US Army Corps
of Engineers
Waterways Experiment
Station

Preliminary Data Summary for June 1994 CERC Field Research Facility

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Coastal Engineering Research Center

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June 1994
Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
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Preface

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

1 Introduction

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.75 m above the National Geodetic Vertical Datum (NGVD) of the year 1929.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local bathymetric, oceanographic, and meteorological conditions. This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Clifford F. Baron at (919) 261-3511.

Chapter 2 presents the meteorological data; Chapters 3 through 6 present oceanographic data; Chapter 7 presents nearshore profiles and bathymetry; and Chapter 8, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used and their operational status during the month. Figure 2 shows weather and ocean conditions for the month. Table 2 and Figure 3 identifies the location of the instruments. The water depths at the wave gauges and current meters vary and may be determined from information contained in Figure 9. Other installation information is contained in Table 1.

Times given in the report are referenced to eastern standard time (EST).

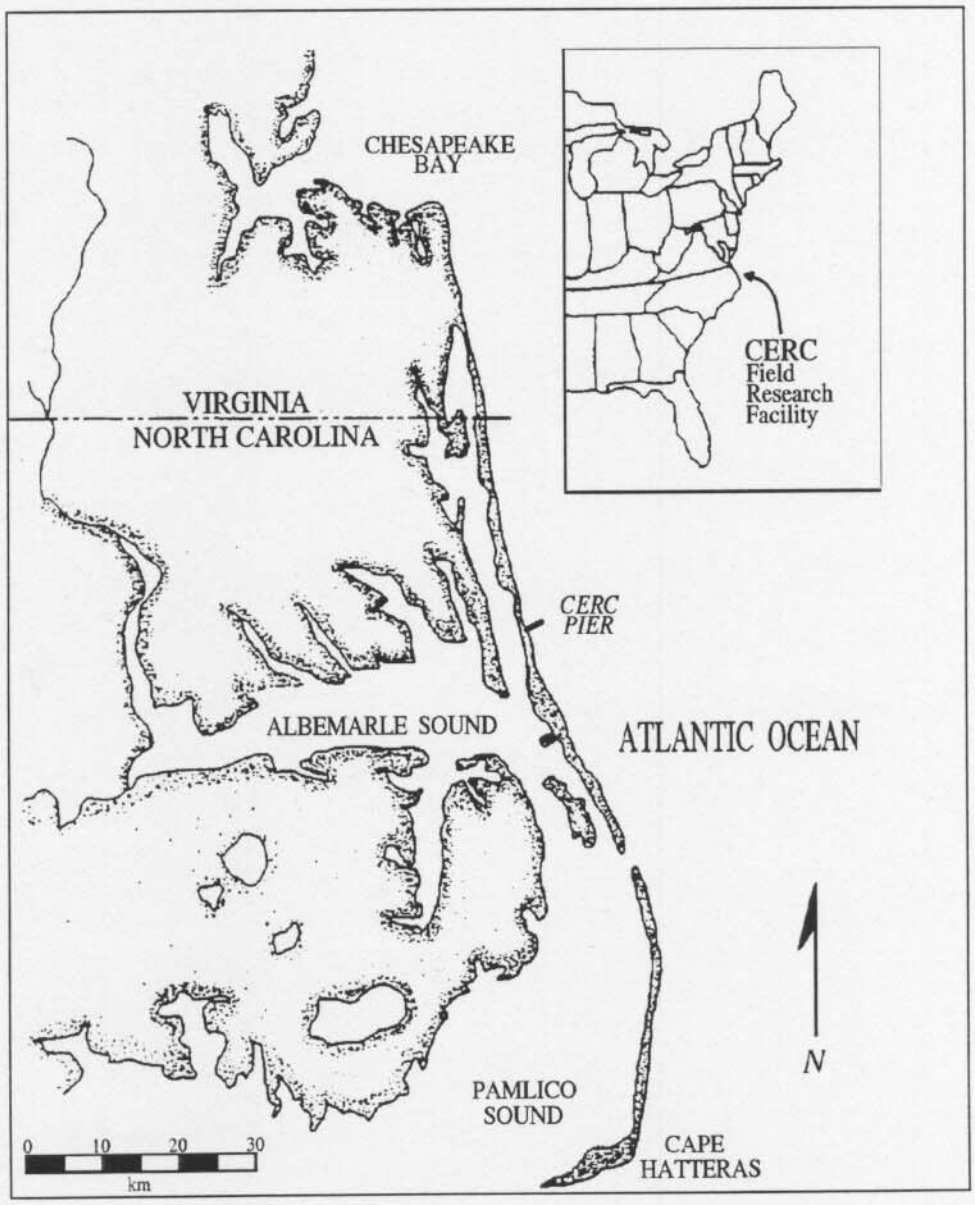

Figure 1. FRF Location Map

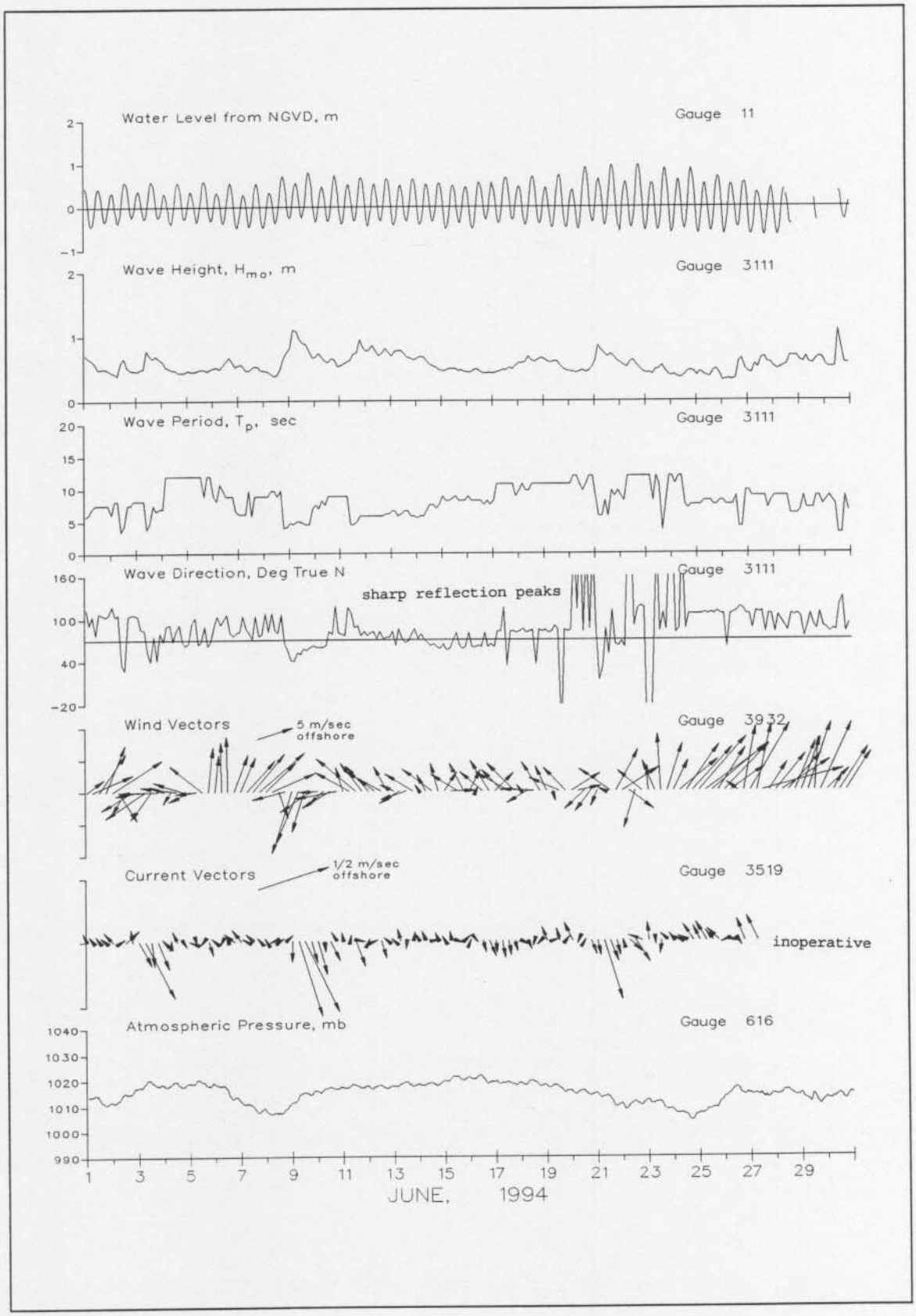

Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

June 1994

Day of the month

Gauge ID	Description/Remarks		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
932	Anemometer	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
111	Pressure Gauge center of 8 Meter Array	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
630	Waverider buoy 4.0 km offshore	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
519	Current meter 434 m north of FRF pier (0.9 km offshore)	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	-
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	-	-	-
11	NOAA tide gauge at end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	/	
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	/	
	Visual Observations (daily oceanographic and meteorological observations)	Daily observation	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*

