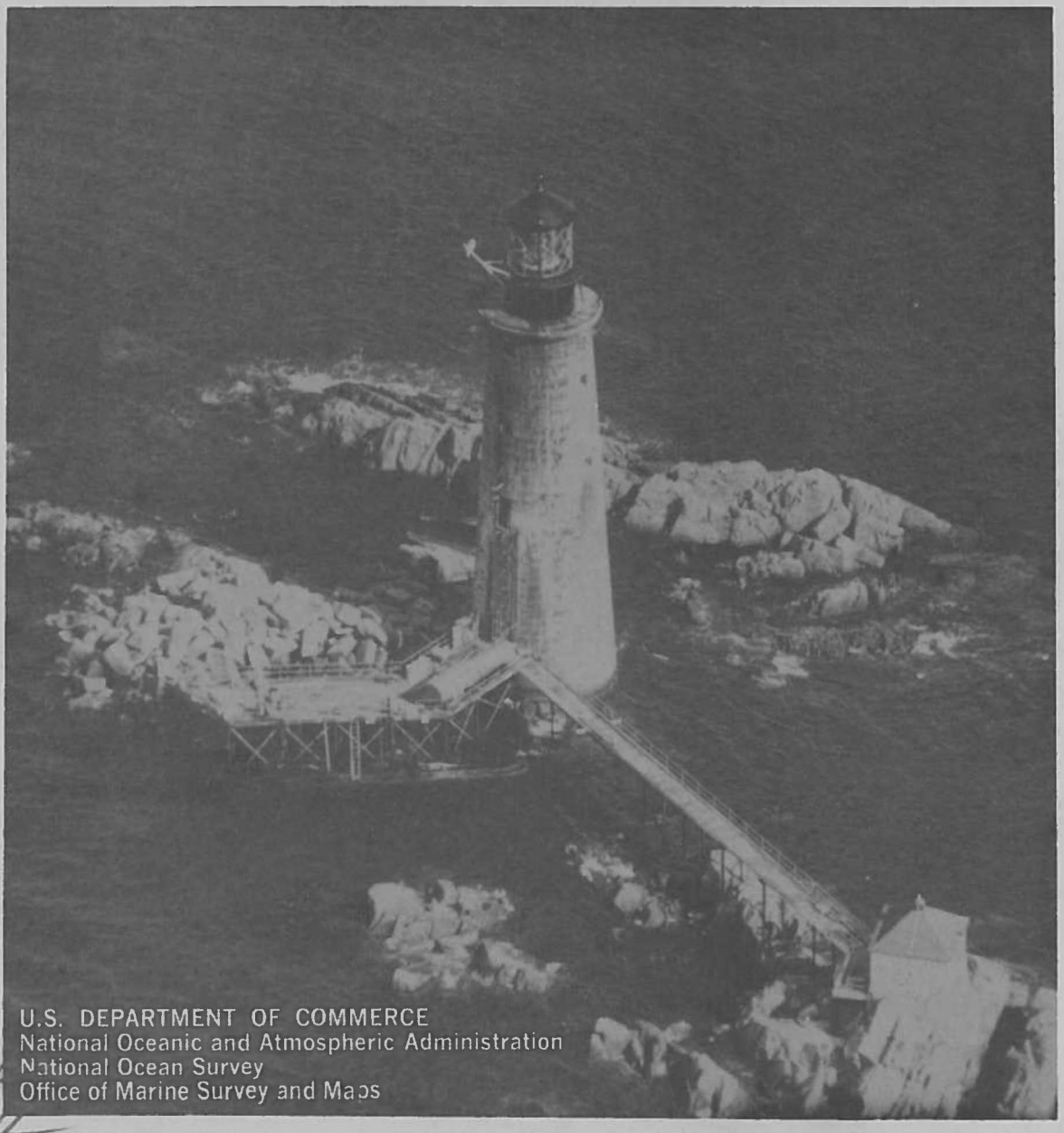
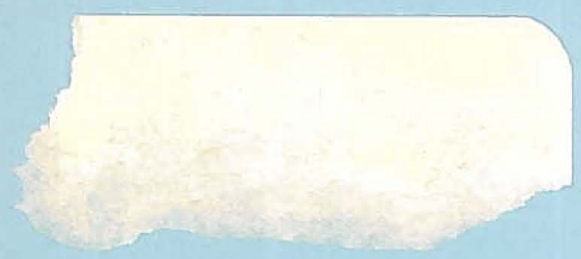
Photographic and Thermal Remote Sensing Survey of Boston Harbor Surface Currents

Data Acquisition Phase
October 1971



U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey
Office of Marine Survey and Maps

The Graves Light, Boston Harbor



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INTRODUCTION

During the summer of 1971, the National Ocean Survey (NOS) conducted a circulatory survey of the Boston Harbor and Massachusetts Bay area. This survey was initiated as part of the ongoing program of providing tide and tidal current data to the public for navigational, scientific, engineering, and recreational uses. The City of Boston and the New England River Basins Commission (Appendix 1, letters dated August 25, 1969, and October 19, 1970) stressed the importance of the survey for use as baseline data on which to form sound environmental policy and planning. Consequently, the original plans were augmented to some extent to include input from the Environmental Protection Agency (EPA) (Appendix 1, letter dated February 18, 1971). The resulting photogrammetric tidal current and thermal mapping surveys are the subject of this operations report.

These surveys were planned to be over a complete tidal current cycle during a period of spring tides, when current velocities are greater than the mean flows. An eight day period, October 2-9, was selected for operations. Because a survey of this type requires sophisticated equipment, aircraft, ground support, and a large number of people, NOS sought and acquired cooperation from other Government agencies, academia, and private concerns.

This report is intended to summarize the activities, participants and expected results of the project. Data and final reports on the various activities will be forthcoming.

NARRATIVE

The general objectives of the project were:

1. To further investigate the circulation patterns of Boston Harbor;

2. To develop new methods of remote sensing techniques for water quality studies;

3. To develop new products and services particularly in the area of water quality.

The primary concern of the project was to provide supplementary support to the tidal current survey in progress in Boston Harbor and Massachusetts Bay. The use of remote sensing techniques was first applied to surveys of this kind in the early 1960's by the National Ocean Survey (then the Coast and Geodetic Survey). These techniques promise to be invaluable tools for synoptic descriptions of the surface current and thermal structures of estuarine and coastal waters. Synoptic coverage of large areas are impossible to obtain through surface observations unless one has access to a tremendous amount of instrumentation and personnel.

The project had two basic observational concerns -- surface currents and surface temperatures. Both sets of data will be used for a better understanding of the circulation of the area. The currents observed will be used to supplement current data, obtained by Eulerian techniques through the activities of the NOAA Ship FERREL, in the construction of tidal current charts. The temperature data will be used to construct charts of isotherms which should further the study of the basic circulation and provide thermal baseline information to pollution control agencies and the City of Boston.

Because this type of survey is quite new and needs further development, the mission was also used for testing and evaluation purposes. The photogrammetric

targets used for observing currents consisted of aluminum powder which floats on the very surface of the water. Use of such targets has rather severe restrictions based on the local wind conditions, yielding data valid only under existing conditions. Our investigation included controls to further study the effects of wind on the distribution of the aluminum powder targets. Also, in association with the current survey a dye study was made at a preselected site near the entrance to Boston Harbor. Intentions are to evaluate its usefulness in observing surface currents through small-scale photography. Aluminum targets were also used in conjunction with the dye study to investigate the differences in the use of these two techniques.

This project, coordinated by the National Ocean Survey, had a variety of participants. These participants, with their primary responsibilities, are listed below.

The National Oceanic & Atmospheric Administration (NOAA) - National Ocean Survey. The National Ocean Survey was the principal participant, having total responsibility for development, operation, coordination, and completion of this project. Several elements of NOS were involved: The Oceanographic Division, the Coastal Mapping Division, the Photogrammetric Division and Photogrammetric Field Party 62 of the Atlantic Marine Center (AMC), and the NOAA Ships FERREL and PEIRCE. The Oceanographic Division provided the Principal Investigator and three other oceanographers for coordination and analysis of ground truth observations. The Coastal Mapping Division provided the Co-Investigator, Air Photo Mission I, and several other scientists for coordination and analysis of photography and data taken from aircraft. The Photogrammetric Division of AMC furnished the logistic support, field coordination and a field party to occupy three ground truth stations. The FERREL was already in the Boston area conducting a circulatory survey. She furnished general support in addition to providing two launches used for taking ground truth data and for tracking of dye. The PEIRCE provided two launches for ground truth stations and served as an anchored

station for clearing the photogrammetric models used to measure offshore surface currents. She also provided general support when needed.

The National Ocean Survey made provisions for informing the public and the officials in the Boston area of all aspects of the project. This provision proved quite invaluable as no adverse criticisms were received, demonstrating the value of an informed public.

The National Aeronautics & Space Administration (NASA). The National Aeronautics & Space Administration furnished an aircraft and flight crew whose primary responsibility was to obtain infrared imagery. The NASA aircraft carried an infrared line scanner, two Wild RC-8 cameras, a bank of six Hasselblad EL-500 cameras as a multiband photographic system, and a precision radiation thermometer.

U. S. Coast Guard. The Coast Guard provided a helicopter and flight crew for flying a precision radiation thermometer to obtain data for calibration of infrared imagery. They also provided a launch used to transport members of the press corps around Boston Harbor.

Lockwood, Kessler, and Bartlett - Long Island University. Lockwood, Kessler, and Bartlett provided an aircraft and personnel for flying multispectral photography.

Grumman Aerospace Corporation. Grumman provided an aircraft and personnel for flying a digital photometric and polarimetric imaging scanner.

U. S. Navy. The Navy provided a base of operations and flight facilities at the South Weymouth Naval Air Station.

Massachusetts Institute of Technology (MIT). The Massachusetts Institute of Technology cooperated by providing its Research Vessel R. R. SCHROCK and two

Boston Whalers with personnel for occupation of three ground truth stations. The Draper Lab of MIT assisted the helicopter operations of the Coast Guard and obtained water samples taken at ground truth stations for analysis beyond that planned in this project.

New England Aquarium. The New England Aquarium provided a fluorometer and a scientist to assist in taking dye samples for analysis. This was invaluable support for the tracking of dye which was dispersed on two occasions.

The activities of Lockwood, Kessler, and Bartlett and Grumman Aerospace Corporation were performed for their own research benefit. However, NOS will have access to their data. Likewise, they will use data collected by NOS and the other participants.

This project was quite fortunate in having abundant and favorable press coverage. Time was given by many participants to representatives of various newspapers and local television and radio stations. The value of the coverage can be appreciated when one considers that not one complaint was received concerning the various activities, many of which would appear to the uninformed as a degradation of the environment.

