November 1995
Preliminary Data Summary

by Field Research Facility

U.S. Army Corps of Engineers
Waterways Experiment Station
Coastal Engineering Research Center
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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.

These reports are now available via the World Wide Web at http://frf.wes.army.mil/frf.html

These web pages contain general information about the Field Research Facility and data from 1980 to the present.

Your comments and criticisms are welcome.

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 *(baron@duck.wes.army.mil)*.

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).

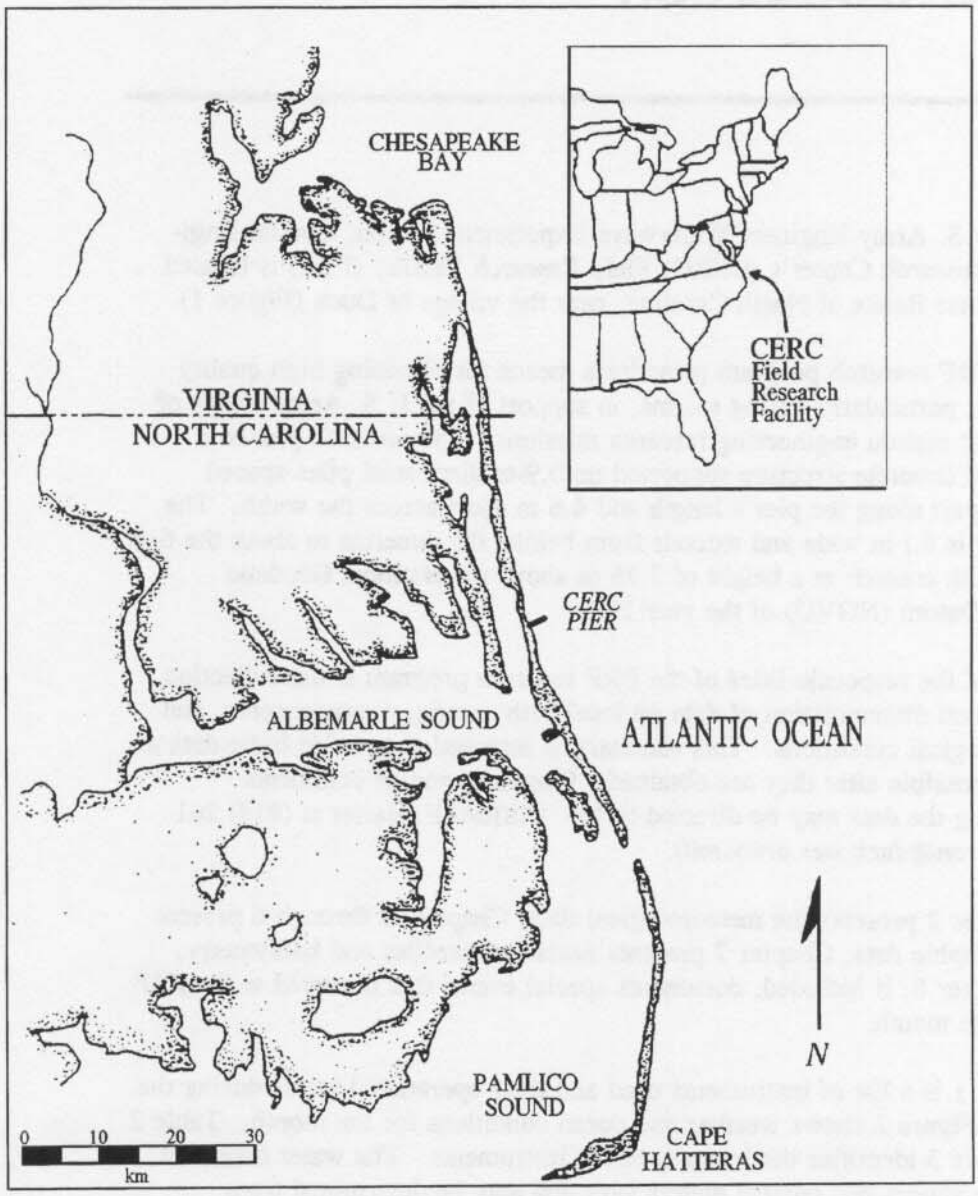

Figure 1. FRF Location Map

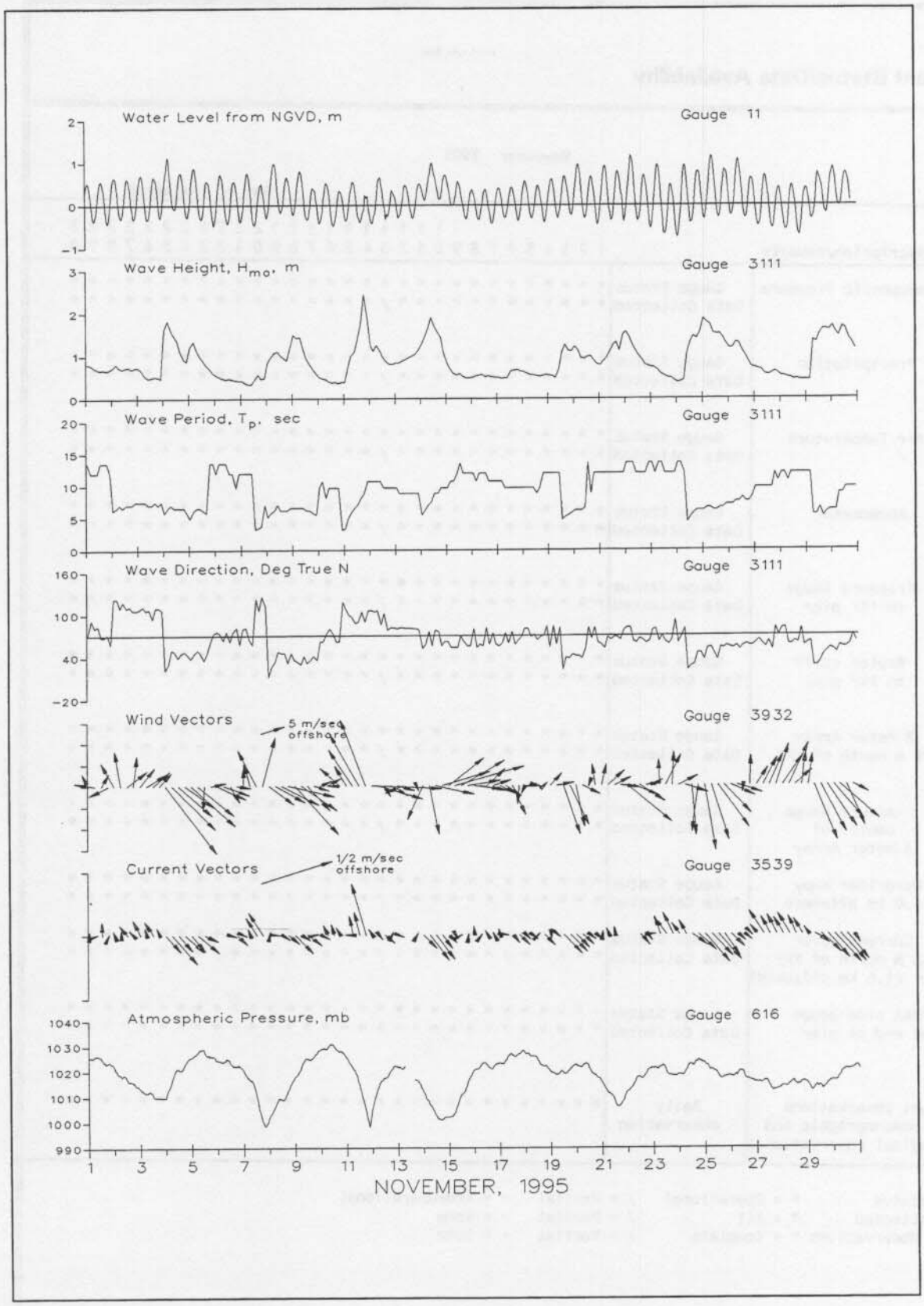

Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

November 1995

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	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3932	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	*	*	*	*	*	*	*	*	*	*	*	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3539	Current meter 343 m north of FRF pier (1.6 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′ 57.03"	75 45′ 5.50"	11.60	569.00	-----	-----
3932	Anemometer	36 11′ 1.23"	75 44′ 43.07"	585.20	517.30	19.50	-----
