NOAA Technical Memorandum NOS OES

EFFECTS OF HURRICANE BOB ON WATER LEVELS

DATA REPORT

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OCEAN AND LAKE LEVELS DIVISION

OFFICE OF OCEAN AND EARTH SCIENCES

NATIONAL OCEAN SERVICE

ROCKVILLE, MARYLAND 20852

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ACKNOWLEDGEMENTS

This report was prepared by Stephen K. Gill and Dale H. Deitemyer, Tidal Analysis Branch, Ocean and Lake levels Division, and represents the cumulative effort of Atlantic Operations Section personnel stationed in Norfolk, VA and headquarters personnel of the Ocean and Lake Levels Division located in Rockville, MD responsible for operating and maintaining the tide stations, and for the priority collection, processing and analysis of data and information.

EFFECTS OF HURRICANE BOB ON WATER LEVELS

DATA REPORT

I. INTRODUCTION

This report documents the water levels observed during the passage of Hurricane Bob along the east coast on August 19 and 20, 1991.

As part of the National Oceanic and Atmospheric Administration (NOAA), National Ocean Service (NOS), the Ocean and Lake Levels Division (OLLD), Office of Ocean and Earth Sciences operates and maintains water level measurement stations; collects, processes, and analyses data; and produces standard time series and water level datum products. OLLD operates a network of approximately 200 long-term continuously operating stations in the U.S. coastal ocean, territories, and possessions, including the Great Lakes, that comprise the National Water Level Observation Network (NWLON). The OLLD water level program also installs, operates and maintains short term water level stations for various special projects for other federal and state agencies.

This report contains information from selected NWLON stations and special project stations in operation during Hurricane Bob. The maximum water elevations recorded during the hurricane are reported and compared to the maximum historical elevations observed over the period of record at each location. Storm surge as defined in this report is the difference between observed and predicted water elevations. Predicted tides are computed using standard NOS harmonic analysis and prediction algorithms. Characteristics of the storm surge at each location are included in this report. Finally, the predicted and observed time series are presented in a set of time series plots.

Structural damage from the hurricane to the tide stations was relatively minor, except for the station at Fort Pond Bay, Montauk, NY. This station was completely destroyed, along with the outer section of the pier. Data were transmitted by satellite up to about three hours before the hurricane passage. The station was destroyed sometime after this. Maximum water levels were

not recorded because the marigram data from the mechanical gauges were destroyed. Levels were run to a nearby high water mark to estimate the storm surge magnitude.

Detailed analyses are not presented in this data report, however some interpretive information is provided to highlight effects of the storm surge on water levels observed at the tide stations.

II. MAXIMUM ELEVATIONS AND DATUM RELATIONSHIPS

Information on the observed maximum water elevations during Hurricane Bob are found in Table I. Appendix 1 is a copy of the best track positions for Hurricane Bob as obtained from a National Weather Service (NWS) preliminary report and Appendix 2 is a set of station location chartlets for each station listed. Table I includes the following information: date, time and height above Mean Lower Low Water (MLLW) and Mean Higher High Water (MHHW) of the maximum elevations; the maximum elevation relationships above National Geodetic Vertical Datum (NGVD); the date and height above MLLW of the maximum historical observed water elevations; and the Mean Great Diurnal Range (GT).

The elevations are referenced to the computed or derived MLLW and MHHW datums at each location. These datums are relative to the 1960-78 National Tidal Datum Epoch. MLLW is the reference datum for NOAA nautical charts and the NOS published tide prediction tables. The MHHW datum is the mean elevation of the higher high tide observed each tidal day. The maximum historical values are based on the entire period of record for each location, which is quite different at each station.

The maximum historical observed water elevations were not exceeded at any location during Hurricane Bob. The maximum elevations referenced to NGVD were observed at Woods Hole, MA; Providence, RI; Newport, RI; and Willets Point, NY. These locations coincide with the locations where maximum storm surges were observed (see section III). Elevation comparisons to MHHW are provided to put the hurricane effects in context with the normal elevation of a tidal high water at each location.

TABLE I. HURRICANE BOB - MAXIMUM OBSERVED WATER LEVEL ELEVATIONS AND HISTORICAL DATA COMPARISON

STATION	DATE/TIME	HURRICANE BOB ELEVATION ABOVE MLLW	MHHW	NGVD	HISTORICAL ELEVATION ABOVE MLLW DATE	ELEV.	DIURNAL RANGE
Portland, ME	8/19 1800	10.55	0.64	5.98	2/78	14.17	9.91
Camp Ellis, ME*	8/19 1754	10.57	0.82	-	-	-	9.75
Biddeford, ME*	8/19 1818	11.28	1.26	-	-	-	10.02
Kennebunkport, ME*	8/19 1748	9.90	0.28	-	-	-	9.62
Boston, MA	8/19 1812	10.55	-0.22	5.20	2/78	15.25	10.33
Woods Hole, MA	8/19 1348	7.33	5.08	6.86	8/54	10.39	2.25
Nantucket, MA	8/19 1530	3.66	0.06	-	1/87	6.58	3.60
Newport, RI	8/19 1330	8.31	4.39	6.91	9/38	13.53	3.92
Providence, RI	8/19 1400	10.32	5.32	8.43	9/38	17.71	4.96
New London, CT	8/19 1248	6.19	3.11	5.12	9/38	10.76	3.08
Bridgeport, CT	8/19 1448	7.59	0.26	4.67	9/38	12.44	7.33
Willets Point, NY	8/19 1548	10.52	2.74	7.36	9/38	16.90	7.78
The Battery, NY	8/19 1724	6.07	0.95	4.19	9/60	10.23	5.12
Sandy Hook, NJ	8/19 1706	6.36	1.16	4.59	3/62	10.33	5.20
Atlantic City, NJ	8/19 1630	5.34	0.66	3.70	9/44	9.20	4.68
Lewes, DE	8/19 1706	5.45	0.72	3.73	3/62	9.49	4.73
Ocean City, MD	8/19 1454	4.75	0.79	2.98	9/85	7.54	3.96
Ches. Bay Brdg., VA	8/19 1424	3.52	0.57	-	4/78	6.36	2.95
Duck Pier, NC	8/19 1436	4.27	0.51	2.69	11/81	6.48	3.76
Charleston, SC	8/18 1500	6.16	0.36	3.73	9/89	12.80	5.80

Notes:
Elevations are in feet (ft.); MLLW is Mean Lower Low Water; NGVD is National Geodetic Vertical Datum; GT is Great Diurnal Range of Tide (MHHW minus MLLW); Times are in EST.
* - Preliminary tidal datum elevations based on one month series.

III. STORM SURGE CHARACTERISTICS

Information on the maximum storm surge measured at each station is found in Table II. Storm surge is defined as the difference between the observed and predicted water level elevations. Predicted water level elevations are computed using standard NOS harmonic analysis and prediction algorithms. The timing of the maximum storm surge is largely dependent upon the timing of interaction of the tide and the storm passage, and the maximum storm surge may not coincide with the occurrence of a predicted tidal high water. Table II provides information for each station on the date and time of the maximum storm surge; the observed elevation of the water above MLLW at that time; the predicted elevation of the water above MLLW at that time; and the storm surge value (observed minus predicted elevations).

Time series of the storm surge are constructed by subtracting the predicted hourly height time series from the observed hourly height time series. Figures 1 through 4 are simultaneous plots of the storm surge for various geographical regions for a five-day time period centered around the time period of the storm track. All of the figures use the same vertical scale (in feet) so that the magnitude of the surge can be put into perspective between stations and regions. Table II and the figures show that storm surge values over 5.00 feet were found at Newport, RI; Providence, RI; and Woods Hole, MA near the landfall of the hurricane. The maximum storm surge value of 6.71 feet was measured at Willets Point, NY, in western Long Island Sound.

Figure 1 shows the southern extent of significant storm surge with Charleston exhibiting a slight difference before and after the storm passage offshore. The storm surge signatures show the effects of the hurricane spread out much more over time than the northern stations due to the distance of the storm track offshore and because the track was parallel to the shoreline. The maximum surges for these stations are generally less than 1.4 feet. The storm surge was slightly higher near the Outer Banks of North Carolina, where the hurricane track was closest to the mainland.

Much more severe storm surge effects are increasingly seen in the New York Bight, New York Harbor, and Western Long Island Sound, as shown in Figure 2. The storm surge signatures in western Long Island Sound are particularly dramatic, given the distance of these stations from the storm track. Based on these signatures and the others from Long Island Sound, it appears that the geometry of the Sound relative to the storm track and associated changes in wind direction allowed for a severe oscillation with significant positive and negative surge as the storm passed up through Rhode Island.

The storm surge signatures near the hurricane landfall at Newport, Providence and Woods Hole are very similar, as shown in Figure 3, with very sharp initial peaks and a short-lived low frequency oscillation afterwards. The signature at Nantucket shows a much lower magnitude storm surge oscillation, probably due to the sheltering effect of Nantucket Island and Nantucket Sound. At landfall the hurricane track was nearly perpendicular to the coastline and the storm was moving at a speed of 28 knots.

The storm surge signatures shown in Figure 4 show the effects of the hurricane after it had weakened and the eye passed over Massachusetts Bay and up the coast. The most intense surge was found at Boston with minimal effects at Portland. Camp Ellis is at the entrance to the Saco River and Biddeford is up near the head of tide where the navigation channel ends. The apparent effects of river runoff and storm surge affected the water levels at Biddeford over a longer duration than nearby stations. Kennebunkport has a similar signature to Biddeford, and it too is located up a river and sheltered from the ocean.

TABLE II. HURRICANE BOB - MAXIMUM STORM SURGE INFORMATION

STATION	DATE/TIME	ELEVATION ABOVE MLLW OBSERVED	PREDICTED	DIFFERENCE
Portland, ME	8/19 1654	10.25	7.68	2.48
Camp Ellis, ME	8/19 1624	9.53	6.67	2.86
Biddeford, ME	8/20 0030	5.43	1.66	3.77
Kennebunkport, ME	8/19 1618	8.79	6.43	2.36
Boston, MA	8/19 1454	8.01	4.38	3.63
Woods Hole, MA	8/19 1348	7.33	1.55	5.78
Nantucket, MA	8/19 1518	3.63	1.62	2.01
Newport, RI	8/19 1306	8.09	2.58	5.51
Providence, RI	8/19 1400	10.28	3.71	6.57
New London, CT	8/19 1230	6.08	1.16	4.92
Bridgeport, CT	8/19 1442	7.54	2.73	4.81
Willets Point, NY	8/19 1536	10.36	3.65	6.71
The Battery, NY	8/19 1742	5.99	4.22	1.77
Sandy Hook, NJ	8/19 1712	6.33	3.99	2.34
Atlantic City, NJ	8/19 1700	5.32	3.63	1.69
Lewes, DE	8/19 1306	4.07	2.78	1.29
Ocean City, MD	8/19 1306	4.34	3.12	1.22
Ches.Bay Brdg., VA	8/19 0106	3.17	2.03	1.14
Duck Pier, NC	8/19 0206	4.17	2.82	1.35
Charleston, SC	8/18 1630	5.68	4.67	1.01

NOTES:
Storm surge is the difference between observed and predicted elevations; Elevations are in feet; MLLW is Mean Lower Low Water datum; Times are in EST.