Gauge Status * = Operational / = Partial - = Non-Operational
Data Collected * = All / = Partial - = None
Visual Observations * = Complete / = Partial - = None

Table 2
Gauge Locations

Gauge ID	Description	Latitude Degrees N	Longitude Degrees W	FRF Coordinates Crosshore m	FRF Coordinates Longshore m	Gauge Depth NGVD, m	Water Depth NGVD, m
616	Atmospheric Pressure	36 10′ 45.48"	75 44′ 37.39"	11.60	569.00	-----	-----
3932	Anemometer	36 11′ 2.64"	75 44′ 46.50"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10′ 51.96"	75 44′ 42.21"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11′ 2.10"	75 44′ 46.31"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11′ 17.59	75 44′ 32.62"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11′ 14.98	75 44′ 42.30"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11′ 16.88	75 44′ 40.32"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11′ 13.18"	75 44′ 38.84"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11′ 15.90"	75 44′ 38.88"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 12′ 16.44"	75 47′ 19.23"	3934.96	-2400.81	Surface	-17.00
3519	Current Meter	36 11′ 17.17"	75 44′ 34.15"	914.76	950.00	-5.30	-7.90
11	NOAA Tide Gauge	36 11′ 2.95"	75 44′ 46.76	596.49	514.20	Surface	-7.62

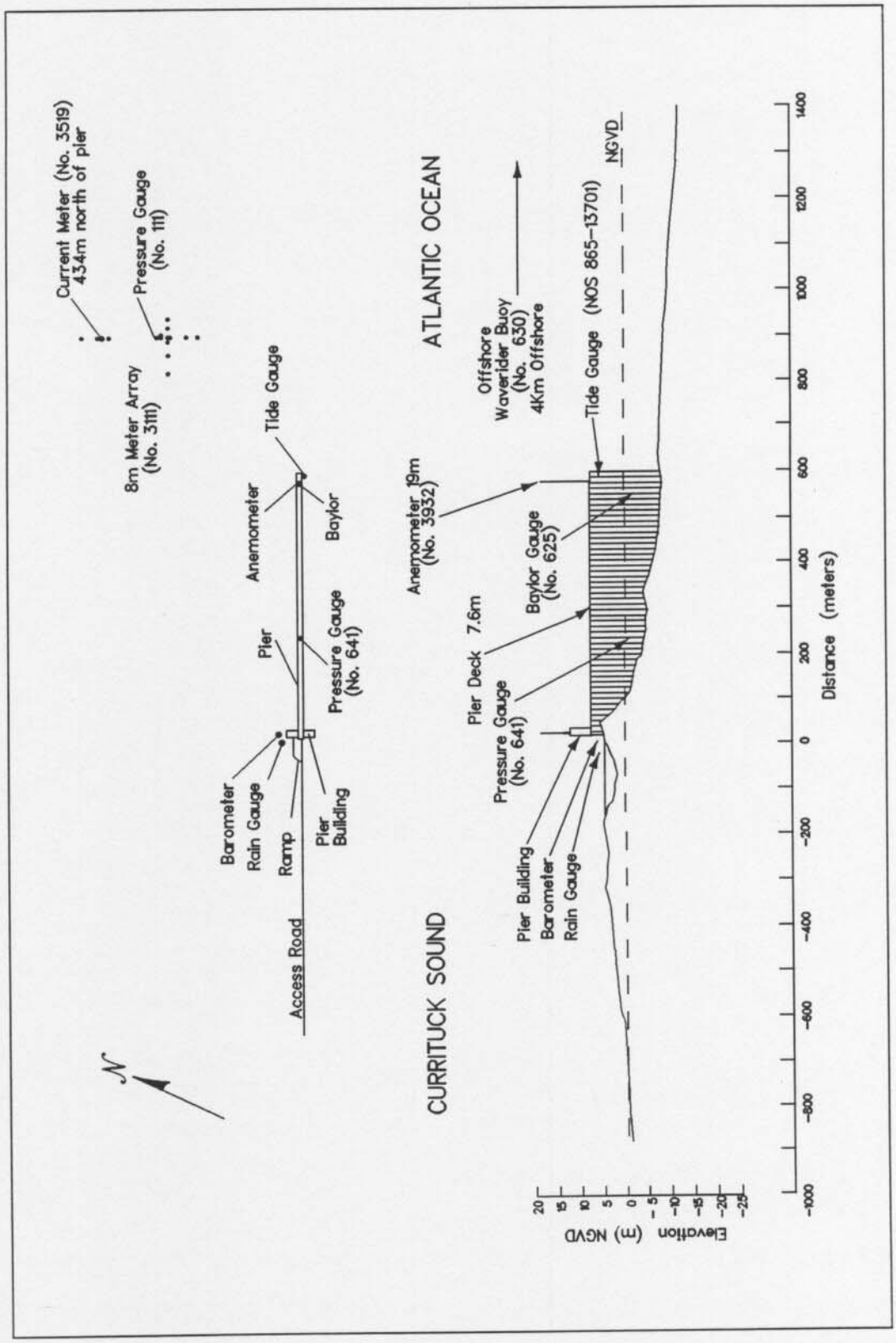

Figure 3. Instrument Locations, Elevations From NGVD

2 Meteorological Data

A variety of instruments have been installed at the FRF (Figure 3) to monitor the meteorological conditions. The data presented in Table 3 are collected and stored using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 4) using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions are determined by vector averaging the data. Wind directions indicate where the wind is coming from. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 3 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
   mm x .03937 = in.

