NOS Oceanographic Circulation
Survey Report No. 5

New York Harbor Circulation Survey: 1980-81

February 1983
Rockville, Md.

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

NOS Oceanographic Survey Report

This serious of reports presents information on circulation surveys by the National Ocean Service. Normal activity includes measurements of water flow (currents), tides, temperature, salinity, and occasionally other parameters needed for understanding the physical processes. These surveys are made primarily for the Nation's navigational waterways; however, data are also obtained to describe the circulation patterns of estuaries and harbors.

These reports offer information on sampling locations, measurement techniques, processing and analysis routine, data formats, and general information on the survey area. They do not present technical interpretations of hydrodynamics of the areas.

Publications listed below are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, VA 22161 (703-487-4650). Price varies for paper copy, microfiched available. Order by accession number (in parentheses) when given.

No. 1 Tide and Tidal Current Observations From 1965 Through 1967 in Long Island Sound, Block Island Sound, and Tributaries. Elmo E. Long, January 1978, (PB 283-849).

No. 2 Tampa Bay Circulatory Survey 1963. Demetrio A. Dinardi, August 1978, (PB 299-163).

No. 3 Puget Sound Approaches Circulatory Survey From 1973 Through 1976. Bruce B. Parker and James T. Bruce, August 1980, (PB81 113375).

No. 4 Cook Inlet Circulatory Survey: 1973-75. Richard C. Patchen, James T. Bruce, August 1980, (PB81-245-235).

NOS Oceanographic Circulation
Survey Report No. 5

New York Harbor Circulation Survey: 1980-81

David R. Browne and Gary Dingle

February 1983
Rockville, Md.

U.S. DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary
National Oceanic and Atmospheric Administration
John V. Byrne, Administrator
National Ocean Service
Kelly E. Taggart, Acting Assistant Administrator

C O N T E N T S

NEW YORK HARBOR CIRCULATION SURVEY

David R. Browne and Gary Dingle

Circulation Section
Estuarine and Ocean Physics Branch
Ocean Requirements and Data Analysis Division
Office of Oceanography and Marine Services
National Ocean Service
National Oceanic and Atmospheric Administration
Rockville, Maryland

ABSTRACT

The National Ocean Service conducted a circulation survey in the New York Harbor complex from August 1980 to June 1981. The survey area included the Lower Bay, Raritan Bay, Arthur Kill, entrance to Newark Bay, Kill Van Kull, Upper Bay, Lower Hudson River, and the East River connecting the Upper Bay to Long Island sound. Extensive measurements were made of currents, tides, water temperature and salinity and atmospheric parameters: wind speed and direction, air pressure, and air temperature. This report provides relevant information about those measurements as well as the survey in general. The location and dates of current and tide data collected prior to this survey are also provided.

INTRODUCTION

The Circulation Survey

A circulation survey consists of the acquisition of various physical data from which a description of water movement can be deduced. Specifically, it includes the measurement of currents, tides, the temperature and salinity of the water, and various atmospheric parameters, such as wind speed and direction, barometric pressure, and air temperature. These measurements are made at selected locations and depths in order to obtain a reasonably complete three-dimensional description of these properties.

The currents measured are the horizontal water movements resulting from the periodic astronomic tide-producing forces, as well as from winds, density differences, and river runoff. The measured tides are simply the periodic vertical water movement resulting from the same astronomic forces, with some movement also caused by atmospheric pressure, winds, and river runoff. The salinity and temperature measurements are used to determine the density structure of the water masses, which can have significant effects on the currents as well as on mixing and dispersion processes. The atmospheric measurements are necessary to correlate the nontidal water movements with their causes such as strong onshore winds and/or varying atmospheric pressures.

There are many benefits derived from the knowledge of water movement in the New York Harbor. The current data obtained from the survey will primarily serve to make navigation safer for commercial and pleasure vessels. However, movement of the water could be predicted in case of oil spills or when knowledge of pollutant transport is desired.

Safe navigation also requires tidal predictions based on accurate tide data. From the tide data obtained in this survey, tidal datums can be calculated, which are useful in marine boundary delineations, determining land subsidence or emergence, and aiding in shoreline control for ecological purposes. Coastal zone management and coastal and marine engineering make use of both tide and current data. The data from this survey will also be available for oceanographic research and as input into various numerical hydrodynamic models.

Purpose of Report

The purpose of this report is to make scientific, engineering, commercial, and management concerns (public and private) aware of the existence and extent of these data collected in the New York Harbor complex. In reading this report, the potential user will be given the pertinent details of the data such as the location of stations, time periods of observations, the quality of data, the sampling rate, the instrumentation used, and the processing done on the data. A chapter summarizing the current and tide data collected by the National Ocean Service (NOS) prior to the 1980-1981 survey is also included in this report.

These data can be obtained from the National Oceanographic Data Center, Page Building 1, 2001 Wisconsin Avenue, N.W., Washington, D. C. 20235.

Survey Area and Purpose of Survey

The New York Harbor complex is one of the busiest ports in the world. Ship traffic in and out of the port has been so heavy that in July 1977, the United States and the Intergovernmental Maritime Consultative Organization established six sea lanes, three each way for port traffic control. Concern for safe navigation had prompted the Port Authority of New York to request that the NOS conduct a circulation survey in the New York Harbor area. This concern was given high priority in planning the survey. Consideration was also given to the Hudson-Raritan Estuary Project (HREP), whose purpose is to provide recommendations for the rehabilitation of that polluted estuary.

The survey area consists of the Lower Bay, Raritan Bay, Arthur Kill, entrance to Newark Bay, Kill Van Kull, Upper New York Bay, Hudson River to two miles north of Harlem River entrance, Harlem River, and the East River from the Upper Bay to the Entrance of Long Island Sound. See figure 1.

Details of the New York Harbor Circulation Survey

The survey consisted of two major observation periods: from August to November of 1980 and March to June of 1981. The survey was designated by the NOS codes OPR-B804-FE-80 and OPR-B804-FE-81. The 1980 survey covered the Lower Bay, Arthur Kill, Kill Van Kull, entrance to Newark Bay, and the Narrows. The 1981 survey covered the Raritan Bay, the Upper Bay, the Hudson River, to two miles north of the Harlem River entrance, the Harlem River, and the entire East River.

The effort for each survey year is as follows:

Survey Year	Dates	Number of Current Stations Deployed	Number of *Tide Stations Installed	Number of CTD Station Casts
1980	Aug.-Nov.	32	9	25
1981	Mar.-June.	42	19	43

The survey data were taken by the NOAA Ship FERREL under the command of Cdr. John Callahan, Jr. The FERREL is a 133 foot Class IV vessel with a maximum draft of 8 feet and a cruising speed of 10 knots. In June of 1968, it was equipped and commissioned to conduct circulatory survey operations on the East Coast estuaries of the United States. The FERREL's home port is Norfolk, Virginia; it has a complement of 5 commissioned officers and 14 crew members, and has a wet oceanographic laboratory of 40 square feet and electronics laboratory of 500 square feet.

The FERREL collected current data, conductivity, temperature, and depth (CTD) data, tide data, and meteorological data. The first three data sets are described in later chapters. The meteorological data were recorded by two

---

* This number includes primary tide stations that were installed prior to the survey.

Aanderaa meteorological stations designed with their own internal power supply for operation at remote locations. Information on the details regarding these data may be obtained by contacting NOS.

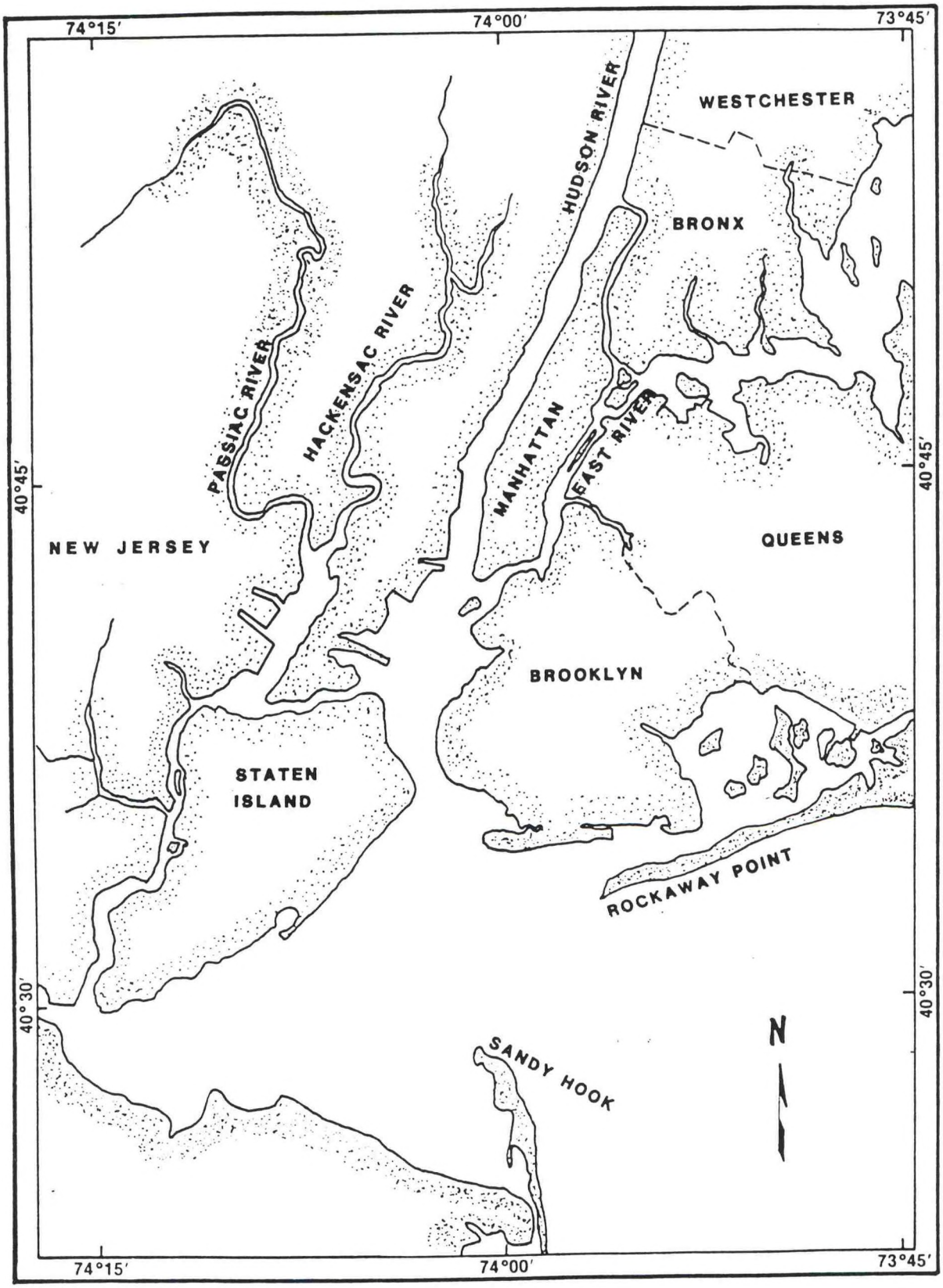

Figure 1.--General Area of Circulatory Survey.

CURRENT DATA

Current Stations

The locations of current stations occupied in the 1980 and 1981 surveys are shown in figures 7 through 14. Information on each station such as latitude, longitude, data quality, etc., is given in tables 1 and 2. All current stations were deployed for a minimum of 15 days; a few were deployed for 30 days or longer. Several stations were occupied during both survey years. Scheduling was based on the desire for simultaneous observations within the constraints of field logistics. The relative time periods of station occupancy for the 1980 and 1981 surveys are depicted graphically in figures 5 and 6.

Instrumentation

The current meter used was a Grundy Model 9021 G current meter which records on a 3-inch diameter, ¼-inch wide magnetic tape in 10-bit binary code: the meter serial number, current direction, current speed, temperature, sample count or time in hours and minutes, conductivity, and for some meters, depth. The instrument is rated at the 2000-meter depth. Refer to figures 2 and 3.

The speed sensor is a Roberts-type rotor oriented into the current by a relatively large tail fin. The speed is measured by the number of rotations of the rotor averaged over a 10-minute sampling period. Current direction is measured instantaneously at the end of the rotor count by comparing direction with that of magnetic north from a gimballed magnetic compass. The temperature transducer is a platinum resistance thermometer exposed to the water. The conductivity sensor is a transformer with the outside water acting as a coupling link. The depth sensor is a bulk silicon bridge transducer with temperature compensation. A continuously running crystal oscillator ensures that the programming of sensors, sampling interval, and tape motor speed are consistent throughout the deployment. The battery is a 12V DC sealed lead storage battery. The meter has an acoustic telemetry output which allows remote monitoring of performance. The uncertainty estimates for all measurements taken including CTD and meteorological, as well as current measurements, are given in the ESO technical report "Uncertainty Estimates for Oceanographic and Meteorological Measurements - Tide and Tidal Current Survey-New York Harbor - OPR-B804-FE-80 and 81, July 1980 to July 1981," published March 1982. Copies can be obtained from NOS by sending a request to NOAA/NOS, Director, Office of Oceanography and Marine Services, 6001 Executive Boulevard, Rockville, Maryland 20852.

The mooring, depicted in figure 4, is a taut-wire mooring system designed to hold one to three meters on the cable. The major components are the surface buoy with light, an umbilical line, the subsurface buoy, a pinger, and the main cable and anchor system. The meters are attached to asymmetrical A-frames, which are then attached to the mooring cable. The meters are situated on the cable such that the surface meter is 15 feet below the surface and the bottom meter is 5 feet above the bottom.

Data Processing

"Processing" in this context means transforming data recorded on magnetic tape inside the Grundy current meter to a computer compatible form in engineering units with all errors due to obvious mechanical or electronic failures edited and timing checked for accuracy.

Using a Grundy Model 8321 Tape Translator, the 3-inch current meter tapes were transcribed onto a nine-track computer compatible tape on board the ship, which were then sent to NOS, Rockville, along with the station logs and other materials necessary for processing. A two-phase processing scheme was then carried out on the data using software written for the UNIVAC 1100 computer. This procedure converted Grundy instrument units into engineering units, assigned correct times to the data points after a careful time-checking procedure was carried out in the time series, and performed a Wiener-type predictor statistical editing routine to eliminate outlying data values due to mechanical or electronic meter malfunctions. The data time series were then plotted on 35 mm microfilm.

These data were stored in compact form at NOS and were also sent to the National Oceanographic Data Center for further dissemination. Analysis results will appear in future editions of the Tidal Current Tables, Atlantic Coast of North America, from which current predictions will be obtainable for these current station locations. A proposed new series of Tidal Current Charts for New York Harbor will also graphically display current flow in the survey area for each hour of a mean tidal current cycle. Other analyses of these data are and will be carried out, such as spectral analyses, nonharmonic comparison analyses, and the correlation of the lower frequency currents with wind and other nontidal factors.

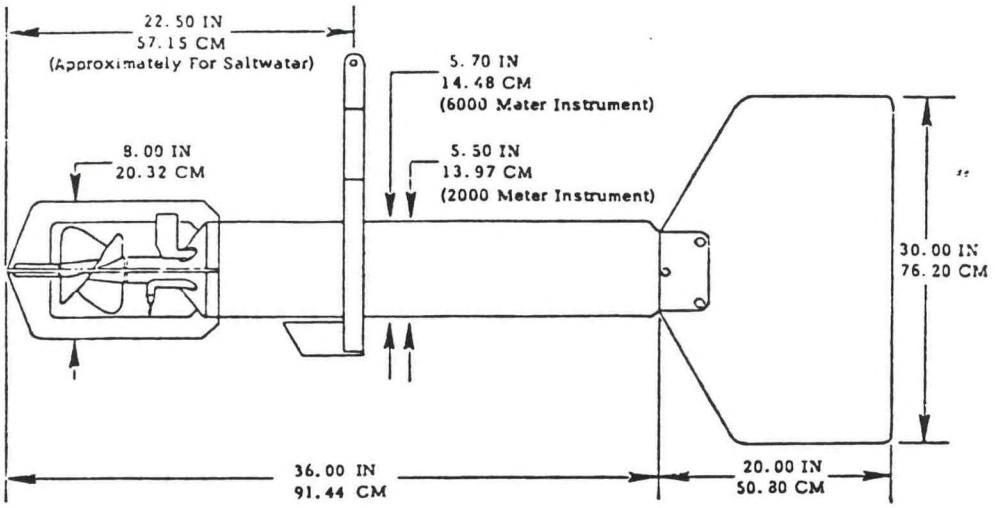

Figure 2.--Grundy 9021 G Current Meter Dimensions

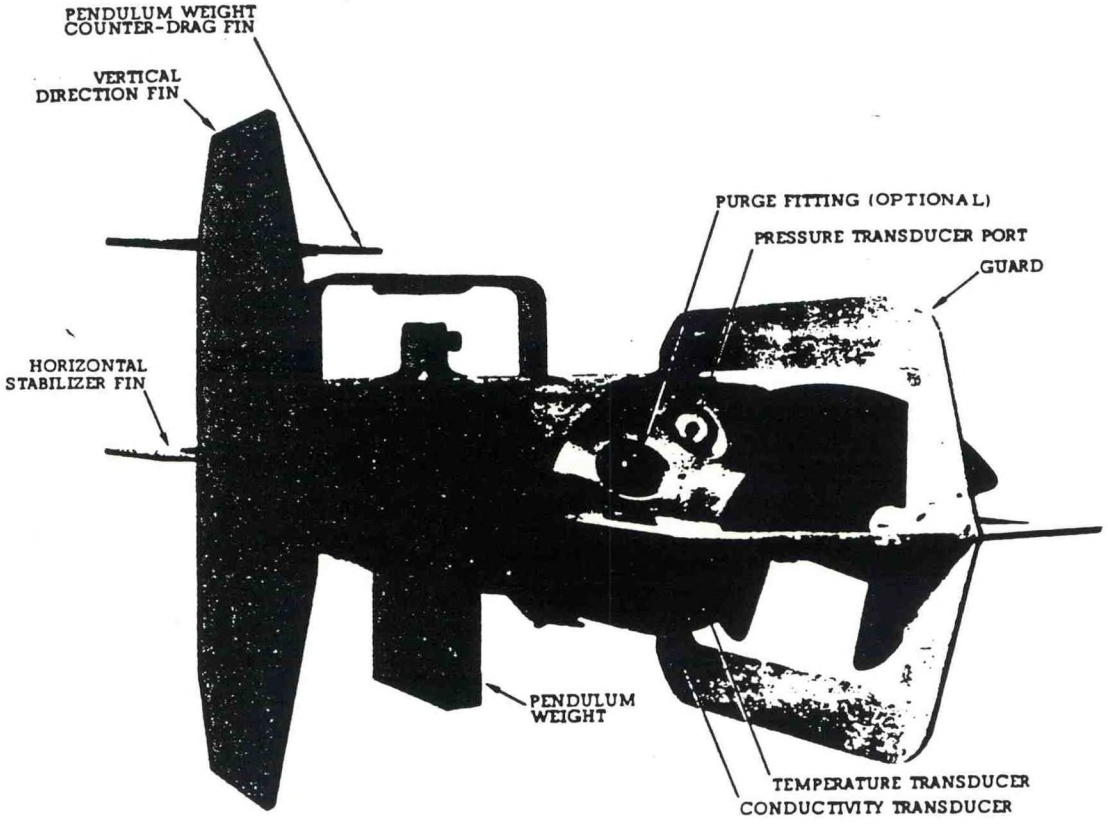

Figure 3.--Grundy 9021 G Current Meter

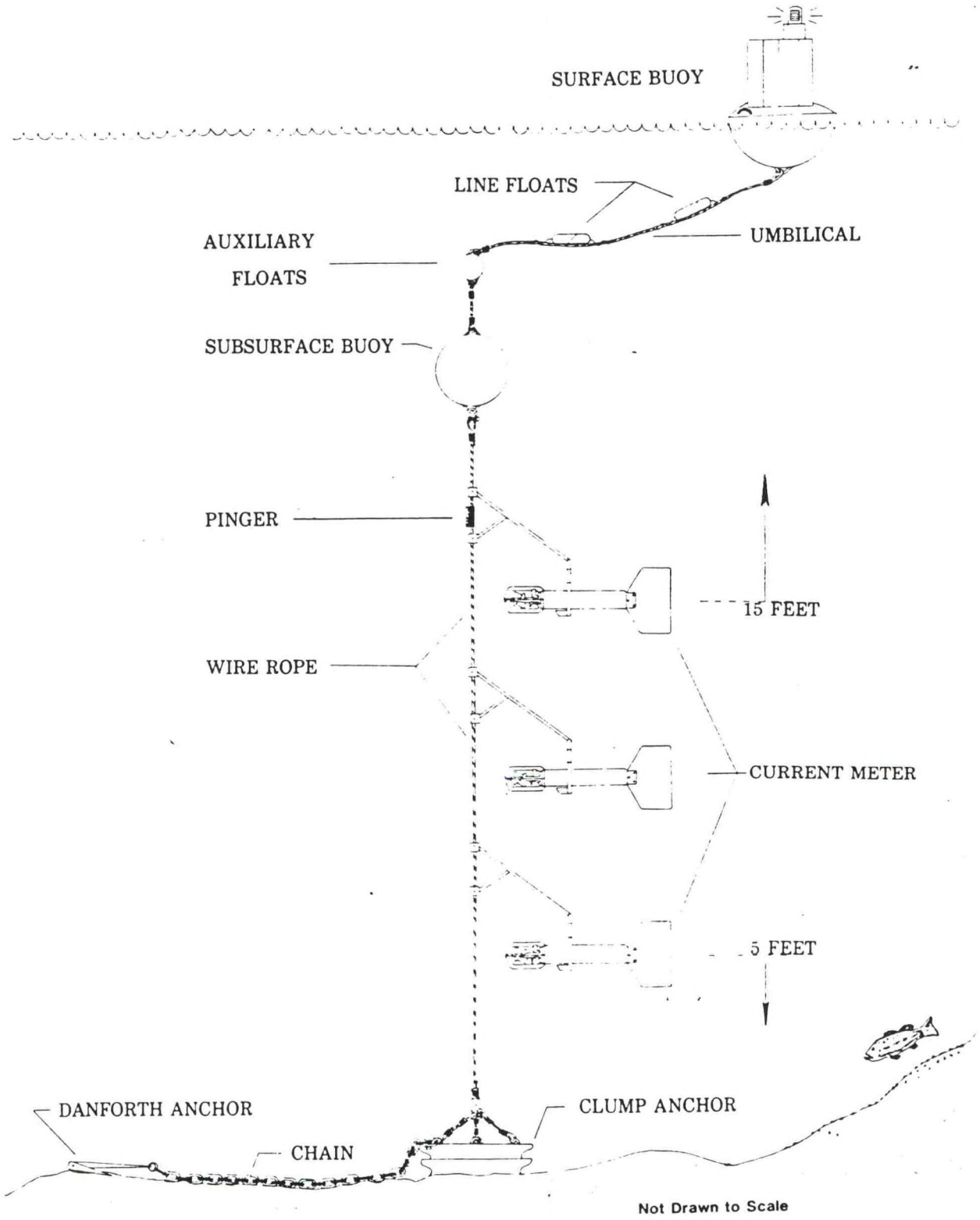

Figure 4.--Current Meter Taut-wire Mooring System

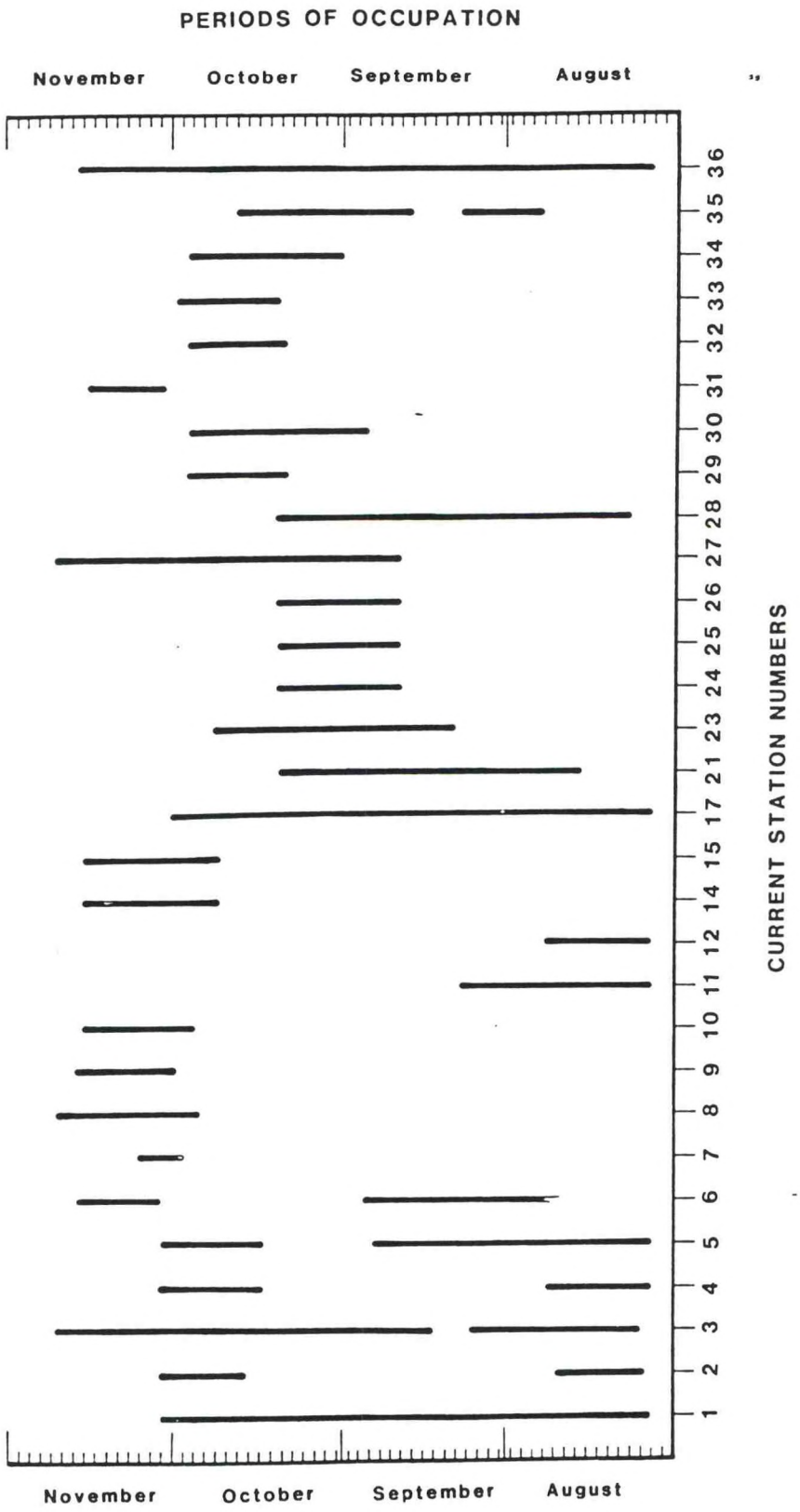

Figure 5.--Periods of Occupation for Current Stations During the 1980 Survey.