641	Pressure Gauge	36 10′ 57.71"	75 44′ 56.23"	239.11	516.64	-1.64	-1.96
625	Baylor Staff	36 11′ 1.04"	75 44′ 43.72"	568.00	516.64	Surface	-8.36
3111	8 Meter Array North	36 11′ 19.14"	75 44′ 36.41"	915.23	990.16	-7.50	-7.90
	8 Meter Array South	36 11′ 11.28"	75 44′ 33.28"	914.20	735.37	-7.42	-7.90
	8 Meter Array East	36 11′ 13.70"	75 44′ 32.56"	954.51	800.58	-7.62	-8.13
	8 Meter Array West	36 11′ 12.48"	75 44′ 37.11"	834.66	800.37	-6.98	-7.44
111	Pressure Gauge in center of 8 M Array	36 11′ 14.06"	75 44′ 34.39"	914.43	825.52	-7.76	-8.08
630	Waverider Buoy	36 10′ 5.10"	75 41′ 59.30"	3934.96	-2400.81	Surface	-17.00
3539	Current Meter	36 11′ 23.57"	75 44′ 9.12"	1605.80	907.60	-11.60	-11.70
11	NOAA Tide Gauge	36 11′ 1.25"	75 44′ 42.60"	596.49	514.20	Surface	-7.62

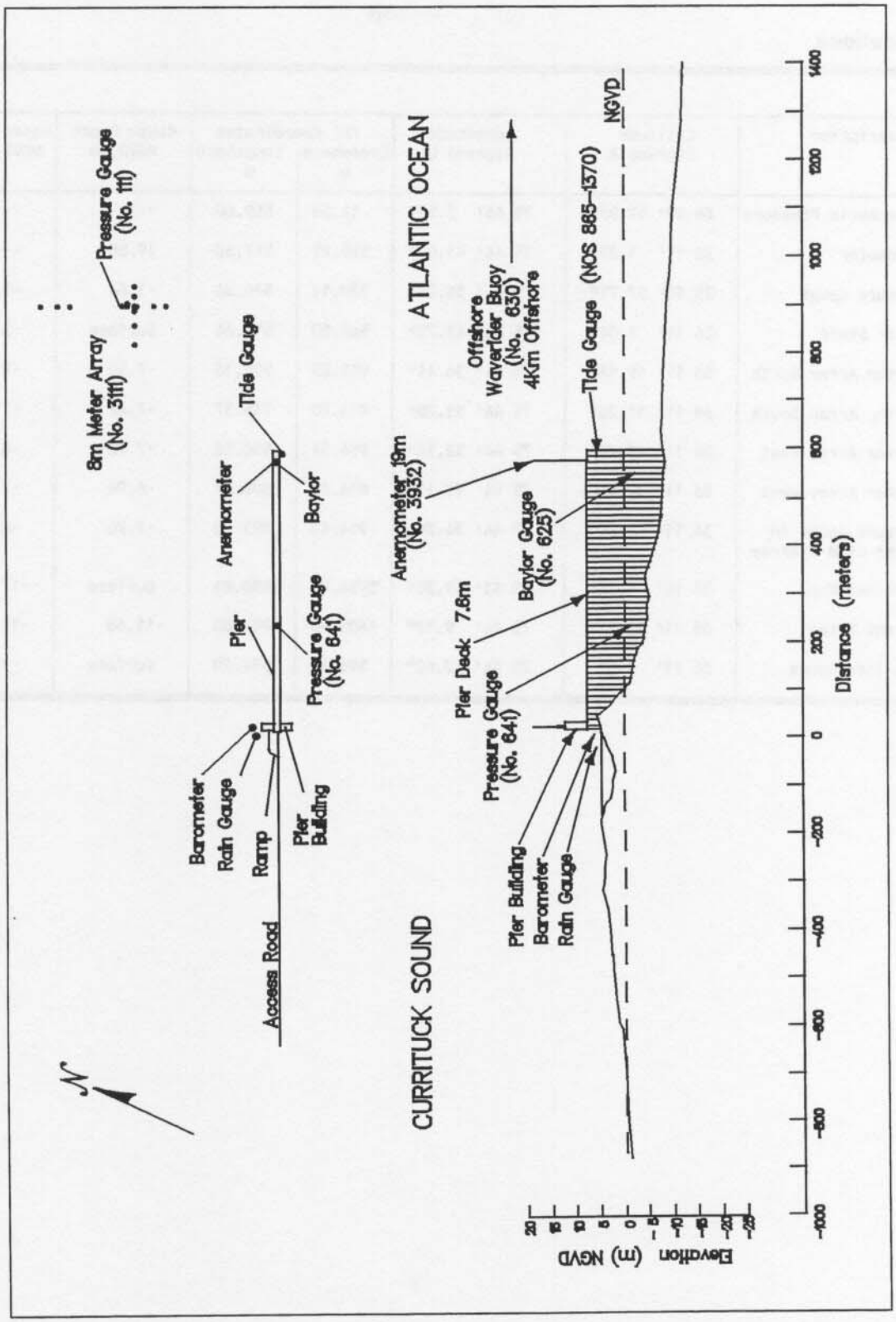

Figure 3. Instrument Locations, Elevations From NGVD

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 VAXstation 4000. 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 using a WeatherMeasure Skyvane anemometer. Monthly resultant wind speeds and directions (Figure 4) are determined by vector averaging the data. Wind directions (Table 3) indicate where the wind is coming from. Temperature and atmospheric pressure means (Table 3) 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