SCIENTIFIC PROGRAM

The project was limited in time to the period of October 2 through October 9, 1971, and covered the tidal current cycle as shown in Figure 1. Time limitation was based on the requirement to obtain observations during a period of spring tides. The intention was to obtain observations to completely cover one tidal current cycle, thus providing detailed synoptic coverage of Boston Harbor which could be correlated to the more sparse meter observations in both time and space. Weather restrictions were quite rigid, consisting of a maximum wind velocity of 10 knots and cloud cover of 10 percent or less. These stringent restrictions required that all participants be on call around the clock for operations whenever weather permitted. This caused some difficulties in communications as the various participants were based at diverse locations in the Boston area.

A project of this magnitude obviously required a great deal of planning. Correspondence was conducted and meetings were held with officials from the City of Boston, the New England River Basins Commission, and the Environmental Protection Agency several months prior to the survey. Commander R. Lawrence Swanson and Lieutenant Commander Karl Kieninger of NOAA participated in a briefing before representatives of the Massachusetts Association for the Marine Sciences in Boston in June 1971. In August, Lieutenant Commander W. S. Simmons of the Flight Operations Group and others of the Rockville office held discussions with representatives of the Environmental Protection Agency and the Federal Aviation Administration (FAA). Discussions with the FAA established procedures for obtaining flight clearances for participating aircraft which would be operating near Logan Airport. Care was taken by NOS representatives to assure the City of Boston and EPA that nothing in the project would have deleterious effects on the ecology of the waters. In early September a planning meeting was

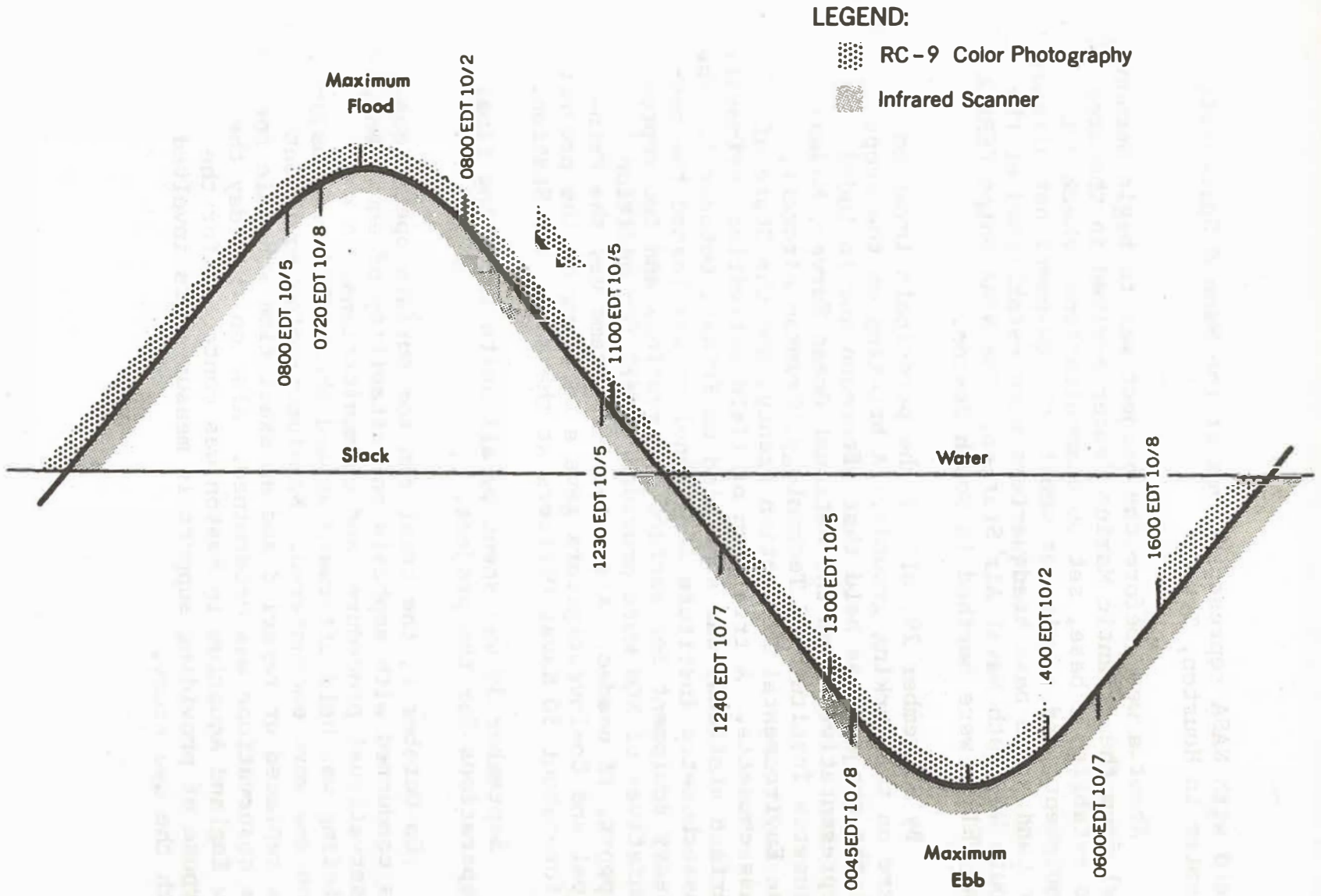


Figure 1. Photographic and Thermal Mapping Coverage

held with NASA representatives at the Manned Spacecraft Center in Houston, Texas.

About a week before the project was to begin personnel from the Atlantic Marine Center arrived in the area to establish a base, set up communications, check out equipment, and acquire or construct equipment not already on hand. The base headquarters were established at the South Weymouth Naval Air Station. The NOAA Ships FERREL and PEIRCE were berthed in South Boston.

By September 29, all of the principals involved were on the working grounds. A briefing on the scope of the project was held that afternoon and included representatives from the National Ocean Survey, Massachusetts Institute of Technology, Grumman Aircraft, the Environmental Protection Agency, and the State of Massachusetts. A trial run of field activities, primarily surface stations, was scheduled on Friday, October 1. The Massachusetts Institute of Technology was loaned the necessary equipment for surface observations and two representatives of NOS were provided to MIT for additional support, if needed. Also, later the same day the Principal and Co-Investigators gave a briefing on the project before about 50 Naval Officers at the Naval Air Station.

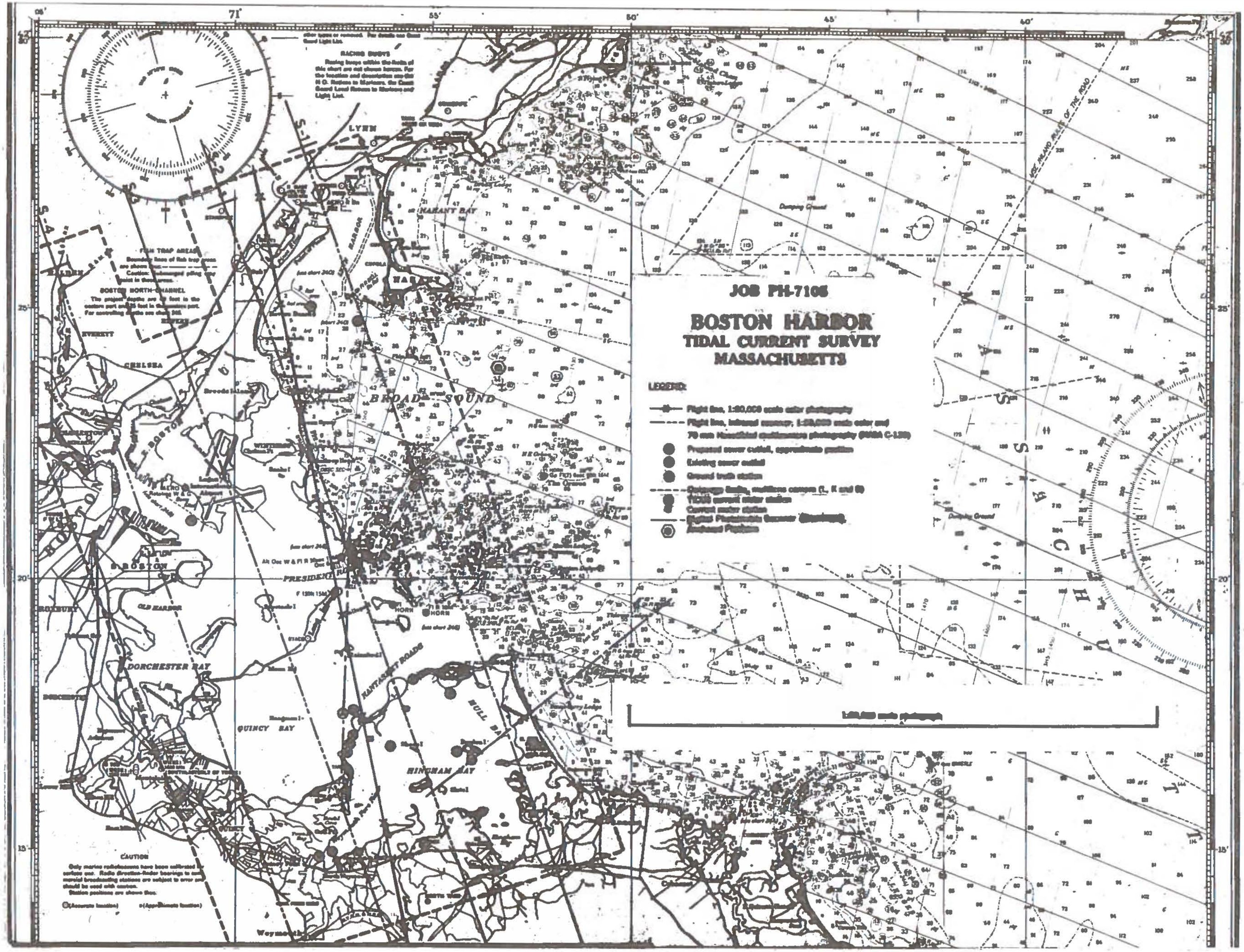
September 30 was spent by all units in making final preparations for the project.

On October 1, the trial run for surface operations was conducted with emphasis on suitability of equipment, observational procedure, and communications. A debriefing was held afterward aboard the PEIRCE. No major problems were encountered. Non-functioning equipment was replaced or reparied and an exact time schedule for the observations was determined. Also on this day the New England Aquarium in Boston was contacted for the purpose of providing support in measurements involved with the dye study.

Actual operations began on October 2. For discussion, the project is divided into four categories: 1. surface currents; 2. thermal mapping; 3. surface observations and support; and 4. research. Each of these categories is discussed separately. A map showing all flight lines and locations of ground stations is given in Figure 2.

Surface Currents. This phase was conducted to provide additional data for the construction of tidal current charts and for inclusion in the Tidal Current Tables published by NOS. The procedure involves acquisition of metric photography of surface targets. The targets consisted of flaked aluminum powder. The general technique used is described in C&GS Technical Bulletin 22. A "fact sheet" on the use of this powder is attached as Appendix 2. The aluminum was packaged in cylindrical cardboard containers and polyvinyl alcohol bags (a water soluble plastic), each containing about eight ounces of powder. These containers were dropped from three Cessna 172 single-engine airplanes. Flight lines for target distribution were spaced initially at one-half mile intervals with targets dropped every quarter mile along the lines in water depths greater than 15 feet. Time required to distribute the targets dictated a change to one mile spacing for the flight lines. Evaluation of the 1:80,000 scale metric photography indicated usable targets were well distributed throughout the area.

