US Army Corps
of Engineers
Waterways Experiment
Station

Preliminary Data Summary for May 1995 CERC Field Research Facility

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Coastal Engineering Research Center

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May 1995
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.

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

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

Please send comments to webmaster@duck.wes.army.mil .
If the web is sufficient for your needs and you no longer require hardcopies, please let us know.

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).

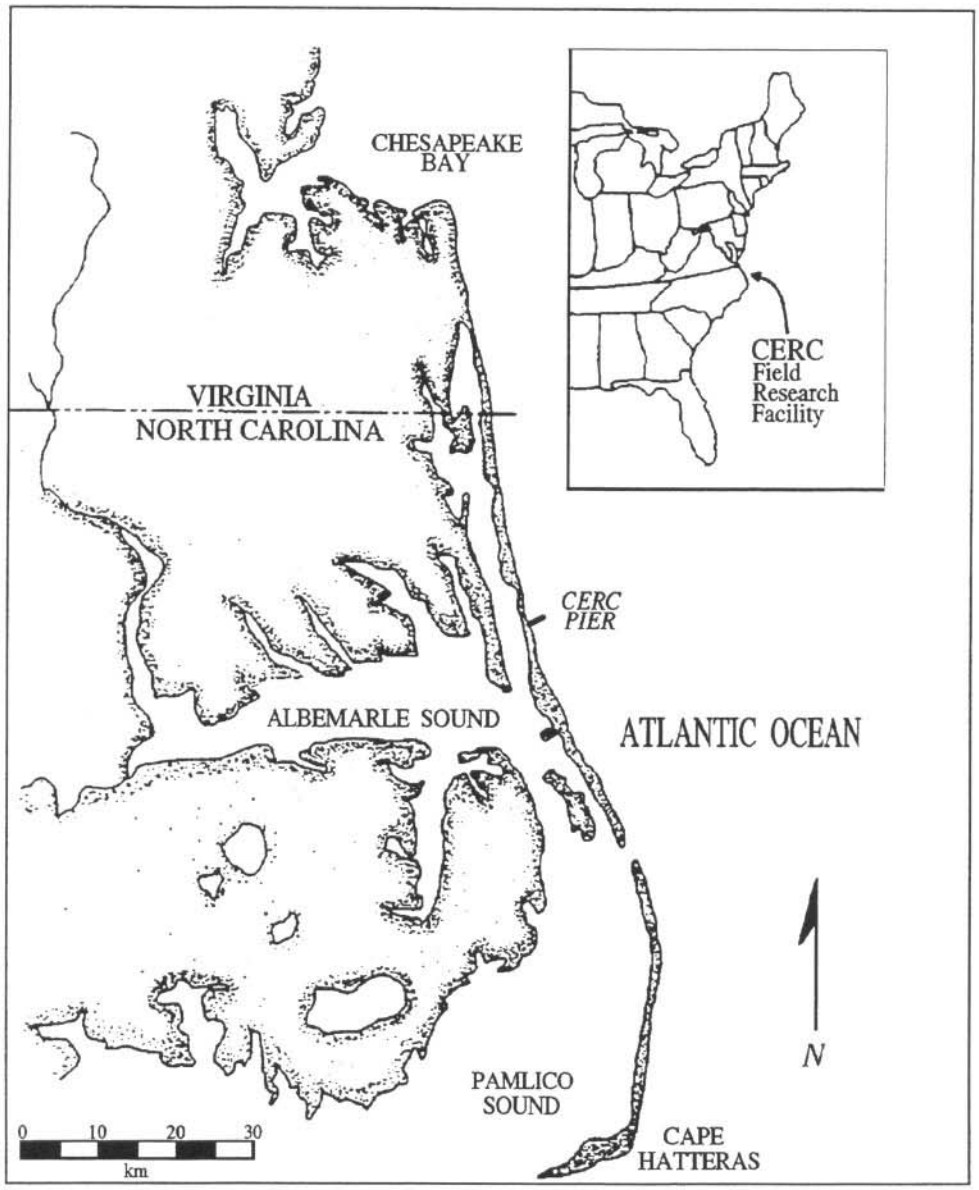

Figure 1. FRF Location Map

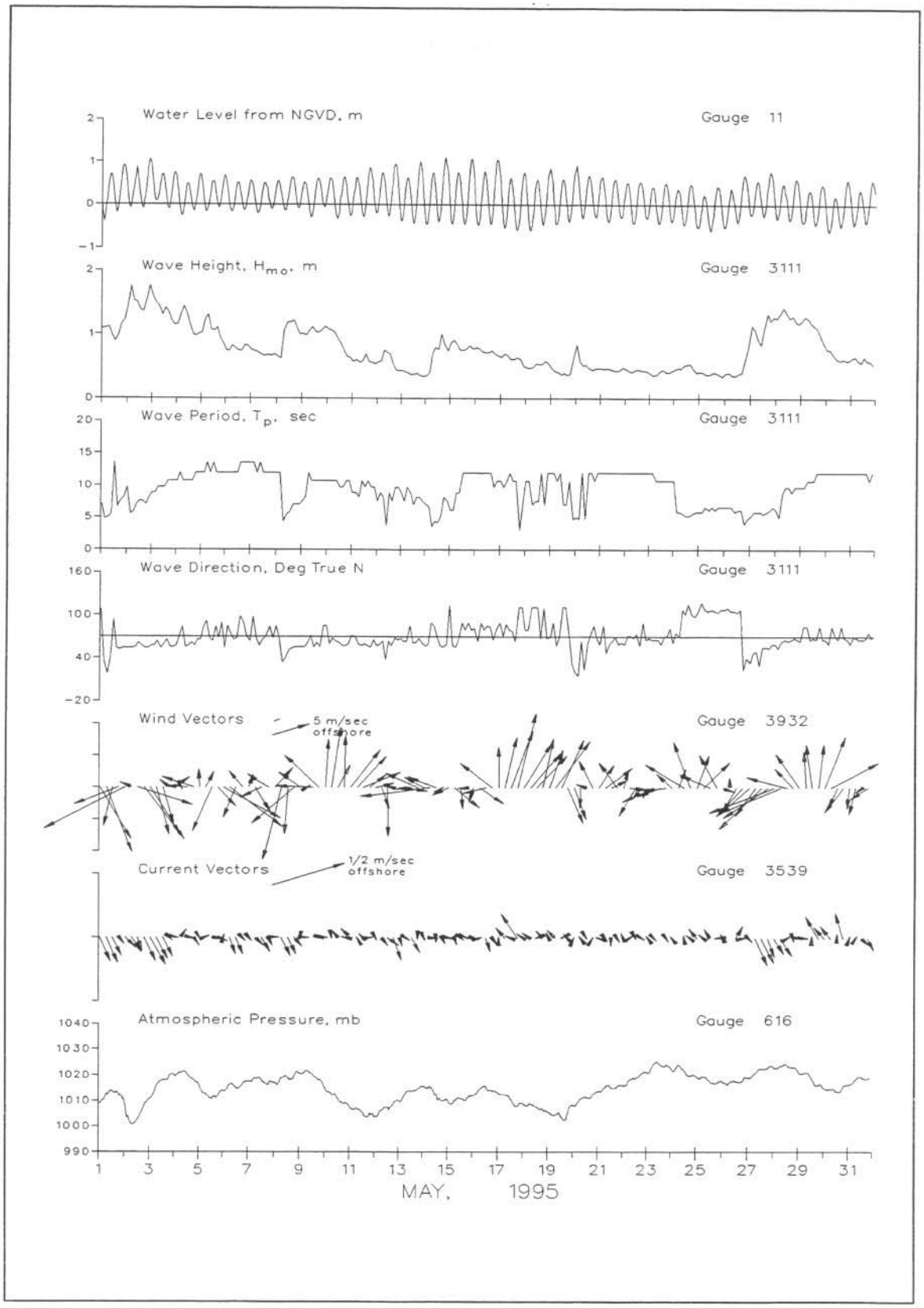

Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

May 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	31
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