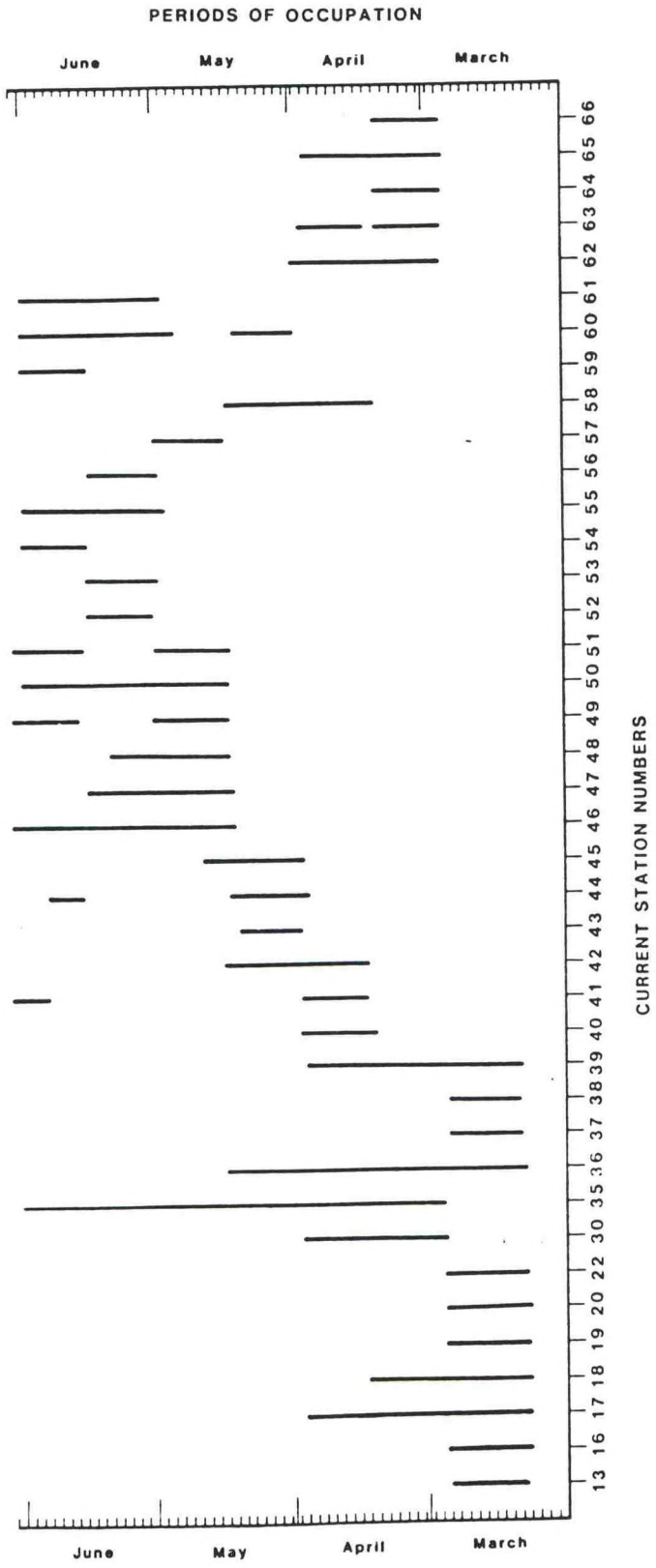

Figure 6.--Periods of Occupation for Current Stations During the 1981 Survey.

KEY TO TABLES

*1. Number indicates depth below surface at mean low water.

*2. Days of Data are days of useable data.

*3. S = Speed Sensor (rotor)
D = Direction Sensor (vane)
T = Temperature Sensor
C = Conductivity Sensor
D = Pressure Sensor

*4. Proc. Comp. = Processing Completed

*5. T.CH. = Data Time Checks

Table 1.--Current Stations Occupied During the 1980 Observational Period of the New York Harbor Circulatory Survey

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
1	40°32.3'	73°56.8'	26	-17	8/04- 8/15	11	✓ ✓ ✓ ✓	✓	✓
				-21	8/04- 8/13	0	BAD DATA		
				-17	8/21- 9/07	16	✓ ✓ ✓ ✓	✓	✓
				-21	8/16- 8/21	6	✓ ✓ ✓ ✓	✓	✓
				-15	9/07- 9/16	0	BAD DATA		
				-21	8/21- 9/06	16	✓ ✓ ✓ ✓	✓	✓
				-21	9/06- 9/15	9	✓ ✓ ✓	✓	✓
	40°32.3'	73°56.7'	28	-15	9/14-10/02	12	✓ ✓ ✓ ✓ ✓	✓	✓
				-23	9/15-10/02	15	✓ ✓ ✓ ✓ ✓	✓	✓
				-16	10/15-11/02	17	✓ ✓ ✓ ✓	✓	✓
				-22	10/15-11/02	14	✓ ✓ ✓ ✓	✓	✓
2	40°31.3'	73°57.2'	23	-14	8/05- 8/23	17	✓ ✓ ✓ ✓	✓	✓
				-18	8/05- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
	40°31.4'	73°56.8'	25	-16	10/15-11/09	23	✓ ✓ ✓	✓	✓
				-20	10/15-11/09	23	✓ ✓ ✓ ✓ ✓	✓	✓
3	40°30.9'	73°58.4'	44	-18	8/04- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
				-39	8/06- 8/23	0	BAD DATA		
	40°30.8'	73°58.3'	44	-17	8/21 9/06	13	✓ ✓ ✓ ✓ ✓	✓	✓
				-39	8/21 9/06	13	✓ ✓ ✓ ✓ ✓	✓	✓
	40°31.0'	73°58.8'	50	-16	9/11 9/28	16	✓ ✓ ✓ ✓	✓	✓
				-45	9/13- 9/29	16	✓ ✓ ✓ ✓	✓	✓
			49	-16	9/28-10/23	0	METER MALFUNCTION		
				-44	10/03 10/23	18	✓ ✓ ✓ ✓	✓	✓
	40°31.0'	73°58.6'	53	-26	9/04 10/09	34	✓ ✓ ✓ ✓ ✓	✓	✓
				-48	9/05-10/10	0	BAD DATA		
	40°31.0'	73°58.8'	48	-15	10/21-11/09	17	✓ ✓ ✓ ✓	✓	✓
				-43	10/23-11/09	0	BAD DATA		
			51	-18	11/27-11/21	12	✓ ✓ ✓ ✓	✓	✓
				-46	11/27-11/21	12	✓ ✓ ✓ ✓ ✓	✓	✓

Table 1.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
4	40°29.8'	73°59.5'	25	-16	8/04- 8/21	16	✓ ✓ ✓ ✓	✓	No
				-16	8/20- 8/23	3	✓ ✓ ✓ ✓	✓	✓
				-20	8/06- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
			24	-13	10/14-11/02	15	✓ ✓ ✓ ✓	✓	✓
				-19	10/14-11/02	15	✓ ✓ ✓	✓	✓
5	40°29.2'	74°00.1'	46	-15	8/04- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
				-41	8/06- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
			46	-15	8/23- 9/04	12	✓ ✓ ✓ ✓	✓	✓
				-41	8/23- 9/04	12	✓ ✓ ✓	✓	✓
	40°29.1'	74°00.1'	46	-16	9/04- 9/24	20	✓ ✓ ✓ ✓ ✓	✓	✓
				-41	9/04- 9/24	19	✓ ✓ ✓ ✓	✓	✓
			45	-16	10/14-11/02	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-40	10/15-11/02	16	✓ ✓ ✓ ✓ ✓	✓	✓
6	40°34.2'	73°53.8'	37	-15	8/20- 9/06	17	✓ ✓ ✓ ✓ ✓	✓	No
				-32	8/20- 9/06	17	✓ ✓ ✓ ✓	✓	✓
			37	-15	9/06- 9/26	14	✓ ✓ ✓ ✓	✓	✓
				-32	9/06- 9/24	18	✓ ✓ ✓ ✓ ✓	✓	✓
			38	-15	10/31-11/15	15	✓ ✓ ✓ ✓	✓	✓
				-33	10/31-11/15	15	✓ ✓ ✓ ✓	✓	✓
7	40°31.7'	74°00.6'	50	-16	10/27-11/21	23	✓ ✓ ✓ ✓ ✓	✓	✓
				-45	10/29-11/06	8	✓ ✓ ✓ ✓	✓	✓
				-45	11/04-11/21	15	✓ ✓ ✓ ✓ ✓	✓	✓
8	40°33.5'	74°01.5'	34	-16	10/04-11/21	26	✓ ✓ ✓ ✓	✓	✓
				-29	10/04-11/21	26	✓ ✓ ✓ ✓ ✓	✓	✓
9	40°33.5'	74°03.8'	28	-15	10/29-11/17	16	✓ ✓ ✓ ✓	✓	✓
10	40°31.3'	74°02.4'	27	-15	10/29-11/01	0	B A D D A T A		
				-15	11/01-11/16	15	✓ ✓ ✓ ✓	✓	✓

Table 1.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
11	40°28.6'	73°02.0'	30	-15	8/04- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
				-25	8/04- 8/23	17	✓ ✓ ✓ ✓	✓	✓
			30	-15	8/21- 9/08	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-25	8/21- 9/08	16	✓ ✓ ✓ ✓	✓	✓
12	40°27.4'	74°01.4'	20	-15	8/04- 8/23	17	✓ ✓ ✓ ✓ ✓	✓	✓
14	40°31.3'	74°06.0'	16	-13	10/27-11/16	18	✓ ✓ ✓	✓	✓
15	40°29.6'	74°07.1'	38	-16	10/27-11/16	18	✓ ✓ ✓ ✓	✓	✓
17	40°36.5	74°02.9'	85	-10	8/06- 8/20	4	✓ ✓ ✓ ✓	✓	✓
				-55	8/06- 8/20	3	✓ ✓ ✓ ✓	✓	No
				-80	8/06- 8/20	14	✓ ✓ ✓	✓	✓
				-10	8/20- 9/05	15	✓ ✓ ✓ ✓	✓	No
				-55	8/20- 8/23	0	METER MALFUNCTION		
				-55	8/23- 9/05	14	✓ ✓ ✓ ✓ ✓	✓	✓
				-80	8/20- 9/05	16	✓ ✓ ✓ ✓	✓	✓
			87	-16	9/05- 9/22	17	✓ ✓ ✓ ✓	✓	✓
				-58	9/05- 9/22	17	✓ ✓ ✓ ✓	✓	✓
				-77	9/05- 9/24	17	✓ ✓ ✓ ✓	✓	✓
				-18	9/22-10/09	17	✓ ✓ ✓ ✓	✓	✓
				-57	9/22-10/09	17	✓ ✓ ✓ ✓	✓	✓
				-77	9/24-10/01	7	✓ ✓ ✓	✓	✓
				-77	10/01-10/09	8	✓ ✓ ✓ ✓	✓	✓
			86	-16	10/09-10/28	18	✓ ✓ ✓ ✓	✓	✓
				-56	10/09-10/28	19	✓ ✓ ✓ ✓	✓	✓
				-76	10/09-10/15	5	✓ ✓ ✓ ✓	✓	✓
				-76	10/15-10/18	0	METER MALFUNCTION		
			85	-16	10/28-11/15	18	✓ ✓ ✓ ✓ ✓	✓	✓
				-56	10/28-11/15	18	✓ ✓ ✓ ✓	✓	✓
				-76	10/28-11/15	18	✓ ✓ ✓	✓	✓

Table 1.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
21	40°29.9'	74°17.0'	28	-15	8/20- 9/02	0	METER MALFUNCTION		
				-23	8/20- 9/02	9	✓ ✓ ✓ ✓	✓	✓
			28	-15	9/04- 9/22	19	✓ ✓ ✓ ✓ ✓	✓	✓
				-23	9/04- 9/23	18	✓ ✓ ✓ ✓ ✓	✓	✓
			29	-16	9/22-10/09	17	✓ ✓ ✓ ✓	✓	✓
				-24	9/23-10/09	17	✓ ✓ ✓ ✓	✓	✓
23	40°32.7'	74°15.1'	38	-15	9/24-10/23	28	✓ ✓ ✓	✓	✓
				-33	9/19-10/23	28	✓ ✓ ✓ ✓	✓	✓
24	40°33.5'	74°13.1'	37	-15	9/25-10/12	0	B A D D A T A		
				-32	9/21-10/12	0	B A D D A T A		
25	40°35.3'	74°12.5'	37	-15	9/25-10/12	17	✓ ✓ ✓ ✓	✓	✓
				-32	9/25-10/12	17	✓ ✓ ✓	✓	✓
26	40°38.1'	74°11.9'	37	-15	9/25-10/12	17	✓ ✓ ✓ ✓	✓	✓
				-32	9/25-10/12	17	✓ ✓ ✓ ✓	✓	✓
27	40°38.4'	74°09.0'	38	-15	9/23-10/10	17	✓ ✓ ✓ ✓	✓	✓
				-33	9/23-10/10	0	B A D D A T A		
			38	-18	10/10-10/25	14	✓ ✓ ✓ ✓	✓	✓
				-33	10/10-10/25	12	✓ ✓ ✓ ✓	✓	No
27	40°38.8'	74°09.2'	27	-16	11/01-11/19	19	✓ ✓ ✓ ✓	✓	✓
				-22	11/01-11/05	0	B A D D A T A		
				-22	11/05-11/19	15	✓ ✓ ✓ ✓	✓	✓
28	40°39.7'	74°08.4'	39	-15	8/22- 9/06	15	✓ ✓ ✓ ✓	✓	✓
				-34	8/22- 9/06	15	✓ ✓ ✓ ✓	✓	✓
	40°39.6'	74°08.4'	37	-15	9/06- 9/25	18	✓ ✓ ✓ ✓ ✓	✓	✓
				-32	9/06- 9/25	0	B A D D A T A		
	40°39.7'	74°08.4'	36	-15	9/25-10/11	15	✓ ✓ ✓ ✓	✓	✓
				-31	9/25-10/11	16	✓ ✓ ✓ ✓ ✓	✓	✓

Table 1.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
29	40°38.7'	74°07.8'	45	-16	10/19-10/28	16	✓ ✓ ✓ ✓	✓	✓
				-40	10/11-10/26	9	✓ ✓ ✓ ✓ ✓	✓	✓
30	40°39.0'	74°05.1'	40	-15	9/26-10/13	17	✓ ✓ ✓ ✓ ✓	✓	✓
				-35	9/25-10/13	17	✓ ✓ ✓ ✓ ✓	✓	✓
			39	-17	10/11-10/28	14	✓ ✓ ✓ ✓ ✓	✓	✓
				-34	10/13-10/28	14	✓ ✓ ✓ ✓	✓	✓
31	40°38.9'	74°04.0'	36	-13	11/02-11/17	15	✓ ✓ ✓ ✓ ✓	✓	✓
				-31	11/01-11/17	15	✓ ✓ ✓ ✓ ✓	✓	✓
32	40°37.9'	74°04.1'	40	-15	10/11-10/28	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-35	10/11-10/28	16	✓ ✓ ✓ ✓	✓	✓
33	40°37.9'	74°03.4'	47	-22	10/11-10/29	16	✓ ✓ ✓ ✓	✓	✓
				-42	10/11-10/30	16	✓ ✓ ✓ ✓	✓	✓
34	40°38.1'	74°02.9'	47	-15	10/12-10/28	0	METER MALFUNCTION		
				-42	10/12-10/28	15	✓ ✓ ✓ ✓	✓	✓
35	40°42.4'	73°59.1'	40	-15	8/22- 9/03	11	✓ ✓ ✓ ✓	✓	✓
				-15	9/03- 9/06	4	✓ ✓ ✓	✓	✓
				-35	8/22- 9/06	15	✓ ✓ ✓ ✓ ✓	✓	No
			43	-15	9/15-10/01	6	✓ ✓ ✓ ✓ ✓	✓	✓
				-34	9/15-10/01	1	✓ ✓ ✓ ✓ ✓	✓	✓
			43	-16	10/01-10/17	16	✓ ✓ ✓ ✓	✓	✓
36	40°48.1'	73°58.1'	56	-17	8/05- 8/22	0	METER MALFUNCTION		
				-51	8/05- 8/22	15	✓ ✓ ✓ ✓ ✓	✓	✓
			55	-16	8/22- 9/04	15	✓ ✓ ✓ ✓ ✓	✓	✓
				-50	8/22- 9/04	0	METER MALFUNCTION		
			55	-16	9/04- 9/25	21	✓ ✓ ✓ ✓	✓	✓
				-50	9/04- 9/25	21	✓ ✓ ✓ ✓	✓	✓
			59	-16	9/26-10/11	15	✓ ✓ ✓ ✓	✓	✓
				-50	9/28-10/15	15	✓ ✓ ✓ ✓	✓	✓

Table 1.--Concluded

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S	D	T	C	P	PROC.*4 COMP.	T.CH.*5
36	40°48.1'	73°58.1'	62	-20	10/11-10/28	12	✓		✓	✓		✓	✓
				-53	10/11-10/28	17	✓	✓	✓	✓		✓	✓
			59	-18	10/28-11/15	18	✓	✓	✓	✓	✓	✓	✓
				-50	10/28-11/15	18	✓	✓	✓	✓	✓	✓	✓

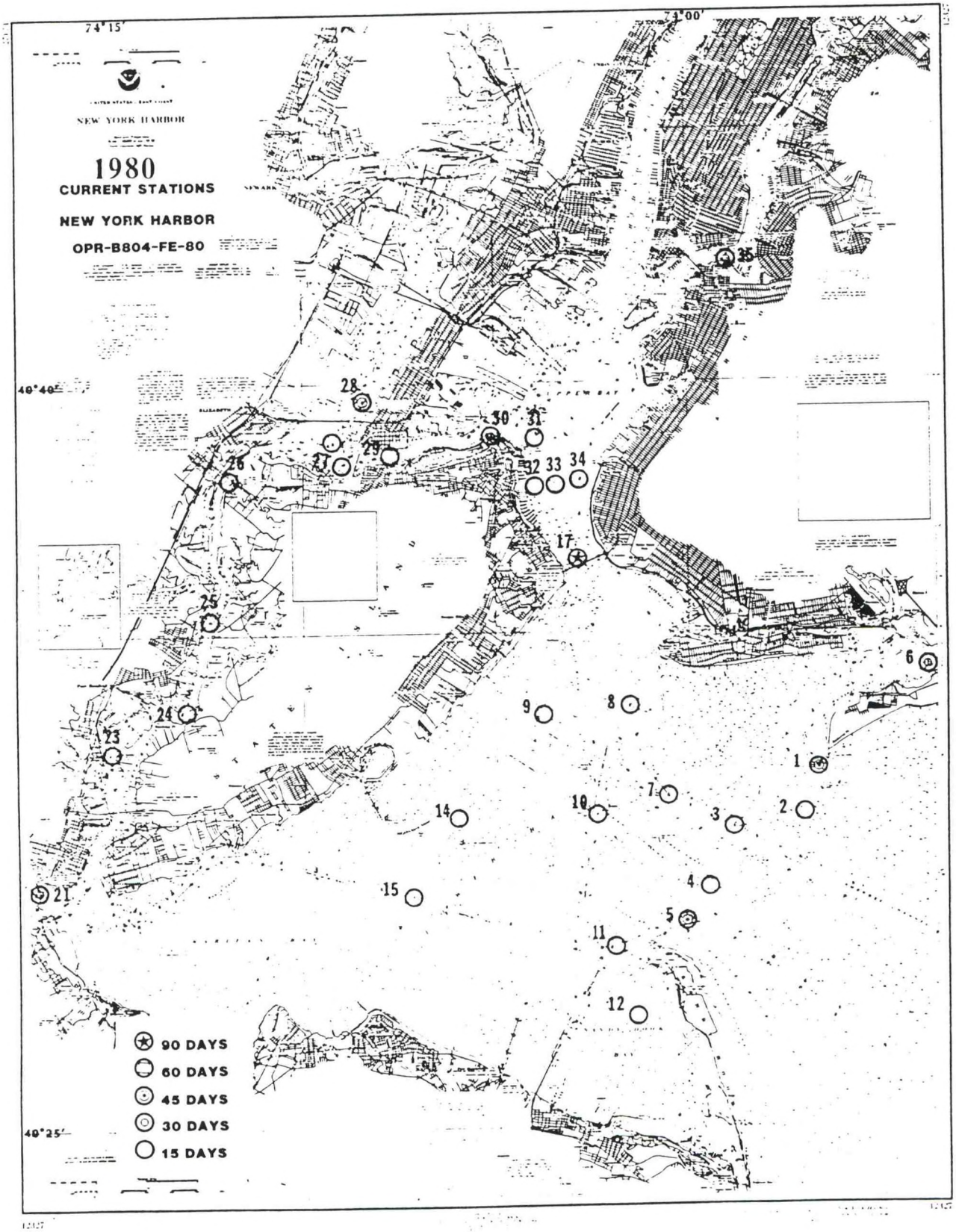

Figure 7.--Current Stations Occupied During the 1980 Survey.

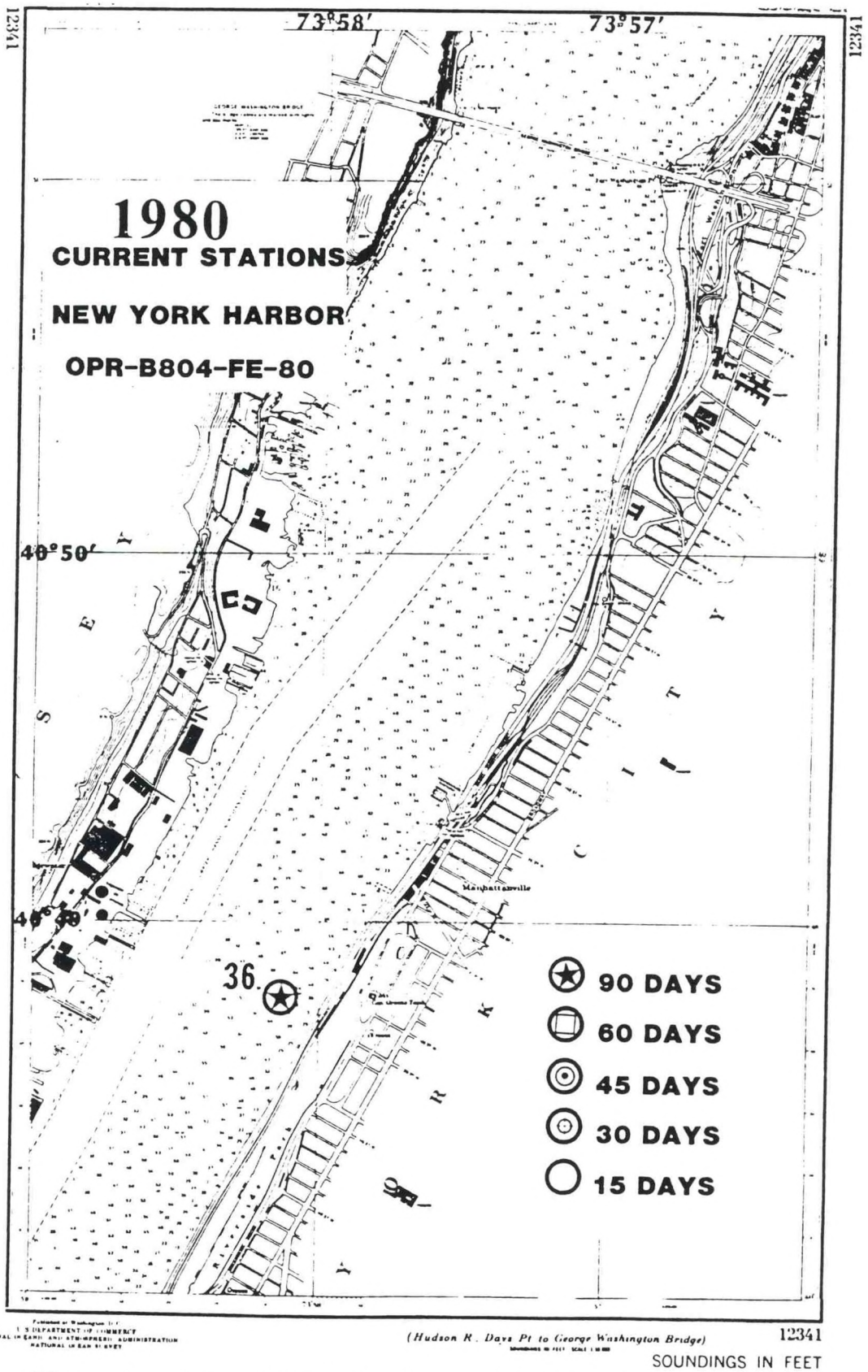

Figure 8.--Current Stations Occupied During the 1980 Survey.