The NOAA-NOS Dehavilland C-8 Buffalo aircraft was used to obtain all metric photography for measurement of surface currents and was flown by NOS Air Photo Mission 1. A Wild RC-9 camera was operated at 23,150 feet, MSL, true altitude (1:80,000 scale) at 30 minute intervals over the single photographic flight line. Photographic operations were conducted on October 2, 5, and 8. The camera was loaded with Kodak Ektachrome MS film (regular color) on October 2, and 5, and with Kodak Ektachrome Infrared film (false color) on October 8. The change in film was made to take advantage of the better haze penetration characteristics of the infrared color emulsion.



JOB PH-7106
BOSTON HARBOR
TIDAL CURRENT SURVEY
MASSACHUSETTS
Existing sewer outfall
Ground truth station
LYNN
NAHANT BAY
NAHANT
BROAD SOUND
CHELSEA
EVERETT
BOSTON
PRESIDENT ROADS
NANTASKET ROADS
OLD HARBOR
DORCHESTER BAY
QUINCY BAY
HINGHAM BAY
HULL BAY
ROXBURY
QUINCY
Weymouth
RACING BUOYS
FISH TRAP AREAS
BOSTON NORTH CHANNEL
CAUTION
Dumping Ground
M A S S A C H U S E T T S

On October 2, photography began at 0814 and ended at 1341 (EDT). Operations were cut short because of an apparent camera malfunction. The malfunction was suspected in flight due to an inoperative shutter indicator light. When the mission landed for a crew change, a broken electrical lead was discovered and repaired. Photographic daylight remaining after completion of the camera check and repair did not justify a return to altitude. The roll of exposed film was removed and sent immediately to Washington for processing and evaluation. It was discovered that the malfunction was limited to the indicator light circuit, as good imagery was found in all frames after processing.

Photographic operations on October 5 began at 1028 (EDT) and ended at 1158 when increasing cloud cover reached 30 percent. Photography on October 8 was limited to that part of the tidal current cycle not previously covered. Operations began at 0803 (EDT) and ended at 1205. The total photographic coverage obtained leaves a hiatus in the tidal current cycle of approximately 1½ hours between maximum ebb and slack before flood (Figure 1). However, interpolation should adequately fill this gap for current chart purposes.

Thermal Mapping. This part of the survey was conducted to obtain synoptic coverage of the surface water temperatures as a function of the tidal current cycle from which charts of isotherms can be constructed. These data will be used for a better understanding of the effect of circulatory patterns on thermal distribution and for location of areas of steep thermal gradients. The infrared imagery was obtained by a NASA C-130B Lockheed Hercules, one of the support aircraft of the Earth Resources Survey Program. Imagery was obtained for the entire tidal current cycle. An HRB-Singer Reconofax IV single channel scanner, operating in the 8 - 14 micrometer region, filtered to 8 - 12 micrometers, recorded the imagery on 70 mm photographic film, and on magnetic tape in the analog mode. Scanner flights were planned to be concurrent with photographic

flights by the NOS Buffalo. The NASA mission was not limited to daytime flights and weather conditions were not as restrictive as required for metric photography. Consequently, when weather appeared to hinder the entire effort, the thermal mapping was undertaken independently of the metric coverage.

The NASA aircraft operated on October 5, between 0900 and 1300 (EDT), October 7 between 0700 and 1100, and October 8 between 0230 and 0830. All infrared imagery is presumed to have been successful, based on a "first look" of the film only.

Simultaneous coverage with a Wild RC-8 camera and Ektachrome MS film, a second Wild RC-8 with Ektachrome Infrared, and a bank of six Hasselblad cameras equipped with 40 mm lenses was obtained on three passes over the four scanner flight lines, one at maximum flood velocity and one at each slack water.

A precision radiation thermometer (Barnes PRT-5) was operated simultaneously with the scanner during all flights.

A U. S. Coast Guard H-3 Helicopter, based at Otis Air Force Base, and equipped with a precision radiation thermometer (Barnes PRT-5) made low level flights (surface to 100 ft.) over a flight pattern that included each of the nine ground truth stations. The pattern was extended to cover some of the suspected hot-spots resulting from industrial waste water outfalls. No attempt was made to synchronize flights with the NASA C-130 because of the disparity in ground speed and flight duration.

Surface Observations and Support. In support of the flight missions there were, in general, nine surface platforms on station to collect data necessary to calibrate imagery from the airborne sensors and to collect supplementary descriptive oceanographic data. The types of data collected included, by schedule were:

On the hour:

bucket temperature
air temperature
wind speed and direction
turbidity (Secchi disk)
other weather (sky cover, wind waves)
optional
Nansen cast with reversing thermometers

On the half hour:

bucket temperature
surface water sample
current drogues

The nine surface platforms consisted of a high speed launch from the NOAA Ship FERREL, two launches from the NOAA Ship PEIRCE, three skiffs operated by Photogrammetric Field Party 62, and the RV/R. R. SHROCK and two Boston Whalers, operated by MIT. These platforms were on station, except when completely impractical, during the times of overflights by the aircraft involved in imagery acquisition.

The surface temperatures will be used primarily to calibrate infrared imagery. The Secchi disk observations will be used in evaluating the digital Photometric and Polarimetric Scanner flown by Grumman Aerospace Corporation's Douglas A-26. One station also used a Beckman Environtrans Turbidimeter for that purpose. The current drogues will supplement the photogrammetric tidal current survey, and weather observations will supplement all operations. Temperature and salinities from the Nansen casts will be used to correlate surface characteristics with the structure of the water column at depth.

The in situ observations were scheduled to be taken at all times when the NASA C-130 was in flight. However, since the C-130 began in the early morning hours of

October 8, the MIT contingent was released from operations because of a lack of night capabilities. The NOS launches capable of nighttime operations were on station throughout the flight and the skiffs took their stations at sunrise.

In support of the photogrammetric tidal current survey, Rhodamine WT dye was dispersed at the site of a proposed sewer outfall near Finn's Ledge on two occasions, the flood and ebb currents. This dispersal had two primary objectives: to test its imagery characteristics for use in photogrammetric current survey techniques, and to supplement other current data collected. The first dispersal was on October 5, beginning at about ½ hour after slack before ebb at 1235 (EDT). The second dispersal was on October 8, beginning at about ½ hour after slack before flood at 0938. The dye was tracked on the surface by a small launch (Jo-boat) with three samples being taken across the patch every half hour. Sextant fixes were taken for each sample. The New England Aquarium assisted in this operation by furnishing a scientist to help in the sampling and subsequent analysis of the samples by fluorometer. On both occasions the dye was tracked for about 3½ hours until it became too dispersed to follow.

Research. Lockwood, Kessler and Bartlett, Inc., and Grumman Aerospace Corporation completed flights over the area with a multilens camera and a digital scanner, respectively. Imagery from these flights will be for the purpose of investigating remote sensing research applications, utilizing the in situ observations.

The multilens camera referred to in the preceding paragraph was developed by Dr. Edward Yost of the Long Island University. The camera and associated instrumentation comprise a system designed to aid in photographic enhancement and interpretation. Dr. Yost will evaluate use of the system for application to water quality surveys and environmental impact studies.

Grumman Aerospace Corporation will evaluate their scanner for similar applications and for determining water depths. The scanner employs a vidissector with a single aperture and both horizontal and vertical polarizing filters. It operates in the visible portion of the electromagnetic spectrum and records in the digital mode on magnetic tape.

SUMMARY

The project herein described has provided a mechanism by which the capabilities and expertise of a diverse group of organizations have been channeled for the mutual interest of obtaining basic data from which to further our understanding of the hydrodynamic problems and processes in Boston Harbor and vicinity. It would have been difficult for any one organization to undertake a program of this magnitude with such a short lead time, particularly with the present governmental funding restrictions. It is in the spirit with which this program was conducted, that the Federal, state and local governments, academia and industry can collectively serve the public in our efforts to solve some of the pressing environmental problems.

The National Ocean Survey appreciated the excellent cooperation of all involved. We extend our thanks and hope to again have the pleasure of working with all concerned.

APPENDIX 1

Correspondence

CITY OF BOSTON
OFFICE OF THE MAYOR
CITY HALL, BOSTON

EVIN H. WHITE
MAYOR

25 August 1969

The Director
The Environmental Science Service Administration
Coast and Geodetic Survey
Rockville, Maryland 20852

Dear Sir:

This letter concerns the Current Survey of Boston Harbor scheduled by the U.S. Coast and Geodetic Survey for either 1970 or 1971. The timing of this survey is of great importance to the City of Boston and to all parties concerned with Boston Harbor.

As you may be aware, the shoreline, waters and islands of Boston Harbor are the center of intense interest among groups concerned with both conservation and development. Senator Edward Kennedy is filing a bill with the Congress authorizing the Department of the Interior to study the feasibility of establishing all of Boston Harbor as a National Recreation Area. A commission appointed by the Massachusetts General Court is studying the feasibility of increased utilization of the Harbor Islands. The Expo 76 Corporation is proposing a National Bicentennial Exposition on landfill and platforms in Dorchester Bay. The Boston Redevelopment Authority is studying the feasibility of a New Community on major islands within the City's jurisdiction. Many private interests are looking to the Harbor shoreline for development opportunities, and many others depend on the Harbor for their recreation activities.

Meanwhile, the waters of the Harbor suffer from gross pollution that is limiting the recreational use of this valuable resource in a congested city. The dangers of increasing the effects of this pollution, and the difficulties of predicting the ecological effects of alternative proposals for development or pollution control, are hampering the rational assessment of the Harbor's future. In consequence this resource is the center of lively controversy in the Boston community, and the need for a detailed and objective study of pollution in these waters is very apparent.

In response to this need, the Boston Redevelopment Authority is undertaking such a study, using the research facilities and engineering expertise of the Massachusetts Institute of Technology. This study is to analyze the present levels of pollution in the harbor and the effects of tidal flow on the movement and dispersal of pollutants. The objective is to develop a Water Quality Management Model that will estimate the costs of various levels of pollution and pollution control, and the effects of alternate development proposals on the quality of the Harbor environment, and on the recreation activities that are possible along the shoreline.

A vital component of this study is the Hydraulic Flow Model that simulates the tidal patterns in the Harbor and the movement of pollutants under a variety of conditions. Available information is adequate to begin work on this model and to obtain preliminary results. I understand, however, that it is essential that we obtain additional information of the kinds that can best be gathered by a USC & GS Current Survey in order to update and expand these studies.

It is my understanding that the USC & GS has scheduled a resurvey of Boston Harbor for the summer of 1970, to follow a survey off Cape Ann. I also understand that this schedule is unlikely to be met, and that the survey of the Harbor may well be postponed until 1971.