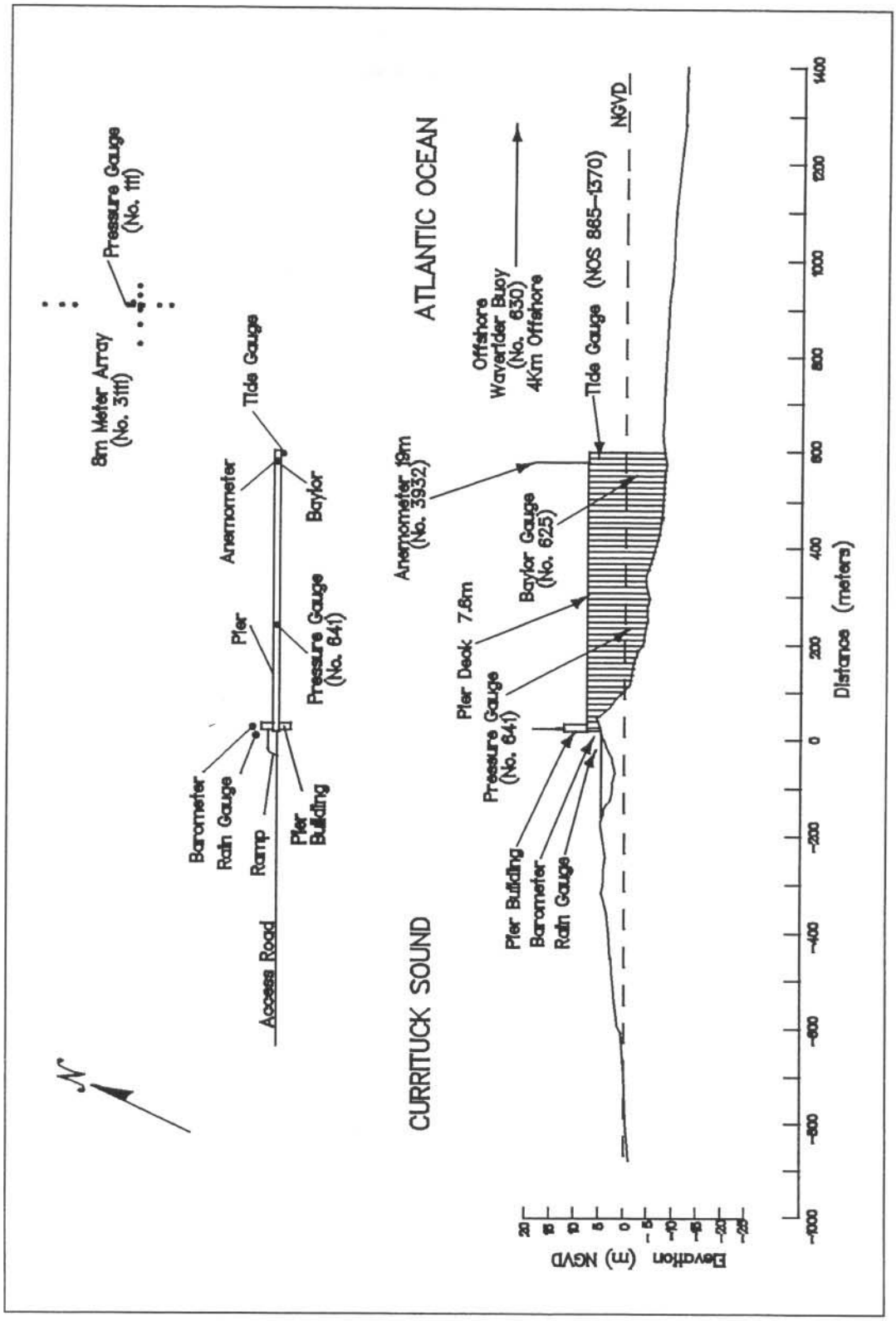

Figure 3. Instrument Locations, Elevations From NGVD

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

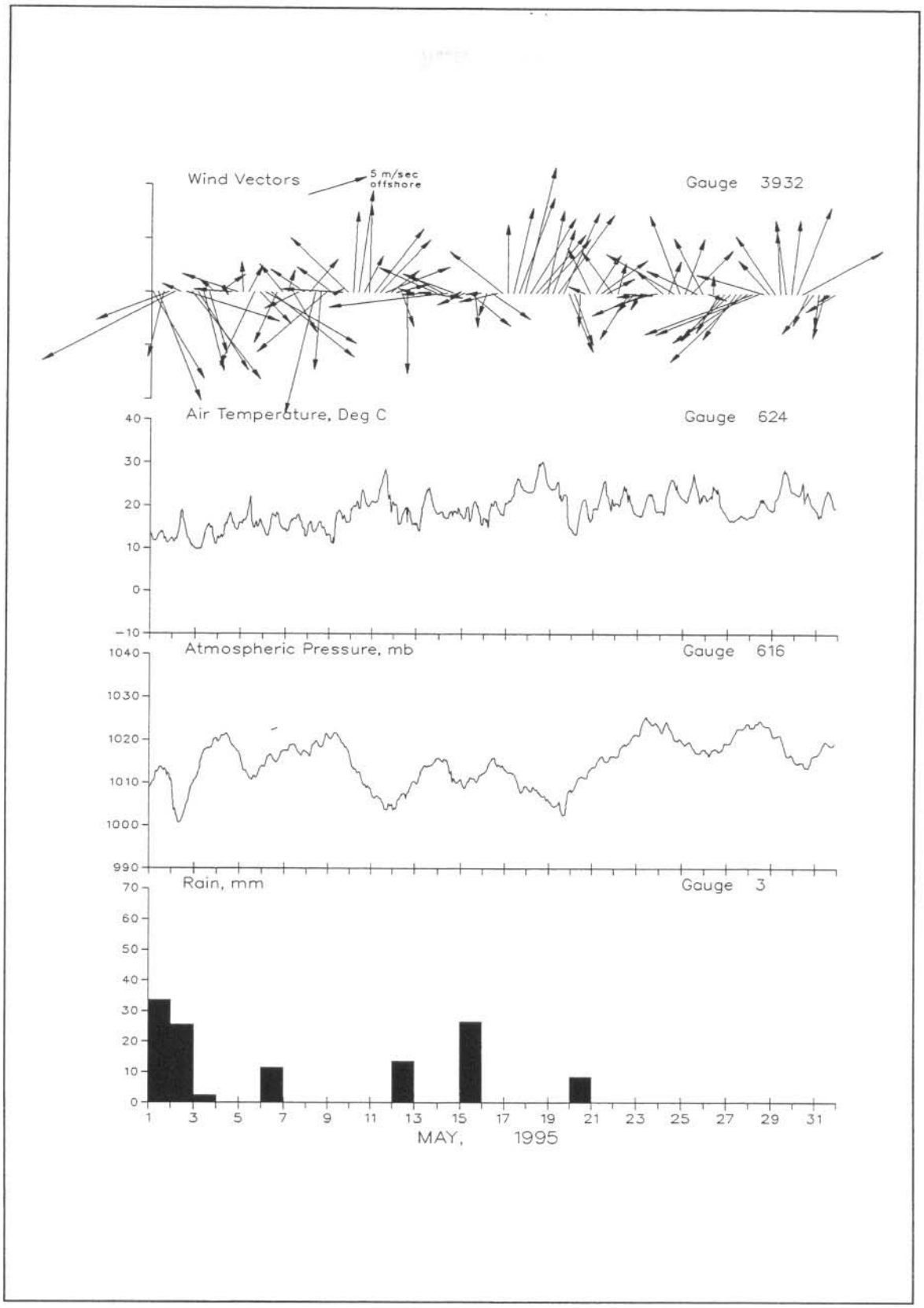

Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

May 1995

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	9	333	13.3	1009.1	0
	700	11	341	11.9	1012.4	33
	1300	6	11	13.9	1013.8	0
	1900	6	65	11.2	1012.8	0
2	100	12	58	11.7	1008.5	0
	700	2	116	14.5	1001.0	25
	1300	8	290	15.6	1002.7	0
	1900	10	326	11.0	1007.7	0
3	100	8	331	9.8	1010.8	0
	700	8	347	10.9	1015.5	3
	1300	6	346	15.2	1018.1	0
	1900	2	133	12.6	1018.8	0
4	100	3	229	12.4	1019.6	0
	700	0		15.3	1021.1	0
	1300	3	94	18.3	1020.6	0
	1900	5	110	14.5	1018.2	0
5	100	3	177	16.0	1016.1	0
	700	3	204	17.6	1012.8	0
	1300	7	21	15.6	1010.9	0
	1900	4	320	15.2	1011.6	0
6	100	9	303	14.5	1013.9	0
	700	9	312	14.5	1016.3	11
	1300	5	20	17.5	1015.2	0
	1900	3	145	15.2	1016.2	0
7	100	2	194	13.8	1017.6	0
	700	4	333	16.8	1018.9	0
	1300	3	59	17.8	1018.1	0
	1900	3	128	14.6	1016.4	0
8	100	4	216	15.4	1017.1	0
	700	12	11	13.8	1019.0	0
	1300	7	3	16.0	1019.2	0
	1900	8	44	14.3	1019.5	0
9	100	4	129	12.9	1020.5	0
	700	1	236	16.7	1021.8	0
	1300	5	93	18.1	1020.5	0
	1900	7	137	15.9	1018.3	0
10	100	8	182	19.3	1015.0	0