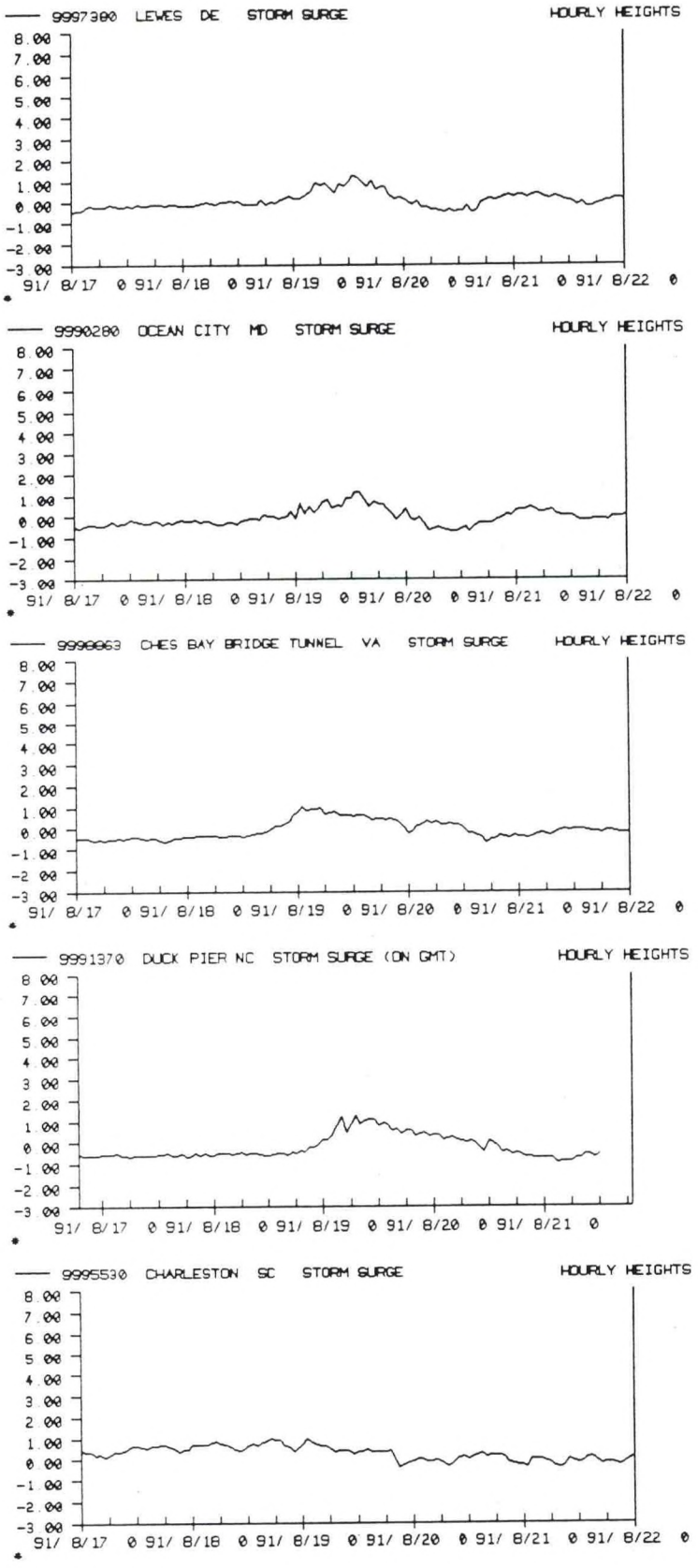


FIGURE 1. HURRICANE BOB STORM SURGE

EASTERN SEABOARD: SOUTH CAROLINA TO DELAWARE

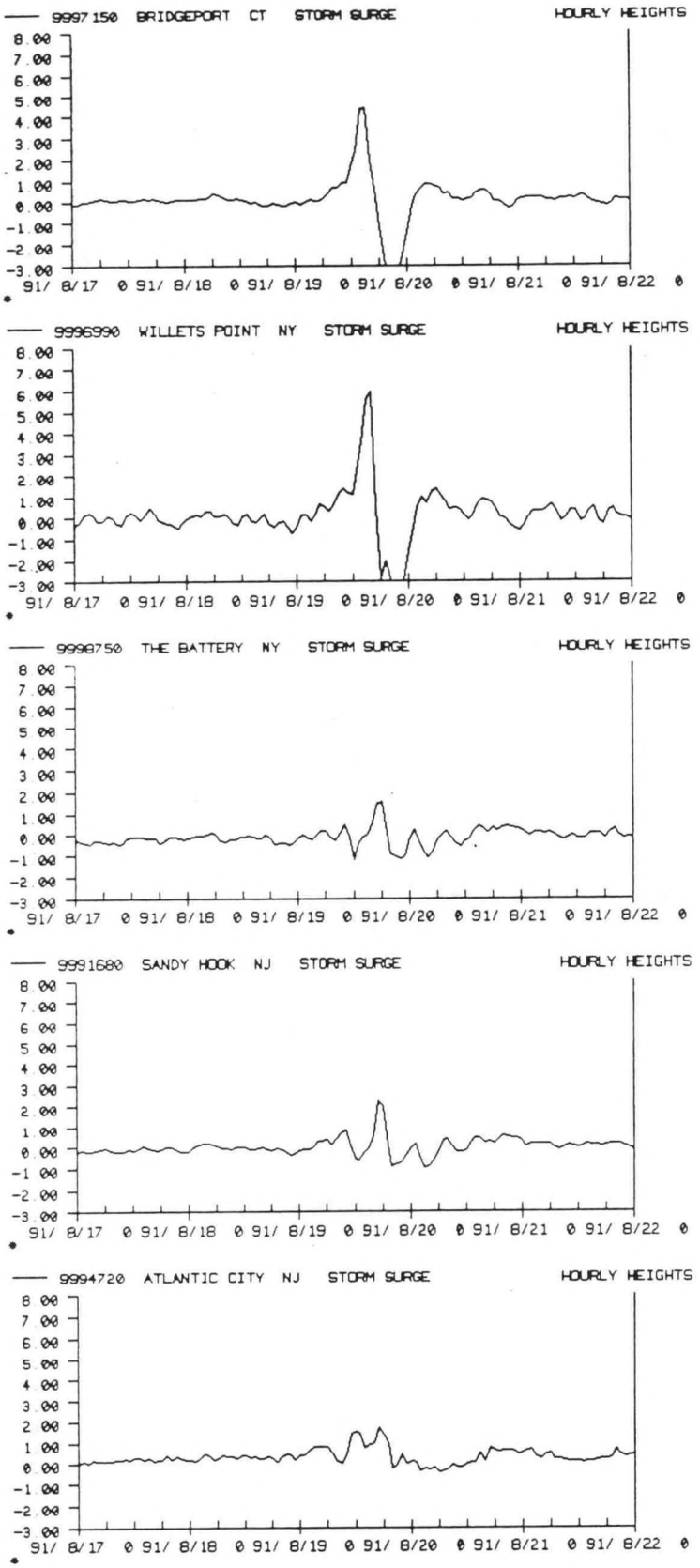


FIGURE 2. HURRICANE BOB STORM SURGE

NEW YORK BIGHT TO WESTERN LONG ISLAND SOUND

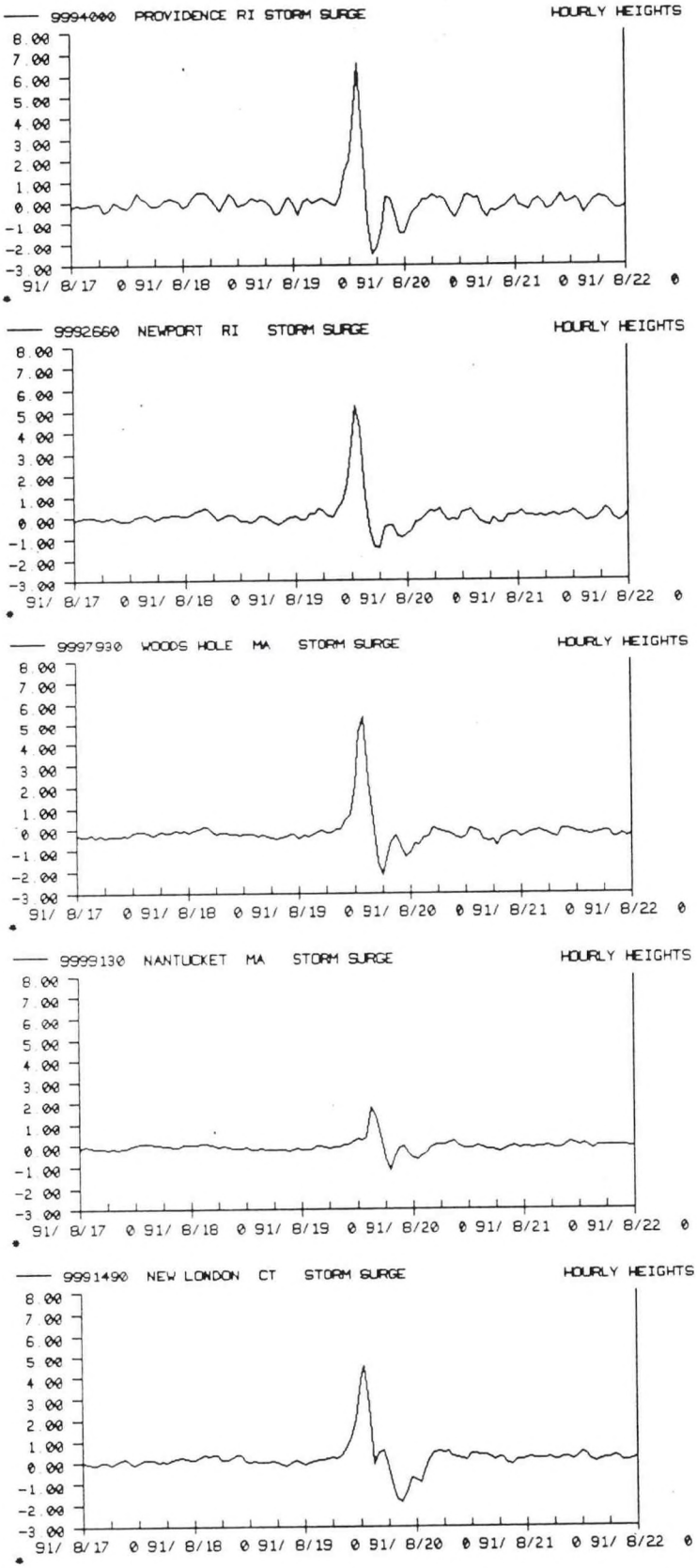


FIGURE 3. HURRICANE BOB STORM SURGE

NARRAGANSETT BAY, BUZZARDS BAY, EASTERN LONG ISLAND SOUND

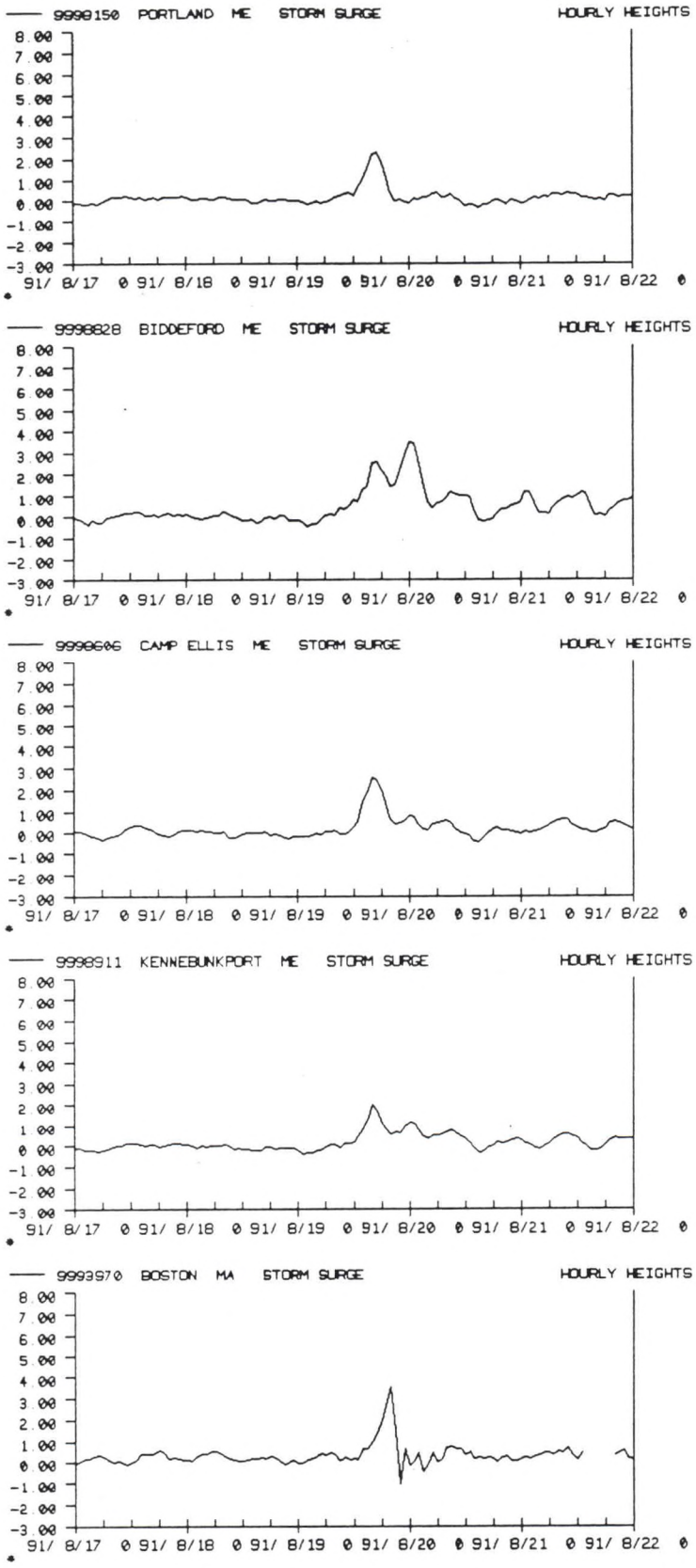
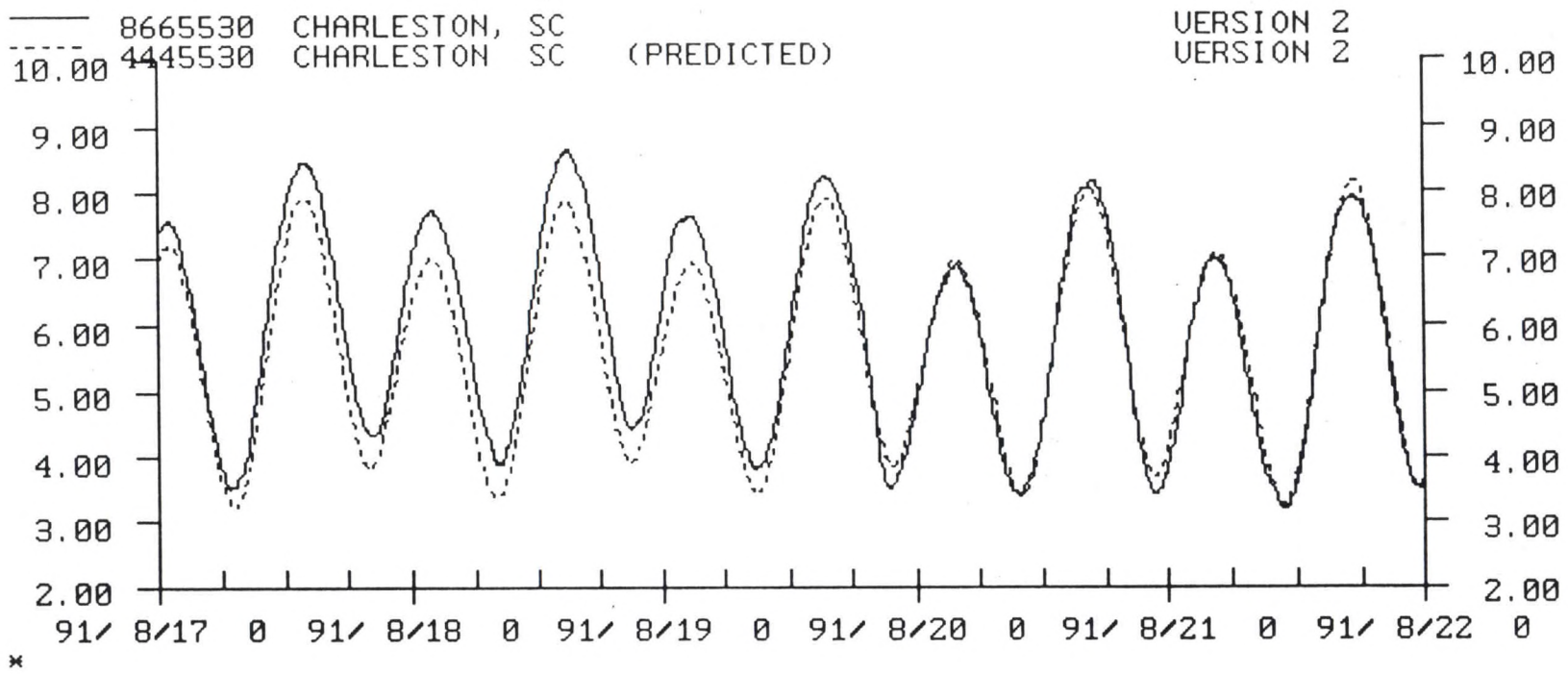


