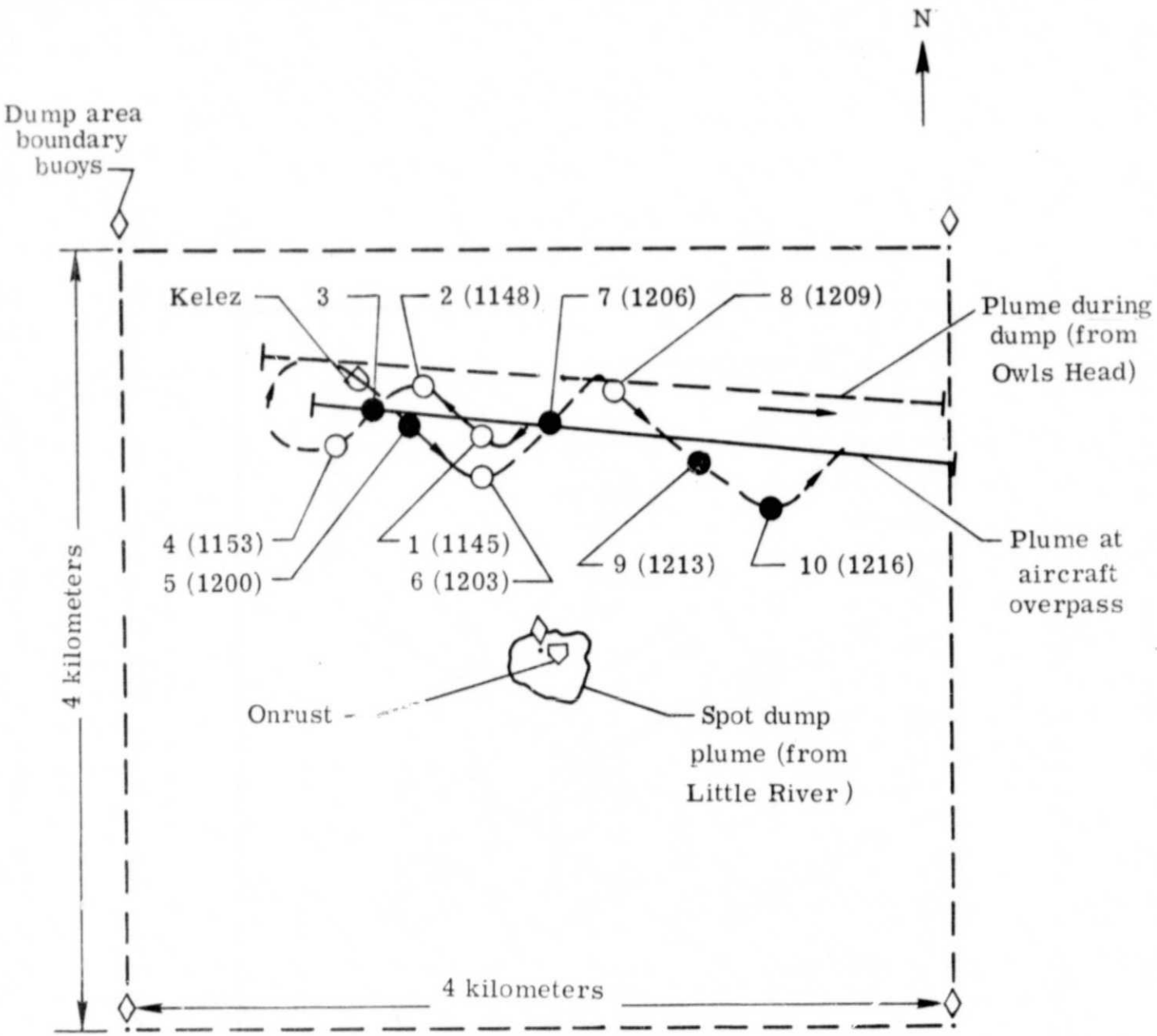

Figure 2.- Sewage siudge plumes from moving and spot dump barges at time of NP-3A aircraft overpass at 1159. NOAA ship Kelez path during water sampling and approximate location and time of surface water samples (solid circles are samples taken in the plume and open circles outside the plume) are indicated.