	700	10	186	21.1	1013.1	0
	1300	4	204	23.8	1010.9	0
	1900	8	181	19.8	1008.9	0

Table 3
Meteorological Data (continued)

May 1995

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	7	213	20.9	1007.1	0
	700	6	218	22.3	1007.0	0
	1300	6	244	27.3	1005.4	0
	1900	3	227	22.5	1004.5	0
12	100	3	253	20.3	1003.9	0
	700	3	342	16.0	1006.2	14
	1300	8	359	19.6	1007.6	0
	1900	1	106	16.6	1008.7	0
13	100	0		15.8	1010.2	0
	700	3	279	19.8	1012.9	0
	1300	2	85	24.1	1013.8	0
	1900	5	117	19.1	1014.6	0
14	100	3	122	18.5	1015.9	0
	700	10	81	17.0	1015.5	0
	1300	4	114	18.7	1012.1	0
	1900	0		18.1	1010.1	0
15	100	2	61	17.1	1010.2	0
	700	4	313	19.5	1010.1	27
	1300	3	355	20.6	1011.1	0
	1900	1	83	18.1	1010.8	0
16	100	2	15	17.0	1012.3	0
	700	4	308	19.3	1014.5	0
	1300	3	74	21.0	1016.0	0
	1900	6	132	18.0	1014.2	0
17	100	6	179	20.6	1013.0	0
	700	8	190	22.2	1012.4	0
	1300	9	197	26.6	1010.9	0
	1900	12	191	23.8	1008.1	0
18	100	8	207	23.2	1008.9	0
	700	7	216	24.1	1009.2	0
	1300	6	218	29.4	1007.8	0
	1900	8	189	26.6	1007.1	0
19	100	6	196	23.9	1005.6	0
	700	9	211	25.0	1004.7	0
	1300	8	201	21.6	1003.6	0
	1900	6	340	18.5	1004.9	0
20	100	5	342	13.9	1007.9	0
	700	3	1	16.3	1010.4	9
	1300	2	114	21.5	1011.4	0
	1900	5	156	16.9	1012.0	0

Table 3
Meteorological Data (concluded)