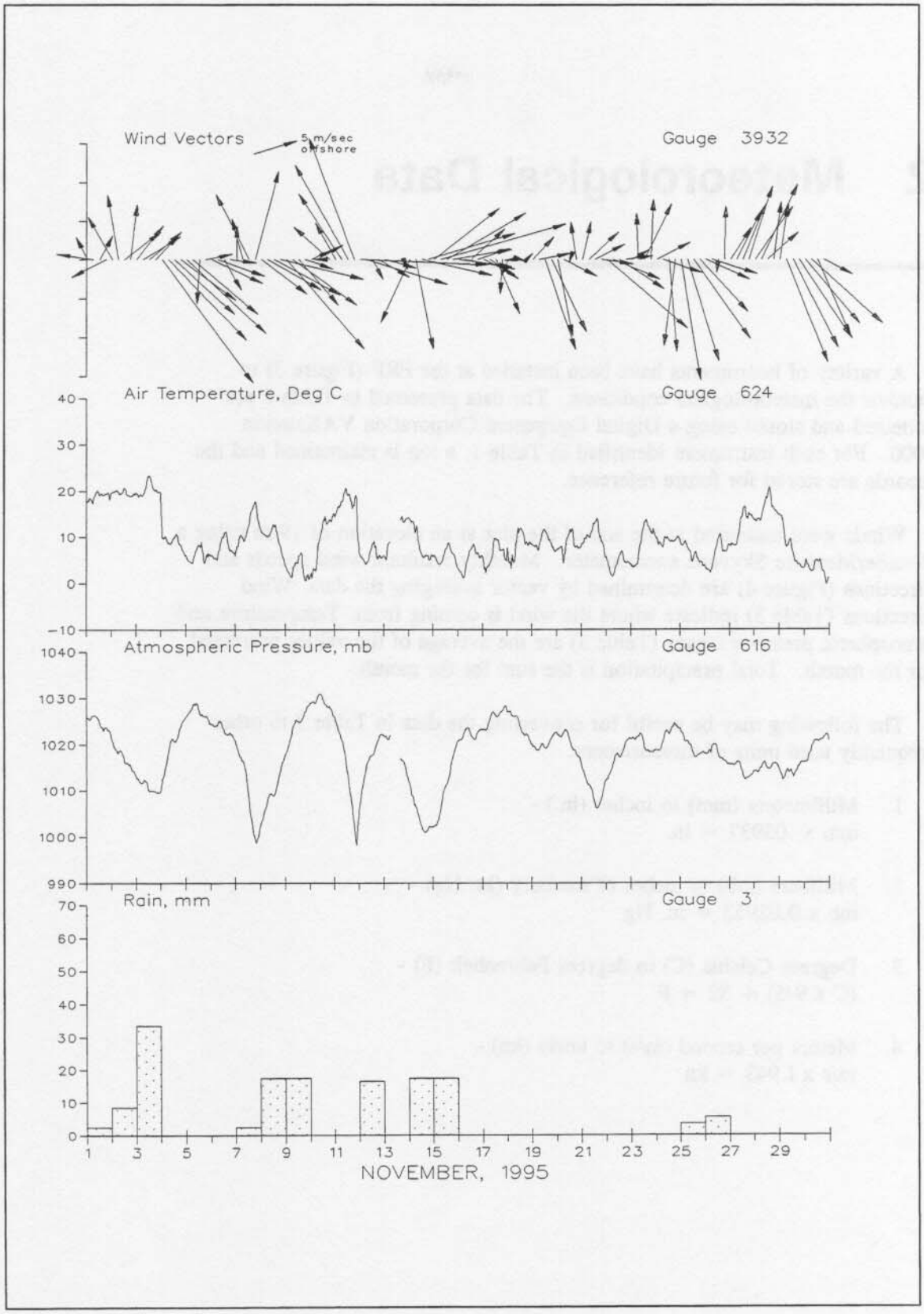

Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Nov 1995

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	156	17.6	1025.8	0
	700	4	1	18.6	1026.3	3
	1300	3	204	19.1	1024.5	0
	1900	4	59	19.4	1023.7	0
2	100	6	154	19.8	1020.7	0
	700	8	171	19.9	1018.3	9
	1300	5	227	20.6	1016.2	0
	1900	7	185	18.8	1015.4	0
3	100	5	213	19.4	1012.7	0
	700	5	233	19.1	1011.9	33
	1300	5	224	23.1	1010.0	0
	1900	4	218	20.1	1009.8	0
4	100	19	327	11.0	1012.0	0
	700	13	320	8.6	1018.4	0
	1300	10	316	9.9	1020.7	0
	1900	8	310	8.3	1023.9	0
5	100	13	317	5.6	1026.1	0
	700	10	314	4.4	1028.5	0
	1300	6	2	8.2	1026.9	0
	1900	3	256	4.9	1026.1	0
6	100	6	298	6.1	1024.4	0
	700	6	292	6.1	1024.5	0
	1300	4	334	10.9	1022.9	0
	1900	3	279	7.2	1022.5	0
7	100	4	180	7.4	1019.5	0
	700	5	166	9.9	1016.5	3
	1300	9	156	12.5	1008.2	0
	1900	12	192	17.7	999.5	0
8	100	7	311	11.2	1003.0	0
	700	7	303	10.0	1008.0	18
	1300	9	301	12.4	1008.9	0
	1900	10	285	8.2	1014.0	0
9	100	14	322	3.4	1018.4	0
	700	9	309	1.8	1023.4	18
	1300	7	323	5.9	1025.0	0
	1900	3	291	1.3	1027.1	0
10	100	3	241	2.2	1029.1	0
	700	3	236	5.9	1030.1	0
	1300	1	89	13.5	1029.5	0
	1900	6	136	13.8	1028.2	0

Table 3
Meteorological Data (continued)

Nov 1995

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	5	154	14.9	1024.9	0
	700	10	150	17.5	1020.9	0
	1300	14	154	19.0	1013.3	0
	1900	16	162	16.8	1002.8	0
12	100	14	272	6.2	1007.0	0
	700	9	289	4.1	1015.2	17
	1300	3	335	8.5	1017.7	0
	1900	4	303	5.6	1021.1	0
13	100	4	288	5.7	1021.8	0
	700	4	64	8.9	1022.0	0
	1300		Hardware Error			0
	1900	1	340	13.1	1016.4	0
14	100	9	21	13.9	1011.4	0
	700	12	350	11.3	1006.4	18
	1300	8	284	6.2	1002.1	0
	1900	10	250	6.0	1001.4	0
15	100	10	227	5.8	1002.2	0
	700	15	251	4.2	1005.6	18
	1300	11	235	7.6	1011.4	0
	1900	7	258	6.4	1017.2	0
16	100	6	278	3.0	1020.9	0
	700	6	282	2.2	1023.1	0
	1300	5	222	7.5	1022.0	0
	1900	4	248	6.6	1022.6	0
17	100	4	299	4.3	1023.2	0
	700	4	308	4.4	1025.5	0
	1300	7	339	9.7	1026.1	0
	1900	4	3	7.2	1027.3	0
18	100	2	19	6.3	1027.1	0
	700	1	81	4.8	1026.1	0
	1300	1	288	11.8	1023.7	0
	1900	1	220	8.9	1022.3	0
19	100	4	218	8.3	1019.5	0
	700	4	257	7.7	1018.9	0
	1300	12	343	11.4	1019.3	0
	1900	10	337	8.4	1021.5	0
20	100	10	350	7.5	1022.1	0
	700	4	300	4.5	1022.8	0
	1300	0		11.6	1020.7	0
	1900	5	172	7.9	1017.9	0

Table 3
Meteorological Data (concluded)

Nov 1995

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	5	190	8.6	1014.7	0
	700	5	222	10.1	1011.3	0
	1300	4	239	13.2	1007.0	0
	1900	4	279	9.0	1008.0	0
22	100	13	314	4.9	1012.6	0
	700	6	296	1.6	1016.1	0
	1300	6	307	5.9	1017.3	0
	1900	3	260	4.6	1020.7	0
23	100	2	235	3.6	1021.3	0
	700	6	178	5.4	1021.8	0
	1300	8	202	13.2	1019.1	0
	1900	8	182	11.1	1018.4	0
24	100	4	239	9.7	1018.8	0
	700	5	291	7.8	1020.7	0
	1300	12	355	9.3	1022.1	0
	1900	11	6	9.4	1024.5	0
25	100	16	352	8.2	1022.7	0
	700	13	345	7.7	1020.7	4
	1300	12	328	5.7	1017.9	0
	1900	9	321	4.5	1017.9	0
26	100	5	297	3.3	1018.1	0
	700	5	290	2.9	1019.6	5
	1300	2	7	9.7	1017.8	0
	1900	7	181	7.0	1016.6	0
27	100	5	208	7.9	1015.7	0
	700	7	203	8.5	1016.3	0
	1300	8	199	15.7	1013.4	0
	1900	10	194	15.3	1012.9	0
28	100	8	210	13.6	1014.2	0
	700	10	201	14.2	1015.0	0
	1300	5	223	19.0	1014.8	0
	1900	7	185	16.1	1015.9	0
29	100	7	186	14.6	1014.2	0
	700	14	341	7.8	1014.0	0
	1300	12	336	6.6	1013.5	0
	1900	12	330	4.1	1015.3	0
30	100	10	324	3.9	1016.3	0
	700	11	316	2.6	1019.3	0
	1300	10	340	4.7	1020.9	0
	1900	4	301	2.5	1021.6	0
		Resultant		Mean	Mean	Total
		3	284	9.4	1018.1	146

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 VAXstation 4000. Data is sampled at 2 hertz, with five contiguous 34 minute records, for a total collection period of nearly 2 hours and 51 minutes. 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.