In view of the importance of Boston Harbor to Boston and to New England, in view of the problems and proposals facing us for pollution control, for conservation and development, and in view of the urgency of our need for information on the hydraulic systems of the harbor, I would hope that your schedule for the survey of Boston Harbor in 1970 would be adhered to, even if this would postpone Cape Ann until 1971. The priority of Boston Harbor over Cape Ann at this time must be apparent.

I am sure that the many agencies concerned with the future of the Harbor and the natural resources of the region will endorse this petition. To that end, I am sending copies of this letter to the Federal Water Pollution Control Authority, the U.S. Corps of Engineers, the New England River Basins Commission, the Harbor Islands Commission and the Natural Resources Commission of the Commonwealth of Massachusetts. I am sure they will agree that the best interests of the region will be served by a USC & GS survey of Boston Harbor at the earliest possible date.

Sincerely,

Kevin H. White
Mayor

KHW/nmm

SEP 9 1969

C33-81-GTE

Honorable Kevin H. White
Mayor of Boston
Boston, Massachusetts 02201

Dear Mayor White:

We are well aware of your need for a tidal current survey in the Boston Harbor area as we have recently received a similar request from Mr. Malcolm E. Graf of the New England River Basins Commission.

We had planned to work in the Cape Ann vicinity in calendar year 1971, gradually working to the south and eventually connecting with the recent work in Long Island Sound. As was stated in a reply to Mr. Graf, we will reschedule the project at Cape Ann in order to work in Boston Harbor first. Unfortunately, we cannot commence operations in the Boston area prior to 1971 as we have a previous commitment in 1970 to complete a survey already in progress in Penobscot Bay, Maine.

If 1971 is not too late for your purposes, Lt. Cdr. R. L. Swanson, Acting Chief of the Oceanography Division, will be available to discuss the necessary details. He can be reached on phone 301-496-8274 or can meet with your representatives.

Sincerely,

(Signed) Robert M. White

DISPATCHED GP SEP 9 1969

Robert M. White
Administrator

RLSwanson:tmo 9/3/69

CODE	SURNAME	DATE	CODE	SURNAME
C33	Swanson	9/3/69	A	
C3	DARLING	9/4		
C	Jones	9/5		

ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION

September 30, 1970

C3313-143-GTE

Mr. Malcolm E. Graf
Staff Director
New England River Basins Commission
55 Court Street
Boston, Massachusetts 02108

Dear Mr. Graf:

Your letter for the N.E.R.B.C. dated July 31, 1969, requested the Coast and Geodetic Survey to consider a tidal current survey in the Boston Harbor area. Rear Admiral Jones' reply for the Survey dated August 28, 1969, indicated our willingness to do this work beginning with the 1971 field season. Your letter dated September 5, 1969, expressed your appreciation for the Survey's positive reply to your request and your intent to contact this Division in the near future. Since this correspondence, we have heard nothing further regarding your needs for this survey. We must now begin to plan next season's work for the Coast and Geodetic Survey Ship FERREL.

The Survey has had a request from another agency for a circulatory survey in Portland Harbor, Maine, area. However, we still plan to meet our commitment to do Boston Harbor in 1971, if you still require such data. Please let us know your needs as soon as possible. I am available to discuss the necessary details and can be reached on phone 301-496-8274. If you prefer, I could meet with your or your representative regarding this work.

Briefly, the Survey will assign the Ship FERREL to this work. Tidal current data will be obtained using the TICUS System which consists of a buoy anchored on selected station sites and current meters suspended beneath it. The number of meters at each station will depend on depth of water. The Ship will also be able to obtain the temperature and salinity of the water.

CODE	SURNAME	DATE	CODE	SURNAME	D
C3313	CJTaylor	9/30/70			

I look forward to hearing from you regarding this survey. Should you no longer have need for such data, we will delay Boston Harbor and do the other area as mentioned.

Sincerely,

R. L. Swanson

R. L. Swanson
Commander, USESSA
Chief, Oceanography Division

NEW ENGLAND RIVER BASINS COMMISSION
55 COURT STREET · BOSTON, MASSACHUSETTS 02108
PHONE: (617) 223-6244

October 19, 1970

RECEIVED: OCT 22 1970
OCEANOGRAPHY DIVISION
OFFICE OF HYDRO. & OCEANO

Commander R. L. Swanson
USESSA
Coast and Geodetic Survey
Rockville, Md. 20852

Dear Commander Swanson:

Thank you for your letter of September 30, 1970, concerning our request for a tidal current survey in the Boston Harbor area.

As I mentioned to you we are currently coordinating the development of a water quality management plan for Boston Harbor. FWQA and the Massachusetts Division of Water Pollution Control are providing leadership in this study. Both of these agencies have developed water quality management models and are in need of improved tidal current information. Based on these requirements, I would like to reaffirm our request for a tidal current survey in Boston Harbor as soon as practicable. FWQA endorses this priority need.

I have contacted Mr. Daniel Fitzgerald of FWQA and requested him to contact you directly regarding the details concerning data requirements. He is located at 240 Highland Avenue, Needham, Mass. (telephone : (617) 223-6244); ← this is Newman's No.
Fitzgerald is 617-223-7337

Thank you in advance for your cooperation and assistance.

Sincerely yours,

Walter M. Newman

Walter M. Newman
Senior Staff Associate

WMN/amc

cc: Daniel Fitzgerald (FWQA)
Al Ferullo (MDWPC)
Ralph F. Kresge (ESSA)

UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
FEDERAL WATER QUALITY ADMINISTRATION
New England Basins Office
240 Highland Avenue
Needham Heights, Massachusetts 02194

February 18, 1971

C331
GT

R. L. Swanson, Commander, USESSA
Chief, Oceanography Division
Coast and Geodetic Survey
Rockville, Maryland 20852

Dear Commander Swanson:

In response to our previous correspondence please find enclosed a map of the Boston Harbor area showing locations where current information would be very beneficial to our work in simulating water quality in Boston Harbor.

The results of a coordinated effort of several agencies were forty-two points which represent an ideal data base for our model verification. The three orange points represent our present current meter data points. The red points are considered to be the most meaningful of the forty-two points.

The relatively large number of points in the Weymouth Fore River are the result of special water quality problems encountered there.

FOR THE REGIONAL DIRECTOR:

Sincerely yours,

Daniel J. FitzGerald

Daniel J. FitzGerald
Chief, Simulation and Forecasting

Enclosure:
Map

APPENDIX 2

Fact Sheet on the Use of Aluminum Powder in a Photogrammetric Current Survey

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administratio
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

Date: August 13, 1971

Reply to Attn of: C33-86-GTE

Subject: Fact sheet on the use of aluminum powder in a photogrammetric current survey

To: PA11

As our nation grows both economically and in population, use of our coastal and estuarine areas will continue to develop at a rapid pace. Increased shipping, and recreational boating, along with a growing number of engineering structures such as, sewage and industrial outfalls for waste disposal, demand a detailed knowledge of estuarine and coastal circulation. Understanding the physics of these areas will better enable us to achieve a maximum utility with a minimum detrimental effect on the marine environment.

Physical measurements of the speed and direction of the current are some of the basic parameters used for understanding the circulation of the hydrosphere. Usually this is accomplished by means of flow meters moored at specific locations within the area of investigation. Observations of this type are expensive and difficult to obtain. Consequently, only a skeletal network of observations are generally obtained because of practical considerations. Remote sensing can now be used along with the traditional current observations to add synoptic detail impossible to obtain from instrumented arrays.

The National Ocean Survey developed in the early 1960's a technique whereby surface currents could be described by photogrammetric methods. The x and y parallax caused by movement of the surface target (such as a float or dye) with the current can be measured on a pair of stereoscopic aerial photographs. Any number of targets can be released and the speed and direction of each can be determined.

This process is repeated throughout the tidal cycle and related to the Eulerian measurements obtained simultaneously by the instrumented arrays of current meters.

The most effective target has been found to be aluminum powder. This powder has characteristics that enable it to be traced over long periods of time in addition to having reflective characteristics which make it easily distinguishable on black and white, color and infrared film. The powder is packaged in 8 oz. polyvinyl alcohol bags. Polyvinyl is a water soluble plastic.

The area of operations is generally seeded from small aircraft or boats for at least one complete tidal cycle. Hours of photographic day light or weather conditions might necessitate operations continuing over portions of several days to insure proper coverage.

The aluminum powder, which is used in small quantities over widely separated locations, appears as a silver paint on the surface of the water but will break up after several hours and is generally completely dispersed in a few days. It has been found by the National Ocean Survey that it does not stick to the hull of a boat and tests by the U. S. Coast Guard have shown that it is harmless if passed through an engine intake.

The material does present a possible nuisance value because of the black, greasy feel and appearance of aluminum oxide that form when the powder is rubbed between two surfaces. However, any soiled places resulting from contact with aluminum oxide are easily removed with common detergents, soap or solvents; no stains remain.

Aluminum as used is manufactured by the Reynolds Metals Company and has a guaranteed analysis of:

Flaked aluminum	97.5 percent
Stearic acid	2.0 percent
Moisture	0.5 percent

Stearic acid is refined animal fat, commonly found in beef tallow; it is added to facilitate mixing in paint vehicles and to retard oxidation. The material is not toxic in the form and concentrations we use and, according to results of known research, will not break down into other compounds which in themselves constitute a danger to the environment or to an ecosystem.

Two researchers have demonstrated that aluminum chloride, as opposed to pure aluminum used in this study, is lethal in concentrations of 0.5 ppm in freshwater and in concentrations greater than 88 ppm in seawater. However, the material used oxidizes rapidly and becomes inert thus preventing formation of aluminum chloride or any other aluminum salt in significant quantities. This is especially true in seawater due to its inherent neutrality (6 to 9 pH range). There is even less chance of formation of aluminum salts, chiefly because of the inert character of aluminum oxide.

Research done in 1964, by the then Bureau of Commercial Fisheries, shows that the material used does not harm clams and oysters, common to Chesapeake Bay, either physiologically or esthetically.

Aluminum powder, like almost all powders, can be a fire hazard when mixed with oxygen in the right proportion. The material is not a hazard in the container unless it is in an actual fire. With normal care, the material should be perfectly safe for our purposes, as it has been.

Additional information regarding surveys of this type can be addressed to:

Director
National Ocean Survey
6001 Executive Boulevard
Rockville, Maryland 20852

R. L. Swanson
Chief, Oceanographic Division

APPENDIX 3

Participants

Such a large number of people were involved in this project that it is impractical to attempt to list everyone. Therefore, only the principal participants from each participating organization are listed.