Table 2.--Current Stations Occupied During the 1981 Observational Period of the New York Harbor Circulatory Survey

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
13	40°27.47'	74°04.63'	18	-15	3/09- 3/26	17	✓ ✓ ✓ ✓	✓	✓
16	40°30.38'	74°11.17'	40	-14	3/08- 3/27	19	✓ ✓ ✓ ✓	✓	✓
				-34	3/08- 3/27	19	✓ ✓ ✓ ✓	✓	✓
17	40°36.60'	74°02.92'	84	-15	3/08- 3/23	15	✓ ✓ ✓ ✓	✓	✓
				-55	3/08- 3/23	16	✓ ✓ ✓ ✓	✓	No
				-75	3/08- 3/25	16	✓ ✓ ✓ ✓	✓	✓
			82	-14	3/23- 3/31	6	✓ ✓ ✓ ✓	✓	✓
				-53	3/23- 4/08	15	✓ ✓ ✓ ✓ ✓	✓	✓
				-73	3/23- 4/08	16	✓ ✓ ✓ ✓	✓	✓
				-13	3/31- 4/08	8	✓ ✓ ✓ ✓ ✓	✓	✓
				-14	4/08- 4/28	19	✓ ✓ ✓ ✓	✓	✓
				-54	4/08- 4/27	0	BAD DATA		
				-74	4/08- 4/28	19	✓ ✓ ✓ ✓	✓	✓
18	40°28.37'	74°12.20'	12	- 9	3/08- 3/26	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-10	3/26- 4/13	15	✓ ✓ ✓ ✓ ✓	✓	✓
19	40°29.52'	74°13.80'	40	-14	3/08- 3/26	16	✓ ✓ ✓ ✓	✓	✓
				-37	3/09- 3/27	16	✓ ✓ ✓ ✓	✓	✓
20	40°29.37'	74°15.48'	29	-16	3/09- 3/27	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-27	3/08- 3/27	0	BAD DATA		
22	40°30.75'	74°15.32'	37	-15	3/09- 3/27	16	✓ ✓ ✓ ✓	✓	✓
				-32	3/09- 3/27	16	✓ ✓ ✓ ✓	✓	✓
30	40°38.98'	74°05.11'	42	-16	3/27- 4/08	12	✓ ✓ ✓ ✓	✓	✓
				-35	3/27- 4/08	12	✓ ✓ ✓ ✓	✓	✓
				-17	4/08- 4/28	20	✓ ✓ ✓ ✓	✓	✓
				-36	4/08- 4/28	20	✓ ✓ ✓ ✓	✓	✓

Table 2.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC. COMP.*4	T.CH.*5
35	40°42.51'	73°59.40'	44	-14	3/27- 4/08	0	METER MALFUNCTION		
				-39	3/27- 4/08	11	✓ ✓ ✓ ✓	✓	✓
				-15	4/08- 4/21	13	✓ ✓ ✓ ✓	✓	✓
				-40	4/08- 4/27	19	✓ ✓ ✓ ✓	✓	✓
				-15	4/21- 4/27	6	✓ ✓ ✓ ✓	✓	✓
				-14	4/27- 5/13	15	✓ ✓ ✓ ✓ ✓	✓	✓
				-39	4/27- 5/13	15	✓ ✓ ✓ ✓ ✓	✓	✓
				-15	5/13- 5/28	15	✓ ✓ ✓ ✓	✓	✓
				-40	5/13- 5/28	15	✓ ✓ ✓ ✓	✓	✓
				-15	5/28- 6/14	17	✓ ✓ ✓ ✓	✓	✓
				-40	5/28- 6/14	17	✓ ✓ ✓ ✓	✓	✓
				-15	6/14- 6/30	16	✓ ✓ ✓ ✓	✓	✓
				-40	6/14- 6/30	16	✓ ✓ ✓ ✓	✓	✓
36	40°48.78'	73°58.10'	62	-16	3/07- 3/23	13	✓ ✓ ✓ ✓	✓	✓
				-49	3/09- 3/23	13	✓ ✓ ✓ ✓	✓	✓
	40°48.79'	73°58.11'	58	-16	3/22- 4/11	18	✓ ✓ ✓ ✓	✓	✓
	40°48.78'	73°58.12'	58	-50	3/22- 4/11	18	✓ ✓ ✓ ✓	✓	✓
				-15	4/11- 4/27	16	✓ ✓ ✓ ✓	✓	✓
				-49	4/11- 4/27	16	✓ ✓ ✓ ✓	✓	✓
				-15	4/27- 5/15	18	✓ ✓ ✓ ✓	✓	✓
				-49	4/27- 5/15	18	✓ ✓ ✓ ✓	✓	✓
37	40°39.27'	74°01.93'	41	-15	3/10- 3/26	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-36	3/10- 3/26	16	✓ ✓ ✓ ✓ ✓	✓	✓
38	40°40.22'	74°03.13'	32	-15	3/10- 3/26	16	✓ ✓ ✓ ✓ ✓	✓	✓
				-27	3/10- 3/26	16	✓ ✓ ✓ ✓ ✓	✓	✓
39	40°40.38'	74°01.47'	43	-15	3/10- 3/23	12	✓ ✓ ✓ ✓ ✓	✓	✓
				-36	3/10- 3/23	12	✓ ✓ ✓ ✓ ✓	✓	✓
				-15	3/23- 4/11	19	✓ ✓ ✓ ✓	✓	✓
				-36	3/23- 4/11	19	✓ ✓ ✓ ✓	✓	✓
				-34	4/11- 4/27	16	✓ ✓ ✓ ✓	✓	✓

Table 2.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
40	40°41.23'	74°02.22'	60	-15	4/11- 4/28	0	BAD DATA		
				-55	4/11- 4/28	17	✓ ✓ ✓ ✓	✓	✓
41	40°41.26'	74°00.76'	40	-15	4/13- 4/16	3	✓ ✓ ✓ ✓	✓	✓
				-15	4/16- 4/28	12	✓ ✓ ✓ ✓	✓	✓
			39	-15	6/24- 7/02	8	✓ ✓ ✓ ✓	✓	✓
				-35	6/24- 7/02	8	✓ ✓ ✓ ✓	✓	✓
42	40°41.97'	74°00.53'	44	-16	4/13- 4/28	15	✓ ✓ ✓ ✓	✓	✓
				-39	4/13- 4/28	15	✓ ✓ ✓ ✓	✓	✓
				-15	4/29- 5/15	16	✓ ✓ ✓ ✓	✓	✓
				-38	4/29- 5/15	16	✓ ✓ ✓ ✓	✓	✓
43	40°44.46'	73°58.09'	52	-15	4/28- 5/14	16	✓ ✓ ✓ ✓	✓	✓
				-28	4/28- 5/14	16	✓ ✓ ✓ ✓	✓	✓
44	40°45.45'	73°56.99'	38	-16	4/26- 5/14	18	✓ ✓ ✓ ✓	✓	✓
				-31	4/27- 5/14	17	✓ ✓ ✓ ✓	✓	✓
				-15	6/16- 6/24	8	✓ ✓ ✓ ✓	✓	✓
				-30	6/16- 6/24	8	✓ ✓ ✓ ✓	✓	✓
45	40°45.48	73°57.52'	72	-15	4/27- 5/07	0	METER MALFUNCTION		
				-62	4/27- 5/13	16	✓ ✓ ✓ ✓	✓	✓
				-16	5/07- 5/13	0	METER MALFUNCTION		
				-16	5/13- 6/13	0	METER MALFUNCTION		
				-62	5/13- 5/29	7	✓ ✓ ✓ ✓	✓	✓
46	40°46.58'	73°56.30'	74	-15	5/13- 5/20	0	METER MALFUNCTION		
				-43	5/13- 5/20	7	✓ ✓ ✓ ✓	✓	✓
				-52	5/13- 5/20	7	✓ ✓ ✓	✓	✓
				-43	5/20- 6/08	10	✓ ✓ ✓ ✓	✓	✓
				-63	5/20- 6/08	10	✓ ✓ ✓ ✓	✓	✓
				-15	5/20- 6/16	18	✓ ✓ ✓ ✓	✓	✓
				-43	6/08- 6/16	8	✓ ✓ ✓ ✓	✓	✓

Table 2.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
46	40°46.56'	73°56.30'	74	-15	6/16- 7/02	0	METER MALFUNCTION		
				-44	6/16- 7/02	16	✓ ✓ ✓ ✓	✓	✓
				-64	6/16- 7/02	16	✓ ✓ ✓ ✓	✓	✓
47	40°47.35'	73°56.08'	20	-15	5/13- 5/28	15	✓ ✓ ✓ ✓	✓	✓
				-15	5/28- 6/15	18	✓ ✓ ✓ ✓	✓	✓
48	40°46.92'	73°55.31'	63	-16	5/14- 5/18	4	✓ ✓ ✓ ✓	✓	✓
				-26	5/14- 6/10	0	METER MALFUNCTION		
				-46	5/14- 5/28	0	METER MALFUNCTION		
				-18	5/18- 6/10	23	✓ ✓ ✓ ✓	✓	✓
49	40°48.28'	73°54.02'	77	-17	5/14- 5/15	1	✓ ✓ ✓	✓	✓
				-45	5/14- 5/20	6	✓ ✓ ✓ ✓	✓	✓
				-70	5/14- 5/31	17	✓ ✓ ✓ ✓	✓	No
				-17	5/15- 5/31	16	✓ ✓ ✓ ✓	✓	✓
				-45	5/20- 5/31	11	✓ ✓ ✓	✓	✓
				-14	6/17- 7/02	15	✓ ✓ ✓ ✓	✓	✓
				-43	6/17- 7/02	15	✓ ✓ ✓ ✓	✓	✓
				-68	6/17- 7/02	0	METER MALFUNCTION		
50	40°47.84'	73°54.07'	35	-15	5/14- 5/28	0	B A D D A T A		
				-15	5/29- 6/15	17	✓ ✓ ✓ ✓	✓	✓
				-15	6/15- 6/30	15	✓ ✓ ✓ ✓	✓	✓
51	40°47.48'	73°53.90'	47	-12	5/14- 5/30	16	✓ ✓ ✓	✓	✓
				-41	5/14- 5/30	16	✓ ✓ ✓	✓	✓
				-12	6/16- 7/02	16	✓ ✓ ✓ ✓	✓	✓
				-42	6/16- 7/02	16	✓ ✓ ✓ ✓	✓	✓
52	40°47.55'	73°53.41'	32	-15	5/31- 6/15	15	✓ ✓ ✓ ✓	✓	✓
				-26	5/31- 6/15	15	✓ ✓ ✓ ✓	✓	✓
53	40°48.01'	73°52.71'	59	-16	5/30- 6/09	0	METER MALFUNCTION		
				-49	5/30- 6/15	16	✓ ✓ ✓ ✓	✓	✓
				-15	6/09- 6/15	6	✓ ✓ ✓ ✓	✓	✓

Table 2.--Continued

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
54	40°47.32'	73°51.88'	35	-15	6/15- 6/30	15	✓ ✓ ✓ ✓	✓	No
				-30	6/15- 6/30	15	✓ ✓ ✓ ✓	✓	✓
55	40°47.90'	73°51.17'	71	-15	5/28- 6/14	17	✓ ✓ ✓ ✓	✓	✓
				-41	5/28- 6/14	17	✓ ✓ ✓ ✓	✓	✓
				-66	5/28- 6/09	12	✓ ✓ ✓ ✓	✓	✓
				-66	6/09- 6/14	5	✓ ✓ ✓ ✓	✓	✓
				-15	6/14- 6/30	16	✓ ✓ ✓ ✓	✓	✓
				-41	6/14- 6/30	0	METER MALFUNCTION		
				-66	6/14- 6/30	16	✓ ✓ ✓ ✓	✓	✓
56	40°48.01'	73°49.63'	64	-14	5/30- 6/15	16	✓ ✓ ✓ ✓	✓	✓
				-34	5/30- 6/15	16	✓ ✓ ✓ ✓	✓	✓
				-58	5/30- 6/15	16	✓ ✓ ✓ ✓	✓	✓
57	40°49.90'	73°56.08'	22	-15	5/15- 5/21	6	✓ ✓ ✓ ✓	✓	✓
				-15	5/21- 5/31	10	✓ ✓ ✓ ✓	✓	✓
58	40°52.61'	73°55.34'	30	-15	3/25- 4/11	0	METER MALFUNCTION		
				-15	4/11- 4/27	16	✓ ✓ ✓ ✓	✓	✓
				-16	4/27- 5/15	18	✓ ✓ ✓ ✓	✓	✓
59	40°47.76'	73°51.93'	33	-15	6/15- 6/30	15	✓ ✓ ✓ ✓	✓	✓
				-28	6/15- 6/30	15	✓ ✓ ✓ ✓	✓	✓
60	40°48.11'	73°47.65'	89	-15	4/29- 4/30	1	✓ ✓ ✓ ✓	✓	✓
				-56	4/29- 4/30	1	✓ ✓ ✓ ✓	✓	✓
				-15	4/30- 5/13	13	✓ ✓ ✓ ✓	✓	✓
				-47	4/30- 5/13	0	METER MALFUNCTION		
				-15	5/13- 5/26	0	METER MALFUNCTION		
				-47	5/13- 5/26	0	METER MALFUNCTION		
				-15	5/26- 6/15	20	✓ ✓ ✓ ✓	✓	✓
				-46	5/26- 6/15	20	✓ ✓ ✓ ✓	✓	✓
				-16	6/15- 6/30	0	METER MALFUNCTION		
				-48	6/15- 6/23	8	✓ ✓ ✓ ✓	✓	✓
				-48	6/23- 6/30	7	✓ ✓ ✓ ✓	✓	✓

Table 2.--Concluded

STA.	LATITUDE (N)	LONGITUDE (W)	DEPTH OF WATER (FT)	DEPTH*1 OF METER (FT)	DATES OF OBSERVATION	DAYS*2 OF DATA	SENSORS*3 IN OPERATION S D T C P	PROC.*4 COMP.	T.CH.*5
61	40°47.92'	73°47.62'	76	-14	5/29- 6/14	16	✓ ✓ ✓ ✓	✓	✓
				-45	5/29- 6/14	16	✓ ✓ ✓ ✓	✓	✓
				-71	5/29- 6/14	16	✓ ✓ ✓ ✓	✓	✓
				-15	6/14- 6/30	0	METER MALFUNCTION		
			77	-47	6/14- 6/30	16	✓ ✓ ✓ ✓	✓	✓
				-72	6/14- 6/30	16	✓ ✓ ✓ ✓	✓	✓
62	40°42.45'	74°01.23'	61	-14	3/27- 4/10	14	✓ ✓ ✓ ✓	✓	✓
				-57	3/27- 4/10	14	✓ ✓ ✓ ✓	✓	✓
				-17	4/10- 4/30	20	✓ ✓ ✓ ✓	✓	✓
				-56	4/10- 4/30	20	✓ ✓ ✓ ✓	✓	✓
63	40°46.53'	73°59.83'	46	-15	3/27- 4/11	15	✓ ✓ ✓ ✓	✓	✓
				-41	3/27- 4/11	9	✓ ✓ ✓ ✓	✓	✓
				-15	4/13- 4/28	15	✓ ✓ ✓ ✓	✓	✓
				-41	4/13- 4/28	15	✓ ✓ ✓ ✓	✓	✓
64	40°51.98'	73°56.95'	70	-15	3/25- 4/11	0	METER MALFUNCTION		
				-40	3/25- 4/11	17	✓ ✓ ✓ ✓	✓	✓
				-60	3/25- 4/11	17	✓ ✓ ✓ ✓	✓	✓
65	40°54.73'	73°54.83'	44	-15	3/25- 4/11	17	✓ ✓ ✓ ✓	✓	✓
				-40	3/25- 4/11	0	METER MALFUNCTION		
				-15	4/11- 4/27	16	✓ ✓ ✓ ✓	✓	✓
				-39	4/11- 4/27	0	METER MALFUNCTION		
66	40°54.88'	73°55.62'	20	-15	3/25- 4/11	17	✓ ✓ ✓	✓	✓
67	40°46.85'	73°56.24'	30	-14	5/13- 5/31	0	METER MALFUNCTION		
				-20	5/13- 5/31	0	METER MALFUNCTION		

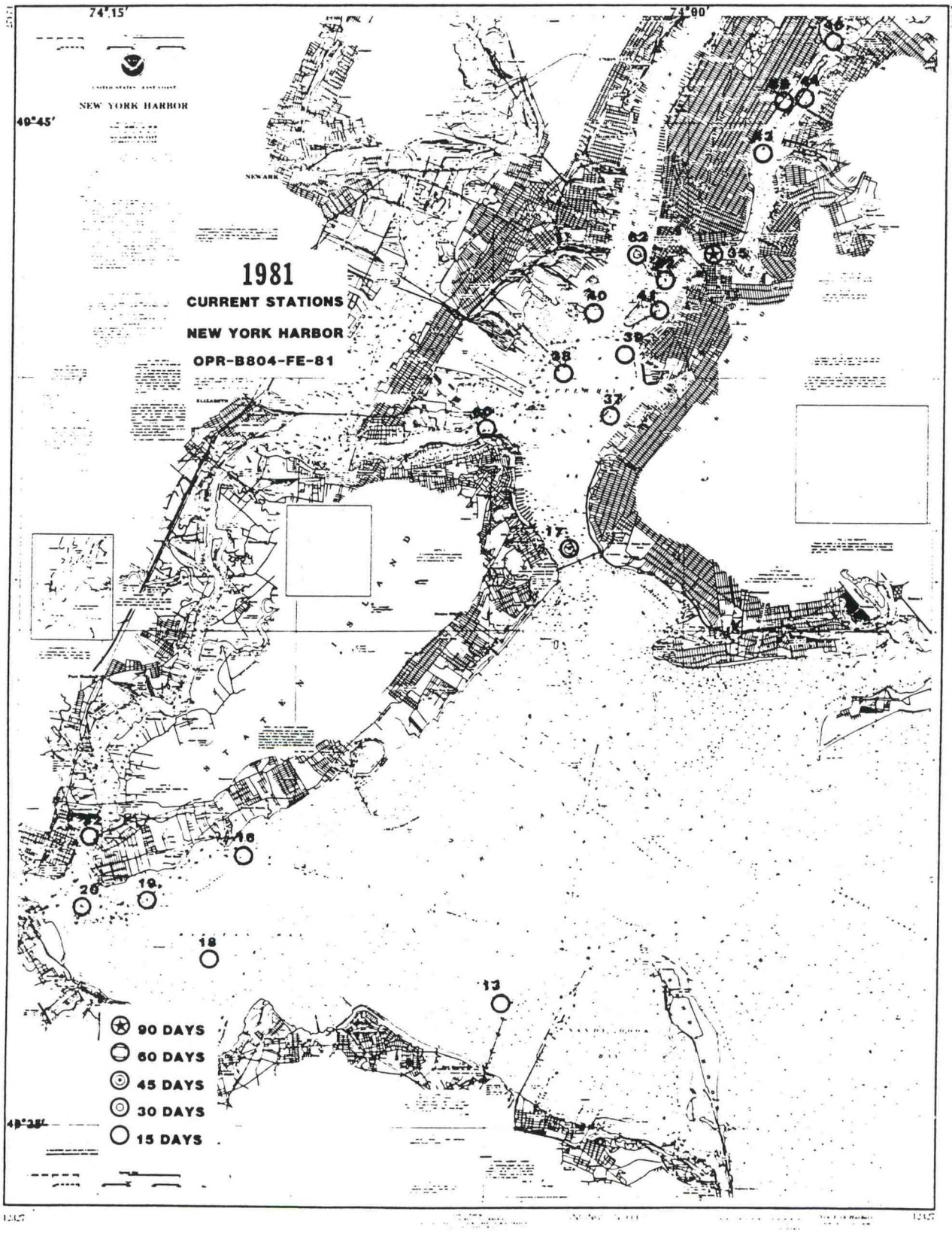

Figure 9.--Current Stations Occupied During the 1981 Survey.

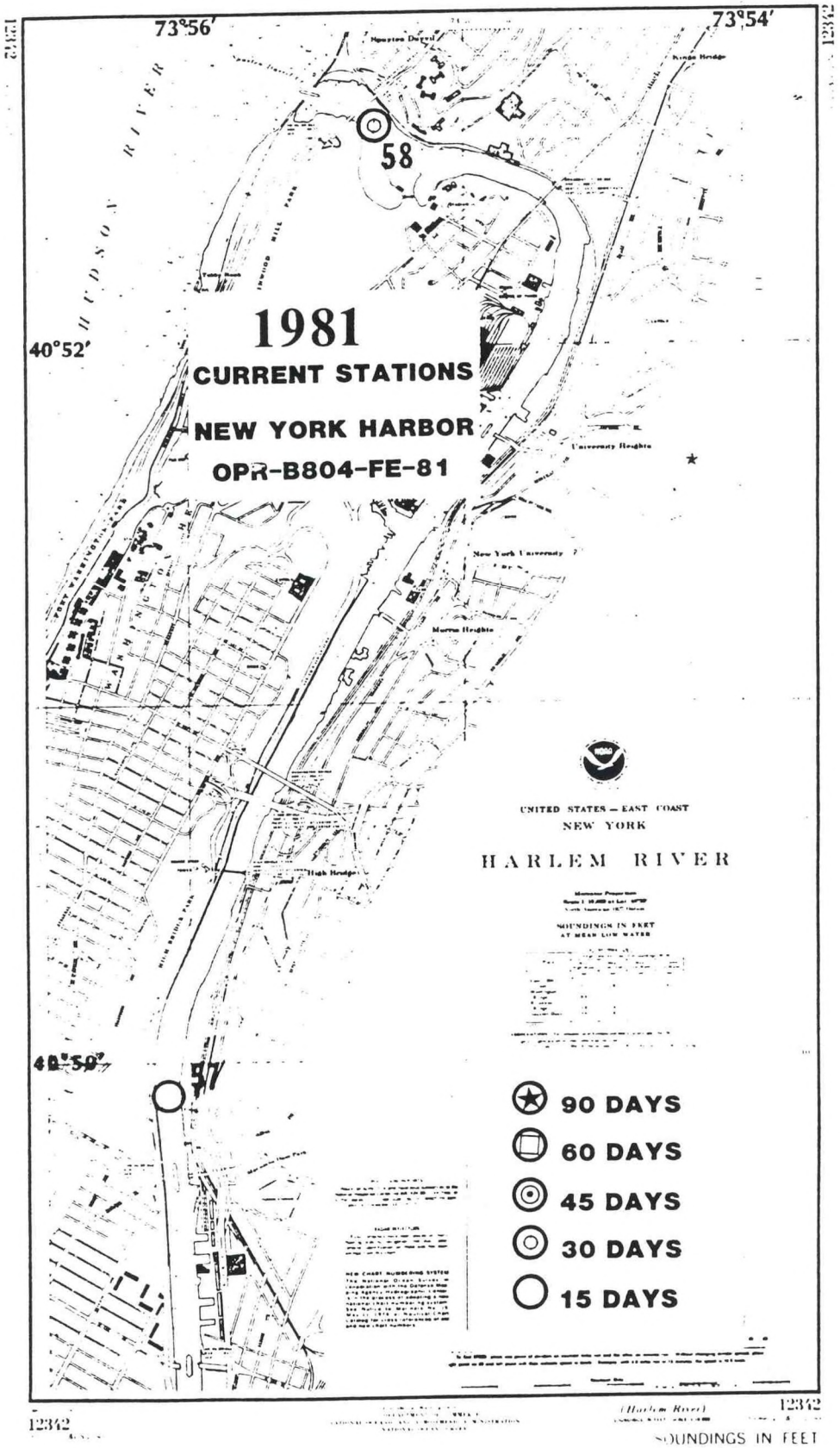

Figure 10.--Current Stations Occupied During the 1981 Survey.

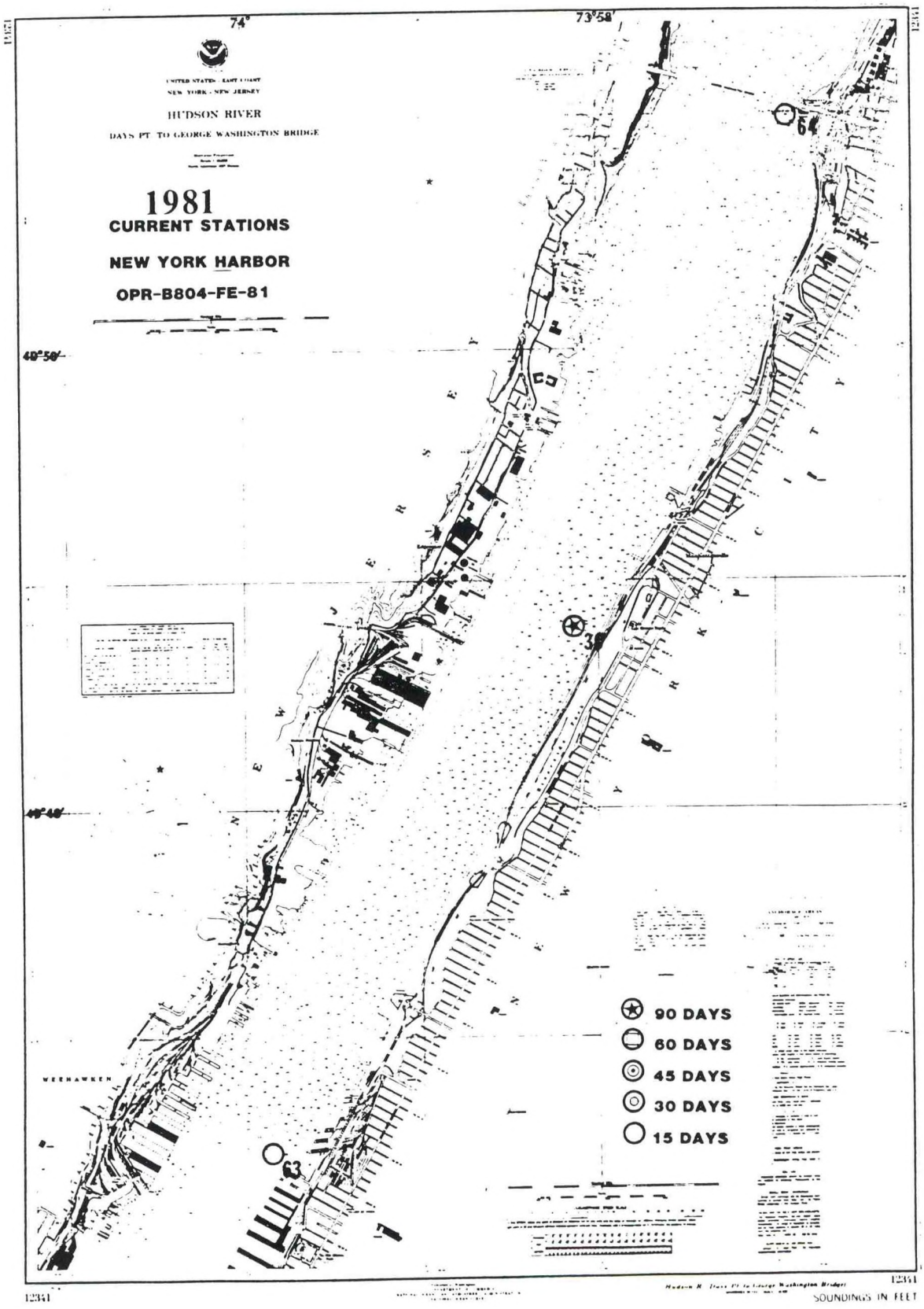

Figure 11.--Current Stations Occupied During the 1981 Survey.