2. Millibars (mb) to inches of mercury (in. Hg) -
   mb x 0.02953 = in. Hg

3. Degrees Celsius (C) to degrees Fahrenheit (F) -
   (C x 9/5) + 32 = F

4. Meters per second (m/s) to knots (kn) -
   m/s x 1.943 = kn

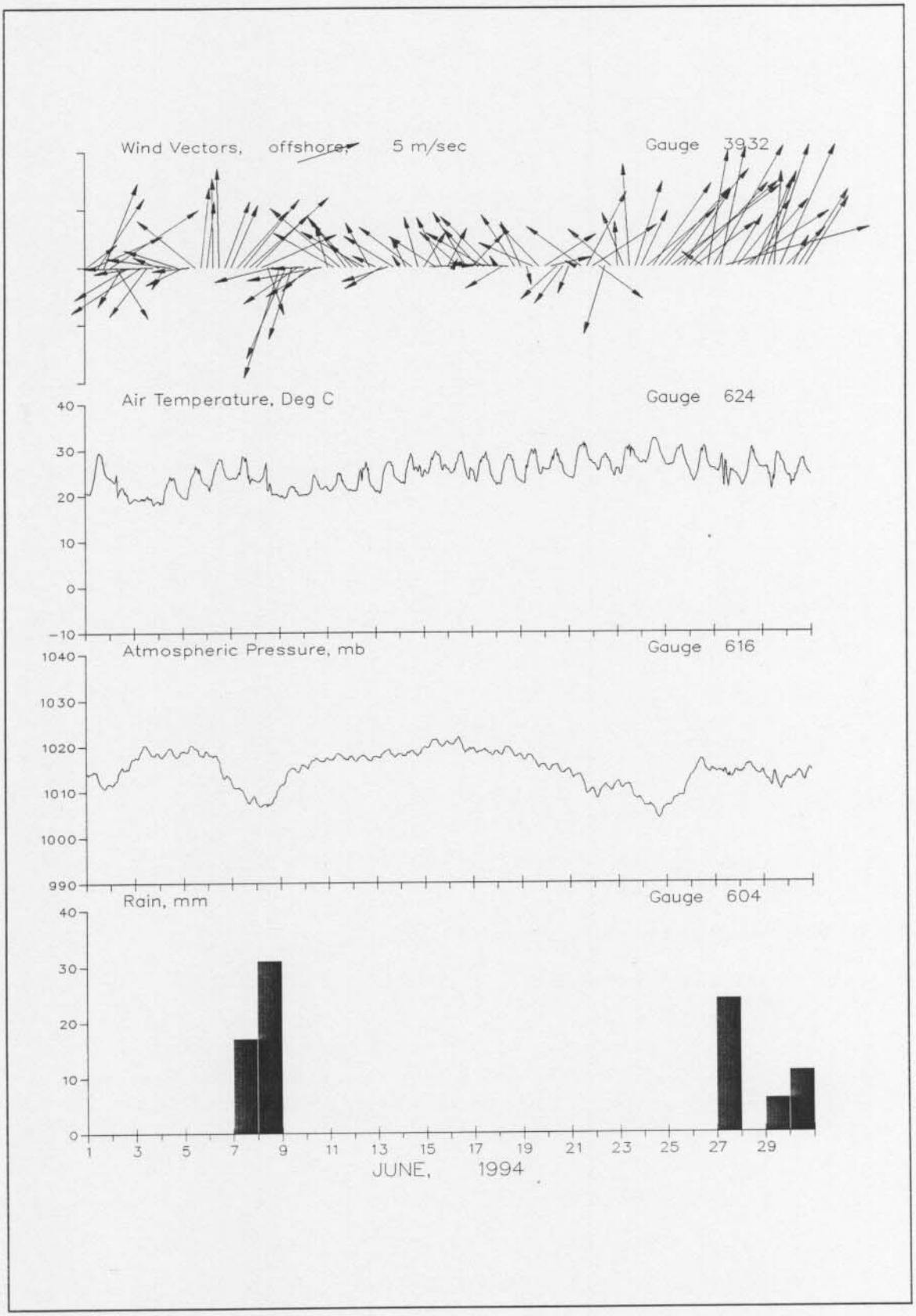

Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Jun 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	229	20.6	1014.1	0
	700	6	1	21.9	1014.4	0
	1300	7	210	29.3	1012.2	0
	1900	8	199	25.6	1010.9	0
2	100	8	233	23.8	1011.5	0
	700	5	331	24.7	1012.9	0
	1300	4	1	21.8	1014.8	0
	1900	5	55	18.9	1015.7	0
3	100	3	1	19.5	1017.6	0
	700	7	52	19.5	1019.3	0
	1300	5	32	20.0	1019.4	0
	1900	5	88	18.1	1017.9	0
4	100	2	114	18.6	1017.7	0
	700	2	28	21.6	1019.0	0
	1300	5	1	23.4	1018.8	0
	1900	4	1	20.9	1017.9	0
5	100	3	60	19.6	1018.9	0
	700	3	82	22.0	1020.2	0
	1300	6	133	26.6	1019.5	0
	1900	7	185	23.7	1018.1	0
6	100	6	185	22.3	1018.3	0
	700	8	179	24.4	1018.1	0
	1300	9	179	28.1	1015.0	0
	1900	6	198	24.3	1013.7	0
7	100	6	200	23.7	1011.4	0
	700	6	218	24.4	1010.9	0
	1300	7	215	28.2	1008.9	0
	1900	9	225	22.5	1008.3	17
8	100	6	221	23.2	1007.4	19
	700	6	243	23.7	1007.2	0
	1300	4	343	21.1	1007.1	0
	1900	5	74	20.4	1008.8	12
9	100	10	15	19.7	1011.5	0
	700	8	20	19.7	1014.4	0
	1300	6	15	22.1	1015.1	0
	1900	5	52	20.1	1014.6	0
10	100	2	86	20.1	1015.7	0
	700	3	45	20.7	1016.7	0
	1300	5	1	23.6	1017.1	0
	1900	6	78	21.4	1016.6	0

Table 3
Meteorological Data (continued)

Jun 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	4	165	21.3	1017.0	0
	700	5	122	22.0	1017.8	0
	1300	7	134	24.8	1017.8	0
	1900	5	146	21.6	1017.1	0
12	100	5	142	21.1	1017.1	0
	700	3	131	23.2	1017.5	0
	1300	6	122	25.7	1017.6	0
	1900	4	154	22.5	1016.8	0
13	100	2	117	20.7	1017.6	0
	700	3	55	22.8	1018.4	0
	1300	4	69	27.3	1019.1	0
	1900	5	125	24.2	1017.5	0
14	100	1	149	22.9	1018.1	0
	700	3	156	25.3	1018.6	0
	1300	5	130	28.2	1018.6	0
	1900	4	167	25.2	1018.4	0
15	100	3	209	25.5	1019.7	0
	700	3	268	26.5	1021.0	0
	1300	4	126	29.5	1021.0	0
	1900	5	156	25.5	1020.2	0
16	100	4	203	25.8	1020.5	0
	700	1	201	25.7	1021.4	0
	1300	4	134	29.2	1020.3	0
	1900	5	152	24.4	1018.9	0
17	100	4	220	25.5	1019.3	0
	700	4	141	25.7	1018.8	0
	1300	5	123	28.5	1018.8	0
	1900	6	139	24.5	1017.8	0
18	100	1	150	22.1	1018.5	0
	700	3	55	25.3	1019.3	0
	1300	4	93	28.6	1019.3	0
	1900	5	151	25.0	1017.7	0
19	100	4	159	23.0	1017.3	0
	700	2	347	25.8	1018.0	0
	1300	4	1	28.9	1016.8	0
	1900	5	140	24.8	1015.8	0
20	100	5	234	25.6	1015.0	0
	700	3	255	27.2	1015.6	0
	1300	4	43	28.3	1014.9	0
	1900	4	33	25.3	1014.3	0

Table 3
Meteorological Data (concluded)

Jun 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	3	19	23.8	1014.1	0
	700	1	120	25.9	1013.5	0
	1300	5	129	30.4	1012.2	0
	1900	7	204	29.0	1009.7	0
22	100	6	233	26.8	1009.4	0
	700	4	311	25.7	1010.3	0
	1300	6	15	29.0	1011.1	0
	1900	5	134	25.3	1010.5	0
23	100	4	177	25.8	1011.9	0
	700	5	161	27.6	1011.4	0
	1300	9	177	30.6	1010.7	0
	1900	8	195	28.1	1008.2	0
24	100	5	202	26.9	1007.4	0
	700	7	226	27.7	1006.9	0
	1300	8	211	32.3	1005.9	0
	1900	9	218	29.8	1004.7	0
25	100	10	217	26.5	1006.9	0
	700	11	229	26.5	1007.9	0
	1300	11	226	29.9	1009.0	0
	1900	7	208	28.2	1010.9	0
26	100	9	219	24.8	1013.5	0
	700	6	230	23.9	1015.8	0
	1300	2	128	29.2	1016.3	0
	1900	10	188	26.7	1014.0	0
27	100	12	206	25.7	1014.3	0
	700	10	190	27.0	1014.2	0
	1300	11	252	24.4	1013.4	18
	1900	5	208	25.3	1013.8	6
28	100	7	215	23.5	1014.2	0
	700	8	233	23.0	1015.7	0
	1300	7	217	29.4	1015.0	0
	1900	8	199	27.1	1013.7	0
29	100	8	197	25.7	1013.4	0
	700	11	196	24.1	1011.6	6
	1300	8	183	25.6	1012.7	0
	1900	11	201	27.3	1011.4	0
30	100	4	221	24.1	1012.4	0
	700	3	205	22.6	1012.9	11
	1300	8	209	26.5	1013.9	0
	1900	7	208	26.1	1013.8	0
		Resultant		Mean	Mean	Total
		3	185	24.7	1014.8	89

3 Wave Data

Wave data are collected from three different sets of instruments, as shown in Table 1 and Figure 3. The first is an array of fifteen pressure gauges, collectively referred to as gauge 3111 (gauge 111 being one of them). Directional information is computed from these gauges using a iterative maximum liklihood estimator. The second is a Baylor staff gauge (625) and a pressure gauge (641), both attached to the pier. The third is a Waverider buoy (630). The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 4100 programmed to sample the gauges for two hour and forty-eight minute time frames. The sampling rate is two times per second which equals five contiguous 34 minute records per collection period. This report reflects the data collection periods of 0100, 0700, 1300, and 1900 EST. The results are based only on the first 34 minute record. The exception is the 8 Meter Array (3111) which condenses the first four records into one statistical value.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gauge has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 degrees of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to optical disc.