NOAA - National Ocean Survey
- Office of Marine Surveys and Maps
  - Cdr. R. Lawrence Swanson, Ph.D. - Principal Investigator
  - Mr. I. Y. Fitzgerald - Co-Investigator
  - Lt. Cdr. W. S. Simmons - Chief, Flight Operations Group
  - Lt. Cdr. William Noble - Chief, Air Photo Mission I
  - Lt. Cdr. Leland Reinke - Chief, Air Photo Mission II
  - Mr. John Smith
  - Mr. Charles R. Muirhead
  - Mr. George Moore
- Atlantic Marine Center
  - Cdr. M. J. Umbach - Chief, Photogrammetric Division
  - Mr. Joe Wilson - Chief, Photogrammetric Field Party 62
  - Mr. Billy Barnes
- NOAA Ships
  - FERREL - Lt. Cdr. Karl Kieninger, Commanding Officer
  - PEIRCE - Cdr. Bruce Williams, Commanding Officer

NASA
- Mr. J. D. Weber - Mission Manager

U. S. Coast Guard
- Mr. Joseph Deaver

MIT
- Dr. Erick Mollo-Christensen
- Mr. Ed McCaffrey

New England Aquarium
Dr. Guy McLeod
Mr. Christopher Neefus

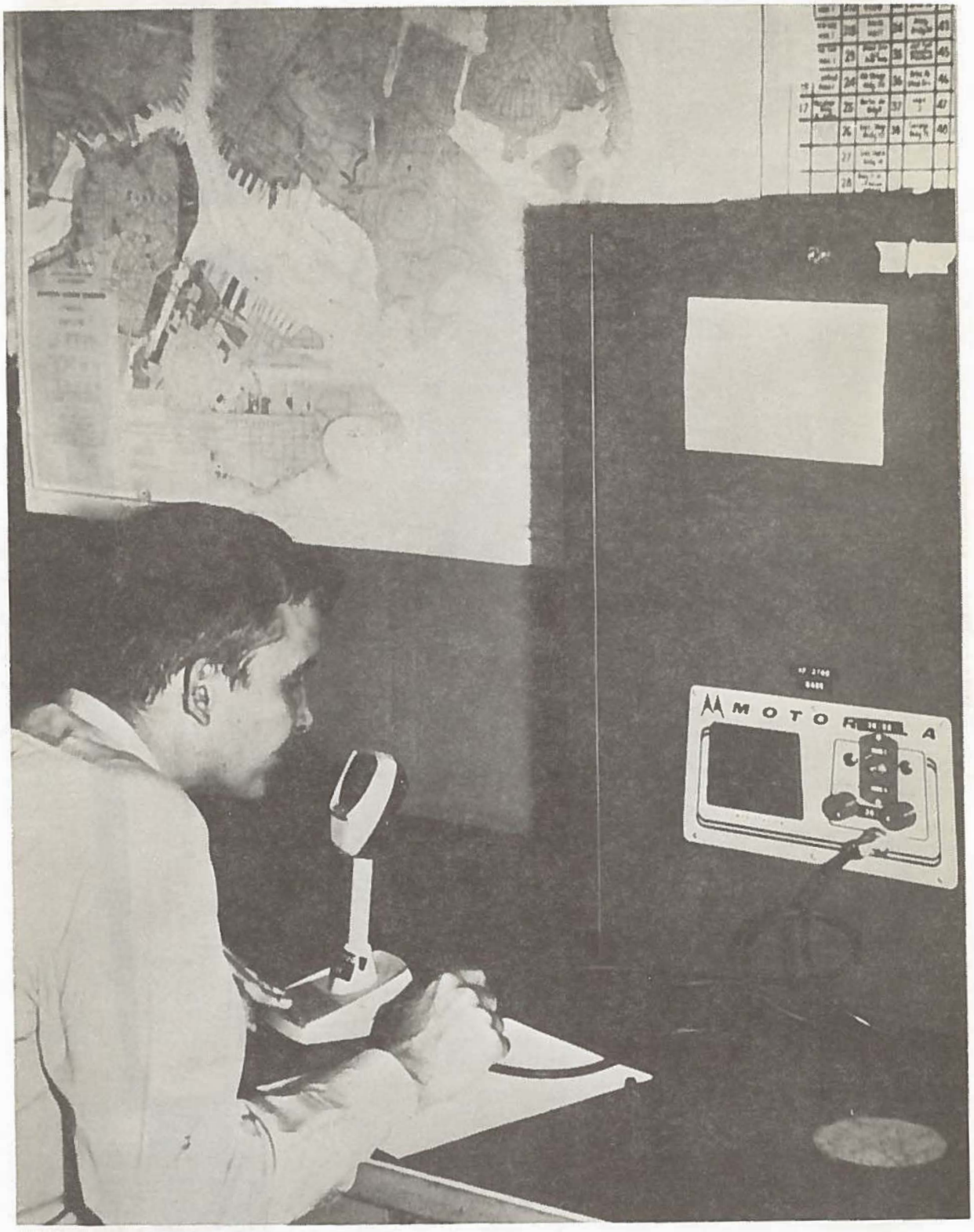
Lockwood, Kessler, and Bartlett
Mr. Charles B. Woodward
Mr. Frank D'Angelo

Grumman Aerospace Corporation
Mr. Herbert Hallock
Mr. John Halojian

U. S. Navy, South Weymouth Naval Air Station
Capt. R. L. Smith - Commanding Officer
Cdr. E. A. Woodall - Flight Operations