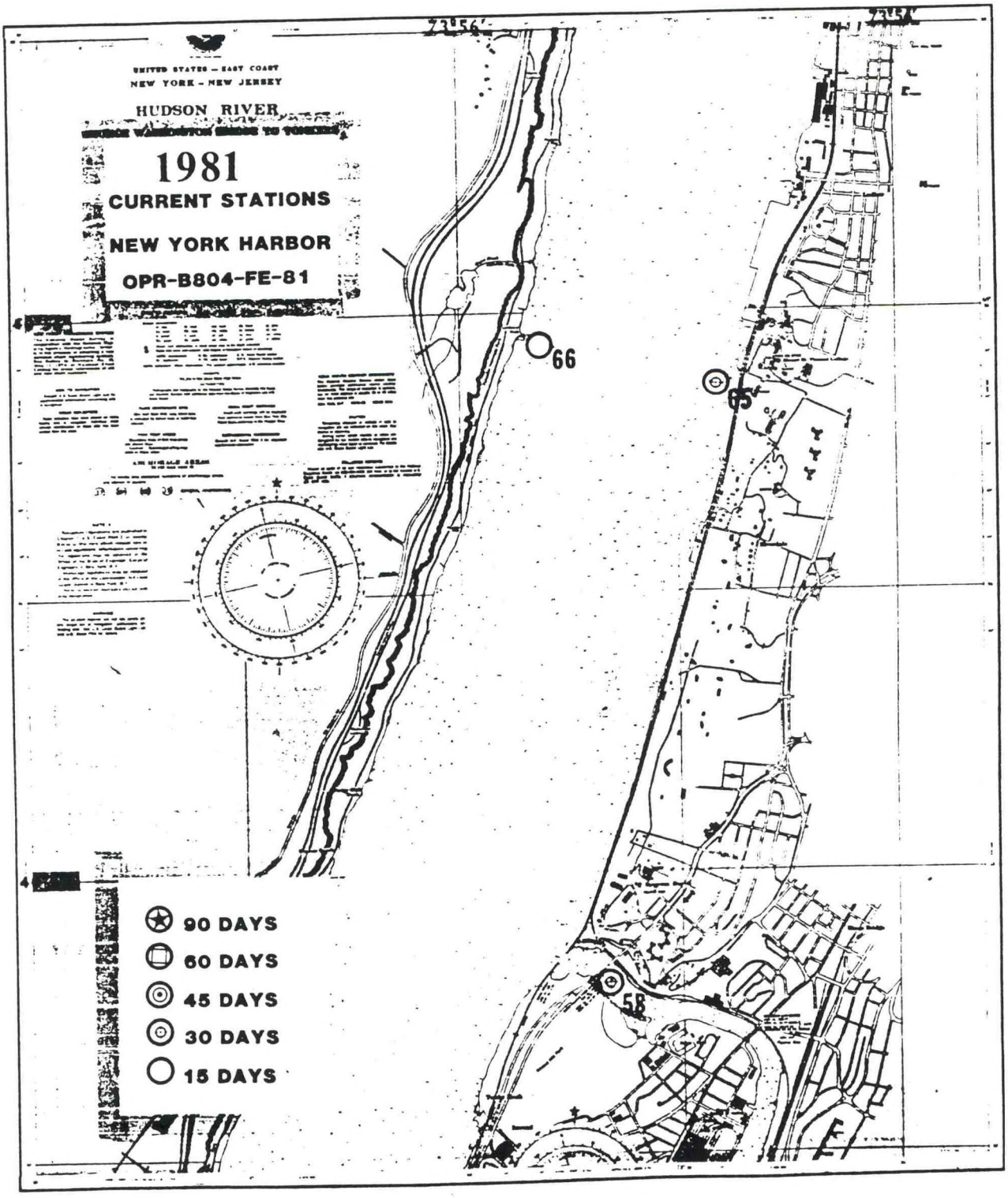

Figure 12.--Current Stations Occupied During the 1981 Survey.

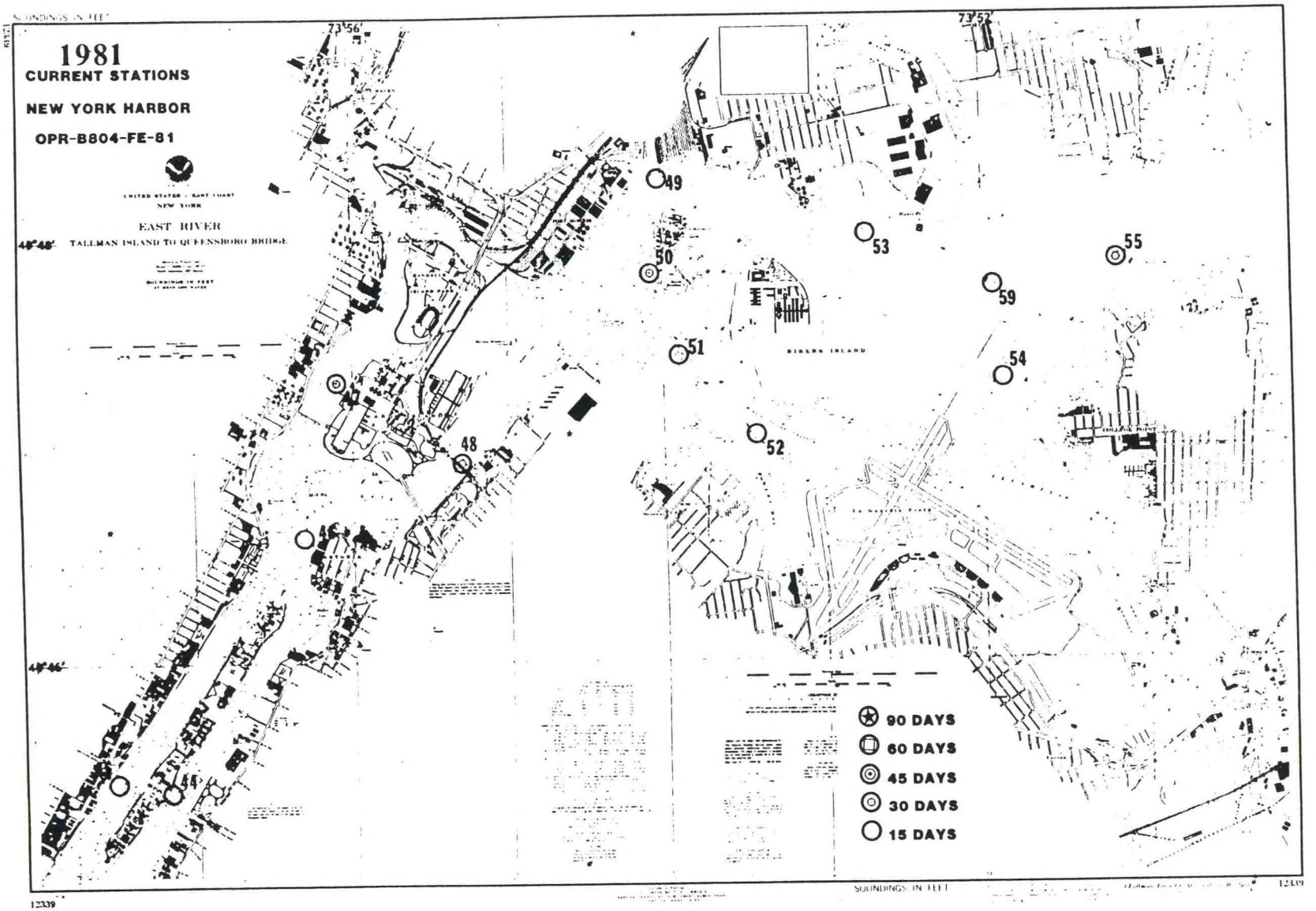

Figure 13.--Current Stations Occupied During the 1981 Survey.

Figure 14.--Current Stations Occupied During the 1981 Survey.

CONDUCTIVITY AND TEMPERATURE DATA

Instrumentation

The temperature and conductivity sensors of the Grundy 9021 G current meter provide a time series of measurements of these parameters at each station meter depth. The sampling rate is every 10 minutes, the same as that for speed and direction. The period of observation and quality of these measurements are given in tables 1 and 2.

The Grundy Model 9400 CTD profiling system was used to make incremented measurements of conductivity and temperature with depth giving values for the entire vertical water column. This unit is lowered and raised in the water column at a rate of 50 ft./min. The 9400 CTD unit uses a platinum resistance thermometer to sense temperature, an inductive transformer to sense conductivity, and bonded strain gage to sense pressure. The outputs from the sensors are transmitted via a single conductor cable to the Grundy Model 8400 data logger on board ship. The data logger processes the data which are then recorded on 9-track magnetic tape by a Kennedy Model 9800 tape recorder. The CTD data are forwarded to NOS in this form for further processing. This tape, when listed on paper output on the PDP 11 minicomputer, gives header information and data in the form of depth, conductivity, and temperature. Further processing of data gives salinity, which is calculated from temperature and conductivity, and Sigma-T, calculated from salinity and temperature.

CTD Stations

The Grundy 9400 CTD unit was used for long period observations at a few single station sites, CTD observations at stations forming a linear transect, and single casts at single station sites. Refer to figures 15 through 22 for the location of current meter sites that serve as sites for CTD measurements. Refer to tables 1 and 2 to obtain the meter depths and current meter CTD measurements. Refer to tables 3 through 8 to obtain the relevant information regarding the long period measurements labled "TS", the transect measurements labled "ST", and the single station casts labled "S".

The few long period stations consisted of CTD casts made at half-hour intervals over 13-hour or 25-hour periods. These measurements were taken in order to see the change in density structure over one or two tidal cycles.

Additional stations were part of a transect, i.e., a series of casts were taken in quick succession to determine the cross-sectional or longitudinal density structure.

Single station casts were taken once or twice at many station sites during slack before ebb or slack before flood.

Table 3.--CTD Time Series Measurements Conducted During the 1980 Observation Period of the New York Harbor Circulatory Survey

STATION	LAT.(N)	LONG.(W)	*DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
TS3	40°30.9'	73°58.4'	F 8/13	2230	11.5	8.80 (MIN.)
			L 8/14	1130		19.78 (MAX.)
TS17	40°36.5'	74°02.9'	F 9/10	1630	26.9	26.70 (MIN.)
			L 9/11	0600		28.86 (MAX.)
TS23	40°32.7'	74°15.2'	F10/21	0200	11.8	5.61 (MIN.)
			L10/21	1500		13.11 (MAX.)
TS35	40°42.4'	73°59.1'	F10/16	2030	13.1	12.37 (MIN.)
			L10/17	1130		15.73 (MAX.)
TS36	40°48.8'	73°58.1'	F 8/06	0030	16.5	18.61 (MIN.)
			L 8/06	0830		20.84 (MAX.)

* F refers to first cast of a time series.
L refers to last cast of a time series.

Table 4.--CTD Transect Measurements Conducted During the 1980 Observation Period of the New York Harbor Circulatory Survey

TRANSECT 1

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST5	40°29.2'	74°00.1'	8/13	1420	14.50	15.21
ST4	40°29.8'	73°59.4'		1435	7.90	8.31
ST3	40°30.9'	73°58.4'		1450	11.75	11.00
ST2	41°31.3'	73°57.2'		1505	7.40	8.83
ST1	40°32.3'	73°56.8'		1518	10.00	9.67
ST1	40°32.3'	73°56.8'		2015	10.00	8.35
ST2	40°31.3'	73°57.2'		2034	7.40	7.78
ST3	40°30.9'	73°58.4'		2049	11.00	14.64
ST4	40°29.8'	73°59.4'		2115	7.90	6.45
ST5	40°29.2'	74°00.1'		2125	14.50	14.51

Table 4.--Continued

TRANSECT 1 - SECOND RUN

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST5	40°29.1'	74°00.1'	10/15	1710	13.9	15.23
ST4	40°29.8'	73°59.3'		1735	7.6	8.31
ST3	40°30.8'	73°58.3'		1752	15.1	16.40
ST2	40°31.4'	73°56.8'		1818	7.6	8.34
ST1	40°32.3'	73°57.7'		1841	8.1	8.97
ST1	40°32.3'	73°57.7'		2315	8.1	7.97
ST2	40°31.4'	73°56.8'		2330	7.6	7.42
ST3	40°30.8'	73°58.3'		2344	15.1	17.66
ST4	40°29.8'	73°59.3'	10/16	0006	7.6	7.02
ST5	40°29.1'	74°00.1'		0016	13.9	13.98

Table 4.--Continued

TRANSECT 2

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST3	40°31.0'	73°58.8'	11/01	1332	14.6	18.36
ST7	40°31.7'	74°00.6'		1350	14.7	16.87
ST17	40°36.5'	74°02.9'		1430	26.0	26.75
ST99	40°40.1'	74°02.5'		1459	13.1	12.33
ST36	40°48.8'	73°58.1'		1608	18.7	18.92
ST3	40°31.0'	73°58.8'		1858	14.6	16.88
ST7	40°31.7'	74°00.6'		1919	14.7	15.02
ST17	40°36.5'	74°02.9'		1959	26.0	27.44
ST99	40°40.1'	74°02.5'		2027	13.1	13.43
ST36	40°48.8'	73°58.1'		2139	18.7	21.23

Table 4.--Continued

TRANSECT 3

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST5	40°29.1'	74°00.1'	9/11	0743	14.9	15.56
ST11	40°28.6'	74°02.2'		0813	11.9	10.24
ST15	40°29.8'	74°07.0'		0850	12.8	8.58
ST16	40°30.4'	74°11.5'		0926	11.9	5.36
ST20	40°29.5'	74°15.5'		1001	12.5	12.37
ST21	40°29.9'	74°17.1'		1033	11.9	12.31
ST5	40°29.1'	74°00.1'		1308	15.3	16.37
ST11	40°28.8'	74°02.2'		1330	14.0	14.34
ST15	40°29.8'	74°07.0'		1405	12.8	9.98
ST16	40°30.4'	74°11.5'		1435	12.2	13.28
ST20	40°29.5'	74°15.5'		1516	12.2	11.86
ST21	40°29.9'	74°17.1'		1550	10.4	10.21

Table 4.--Concluded

KILLS TRANSECT

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST31	40°38.9'	74°03.9'	10/17	1300	11.7	11.93
ST31	40°38.9'	74°03.9'		1310	11.7	11.69
ST30	40°39.0'	74°05.1'		1328	11.9	12.26
ST29	40°38.7'	74°07.8'		1345	13.4	13.52
ST27	40°38.4'	74°09.5'		1359	11.9	11.83
ST26	40°38.1'	74°11.9'		1421	11.3	11.30
ST25	40°35.3'	74°12.5'		1446	11.3	11.82
ST24	40°33.5'	74°13.1'		1505	11.2	11.96
ST23	40°32.7'	74°15.2'		1523	11.8	11.41
ST22	40°30.7'	74°15.5'		1544	13.3	11.66
ST20	40°29.4'	74°15.4'		1556	8.4	9.33

Table 5.--CTD Single Station Cast Measurements Conducted During the 1980 Observation Period of the New York Harbor Survey

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S1	40°32.3'	73°56.8'	8/21	1815	8.9	8.12
	40°31.8'	73°56.8'	9/06	1450	7.9	7.60
	40°32.3'	73°56.8'	9/06	1853	8.5	7.58
S2	40°31.3'	73°57.6'	8/04	2027	8.5	8.19
	40°31.3'	73°57.2'	8/21	1710	7.7	8.20
S3	40°30.9'	73°58.4'	8/04	2018	11.0	13.45
			8/21	1915	14.6	23.59
	40°30.8'	74°00.1'	9/04	1635	16.5	10.71
	40°31.0'	73°58.8'	11/07	1738	14.6	16.08
			11/19	1345		17.23
S4	40°29.8'	73°59.4'	8/04	2005	7.9	8.90
			8/21	1545	8.1	8.95
S5	40°29.2'	74°00.1'	8/04	1945	13.7	14.25
			8/21	1500	14.1	14.96
S6	40°34.2'	73°53.8'	8/20	2345	12.1	11.69
			9/06	1347	11.5	11.96
			11/15	1928		12.09
S7	40°31.6'	74°00.5'	10/27	1656	14.9	16.76
	40°31.7'	74°00.6'	11/04	1450	14.7	15.97
	40°31.6'	74°00.5'	11/19	1500	14.9	
S8	40°33.6'	74°01.6'	10/24	1755	10.1	10.46
	40°33.5'	74°01.5'	11/04	1530	10.5	10.83
			11/19	1540		
S9	40°33.4'	74°03.9'	10/27	1515	8.7	10.19
			10/27	1608		9.52
			11/14	1625		9.40
			11/14	1643		9.50
S10	40°31.2'	74°02.4'	10/27	1750	8.4	8.56
			11/14	1901		7.84

Table 5.--Continued

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S11	40°28.6'	74°02.0'	8/04	1930	9.1	14.79
			8/21	1410		10.83
			9/06	1655	9.8	10.98
S12	40°27.4'	74°01.4'	8/04	1915	7.6	7.39
			8/21	1332	6.1	6.44
S14	40°31.3'	74°06.0'	10/27	1845	4.8	5.15
			11/14	1728		6.19
S15	40°29.6'	74°06.3'	10/27	1923	11.5	9.92
			11/14	1815		12.18
S17	40°36.5'	74°02.9'	8/20	1545	26.0	27.71
			9/04	1754	25.9	12.63
			9/04	1756		27.24
			10/15	1240		27.36
			11/04	1602		27.03
			11/15	1610	25.5	27.53
S21	40°29.9'	74°16.9'	8/20	1940	9.1	12.26
	40°29.9'	74°17.0'	9/04	1340	9.2	10.61
S27	40°38.8'	74°09.2'	11/04	1713	8.0	8.72
			11/19	1710		
S28	40°42.8'	73°58.3'	8/22	1755	12.2	11.04
	40°39.6'	74°08.4'	9/06	2120	11.7	11.96
S29	40°38.7'	74°07.8'	10/26	1500	13.5	14.82
S30	40°39.0'	74°05.1'	10/26	1545	11.9	12.99
S31	40°48.9'	74°04.0'	11/15	1536	11.0	11.99
S34	40°38.1'	74°02.9'	10/26	1615	14.4	13.52
			10/26	1658		14.72
S35	40°42.4'	73°59.0'	8/22	1940	11.6	12.05
	40°42.3'	73°59.1'	9/06	2315	14.8	14.33

Table 5.--Concluded

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S35	40°42.4'	73°59.1'	9/15	1930	15.0	14.27
			9/15	2000	14.8	14.34
S36	40°48.7'	73°58.1'	8/20	1400	18.0	20.23
	40°48.8'	73°58.1'	9/04	1825	19.2	18.33
			11/15	1416	17.7	17.09

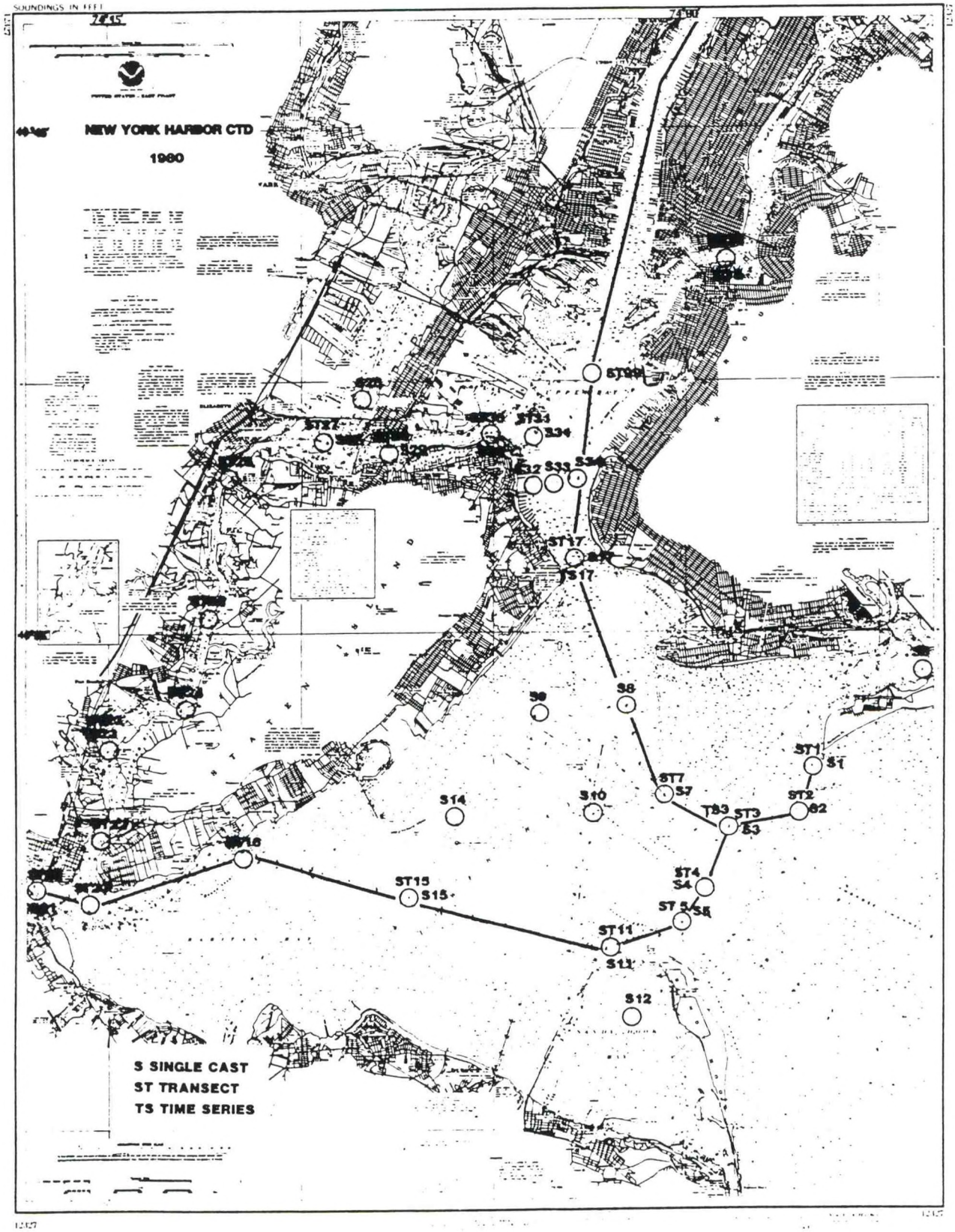

Figure 15.--CTD Cast Locations for Casts Taken During 1980 Survey.

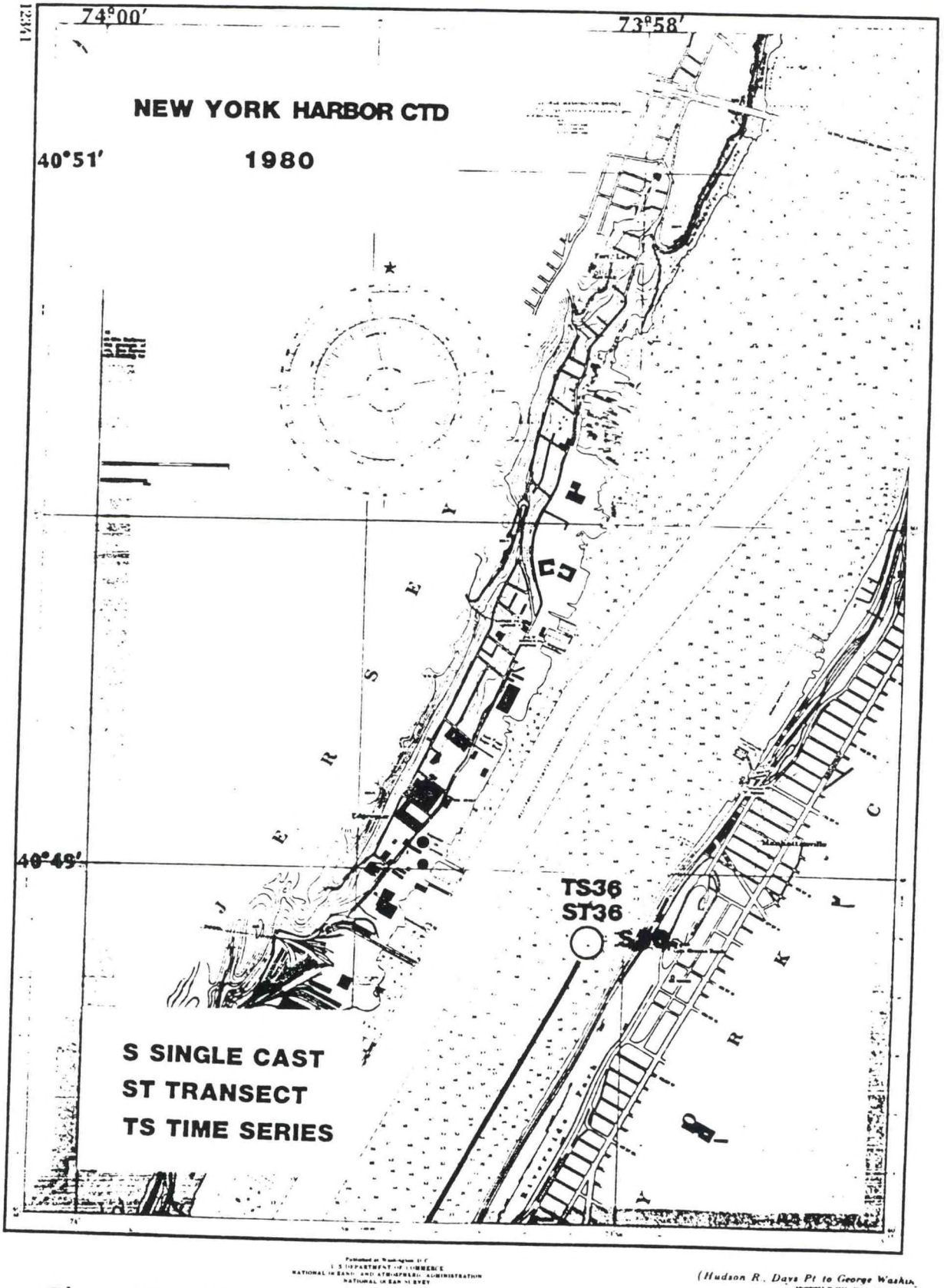

Figure 16.--CTD Cast Locations for Casts Taken During the 1980 Survey.