Table 4 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 4 are average values computed from this data. Figure 5 is a time history of all H_{mo} and T_p values obtained for all gauges.

Differences in wave periods between wave gauges (Table 4 and Figure 5) may be the result of wave breaking, wave reformation, the presence of multiple wave trains containing nearly equal energy, and statistical variations in spectral estimations.

Table 4
Wave Data

Jun 1994

Day	Hour	641 Pressure Gage Hmo,m	641 Pressure Gage Tp,sec	625 Baylor Gauge Hmo,m	625 Baylor Gauge Tp,sec	3111 8 Meter Array Hmo,m	3111 8 Meter Array Tp,sec	3111 8 Meter Array Dir,N	630 Waverider Hmo,m	630 Waverider Tp,sec
1	0100	0.65	6.5	0.64	6.3	0.71	5.9	114	0.87	6.3
	0700	0.46	6.0	0.58	6.5	0.63	7.1	104	0.74	6.0
	1300	0.45	7.2	0.45	7.8	0.50	7.6	108	0.61	8.1
	1900	0.39	6.0	0.47	8.3	0.50	7.6	104	0.64	7.6
2	0100	0.44	6.3	0.43	7.8	0.45	6.2	118	0.65	6.3
	0700	0.34	6.3	0.37	7.8	0.39	8.2	106	0.49	8.3
	1300	0.57	4.1	0.66	4.1	0.66	4.4	28	0.77	4.2
	1900	0.41	6.5	0.53	7.8	0.47	7.6	106	0.66	4.2
3	0100	0.33	7.8	0.45	7.6	0.46	8.2	104	0.57	7.8
	0700	0.31	8.3	0.50	6.5	0.50	8.2	84	0.58	8.6
	1300	0.50	4.5	0.71	4.4	0.70	4.8	40	0.85	4.3
	1900	0.44	5.6	0.73	7.4	0.70	6.6	42	0.80	5.6
4	0100	0.39	12.9	0.66	7.6	0.61	7.1	68	0.78	6.0
	0700	0.31	12.9	0.53	12.2	0.50	12.0	92	0.59	12.2
	1300	0.33	12.2	0.47	12.2	0.48	12.0	82	0.55	12.2
	1900	0.32	12.2	0.45	12.2	0.44	12.0	68	0.55	12.2
5	0100	0.35	11.7	0.50	11.7	0.47	12.0	66	0.51	7.8
	0700	0.36	11.2	0.48	8.9	0.46	12.0	102	0.56	12.2
	1300	0.41	5.3	0.51	11.7	0.49	12.0	68	0.57	11.2
	1900	0.38	8.6	0.48	9.2	0.46	12.0	62	0.56	11.7
6	0100	0.38	4.7	0.46	7.8	0.51	8.9	90	0.57	9.9
	0700	0.41	11.2	0.49	9.2	0.49	10.8	92	0.59	9.2
	1300	0.41	5.6	0.53	8.9	0.61	8.9	106	0.74	8.5
	1900	0.51	4.7	0.56	4.3	0.59	8.9	76	0.75	5.2
7	0100	0.41	5.4	0.50	6.8	0.56	6.2	82	0.67	6.5
	0700	0.46	5.2	0.48	9.9	0.48	6.2	86	0.58	5.5
	1300	0.39	5.9	0.46	8.9	0.50	5.9	72	0.60	6.0
	1900	0.51	6.0	0.49	9.5	0.52	8.9	76	0.68	9.2
8	0100	0.38	5.3	0.44	8.9	0.46	8.9	108	0.57	8.6
	0700	0.37	9.9	0.40	9.2	0.42	9.8	108	0.52	9.5
	1300	0.29	9.2	0.38	9.2	0.39	8.9	80	0.50	8.9
	1900	0.54	3.9	0.65	4.0	0.66	4.1	66	0.82	9.5
9	0100	0.49	4.7	0.69	4.9	0.81	4.8	42	1.20	4.6
	0700	0.75	5.1	1.03	5.3	1.08	5.0	52	1.37	5.1
	1300	0.52	4.7	0.88	5.0	0.90	4.8	58	1.01	5.2
	1900	0.51	4.8	0.78	4.8	0.78	4.6	60	0.91	5.0
10	0100	0.36	8.9	0.66	7.8	0.68	7.6	60	0.74	7.4
	0700	0.39	8.3	0.67	6.6	0.68	8.2	60	0.81	7.4
	1300	0.32	9.2	0.59	9.2	0.59	8.9	82	0.67	9.2
	1900	0.43	8.9	0.66	9.2	0.63	8.9	118	0.76	9.5

Table 4
Wave Data (continued)

Jun 1994

		641 Pressure Gage		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,N	Hmo,m	Tp,sec
11	0100	0.32	9.5	0.56	8.9	0.54	8.9	78	0.64	8.9
	0700	0.44	4.2	0.60	8.1	0.60	8.9	116	0.70	4.5
	1300	0.50	4.9	0.67	5.5	0.72	4.6	88	0.81	5.0
	1900	0.84	6.0	0.87	5.7	0.94	5.9	76	1.13	6.0
12	0100	0.60	5.9	0.77	5.7	0.77	5.9	76	1.02	5.7
	0700	0.70	5.5	0.77	5.5	0.85	5.9	82	0.99	5.7
	1300	0.61	6.0	0.70	6.1	0.70	5.9	82	0.81	6.0
	1900	0.66	5.9	0.74	6.1	0.81	6.2	74	0.93	6.5
13	0100	0.55	6.3	0.69	6.5	0.69	6.6	82	0.80	6.6
	0700	0.59	6.0	0.74	6.5	0.77	5.9	86	0.91	6.1
	1300	0.64	5.9	0.74	6.8	0.73	6.6	66	0.90	6.1
	1900	0.58	6.0	0.61	5.9	0.66	5.9	78	0.77	5.9
14	0100	0.56	5.5	0.63	6.1	0.65	5.6	72	0.76	6.1
	0700	0.53	5.3	0.68	5.7	0.68	5.9	70	0.78	5.6
	1300	0.50	5.4	0.57	7.8	0.56	7.6	62	0.71	5.0
	1900	0.38	5.7	0.52	8.3	0.52	7.1	60	0.60	7.0
15	0100	0.35	6.5	0.44	8.6	0.46	8.9	64	0.50	8.3
	0700	0.29	5.5	0.46	8.3	0.50	8.2	58	0.52	8.6
	1300	0.35	8.9	0.44	8.9	0.50	8.9	80	0.51	8.6
	1900	0.32	7.2	0.47	9.2	0.47	8.2	58	0.49	8.3
16	0100	0.30	8.3	0.40	8.6	0.44	8.9	80	0.50	8.1
	0700	0.30	7.8	0.44	8.1	0.47	8.2	60	0.48	7.8
	1300	0.33	7.8	0.43	7.8	0.45	8.2	60	0.50	8.1
	1900	0.28	6.6	0.47	7.8	0.42	8.2	60	0.49	8.1
17	0100	0.29	7.8	0.41	8.3	0.42	8.2	60	0.50	7.8
	0700	0.26	11.7	0.46	10.7	0.46	10.8	82	0.49	11.2
	1300	0.35	8.6	0.45	10.7	0.47	10.8	34	0.53	10.3
	1900	0.34	9.2	0.53	10.3	0.49	10.8	82	0.58	9.9
18	0100	0.41	8.6	0.52	10.3	0.57	9.8	82	0.63	9.9
	0700	0.37	8.9	0.59	10.3	0.60	9.8	80	0.62	8.3
	1300	0.51	10.3	0.58	9.9	0.62	10.8	84	0.72	9.9
	1900	0.48	5.5	0.68	10.7	0.63	10.8	84	0.74	10.7
19	0100	0.55	5.3	0.63	9.2	0.64	10.8	84	0.72	10.3
	0700	0.43	5.7	0.62	10.3	0.59	10.8	82	0.67	10.7
	1300	0.50	5.9	0.53	10.7	0.61	10.8	84	0.67	6.0
	1900	0.38	11.2	0.52	10.7	0.50	10.8	84	0.57	10.3
20	0100	0.37	5.3	0.41	11.2	0.46	10.8	84	0.50	9.9
	0700	0.32	11.2	0.43	10.3	0.43	12.0	114	0.47	9.5
	1300	0.38	11.2	0.40	12.2	0.47	9.8	82	0.50	10.7
	1900	0.35	9.5	0.42	9.5	0.46	12.0	86	0.48	11.2