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

Nov 1995

		641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
1	0100	0.53	13.5	0.74	13.5	0.81	13.6	72	0.82	12.9
	0700	0.43	11.7	0.65	12.2	0.74	12.0	82	0.79	12.9
	1300	0.46	12.2	0.63	12.9	0.67	13.6	68	0.79	11.7
	1900	0.44	5.6	0.61	12.9	0.66	13.6	72	0.78	6.3
2	0100	0.53	6.3	0.67	12.2	0.73	6.2	122	0.92	6.0
	0700	0.58	6.8	0.70	6.8	0.74	7.1	110	0.96	7.0
	1300	0.61	6.6	0.62	7.0	0.73	7.1	110	0.88	7.0
	1900	0.59	7.4	0.67	7.4	0.70	7.1	106	0.87	7.4
3	0100	0.67	7.4	0.73	8.3	0.73	7.6	108	0.89	8.1
	0700	0.48	7.8	0.50	7.6	0.54	7.6	106	0.70	7.8
	1300	0.41	6.8	0.46	7.4	0.49	7.1	94	0.61	7.8
	1900	0.42	7.4	0.48	7.6	0.51	7.1	110	0.63	7.4
4	0100	0.77	5.0	1.21	4.9	1.61	5.9	22	1.65	4.8
	0700	0.88	7.0	1.48	7.0	1.63	7.1	50	1.95	6.5
	1300	0.59	6.8	1.33	6.8	1.36	6.6	40	1.74	7.4
	1900	0.68	6.1	0.90	6.6	0.92	6.6	48	1.15	6.3
5	0100	0.57	5.3	0.98	4.9	1.21	5.0	38	1.33	7.4
	0700	0.80	6.8	1.03	6.8	1.14	6.6	50	1.38	6.8
	1300	0.45	6.3	0.87	6.6	0.89	6.2	36	1.02	6.3
	1900	0.47	5.4	0.66	13.5	0.70	13.6	62	0.76	6.3
6	0100	0.25	13.5	0.56	12.9	0.56	12.0	76	0.59	12.9
	0700	0.31	13.5	0.49	13.5	0.49	13.6	64	0.52	12.2
	1300	0.21	13.5	0.44	11.7	0.47	12.0	62	0.52	11.7
	1900	0.24	11.7	0.42	11.7	0.44	9.8	82	0.47	9.2
7	0100	0.17	10.3	0.40	12.2	0.42	12.0	80	0.44	11.2
	0700	0.23	11.7	0.36	11.7	0.34	12.0	64	0.41	11.2
	1300	0.23	3.1	0.42	11.7	0.46	3.3	122	0.57	3.1
	1900	0.32	4.2	0.50	3.6	0.47	3.8	126	0.68	3.6
8	0100	0.53	4.8	0.74	4.4	0.85	5.3	12	1.02	4.5
	0700	0.89	6.3	1.06	6.0	1.06	6.2	34	1.33	6.5
	1300	0.57	6.6	0.96	7.6	1.02	6.2	46	1.29	6.8
	1900	0.68	5.4	0.78	6.1	0.90	6.2	32	1.13	6.1
9	0100	0.57	6.3	1.32	6.8	1.49	6.6	36	1.70	6.6
	0700	0.94	6.3	1.32	7.0	1.43	6.6	30	1.71	7.0
	1300	0.51	6.0	0.95	5.9	0.95	6.2	32	1.11	6.3
	1900	0.57	5.7	0.69	5.9	0.70	5.9	42	0.83	5.6
10	0100	0.34	5.4	0.51	5.2	0.51	9.8	62	0.60	5.7
	0700	0.26	9.9	0.43	10.7	0.46	8.2	74	0.49	7.6
	1300	0.18	14.3	0.35	10.3	0.37	9.8	74	0.40	6.6
	1900	0.23	8.9	0.38	9.2	0.37	9.8	62	0.44	5.0

Table 4
Wave Data (continued)

Nov 1995

		641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
11	0100	0.22	3.0	0.40	9.9	0.39	3.4	108	0.48	3.0
	0700	0.69	6.1	0.90	6.1	1.00	5.9	96	1.18	5.9
	1300	0.64	7.4	1.19	7.0	1.38	7.1	90	1.50	6.8
	1900	0.86	9.9	2.22	8.9	2.43	8.9	90	2.49	8.9
12	0100	0.73	10.3	1.35	10.7	1.26	10.8	106	1.66	10.7
	0700	0.89	11.2	1.12	10.7	1.24	10.8	106	1.43	10.3
	1300	0.66	10.3	0.91	10.3	0.95	9.8	102	1.14	10.3
	1900	0.51	8.9	0.83	9.2	0.80	9.8	82	0.88	9.5
13	0100	0.41	8.6	0.78	9.9	0.83	9.8	80	0.85	10.3
	0700	0.46	9.1	0.91	8.8	0.83	8.9	0	0.91	9.8
	1300			inoperative				inoperative		
	1900	0.60	8.3	1.03	8.9	1.03	8.9	80	1.11	8.3
14	0100	0.71	5.3	1.14	5.4	1.27	5.6	52	1.25	5.5
	0700	0.83	7.0	1.38	7.6	1.65	7.1	76	1.73	7.2
	1300	1.07	6.8	1.47	7.8	1.70	8.9	78	1.80	7.8
	1900	0.76	9.5	1.29	9.9	1.43	9.8	56	1.62	10.3
15	0100	0.41	9.5	0.75	12.2	0.83	9.8	62	0.98	10.3
	0700	0.21	11.7	0.58	11.7	0.58	10.8	54	0.89	11.2
	1300	0.28	12.9	0.55	11.7	0.60	13.6	70	0.77	13.5
	1900	0.18	12.2	0.45	11.7	0.48	12.0	56	0.54	12.2
16	0100	0.25	9.9	0.47	11.7	0.50	12.0	80	0.60	11.2
	0700	0.23	11.7	0.58	11.2	0.54	12.0	58	0.65	11.7
	1300	0.24	10.7	0.49	11.2	0.51	12.0	82	0.60	10.7
	1900	0.16	9.9	0.48	10.3	0.51	10.8	74	0.50	11.2
17	0100	0.21	10.3	0.43	10.3	0.49	10.8	56	0.48	9.9
	0700	0.20	10.3	0.49	10.3	0.49	9.8	74	0.62	9.9
	1300	0.32	3.9	0.62	10.3	0.64	9.8	76	0.72	10.3
	1900	0.28	4.1	0.66	9.9	0.67	9.8	64	0.78	10.3
18	0100	0.28	9.9	0.59	9.9	0.63	9.8	80	0.65	9.9
	0700	0.22	9.9	0.54	9.9	0.56	9.8	68	0.62	9.9
	1300	0.23	9.5	0.48	9.5	0.53	8.9	64	0.58	10.3
	1900	0.21	9.5	0.47	10.7	0.53	12.0	70	0.52	9.9
19	0100	0.24	12.9	0.48	12.9	0.54	12.0	54	0.52	11.7
	0700	0.21	12.2	0.45	12.2	0.48	12.0	58	0.48	12.2
	1300	0.69	4.8	1.05	4.5	1.08	4.8	22	1.36	4.8
	1900	0.65	5.5	1.01	5.4	1.12	5.6	38	1.37	5.4
20	0100	0.67	5.5	1.13	5.9	1.21	6.2	42	1.41	6.0
	0700	0.57	5.7	0.90	6.3	0.93	6.2	38	1.02	5.9
	1300	0.42	12.9	0.89	12.9	0.97	13.6	82	0.97	6.5
	1900	0.37	13.5	0.81	8.9	0.90	12.0	82	1.00	7.2