Table 6.--CTD Time Series Measurements Conducted During the 1981 Observation Period of the New York Harbor Circulatory Survey

STATION	LAT.(N)	LONG.(W)	* DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
TS35	40°42.5'	73°59.4'	F 4/08	1530	13.7	11.96 (MIN.)
			L 4/09	0440		15.23 (MAX.)
TS36	40°48.8'	73°58.1'	F 3/19	1610	18.0	17.27 (MIN.)
			L 3/20	0440		20.13 (MAX.)
TS46	40°46.5'	73°56.3'	F 6/08	1250	22.5	16.24 (MIN.)
			L 6/09	0210		28.42 (MAX.)
TS60	40°48.2'	73°47.4'	F 4/29	2000	26.2	17.13 (MIN.)
			L 4/30	0900		31.61 (MAX.)
TS60	40°48.1'	73°47.6'	F 5/26	1430	15.9	14.24 (MIN.)
			L 5/27	0330		17.35 (MAX.)
TS98	40°47.4'	73°55.1'	F 5/27	0430	18.3	11.59 (MIN.)
			L 5/27	1730		21.84 (MAX.)

* F refers to first cast of a time series.
L refers to last cast of a time series

Table 7.--CTD Transect Measurements Conducted During the 1981 Observation Period of the New York Harbor Circulatory Survey

TRANSECT 1

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST46	40°46.6'	73°56.3'	4/30	1040	15.2	13.31
ST45	40°45.5'	73°57.5'		1055	21.8	23.11
ST43	40°44.3'	73°58.2'		1111	15.7	13.62
ST35	40°42.5'	73°59.4'		1134	13.7	18.86
ST42	40°41.9'	74°00.5'		1145	13.2	13.90
ST62	40°42.4'	74°01.3'		1204	19.2	14.41
ST46	40°46.6'	73°56.3'	5/04	2030	15.2	20.57
ST45	40°45.5'	73°57.5'		2046	21.8	19.81
ST43	40°44.3'	73°58.2'		2103	15.7	11.75
ST35	40°42.5'	73°59.4'		2126	13.7	17.02
ST42	40°41.9'	74°00.5'		2146	13.2	13.48
ST45	40°45.5'	73°57.5'		2218	21.8	23.92

Table 7.--Continued

TRANSECT 2

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST45	40°42.5'	73°59.4'	5/20	1515	13.7	24.58
ST46	40°46.6'	73°56.3'		1530	15.2	22.52
ST98	40°47.2'	73°55.3'		1552	15.2	16.36
ST50	40°47.8'	73°54.0'		1603	10.9	13.27
ST53	40°47.9'	73°52.7'		1620	21.0	22.60
ST53	40°47.9'	73°52.7'		2117	18.0	20.52
ST50	40°47.8'	73°54.0'		2131	10.9	11.00
ST98	40°47.2'	73°55.3'		2144	18.9	18.23
ST46	40°46.6'	73°56.3'		2159	15.2	13.36
ST45	40°42.5'	73°59.4'		2217	13.7	29.82

Table 7.--Continued

TRANSECT 3

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST60	40°48.1'	73°47.7'	5/31	1808	16.0	19.60
ST56	40°48.1'	73°49.6'		1826	19.9	23.26
ST55	40°47.9'	73°51.2'		1842	21.6	22.98
ST53	40°48.2'	73°52.9'		1858	16.4	19.66
ST50	40°47.8'	73°54.0'		1915	10.9	8.25
ST49	40°48.3'	73°54.0'		1929	22.6	20.81
ST60	40°48.1'	73°47.7'	6/01	1302	16.0	21.80
ST56	40°48.1'	73°49.6'		1318	19.9	24.28
ST55	40°47.9'	73°51.2'		1332	21.6	25.17
ST53	40°48.2'	73°52.9'		1348	16.4	23.28
ST50	40°47.8'	73°54.0'		1402	10.9	13.17
ST43	40°44.1'	73°58.2'		1503	14.5	14.21

Table 7.--Concluded

TRANSECT 4

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
ST62	40°42.4'	74°01.3'	4/03	1404	19.2	17.74
ST63	40°46.5'	73°59.8'		1445	14.0	14.90
ST36	40°48.8'	73°58.1'		1508	18.0	20.45
ST64	40°51.0'	73°56.9'		1530	20.7	22.25
ST65	40°54.8'	73°54.8'		1609	13.7	12.78
ST62	40°42.4'	74°01.3'	4/03	2108	19.2	18.87
ST63	40°46.5'	73°59.8'		2150	14.0	15.91
ST36	40°48.8'	73°58.1'		2220	18.0	20.85
ST64	40°51.0'	73°56.9'		2243	20.7	18.54
ST65	40°54.8'	73°54.8'		2312	13.7	15.06

Table 8.--CTD Single Station Cast Measurements Conducted During the 1981 Observation Period of the New York Harbor Circulatory Survey

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S00	40°41.2'	74°01.0'	4/07	1650	7.0	6.27
			4/10	1942		6.09
			4/13	2244		6.60
			4/16	1301		6.33
			4/23	1252		6.08
			4/28	2145		6.37
			5/12	2230		6.31
			6/12	2324		6.46
			6/12	2328		6.52
			6/19	1555		6.15
S13	40°27.5'	74°04.3'	3/09	1708	5.2	6.11
S16	40°30.4'	74°11.2'	3/09	2015	12.7	11.09
S17	40°36.5'	74°02.9'	3/09	1509	25.9	26.65
	40°36.4'	74°02.9'	3/25	1345		25.79
			4/01	1347		25.62
	40°36.6'	74°02.9'	4/09	1613		26.97
			4/28	1743		26.82
S18	40°28.5'	74°11.0'	3/09	1858	3.7	3.72
	40°28.4'	74°12.2'	4/13	1630		3.90
S19	40°29.5'	74°13.8'	3/09	2114	13.2	12.00
			3/26	1828		13.83
S20	40°29.4'	74°15.5'	3/09	2223	9.3	8.34
S22	40°30.7'	74°15.4'	3/09	2300	11.4	10.85
S30	40°39.0'	74°05.1'	3/26	2216	11.9	12.21
			4/08	1411		13.43
			4/28	1854		13.17
S31	40°38.9'	74°04.0'	5/06	1823	11.0	12.26
	40°39.0'	74°03.9'	5/07	1842	11.4	11.42

Table 8.--Continued

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S35	40°42.5'	73°59.4'	3/27	1921	13.7	16.42
			4/27	1326		12.70
			5/13	1242		13.83
			5/28	1101		13.47
			6/14	1422		15.02
			6/30	1847		15.49
S36	40°48.8	73°58.1'	3/10	1654	18.0	19.55
			3/25	2123		18.88
			4/11	1822		18.78
			4/27	1900		18.70
			5/15	1538		18.70
S37	40°39.3'	74°01.9'	3/10	1905	12.6	13.66
			3/26	2324		12.85
S38	40°40.2'	74°03.1'	3/10	1834	10.0	10.40
			3/26	2244		7.11
S39	40°40.3'	74°01.5'	3/10	1943	12.5	13.40
			4/27	1220		12.93
S40	40°41.2'	74°02.2'	4/11	2001	18.3	19.00
			4/28	2106		19.02
S41	40°41.3'	74°00.8'	4/13	1402	12.2	11.85
			6/24	1821		12.61
			7/02	1212		13.10
S42	40°41.9'	74°00.5'	4/13	1332	13.1	10.98
			4/28	0000		11.88
			4/29	1723		12.97
			5/15	1642		10.98

Table 8.--Continued

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S43	40°44.3'	73°58.2'	4/28	1315	15.8	18.52
			5/14	1947		11.44
S44	40°45.5'	73°57.0'	4/27	1420	10.7	7.63
			5/14	1756		9.66
			6/16	1408		5.55
			6/24	1543		5.12
S45	40°45.5'	73°57.5'	4/27	1522	21.6	22.27
			5/13	1904		23.54
			5/29	1733		17.42
S46	40°46.5'	73°56.3'	5/13	1944	22.6	23.32
			5/29	1849		23.32
			5/30	1811		22.43
			6/16	1744		21.85
			7/02	1311		24.05
S47	40°47.3'	73°56.1'	5/13	1811	6.3	5.55
			5/28	1740		5.79
			5/30	1800		5.43
			6/08	1940		7.15
			6/15	1557		6.93
S48	40°46.9'	73°55.7'	5/14	1904	21.1	16.12
	40°46.9'	73°55.3'	5/15	1901	19.1	22.07
			5/28	1530		22.96
S49	40°48.2'	73°53.8'	5/14	1514	23.5	26.78
	40°48.3'	73°54.0'	5/15	2050	22.6	24.50
	40°48.4'	73°53.8'	6/17	1322	23.5	23.33
	40°48.2'	73°53.8'	7/02	1412		23.46

Table 8.--Continued

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S50	40°47.8'	73°54.0'	5/14	1555	10.9	13.26
			5/29	1929		10.54
			6/15	1523		13.64
			6/30	1730		13.23
S51	40°47.5'	73°53.9'	5/14	1651	15.4	15.67
			5/30	1720		13.30
			6/16	1858		10.48
			7/02	1444		9.11
S52	40°47.1'	73°53.4'	5/31	1701	9.9	9.78
			6/15	1446		10.66
S53	40°48.0'	73°52.8'	5/30	1701	16.4	18.15
			6/15	1415		15.45
S54	40°47.4'	73°51.9'	6/15	1401	10.7	12.27
			6/30	1618		12.74
S55	40°47.9'	73°51.1'	5/28	1451	21.6	23.65
			6/14	1654		24.78
			6/30	1525		22.77
S56	40°48.1'	73°49.6'	5/30	1541	19.9	22.79
			6/15	1238		18.98
S57	40°49.9'	73°56.1'	5/15	1412	7.0	6.84
			5/31	1424		6.72
S58	40°52.6'	73°55.3'	3/25	2046	9.1	9.25
			4/11	1440		7.83
			4/27	2045		9.47
			5/15	1456		7.67
S59	40°47.8'	73°51.9'	6/15	1331	10.1	10.90
			6/30	1650		11.31

Table 8.--Concluded

STATION	LAT.(N)	LONG.(W)	DATE	TIME (GMT)	APPROX. WATER DEPTH(M)	BOTTOM DATA DEPTH (M)
S60	40°48.2'	73°47.4'	5/04	1943	15.9	16.65
	40°48.1'	73°47.6'	5/13	1547	16.0	16.63
			5/20	1934		16.88
			6/15	1221		17.11
			6/30	1350		23.47
S61	40°47.9'	73°47.6'	5/29	2048	23.3	24.06
			6/14	1743		24.61
			6/30	1412		27.83
S62	40°42.4'	74°01.3'	3/27	1721	19.2	17.80
			4/10	1343		18.43
S63	40°46.5'	73°59.8'	3/27	1817	14.0	14.73
			4/11	1851		14.63
			4/13	1951		14.80
			4/28	2010		14.24
S64	40°51.0'	73°56.9'	3/25	1652	20.7	22.88
			3/25	1803		23.04
			4/11	1711		21.90
S65	40°54.8'	73°54.8'	3/25	1933	13.7	14.85
			4/11	1556		12.96
			4/27	1955		13.47
S66	40°54.9'	73°55.6'	3/25	1804	5.8	6.29
			4/11	1628		5.63
S67	40°46.8'	73°56.2'	5/13	1842	9.5	9.58
			5/31	1545		9.24

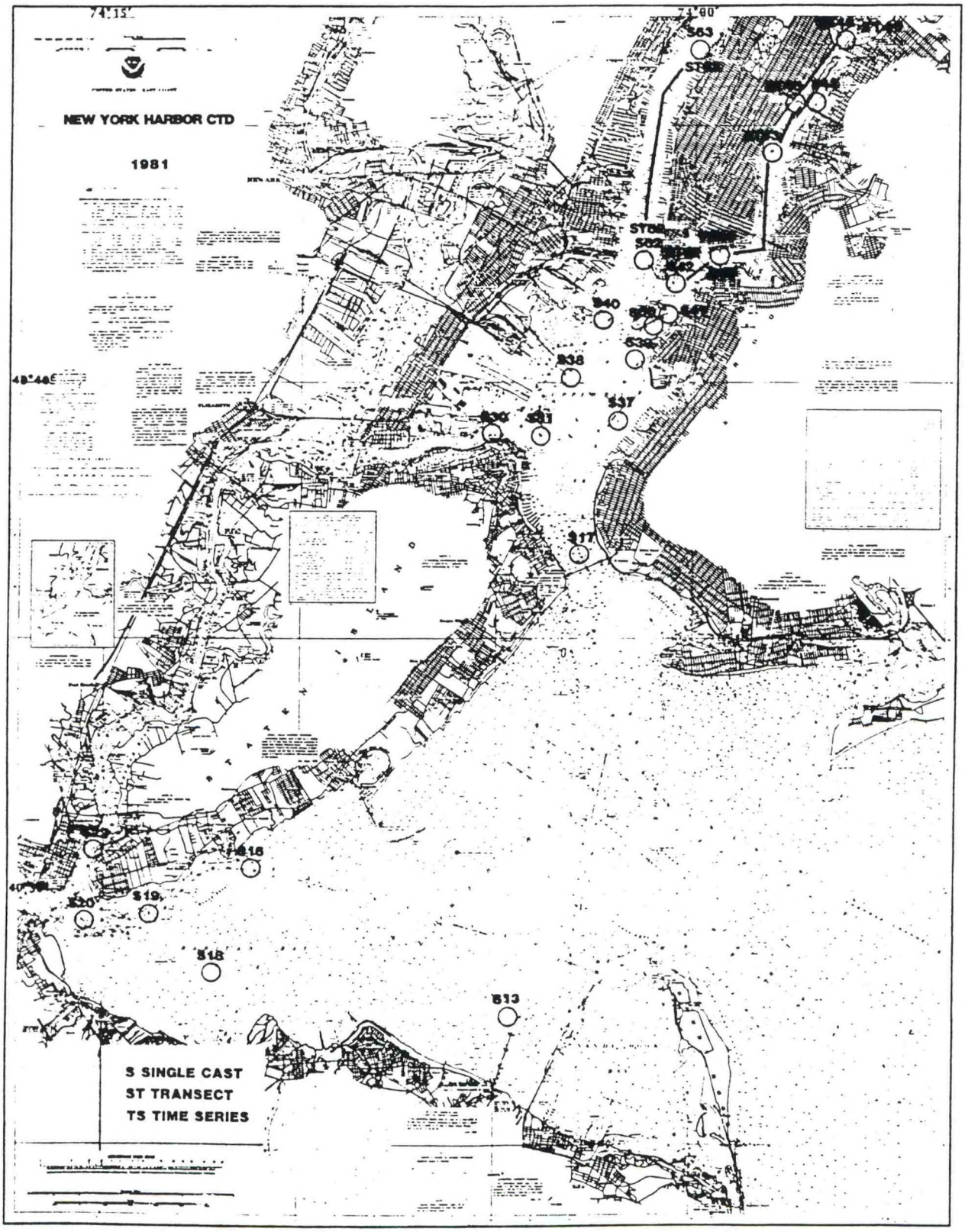

Figure 17.--CTD Cast Locations for Casts Taken During the 1981 Survey.

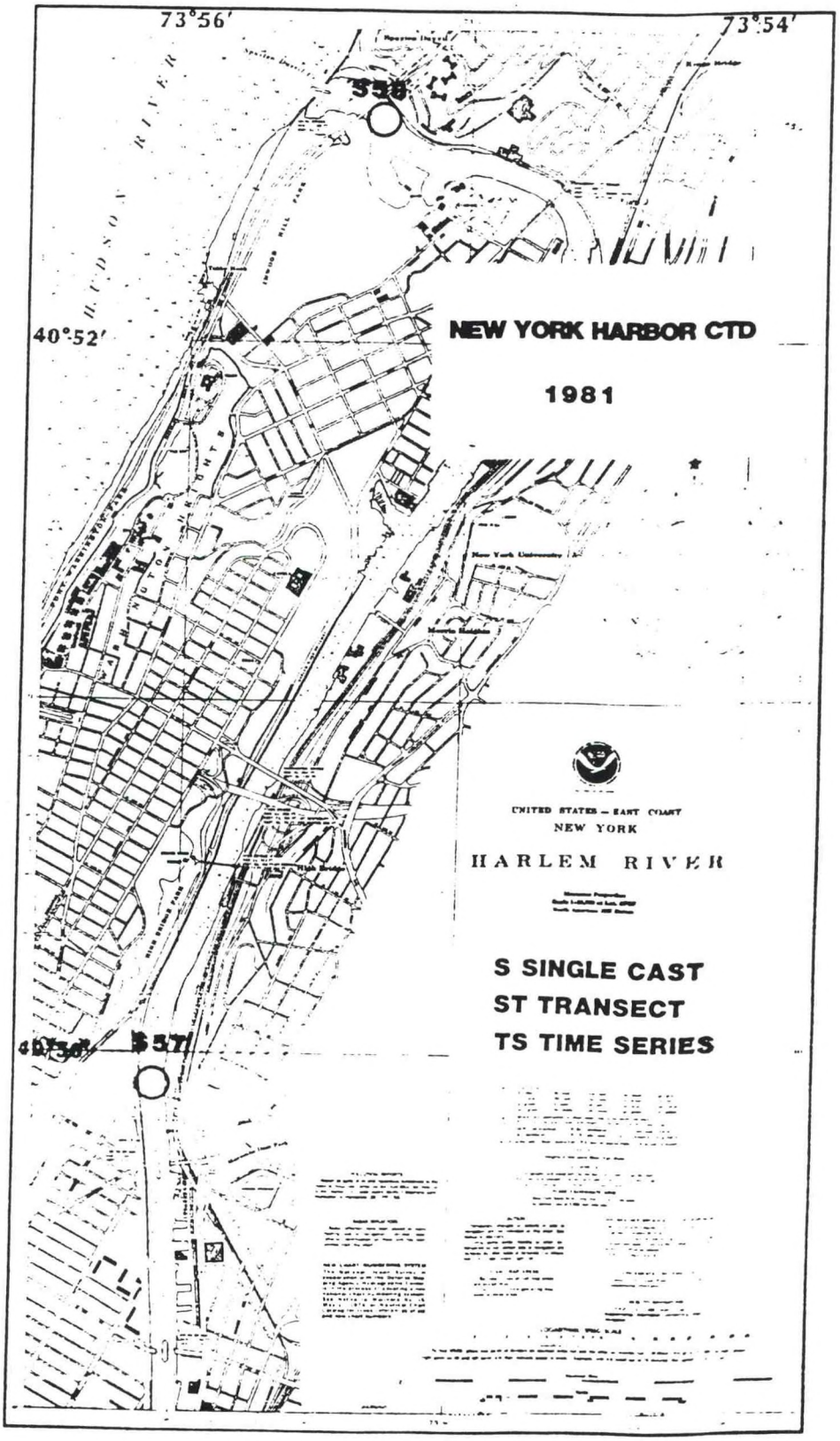

Figure 18.--CTD Cast Locations for Casts Taken During the 1981 Survey.

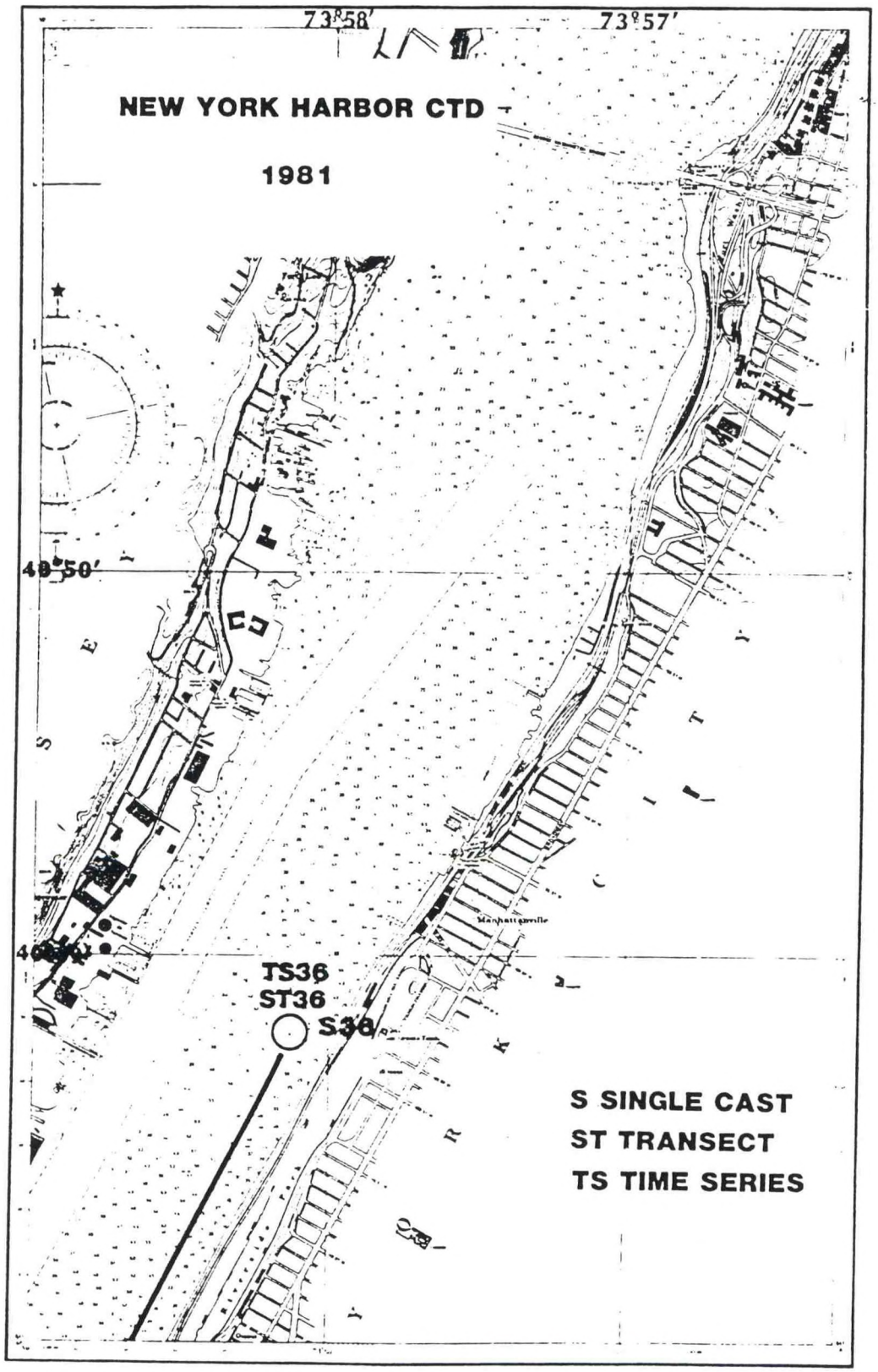

Figure 19.--CTD Cast Locations for Casts Taken During the 1981 Survey.

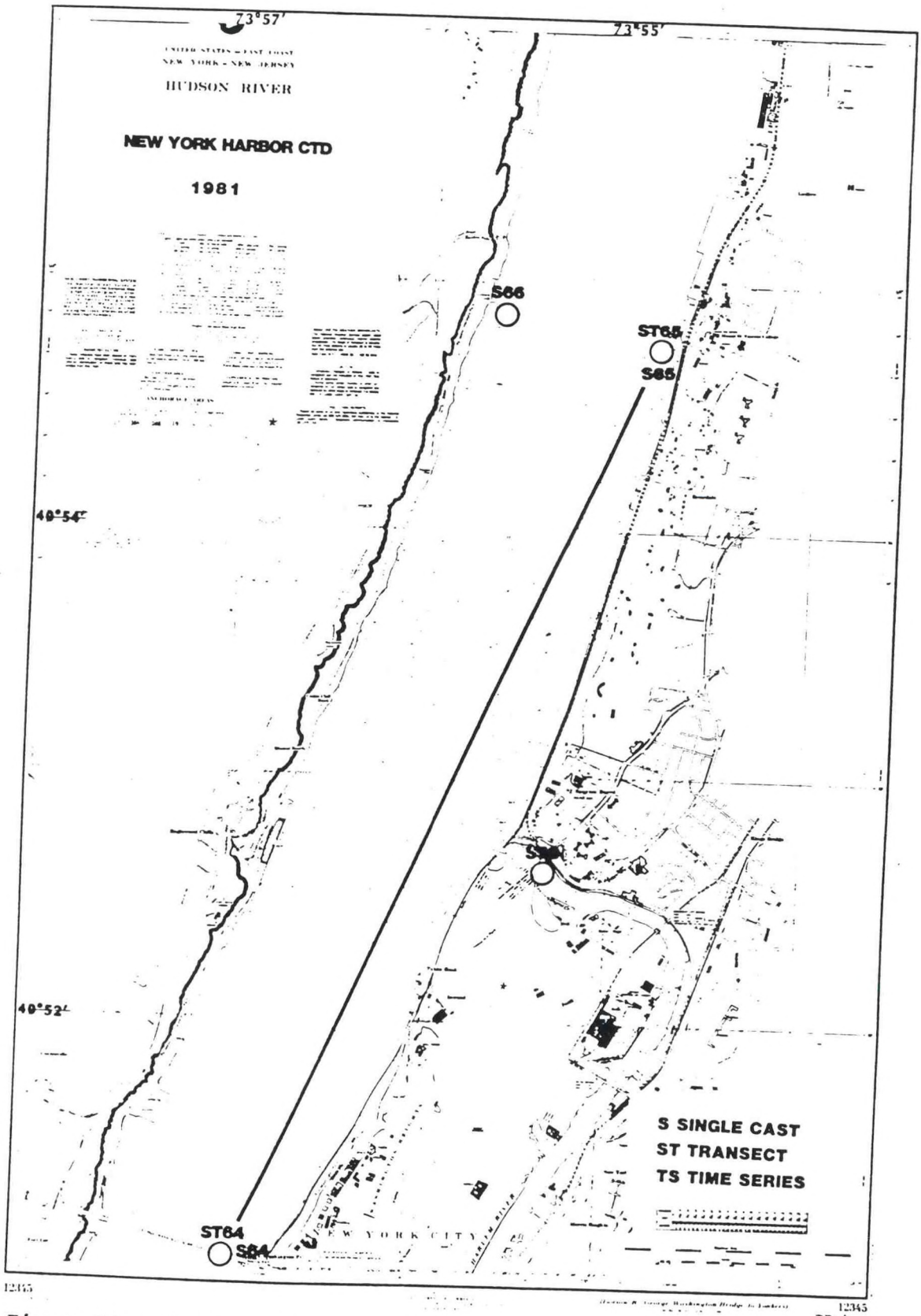

Figure 20.--CTD Cast Locations for Casts Taken During the 1981 Survey.