May 1995

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	4	208	19.3	1013.7	0
	700	5	229	21.5	1015.4	0
	1300	3	238	25.9	1015.3	0
	1900	5	147	19.3	1015.7	0
22	100	3	192	20.5	1016.2	0
	700	2	274	22.3	1018.2	0
	1300	5	28	22.5	1018.9	0
	1900	2	39	18.8	1020.7	0
23	100	2	26	17.7	1021.2	0
	700	5	63	19.6	1024.4	0
	1300	3	67	22.9	1024.6	0
	1900	3	83	18.9	1023.8	0
24	100	3	135	18.9	1022.7	0
	700	3	198	22.8	1024.1	0
	1300	6	124	26.1	1022.3	0
	1900	8	162	23.1	1020.0	0
25	100	5	196	21.6	1019.6	0
	700	5	219	23.1	1019.5	0
	1300	4	118	25.3	1017.9	0
	1900	6	156	21.7	1017.0	0
26	100	2	292	21.1	1017.9	0
	700	2	179	21.8	1017.3	0
	1300	4	25	24.1	1017.9	0
	1900	6	37	18.8	1017.9	0
27	100	6	42	16.8	1019.2	0
	700	5	31	16.5	1020.9	0
	1300	9	40	17.6	1022.7	0
	1900	7	51	17.2	1023.0	0
28	100	9	65	17.6	1023.1	0
	700	9	64	19.5	1023.9	0
	1300	6	108	21.8	1024.4	0
	1900	4	141	19.6	1023.3	0
29	100	6	149	19.3	1021.2	0
	700	6	177	23.0	1021.1	0
	1300	7	173	28.6	1018.9	0
	1900	7	186	24.5	1016.4	0
30	100	9	198	22.9	1015.0	0
	700	7	237	23.5	1014.6	0
	1300	3	21	22.8	1013.7	0
	1900	5	34	20.1	1015.2	0
31	100	3	6	18.6	1016.6	0
	700	4	12	20.0	1018.2	0
	1300	1	51	23.6	1019.4	0
	1900	3	54	19.8	1018.7	0
		Resultant		Mean	Mean	Total
		1	127	19.0	1014.9	122

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

May 1995

Day	Hour	641 Pressure Gauge Hmo,m	Tp,sec	625 Baylor Gauge Hmo,m	Tp,sec	3111 8 Meter Array Hmo,m	Tp,sec	Dir,TN	630 Waverider Hmo,m	Tp,sec
1	0100	0.60	4.1	0.89	7.4	1.09	7.1	108	1.07	7.0
	0700	0.80	5.0	1.03	5.0	1.11	5.0	18	1.30	5.2
	1300	0.56	5.3	0.92	5.4	0.90	13.6	94	1.00	5.3
	1900	0.72	6.6	1.11	7.0	1.15	7.6	52	1.17	6.6
2	0100	0.68	4.5	1.35	8.9	1.45	9.8	54	1.38	8.1
	0700	0.93	5.9	1.42	5.9	1.52	5.9	54	1.62	9.2
	1300	0.76	7.6	1.29	7.6	1.38	7.6	62	1.55	7.2
	1900	1.00	6.3	1.34	7.2	1.55	7.1	54	1.60	6.6
3	0100	0.90	7.6	1.52	8.1	1.60	8.9	58	1.87	8.1
	0700	0.86	8.6	1.25	8.9	1.45	9.8	64	1.60	8.6
	1300	0.75	9.9	1.21	10.3	1.41	9.8	60	1.40	9.9
	1900	0.67	11.2	1.22	10.7	1.21	10.8	56	1.19	9.9
4	0100	0.52	10.3	1.19	10.3	1.16	10.8	58	1.25	11.2
	0700	0.81	11.7	1.47	11.7	1.43	10.8	84	1.26	11.7
	1300	0.51	11.7	1.24	11.2	1.14	10.8	58	1.16	11.7
	1900	0.39	12.2	0.99	12.9	0.98	12.0	58	0.88	12.2
5	0100	0.48	11.7	1.04	11.7	1.02	12.0	66	1.04	11.7
	0700	0.66	14.3	1.29	13.5	1.30	13.6	92	1.18	13.5
	1300	0.60	13.5	0.99	13.5	1.06	13.6	64	1.00	12.9
	1900	0.49	12.2	1.02	12.2	0.94	12.0	68	0.92	12.2
6	0100	0.41	12.2	0.75	12.2	0.75	12.0	54	0.74	12.9
	0700	0.39	12.9	0.74	12.2	0.83	12.0	74	0.78	12.2
	1300	0.38	12.9	0.68	12.9	0.75	12.0	68	0.78	13.5
	1900	0.37	13.5	0.81	12.9	0.83	13.6	90	0.80	13.5
7	0100	0.45	14.3	0.86	13.5	0.76	13.6	64	0.63	14.3
	0700	0.30	13.5	0.69	13.5	0.72	12.0	68	0.61	12.9
	1300	0.32	12.2	0.63	12.9	0.66	12.0	66	0.59	12.2
	1900	0.25	12.9	0.72	12.9	0.67	12.0	84	0.61	9.9
8	0100	0.30	12.2	0.85	11.2	0.66	12.0	86	0.66	12.9
	0700	0.57	3.8	1.02	3.7	1.06	4.4	34	0.94	3.5
	1300	0.74	5.7	1.11	5.7	1.19	5.9	52	1.33	5.7
	1900	0.57	7.2	1.16	7.6	1.11	7.1	56	1.13	7.6
9	0100	0.49	7.0	1.08	7.2	1.00	7.6	56	1.03	7.6
	0700	0.47	11.7	1.19	7.4	1.06	12.0	62	1.02	7.2
	1300	0.54	11.7	1.20	11.2	1.04	10.8	56	1.11	11.2
	1900	0.42	10.7	1.19	10.3	1.06	10.8	56	1.04	11.7
10	0100	0.48	11.7	1.16	11.2	1.08	10.8	86	1.15	11.7
	0700	0.38	11.2	1.14	10.7	1.04	10.8	68	1.04	10.7
	1300	0.42	10.7	0.88	10.3	0.86	9.8	62	0.91	9.9
	1900	0.36	11.2	0.88	10.7	0.65	10.8	58	0.75	10.3