Table 4
Wave Data (concluded)

Jun 1994

		641 Pressure Gage		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,N	Hmo,m	Tp,sec
21	0100	0.43	4.5	0.56	8.6	0.60	8.9	82	0.66	8.3
	0700	0.65	5.5	0.68	5.9	0.77	5.9	32	1.11	5.5
	1300	0.46	5.6	0.69	6.1	0.68	5.9	50	0.78	5.9
	1900	0.47	7.4	0.64	9.2	0.67	8.9	64	0.82	9.5
22	0100	0.34	11.7	0.54	8.9	0.57	8.9	68	0.65	8.3
	0700	0.35	11.7	0.52	8.1	0.52	12.0	226	0.62	8.1
	1300	0.43	12.2	0.64	11.7	0.63	12.0	90	0.78	11.2
	1900	0.40	11.2	0.50	11.2	0.50	12.0	118	0.60	11.7
23	0100	0.31	11.7	0.44	8.1	0.43	12.0	80	0.49	8.1
	0700	0.36	7.6	0.42	6.8	0.41	8.2	62	0.54	7.0
	1300	0.35	4.1	0.49	11.2	0.48	10.8	82	0.61	11.2
	1900	0.41	6.0	0.44	4.6	0.47	7.6	84	0.63	4.8
24	0100	0.31	5.2	0.37	7.2	0.38	12.0	222	0.45	7.2
	0700	0.32	4.8	0.36	8.1	0.36	12.0	86	0.46	11.2
	1300	0.32	5.2	0.40	11.2	0.40	7.6	86	0.54	11.2
	1900	0.40	6.0	0.40	9.2	0.46	7.6	106	0.65	4.2
25	0100	0.34	7.6	0.40	7.8	0.38	7.6	106	0.62	7.6
	0700	0.42	8.3	0.39	8.1	0.41	8.2	108	0.64	7.8
	1300	0.37	6.5	0.35	8.6	0.37	8.2	108	0.60	6.3
	1900	0.48	7.0	0.47	8.1	0.49	7.6	110	0.69	4.7
26	0100	0.28	9.2	0.34	8.3	0.30	8.2	106	0.46	8.1
	0700	0.30	7.4	0.29	9.2	0.33	7.6	106	0.42	7.8
	1300	0.31	5.9	0.32	8.9	0.34	8.9	110	0.39	8.6
	1900	0.49	4.4	0.58	3.9	0.64	4.2	114	0.85	4.4
27	0100	0.41	6.0	0.50	9.2	0.44	9.8	106	0.81	3.1
	0700	0.40	8.9	0.53	8.9	0.55	8.9	110	0.75	3.6
	1300	0.57	5.5	0.64	8.9	0.64	8.9	110	1.07	4.8
	1900	0.50	7.0	0.60	8.6	0.59	7.1	106	0.71	6.8
28	0100	0.50	7.0	0.54	9.2	0.52	8.9	80	0.67	7.6
	0700	0.40	6.0	0.47	8.6	0.48	8.9	0	0.58	9.2
	1300	0.48	6.1	0.44	8.6	0.55	8.9	82	0.59	6.3
	1900	0.62	6.0	0.70	5.9	0.68	6.2	104	0.92	5.7
29	0100	0.60	6.5	0.58	8.6	0.62	6.6	102	0.87	6.1
	0700	0.54	4.1	0.70	8.9	0.68	7.1	88	0.98	4.4
	1300	0.55	7.2	0.49	7.4	0.56	7.1	90	0.75	7.0
	1900	0.53	6.5	0.64	8.9	0.67	8.9	108	1.02	8.9
30	0100	0.52	8.6	0.53	9.2	0.56	8.2	86	0.75	7.8
	0700	0.41	7.4	0.48	8.9	0.51	8.2	84	0.58	8.1
	1300	0.52	6.9	0.51	8.8	1.09	3.2	118	0.70	6.1
	1900	0.46	6.6	0.56	8.9	0.57	8.9	80	0.71	8.9
Mean		0.43	7.2	0.54	8.3	0.56	8.4	83	0.68	7.7
Std dev		0.11	2.3	0.13	1.9	0.14	2.2	31	0.18	2.2

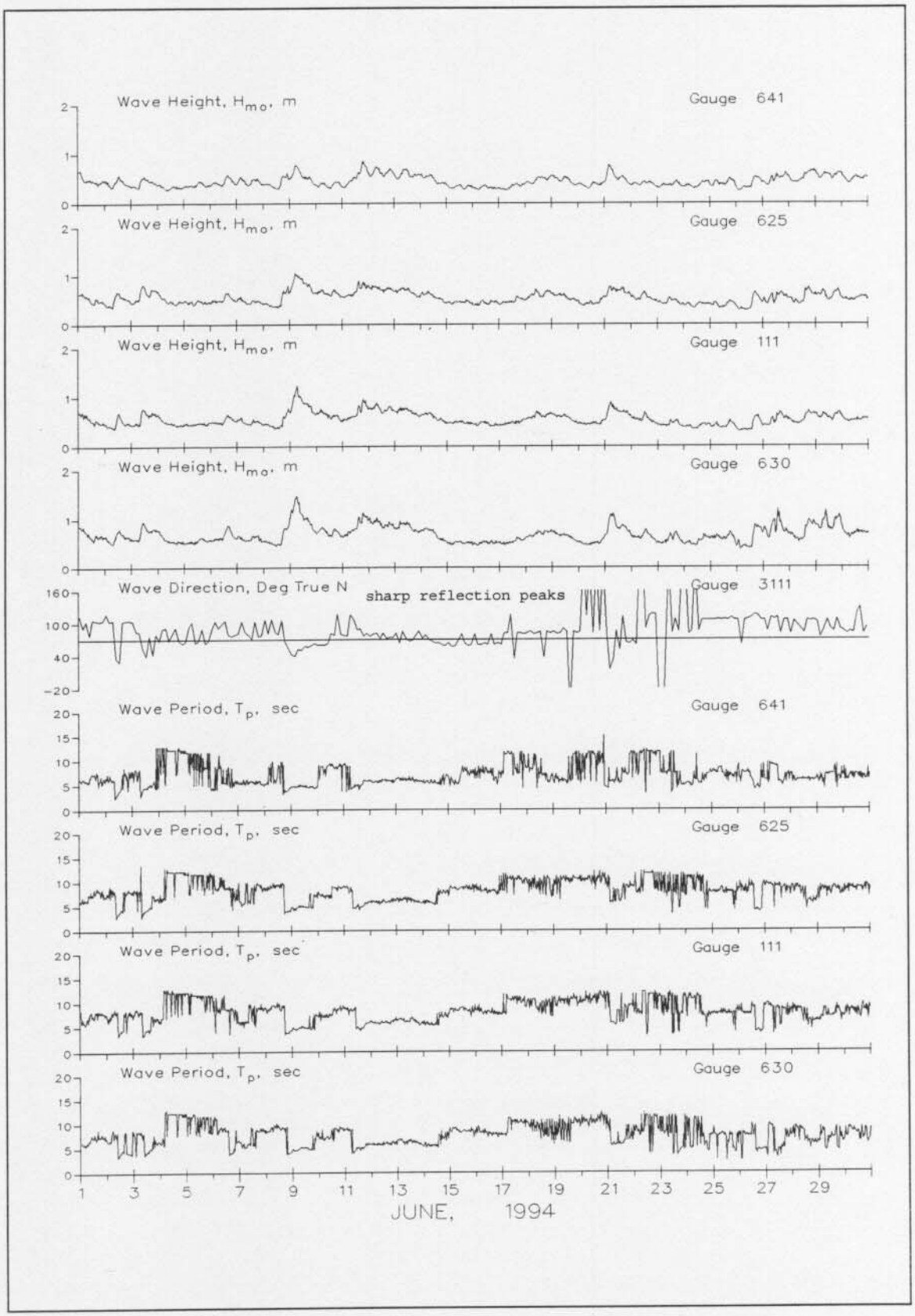

Figure 5. Wave Heights and Periods

4 Current Data

Current data (Table 5) are collected from a Marsh-McBirney electromagnetic biaxial current meter and by visually observing the movement of small drogues on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier, approximately 12 m offshore (Table 6).

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward). All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the cross-shore and longshore data. Current directions indicate the direction that the current is moving towards. Current data are plotted in Figure 2.