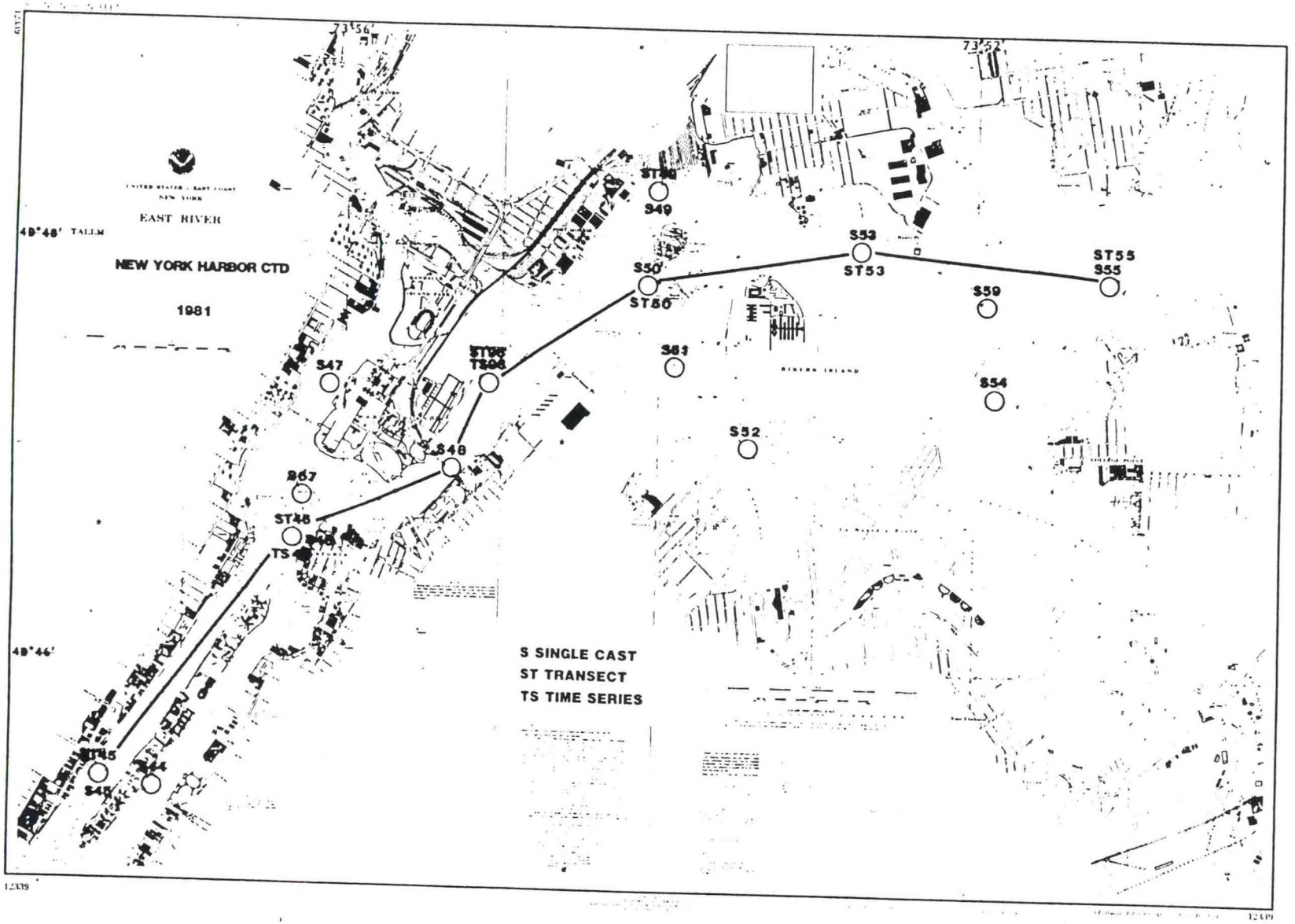

Figure 21.--CTD Cast Locations for Casts Taken During the 1981 Survey.

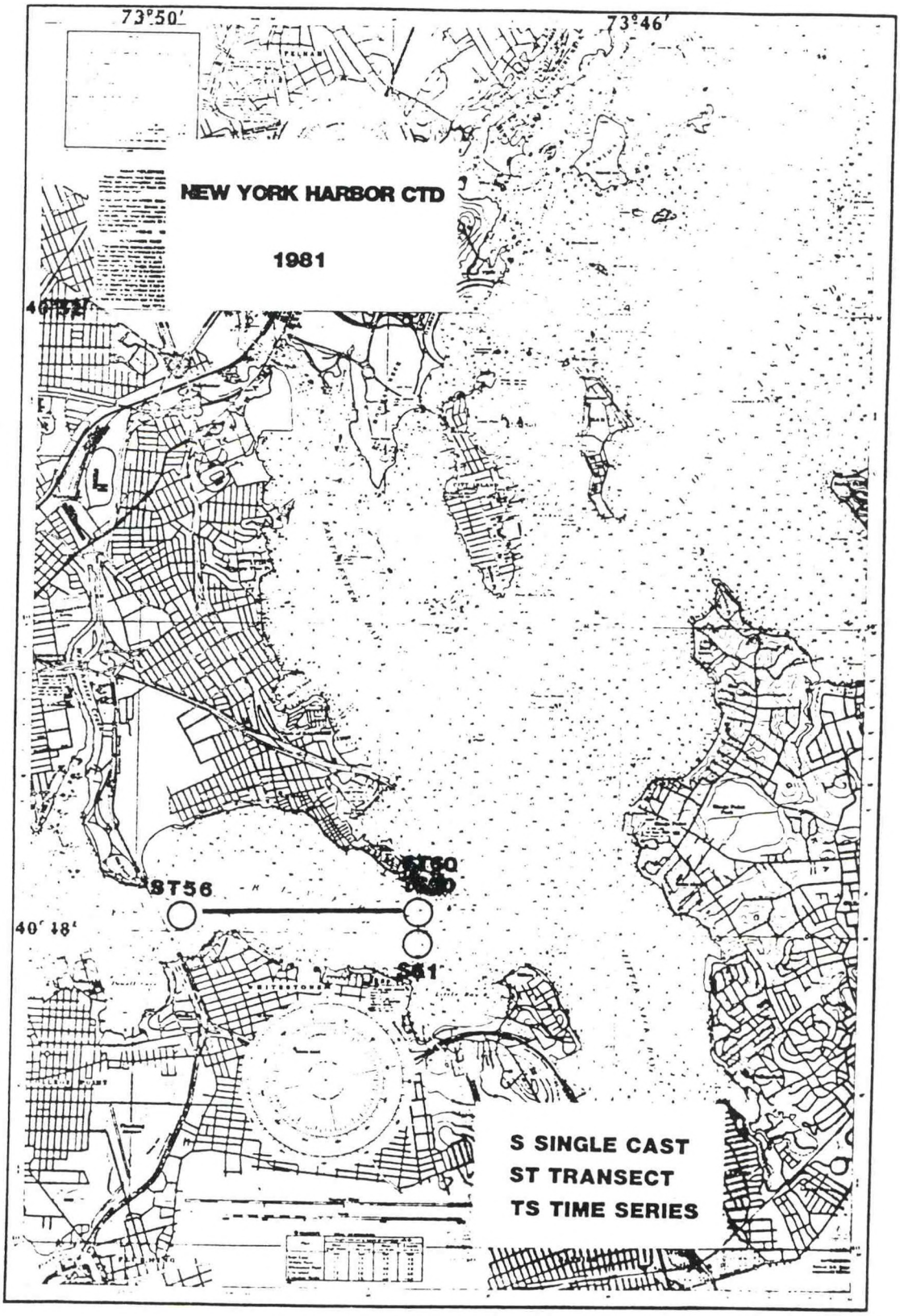

Figure 22.--CTD Cast Locations for Casts Taken During the 1981 Survey.

TIDE DATA

Tide Stations

The locations of tide gages occupied during the 1980-1981 periods of observation of this survey are shown in figures 23 through 27. Tables 10 and 11 give relevant information about each tide station including: latitude and longitude, dates of occupation, type of gage, stage of processing accomplished, and comments on data quality. All stations were occupied for at least 30 days, and some were in for one or more years. The shorter period tide stations were usually installed simultaneously with nearby current stations.

Tide gages were installed by the NOAA Ship FERREL. Before a tide gage was installed, a reconnaissance of the proposed site was carried out to determine the availability of structures for the gage, water depths, the recovery of old bench marks, and possible sites for new bench marks. During installation differential levels were run from the tide staff to established bench marks and, whenever possible, to the National Geodetic Vertical Control Network.

Instrumentation, Processing, and Analysis

The National Ocean Service used two types of tide gages during this part of the project: an ADR (Analog-Digital-Recorder) and a Bubbler (gas purged). Table 9 gives specifications for these gages.

The ADR gage outputs samples every 6 minutes onto foil-backed paper tape, which is processed using a mechanical translator and computers. The steps in processing are generally: (1) putting the 6-minute samples onto computer-compatible magnetic tape; (2) deriving hourly values from these (by picking the nearest 6-minute value to the hour) and storing them on cards and tape and in tablulated form; and (3) tabulating high and low waters, various tidal datums (e.g., mean high water, mean low water, and mean sea level), and other relevant parameters.

The Bubbler gage produces a continuous analog plot on a 6-inch strip chart. Resolution is not as good as with the ADR and generally only high and low waters and various tidal datums are tabulated. Hourly values are sometimes determined for special needs using a Bubbler marigram scanner, which digitizes the data at visually selected points.

Processed monthly tabulations (high and low waters and tidal datums) from each station are verified as to staff-marigram relationship, and equivalent 19-year mean values are computed through simultaneous comparison with the appropriate tide control station. Tidal bench mark elevations are established by referencing these bench marks to the computed tidal datums. New elevations for historical bench marks are used to check any vertical land movement that may have occurred. The relationships between tidal datums and the National Geodetic Vertical Control Network are also computed when level connections can be made to geodetic bench marks.

Tide data are further analyzed using: (1) 29-day Fourier harmonic analyses; (2) least-squares harmonic analyses (for 1-year series); (3) non-harmonic comparison analyses relating a short period station to a longer period control station; (4) various filtering and spectral techniques; and (5) FR80 microfilm plotting. The harmonic constants obtained from item (2) can be used to make predictions for table 1 of the Tide Tables, East Coast of North and South America including Greenland. Results from items (1), (2), and (3) can be used in table 2 of this same publication.

Table 9.-- Tide Gage Specifications

Bubbler (Gas Purged)

Manufacturer: Bristol
Range: 0-10 feet to 0-50 feet
Precision: 1 percent of full scale
Recorder: 6-inch strip chart
Record Format: Analog, curvilinear
Sampling Rate: Continuous
Duration: Chart - 1 month
Chart drive, spring wound - 8 days
Processing: Visual
Mode of Operation: Compressed nitrogen is purged through the system, actuating a pressure-sensitive element, which measures water level fluctuations.

ADR (Analog - Digital Recorder)

Manufacturer: Fischer - Porter
Range: 0-99.99 feet
Precision: ± 1/2 binary count
Recorder: Foil-backed paper tape (punch)
Record Format: Binary - decimal code
Sampling Rate: 6-minute intervals
Duration: Chart - 3 months
Chart drive, battery - 3 months
Processing: Mechanical translator
Mode of operation: Float movement is translated into binary code and recorded on paper tape.

Table 10.-- Tide Stations Occupied During the 1980 Observation Period of the New York Harbor Circulatory Survey

STATION NO.	STATION	LAT(N)	LONG(W)	DATES OF OBSERVATION	GAGE TYPE	PROC.	MISSING DATA
851-8750	The Battery, NY	40°42.0'	74°05.5'	Entire Survey	P, A, B	✓	
853-0882	Port Elizabeth, NJ	40°40.4'	74°08.4'	Entire Survey	P, A	✓	9/23-10/7
853-1681	Sandy Hook, NJ	40°28.0'	74°00.1'	Entire Survey	P, A, B	✓	
853-1991	Long Branch, NJ	40°18.2'	73°58.6'	Entire Survey	P, A, B	✓	4/8-7/15, 10/1-9
851-9789	Rossville, Arthur Kill, NY	40°33.3'	74°13.5'	10/06/80-11/16/80	T. A	✓	
851-9024	Fort Wadsworth, Staton Is., NY	40°36.4'	74°03.3'	7/26/80-11/16/80	T, A	✓	
853-1232	South Amboy, NJ	40°29.5'	74°16.9'	7/25/80-11/16/80	T, A	✓	FLW: 9/26-27 10/26-27, 11/10-11
853-0645	Union City, NJ	40°46.0'	74°01.1'	7/31/80-11/11/80	T, A	✓	FLW: 9/24, 26-28 10/20-27, 11/10-11
851-7732	Wallaboot Bay, NY	40°42.4'	73°58.5'	7/24/80-11/16/80	T, A	✓	

* P - Primary Tide Gage-over 19 years of observations
T - Tertiary Tide Gage-30 to 90 days of observations
A - Analog Digital Recorder (ADR) Tide Gage
B - Bubbler Tide Gage

** FLW: - Flat low waters for following dates

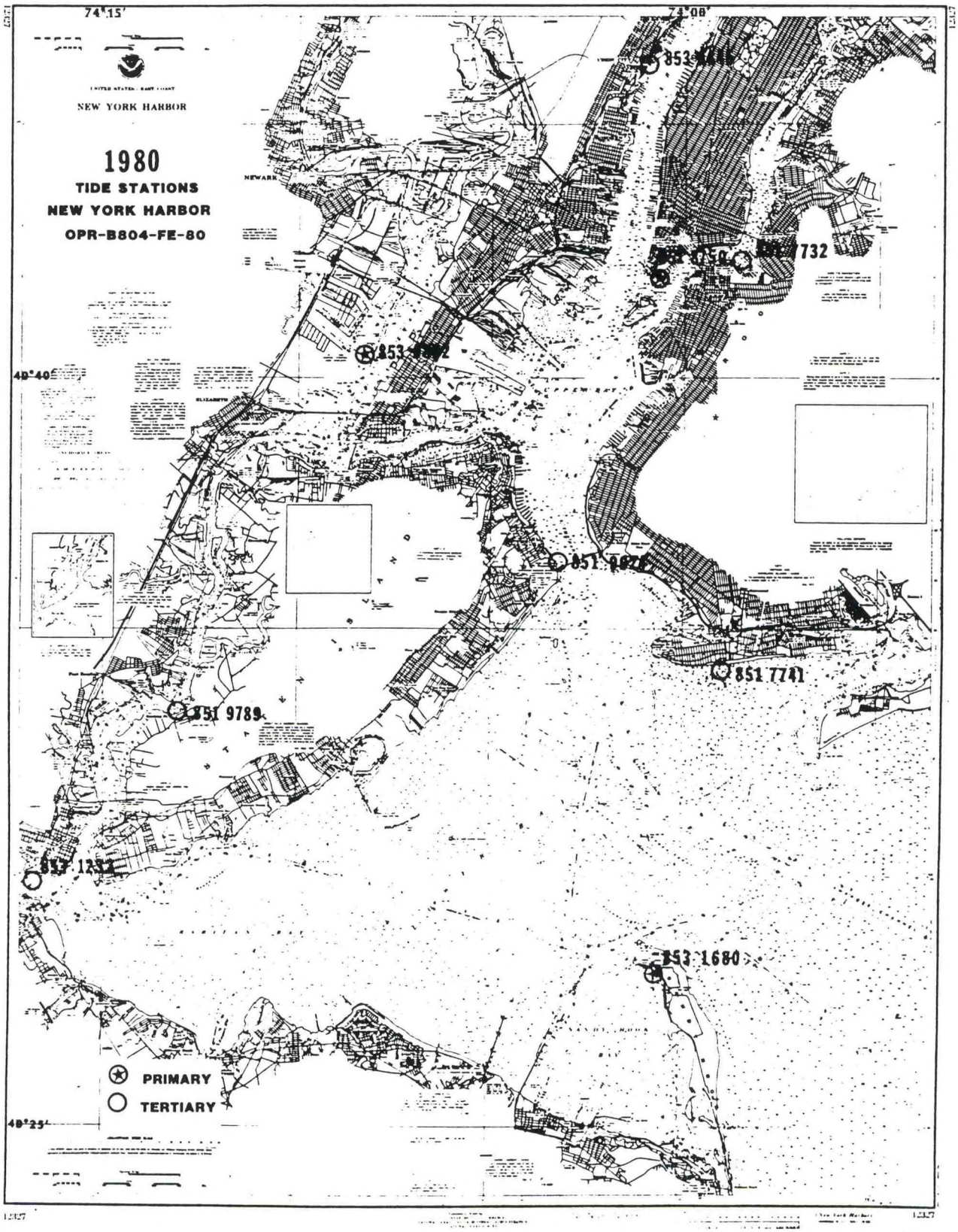

Figure 23.--Tide Stations Installed During the 1980 Survey.

Table 11. --Tide Stations Occupied During the 1981 Observation Period of the New York Harbor Circulatory Survey

STATION NO.	STATION	LAT(N)	LONG(W)	DATES OF OBSERVATION	*GAGE TYPE	PROC.	**MISSING DATA
851-8750	The Battery, NY	40°42.0'	74°05.5'	Entire Survey	P, A, B	✓	
851-6990	Willets Point, NY	40°47.6'	73°46.9'	Entire Survey	P, A, B	✓	
853-0882	Port Elizabeth, NJ	40°40.4'	74°08.4'	Entire Survey	P, A	✓	
853-1680	Sandy Hook, NJ	40°28.0'	74°00.1'	Entire Survey	P, A, B		ADR Data Bad Bubbler Data Good
853-1991	Long Branch, NJ	40°18.2'	73°58.6'	Entire Survey	P, A, B	✓	
851-7125	Whitestone, NY	40°47.9'	73°49.0'	5/26-7/08/81	T, A	✓	
851-7276	College Pt., 110th St., LI	40°47.0'	73°51.4'	5/17-7/01/81	T, A	✓	
851-7401	Wards Is., NY	40°54.0'	73°56.0'	5/06-6/29/81	T, A	✓	5/24-5/29
851-7732	Wallaboot Bay, NY	40°42.4'	73°58.4'	3/06-7/01/81	T, A	✓	
851-8621	Hunts Pt., NY	40°48.1'	73°51.3	5/27-7/01/81	T, A	✓	
851-8639	Port Morris, E. 138th St., NY	40°48.1'	73°54.4	3/11-4/09/81	T, B	✓	3/28-3/30
851-8643	Randalls Is., NY	40°48.1'	73°54.4	5/09-7/03/81	T, A	✓	
		40°54.0'	73°56.0'	4/30-6/22/81	T, A	✓	Inferred Highs & Lows for 4/30-5/23
851-8668	Horns Hook, E. 90th St., NY	40°46.6'	73°56.5'	4/22-6/28/81	T, A	✓	
851-8695	East 41st St. Pier, NY	40°44.8'	73°58.1'	4/01-6/24/81	T, A	✓	
851-8903	Spuyten Duyvil Ck., Ent. Hudson River, NY	40°52.7'	73°55.5'	3/17-5/16/81	T, A	✓	
851-8905	Riverdale, Hudson R., NY	40°54.2'	73°55.0'	3/04-5/05/81	T, A	✓	
851-9024	Fort Wadsworth, Staten Is. NY	40°36.4'	74°03.3'	3/06-4/30/81	T, A	✓	3/6-3/13

Table 11.--Concluded

STATION NO.	STATION	LAT(N)	LONG(W)	DATES OF OBSERVATION	*GAGE TYPE	PROC.	**MISSING DATA
853-0505	Edgewater, NJ	40°48.8'	73°58.7'	3/06-5/19/81	T, A	✓	FLW: 3/7-19, 31, 4/2-11, 4/15-23 4/30-5/9, 18, 19
853-1232	South Amboy, NJ	40°29.5'	74°16.9'	3/07-4/15/81	T, A	✓	

* P - Primary Tide Gage- over 19 years of observations
T - Tertiary Tide Gage-30 to 90 days of observations
A - Analog Digital Recorder (ADR) Tide Gage
B - Bubler Tide Gage

** FLW: - Flat low waters for following dates

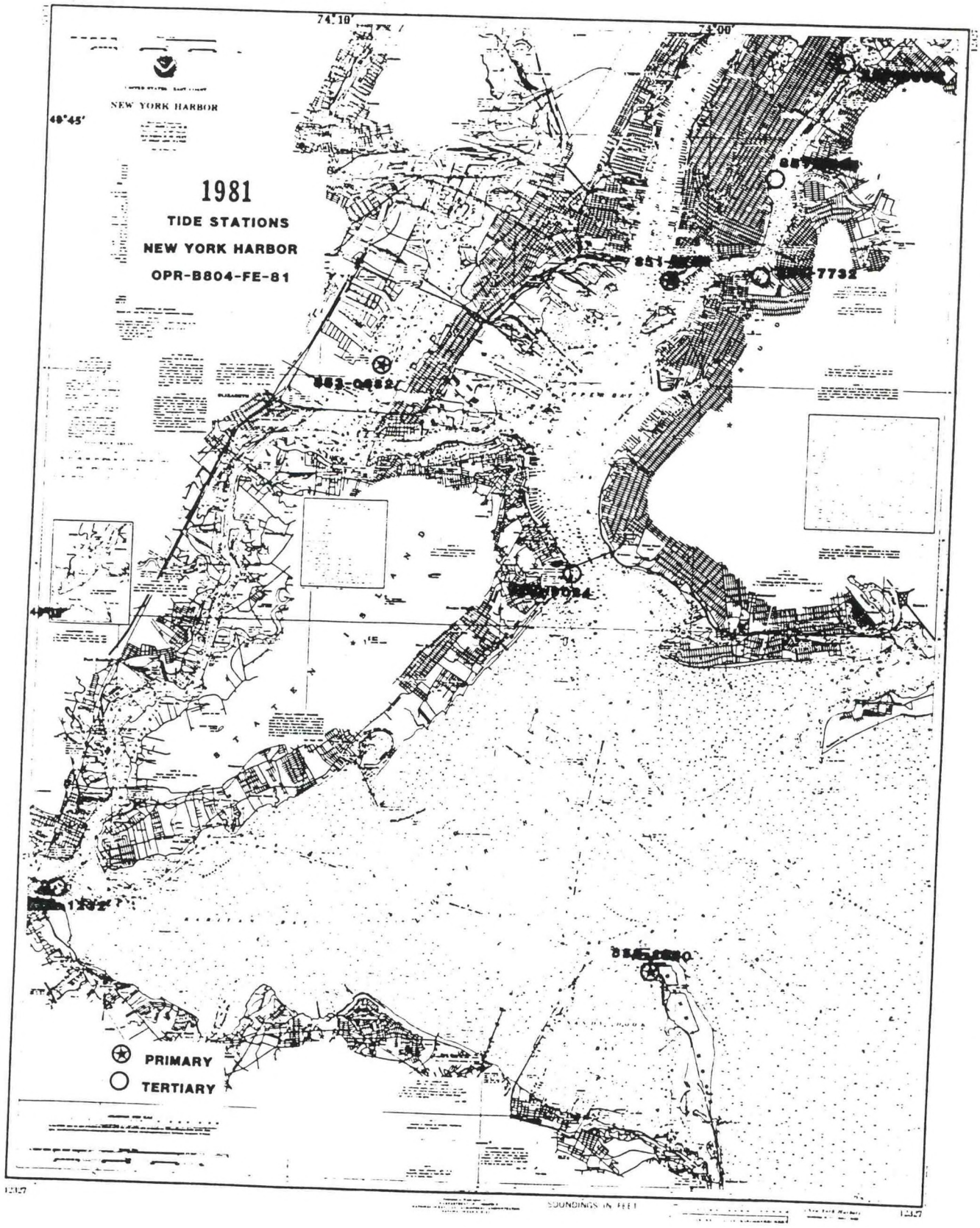

Figure 24.--Tide Stations Installed During the 1981 Survey.