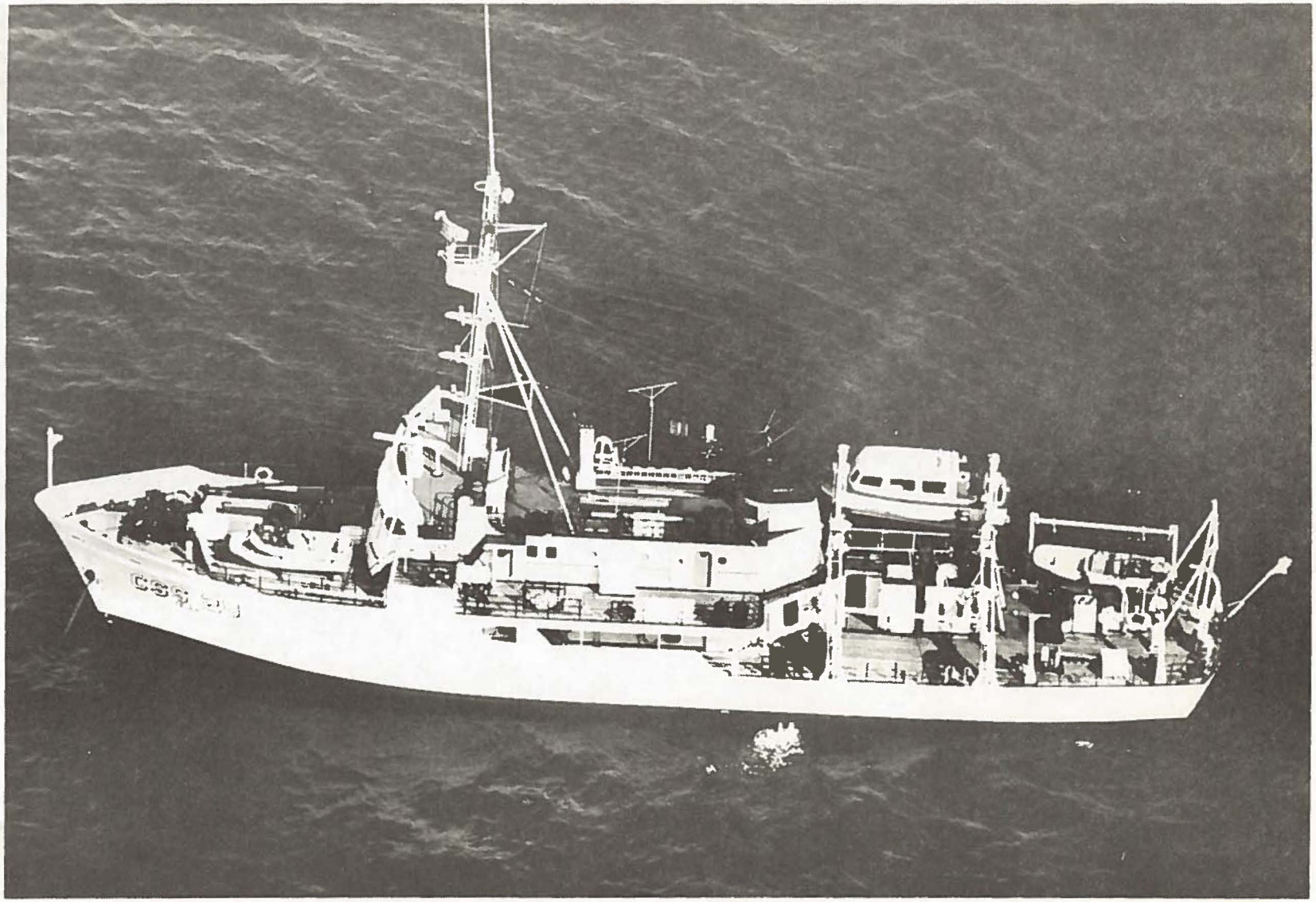
APPENDIX 4

Photographs



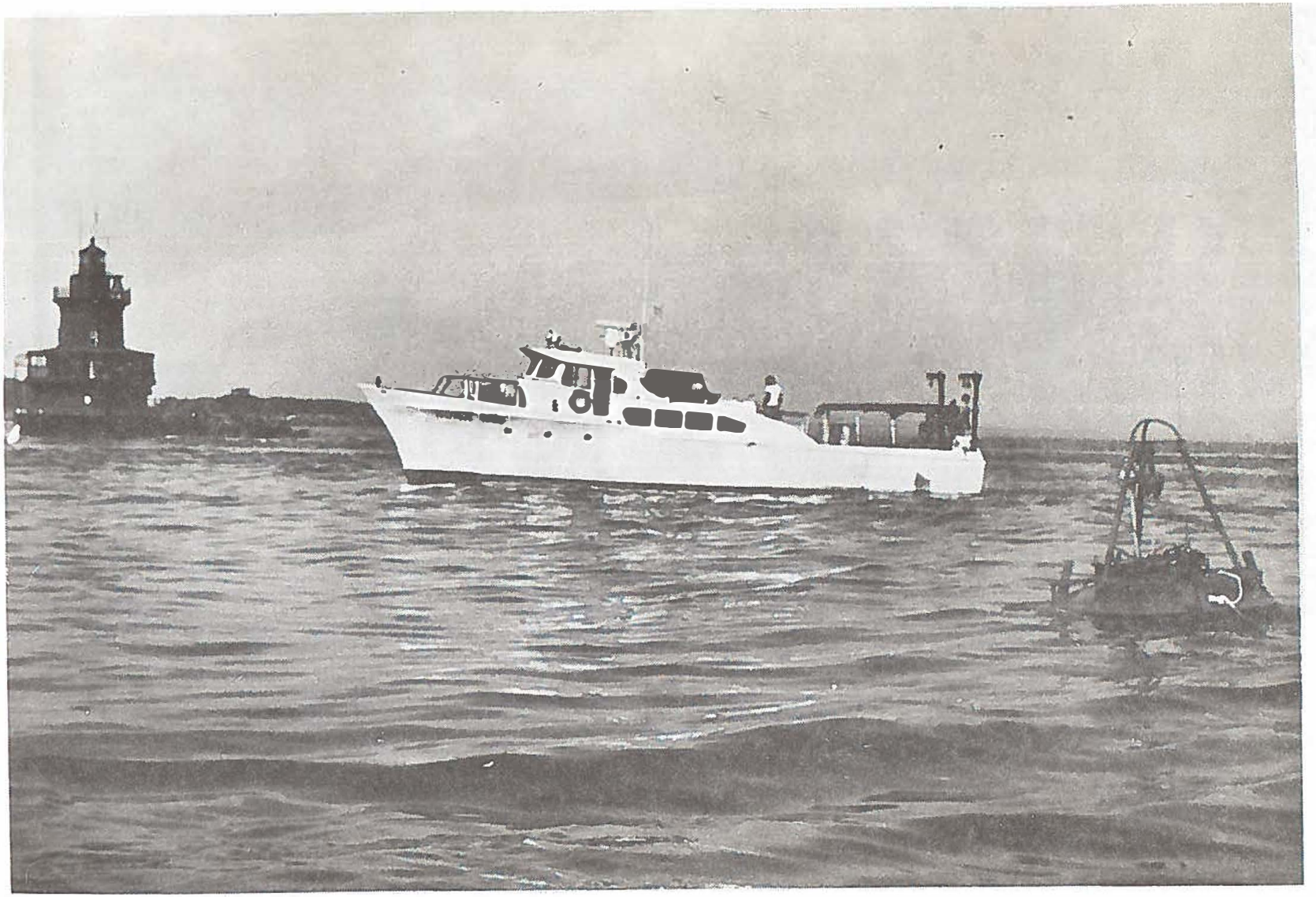
Communications Center

NOAA Ship FERREL



NOAA Ship PEIRCE

Launch 1255 and Current Buoy at Deer Island Light Reference Station

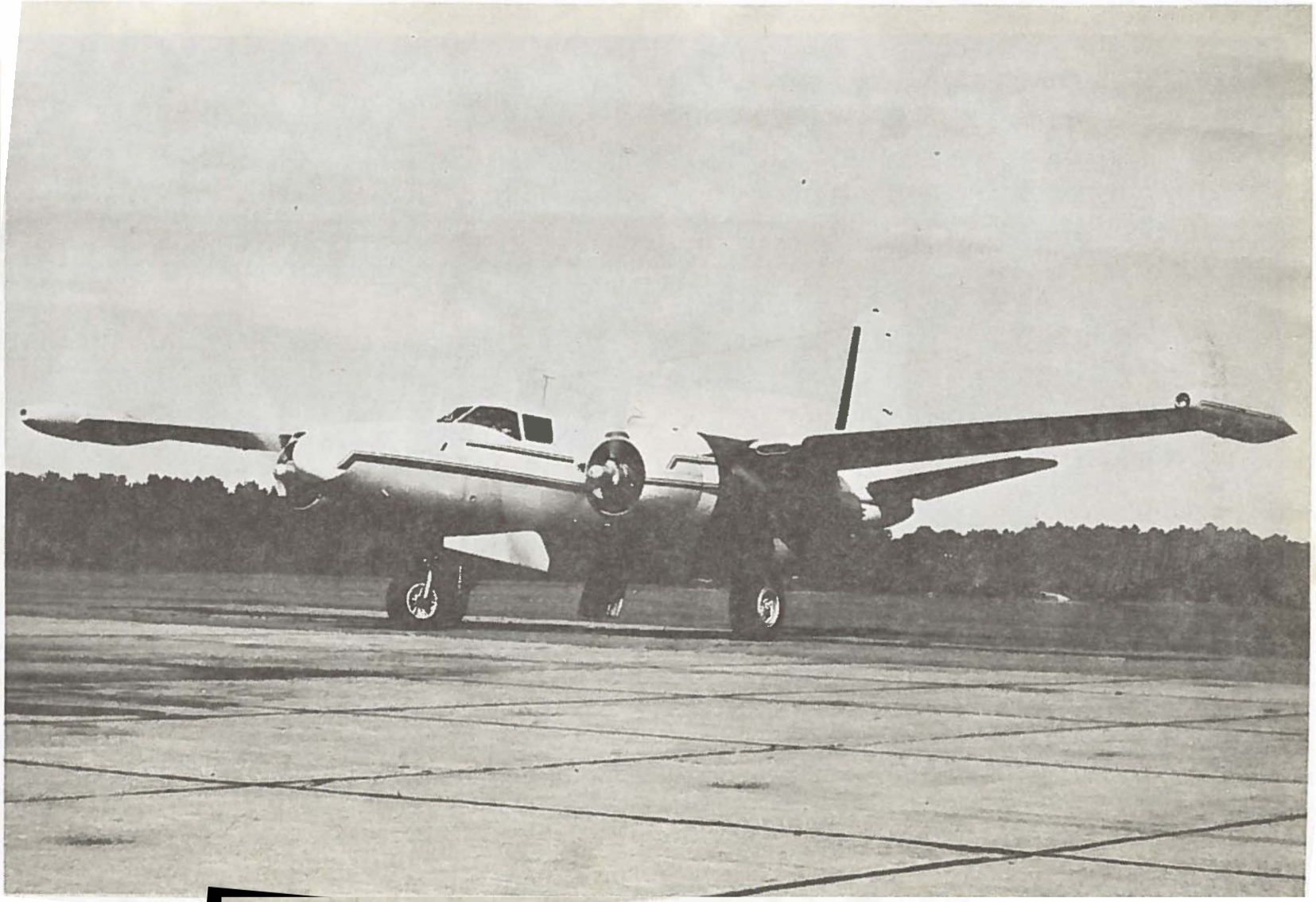


NOAA-NOS Dehavilland C-8 Buffalo