Table 4
Wave Data (concluded)

Nov 1995

		641 Pressure Gauge		625 Baylor Gauge		3111 8 Meter Array			630 Waverider	
Day	Hour	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Hmo,m	Tp,sec	Dir,TN	Hmo,m	Tp,sec
21	0100	0.27	12.9	0.77	12.2	0.77	12.0	58	0.81	12.2
	0700	0.41	10.7	0.85	11.7	0.95	12.0	68	0.91	11.7
	1300	0.64	12.9	1.15	12.2	1.25	12.0	68	1.12	12.2
	1900	0.58	12.9	1.08	12.9	1.12	12.0	64	1.12	12.9
22	0100	0.66	5.7	1.49	12.9	1.57	13.6	82	1.68	12.9
	0700	0.78	15.1	1.21	12.2	1.25	13.6	62	1.29	11.7
	1300	0.49	15.1	0.94	15.1	1.00	12.0	66	1.14	12.2
	1900	0.39	13.5	0.65	13.5	0.79	12.0	60	0.84	12.9
23	0100	0.32	15.1	0.70	14.3	0.73	13.6	78	0.72	14.3
	0700	0.32	14.3	0.62	14.3	0.64	13.6	62	0.64	12.9
	1300	0.19	14.3	0.47	12.2	0.53	12.0	62	0.54	12.9
	1900	0.21	13.5	0.43	13.5	0.48	12.0	64	0.50	12.9
24	0100	0.12	11.7	0.33	12.2	0.38	13.6	60	0.41	12.2
	0700	0.22	12.9	0.35	12.2	0.42	12.0	80	0.39	12.2
	1300	0.62	5.4	1.14	5.4	1.33	5.3	28	1.32	5.3
	1900	0.89	5.7	1.31	5.9	1.39	6.2	46	1.59	6.1
25	0100	0.63	6.3	1.63	6.5	1.87	6.2	36	1.88	6.5
	0700	1.07	6.5	1.52	6.5	1.73	6.6	54	1.95	6.5
	1300	0.75	6.1	1.33	6.5	1.50	6.2	36	1.71	6.5
	1900	0.81	6.1	1.27	6.8	1.41	6.6	52	1.69	7.0
26	0100	0.69	6.8	1.10	7.2	1.17	7.1	54	1.44	7.4
	0700	0.74	7.0	1.13	7.2	1.29	7.6	56	1.29	7.4
	1300	0.68	7.2	1.04	7.0	1.10	8.2	56	1.24	8.1
	1900	0.41	5.0	0.86	8.1	0.85	7.6	56	1.01	8.1
27	0100	0.29	9.9	0.66	9.2	0.71	9.8	60	0.78	9.9
	0700	0.24	9.5	0.61	9.5	0.66	9.8	58	0.74	9.5
	1300	0.23	11.2	0.45	9.5	0.54	9.8	62	0.63	9.5
	1900	0.29	12.9	0.67	11.7	0.63	12.0	82	0.70	11.2
28	0100	0.27	11.7	0.51	11.7	0.51	12.0	80	0.56	11.2
	0700	0.25	7.6	0.47	11.2	0.49	10.8	58	0.62	11.2
	1300	0.30	7.6	0.39	12.2	0.44	12.0	62	0.50	7.4
	1900	0.22	7.6	0.41	11.2	0.42	12.0	80	0.48	11.7
29	0100	0.30	7.0	0.41	12.2	0.43	12.0	60	0.55	7.2
	0700	0.74	5.2	1.15	5.1	1.34	5.6	28	1.42	5.1
	1300	1.00	6.3	1.31	6.5	1.50	6.6	34	1.54	6.5
	1900	0.69	7.2	1.50	5.6	1.62	5.9	48	1.79	5.9
30	0100	1.00	6.5	1.38	6.8	1.68	6.2	50	1.71	7.6
	0700	0.71	8.1	1.39	6.8	1.46	8.9	56	1.71	8.6
	1300	0.97	5.6	1.46	9.9	1.63	9.8	54	1.71	9.5
	1900	0.62	9.9	1.16	9.9	1.29	9.8	72	1.44	9.2
Mean		0.49	8.8	0.83	9.4	0.90	9.3	65	1.01	8.8
Std dev		0.24	3.1	0.37	2.8	0.42	2.8	23	0.46	2.7