Table 4
Wave Data (continued)

May 1995

Day	Hour	641 Pressure Gauge Hmo,m	Tp,sec	625 Baylor Gauge Hmo,m	Tp,sec	3111 8 Meter Array Hmo,m	Tp,sec	Dir,TN	630 Waverider Hmo,m	Tp,sec
11	0100	0.37	8.1	0.64	9.5	0.57	8.9	72	0.62	10.7
	0700	0.38	8.3	0.74	11.2	0.56	8.2	60	0.62	8.1
	1300	0.39	8.3	0.71	8.6	0.69	9.8	60	0.66	8.3
	1900	0.39	7.8	0.68	9.9	0.56	9.8	56	0.66	9.9
12	0100	0.36	7.0	0.68	9.9	0.57	7.6	58	0.60	7.4
	0700	0.47	7.8	0.68	7.4	0.76	8.2	64	0.78	7.0
	1300	0.44	3.7	0.68	7.8	0.70	8.9	64	0.73	3.7
	1900	0.34	8.1	0.42	10.3	0.44	9.8	68	0.53	6.5
13	0100	0.21	7.8	0.38	8.1	0.43	8.9	68	0.44	7.6
	0700	0.24	7.4	0.38	7.6	0.40	9.8	64	0.41	7.8
	1300	0.16	18.3	0.32	6.8	0.38	7.1	62	0.40	7.0
	1900	0.25	7.4	0.41	7.6	0.36	8.2	68	0.44	6.6
14	0100	0.19	18.3	0.52	7.4	0.36	7.1	58	0.40	7.0
	0700	0.44	3.4	0.84	3.5	0.71	3.6	90	0.70	3.3
	1300	0.47	4.1	0.93	4.2	0.77	4.2	70	0.86	4.2
	1900	0.55	5.2	0.88	5.3	0.85	8.2	56	0.96	4.8
15	0100	0.38	6.1	0.77	7.6	0.87	6.2	114	0.91	6.0
	0700	0.51	6.0	0.81	6.1	0.84	8.9	56	0.91	5.6
	1300	0.31	12.9	0.70	9.5	0.75	12.0	90	0.73	9.2
	1900	0.42	11.2	0.71	10.3	0.83	12.0	90	0.73	9.2
16	0100	0.27	12.2	0.77	11.7	0.80	12.0	82	0.71	10.7
	0700	0.36	14.3	0.65	11.7	0.73	12.0	90	0.66	9.9
	1300	0.27	14.3	0.68	11.2	0.72	12.0	86	0.64	11.7
	1900	0.37	13.5	0.73	9.2	0.70	9.8	66	0.71	10.7
17	0100	0.27	14.3	0.86	10.3	0.65	10.8	90	0.65	9.5
	0700	0.32	12.9	0.71	11.7	0.67	10.8	88	0.71	10.7
	1300	0.33	13.5	0.77	11.2	0.62	10.8	78	0.71	11.2
	1900	0.47	3.9	0.66	10.3	0.61	3.2	112	0.77	4.1
18	0100	0.37	7.4	0.61	11.2	0.48	10.8	80	0.55	7.2
	0700	0.33	7.2	0.57	10.3	0.49	7.1	112	0.60	7.4
	1300	0.43	7.6	0.62	8.6	0.54	7.6	112	0.62	6.8
	1900	0.44	7.0	0.61	7.0	0.58	7.1	110	0.64	7.2
19	0100	0.38	6.8	0.55	12.2	0.47	12.0	70	0.62	7.2
	0700	0.34	6.5	0.51	11.7	0.41	10.8	58	0.54	6.5
	1300	0.31	7.2	0.46	11.7	0.39	7.1	112	0.47	7.0
	1900	0.31	7.2	0.46	11.2	0.39	10.8	78	0.50	7.2
20	0100	0.72	5.1	0.95	5.0	0.83	5.0	20	0.88	5.2
	0700	0.33	4.5	0.63	11.7	0.51	12.0	64	0.56	4.5
	1300	0.32	12.2	0.59	12.2	0.47	12.0	62	0.51	11.2
	1900	0.23	12.2	0.58	10.7	0.46	10.8	86	0.42	11.7

Table 4
Wave Data (concluded)