Table 5
Current Meter Data - Gauge 519

JUNE 1994

Day	Time	Cross Shore	Long Shore	Speed	Dir
1	100	0	-7	8	339
	700	-1	-5	6	324
	1300	0	-4	6	327
	1900	-1	-4	5	314
2	100	-2	-8	10	321
	700	4	0	4	56
	1300	11	-5	13	43
	1900	2	-9	10	354
3	100	2	20	20	155
	700	4	47	47	156
	1300	-4	18	19	174
	1900	0	22	22	160
4	100	0	-1	3	319
	700	0	0	0	
	1300	0	-8	9	338
	1900	1	4	4	152
5	100	0	0	0	
	700	0	2	2	164
	1300	-1	2	3	215
	1900	0	11	11	165
6	100	-1	-2	4	313
	700	-1	2	3	204
	1300	1	-5	6	347
	1900	-4	-7	10	309
7	100	-2	-10	11	327
	700	-2	-2	4	302
	1300	-2	-6	8	317
	1900	0	-2	3	323
8	100	0	-2	3	333
	700	-1	1	2	239
	1300	4	0	4	52
	1900	6	-2	7	42
9	100	-5	15	16	180
	700	-4	60	60	165
	1300	3	59	59	157
	1900	-1	17	17	167
10	100	-2	26	26	166
	700	-1	8	8	174
	1300	1	16	16	158
	1900	0	-7	8	331
11	100	1	-6	7	350
	700	2	-3	5	8
	1300	0	20	20	163
	1900	1	1	2	105
12	100	1	0	2	24
	700	2	0	2	66
	1300	-1	14	14	166
	1900	-1	-3	4	312
13	100	0	-2	3	317
	700	1	-9	10	347
	1300	-2	6	6	187
	1900	3	-5	7	7
14	100	0	-6	7	330
	700	0	-7	8	340
	1300	5	1	6	78
	1900	0	-6	7	338
15	100	0	-3	4	331
	700	2	-7	8	352
	1300	4	3	5	108
	1900	5	-2	6	43
16	100	1	0	1	20
	700	0	1	1	144
	1300	0	9	9	168
	1900	0	13	13	160
17	100	-2	9	9	176
	700	-2	13	13	172
	1300	-1	11	11	172
	1900	0	8	8	169
18	100	4	5	6	120
	700	0	7	7	158
	1300	-1	4	4	191
	1900	-2	2	4	220
19	100	0	-10	11	340
	700	4	0	4	69
	1300	1	-9	10	345
	1900	4	-2	4	35
20	100	0	-14	15	338
	700	0	2	2	200
	1300	1	0	1	30
	1900	0	11	11	162
21	100	-1	12	12	170
	700	-3	47	47	165
	1300	0	17	17	162
	1900	-1	12	12	169
22	100	0	0	0	
	700	5	11	12	136
	1300	3	19	19	151
	1900	-7	-6	11	293
23	100	4	-13	14	355
	700	0	3	3	174
	1300	-4	10	11	185
	1900	-2	-6	8	315
24	100	-1	-5	7	327
	700	-2	-3	5	300
	1300	-4	-4	7	298
	1900	-2	-13	14	329
25	100	0	-11	12	337
	700	-1	-15	16	333
	1300	-1	-8	9	325
	1900	-4	-10	12	317
26	100	-2	1	3	241
	700	-3	-1	4	272
	1300	1	5	5	152
	1900	0	-16	17	341
27	100				
	700	0	-20	21	338
	1300				
	1900				
28	100				
	700		Gauge		
	1300				
	1900				
29	100				
	700		Inoperative		
	1300				
	1900				
30	100				
	700				
	1300				
	1900				

KEY:

+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

Table 6
Visually Observed Current Data

Jun 1994

	Pier End				Mid-Surf Zone				Beach		
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	18	30	36	70	0	-55	55	340	South	15	N
2	0	0	0		0	-12	12	340	South	9	S
3	0	102	102	160	0	15	15	160	North	8	S
4	-17	17	25	250	0	-30	30	340	South	2	S
5	-6	-32	33	329	-3	-55	55	337	South	5	S
6	0	-47	47	340	0	-23	23	340	South	8	N
7	0	-18	18	340	13	-13	19	25	South	5	N
8	0	-14	14	340	0	-7	7	340	South	3	N
9	0	55	55	160	0	61	61	160	North	0	
10	0	18	18	160	0	-34	34	340	South	10	S
11	0	-22	22	340	0	-23	23	340	South	10	S
12	0	-20	20	340	0	-24	24	340	South	10	N
13	0	-30	30	340	0	-27	27	340	South	15	N
14	0	-18	18	340	0	-28	28	340	South	8	N
15	0	-18	18	340	0	-20	20	340	South	10	S
16	0	-30	30	340	0	-47	47	340	South	15	N
17	0	9	9	160	0	-38	38	340	South	17	N
18	0	20	20	160	0	-34	34	340	South	10	N
19	0	-14	14	340	0	-20	20	340	South	6	N
20	0	0	0		0	0	0		South	3	N
21	0	102	102	160	0	18	18	160	North	0	
22	0	27	27	160	0	38	38	160	North	11	S
23	0	-38	38	340	0	-18	18	340	South	0	
24	0	-14	14	340	0	-14	14	340	South	0	
25	0	-34	34	340	0	-29	29	340	South	8	N
26	No observations				No observations				No observations		
27	0	-61	61	340	0	-36	36	340	South	20	N
28	0	0	0		0	-22	22	340	South	12	
29	0	-87	87	340	0	-41	41	340	South	17	N
30	0	0	0		0	-16	16	340	North	30	N

KEY:
+cross-shore = offshore, cm/sec
-cross-shore = onshore, cm/sec
+longshore = south, cm/sec
-longshore = north, cm/sec
Speed = Resultant speed, cm/sec
Dir = Resultant direction, degrees true north

5 Visual Observations

Visual wave direction measurements (Table 7) of both the primary wave train (i.e. that having the higher wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is oriented 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A Bucket Thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The temperature is then read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the depth of visibility.

Table 7
Visual Observations

Jun 1994

Day	Time	Wave Approach Angle at Pier End deg from True N Primary	Secondary	Radar Wave Angle deg from True N	Width of Surf Zone,m	Water Characteristics at Pier End Temp.,C	Density g/cc	Secchi Vis.,m
1	0740	105			113	16.1	1.0239	3.0
2	0730	100			4	16.4	1.0243	4.0
3	0630	85			21	20.0	1.0175	2.1
4	0910	90			18	20.8	1.0160	2.4
5	1026	90		95	24	21.4	1.0162	2.7
6	0640	80			7	18.6	1.0223	4.3
6	0640	80		inoperative	7	18.6	1.0223	4.3
7	0615	100	115		10	15.3	1.0225	4.0
8	0620	90			4	15.6	1.0225	4.9
9	0640	50		95	16	20.6	1.0165	2.4
10	0615	70	50		9	21.1	1.0165	1.8
11	0920	85		95	4	21.7	1.0170	2.4
12	0905	85		inoperative	55	22.2	1.0175	2.4
13	0630	80			48	21.1	1.0163	3.7
14	0630	85			38	23.0	1.0223	4.6
15	0615	80			7	20.0	1.0224	2.1
16	0630	70			7	22.8	1.0223	4.0
17	0620	90	70		4	22.7	1.0210	4.0
18	0805	70	80		4	23.1	1.0210	4.3
19	0750	70	80		9	23.1	1.0223	3.7
20	0630	70			5	18.8	1.0224	4.0
21	0650	45	70		10	25.0	1.0200	3.7
22	0640	70			4	23.3	1.0210	4.0
23	0615	110	70	90	2	25.6	1.0195	3.7
24	0625	130		inoperative	2	18.8	1.0226	3.7
25	0545	120		inoperative	4	21.7	1.0226	3.0
26	no observations made							
27	0615	120		110	7	22.7	1.0226	3.0
20	0620	110			5	22.7	1.0226	3.0
29	0615	145		90	5	22.7	1.0226	2.4

6 Water Levels

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A NOS acoustic tide gauge (Next Generation Water Level Measurement System, NGWLMS) is used to collect water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 6 along with a list of means and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level. Table 8 contains the range, high, low, and mean water level for each 12.42-hr tidal cycle.