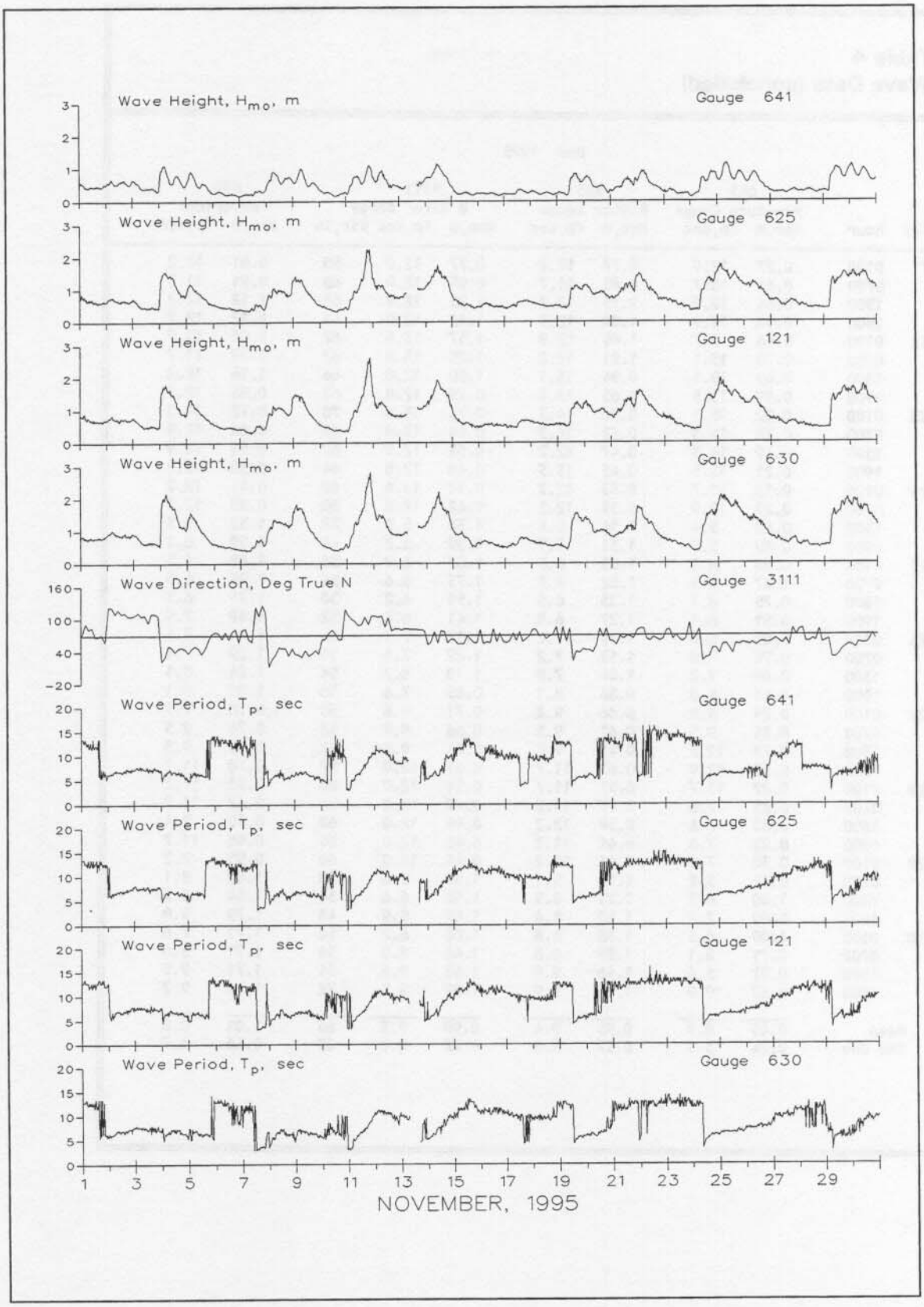

Figure 5. Wave Heights and Periods

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 3539

NOVEMBER 1995

Day	Time	Cross Shore	Long Shore	Speed	Dir
1	100	0	-2	3	6
	700	-1	0	2	66
	1300	-2	-9	11	358
	1900	0	0	0	
2	100	0	-2	3	338
	700	0	-3	4	359
	1300	3	-9	10	324
	1900	2	-4	5	321
3	100	1	-12	13	337
	700	0	-5	6	347
	1300	2	-11	12	331
	1900	0	-5	6	338
4	100	-4	15	16	143
	700	-7	27	28	144
	1300	-3	15	15	144
	1900	-6	16	18	137
5	100	-3	15	15	145
	700	-7	18	20	135
	1300	-6	7	10	119
	1900				
6	100	inoperative			
	700				
	1300	-2	3	4	109
	1900	-3	9	10	139
7	100	-1	2	2	120
	700	0	-4	5	341
	1300	2	-14	15	332
	1900	3	-19	20	331
8	100	0	-1	3	10
	700	-1	1	3	100
	1300	-3	5	6	127
	1900	-3	9	10	136
9	100	-5	18	19	141
	700	-3	6	7	127
	1300	-5	11	12	133
	1900	-2	0	3	77
10	100	-3	5	7	120
	700	0	-7	8	338
	1300	0	-8	9	346
	1900	1	-6	7	332
11	100	1	0	1	272
	700	-1	-14	15	349
	1300	-2	-17	19	348
	1900	-4	-40	41	346
12	100	1	-4	5	329
	700	0	4	4	147
	1300	-3	8	9	136
	1900	-1	-1	2	23
13	100	-2	3	5	116
	700				
	1300	inoperative			
	1900	0	0	0	
14	100	-4	13	14	139
	700	-4	23	24	147
	1300	-4	22	23	147
	1900	-2	12	13	149
15	100	-2	8	8	141
	700	0	4	4	154
	1300	0	0	0	
	1900	0	0	0	
16	100	-1	-6	7	352
	700	0	0	0	
	1300	1	-3	4	331
	1900	0	-1	2	335
17	100	0	-4	5	345
	700	0	1	1	100
	1300	-1	8	8	146
	1900	-3	10	11	138
18	100	-1	5	5	141
	700	-2	4	5	129
	1300	0	0	0	
	1900	-2	10	11	141
19	100	1	3	3	174
	700	0	3	3	133
	1300	-5	18	19	141
	1900	-5	17	18	140
20	100	-3	13	13	141
	700	-3	10	11	137
	1300	-2	5	6	131
	1900	-2	6	7	135
21	100	0	-1	2	5
	700	0	-4	5	339
	1300	0	-5	6	350
	1900				
22	100	inoperative			
	700				
	1300	-2	10	10	144
	1900	0	6	6	148
23	100	0	0	0	
	700	0	-13	14	344
	1300	4	-14	15	326
	1900	1	-17	18	337
24	100	2	-9	10	328
	700	1	-10	11	336
	1300	-5	12	13	131
	1900	-5	16	17	139
25	100	-6	26	28	144
	700	-6	21	22	142
	1300	-6	25	26	143
	1900	-2	20	20	150
26	100	-4	13	14	140
	700	-2	7	8	138
	1300	-2	7	7	133
	1900	0	2	2	139
27	100	2	-7	8	324
	700	3	-19	20	332
	1300	2	-13	14	334
	1900	1	-15	16	337
28	100	2	-13	14	333
	700	2	-17	18	333
	1300	0	-14	15	339
	1900	2	-12	13	332
29	100	1	-5	6	326
	700	-5	10	12	128
	1300	-6	19	20	139
	1900	-6	23	24	143
30	100	-8	28	29	143
	700	-7	27	28	143
	1300	-5	24	25	145
	1900	0	9	9	152

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

Nov 1995

	Pier End				Mid-Surf Zone				Beach		
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	-9	-8	12	290	-7	-44	44	331	South	28	N
2	7	-23	24	357	0	-47	47	340	South	75	N
3	7	-12	15	11	7	-18	20	2	South	68	N
4	8	51	51	151	0	87	87	160	North	50	S
5	-7	44	44	169	0	76	76	160	North	82	S
6	9	23	25	138	10	22	24	136	North	12	S
7	6	-23	24	354	6	-20	21	357	South	26	N
8	6	30	31	149	10	68	68	151	North	78	S
9	7	44	44	151	13	87	88	151	North	71	S
10	6	-4	7	39	9	-4	9	47	South	37	S
11	-4	-76	76	337	5	-102	102	343	South	135	N
12	0	23	23	160	24	10	26	70	North	23	S
13	-12	7	14	220	9	22	23	138	North	18	S
14	20	68	71	143	9	61	62	151	North	36	S
15	11	6	13	98	22	-14	26	38	South	30	S
16	11	10	15	70	15	18	24	120	South	64	N
17	6	18	19	143	14	23	26	129	North	41	S
18	0	3	3	160	5	10	11	70	South	49	N
19	-2	47	47	163	3	61	61	157	South	117	S
20	5	36	36	151	17	55	58	143	North	73	S
21	8	4	9	70	18	23	29	121	South	62	S
22	20	51	55	138	17	68	70	146	North	48	S
23	15	-29	32	7	10	-20	23	7	South	7	N
24	0	34	34	160	-8	51	51	169	North	45	S
25	0	76	76	160	0	76	76	160	North	24	S
26	7	22	23	143	-6	61	61	166	North	13	S
27	17	-34	38	7	53	32	62	70	South	14	S
28	14	-36	39	2	8	-38	39	351	South	40	N
29	0	87	87	160	0	102	102	160	North	43	S
30	0	61	61	160	4	76	76	157	South	102	S

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 depth of 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

Nov 1995

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	0808	80			134	20.6	1.0246	2.1
2	0824	110			122	20.8	1.0246	1.5
3	0745	105			73	21.1	1.0241	1.5
4	1036	30			195	18.9	1.0249	0.3
5	1050	30			123	16.9	1.0245	1.2
6	0817	40			27	16.4	1.0243	1.8
7	0817	80			13	16.7	1.0235	2.4
8	0829	25			112	17.8	1.0245	1.8
9	0850	25			162	15.6	1.0243	2.1
10	1046	65	40		27	15.6	1.0244	1.8
11	1123	105			156	17.8	1.0242	1.5
12	1049	95	25		145	16.1	1.0252	1.2
13	0838	65			145	15.6	1.0252	1.5
14	0900	45	30		194	15.3	1.0250	0.9
15	0823	65			77	13.1	1.0251	0.6
16	0826	75	355		116	12.8	1.0254	0.9
17	0834	75			90	12.8	1.0254	0.9
18	1012	60			84	13.6	1.0253	1.5
19	1123	50	15		122	13.3	1.0243	1.2
20	0814	40			147	12.8	1.0243	0.9
21	0846	75			131	12.8	1.0244	0.9
22	0839	40	25		134	12.5	1.0245	0.6
23	0955	75	125		23	12.2	1.0244	0.9
24	0840	20			12	14.4	1.0252	0.9
25	0855	25			94	12.8	1.0248	0.3
26	0805	45			151	10.0	1.0240	0.3
27	0835	75			107	11.7	1.0241	0.9
28	0654	75	120		49	13.9	1.0254	0.3
29	0650	10			155	13.6	1.0254	0.6
30	0827	55			201	10.6	1.0241	0.3

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.