May 1995

Day	Hour	641 Pressure Gauge Hmo,m	Tp,sec	625 Baylor Gauge Hmo,m	Tp,sec	3111 8 Meter Array Hmo,m	Tp,sec	Dir,TN	630 Waverider Hmo,m	Tp,sec
21	0100	0.30	11.7	0.48	11.2	0.46	12.0	60	0.48	12.2
	0700	0.23	12.2	0.54	12.2	0.47	12.0	48	0.44	12.2
	1300	0.27	11.7	0.38	11.7	0.44	12.0	64	0.40	11.2
	1900	0.22	12.2	0.48	12.2	0.44	12.0	60	0.44	12.2
22	0100	0.33	12.9	0.53	12.9	0.46	12.0	60	0.47	12.2
	0700	0.23	4.8	0.53	11.7	0.41	12.0	72	0.41	11.7
	1300	0.29	4.8	0.47	11.7	0.45	12.0	74	0.41	11.7
	1900	0.25	4.8	0.50	11.7	0.43	12.0	90	0.40	11.2
23	0100	0.27	4.7	0.44	11.2	0.39	12.0	68	0.37	11.7
	0700	0.22	11.2	0.47	10.7	0.38	10.8	66	0.38	11.2
	1300	0.34	4.0	0.53	11.2	0.46	10.8	60	0.50	10.7
	1900	0.25	10.7	0.54	10.7	0.41	10.8	72	0.43	11.2
24	0100	0.32	5.6	0.54	10.7	0.46	10.8	62	0.47	5.7
	0700	0.30	5.4	0.60	10.3	0.47	5.9	70	0.48	5.4
	1300	0.45	5.5	0.62	5.3	0.53	5.3	102	0.57	5.6
	1900	0.39	5.4	0.58	5.9	0.47	5.6	102	0.55	5.6
25	0100	0.28	5.9	0.42	6.0	0.41	5.9	106	0.44	5.5
	0700	0.29	7.0	0.49	7.0	0.37	6.6	108	0.41	6.1
	1300	0.28	5.4	0.44	6.1	0.40	6.6	108	0.41	6.5
	1900	0.31	6.5	0.45	6.3	0.37	6.6	104	0.43	6.6
26	0100	0.27	6.0	0.46	6.5	0.40	6.6	108	0.41	6.8
	0700	0.27	7.0	0.44	8.9	0.36	6.6	106	0.40	6.5
	1300	0.28	6.1	0.33	6.1	0.39	6.2	104	0.41	6.0
	1900	0.42	4.0	0.56	3.9	0.61	4.1	24	0.60	3.7
27	0100	0.68	5.3	0.96	4.7	1.13	5.3	34	1.16	4.9
	0700	0.69	5.7	0.85	5.9	0.92	5.9	50	1.02	6.1
	1300	0.64	5.7	0.89	5.6	1.09	5.6	56	1.15	5.4
	1900	0.84	6.0	1.20	6.5	1.21	6.2	54	1.33	5.9
28	0100	0.63	5.6	1.24	6.5	1.26	6.2	60	1.37	6.0
	0700	0.79	4.6	1.34	8.1	1.42	8.9	64	1.42	6.0
	1300	0.62	9.5	1.26	9.5	1.25	9.8	64	1.35	8.3
	1900	0.66	5.7	1.14	9.2	1.20	9.8	68	1.25	8.3
29	0100	0.60	5.3	1.10	9.2	1.22	9.8	64	1.28	9.5
	0700	0.72	5.0	1.15	9.9	1.24	10.8	84	1.30	11.2
	1300	0.61	11.7	1.08	11.7	1.13	10.8	68	1.13	11.2
	1900	0.65	11.7	0.89	10.7	0.94	12.0	84	1.02	11.7
30	0100	0.44	5.6	0.74	11.2	0.76	12.0	66	0.79	11.2
	0700	0.44	6.6	0.59	11.2	0.68	12.0	84	0.67	11.2
	1300	0.33	6.3	0.55	11.7	0.59	12.0	66	0.58	11.7
	1900	0.43	11.7	0.59	11.7	0.59	12.0	68	0.56	11.2
31	0100	0.33	12.2	0.56	11.7	0.63	12.0	60	0.58	12.2
	0700	0.42	7.0	0.60	12.2	0.60	12.0	68	0.64	12.2
	1300	0.33	7.0	0.54	6.8	0.65	12.0	66	0.55	8.1
	1900	0.36	12.2	0.53	11.2	0.58	10.8	76	0.60	7.2
Mean		0.44	8.7	0.79	9.5	0.77	9.6	71	0.80	8.8
Std dev		0.18	3.5	0.29	2.6	0.33	2.6	19	0.34	2.8