NASA Lockheed C-130B Hercules with Cessna 182 in Foreground

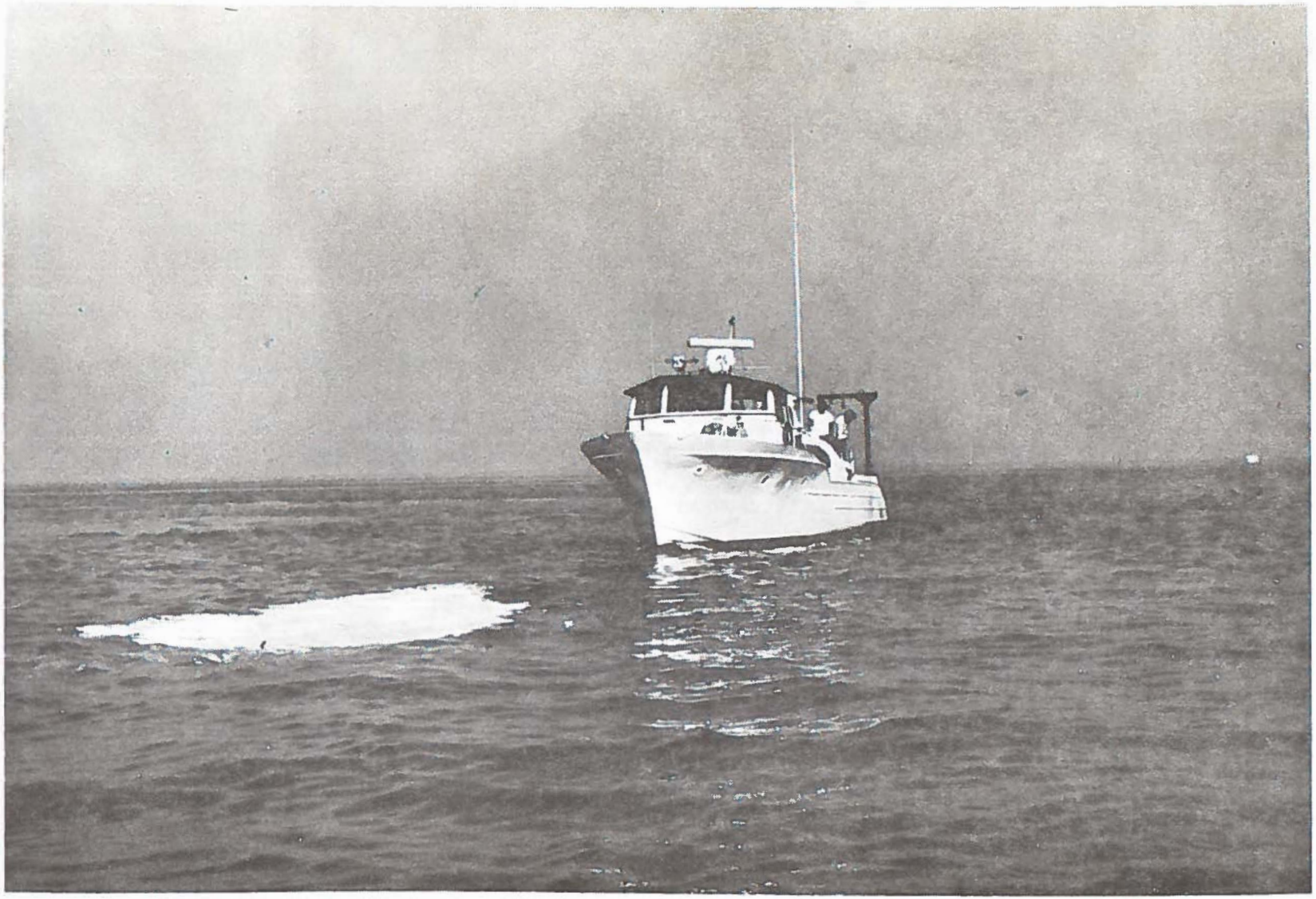
U. S. Coast Guard, H-3 Helicopter

Lockwood, Kessler, and Bartlett, Piper Apache



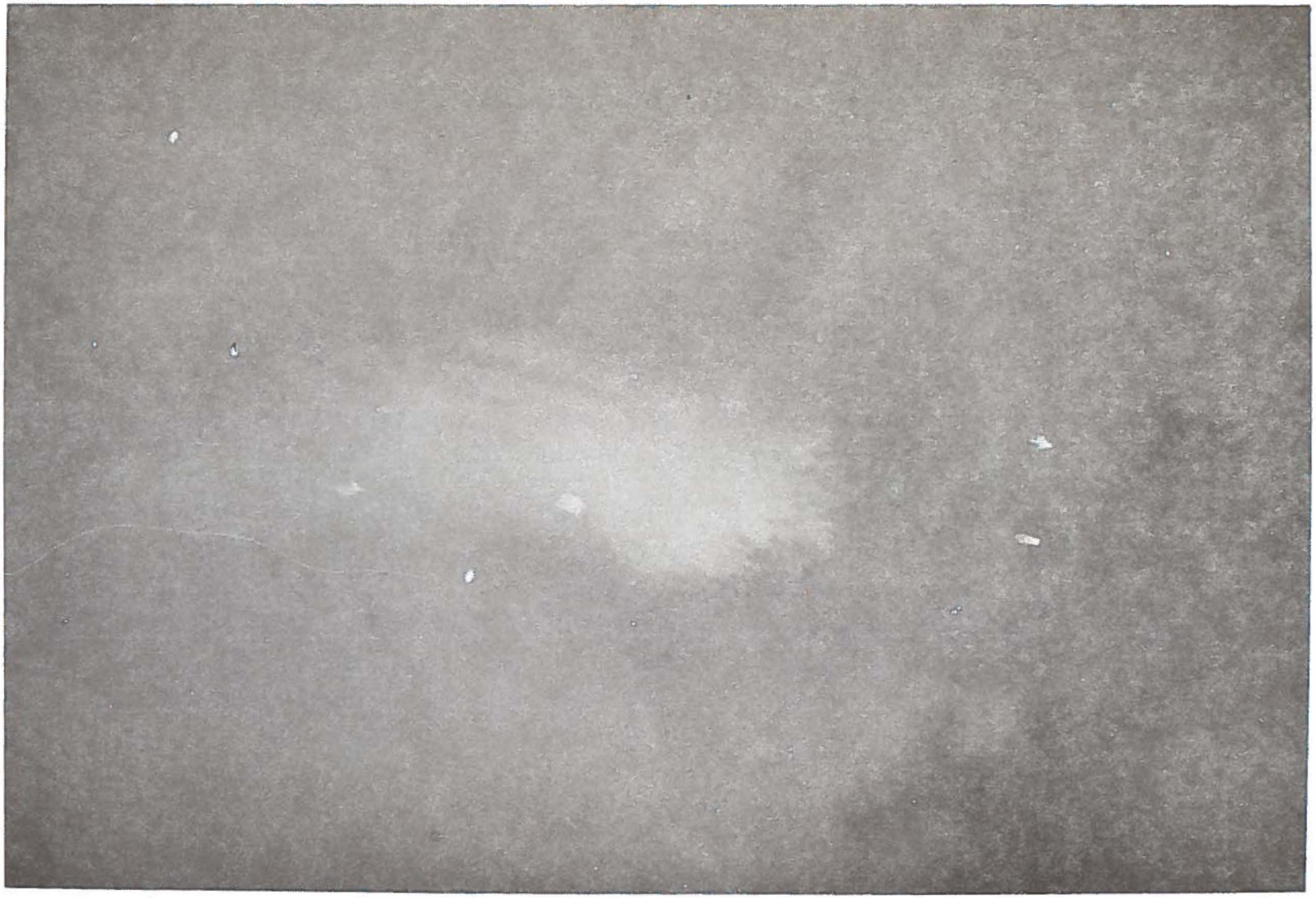
Grumman Ecosystems Inc., Douglas A-26

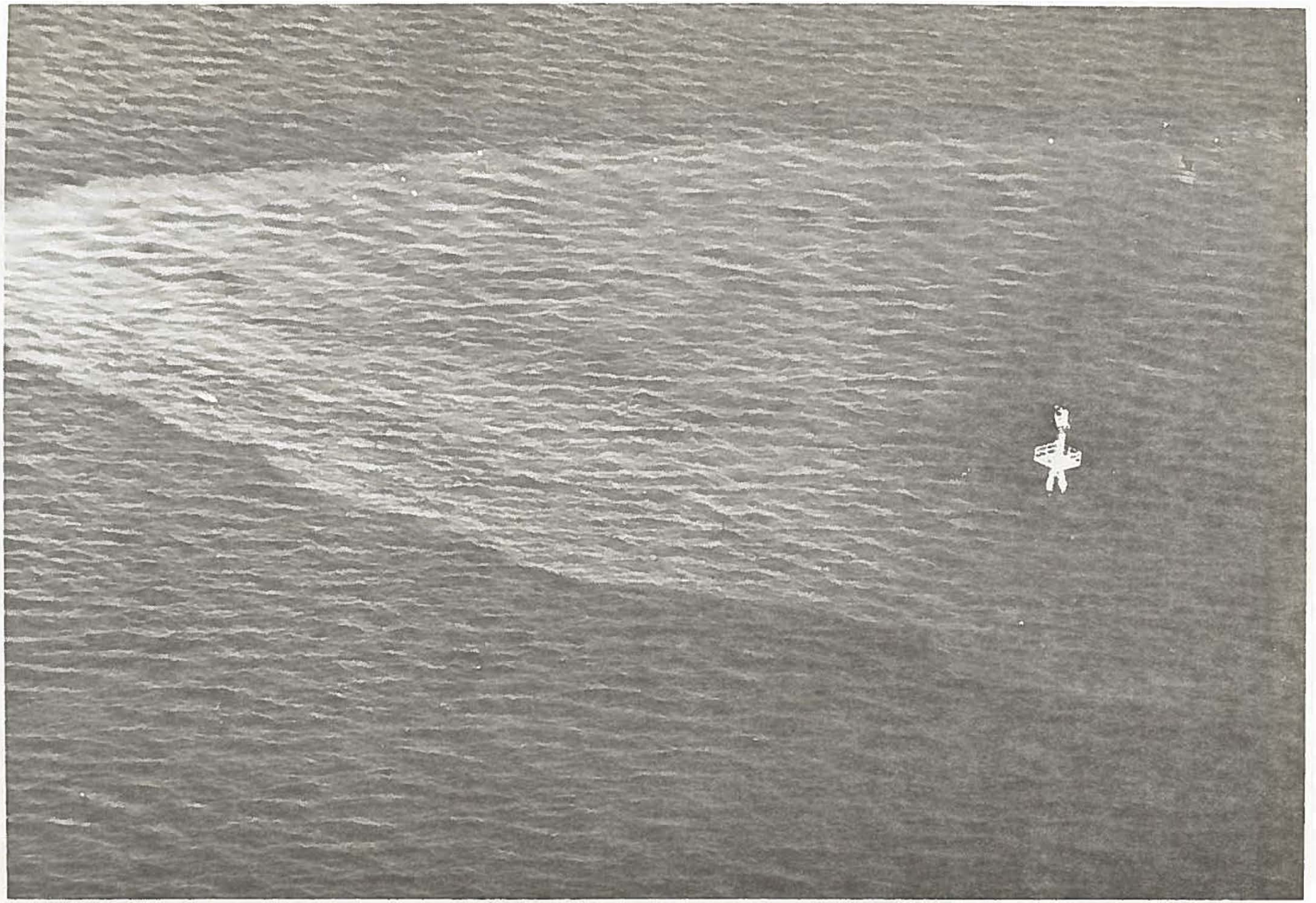
NOAA High-Speed Launch 1255 and an Aluminum Powder Target