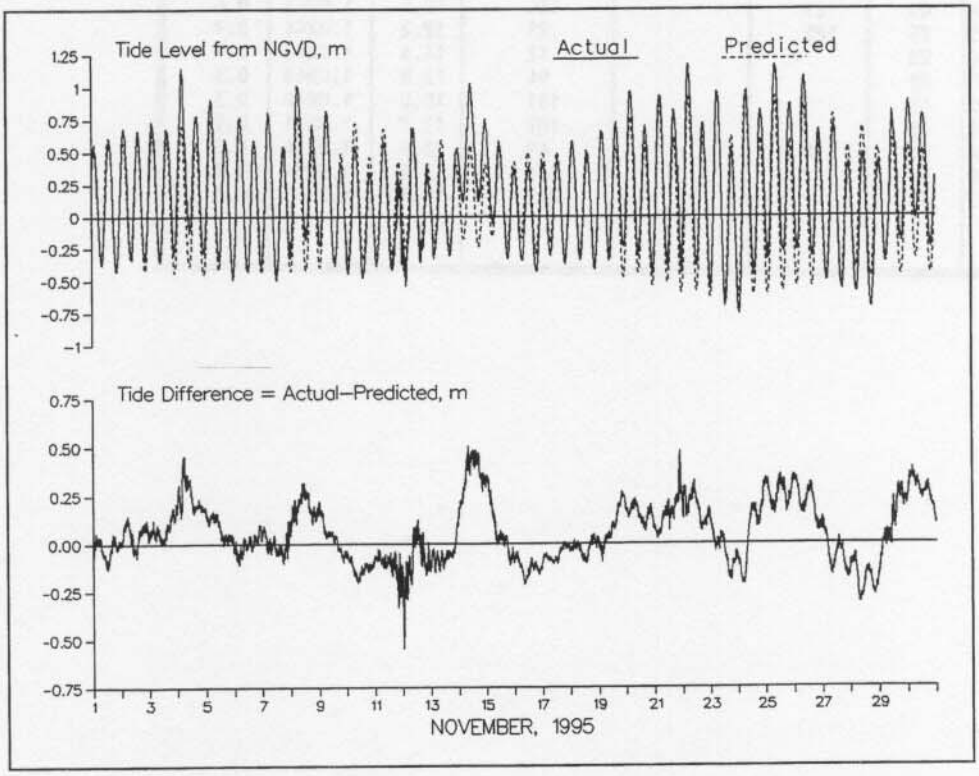

Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

NOV 1995 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	0224	0.56	1	0818	-0.38	0.09	0.94	16	0136	0.37	16	0742	-0.35	0.02	0.71
1	1418	0.59	1	2054	-0.43	0.09	1.02	16	1412	0.38	16	1954	-0.43	-0.03	0.82
2	0306	0.68	2	1012	-0.34	0.18	1.02	17	0230	0.41	17	0824	-0.31	0.06	0.72
2	1542	0.67	2	2112	-0.34	0.14	1.01	17	1424	0.44	17	2048	-0.37	0.05	0.81
3	0324	0.74	3	1018	-0.35	0.20	1.09	18	0300	0.58	18	0924	-0.34	0.12	0.93
3	1606	0.68	3	2148	-0.30	0.21	0.98	18	1518	0.49	18	2154	-0.42	0.05	0.91
4	0512	1.14	4	1124	-0.13	0.45	1.28	19	0454	0.63	19	1018	-0.33	0.17	0.97
4	1736	0.78	4	2312	-0.28	0.25	1.06	19	1636	0.72	19	2236	-0.24	0.23	0.96
5	0536	0.91	5	1224	-0.35	0.27	1.26	20	0442	0.96	20	1112	-0.32	0.32	1.28
5	1730	0.60	5	2336	-0.49	0.07	1.09	20	1724	0.70	20	2300	-0.46	0.14	1.16
6	0606	0.74	6	1300	-0.43	0.15	1.17	21	0554	0.93	21	1242	-0.43	0.28	1.36
6	1824	0.59	7	0024	-0.39	0.10	0.99	21	1742	0.82	22	0018	-0.44	0.26	1.26
7	0636	0.81	7	1330	-0.50	0.15	1.31	22	0618	1.17	22	1236	-0.39	0.37	1.56
7	1930	0.54	8	0018	-0.33	0.11	0.87	22	1854	0.72	23	0054	-0.56	0.10	1.27
8	0730	1.01	8	1400	-0.18	0.40	1.19	23	0642	0.96	23	1348	-0.70	0.13	1.66
8	1948	0.71	9	0200	-0.23	0.22	0.94	23	1936	0.53	24	0206	-0.77	-0.12	1.30
9	0812	0.82	9	1448	-0.36	0.21	1.18	24	0842	0.98	24	1430	-0.46	0.22	1.44
9	2024	0.42	10	0212	-0.45	0.00	0.87	24	2024	0.82	25	0230	-0.34	0.25	1.16
10	0836	0.54	10	1500	-0.48	0.03	1.02	25	0918	1.16	25	1600	-0.28	0.41	1.45
10	2100	0.34	11	0242	-0.39	-0.01	0.73	25	2212	0.87	26	0324	-0.27	0.30	1.13
11	0842	0.59	11	1618	-0.42	0.07	1.01	26	1000	1.08	26	1648	-0.32	0.36	1.40
11	2112	0.35	12	0330	-0.54	-0.12	0.89	26	2230	0.67	27	0436	-0.50	0.08	1.17
12	0924	0.68	12	1630	-0.36	0.14	1.05	27	1100	0.71	27	1812	-0.57	0.05	1.28
12	2148	0.37	13	0342	-0.33	0.01	0.70	27	2348	0.42	28	0630	-0.59	-0.09	1.01
13	1036	0.49	13	1718	-0.31	0.09	0.80	28	1206	0.49	28	1842	-0.71	-0.11	1.20
14	0030	0.53	13	2024	-0.02	0.31	0.55	29	0106	0.42	29	0606	-0.36	0.04	0.78
14	1130	1.03	14	1824	0.11	0.56	0.92	29	1206	0.81	29	2006	-0.20	0.27	1.01
15	0012	0.75	15	0718	-0.07	0.36	0.83	30	0200	0.89	30	0748	-0.03	0.42	0.93
15	1212	0.58	15	1924	-0.33	0.13	0.91	30	1348	0.78	30	2030	-0.25	0.29	1.03

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 October 1995 and the survey(s) in November 1995 on profile line 188, located 517 m south of the pier.