FIGURE 4. HURRICANE BOB STORM SURGE

MASSACHUSETTS BAY AND GULF OF MAINE

IV. COMPARISON PLOTS: OBSERVED VS. PREDICTED

This section is a set of plots showing the observed and predicted simultaneous six-minute interval time series for each station from which the storm surge signatures in Section III were derived. The effects of the storm surge on the expected tide are clearly seen. The effects of the timing of the storm surge effects with the phase of tide can also be seen. For instance the maximum storm surge effects occurred near the time of high tide in New York Harbor, on a rising tide in Long Island Sound, Block Island Sound, and Narragansett Bay, and near the time of high tide from Boston to Portland. The effects of the heavy sea swell and local wave action are also apparent in the 6-minute interval plots at the open exposed locations, such as Duck Pier and Atlantic City. All elevations on the plots are in feet relative to arbitrary datum.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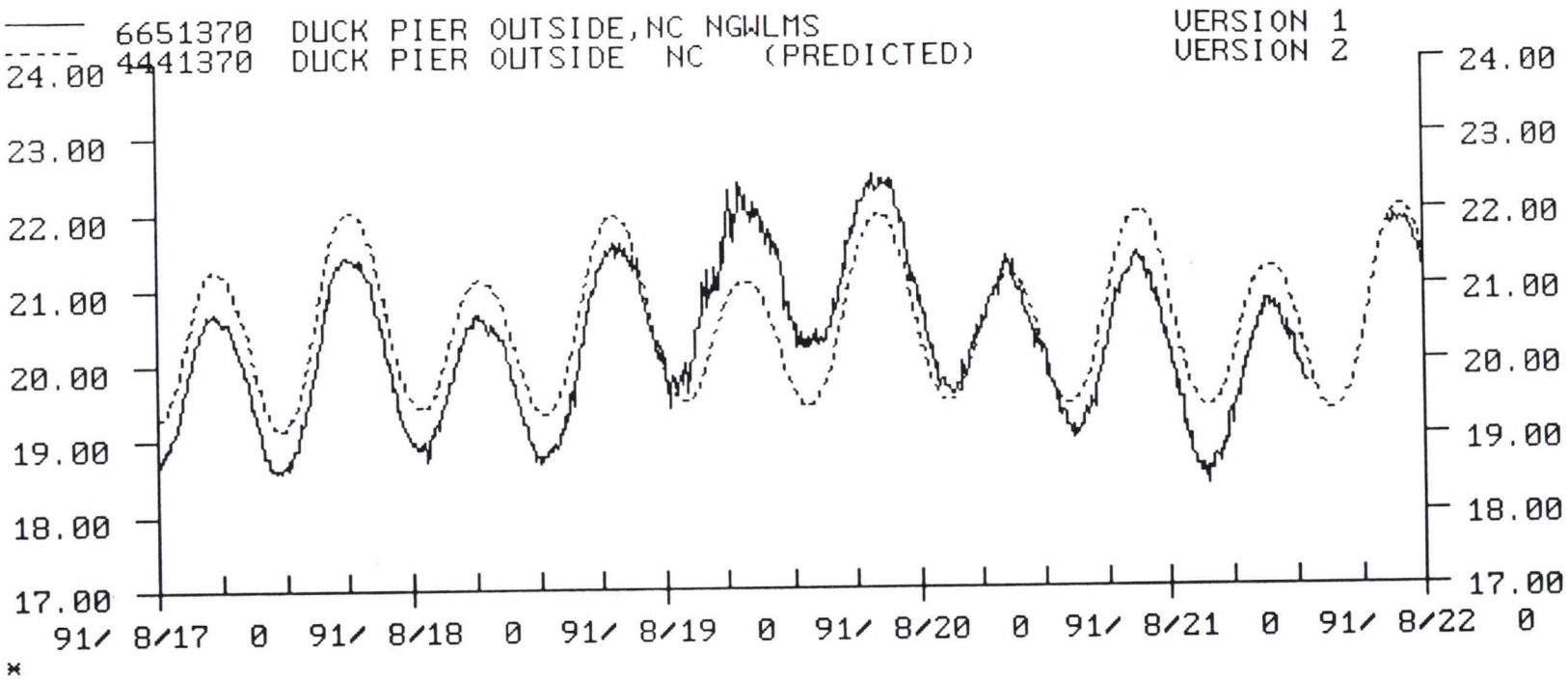
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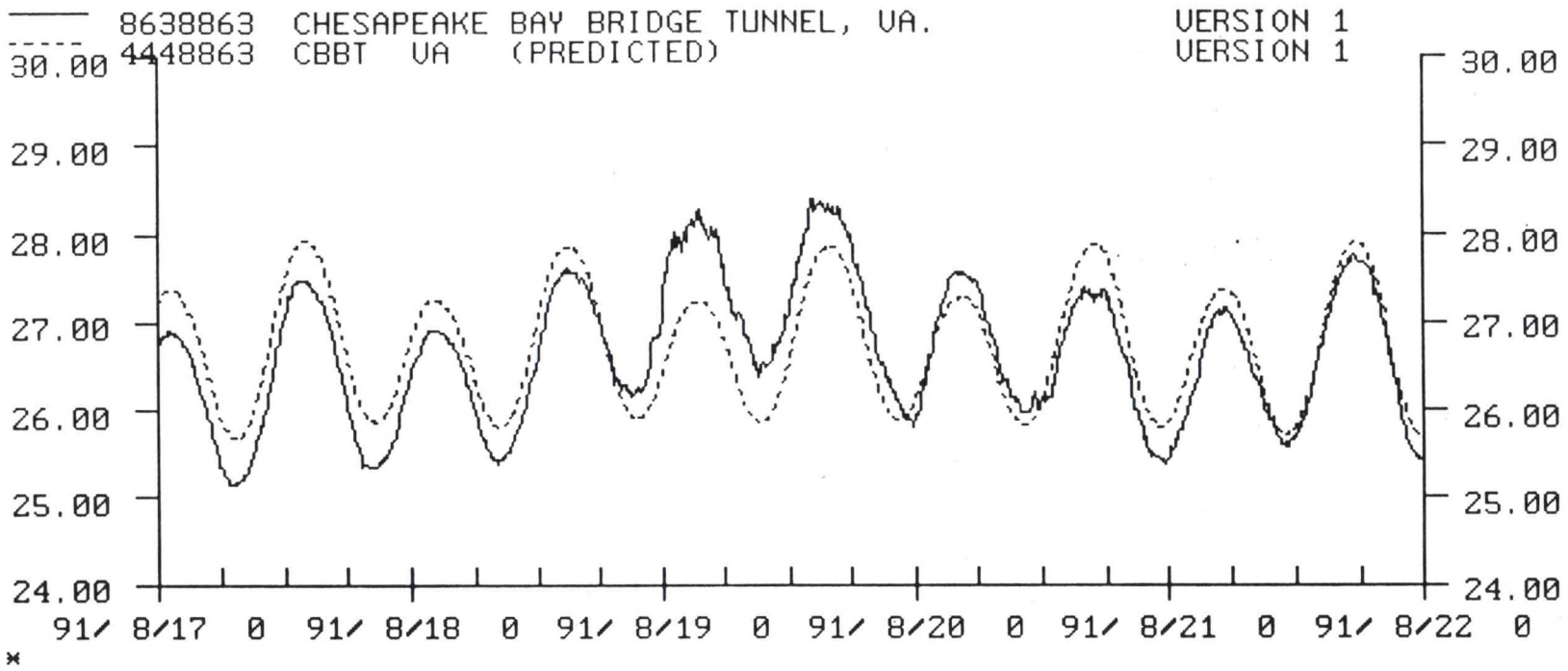
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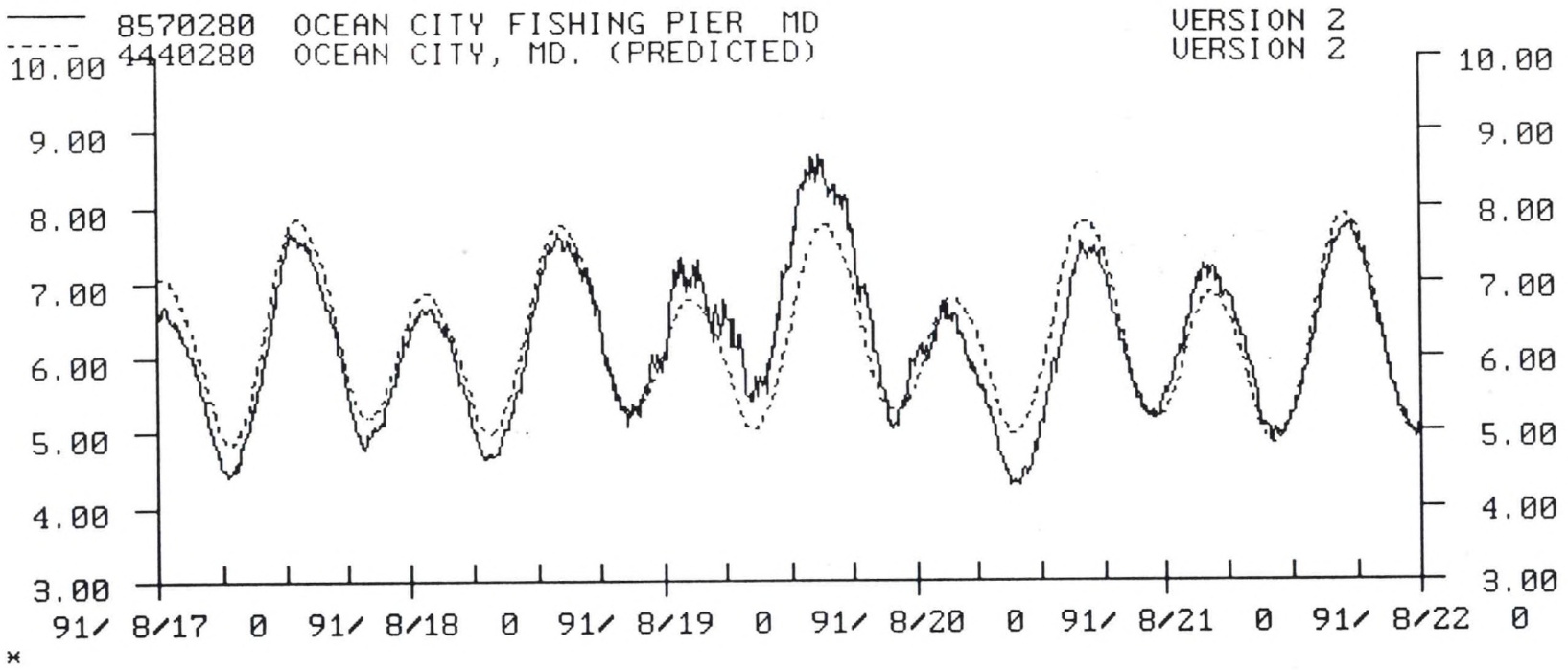
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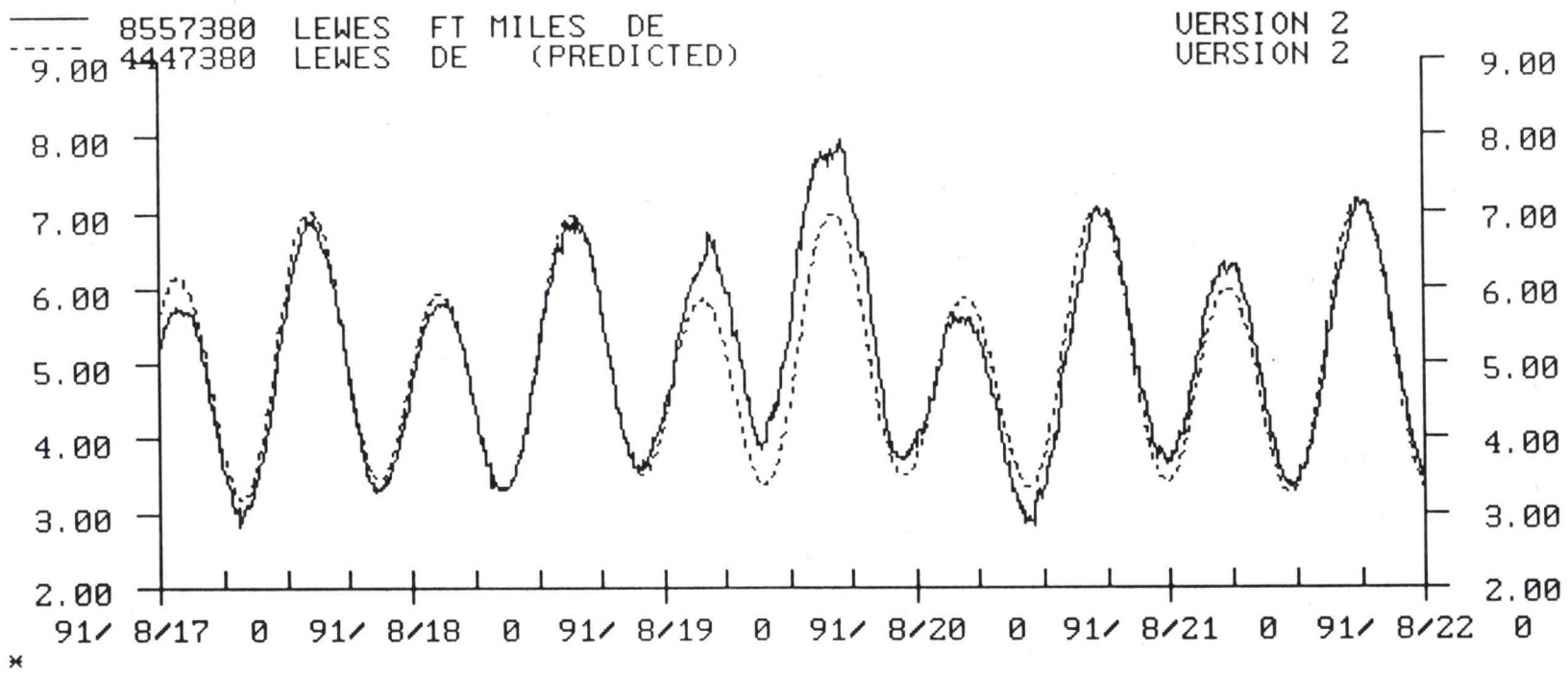
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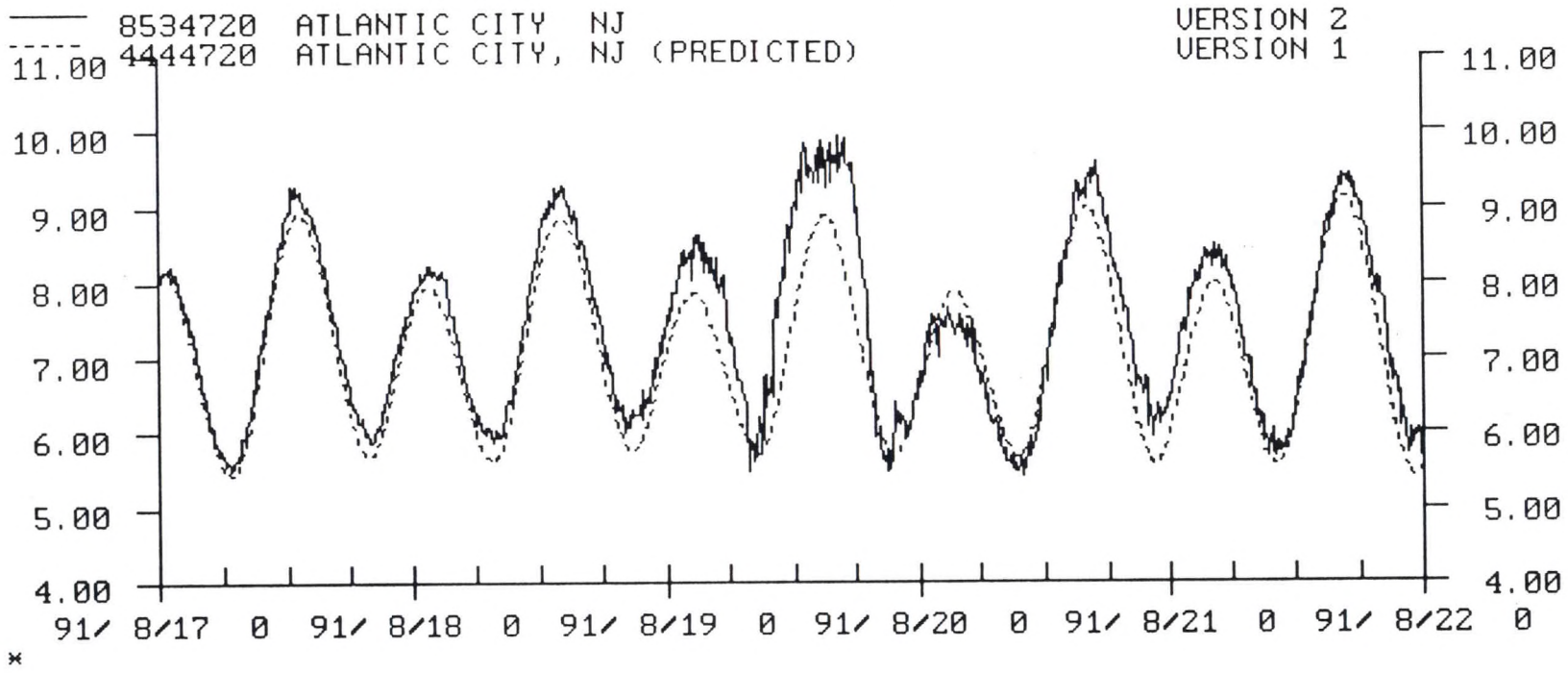
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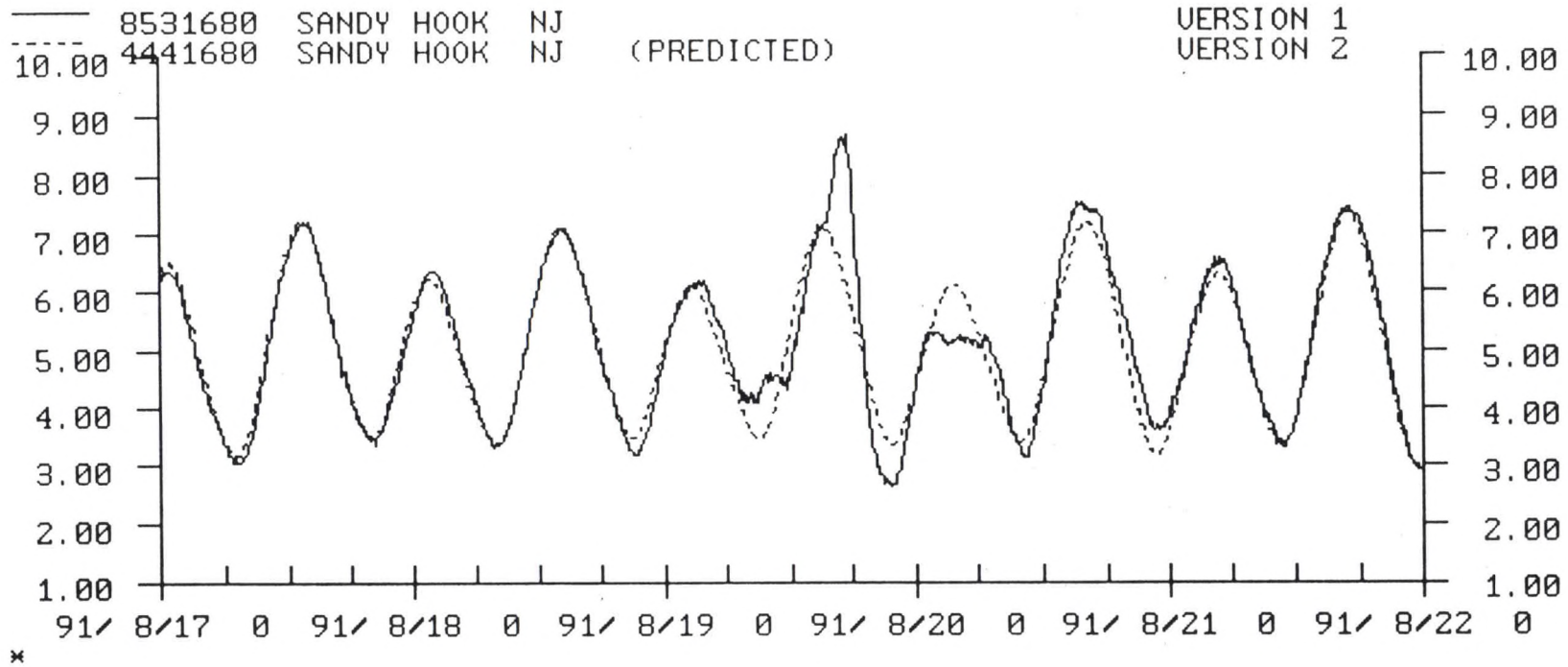
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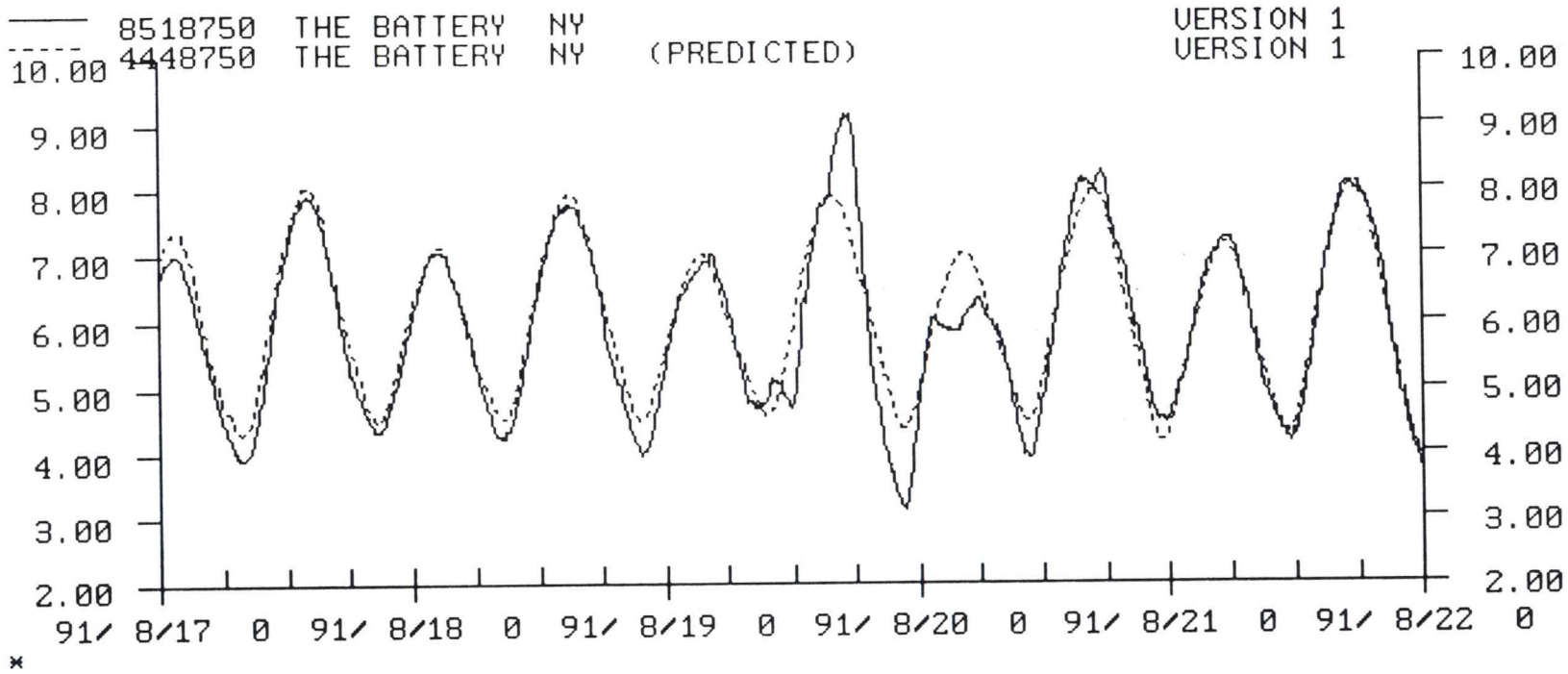
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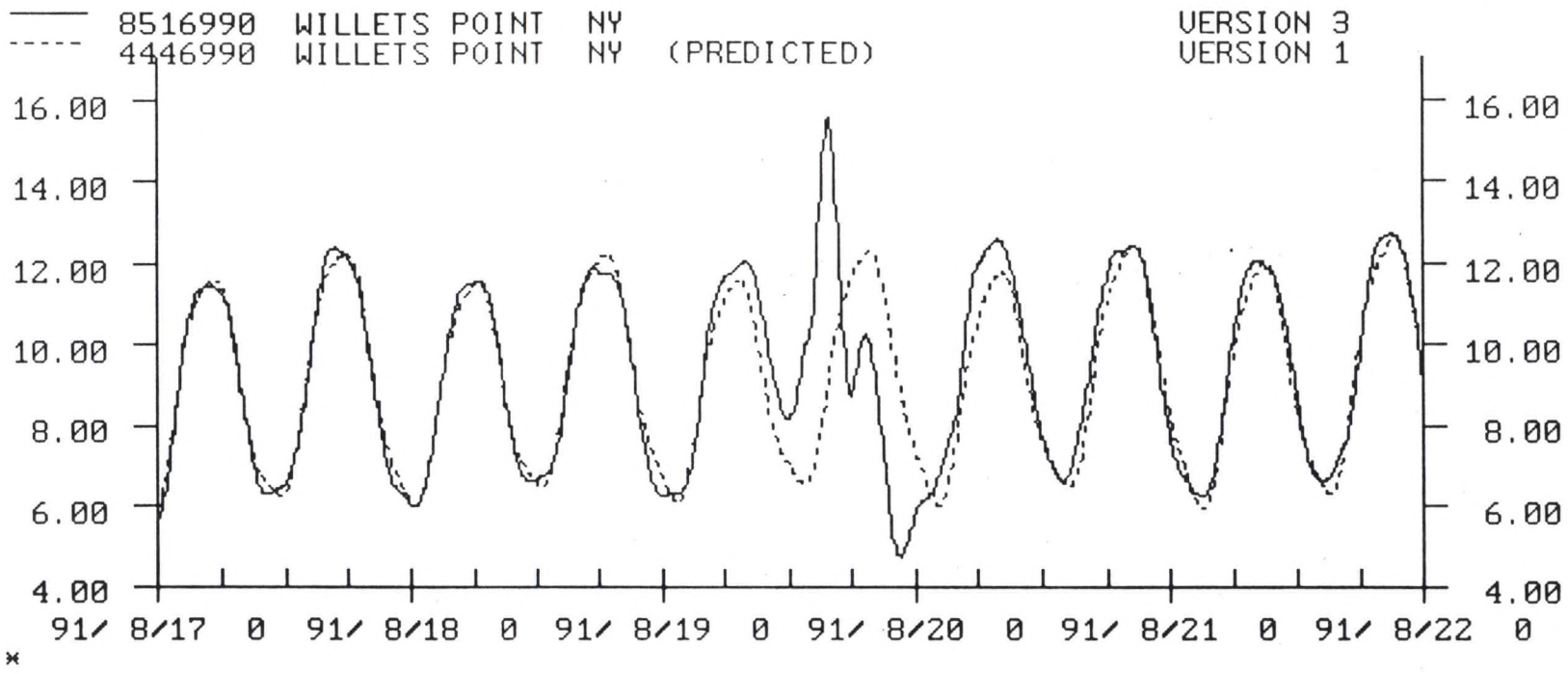
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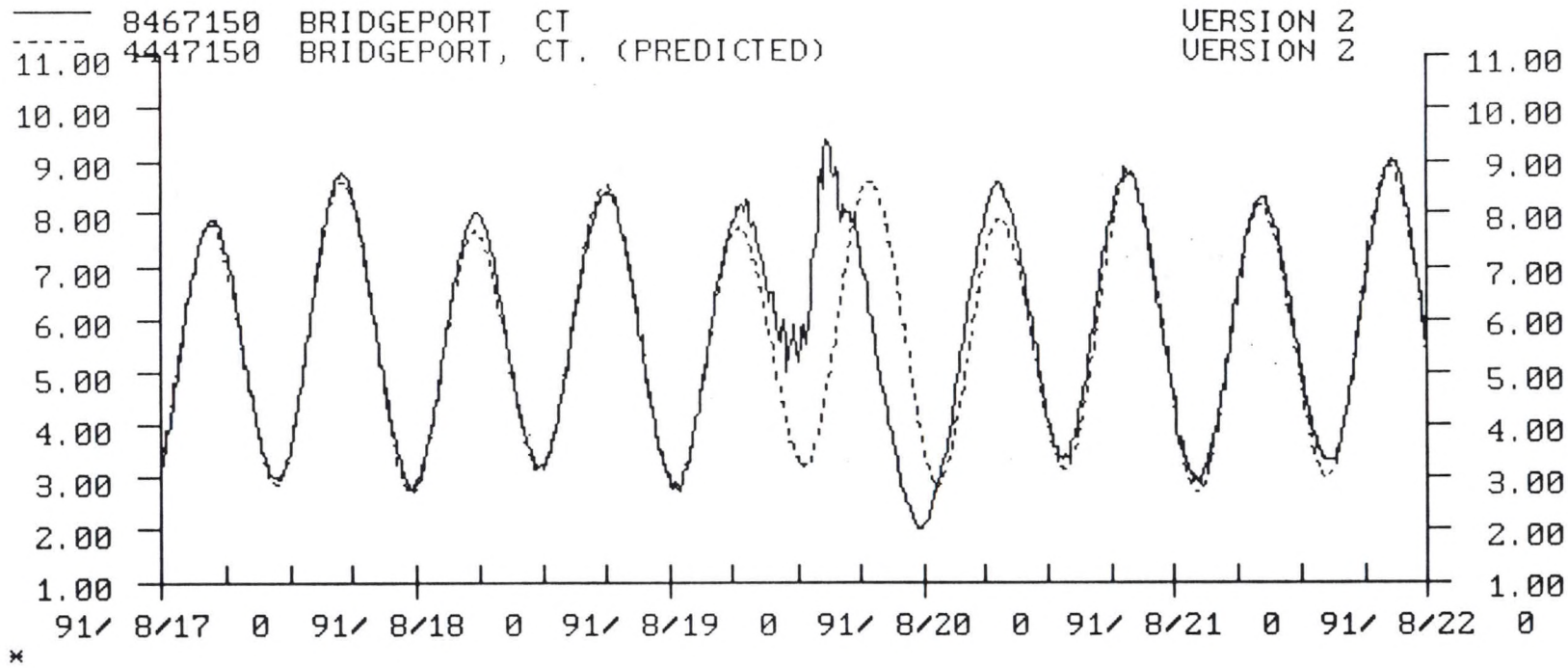
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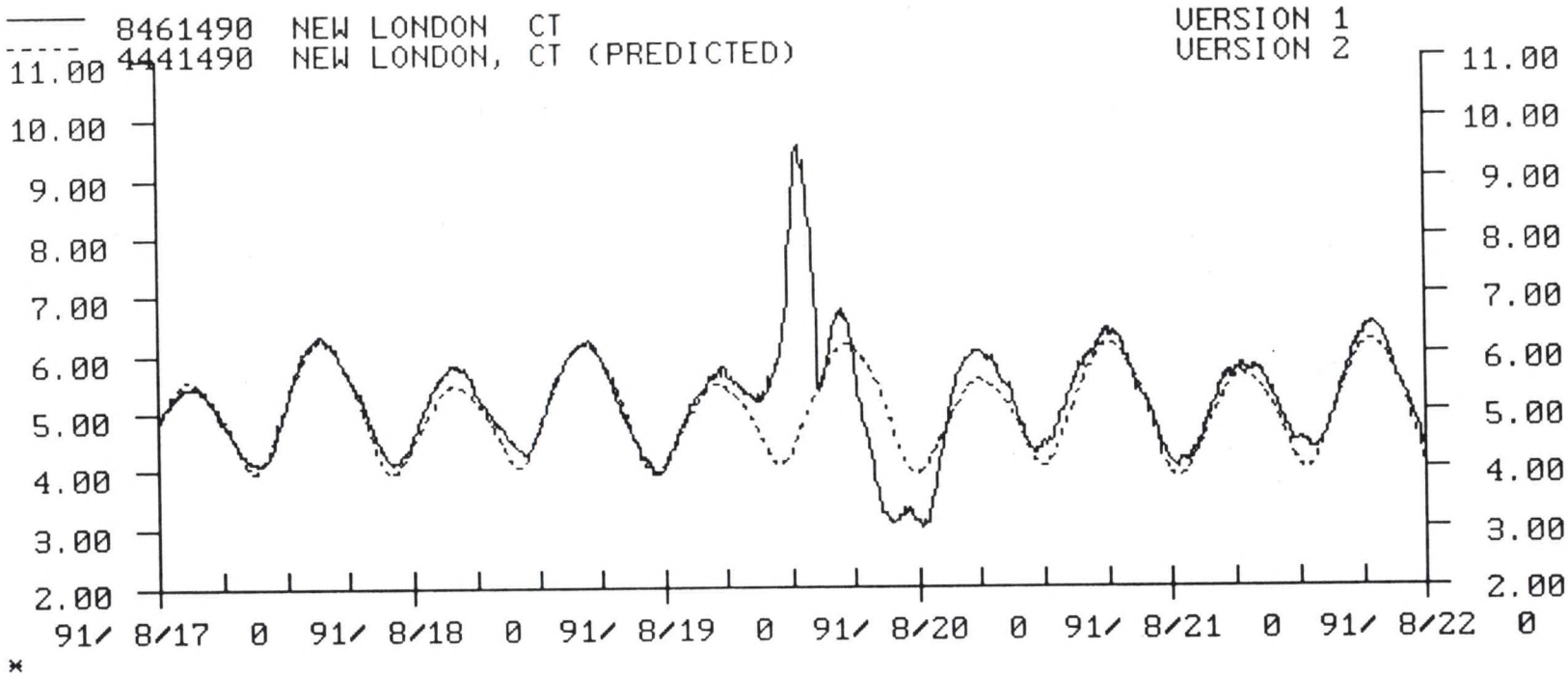
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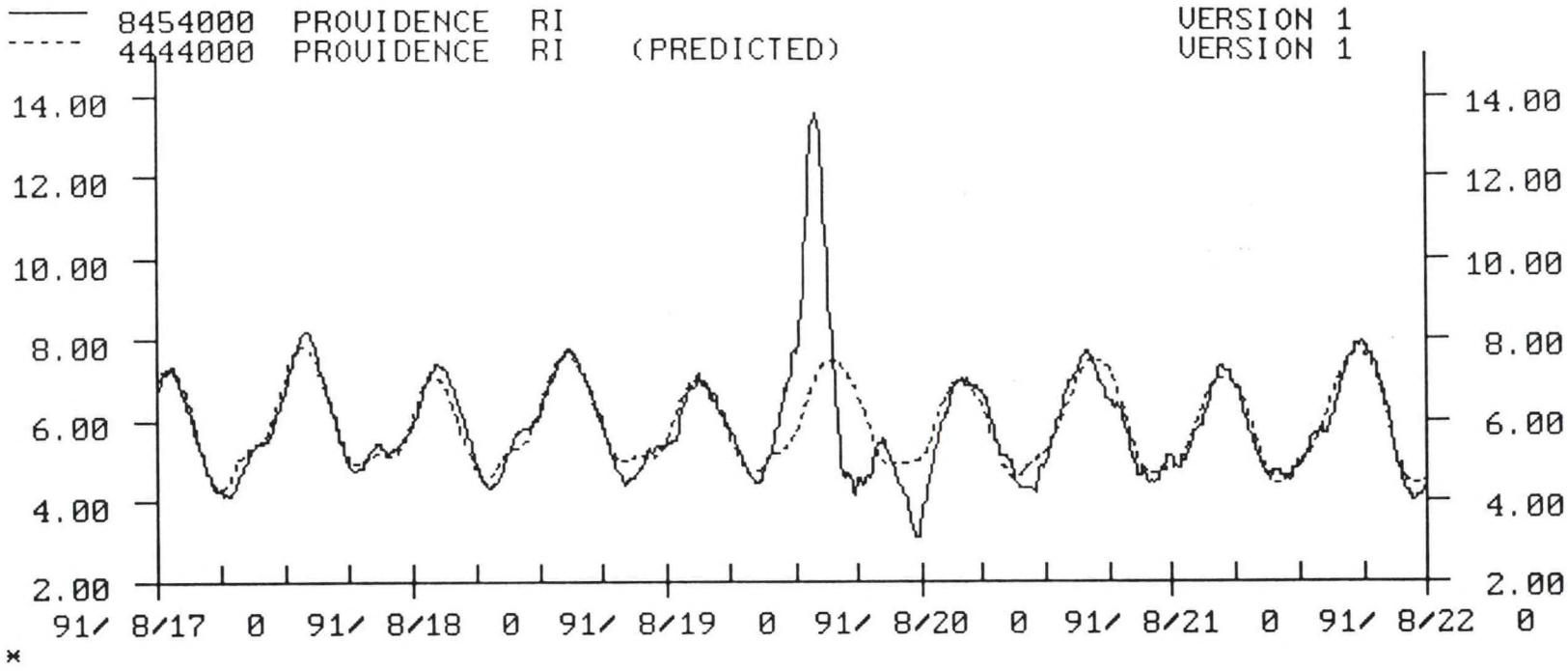
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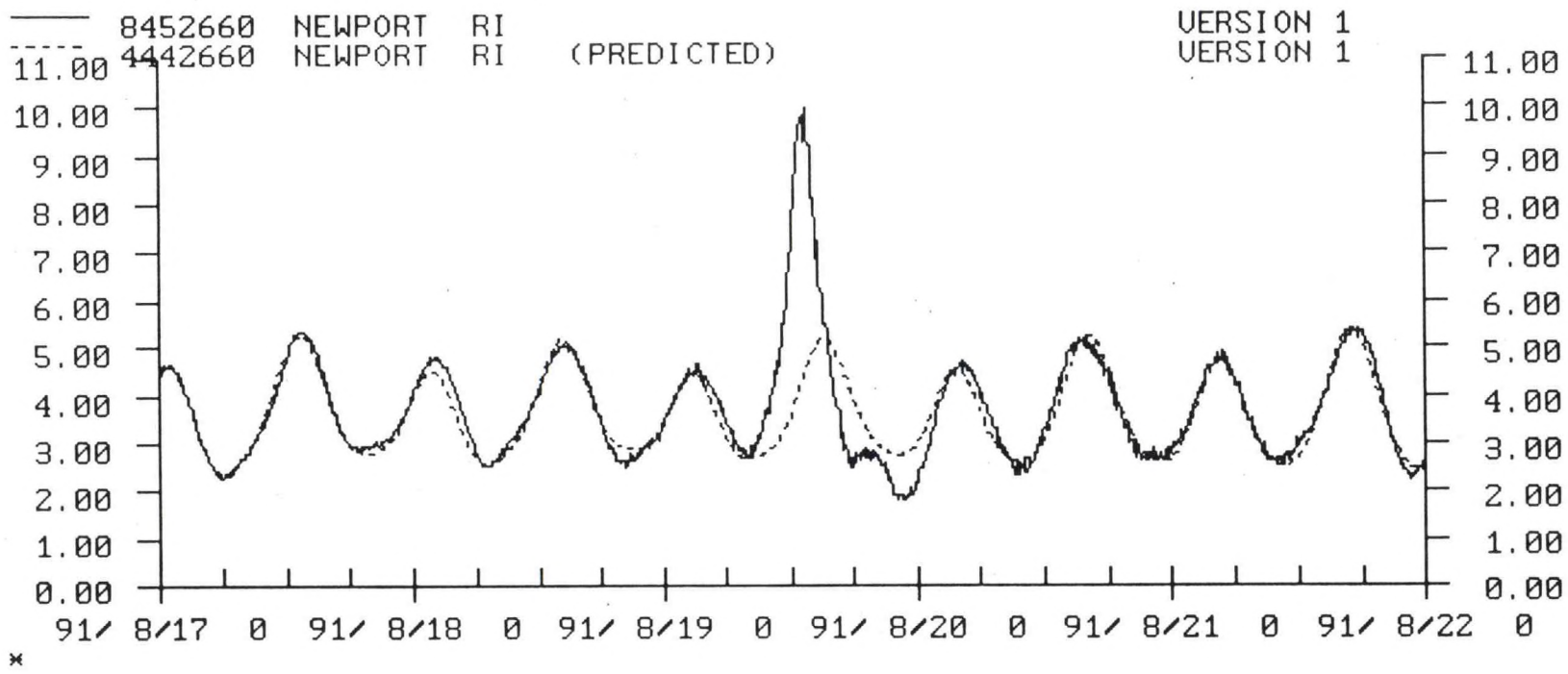
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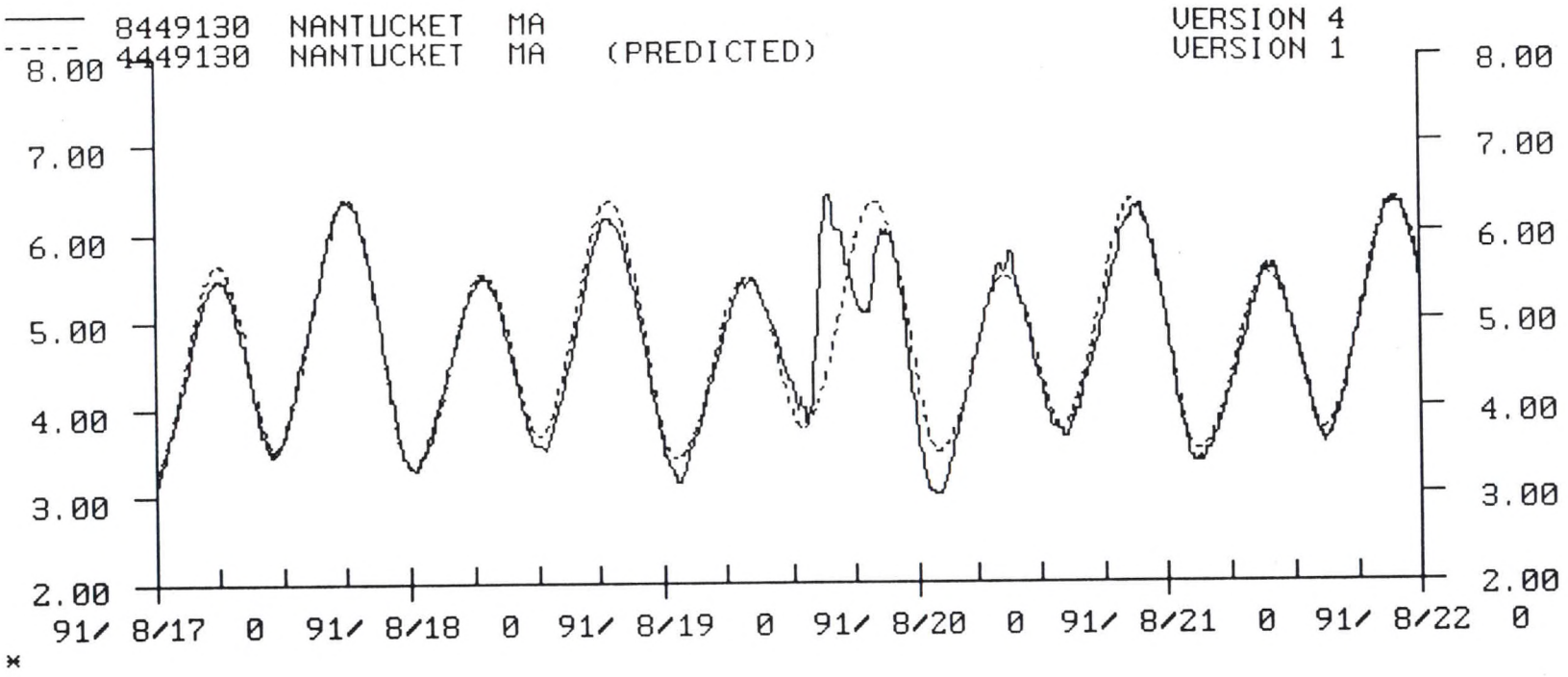
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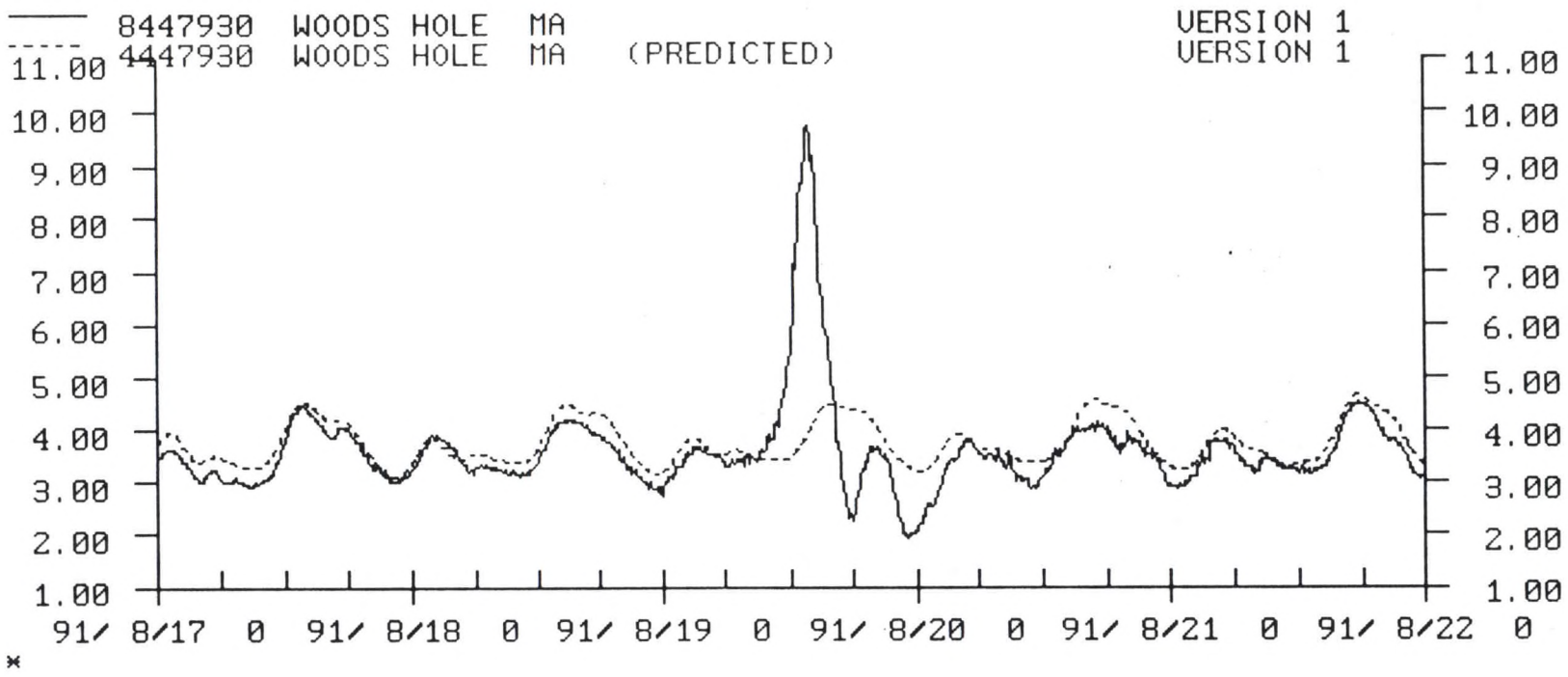
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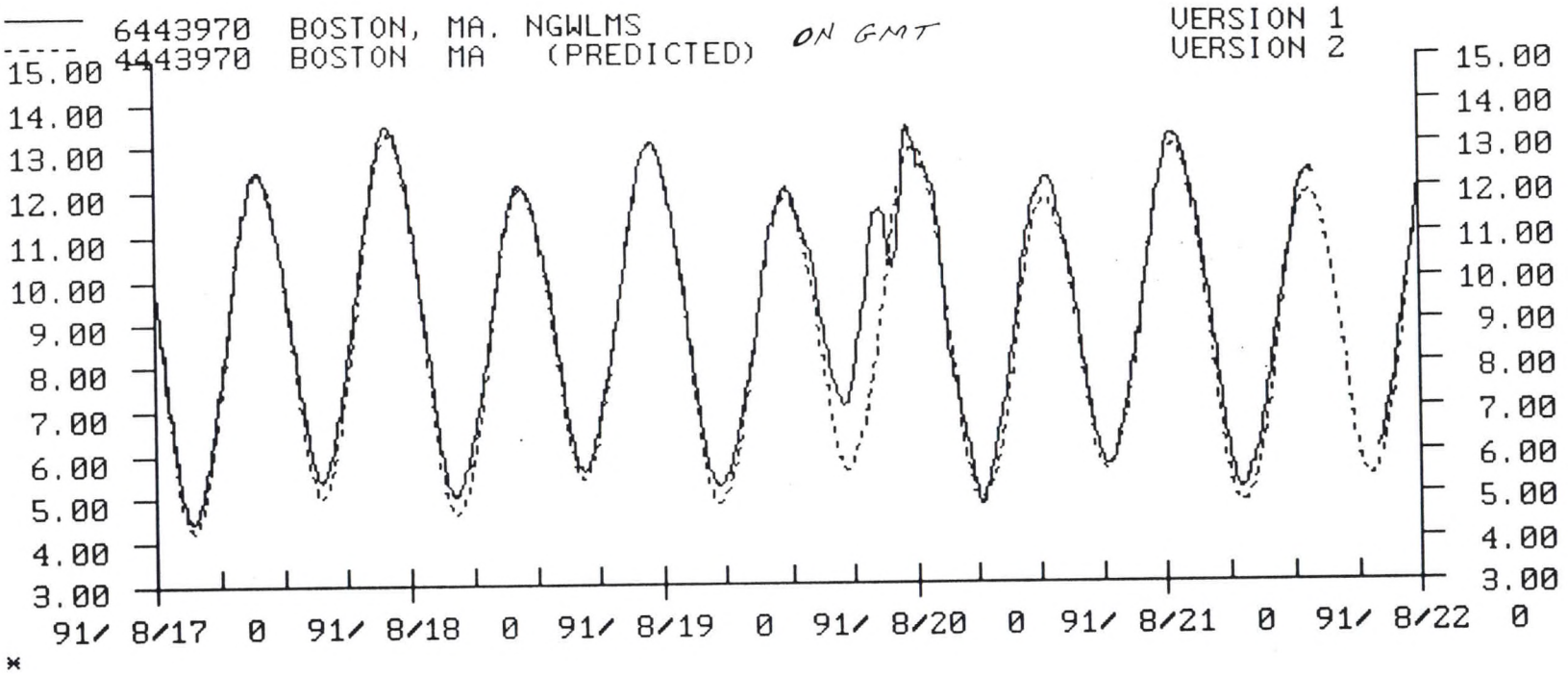
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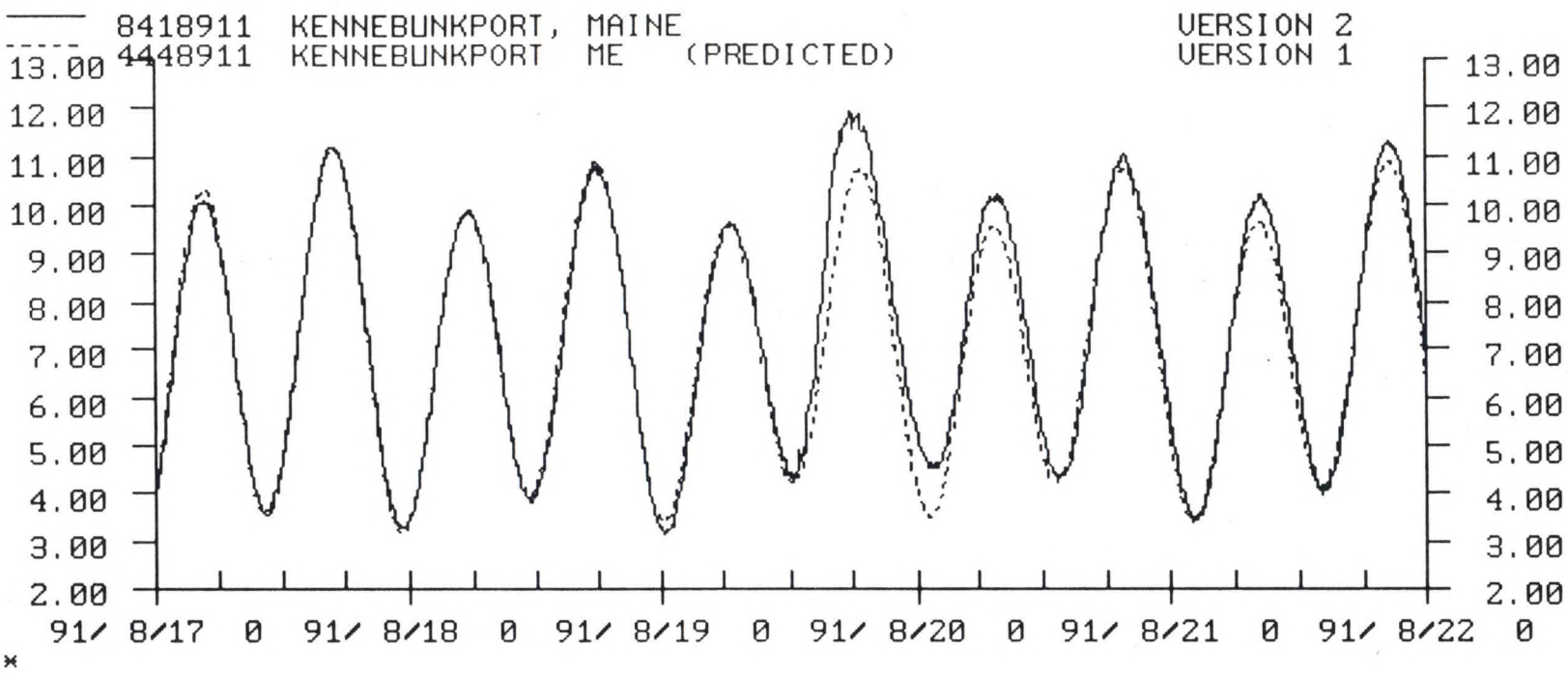
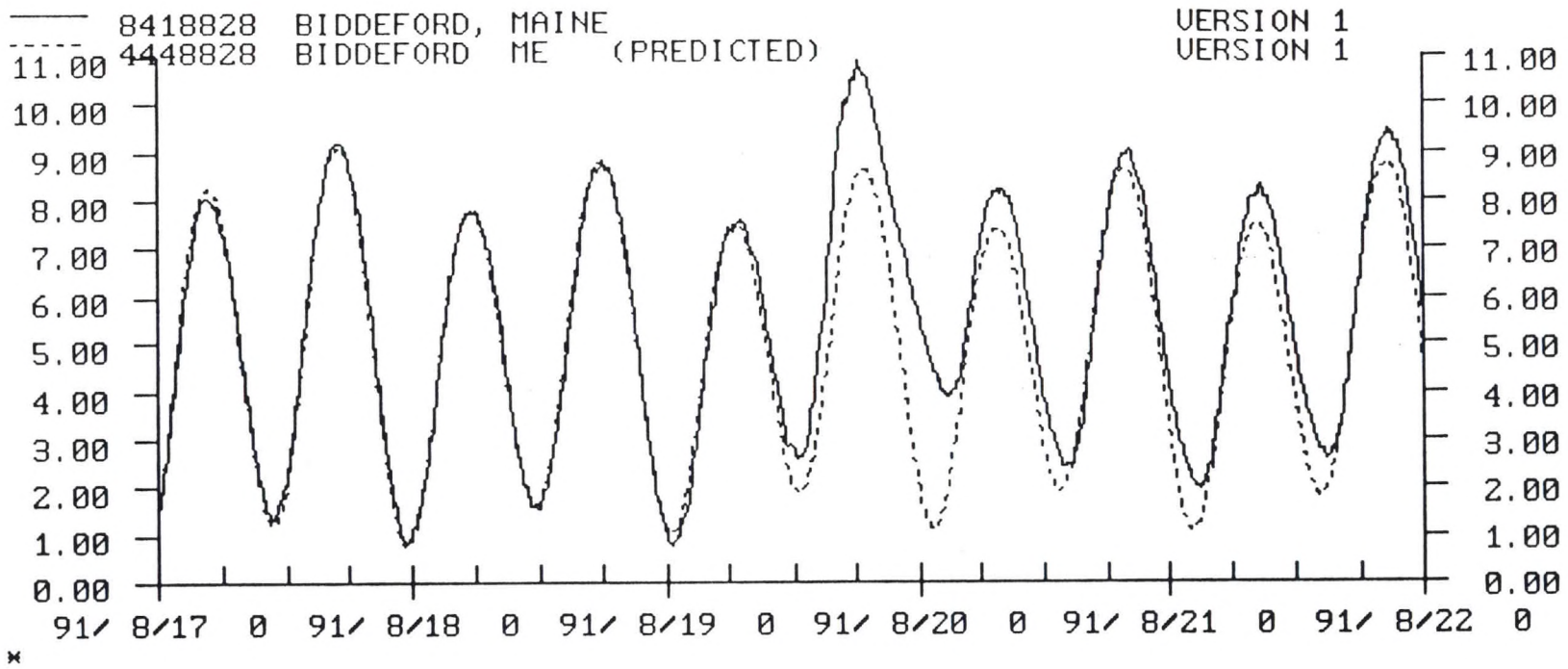
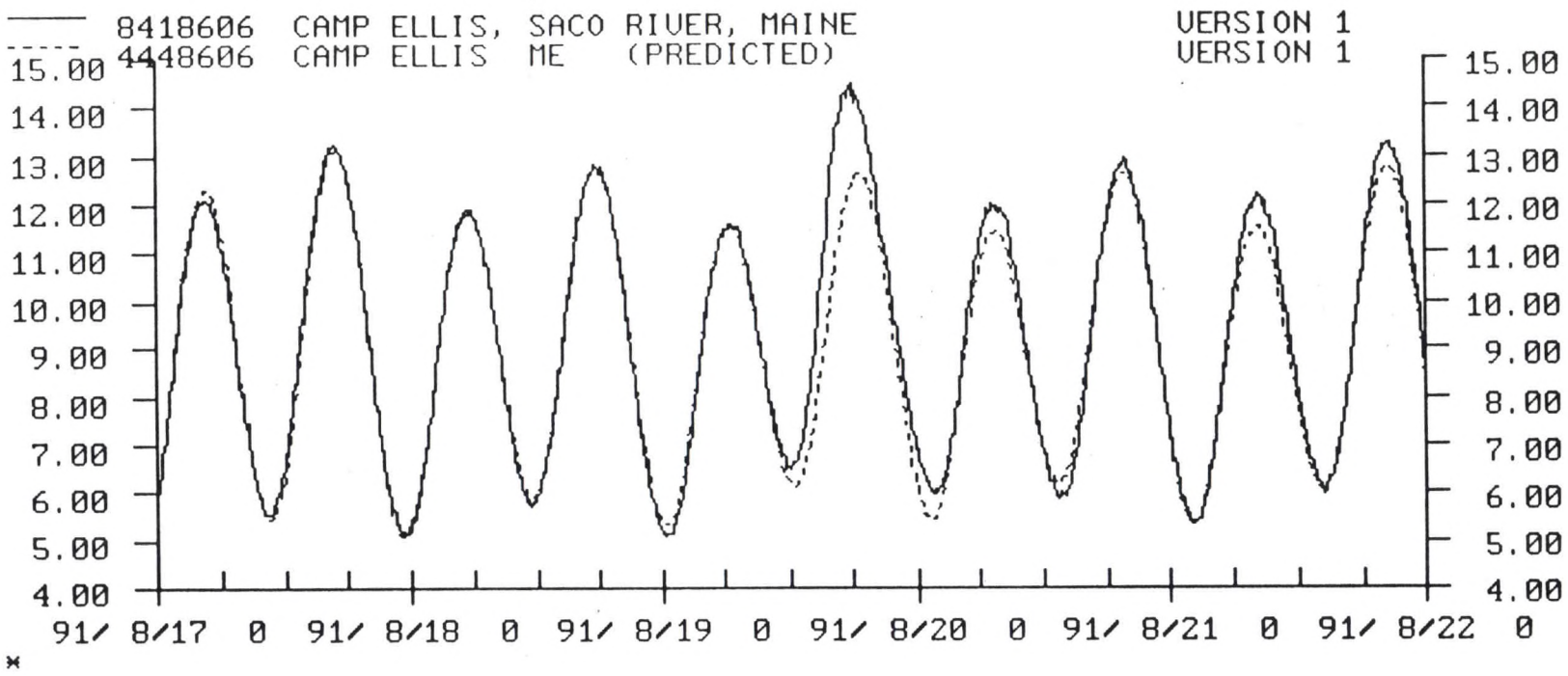
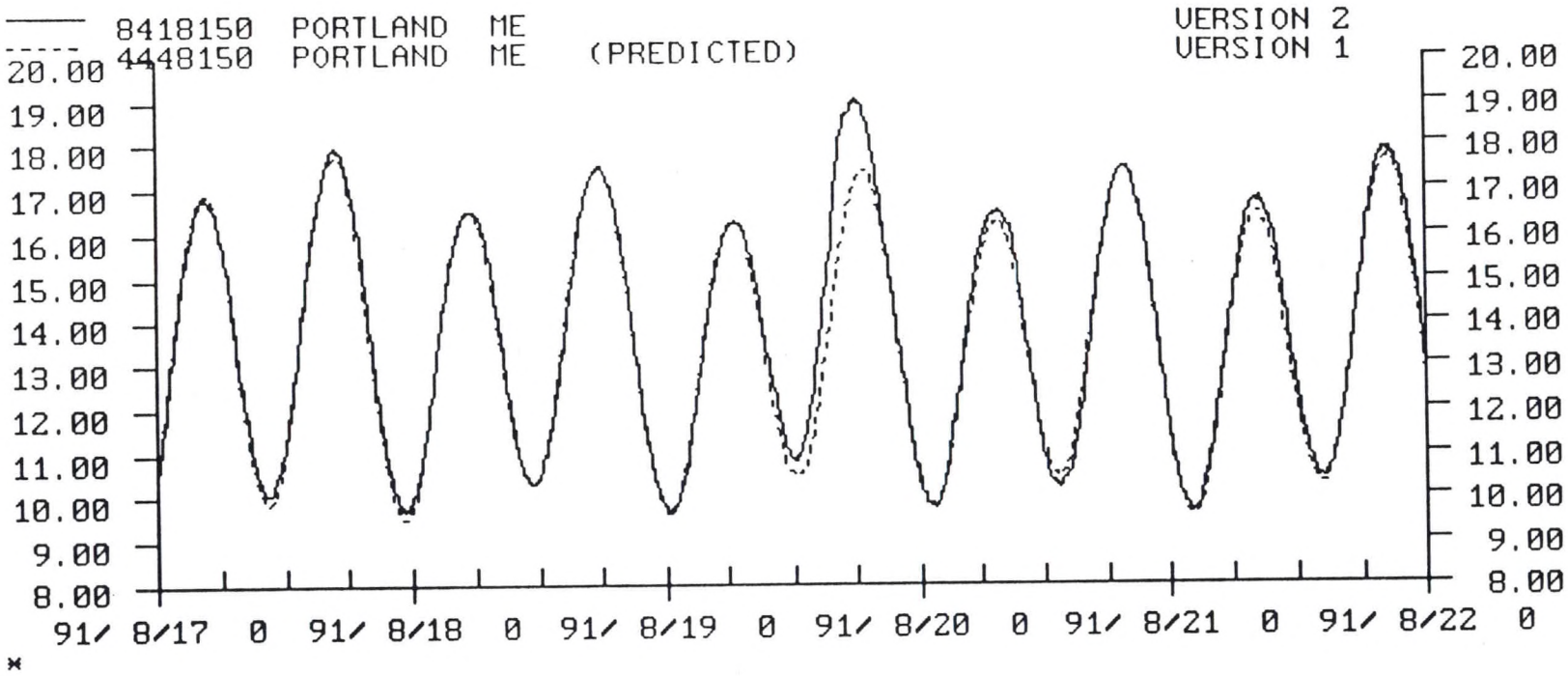
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
91/ 8/17 0
91/ 8/18 0
91/ 8/19 0
91/ 8/20 0
91/ 8/21 0
91/ 8/22 0