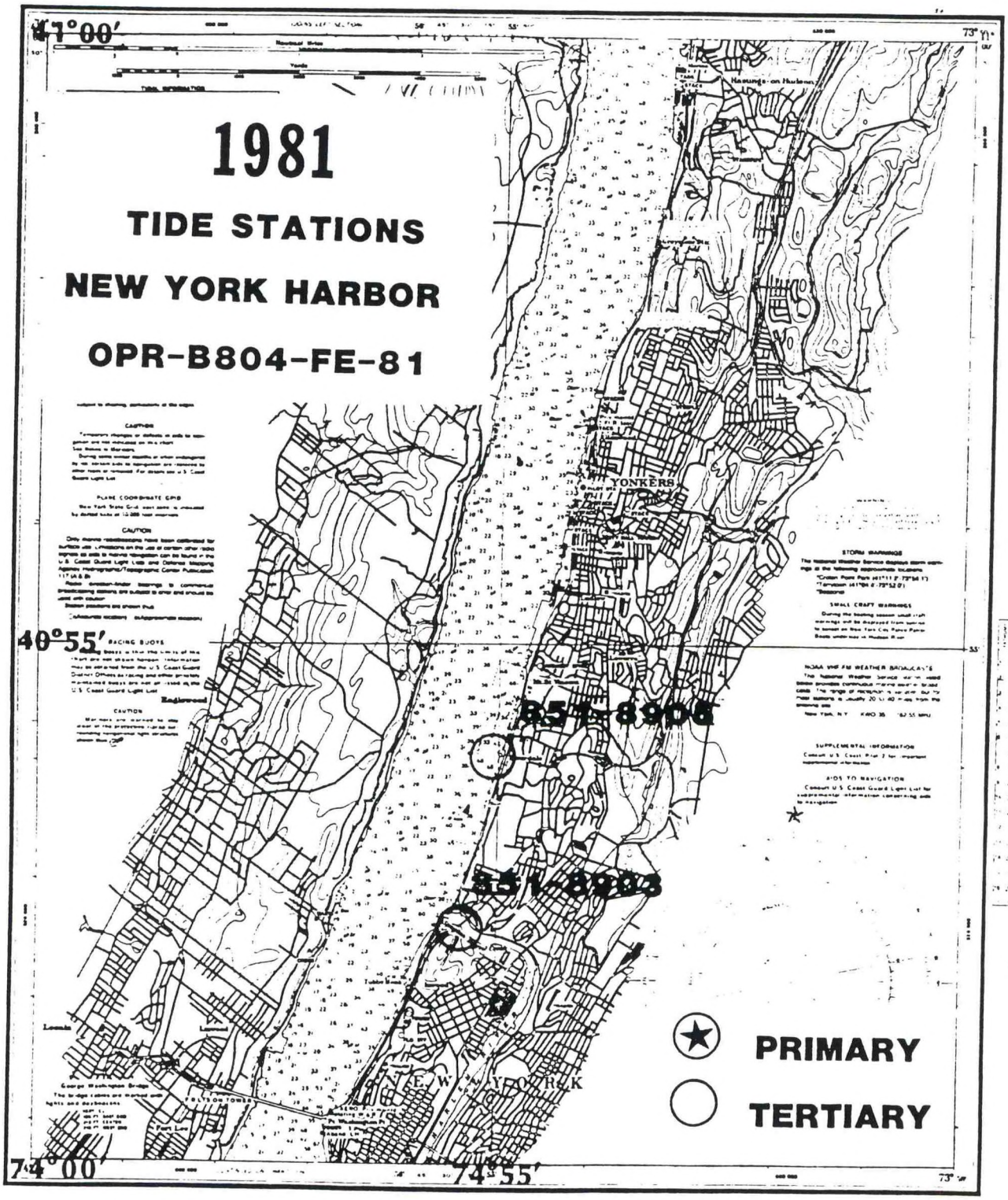

Figure 25.--Tide Stations Installed During the 1981 Survey.

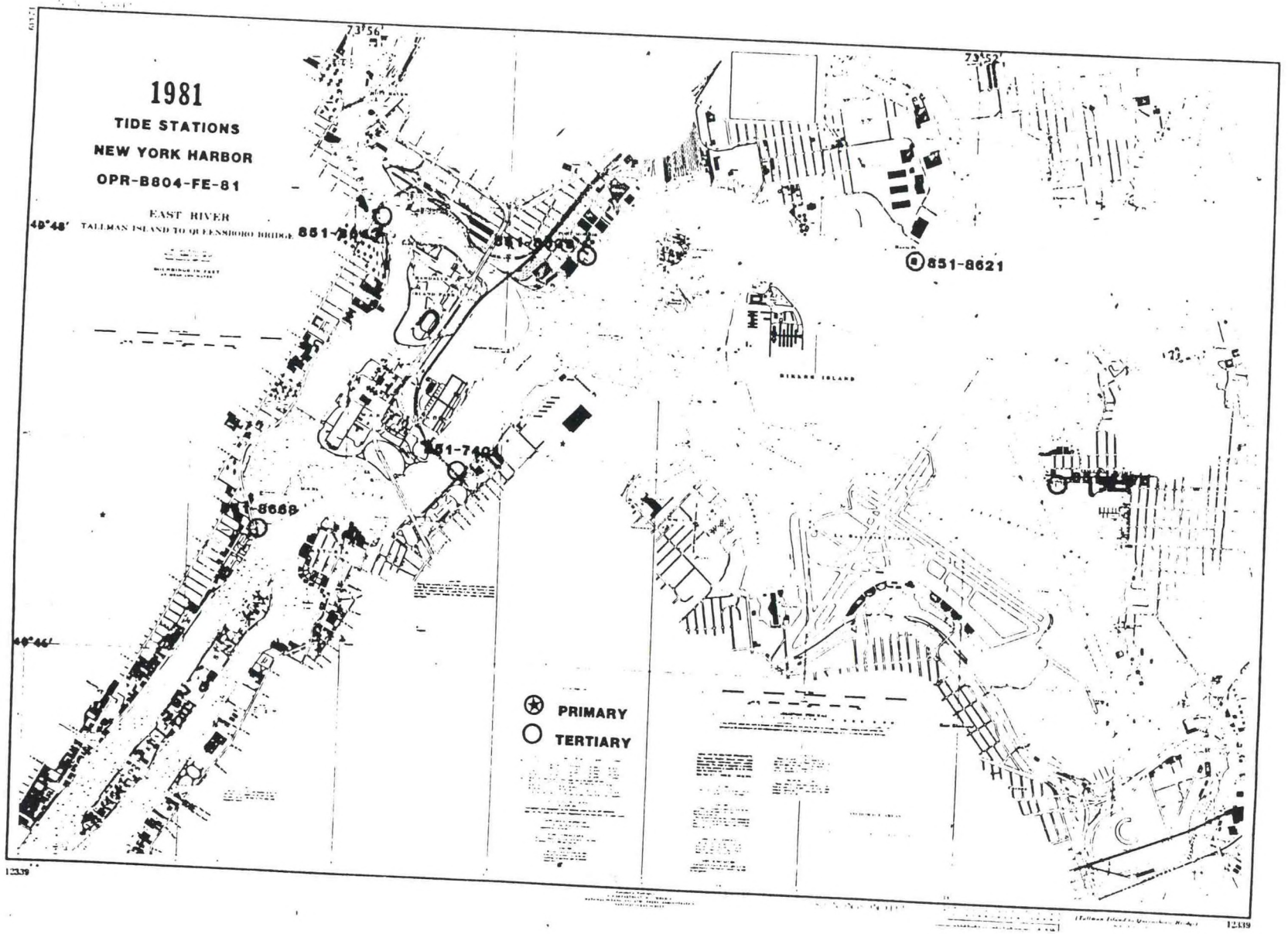

Figure 26.--Tide Stations Installed During the 1981 Survey.

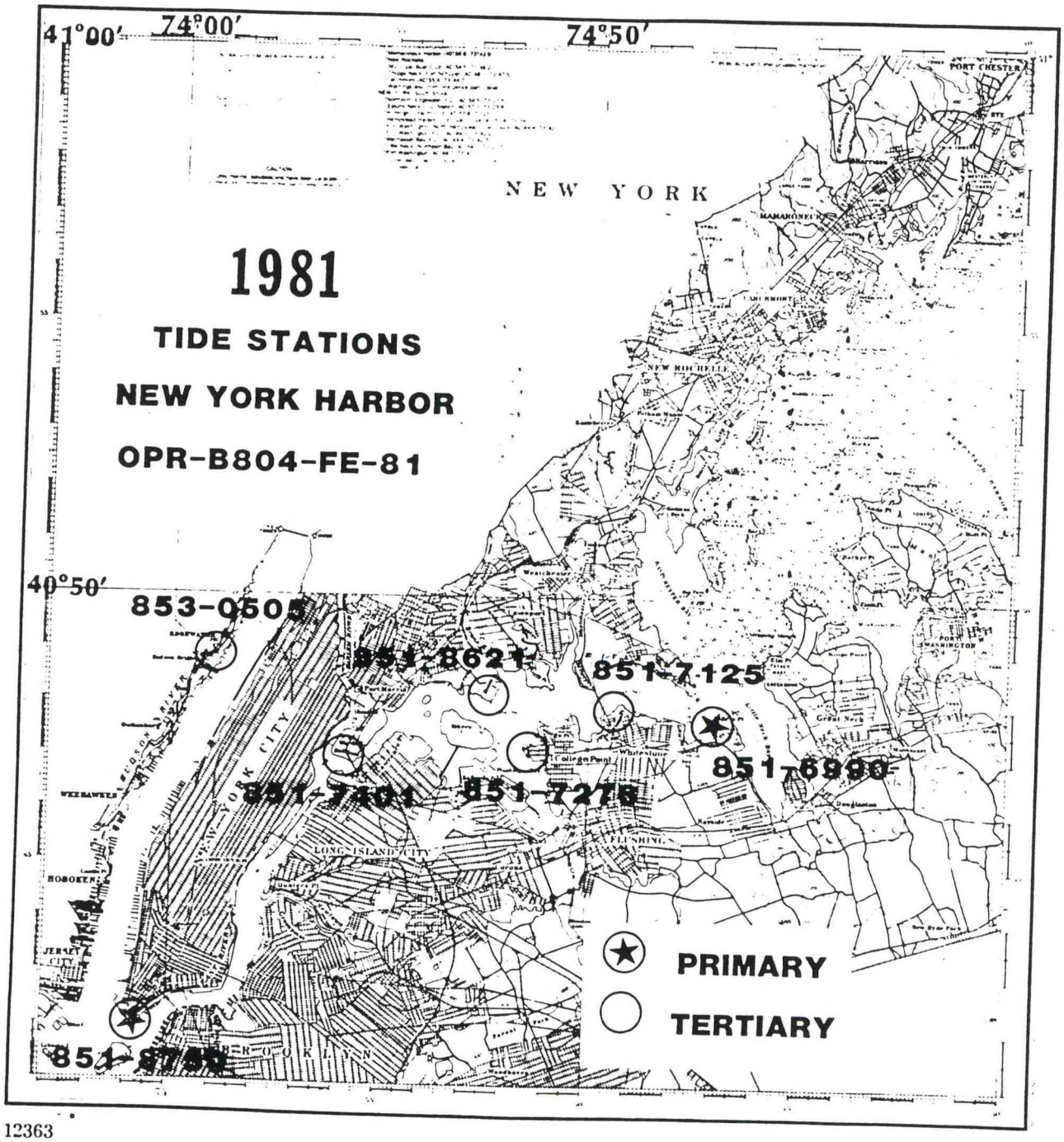

Figure 27.--Tide Stations Installed During the 1981 Survey.

HISTORICAL DATA

Introduction

The NOS was established in 1807 and was formerly known as the U.S. Coast and Geodetic Survey up until the beginning of the last decade. Since its inception, a large quantity of tide and current data have been acquired. The New York Harbor has been a major port well over the last century and therefore has received a good share of attention from this agency. For the most part, NOS's historical current data are relatively recent compared to historical tide data in this area. The tide measurements were first taken in 1836, whereas, current measurements of any significance began in the 1920's.

Current Data

Please refer to table 12 which gives a summary of current data collected by NOS before 1958. The reader can see that there was very little data collected in the 100 years between 1858 and 1957. The usual method of observation was by surface pole.

The most intensive surveys prior to 1980 were the 1958 and 1959 surveys headed by Cdr. Philip A. Weber and Cdr. Raymond M. Stone. The instrument used in both surveys was the Roberts Radio Current Meter. Refer to table 13 for station locations, meter depths and duration of data. Information concerning these methods of current measurements can be found in Manual of Current Observations, U.S. Coast and Geodetic Survey, S.P. 215, 1950. Predictions and mean values for some of these historical current stations can be found in Tidal Current Tables, Atlantic Coast of North America, published by NOS.

The significant improvement of the 1980-1981 New York Survey over the 1958-1959 survey is at least twofold. One is the increased number of station sites in the New York Harbor complex. The other is the increased duration of observations for each meter. No one station was planned for less than 15 days and a good number of stations were planned to record measurements for 30 days or more. Any meter having less data than this was due to electrical or mechanical failure.

These data may be obtained by writing NOAA/NOS, Director, Office of Oceanography and Marine Services, 6001 Executive Boulevard, Rockville, Maryland 20852.

Tide Data

As one reviews table 14, it is obvious that the historical tide data in this area are extensive. Tide data in the New York Harbor were first collected in 1836. The number of stations was so great that the authors found it necessary to begin the tabulation of stations with those that were occupied in 1930. These data series ran from 3 days to 30 years in length.

Various types of water-level measuring devices were used to obtain these data. Descriptions of these devices can be found in Manual of Tide Observations, U.S. Coast and Geodetic Survey, Pub. 30-1, 1965, or in Tidal Datum Planes, U.S. Coast and Geodetic Survey, S.P. 135, 1951. Predictions and mean ranges for some of these historical tide stations can be found in Tide

Tables, East Coast of North and South America Including Greenland, published by NOS.

These data may be obtained by writing NOAA/NOS, Director, Office of Oceanography and Marine Services, 6001 Executive Boulevard, Rockville, Maryland 20852.

Table 12.-- NOS Historical Current Data Prior to 1958

C.O. OR OBSERVER	LOCATION	NUMBER OF STATIONS	DATES OBSERVED	DURATION	METHOD OF OBSERVATION
Mitchell Marinden Hanus	East River	1	1858-1887	5 days	Surface
	Hudson River	1			
	Upper Bay	8			
	Narrows	1			
	Lower Bay	5			
Winston	Hudson River	7	8-12/1919	3-5 days	Pole (surface), Meters (3 spaced)
	Upper Bay	9			
	Kill Van Kull	4			
Auld	Harlem River	3	9-11/1920	2-3 days	Pole (surface), Meters (3 spaced)
	East River (South of Hells Gate)	13			
	Upper Bay	2			
	Newark Bay, Arthur Kill	5		3 days	
Denson	Hudson R. (North of Harlem River)	6	7-9/1922	3-7 days	Pole (surface), Meters (3 spaced)
	Hudson R. (South of Harlem River)	16		1-5 days	
	Harlem River	6		2-21 days	
	Hells Gate	5		1-4 days	
	East R. (Northeast of Hells Gate)	14		1-16 days	
	East R. (South of Hells Gate)	32		1-14 days	
	Upper Bay	20		2 days	

Table 12.--Continued

C.O. OR OBSERVER	LOCATION	NUMBER OF STATIONS	DATES OBSERVED	DURATION	METHOD OF OBSERVATION
	Narrows	3		4-13 days	
	Jamaica Bay & Rockaways	3		3 days	
	Lower Bay	13		1- 4 days	
	Newark Bay, Arthur Kill	5		1- 5 days	
Bean	Jamaica Bay	3	8/1924	2 days	Pole
Meaney	Jamaica Bay	3	10/1928	2 days	Pole
Finnegan	Hudson River	2	6/1929	2 days	Pole (surface)
	East R. (South of Hells Gate)	2			Meters (3 spaced)
U.S. Army Corps.Engrs.	Hudson River	5	2-9/1932	25-30 days	Pole (surface)
	East R. (North of Hells Gate)	10			Meters (3 spaced)
	Narrows	5			
Rittenberg	Hudson River	15	7-9/1932	2 days	Pole (surface)
	Harlem River	14			Meters (3 spaced)
	East R. (Northeast of Hells Gate)	16			
	East R. (South of Hells Gate)	9			
	Upper Bay	24			
	Narrows	3			
	Jamaica Bay & Rockaways	4			
	Lower Bay	7			

Table 12.--Concluded

C.O. OR OBSERVER	LOCATION	NUMBER OF STATIONS	DATES OBSERVED	DURATION	METHOD OF OBSERVATION
Bond	Hudson R. (North of Harlem River)	1	10/1934	2 days	Pole (surface) Meters (3 spaced)
Witherbee	Jamaica Bay & Rockaways	5	7-9/1934	3 days	Pole (surface) Meters (3 spaced)
McCarthy	Raritan Bay	2	7-8/1934	3 days	Pole
Thomas	Lower Bay	3	4/1939	4 days	Pole (surface) Meters (3 spaced)
Ratti	East R. (South of Hells Gate)	3	7/1942	3 days	Pole (surface) Meters (3 spaced)
Riggs	East R. (South of Hells Gate)	7	9-10/1943	30 days	Pole (surface) Meters (3 spaced)
Kirsch	Hudson R. (North of Harlem R.)	5	5-6/1952	5-8 days	Roberts Current Meter
	Harlem River	3			
	East R. (Northeast of Hells Gate)	4			
	Upper Bay	7			
	Lower Bay & Rockaways	4			

Table 13.-- NOS Historical Current Data From 1958 to the Present Survey

STATION	C.O. OF SHIP	LAT.(N)	LONG.(W)	DATES OF OBSERVATION	DURATION (DAYS)	DEPTH (FT.)	TYPE OF INSTRUMENT
1	Stone	40°32.07'	73°57.47'	5/21-25/58	5	4.5, 13.5	Roberts Radio Current Meter
1B	Stone	40°32.03'	73°57.33'	8/12-16/59	4	4.5, 13.5, 21	
3	Weber	40°30.42'	73°58.34'	5/21-26/58	5	5.5, 16.5, 17	
3B	Stone	40°30.43'	73°58.46'	8/12-16/59	4	5.5, 16.5, 27	
4	Weber	40°29.65'	73°58.92'	5/21-25/58	4	8, 16	
4b	Stone	40°29.73'	73°59.03'	8/12-16/59	4	8, 16	
5	Weber	40°28.96'	73°59.50'	5/21-25/58	5	7.5, 22.5, 37.5	
5b	Stone	40°28.9 '	73°59.75'	8/12-16/59	4	7.5, 22.5, 37.5	
6	Weber	40°28.74'	74°01.29'	5/09-13/58	4	5, 14, 22	
6A	Weber	40°28.78'	74°01.32'	8/11-15/58	4	5, 15, 24	
6B	Stone	40°28.80'	74°01.28'	9/09-13/59	4	5, 15, 24	
7	Weber	40°29.9 '	74°02.80'	5/08-13/58	5	7.3, 14.7	
7A	Weber	40°29.88'	74°02.84'	8/11-15/58	4	7.3, 14.7	
7B	Stone	40°29.60'	74°02.85'	9/09-14/59	5	7.3, 14.7	
8	Weber	40°31.13'	74°04.36'	5/08-13/58	Broken up	5.7, 11.3	
8A	Weber	40°31.12'	74°04.38'	8/11-15/58	4	5.7, 11.3	
8B	Stone	40°31.08'	74°04.33'	9/09-14/59	6	5.7, 11.3	
9	Weber	40°32.22'	74°05.69'	5/08-13/58	5	5; 10	
9A	Weber	40°32.31'	74°05.82'	8/11-15/58	4	5, 10	
9B	Stone	40°32.26'	74°05.75'	9/09-14/59	5	5, 10	
10	Weber	40°32.82'	74°03.60'	4/17-22/58	5	4.7, 9.3	

Table 13.--Continued

STATION	C.O. OF SHIP	LAT.(N)	LONG.(W)	DATES OF OBSERVATION	DURATION (DAYS)	DEPTH (FT.)	TYPE OF INSTRUMENT
10A	Weber	40°32.81'	74°03.48'	7/24-28/58	4	4.7, 9.3	Roberts Radio
10b	Stone	40°32.82'	74°03.4 '	8/26-30/59	5	4.7, 9.3	Current Meter
11	Weber	40°32.85'	74°02.20'	4/17-21/58	5	4.7, 14, 22	
11A	Weber	40°32.77'	74°02.37'	7/24-28/58	4	4.7, 14, 22	
11b	Stone	40°32.82'	74°02.33'	8/26-30/59	5	4.7, 14	
12	Weber	40°33.12'	74°01.39'	4/17-22/58	5	5.3, 16.0	
12A	Weber	40°33.04'	74°01.4 '	7/24-28/58	4	5.3, 16, 26	
12b	Stone	40°33.03'	74°01.36'	8/26-30/59	4	5.3, 16.0, 26.0	
13	Weber	40°33.09'	74°00.28'	4/17-22/58	5	5, 10	
13A	Weber	40°33.09'	74°00.28'	7/24-28/58	4	5, 10	
13b	Stone	40°33.00'	74°00.25'	8/26-30/59	4	5, 10	
14	Weber	40°36.6 '	74°03.3 '	4/02-07/58	5	12.5, 37.5, 59	
14b	Stone	40°36.52'	74°03.13'	9/23-27/59	4	12.3, 37.0, 61.7	
15	Weber	40°36.76'	74°02.66'	4/02-07/58	5	10, 30, 50	
15b	Stone	40°36.6 '	74°02.53'	9/23-27/59	4	11.7, 35.0, 58.3	
16A	Weber	40°39.02'	74°05.12'	8/21-25/58	4	6.3, 19.0, 31.7	
16B	Stone	40°39.01'	74°05.1 '	4/25-30/59	5	6.3, 19.0, 31.7	
17	Weber	40°39.86'	74°03.18'	6/12-17/58	5	8.8, 26.5, 44.2	
17A	Weber	40°39.83'	74°03.19'	8/21-25/58	4	8.8, 26.5, 44.2	
17b	Stone	40°39.88'	74°03.16'	4/25-29/59	4	8.8, 26.5, 44.2	
18	Weber	40°39.96'	74°02.50'	6/12-17/58	5	4.8, 14.5, 23.0	
18A	Weber	40°39.96'	74°02.52'	8/21-25/58	4	4.8, 14.5, 23.0	
18b	Stone	40°39.92'	74°02.50'	4/25-29/59	4	4.8, 14.5, 23	
19A	Weber	40°39.99'	74°01.79'	8/21-25/58	4	6.2, 18.5, 30.8	
19b	Stone	40°40.01'	74°01.2 '	4/25-29/59	4	6.2, 18.5, 30.8	
20	Weber	40°41.62'	74°02.08'	7/08-13/58	5	5, 15, 24	
20b	Stone	40°41.58'	74°02.1 '	5/08-12/59	4	5, 15, 24	
21	Weber	40°41.49'	74°01.56'	7/08-13/58	5	6.7, 20.0, 33.3	
21b	Stone	40°41.50'	74°01.50'	5/08-12/59	4	6.7, 20.0, 33.3	

Table 13.--Continued

STATION	C.O. OF SHIP	LAT.(N)	LONG.(W)	DATES OF OBSERVATION	DURATION (DAYS)	DEPTH (FT.)	TYPE OF INSTRUMENT
22	Weber	40°41.16'	74°00.79'	7/09-13/58	4	5, 15, 24	Roberts Radio
22b	Stone	40°41.15'	74°00.83'	5/08-12/59	4	5, 15, 24	Current Meter
22c	Stone	40°41.15'	74°00.81'	9/29-10/4/59	5	5, 15, 24	
23	Weber	40°42.6 '	74°01.6 '	7/08-13/58	5	7.5, 22.5, 37.5	
23b	Stone	40°42.62'	74°01.58'	5/08-12/59	4	7.5, 22.5, 37.5	
25	Weber	40°43.09'	73°58.24'	11/01-05/58	4	5.3, 16.0, 26	
25b	Stone	40°43.06'	73°58.23'	7/30-8/03/59	4	5.3, 16.0, 26	
26	Weber	40°45.06'	74°01.12'	9/09-13/58	4	8.3, 25, 41.7	
26b	Stone	40°45.05'	74°01.1 '	5/28-6/1/59	4	8.3, 25, 41.7	
27	Weber	40°45.04'	74°00.79'	9/09-13/58	4	6.8, 20.5, 34.2	
27b	Stone	40°45.03'	74°00.82'	5/28-6/3/59	6	6.8, 20.5, 34.2	
28	Weber	40°48.13'	73°47.26'	10/27-31/58	4	12.5, 37.5, 62.5	
28b	Stone	40°48.11'	73°47.28'	6/24-28/59	4	12.5, 37.5, 62.5	
29	Weber	40°48.00'	73°47.08'	10/27-31/58	4	12.5, 37.5, 62.5	
29b	Stone	40°48.00'	73°47.06'	6/24-28/59	4	12.5, 37.5, 62.5	
30	Weber	40°46.6 '	73°56.5 '	12/07-08/58	1	8.3, 25, 41.7	
31	Weber	40°46.6 '	73°56.3 '	12/08-13/58	5	12.5, 37.5, 62.5	
32	Weber	40°47.08'	73°56.32'	12/08-11/58	3	8, 16	
32b	Stone	40°47.08'	73°56.32'	7/23-27/59	3	8, 16	
33	Weber	40°47.47'	73°54.88'	12/02-06/58	4	6.2, 18.5, 30.8	
33b	Stone	40°47.48'	73°54.88'	7/23-27/59	4	6.2, 18.5, 30.8	
33c	Stone	40°47.48'	73°54.88'	10/27-31/59	4	6.2, 18.5, 30.8	
34	Weber	40°47.4 '	73°54.8 '	12/02-07/58	5	6.2, 18.5, 30.8	
34b	Stone	40°47.43'	73°54.8 '	7/23-27/59	4	6.2, 18.5, 30.8	
34c	Stone	40°47.43'	73°54.78'	10/27-31/59	4	6.2, 18.5, 30.8	
35	Weber	40°48.30'	73°55.85'	12/02-06/58	4	6.7, 13.3	
35b	Stone	40°48.28'	73°35.83'	7/23-27/59	4	6.7, 13.3	
36	Weber	40°47.94'	73°54.3 '	11/18-23/58	5	11.0, 33.0, 55.0	
36b	Stone	40°47.93'	73°54.36'	7/09-13/59	4	11.0, 33.0, 55.0	

Table 13.--Continued

STATION	C.O. OF SHIP	LAT.(N)	LONG.(W)	DATES OF OBSERVATION	DURATION (DAYS)	DEPTH (FT.)	TYPE OF INSTRUMENT
37	Weber	40°47.82'	73°54.14'	11/18-23/58	5	6.2, 18.5, 30.8	Roberts Radio Current Meter
37b	Stone	40°47.82'	73°54.13'	7/09-13/59	4	6.2, 18.5, 30.8	
38	Weber	40°47.18'	73°53.53'	11/18-22/58	4	4.5, 13.5, 21.0	
38b	Stone	40°47.18'	73°53.53'	7/09-13/59	4	4.5, 13.5, 21	
39	Weber	40°48.04'	73°51.07'	10/27-31/58	4	12.5, 37.5, 62.5	
39b	Stone	40°48.03'	73°51.06'	6/24-28/59	4	12.5, 37.5, 62.5	
40	Weber	40°51.07'	73°57.29'	9/09-14/58	4	7.7, 15.3	
40b	Stone	40°50.2 '	73°57.65'	5/28-6/2/59	4	8.3, 25	
41	Weber	40°51.02'	73°57.01'	9/09-13/58	4	10.7, 32, 53.4	
41b	Stone	40°50.1 '	73°57.26'	5/28-6/1/59	4	7.7, 32, 38.3	
42	Weber	40°50.68'	73°55.47'	9/22-26/58	4	7.3, 14.7	
42b	Stone	40°52.68'	73°55.45'	6/02-06/59	4	7.3, 14.7	
43	Weber	40°54.15'	73°55.63'	9/22-26/58	4	7.3, 14.7	
43b	Stone	40°54.13'	73°55.6 '	6/02-06/59	4	7.3, 14.7	
44	Weber	40°54.05'	73°55.17'	9/22-26/58	4	7.7, 23, 38	
44b	Stone	40°54.05'	73°55.18'	6/02-06/59	4	7.7, 23.0, 38.3	
45	Weber	41°04.58'	73°53.00'	10/07-11/58	4	7.3, 22, 36.7	
45b	Stone	41°04.56'	73°52.98'	6/17-21/59	4	7.3, 22, 36.7	
46	Weber	41°09.70'	73°54.81'	10/07-12/58	5	5.7, 17.0, 28	
46b	Stone	41°09.7 '	73°54.82'	6/17-21/59	4	5.7, 17.0, 28	
47	Weber	41°09.92'	73°54.38'	10/07-12/58	5	5.2, 15.2, 25	
47b	Stone	41°09.9 '	73°54.38'	6/17-21/59	4	5.2, 15.2, 25	
48	Weber	41°22.01'	73°57.51'	10/12-16/58	4	12.5, 37.5, 62.5	
48b	Stone	41°22.00'	73°57.55'	4/20-24/59	4	12.5, 37.5, 62.5	
49b	Stone	40°44.38'	73°58.16'	7/30-8/3/59	4	7.5, 22.5, 37.5	
50b	Stone	40°38.86'	74°05.96'	9/29-10/3/59	4	5, 15, 24	