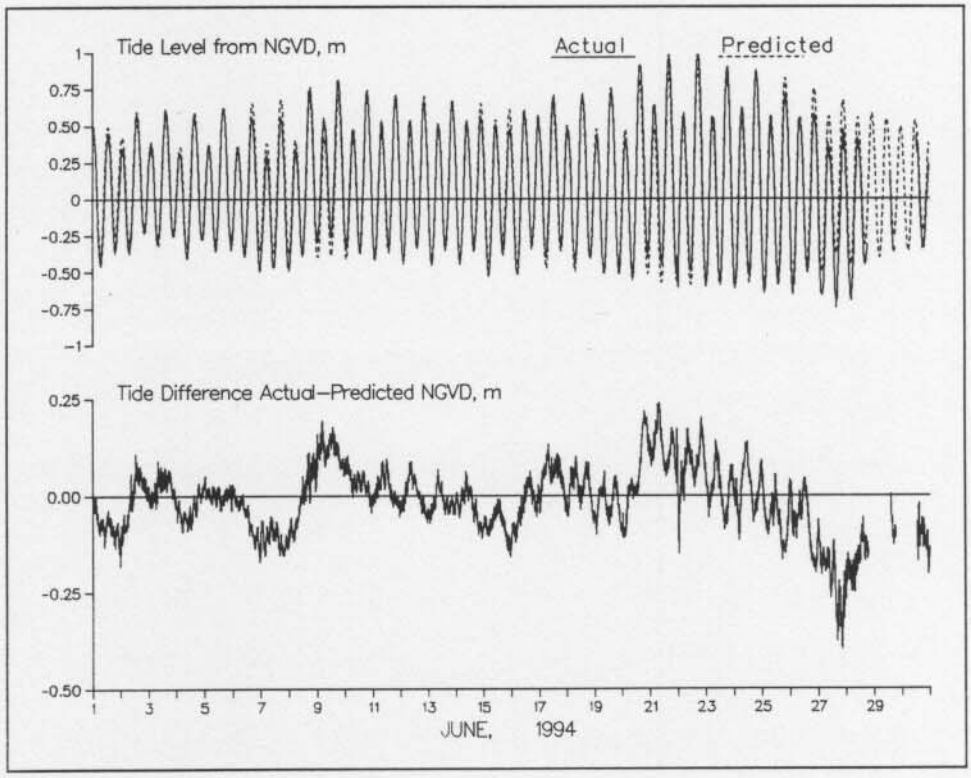

Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

JUN 1994 Tide Levels

	High			Low		Mean	Range		High			Low		Mean	Range
Day	Time	m	Day	Time	m	m	m	Day	Time	m	Day	Time	m	m	m
1	0042	0.47	1	0712	-0.46	-0.04	0.93	15	2336	0.47	16	0600	-0.52	-0.02	0.99
1	1336	0.45	1	1924	-0.37	0.04	0.82	16	1230	0.60	16	1830	-0.34	0.13	0.95
2	0124	0.35	2	0806	-0.38	-0.02	0.72	17	0018	0.57	17	0630	-0.40	0.08	0.97
2	1412	0.59	2	2100	-0.23	0.18	0.82	17	1348	0.71	17	2012	-0.32	0.20	1.03
3	0248	0.39	3	0848	-0.29	0.05	0.69	18	0118	0.48	18	0748	-0.45	0.04	0.93
3	1506	0.61	3	2212	-0.25	0.17	0.86	18	1448	0.72	18	2112	-0.41	0.16	1.13
4	0306	0.31	4	0942	-0.41	-0.03	0.73	19	0300	0.44	19	0930	-0.50	-0.03	0.94
4	1554	0.57	4	2218	-0.28	0.14	0.85	19	1536	0.75	19	2154	-0.52	0.12	1.27
5	0430	0.37	5	1000	-0.36	0.02	0.73	20	0354	0.42	20	0954	-0.56	-0.04	0.98
5	1724	0.62	5	2324	-0.35	0.14	0.97	20	1618	0.92	20	2242	-0.40	0.26	1.32
6	0442	0.34	6	1054	-0.40	-0.01	0.74	21	0500	0.64	21	1054	-0.45	0.12	1.09
6	1724	0.56	6	2348	-0.50	0.04	1.06	21	1724	0.98	22	0106	-0.61	0.22	1.59
7	0542	0.30	7	1154	-0.47	-0.09	0.77	22	0606	0.58	22	1154	-0.50	0.05	1.08
7	1730	0.55	8	0048	-0.49	0.02	1.05	22	1812	0.98	23	0048	-0.58	0.22	1.56
8	0630	0.34	8	1206	-0.39	-0.02	0.74	23	0630	0.56	23	1242	-0.57	0.02	1.13
8	1918	0.76	9	0036	-0.30	0.22	1.06	23	1942	0.90	24	0118	-0.62	0.13	1.52
9	0700	0.55	9	1254	-0.27	0.16	0.82	24	0800	0.62	24	1348	-0.54	0.05	1.16
9	1912	0.81	10	0142	-0.35	0.23	1.16	24	2000	0.88	25	0236	-0.65	0.12	1.53
10	0824	0.47	10	1342	-0.37	0.07	0.84	25	0830	0.56	25	1424	-0.59	-0.02	1.15
10	2018	0.74	11	0206	-0.42	0.15	1.17	25	2106	0.71	26	0306	-0.66	0.05	1.36
11	0830	0.53	11	1424	-0.35	0.09	0.88	26	0836	0.54	26	1518	-0.51	0.02	1.04
11	2042	0.70	12	0300	-0.45	0.13	1.15	26	2112	0.57	27	0406	-0.66	-0.04	1.24
12	0900	0.53	12	1500	-0.34	0.10	0.87	27	0942	0.38	27	1618	-0.75	-0.13	1.13
12	2112	0.68	13	0342	-0.46	0.10	1.13	27	2230	0.47	28	0454	-0.70	-0.14	1.17
13	0930	0.51	13	1536	-0.35	0.08	0.86	28	1100		28	1712	No data this cycle		
13	2148	0.66	14	0430	-0.45	0.10	1.11	28	2306		29	536	No data this cycle		
14	1036	0.53	14	1618	-0.36	0.09	0.89	29	1148		29	1806	No data this cycle		
14	2230	0.57	15	0530	-0.53	0.02	1.10	29	2348		30	612	No data this cycle		
15	1112	0.51	15	1748	-0.39	0.06	0.90	30	1236		30	1906	No data this cycle		

7 Bathymetry

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 7 shows the last survey in May 1994 and the survey(s) in June 1994 on profile line 188, located 517 m south of the pier.

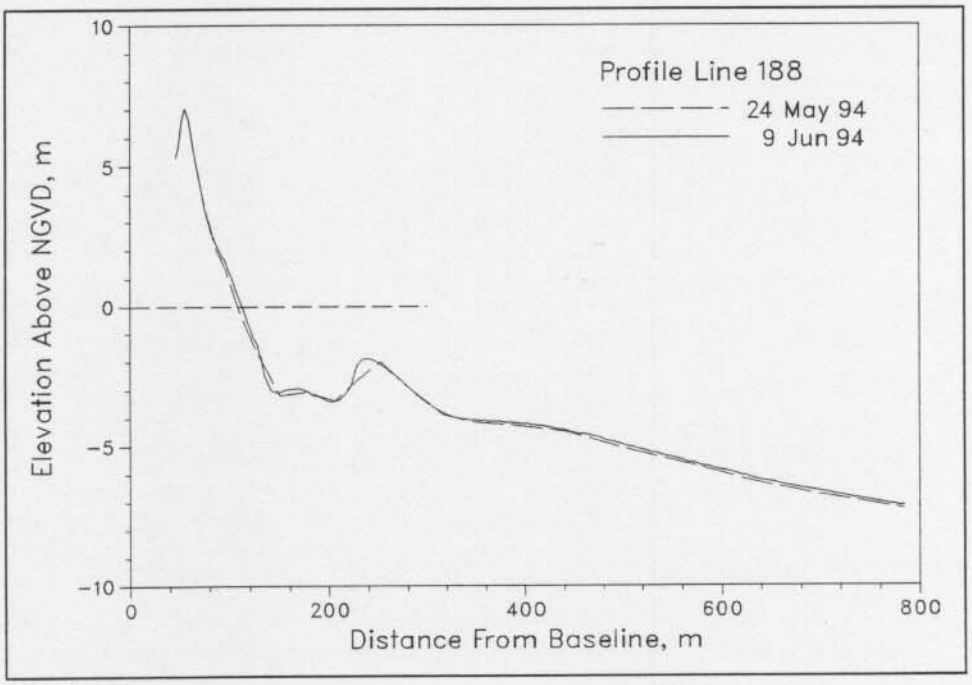

Figure 7. Monthly CRAB Profiles on Profile Line 188.