8418911 KENNEBUNKPORT, MAINE
4448911 KENNEBUNKPORT ME (PREDICTED)
VERSION 2
VERSION 1
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
91/ 8/17 0
91/ 8/18 0
91/ 8/19 0
91/ 8/20 0
91/ 8/21 0
91/ 8/22 0


8418828 BIDDEFORD, MAINE
4448828 BIDDEFORD ME (PREDICTED)
VERSION 1
VERSION 1
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
91/ 8/17 0
91/ 8/18 0
91/ 8/19 0
91/ 8/20 0
91/ 8/21 0
91/ 8/22 0


8418606 CAMP ELLIS, SACO RIVER, MAINE
4448606 CAMP ELLIS ME (PREDICTED)
VERSION 1
VERSION 1
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
91/ 8/17 0 91/ 8/18 0 91/ 8/19 0 91/ 8/20 0 91/ 8/21 0 91/ 8/22 0


8418150 PORTLAND ME
4448150 PORTLAND ME (PREDICTED)
VERSION 2
VERSION 1
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
91/ 8/17 0
91/ 8/18 0
91/ 8/19 0
91/ 8/20 0
91/ 8/21 0
91/ 8/22 0

V. SUMMARY

The continuous operation of the National Water Level Observation Network (NWLON) and the timing with a special project with the Corps of Engineers, New England Division, have resulted in an important data set documenting the effects of Hurricane Bob on water levels in the U.S. coastal ocean. Only a few stations incurred minor structural damage, with one station at Montauk, NY destroyed when the outer portion of the pier was destroyed by high wave action.