Table 13.--Concluded

STATION	C.O. OF SHIP	LAT.(N)	LONG.(W)	DATES OF OBSERVATION	DURATION (DAYS)	DEPTH (FT.)	TYPE OF INSTRUMENT
51	Weber	40°48.26'	73°47.83'	10/12-16/59	4	7.5, 22.5, 37.5	Roberts Radio Current Meter
52b	Stone	40°48.13'	73°47.88'	10/12-16/59	4	7.7, 23, 38.3	
53b	Stone	40°48.01'	73°47.92'	10/12-17/59	5	8.3, 25, 41.7	
54b	Stone	40°47.88'	73°47.97'	10/12-17/59	5	10, 30, 50	
55b	Stone	40°38.75'	74°05.96'	9/29-10/3/59	4	6.3, 19, 31.7	
1	De Rycke	40°45.74'	73°57.24'	10/20-30/70	10	10, 35, 60	
2	De Rycke	40°45.58'	73°57.27'	10/20-30/70	10	10, 18, 55	
3	De Rycke	40°45.49'	73°57.08'	10/20-30/70	10	10, 18, 38	

Table 14.--NOS Historical Tide Data After 1930

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
New York, Hudson R., NY	40°45.8'	74°00.2'	May-Dec. 1932, Jan. 1933
New York, Hudson R., NY	40°46.8'	73°59.4'	June-Dec. 1932, Jan. 1933
New York, Hudson R., NY - W. 98th	40°47.9'	73°58.6'	May-Dec. 1932, Jan. 1933
New York, Hudson R., NY - W. 129th St.	40°49.1'	73°57.7'	June-Dec. 1932, Jan. 1933
New York, Hudson R., NY - 156th St. Pier	40°50.1'	73°57.0'	May-Dec. 1932, Jan. 1933
New York City - 157th St.	40°50.2'	73°56.5'	Aug. 30-Sept. 27, 1930
New York, Hudson R., NY	40°51.0'	73°56.9'	June-Oct. 1932
New York, Hudson R., NY - Chambers St., Pier 20	40°43.0'	74°00.9'	May-Dec. 1932, Jan. 1933
New York, Hudson R., NY	40°43.9'	74°00.9'	May-Dec. 1932, Jan. 1933
Hudson R., Dyckman St. Ferry	40°52.1'	73°56.0'	June-Dec. 1932, Jan. 1933
Dyckman St. Ferry Slip - Hudson R., NY	40°52.1'	73°56.0'	Jan. 25-Apr. 25, 1939
Astoria, Potcove, NY - 100 ft. south of Hoyt Ave.	40°46.6'	73°55.8'	Apr.-Oct. 1932
Astoria, Potcove, Marchette Marble Co. Pier	40°46.6'	73°55.9'	Sept.-Oct. 1932
Astoria Ferry, J. A. Scriven Co.	40°46.5'	73°56.3'	Apr.-Dec. 1932, Jan. 1933
Astoria, Gibbs Point, NY	40°46.1'	73°56.4'	Apr. 1932, Aug.-Dec. 1932, Jan. 1933
Astoria, NY, Hell Gate Bridge	40°46.9'	73°55.3'	Apr. 1932
Astoria, Hallets Cove, NY	40°46.2'	73°56.1'	Apr. 1932, Oct.-Dec. 1932, Jan. 1933
Astoria, Power Co. Dock, NY	40°47.2'	73°55.0'	1932 Aug.-Dec., Jan. 1933
Atlantic Beach, L.I., NY	40°35.6'	73°44.5'	June 8-26, 1950
Baldwin Parsonage Cove, L.I.	40°38.0'	73°37.0'	Aug. 26, 1949
Barren Island, Jamaica Bay, Municipal Airport Dock, NY	40°35.0'	73°53.0	May 26-28, 1942, Apr. 1-Aug. 11, 1943
The Battery, NY, NY	40°42.0'	74°01.0'	1968-1974
New York Battery	40°42.0'	74°01.0'	1938 Oct. to 1958 Jan., May 1958 to Dec. 1967

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
Beach Channel Bridge, Rockaway Beach	40°35.3'	73°49.1'	1934, June 26-July 23, Aug. 15, 16, 17, 1934, Oct. 15, 19, 1934, Oct. 24-30, 1945 (Staff)
Blackwells I., Westside Dock North or Queensboro Bridge	40°45.5'	73°57.3'	May-Aug. 1932, Dec. 1932, Jan. 1933
Blackwells I., NY Dock SW Tip	40°45.1'	73°57.6'	May-Aug. 1932
Blackwells I., NY, Eastside 1000 ft. N. of Queensboro Br.	40°45.5'	73°57.1'	May-Aug. 1932, Dec. 1932, Jan. 1933
Blackwells I., Eastside, NY	40°46.1'	73°56.6'	Apr. 1932
Blackwells I., Westside, NY 500 ft. south of North Light	40°46.3'	73°56.5'	Apr. 1932
Bronx Kill, NY	40°47.9'	73°55'	July 28-Aug. 9, 1932
Brooklyn (South side of Erie Basin, outside) NY, Crane Ship Yard	40°39.9'	74°01.1'	Apr.-May 1932
Fort Hamilton, NY	40°36.5'	74°02.1'	Jan.-Dec. 1930
Fort Hamilton, NY			Continuous Data from 1921 Apr. to Dec. 1930
Fort Hamilton, NY			Continuous Data from Jan. 1902 to Dec. 1911
Fort Schuyler, Throgs Neck	40°48.23'	73°47.57'	May 1932-April 1933, Dec. 12, 1951-Mar. 1, 1952
Fort Wadworth (Staten Is.)	40°36.40'	74°03.28'	July 1931, May-Sept. 1932, Feb.-Apr. 1933, Dec. 19, 1951-Mar. 12, 1952
Fort Wadworth (Staten Is.), South Dock	40°36.4'	74°03.3'	Apr.-May 1932
Freeport, L.I.			July 15-31, 1966
Freeport, L.I., Baldwin Bay	40°38.0'	73°35.2'	July 5-23, 1934, July 3, 26, 27, 30, 31, Aug. 22, Oct. 1, 1934, July 12-Sept. 14, 1949
Blackwells I., Westside	40°45.9'	73°57.0'	Apr.-Aug. 1932, Jan. 1933

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
Gerritsen Creek, Rockaway Inlet	40°38.6'	73°55.9'	Aug. 6-28, 1934
Governors I., NY	40°41.4'	73°00.7'	May-Sept. 1932, Oct. 10-15, 1975
Governors I., NY			Continuous Data from Dec. 1852 to May 1879
Gross Hassock Channel (Jamaica Bay)	40°36.5'	73°47.1'	Sept. 29-Oct. 4, 1932, Oct. 12-29, 1945
Great Gull Island			Aug. 8-9, 1971
Greenpoint, NY, Quay St. Liberty Dock Co.	40°43.6'	73°57.6'	May-Nov. 1932
Greenpoint, NY, Dupont St.	40°44.1'	73°57.7'	May-Nov. 1932
Bronx, Harlem R. 3rd Ave. Bridge	40°48.5'	73°55.9'	May-July 1932
Harlem R. 4th Ave. Bridge, Fire Dock	40°48.7'	73°56.1'	May-Dec. 1932, Jan. 1933
Harlem R. Academy St.	40°51.5'	73°55.2'	May-Dec. 1932, Jan. 1933
Bronx, Harlem R., 400 ft. east of Broadway Bridge	40°52.4'	73°54.6'	June-Dec. 1932, Jan. 1933
High Bridge, Harlem R.			May 1932-Apr. 1933
Harlem R., NY, Interboro R.R. Yard	40°50.1'	73°56.1'	June-Dec. 1932, Jan. 1933
Bronx, Harlem R. Consolidated Electric Subway Co.	40°48.9'	73°56.0'	May-Aug. 1932
Sputyten Duyvil, Harlem R. Johnson Iron Works	40°52.5'	73°55.3'	June-Dec. 1932, Jan. 1933
Washington Bridge, Bronx, Harlem R.	40°50.8'	73°55.7'	May-Dec. 1932, Jan. 1933
Willis Ave. Bridge, Harlem R.	40°48.2'	73°55.7'	May 1932-Apr. 1933
East 120th St., Harlem R.	40°47.8'	73°55.8'	Apr., Nov.-Dec. 1932, Jan. 1933
East 125th St., Harlem R.	40°48.1'	73°55.8'	Apr.-Dec. 1932, Jan. 1933
145th St. Bridge, Bronx	40°49.2'	73°56.0'	May-Dec. 1932, Jan. 1933
Bronx, Harlem R., Macombs Dam Bridge	40°49.7'	73°56.0'	June-Dec. 1932, Jan. 1933
Bronx, Harlem R., opp. West 190th St.	40°51.2'	73°55.4'	June-July 1932

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
207th St., Harlem R., NY	40°51.8'	73°55.0'	June-Aug. 1932, Dec. 1932, Jan. 1933
W-215th St., Harlem R.	40°52.1'	73°54.7'	June-Dec. 1932, Jan. 1933
Hunters Point, NY	40°44.4'	73°57.7'	Nov. 29, 1951-Jan. 2, 1953
International Airport, Jamaica Bay	40°37.44'	73°47.0'	June 20-July 21, 1950
Lawrence Point, NY	40°47.5'	73°54.6'	Apr.-Dec. 1932, Jan. 1933
Long I. City, 3rd St., R. R. Pier	40°44.6'	73°57.7'	May-Aug., Dec. 1932, Jan. 1933
Long I. City, Newtown Creek, NY	40°44.4'	73°57.3'	May-Aug., Dec. 1932
Long I. City, 14th St., Warner-Quinlan Co.	40°45.1'	73°57.3'	May-Aug., Dec. 1932, Jan. 1933
Long I. City, NY, Freeman Ave.	40°45.6'	73°56.8'	May-Dec. 1932, Jan. 1933
Malba, L. I., NY, Malba Pier, east of Powell Cove	40°47.9'	73°49.9'	Aug.-Sept. 1932
Manhattan Beach, Rockaway Inlet			Nov. 27, 1951-Jan. 2, 1953
Mill Basin, Jamaica Bay	40°37'	73°55'	Aug. 3-25, 1934
Mott Basin, Jamaica Bay, L.I.	40°36.7'	73°45.6'	July 10-17, 1934, July 3, 17, Aug. 17, 20, 1934, June 19-July 10, 1950
Motts Creek, Jamaica Bay, NY	40°37.95'	73°44.4'	Sept. 19-Nov. 6, 1945
New Rochelle, NY	40°53.6'	73°46.9'	Jan.-May, July-Dec. 1967, Jan. 1968-Nov. 1970, Jan.-July, Oct. 1971, Jan. 1972-Sept. 1973, Jan.-Dec. 1974
	40°53.6'	73°46.9'	July 18-Dec. 31, 1957, Jan. 1958-July 1963, Oct.-Dec. 1963, Jan. 1964-Oct. 1965, Dec. 1965, Mar.-Apr. 1966, June-Dec. 1966
Long I. City, Newtown Creek, NY Greenpoint Ave. Bridge	40°46'	73°59'	May-Aug. 1932, Dec. 1932, Jan. 1933

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
Newtown Creek, English Kills, NY Metropolitan Ave. Bridge	40°43'	73°55'	May-Dec. 1932, Jan. 1933
North Beach (Airport) L.I.	40°46.8'	73°52.7'	July-Oct. 1932
North Beach, Bowery Bay, NY	40°46.4'	73°52'	July 15-25, 1932, Sept. 6-Oct. 4, 1933
North Brother Is., East R.	40°48'	73°54'	Sept. 29-Oct. 31, 1933
North Brother Is., South Side, NY	40°48.0'	73°54.0'	July-Dec. 1932, Jan. 1933
North Brothers Is., West Side	40°48.1'	73°54.0'	July-Dec. 1932, Jan. 1933
Norton Point, Coney Is.	40°35'	74°01'	July 11-18, Aug. 30-Nov. 1, 1934 June 5-Aug. 3, 1945, June 21-29, 1950
Plumb Beach Channel, Jamaica Bay, L.I.	40°35'	73°55'	Aug. 16-Sept. 21, 1950
Port Morris, NY	40°48.1'	73°54.4'	Dec. 4, 1951-Jan. 1, 1953
Port Morris, East 132nd St.	40°47.9'	73°54.6'	Apr. 1932, Oct.-Dec. 1932, Jan. 1933
Port Morris, Gates Lumber Yard, Pier #4	40°48.4'	73°53.5'	June-Dec. 1932, Jan. 1933
Port Washington	40°50'	73°42'	June 29-Sept. 11, 1934
Princes Bay, Staten Is.	40°31'	74°12'	Sept. 13-Oct. 4, 1934
North Channel Bridge, Ramblesville, Jamaica Bay, L.I.	40°38.7'	73°50.2'	July 10, 13, 16, 20, 31-Aug. 2, 3, 1934, June 18-July 21, 1958
Randalls (E. 132nd St.) NY	40°47.7'	73°55.2'	Apr. 1932
Randalls I., N.W. end, Police Pier	40°48.0'	73°55.7'	Apr. 1932
Randalls I., West Side, opp. East 122nd St.	40°47.9'	73°55.7'	Apr. 1932
Randalls I., Southwest Pier	40°47.6'	73°55.7'	Apr. 1932
Rikers Is., East River, NY	40°47.92'	73°53.33	July 13-26, 1932
Rikers Is., East River, NY, North Side	40°47.9'	73°53.3'	Aug.-Dec. 1932, Jan. 1933
Rosebank, S. I., NY, Quarantine Basin	40°36.7'	74°03.3'	May 1932
St. George, S.I., NY, B&O R. R., Pier 7	40°38.7'	74°04.5'	Apr.-Dec. 1932, Jan. 1933

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
St. George, S.I.	40°38.58'	74°04.3'	May-Dec. 1932, Sept. 13-Oct. 23, 1934
Stapleton, S.I., Between Piers 13 & 14	40°37.6'	74°04.4'	Apr.-May, Aug.-Dec. 1932, Jan. 1933
Stapleton, S.I., Pier 7	40°38.2'	74°04.4'	Apr.-May, 1932
Throgs Neck (Fort Schuyler), Wading River	40°48'	73°47'	July 2-Nov. 18, 1930, Jan. 10-June 1968
Wards I., East Side, Hell Gate Bridge	40°47.5'	73°55.4'	Aug.-Oct., Apr. 1932
Wards I., N.W. Corner	40°47.5'	73°55.8'	Apr., Aug.-Oct. 1932
Brooklyn (51st Street) NY, Bush Terminal	40°39.1'	74°01.3'	Apr.-Dec. 1932, Jan. 1933
Brooklyn (66th St.) NY, Brooklyn Edison Plant	40°38.6'	74°02.0'	Apr.-Dec. 1932, Jan. 1933
Brooklyn (83rd St.) NY Cresceot Athletic Club	40°37.7'	74°02.5'	Apr.-Dec. 1932, Jan. 1933
Brooklyn (92nd St.) NY	40°37.2'	74°02.5'	Apr.-Dec. 1932
Brooklyn (16th Ave.) NY, Hazell Basin	40°36.2'	74°00.8'	Apr.-Oct. 1932
Brooklyn East R. Recreation Pier, North 2nd St.	40°43.1'	73°58.0'	Apr. 1932
Several Stations in Brooklyn Area			1932-1933
Brooklyn Navy Yard	40°42.3'	73°58.7'	July 1943-Dec. 1945
Canarise Beach, Jamaica Bay, L.I.	40°38.0'	73°53.0'	Sept. 26-Oct. 3, 1932
Canarise Beach, Jamaica Bay, L.I.	40°37.8'	73°53.0'	July 18-Aug 6, 1934, Oct. 4, 1934, July 10-13, 1950
Clason Point Pier, NY	40°48.2'	73°51.2'	July-Dec. 1932, Jan.-Apr. 1933
Clifton, S.I., NY	40°37.2'	74°04.1'	Apr.-Nov. 1932, Jan. 1933
College Point, East River., L.I.	40°47'	73°52'	Sept. 1-Oct. 31, 1933, June 20-July 20, 1934, Dec. 12, 1951 Mar. 13, 1952
College Point, L.I., Dry Dock, Pier #1	40°47.7'	73°50.7'	June-Dec. 1932, Jan. 1933

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
College Point, L.I., Ferry Slip	40°47.1'	73°51.6'	May-Dec. 1932, Jan. 1933
East River, NY, Emerson Ave., 5000 ft. east of Westchester Creek	40°48.7'	73°49.6'	Aug.-Sept. 1932
East River, NY, 1200 ft. west of west boundary of Ft. Schuyler	40°48.8'	73°48.8'	Aug.-Sept. 1932
Hunts Point, East River, NY	40°48.1'	73°52.5'	May-July 1932
Mill Rock, East River, NY	40°46.83'	73°56.35'	May 1932-April 1933, Oct. missing
East River, Cuylers Lane Pier	40°42.1'	74°00.5'	Apr. 1932, June-Dec. 1932, Jan. 1933
New York, East R. Pier 16, Fulton St.	40°42.3'	74°00.2'	Apr. 1932, June-Dec. 1932, Jan. 1933
New York, East R. Pier 27, Catherine Slip	40°42.5'	73°59.7'	Apr.-Dec. 1932, Jan. 1933
New York, East R. Pier 36, Jefferson St.	40°42.6'	73°59.3'	Apr. 1932, Aug.-Dec. 1932, Jan. 1933
New York, East R. Pier 44, Jackson Pt.	40°42.6'	73°58.9'	Apr. 1932, Nov.-Dec. 1932, Jan. 1933
NY, East R. Pier 50, Rivington St.	40°43.0'	73°58.8'	Apr.-Dec. 1932
NY, East R. Pier 57, 5th St.	40°43.7'	73°58.5'	Apr. 1932, Nov.-Dec. 1932, Jan. 1933
NY, East R., Willard Parker Hospital	40°43.8'	73°58.4'	May-Dec. 1932, Jan. 1933
NY, East R., East 29th St.	40°44.1'	73°58.4'	May-Dec. 1932, Jan. 1933
NY, East R., East 40th St.	40°44.8'	73°58.2'	May-Dec. 1932, Jan. 1933
NY, East R., East 49th St.	40°45.2'	73°57.9'	May-Dec. 1932, Jan. 1933
NY, East R., East 61st St.	40°45.6'	73°57.5'	May-Dec. 1932, Jan. 1933
NY, East R., East 80th St.	40°46.2'	73°56.8'	Apr. 1932, Dec. 1932, Jan. 1933
NY, East R., East 86th St.	40°46.5'	73°56.6'	Apr. 1932, Aug.-Dec. 1932, Jan. 1933
NY, East R., East 90th St.	40°46.7'	73°56.3'	Apr. 5, 1932 to Jan. 1933, May 15, 1939- Jan. 15, 1939, Dec. 14, 1951-Mar. 20, 1952

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
NY, East R., East 94th St.	40°46.9'	73°56.6'	Apr. 1932
NY, East R., East 100 St.	40°47.1'	73°56.5'	Apr. 1932, Nov.-Dec. 1932, Jan. 1933
NY, East R., East 108th St.	40°47.4'	73°56.2'	Apr. 1932, Nov.-Dec. 1932, Jan. 1933
NY, East R., East 112th St., Jefferson Park	40°47.5'	73°56.1'	Apr.-Dec. 1932, Jan. 1933
E. Rockaway Channel, E. Rockaway, L.I.	40°38.0'	73°39.6'	July 2-10, Aug. 21, July 17, 1934, Apr. 27-June 13, 1950
Far Rockaway, E. Rockaway Inlet, L.I.	40°35.7'	73°44.2'	May 28-Aug. 9, 1934
East Elmhurst (Flushing Bay)	40°46'	73°51.8'	July 25-Aug. 15, 1932, Sept. 7-12, 1933
Northern Boulevard, Flushing Creek, NY, 69th Rd.	40°46'	73°50'	Mar. 30-Aug. 14, 1936 Apr. 15-May 26, 1936
Worlds Fair Yacht Basin Dock Flushing Creek Ent., L.I.	40°45.65'	73°51.0'	Oct. 3-4, 1940
Fort Hamilton, NY	40°36.5'	74°02.1'	Nov. 28, 1951-Jan. 2, 1953
Wards I., West Side	40°47.3'	73°56.0'	Apr. 1932
Wards I., (Main Ferry Wharf), NY	40°47.3'	73°56'	July 19-25, 1932
Wards I., opp. East 103rd St.	40°47.1'	73°56.2'	Apr., Aug. 1932
Wards I., W. W. Corner	40°47.0'	73°56.1'	Apr., Aug.-Sept. 1932
Wards I., S.E. Corner Beacon Light	40°46.9'	73°55.6'	Apr., Aug.-Oct. 1932
Westchester Creek, 300 ft. north of Unionport Bridge	40°49.8'	73°50.6'	June-Dec. 1932, Jan.-Mar. 1933
Westchester Creek, McCullen Coal Co.	40°50.4'	73°50.4'	May-Dec. 1932, Jan.-Mar. 1933
Westchester Creek, LaCombe Ave.	40°49'	73°50'	July-Dec. 1932
Bronx R., Westchester Ave. Bridge	40°50'	73°53'	May-Dec. 1932, Jan. 1933
New York (Whitehall St.)	40°42'	74°00.73'	Jan. 1930-Sept. 1938

Table 14.--Continued

STATION	LATITUDE(N)	LONGITUDE(W)	DATES OF OBSERVATION
Whitestone, L.I., R. R. Pier	40°47.8'	73°48.5'	July-Oct. 1932, Jan. 1971-Dec. 1973
Willets Point	40°47.7'	73°47.0'	July 11, 1931-July 19, 1951, Sept. 20, 1951-Dec., Jan.-July 1952, Sept. 1952-Dec. 1970
Woodmere, L.I., NY	40°37'	73°42'	July 17-Aug. 1, 1934, Aug. 1-Oct. 3, 1934, May 6-June 7, 1980
Bayonne, Upper Bay, N.J.	40°40.6'	74°06.0'	Aug. 11-22, 1932
Bergen Point, Kill Van Kull, N.J.	40°38.7'	74°08.2'	Sept. 6-13, 1932
Carteret, Arthur Kill, N.J.	40°35.2'	74°12.6'	Aug. 23-31, 1932, Dec. 6, 1951, Jan. 1, 1953
Constable Hook, Kill Van Kull, N.J.	40°39.1'	74°05.4'	Aug. 11-23, 1932, Dec. 19, 1951-Mar. 18, 1952
Edgewater, Hudson R., N.J.	40°49.0'	73°58.6'	May-Sept. 1932, Feb. 24-Apr. 22, 1939
Elizabeth, Newark Bay, N.J.	40°39'	74°10'	Sept. 2-10, 1932, Jan. 8-Mar. 21, 1952
Hoboken, N.J.	40°44.95'	74°01.45'	May-Sept. 1932
Jersey City, N.J.	40°43.0'	74°01.9'	May-Sept. 1932
Keansburg, Raritan Bay, N.J.	40°27'	74°09'	Sept. 17-24, 1934
Keyport, Raritan Bay, N.J.	40°26'	74°12'	July 5-Oct. 29, 1934
Port Newark, N.J.	40°41.4'	74°08.0'	Dec. 17, 1951-Jan. 4, 1953, July 2-Oct. 19, 1962
Port Newark Terminal, N.J.	40°42.0'	74°09.2'	Sept. 13-Oct. 22, 1934, May 20-21, 1941
Sandy Hook, N.J.	40°28.0'	74°00.6'	Jan. 1963 to Dec. 1973
Sandy Hook, N.J., (Fort Hancock)	40°28.0'	74°00.6'	Oct. 28, 1932-Dec. 1962
South Amboy, Raritan Bay, N.J.	40°29.5'	74°16.8'	Sept. 24-Nov. 8, 1934, Dec. 6-Jan. 2, 1953

A C K N O W L E D G M E N T S

Members of the Office of Oceanography and Marine Services who contributed information and effort to this report include: Messrs. Alan S. Klavans, Robert C. Nace, Bruce B. Parker, William A. Watson, and Mrs. Carol A. Robinson. Mrs. Robinson typed the drafts and final draft of the tables and text.

REFERENCES

National Ocean Survey, 1981. NOS Strategic Petroleum Reserve Support Project: Final Report. Volume Two - Measurements and Data Quality Assurance, 182 pp.

Plessey Environmental Systems Corp., 1977. Plessey Environmental Systems User Manual, 60 pp.

Parker, Bruce and Bruce, James, 1980. Puget Sound Approaches Circulatory Survey, 98 pp.

Engineering Development Laboratory, 1979. NOS East Coast Current Measuring System, Mooring Sub-System Field Manual, 95 pp.

U.S. Coast and Geodetic Survey, 1950. Manual of Current Observations, S. P. 215, 87 pp.

National Ocean Service. Tidal Current Tables 1982, Atlantic Coast of North America, 231 pp.

U.S. Coast and Geodetic Survey, 1965. Manual of Tide Observations, Pub. 30-1, 72 pp.

U.S. Coast and Geodetic Survey, 1951. Tidal Datum Planes, S. P. 135, 142 pp.

National Ocean Service. Tide Tables 1982, East Coast of North and South America Including Greenland, 285 pp.