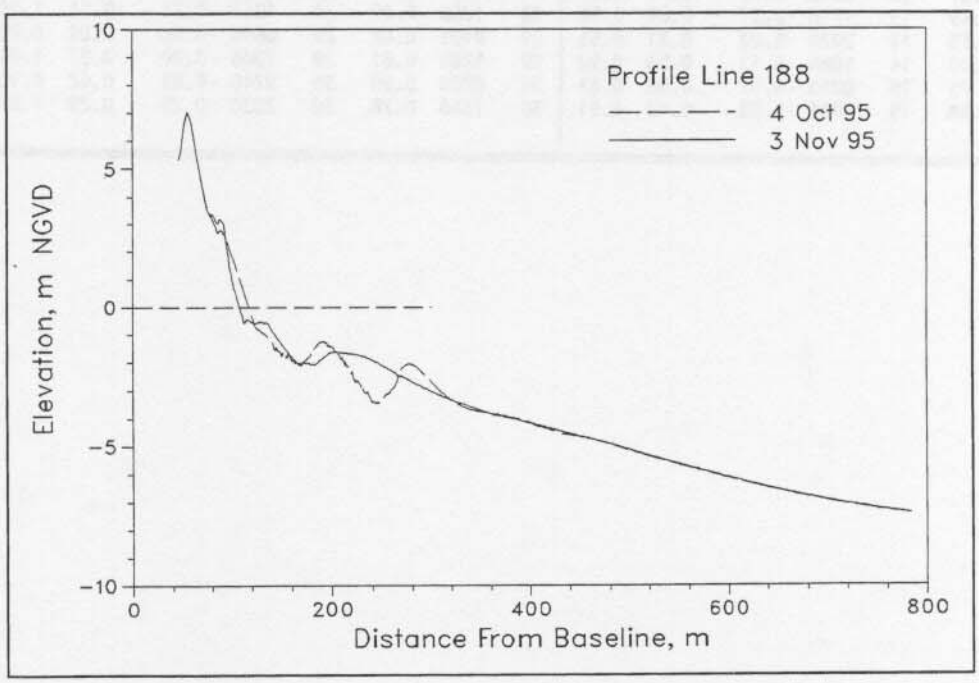

Figure 7. Monthly CRAB Profiles on Profile Line 188.

The profile envelope (Figure 8) reflects the maximum changes that occurred on the profile during 1995. Cross-hatched areas indicate changes to the annual envelope which occurred in November.

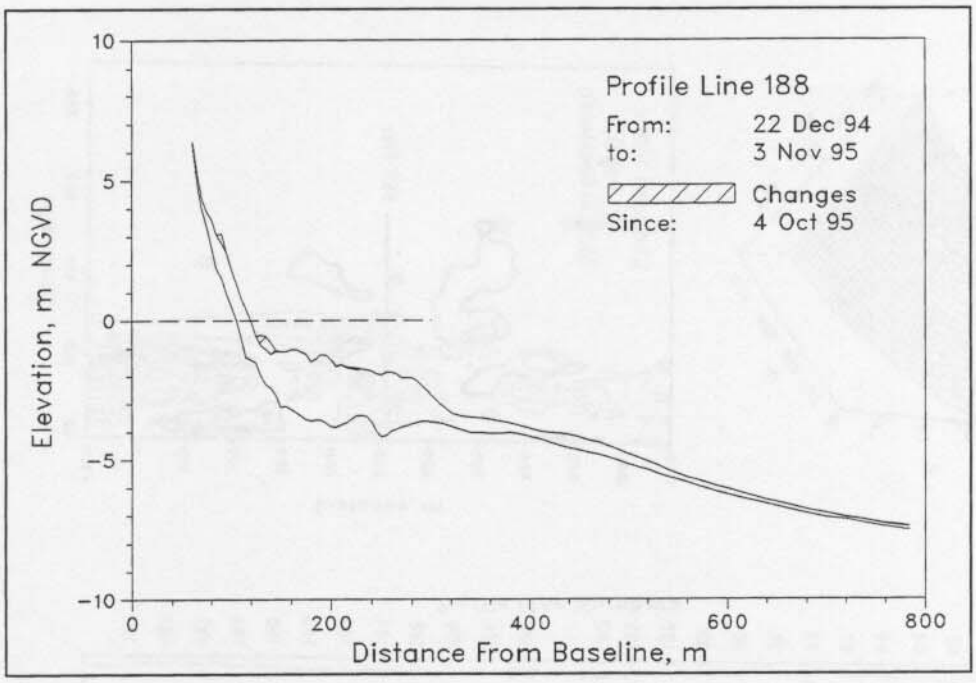

Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 3 October. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no bathymetric survey done in November. Figure 9 is for reference only.

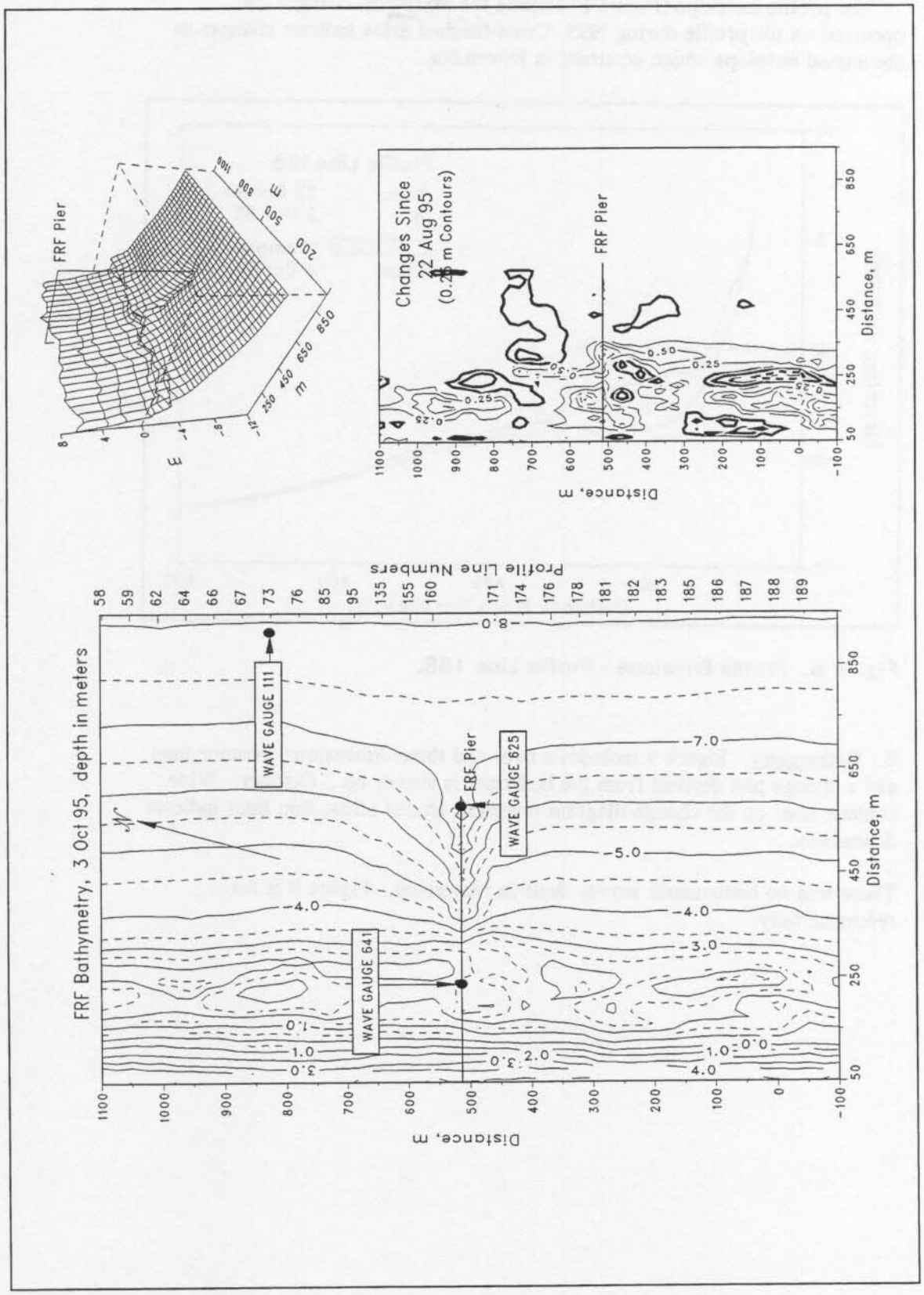

Figure 9. FRF Bathymetry, Depths Relative to NGVD

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)