The upward shift of the survey data shown in figure 7 appears to be associated with a change of survey instruments and not to actual profile change.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1994. Cross-hatched areas indicate changes to the annual envelope which occurred in June.

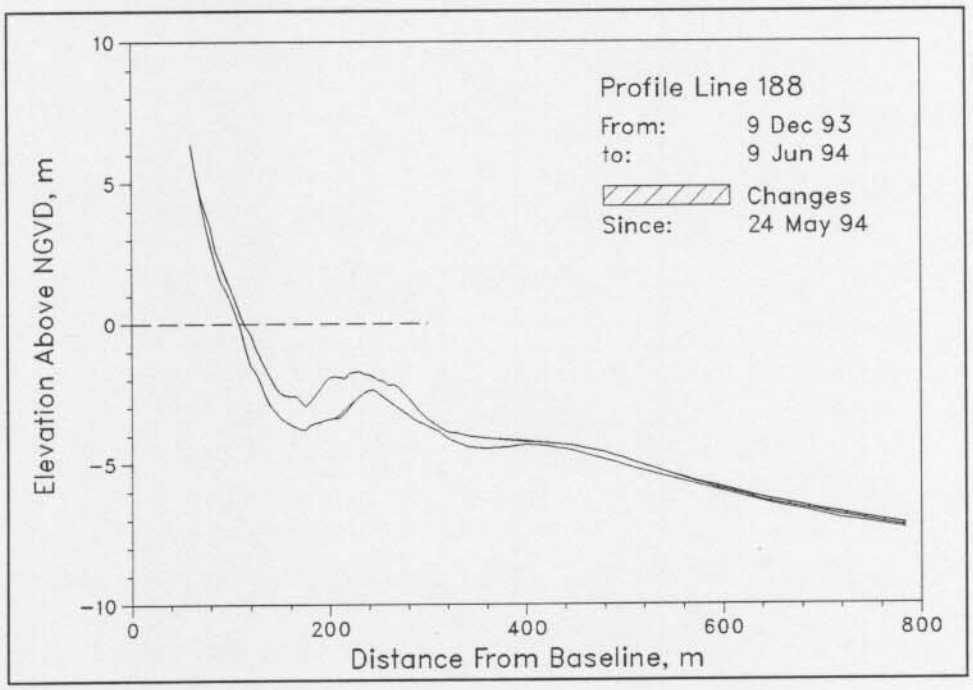

Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 6 April. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition. There was no bathymetric survey in June. Figure 9 is included for reference only.

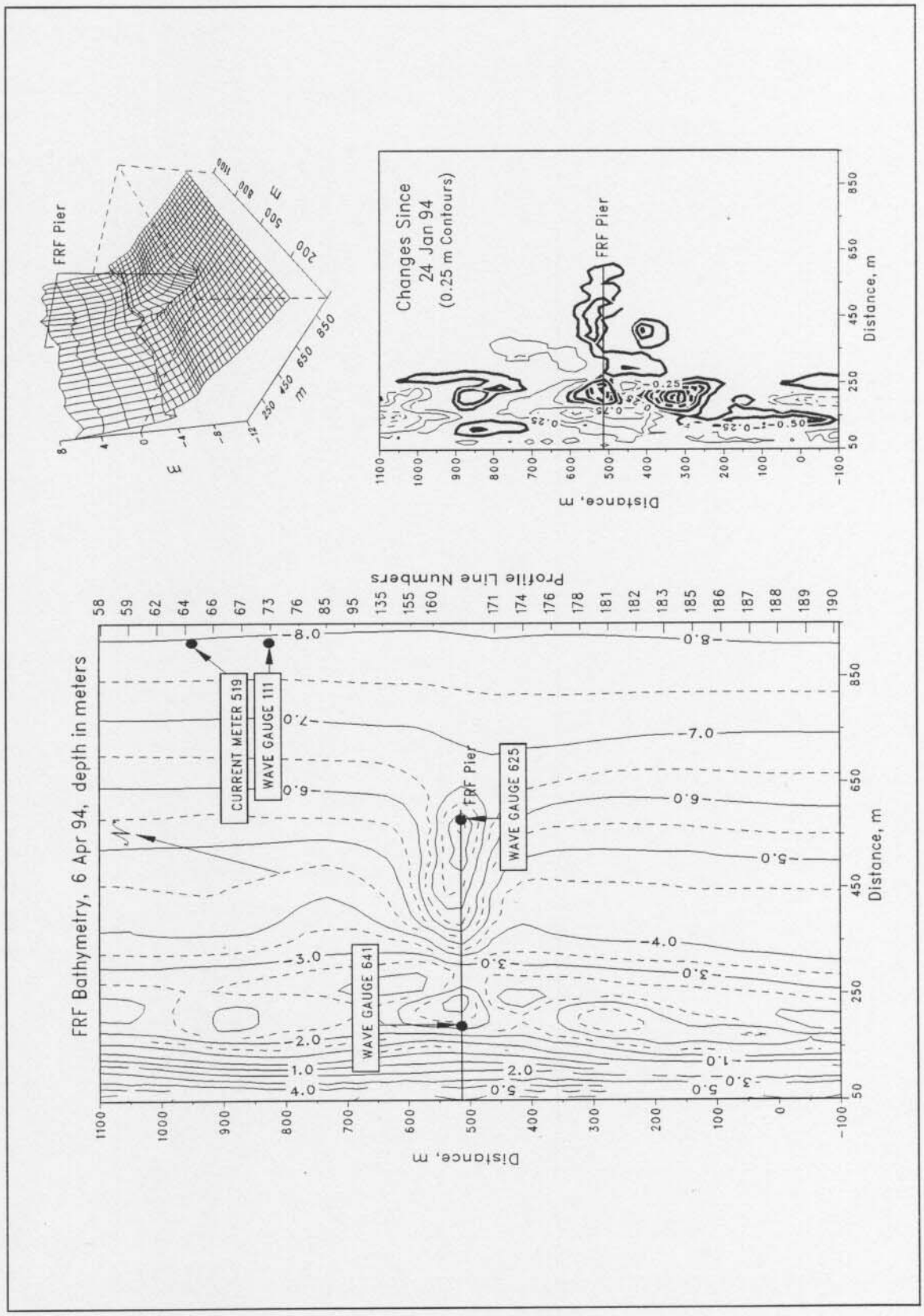

Figure 9. FRF Bathymetry, Depths Relative to NGVD

Distribution List

Government Agencies:

Back Bay National Wildlife Refuge
USACE-OCE
USACE-SAD
USACE-NAP
USACE-SAW
USACE-WES
NAVSAC
NOAA/NOS/OMS
National Marine Fisheries
U.S. Geological Survey
U.S. Library of Congress
U.S. National Park Service
U.S. National Weather Service
U.S. Naval Academy
U.S. Naval Civil Eng. Lab
U.S. Naval Oceanographic Off.
U.S. Naval Research Lab

Colleges/Universities:

Bucknell University
California Inst. of Tech.
Duke Marine Lab
East Carolina University
Florida Inst. of Tech.
M.I.T.
Naval Post Graduate School
NC State University
Old Dominion University
Oregon State University
Prince George's College
Scripps Institution of Oceanography
Stockton State College
University Calif-Berkeley
University of Florida
University of Maryland-College Park
University of Maryland-Baltimore
University of North Carolina
University of N C-Seagrant Program
University of Virginia
Va. Inst. of Marine Science
Rutgers University

Others:

Allied Signal Aerospace Co.
Applied Physics Lab
Cape Hatteras Nat. Seashore
Coastal and Est. Res., Inc.
Coastal Science & Eng., Inc.
Dr. Cy Galvin
GEOMET Tech., Inc.
Mr. Hodges
Dr. Hylton
Mr. Mason
Mr. Rodgers
WCTI-TV
MEC Systems Corporation
Moffatt & Nichol, Eng.
N.C. Div. Coastal Management
Oregon Inlet & Waterways Commis.
Raleigh-Durham Airport
Mr. Rowland
Mr. Savage
Science Application Int'l. Corp
Sherwood Industries
SEASUN Power Systems

Foreign:

Christchurch, Barbados
Ministry of Works, Bahamas
Dalhousie University, Halifax Nova Scotia
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of Sydney (Australia)