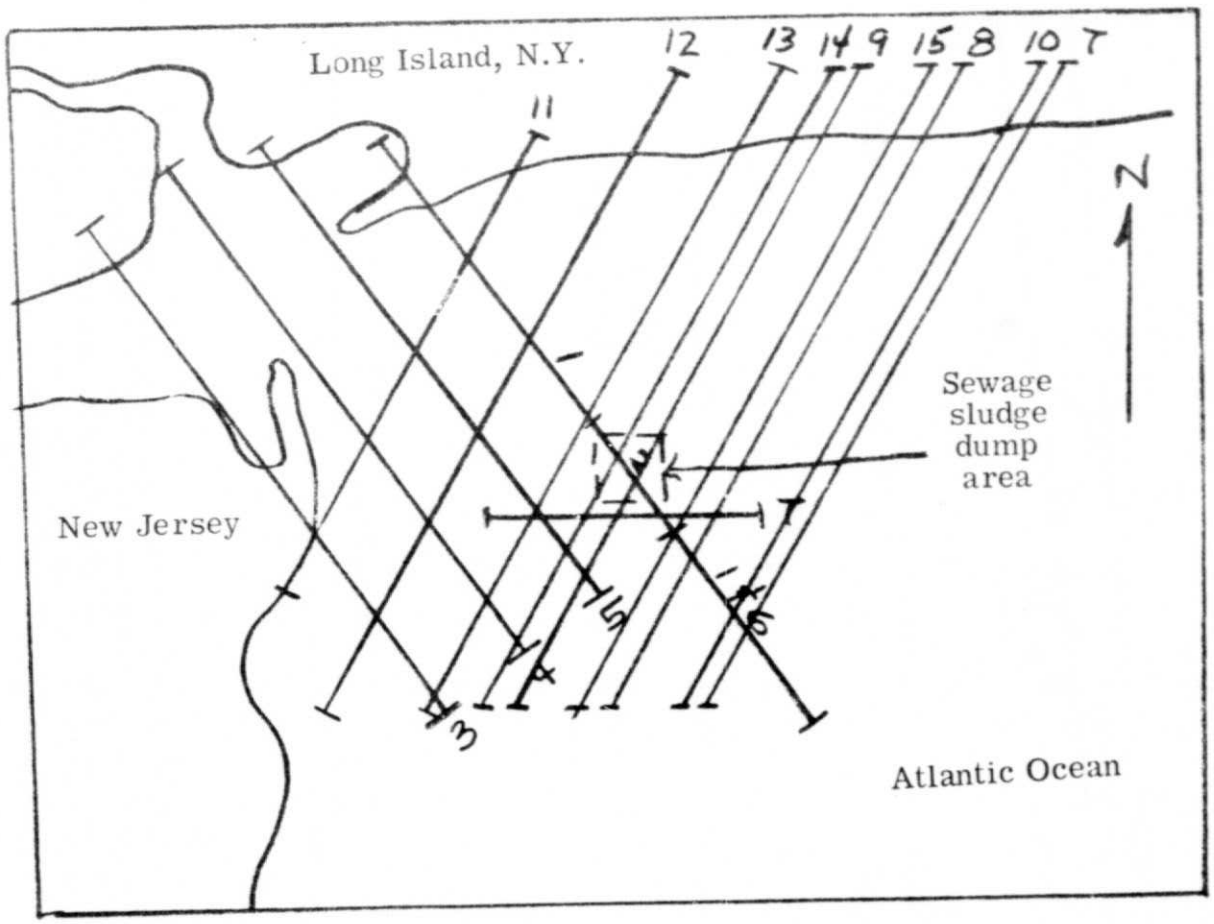

Figure 3.- NP-3A aircraft flight lines over the New York Bight on September 22, 1975.