Maximum recorded historical highest water levels were not exceeded at any of the NWLON stations. Maximum storm surge values were measured at Providence, RI (6.57 feet) near hurricane landfall, and at Willets Point, NY (6.71 feet) in western Long Island Sound. Plots of the storm surge signatures for selected stations have illustrated the varying effects of the hurricane depending on coastline orientation and closeness to the hurricane track.

Preliminary data recorded during the hurricane were provided to the U.S. Army Corps of Engineers, the National Weather Service, and to FEMA. Information on tidal datums, storm surge, and time series from the stations listed in this report and from other NOS stations can be obtained from:

NOAA/National Ocean Service
Office of Ocean and Earth Sciences
Ocean and Lake Levels Division
Products and User Services Section, N/OES23
6001 Executive Blvd.
Rockville, MD 20852

Telephone: (301) 443-8467
FAX: (301) 443-1920

VI. APPENDICES

1. Storm Track Plot from National Weather Service Preliminary Report.

2. Set of tide station location chartlets.

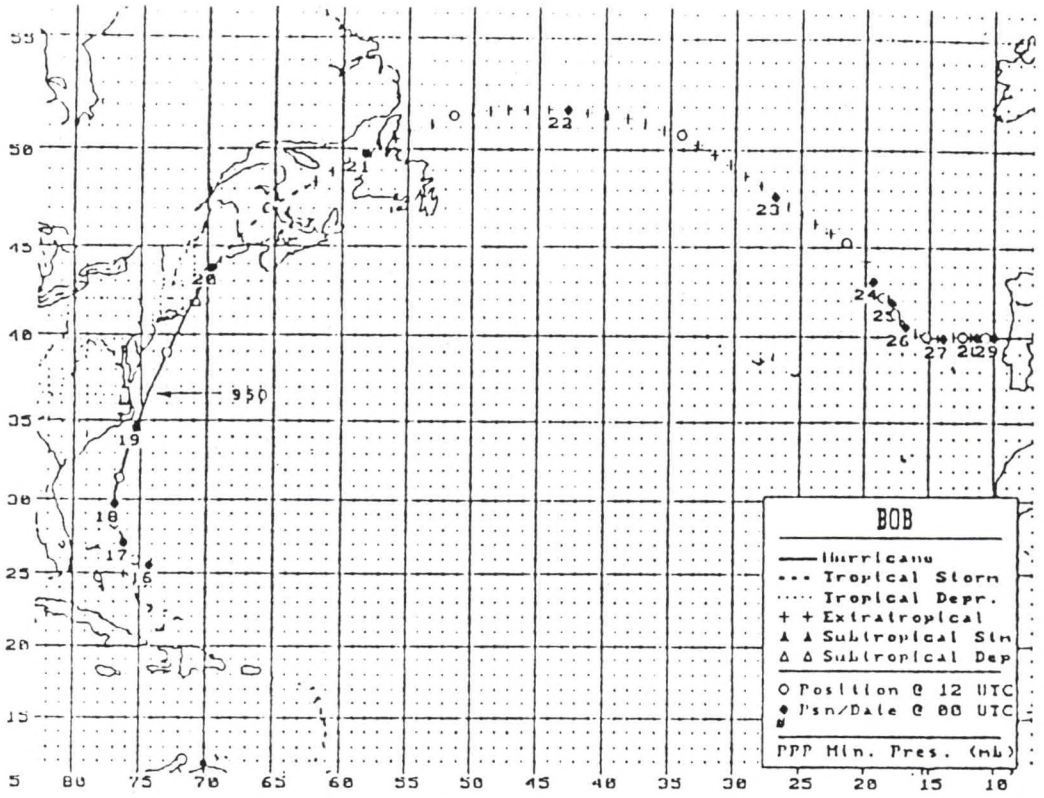


Fig. 1a. Best track positions for Hurricane Bob.

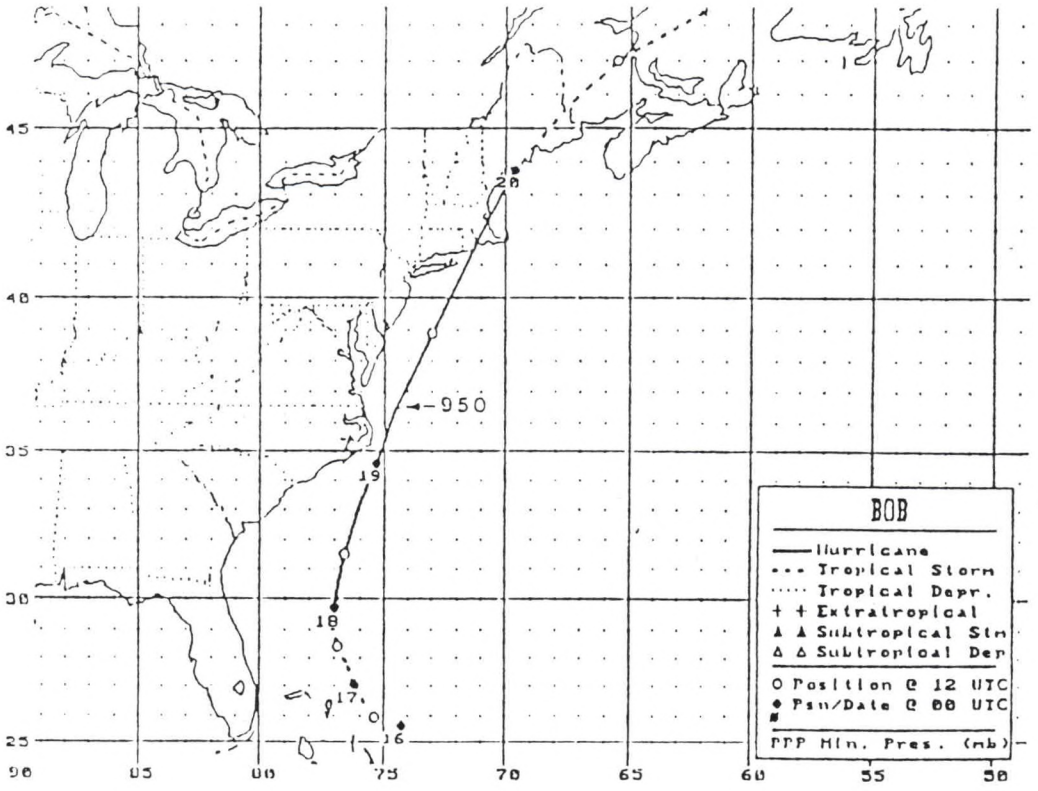
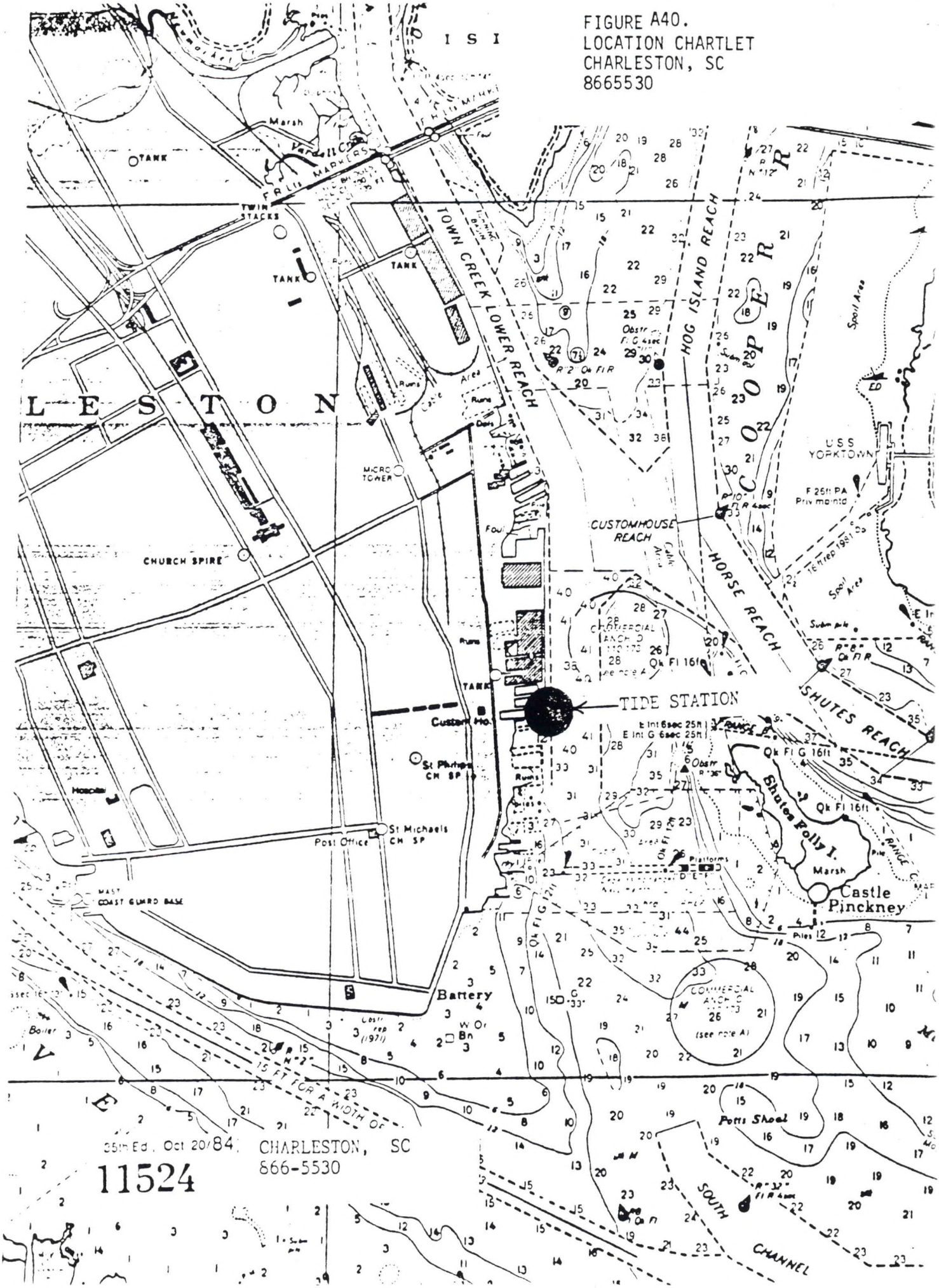
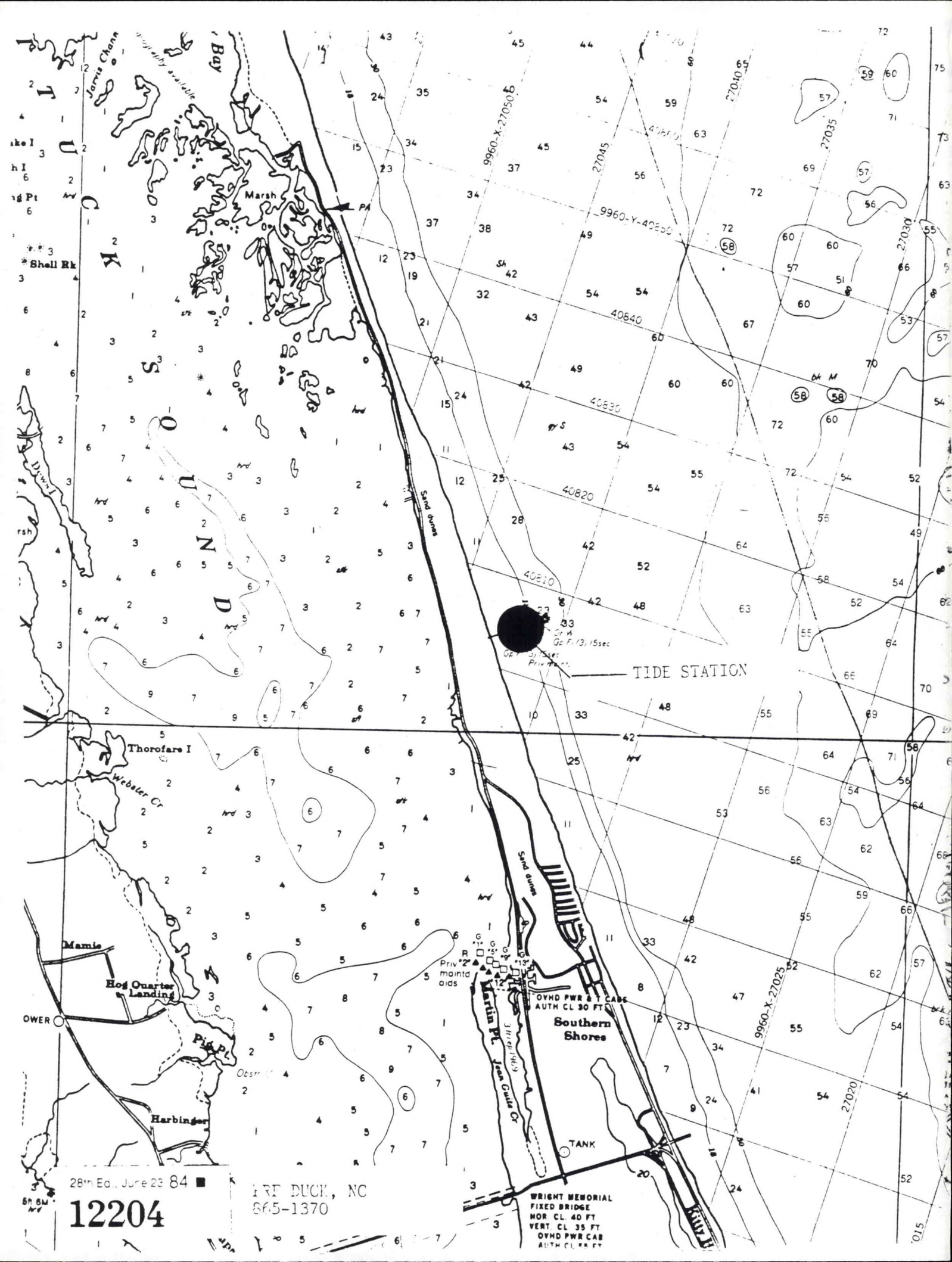


Fig. 1b. Best track positions for Hurricane Bob during the tropical period only, 16-20 August 1991.

FIGURE A40.
LOCATION CHARTLET
CHARLESTON, SC
8665530

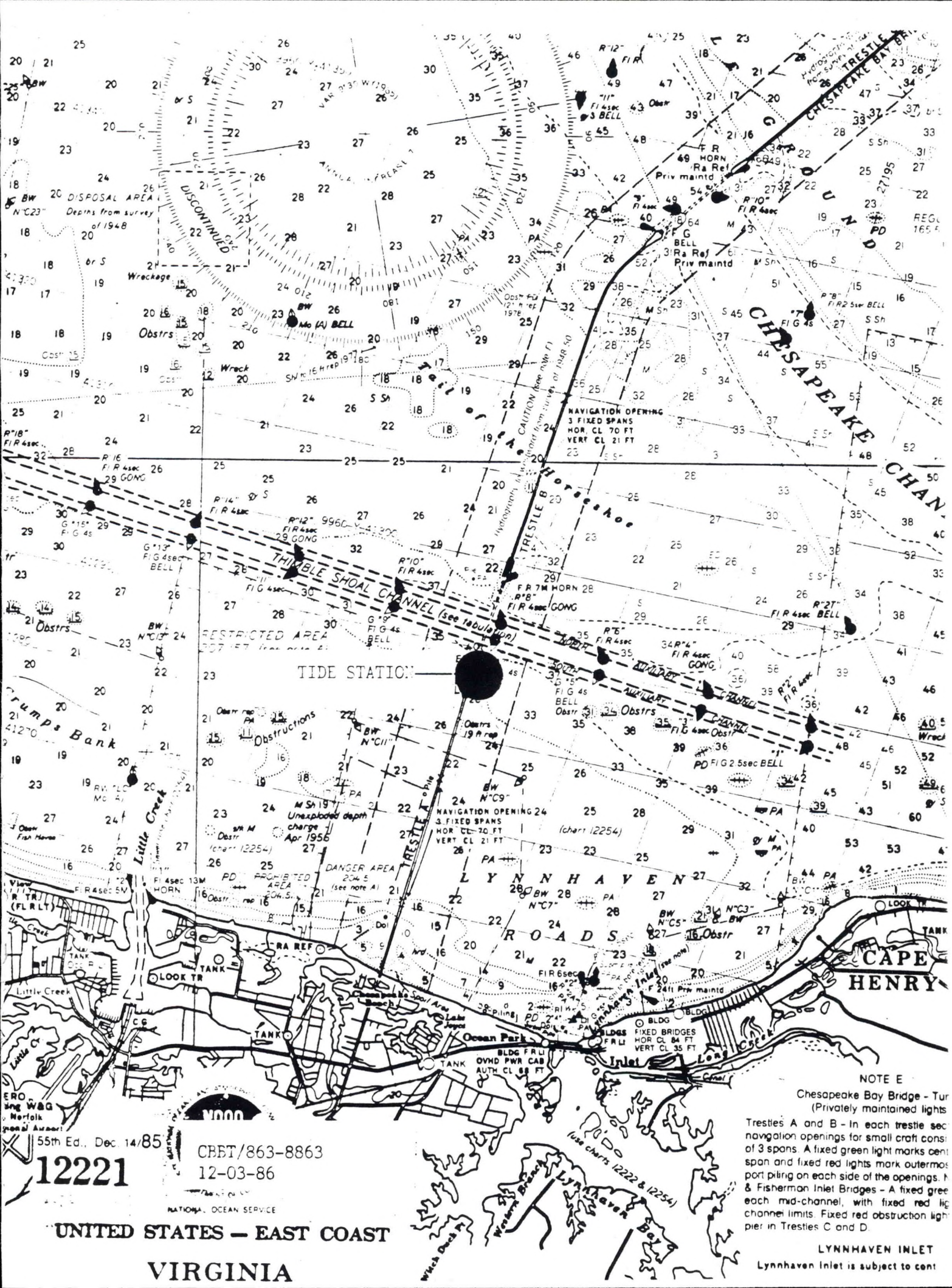




28th Ed., June 23 84 ■

12204

RF DUCK, NC
865-1370



55th Ed., Dec. 14/85

12221

CBBT/863-8863
12-03-86

NATIONAL OCEAN SERVICE

UNITED STATES — EAST COAST

VIRGINIA

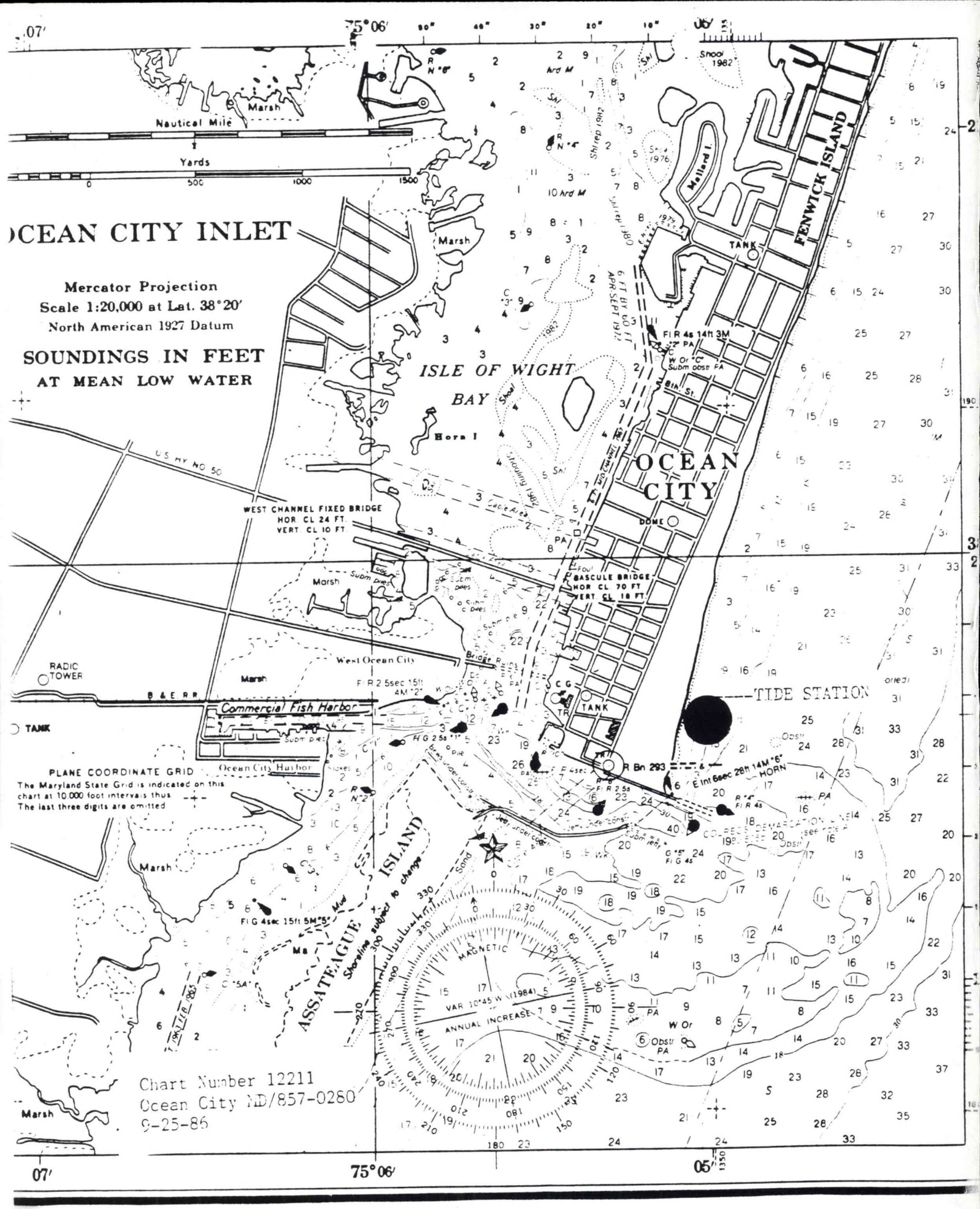
NOTE E

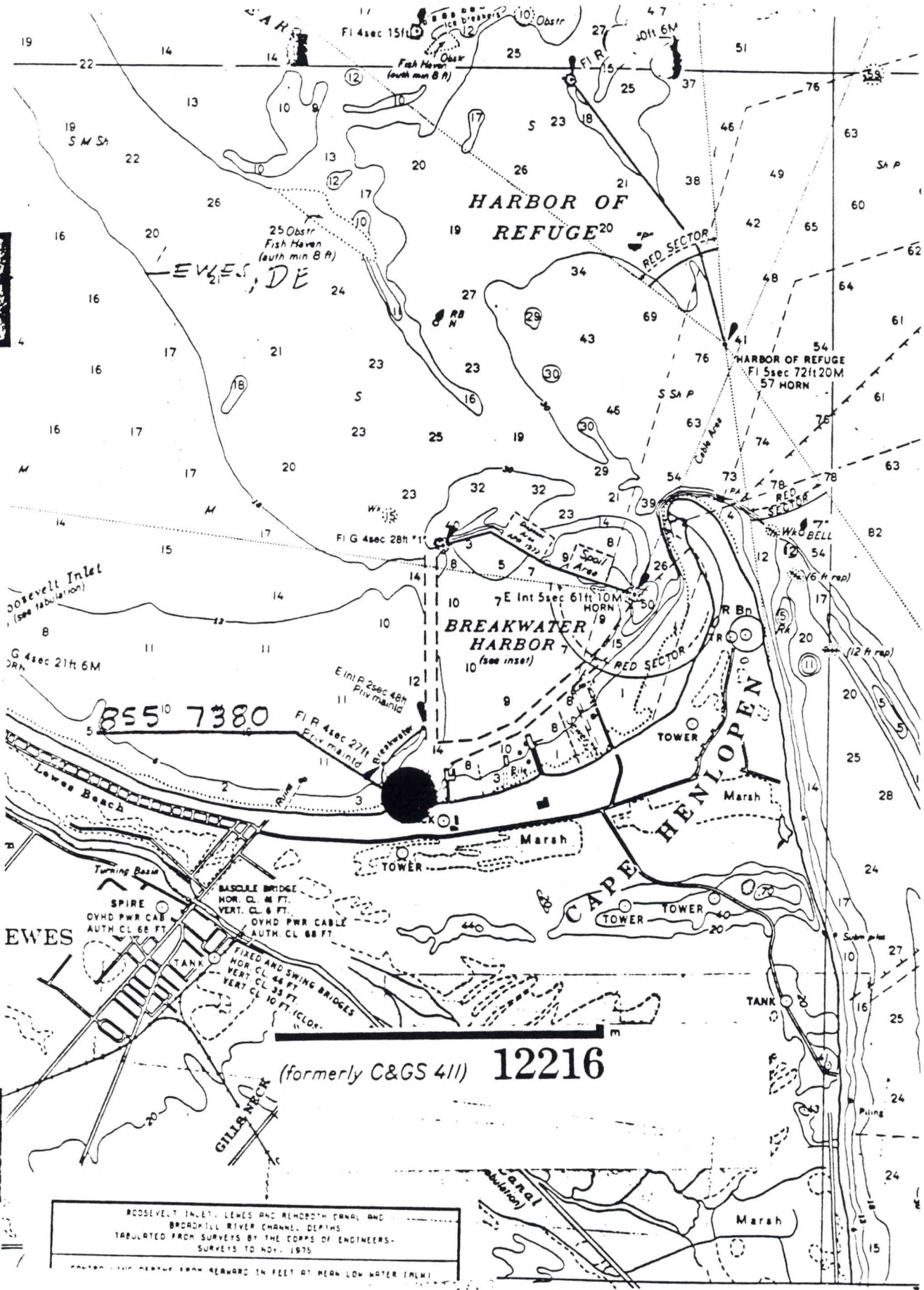
Chesapeake Bay Bridge - Tur
(Privately maintained lights

Trestles A and B - In each trestle sec
navigation openings for small craft consi
of 3 spans. A fixed green light marks cent
span and fixed red lights mark outermos
port piling on each side of the openings. N
& Fisherman Inlet Bridges - A fixed gree
each mid-channel, with fixed red lig
channel limits. Fixed red obstruction ligh
pier in Trestles C and D.