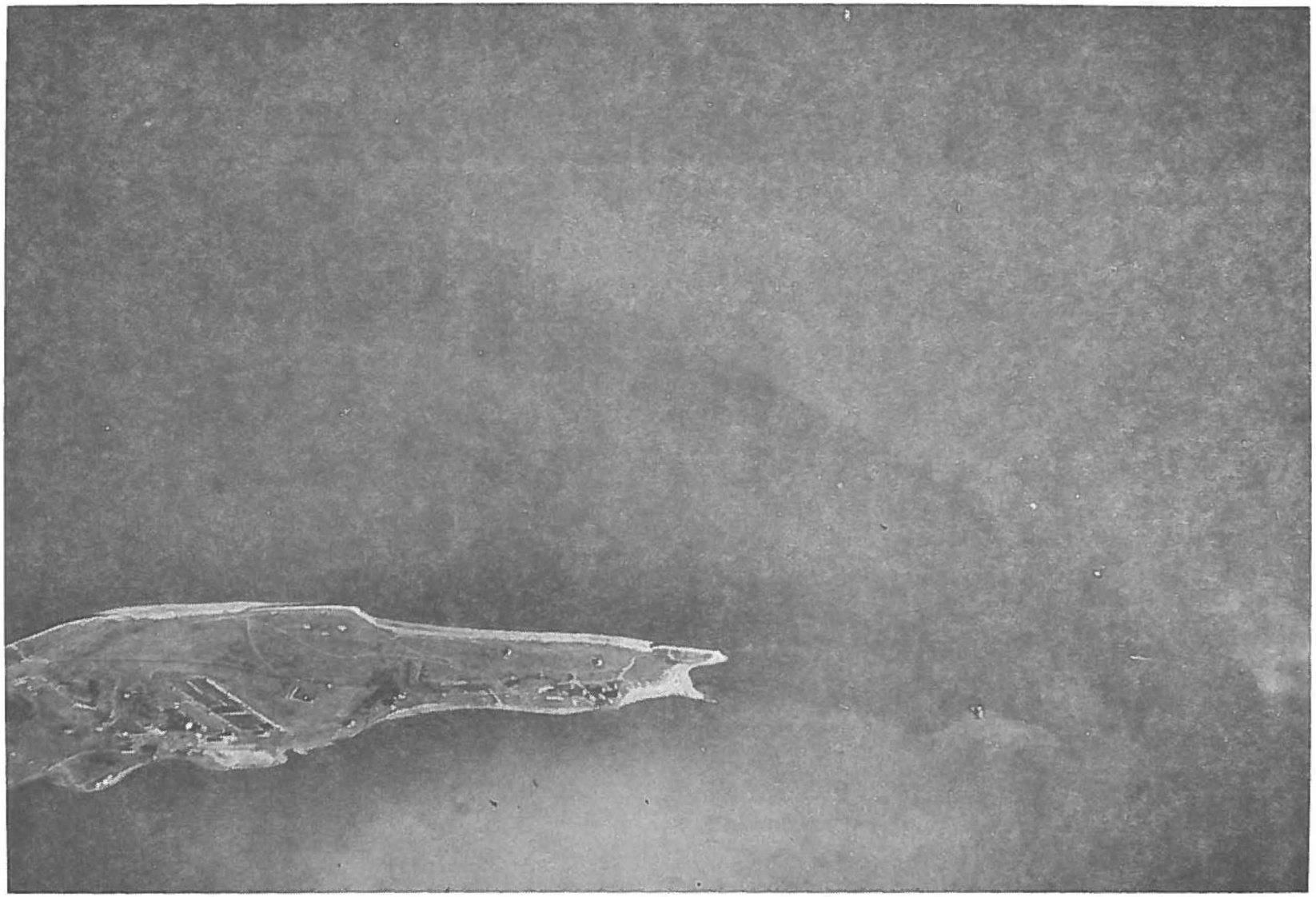
Rhodamine WT Dye Release on Ebb Current

Rhodamine WT Dye Release on Flood Current with Aluminum Powder Targets

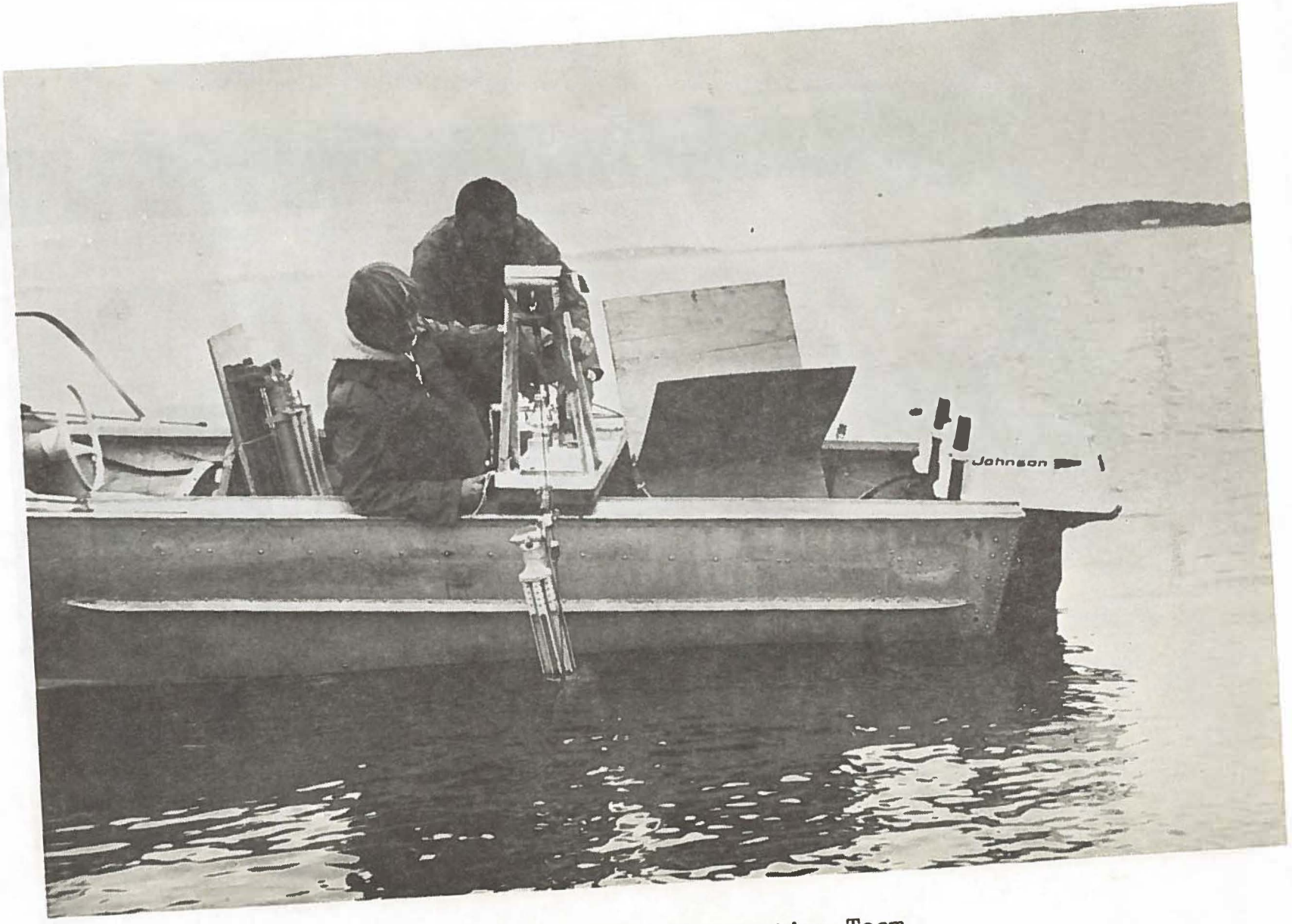




Peddocks Island Sewer
Outfall

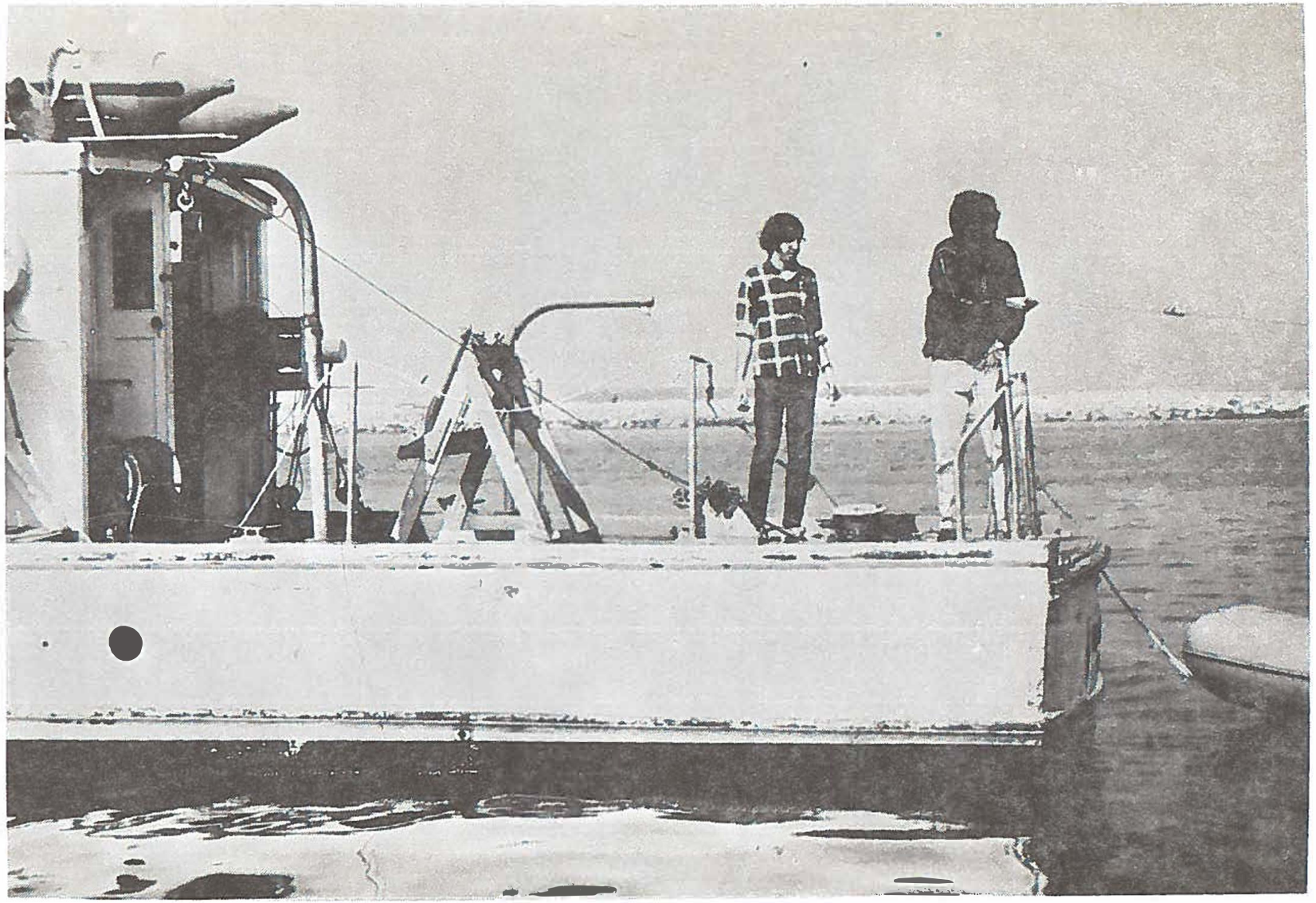


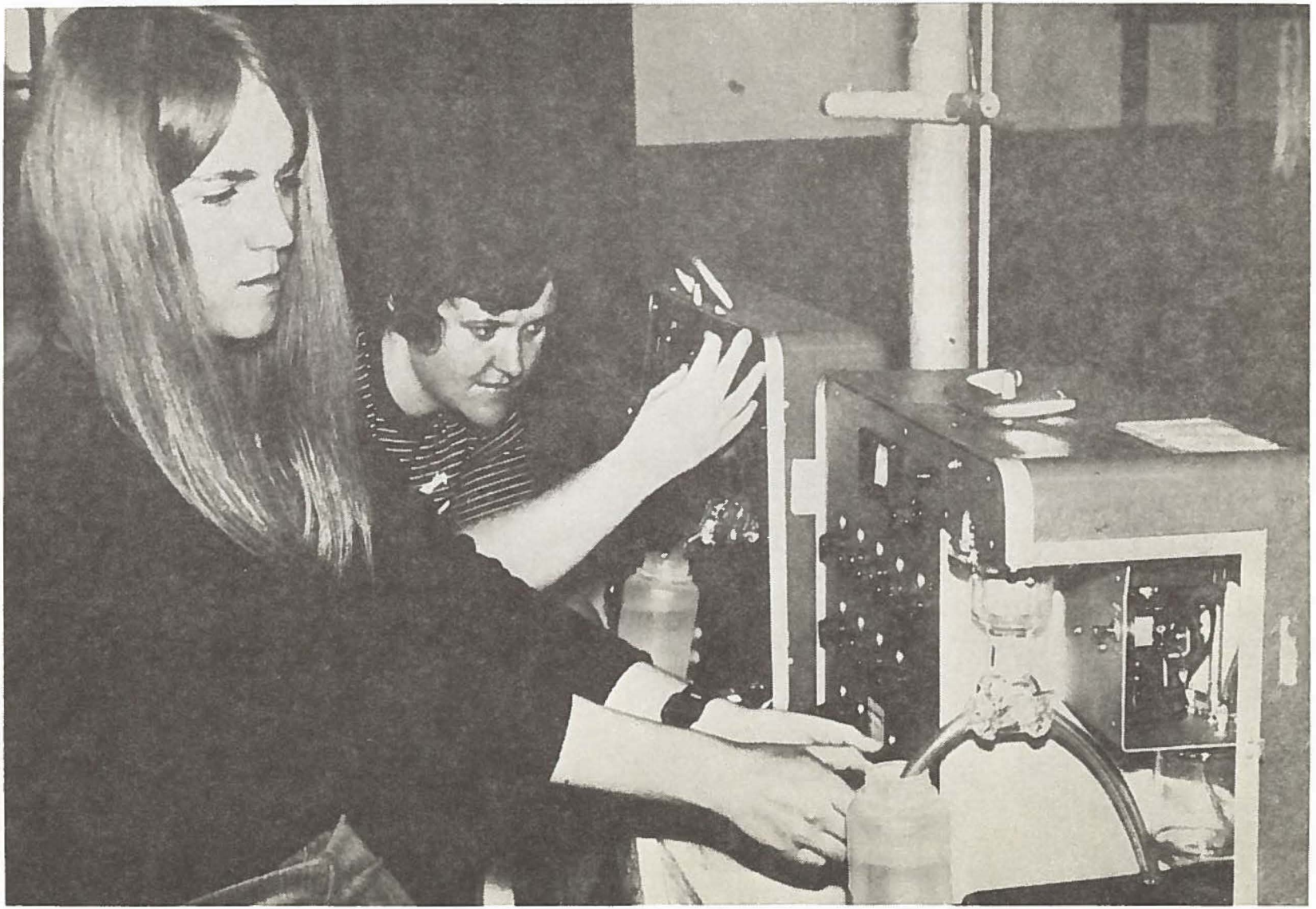
Deer Island Sewer Outfall Near Beginning of Flood



NOAA-NOS Ground Observation Team

MIT R/V R. R. SHROCK





Processing Water Samples for Salinity