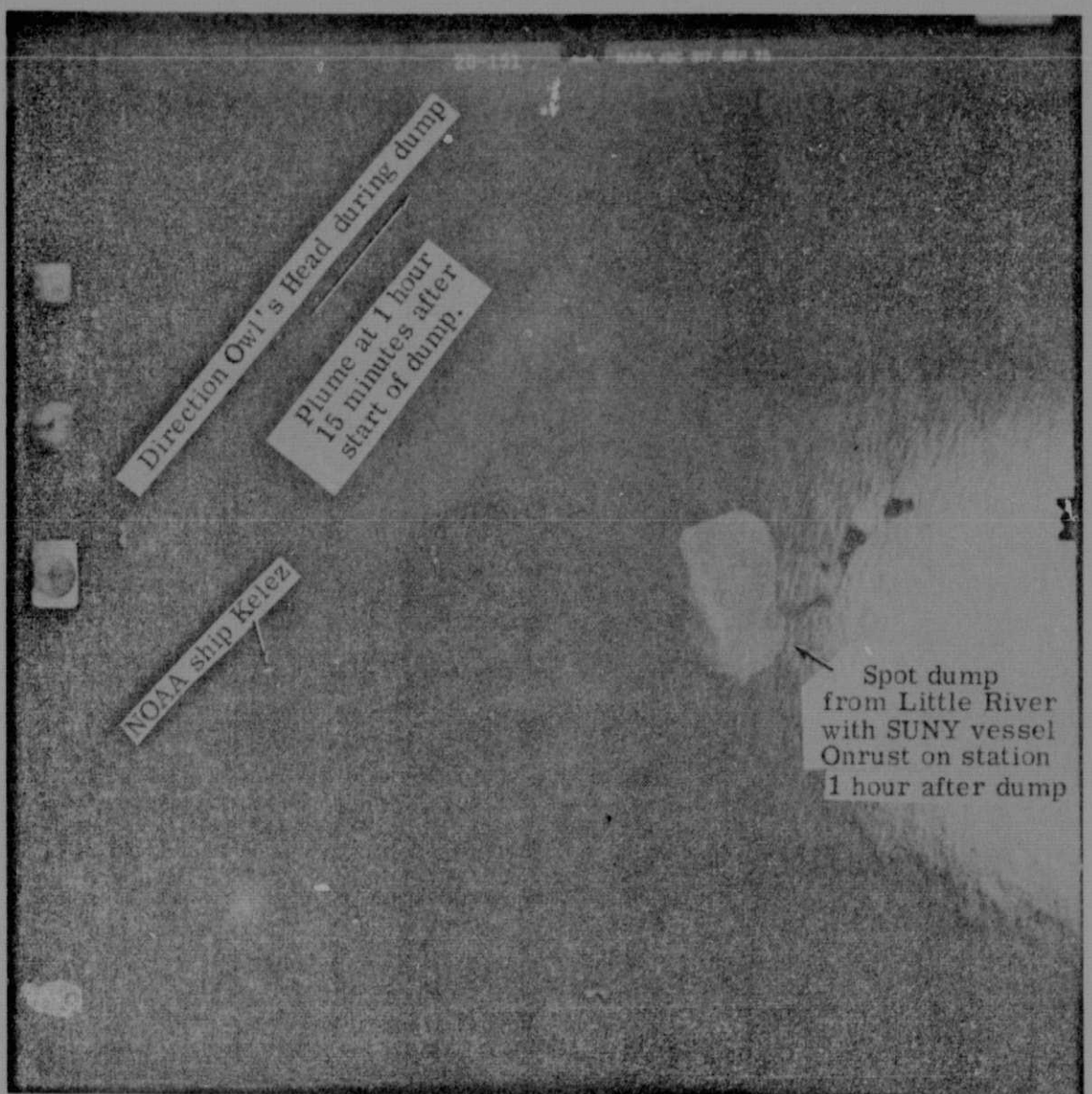

Figure 4.- Zeiss mapping camera photograph showing moving and stationary barge sewage sludge dump plumes in New York Bight at 1159 EDT on September 22, 1975.