LYNNHAVEN INLET

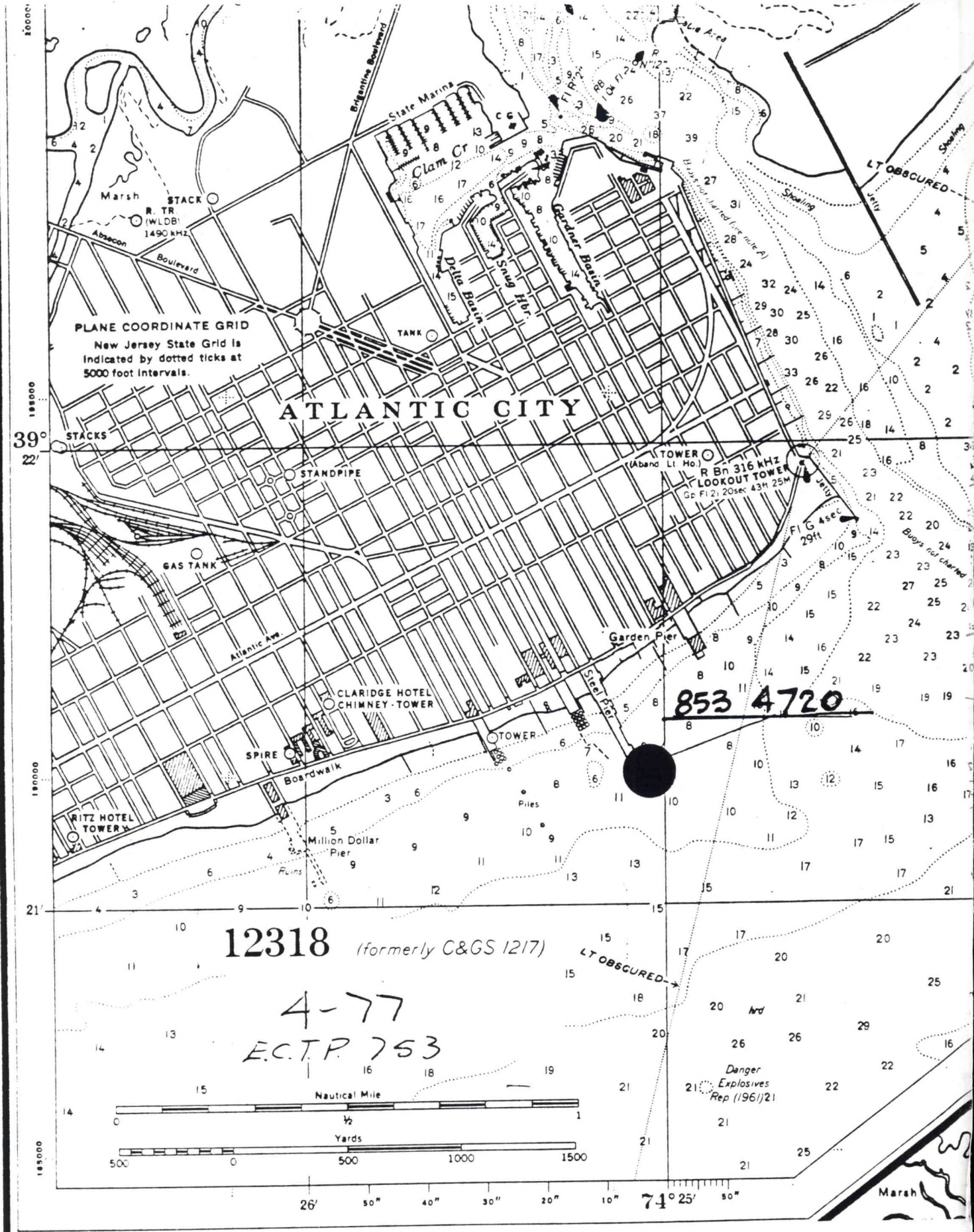
Lynnhaven Inlet is subject to cont

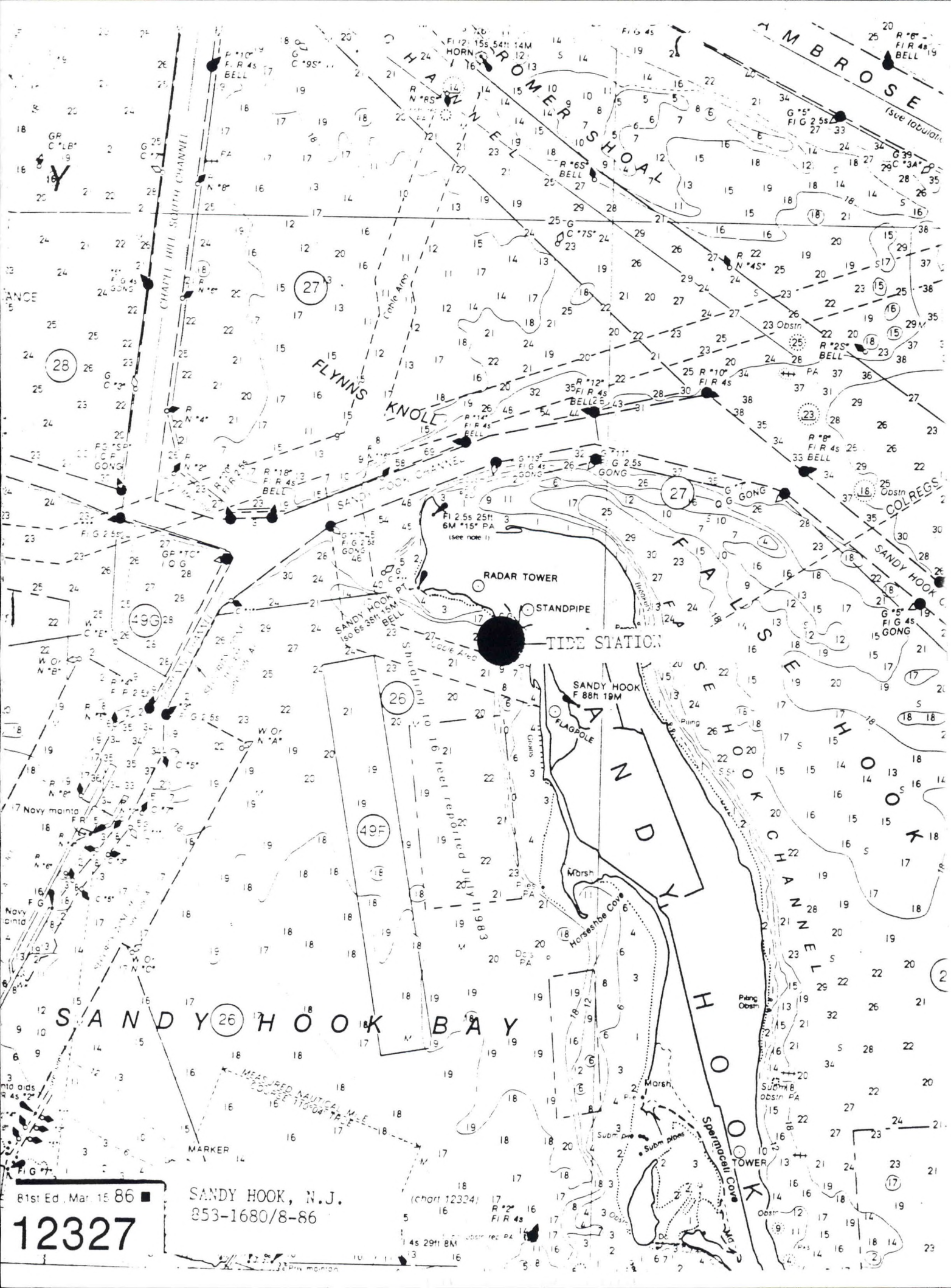

OCEAN CITY INLET
Mercator Projection
Scale 1:20,000 at Lat. 38°20'
North American 1927 Datum
SOUNDINGS IN FEET
AT MEAN LOW WATER
75°06'
07'
05'
Nautical Mile
Yards
0
500
1000
1500
Marsh
FENWICK ISLAND
Mallard I.
TANK
ISLE OF WIGHT
BAY
Horn I
OCEAN
CITY
DOME
U.S. HY NO. 50
WEST CHANNEL FIXED BRIDGE
HOR. CL 24 FT.
VERT. CL 10 FT.
BASCULE BRIDGE
HOR CL 70 FT
VERT CL 18 FT
West Ocean City
RADIC
TOWER
B & E. RR.
Commercial Fish Harbor
Ocean City Harbor
TIDE STATION
C G
TR
R Bn 293
PLANE COORDINATE GRID
The Maryland State Grid is indicated on this chart at 10,000 foot intervals thus
The last three digits are omitted
ASSATEAGUE ISLAND
Shoreline subject to change
MAGNETIC
VAR 10°45 W (1984)
ANNUAL INCREASE
W Or
Obstn
PA
Chart Number 12211
Ocean City MD/857-0280
9-25-86

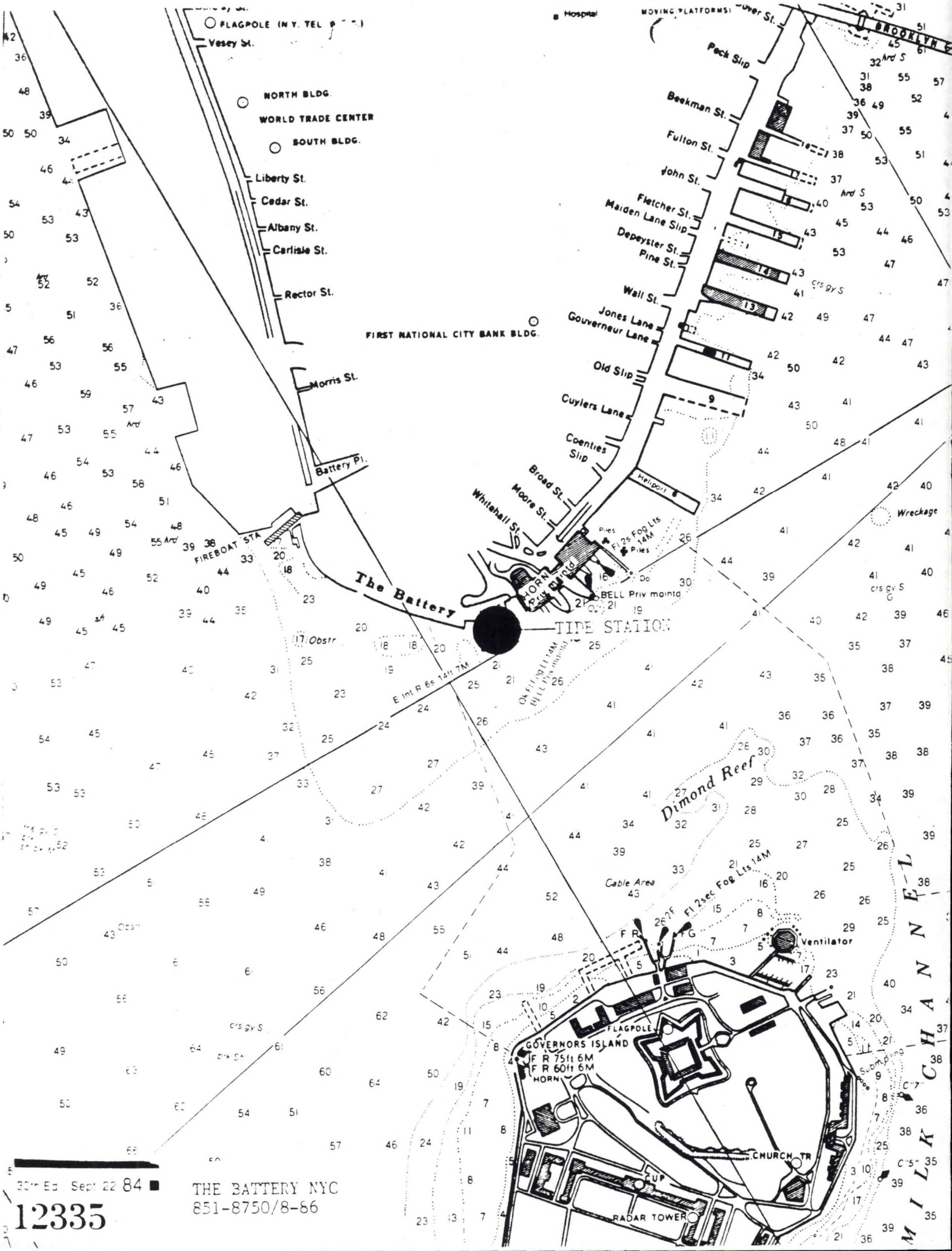


(formerly C&GS 411) **12216**

5/86


ATLANTIC CITY
PLANE COORDINATE GRID
New Jersey State Grid is indicated by dotted ticks at 5000 foot intervals.
39° 22'
74° 25'
Brigantine Boulevard
State Marina
Clam Cr
Marsh
STACK
R. TR (WLDB) 1490 kHz
Absecon Boulevard
Delta Basin
Snug Hbr
Gardner Basin
TANK
STACKS
STANDPIPE
GAS TANK
Atlantic Ave.
CLARIDGE HOTEL CHIMNEY-TOWER
SPIRE
Boardwalk
RITZ HOTEL TOWER
Million Dollar Pier
Ruins
Piles
Garden Pier
Steel Pier
TOWER
(Aband Lt Ho.)
R Bn 316 kHz
LOOKOUT TOWER
Gp Fl 2) 20sec 43M 25M
Fl G 4sec 29ft
Jetty
Shoaling
LT OBSCURED
Buoys not charted
853 4720
12318 (formerly C&GS 1217)
4-77
E.C.T.P 753
Nautical Mile
0 ½ 1
Yards
500 0 500 1000 1500
Danger
Explosives
Rep (1961) 21
Marsh

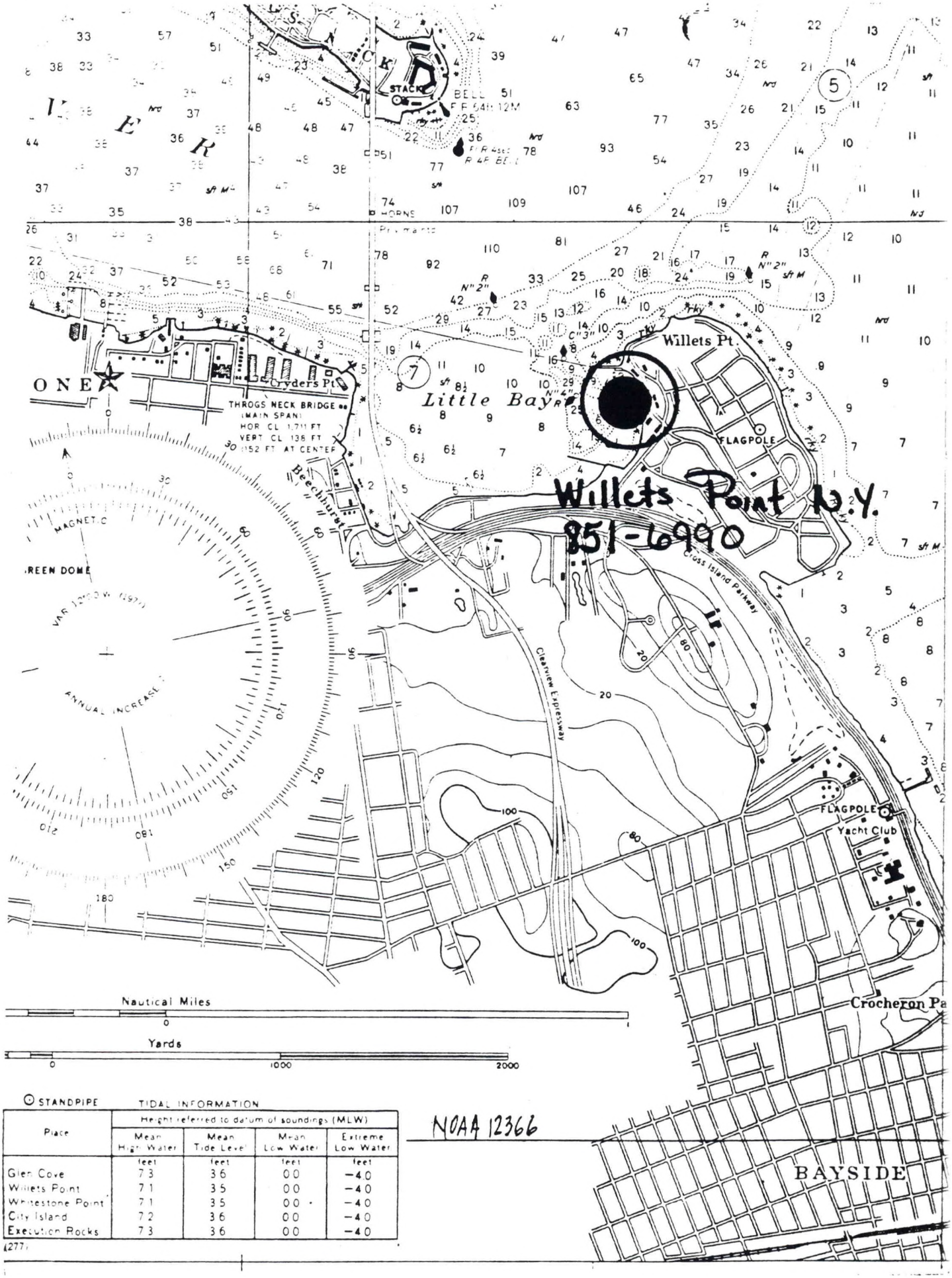

SANDY HOOK BAY
SANDY HOOK
FLYNNS KNOLL
ROMER SHOAL
AMBROSE
CHAPEL HILL SOUTH CHANNEL
SANDY HOOK CHANNEL
FALSE HOOK CHANNEL
COLREGS
RADAR TOWER
STANDPIPE
TIDE STATION
SANDY HOOK F 88ft 19M
FLAGPOLE
Horseshoe Cove
Marsh
Spermaceti Cove
TOWER
MARKER
SANDY HOOK, N.J.
853-1680/8-86
81st Ed., Mar. 15/86
12327



30th Ed., Sept. 22/84 ■

THE BATTERY NYC
851-8750/8-86

12335



Willets Point N.Y.
851-6990

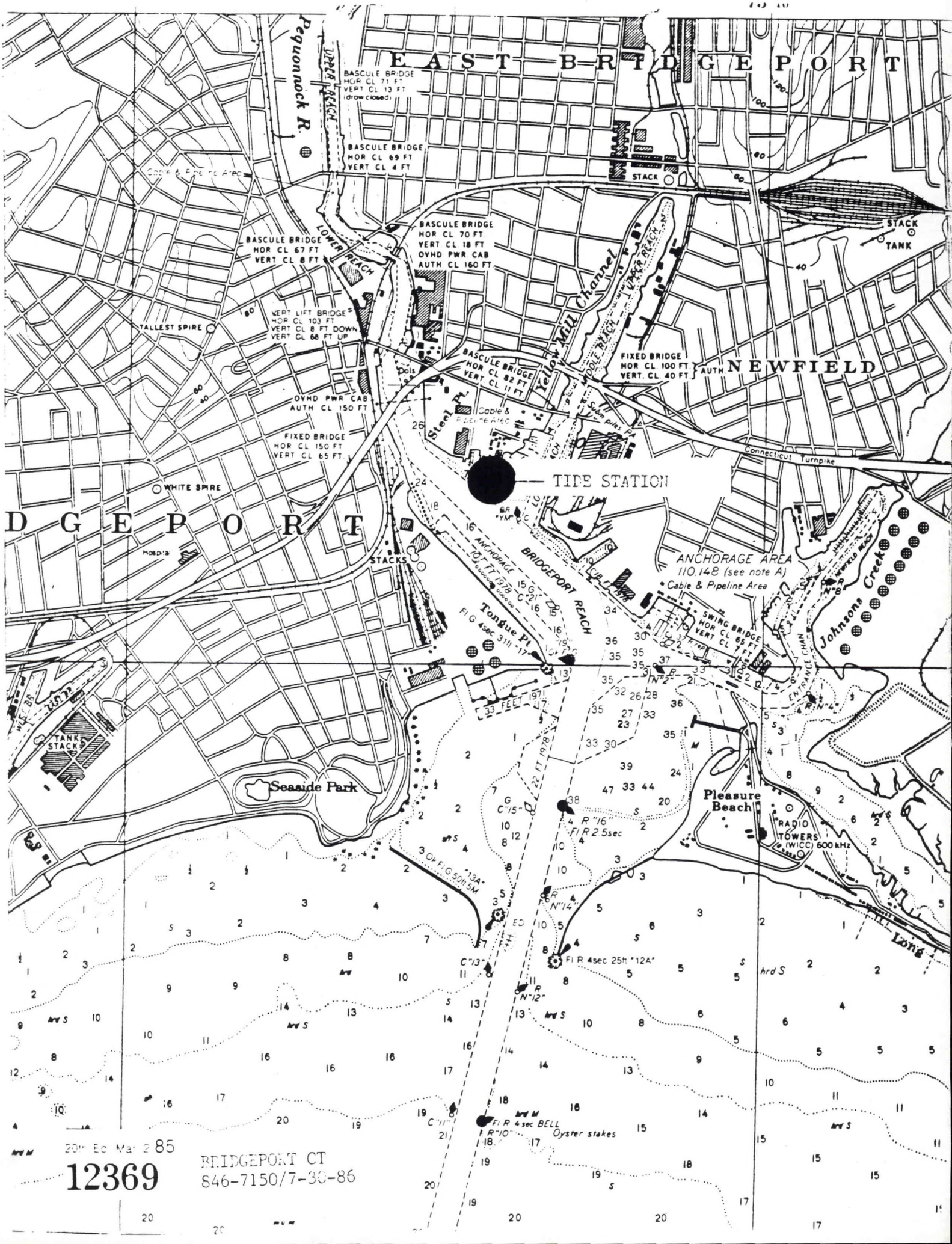
⊙ STANDPIPE

TIDAL INFORMATION

Place	Height referred to datum of soundings (MLW)			
	Mean High Water	Mean Tide Level	Mean Low Water	Extreme Low Water
	feet	feet	feet	feet
Glen Cove	7.3	3.6	0.0	−4.0
Willets Point	7.1	3.5	0.0	−4.0
Whitestone Point	7.1	3.5	0.0	−4.0
City Island	7.2	3.6	0.0	−4.0
Execution Rocks	7.3	3.6	0.0	−4.0

NOAA 12366

4277



20th Ed Mar 2 85

12369

BRIDGEPORT CT
846-7150/7-30-86

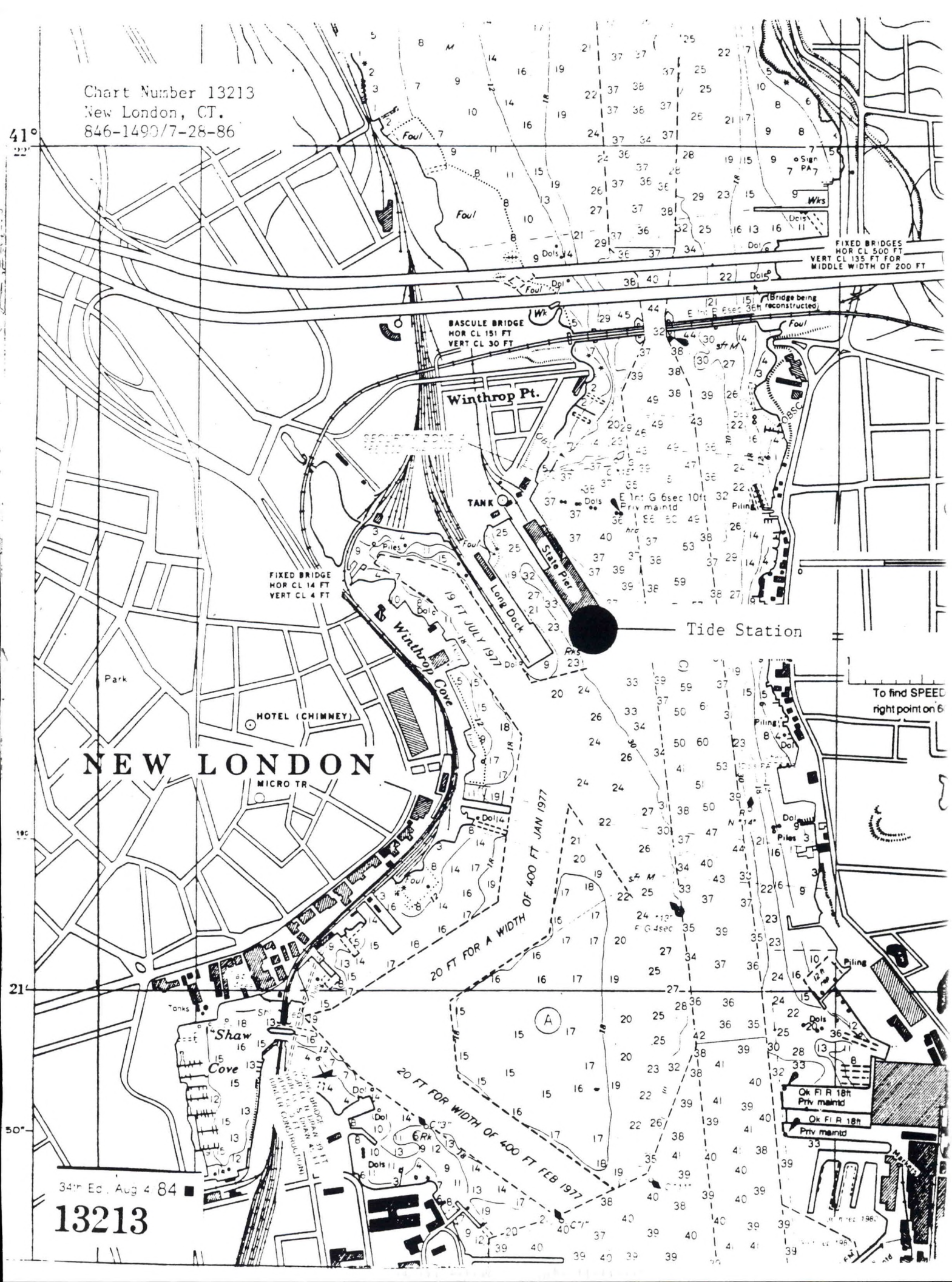


Chart Number 13213
New London, CT.
846-1490/7-28-86
41°
22'
FIXED BRIDGES
HOR CL 500 FT
VERT CL 135 FT FOR
MIDDLE WIDTH OF 200 FT
Bridge being reconstructed
BASCULE BRIDGE
HOR CL 151 FT
VERT CL 30 FT
Winthrop Pt.
TANK
State Pier
Tide Station
FIXED BRIDGE
HOR CL 14 FT
VERT CL 4 FT
Long Dock
19 FT JULY 1977
Winthrop Cove
Park
HOTEL (CHIMNEY)
NEW LONDON
MICRO TR
20 FT FOR A WIDTH OF 400 FT JAN 1977
20 FT FOR WIDTH OF 400 FT FEB 1977
Shaw
Cove
Ok Fl R 18ft
Priv maintd
Ok Fl R 18ft
Priv maintd
To find SPEED
right point on 6
34th Ed., Aug 4 84
13213

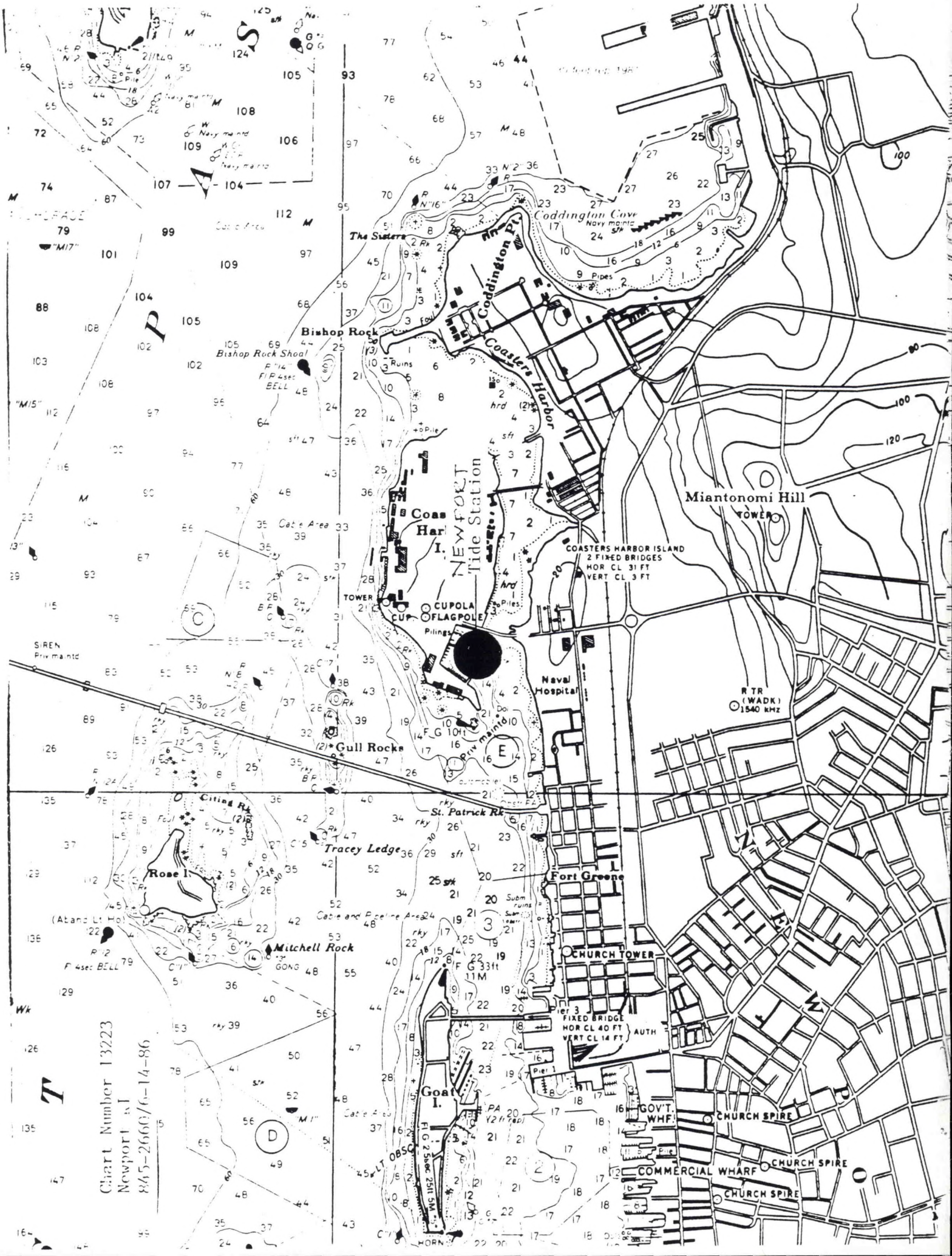


Chart Number 13223
Newport #1
845-2666/6-14-86
Coddington Cove
Navy mainte
Coddington Pt
Coasters Harbor
Bishop Rock
Bishop Rock Shoal
The Sisters
Miantonomi Hill
TOWER
COASTERS HARBOR ISLAND
2 FIXED BRIDGES
HOR CL 31 FT
VERT CL 3 FT
NEWPORT
Tide Station
CUPOLA
FLAGPOLE
Pilings
Naval Hospital
R TR
(WADK)
1540 kHz
Gull Rocks
St. Patrick Rk
Tracey Ledge
Rose I
Fort Greene
CHURCH TOWER
Mitchell Rock
FIXED BRIDGE
HOR CL 40 FT
VERT CL 14 FT
AUTH
Goat I.
GOV'T. WHF
CHURCH SPIRE
COMMERCIAL WHARF
CHURCH SPIRE
CHURCH SPIRE
SIREN
Cable Area
Cable and Pipeline Area
Pipes
Ruins
Piles
GONG
HORN

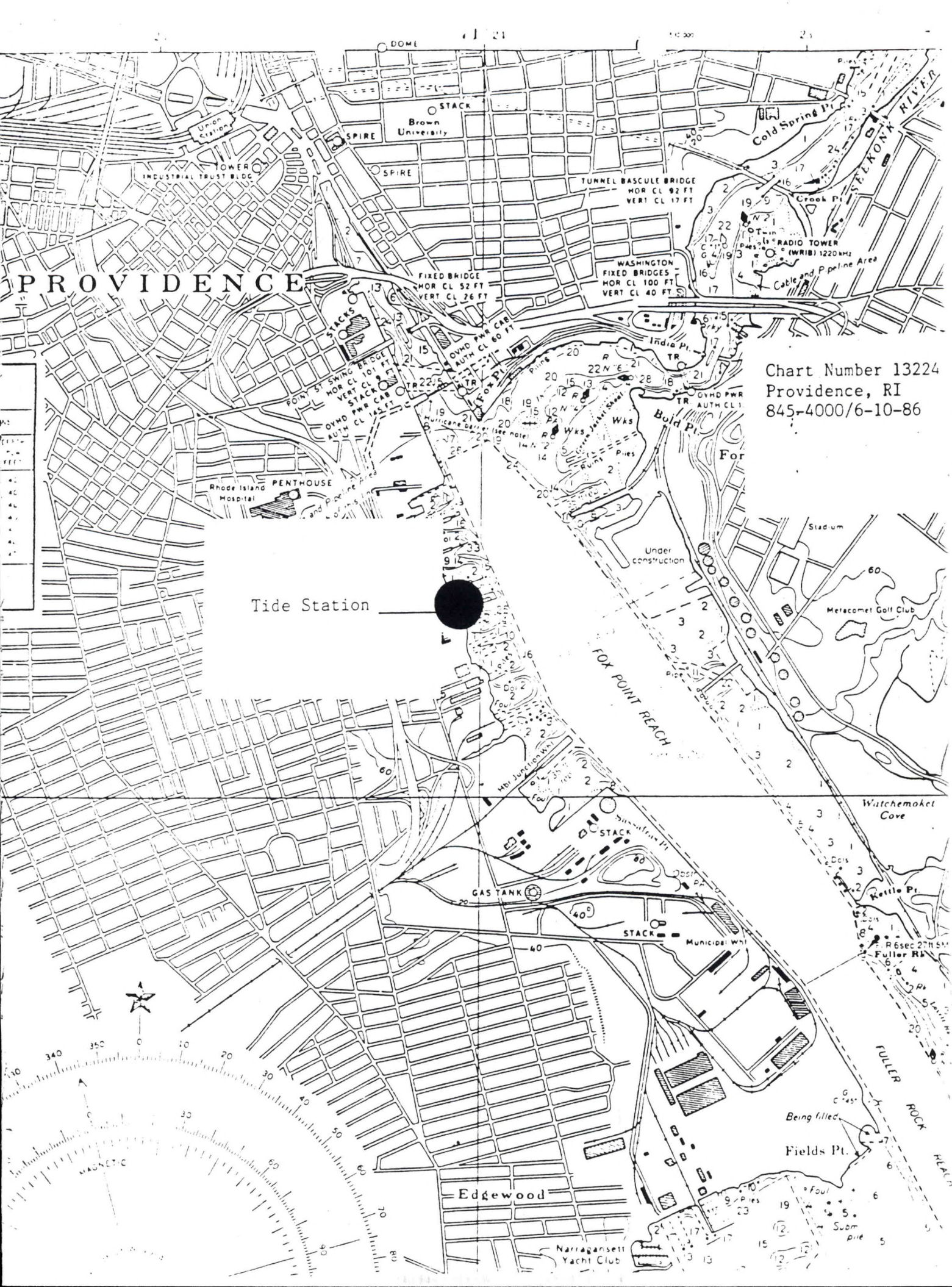
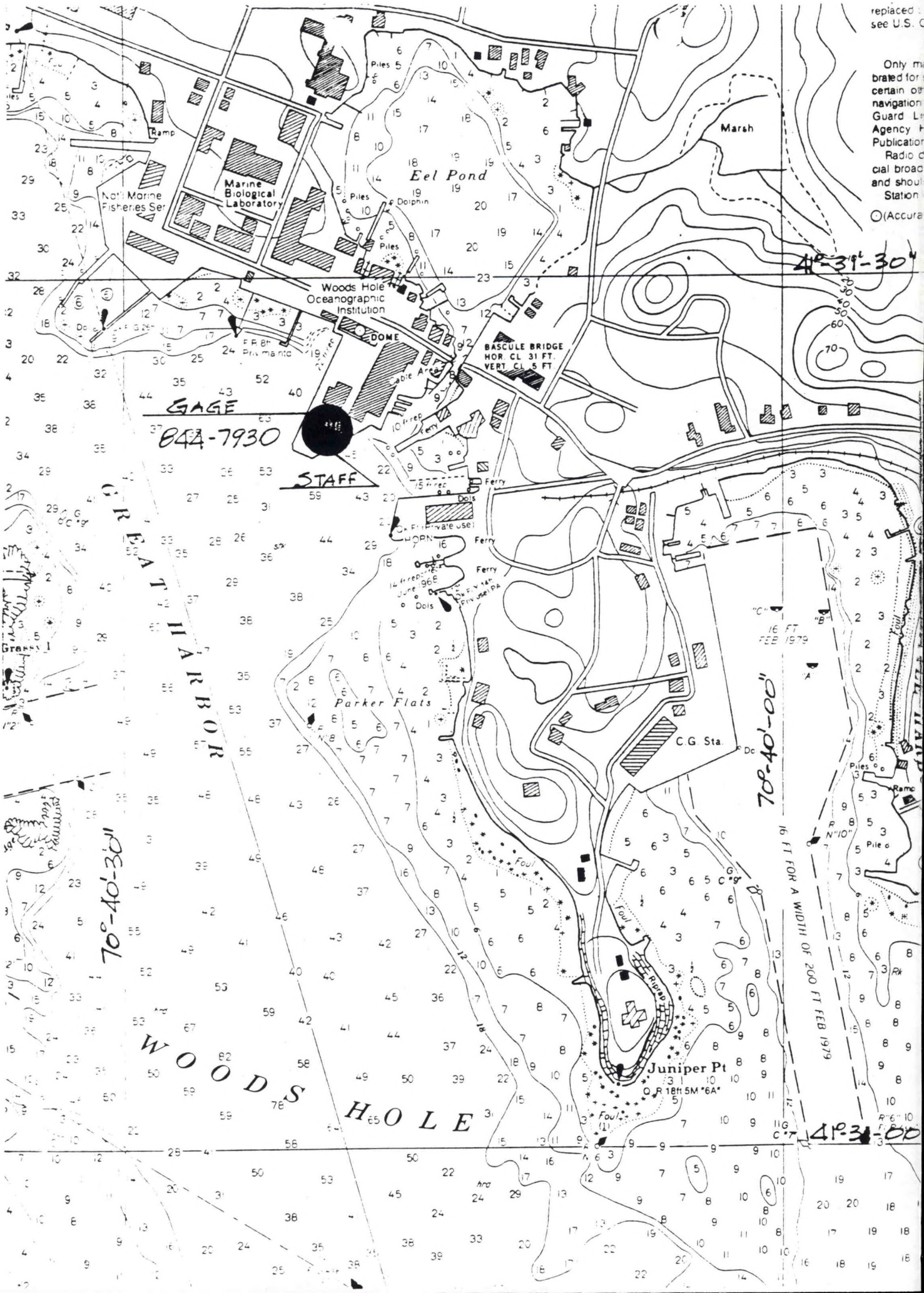
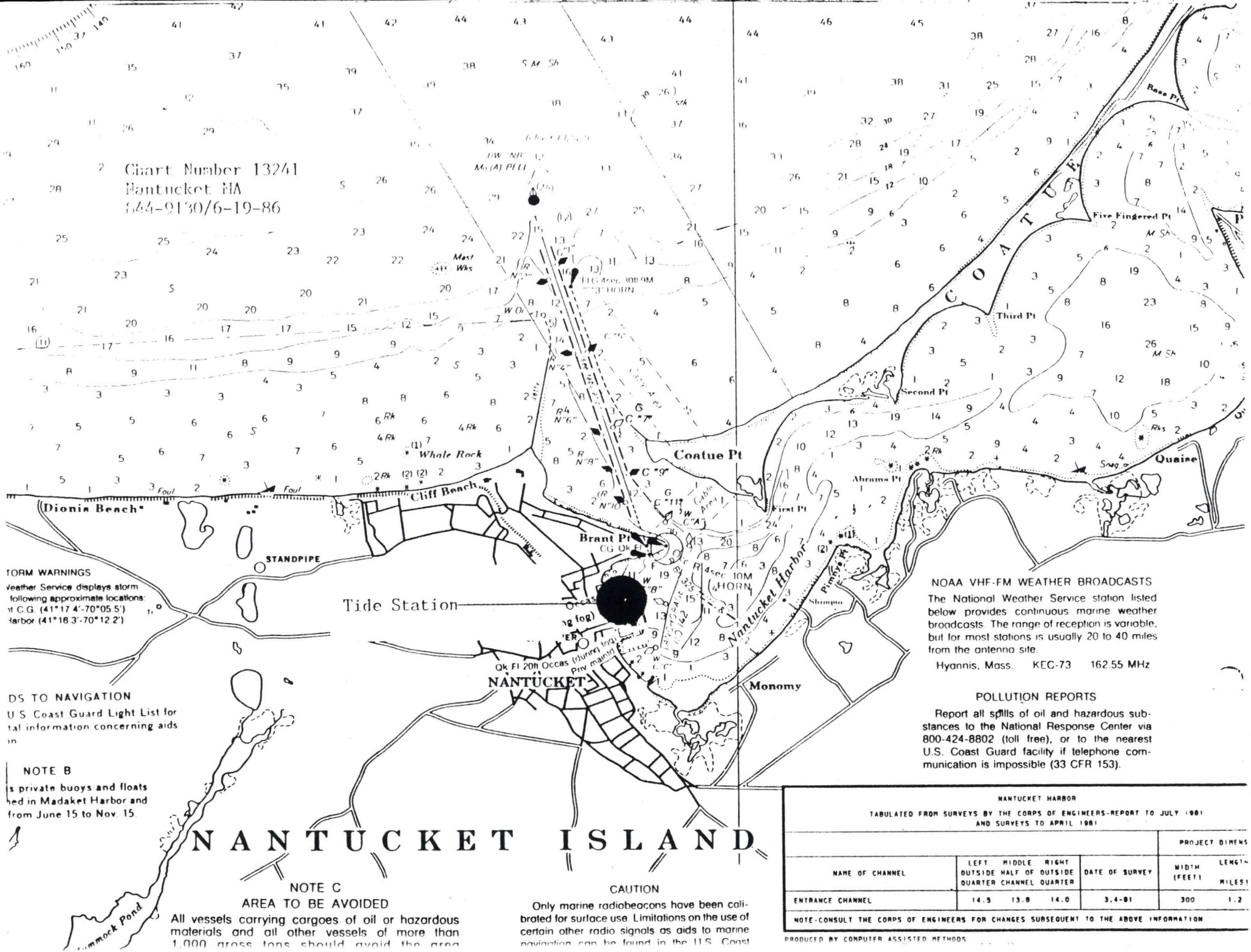


Chart Number 13224
Providence, RI
845-4000/6-10-86


Marsh
Eel Pond
Marine Biological Laboratory
Nat'l Marine Fisheries Ser
Woods Hole Oceanographic Institution
DOME
BASCULE BRIDGE
HOR CL 31 FT.
VERT CL 5 FT.
GAGE
844-7930
STAFF
Parker Flats
GREAT HARBOR
WOODS HOLE
C.G. Sta.
Juniper Pt
O R 18ft 5M "6A"
41°-31'-30"
41°-31'-00"
70°-40'-30"
70°-40'-00"
16 FT FEB 1979
16 FT FOR A WIDTH OF 200 FT FEB 1979
Ramp
Piles
Dolphin
Foul
Ferry
Dols
Ripraps



TORM WARNINGS

Weather Service displays storm following approximate locations: t C.G. (41°17.4'-70°05.5') Harbor (41°16.3'-70°12.2')

DS TO NAVIGATION

U.S. Coast Guard Light List for tal information concerning aids on

NOTE B

s private buoys and floats hed in Madaket Harbor and from June 15 to Nov. 15.

NOTE C

AREA TO BE AVOIDED

All vessels carrying cargoes of oil or hazardous materials and all other vessels of more than 1,000 gross tons should avoid the area

CAUTION

Only marine radiobeacons have been calibrated for surface use. Limitations on the use of certain other radio signals as aids to marine navigation can be found in the U.S. Coast

NOAA VHF-FM WEATHER BROADCASTS

The National Weather Service station listed below provides continuous marine weather broadcasts. The range of reception is variable, but for most stations is usually 20 to 40 miles from the antenna site.

Hyannis, Mass. KEC-73 162.55 MHz

POLLUTION REPORTS

Report all spills of oil and hazardous substances to the National Response Center via 800-424-8802 (toll free), or to the nearest U.S. Coast Guard facility if telephone communication is impossible (33 CFR 153).

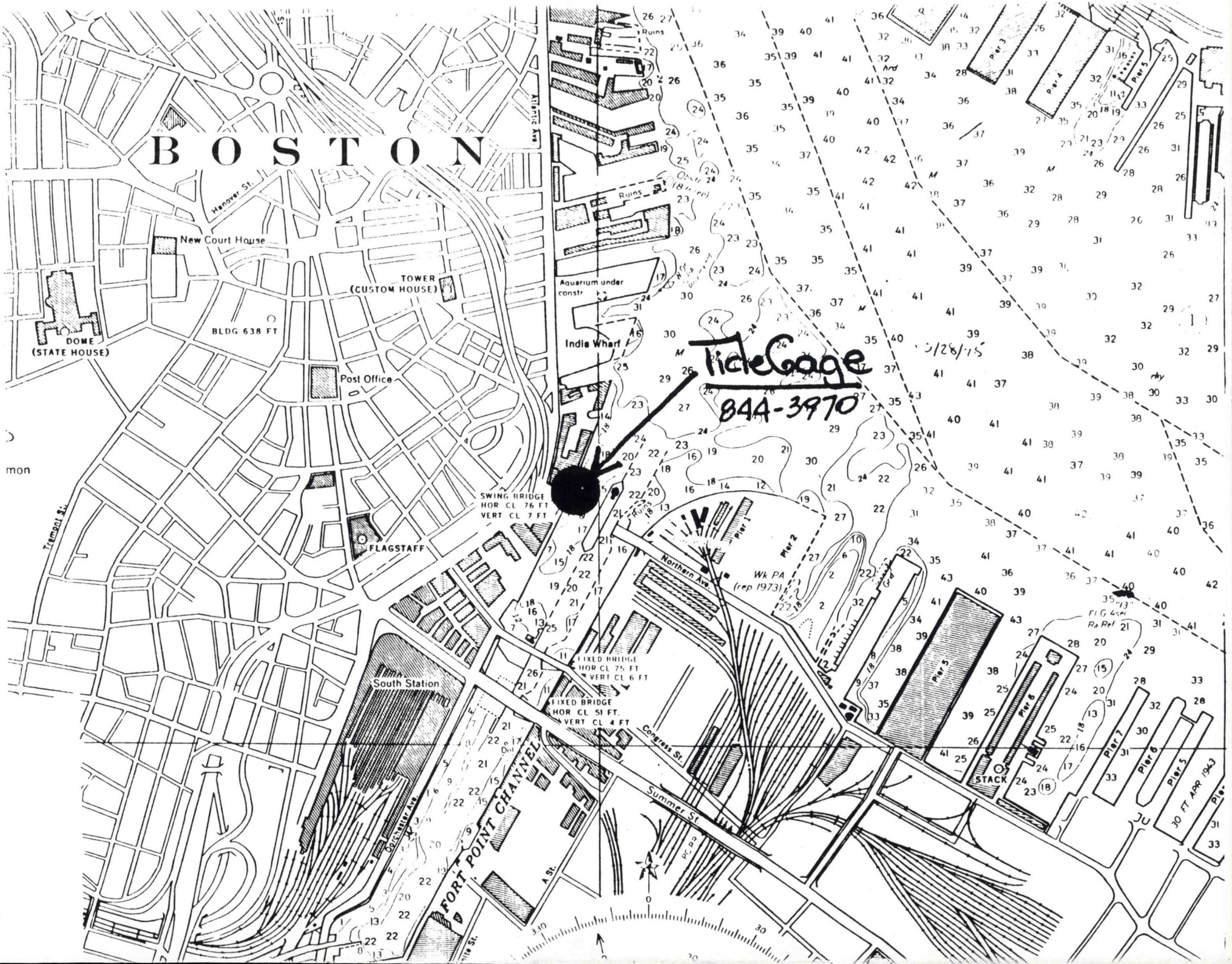
NANTUCKET HARBOR

TABULATED FROM SURVEYS BY THE CORPS OF ENGINEERS-REPORT TO JULY 1981 AND SURVEYS TO APRIL 1981

NAME OF CHANNEL	LEFT OUTSIDE QUARTER	MIDDLE HALF OF CHANNEL	RIGHT OUTSIDE QUARTER	DATE OF SURVEY	PROJECT DIMENS WIDTH (FEET)	PROJECT DIMENS LENGTH MILES
ENTRANCE CHANNEL	14.5	13.8	14.0	3-4-81	300	1.2

NOTE-CONSULT THE CORPS OF ENGINEERS FOR CHANGES SUBSEQUENT TO THE ABOVE INFORMATION

PRODUCED BY COMPUTER ASSISTED METHODS


BOSTON
New Court House
DOME
(STATE HOUSE)
BLDG 638 FT
TOWER
(CUSTOM HOUSE)
Post Office
FLAGSTAFF
Hanover St.
Atlantic Ave
Aquarium under constr
India Wharf
Ruins
Tide Gage
844-3970
SWING BRIDGE
HOR CL 76 FT
VERT CL 7 FT
FIXED BRIDGE
HOR CL 75 FT
VERT CL 6 FT
FIXED BRIDGE
HOR CL 51 FT.
VERT CL 4 FT
South Station
Northern Ave.
Wk PA
(rep 1973)
Pier 1
Pier 2
Pier 3
Pier 4
Pier 5
Pier 6
Pier 7
Congress St.
Summer St.
A St.
FORT POINT CHANNEL
STACK
30 FT APR 1943
Trumbal St.

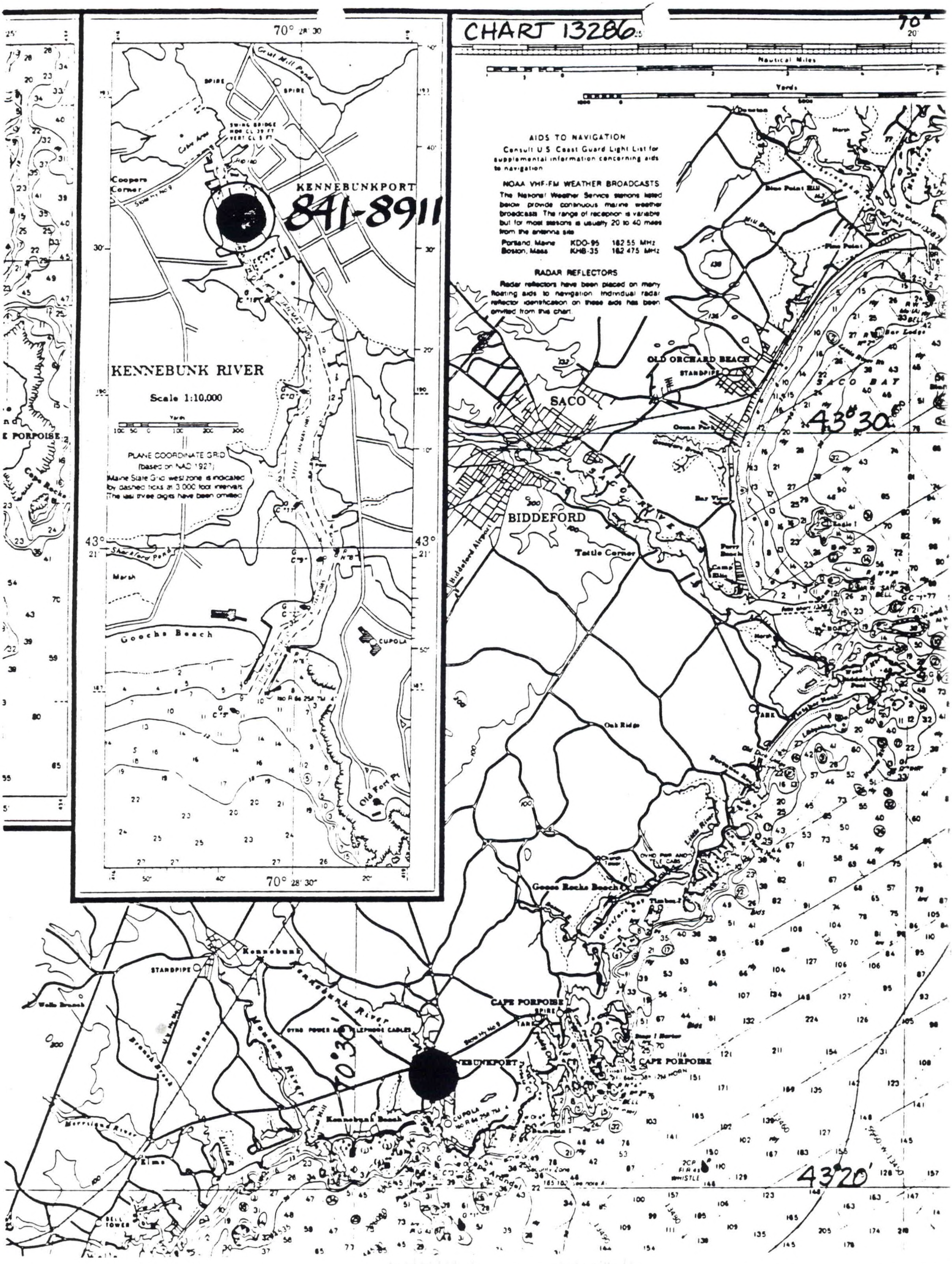


CHART 13286
KENNEBUNKPORT
841-8911
KENNEBUNK RIVER
Scale 1:10,000
PLANE COORDINATE GRID
(based on NAD 1927)
Maine State Grid west zone is indicated by dashed ticks at 3,000 foot intervals. The last three digits have been omitted.
Coopers Corner
Goochs Beach
CUPOLA
Old Fort Pt
Nautical Miles
Yards
AIDS TO NAVIGATION
Consult U.S. Coast Guard Light List for supplemental information concerning aids to navigation.
NOAA VHF-FM WEATHER BROADCASTS
The National Weather Service stations listed below provide continuous marine weather broadcasts. The range of reception is variable but for most stations is usually 20 to 40 miles from the antenna site.
Portland, Maine KDO-95 162.55 MHz
Boston, Mass. KHB-35 162.475 MHz
RADAR REFLECTORS
Radar reflectors have been placed on many floating aids to navigation. Individual radar reflector identification on these aids has been omitted from this chart.
OLD ORCHARD BEACH
SACO
SACO BAY
BIDDEFORD
Tattle Corner
Oak Ridge
Goose Rocks Beach
Kennebunk
STANDPIPE
Kennebunk River
Mousam River
CAPE PORPOISE
Kennebunk Beach
43°30'
43°20'
70°30'

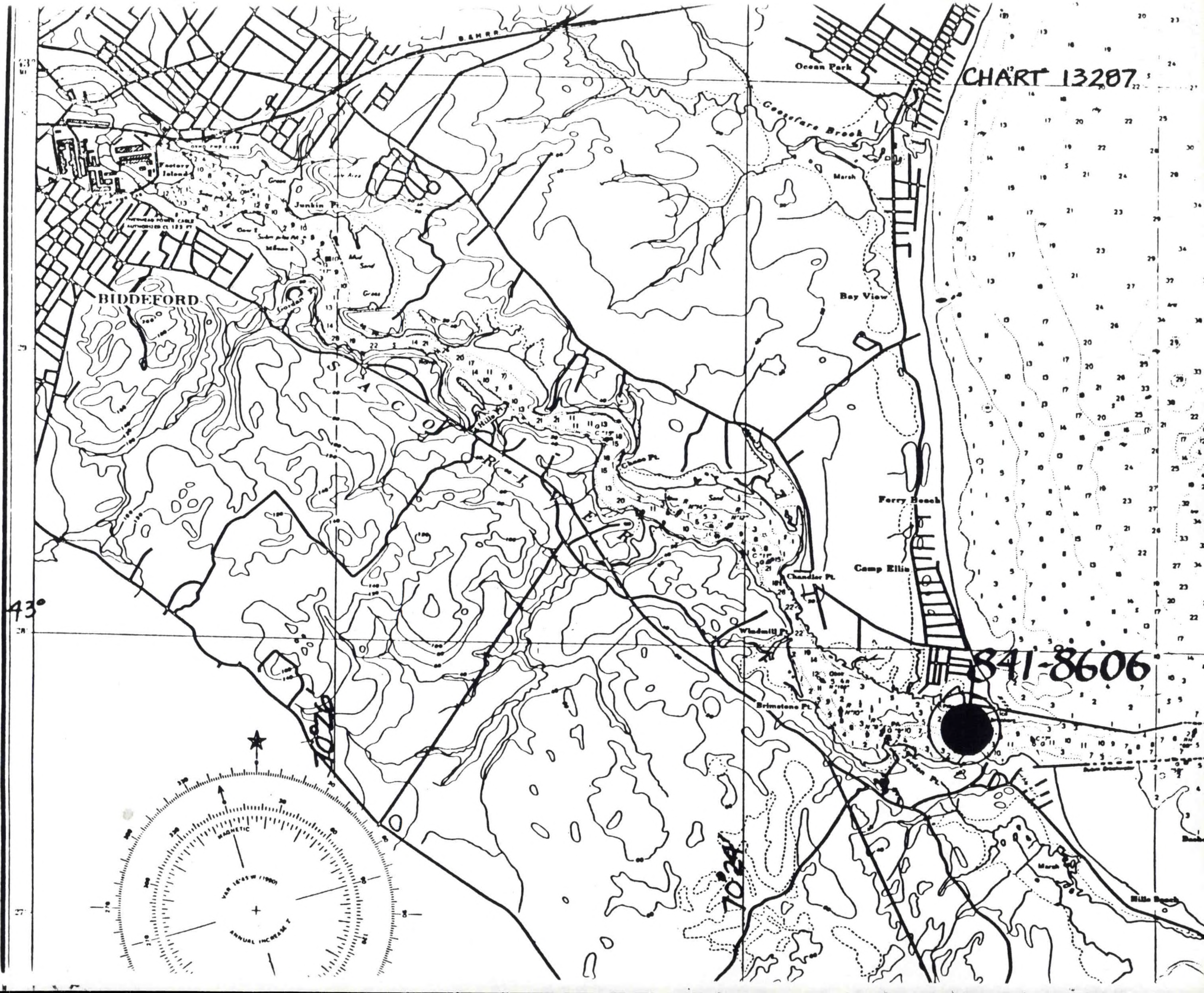


CHART 13287
841-8606
Ocean Park
Goosefare Brook
Marsh
Bay View
Ferry Beach
Camp Ellis
Chandler Pt.
Windmill Pt.
Brimstone Pt.
Junkin Pt.
Factory Island
BIDDEFORD
SACO RIVER
Hills Beach
43°

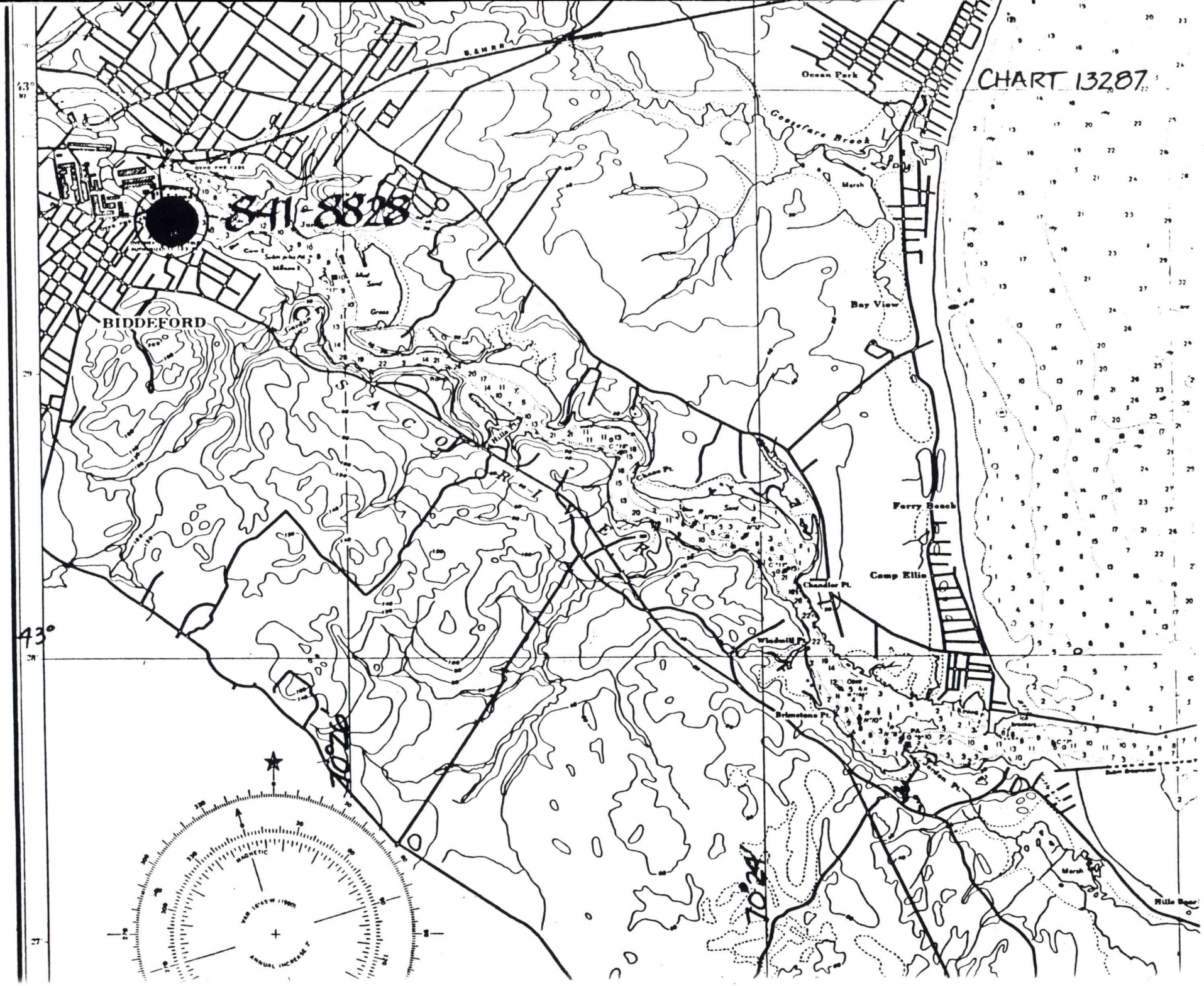


CHART 13287
841-8828
BIDDEFORD
SACO
Ocean Park
Googins Brook
Bay View
Ferry Beach
Camp Ellis
Chandler Pt.
Windmill Pt.
Brimstone Pt.
B.&M.R.R.
43°
70°24'

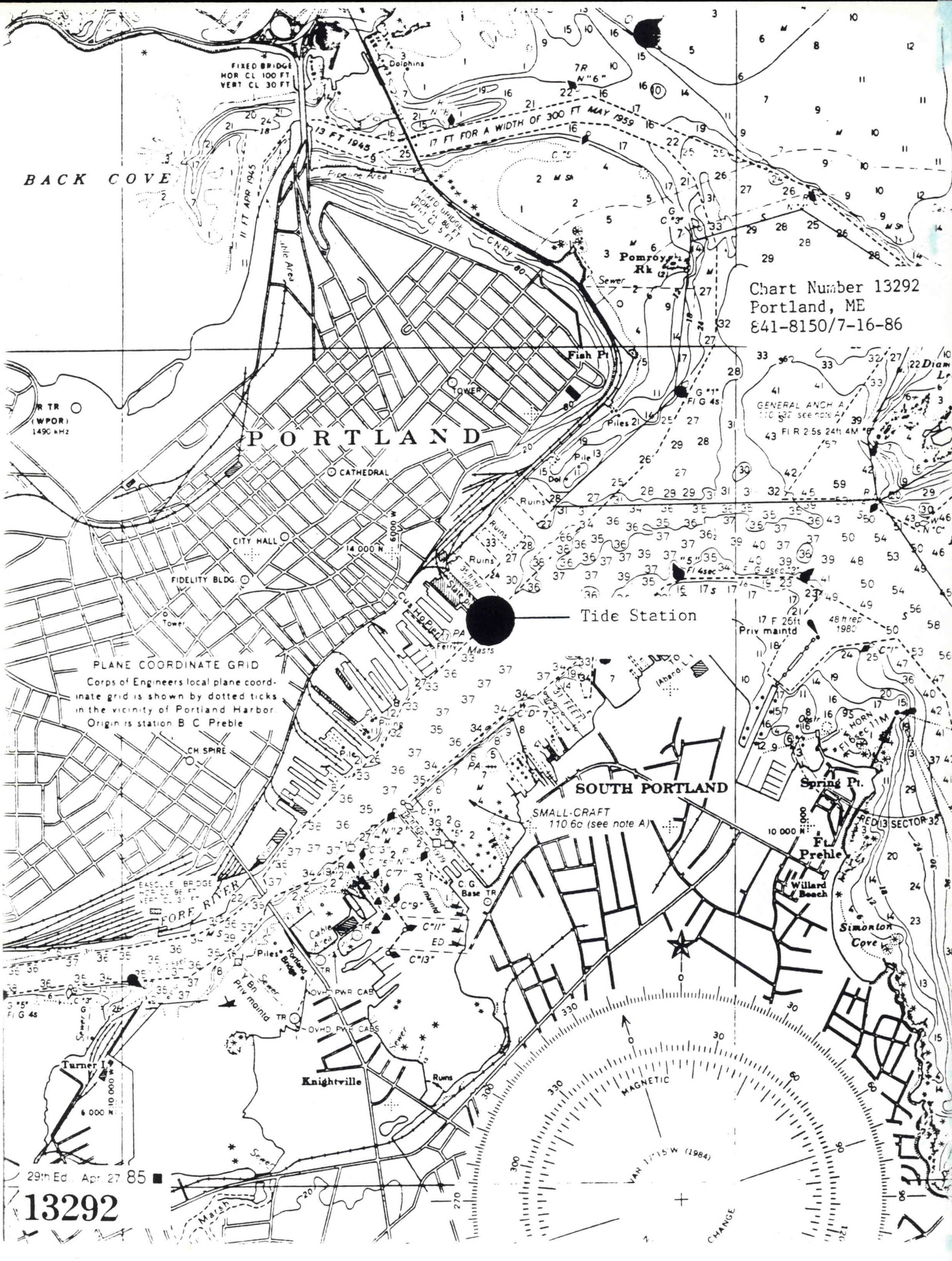


Chart Number 13292
Portland, ME
841-8150/7-16-86
Tide Station
BACK COVE
PORTLAND
CATHEDRAL
CITY HALL
FIDELITY BLDG.
TOWER
CH. SPIRE
FIXED BRIDGE
HOR CL 100 FT
VERT CL 30 FT
17 FT FOR A WIDTH OF 300 FT MAY 1959
13 FT 1945
11 FT APR 1945
Pomroy's Rk
Fish Pt
GENERAL ANCH A
PLANE COORDINATE GRID
Corps of Engineers local plane coordinate grid is shown by dotted ticks in the vicinity of Portland Harbor. Origin is station B C Preble
FORE RIVER
SOUTH PORTLAND
SMALL-CRAFT
110.6a (see note A)
Spring Pt.
Ft. Preble
Willard Beach
Simonton Cove
Knightville
Turner I.
MAGNETIC
29th Ed., Apr. 27 85
13292