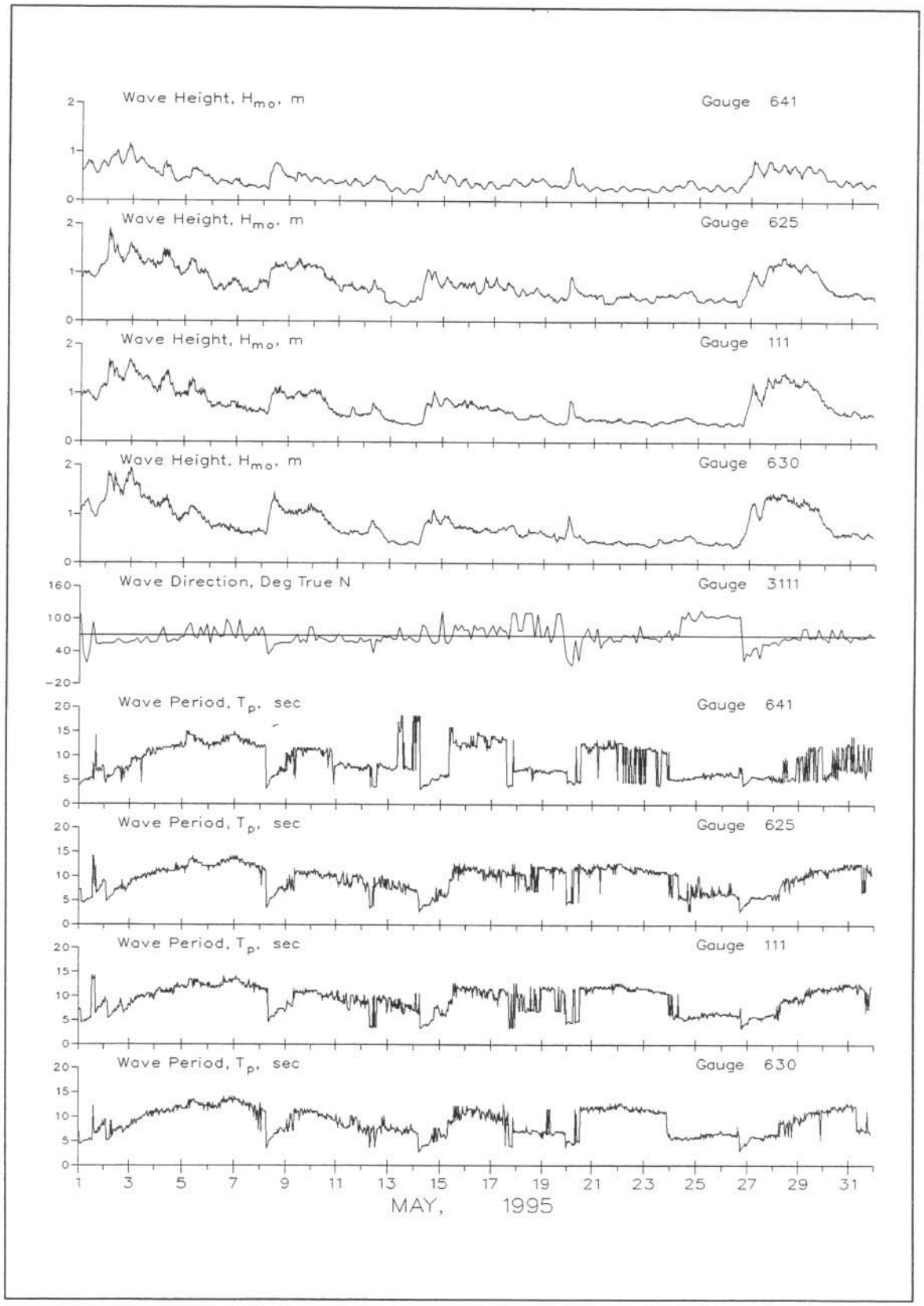

Figure 5. Wave Heights and Periods

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

MAY 1995

Day	Time	Cross Shore	Long Shore	Speed	Dir
1	100	0	21	21	160
	700	0	22	22	159
	1300	0	16	16	158
	1900	0	7	7	148
2	100	-3	10	11	140
	700	-1	13	14	150
	1300	1	11	11	166
	1900	0	20	20	157
3	100	-1	24	24	154
	700	0	19	19	157
	1300	0	17	17	156
	1900	-1	3	4	134
4	100	-1	2	3	104
	700	-5	-4	7	30
	1300	-4	3	6	105
	1900	-1	8	8	148
5	100	0	2	2	148
	700	-2	0	3	64
	1300	-6	4	8	99
	1900	-4	5	7	113
6	100	-1	-1	3	17
	700	1	14	14	163
	1300	0	14	14	160
	1900	0	4	4	142
7	100	0	4	4	144
	700	-2	8	8	140
	1300	0	12	13	155
	1900	0	7	7	160
8	100	-2	1	3	90
	700	0	16	16	158
	1300	0	15	15	157
	1900	-2	9	9	144
9	100	1	2	2	190
	700	-1	1	2	91
	1300				
	1900	-2	3	4	112
10	100	-1	1	2	98
	700	0	1	1	172
	1300	2	-6	7	327
	1900	1	0	2	286
11	100	3	-8	9	320
	700	0	0	0	
	1300	2	-3	4	319
	1900	-1	1	3	84
12	100	0	2	2	154
	700	-1	8	8	144
	1300	-4	9	10	129
	1900	1	19	19	163
13	100	1	7	7	164
	700	-1	3	4	127
	1300	0	13	13	154
	1900	1	1	2	181
14	100	0	2	2	159
	700	-4	3	6	98
	1300	1	4	4	174
	1900	0	5	5	155
15	100	-2	2	4	106
	700	1	6	6	166
	1300	0	3	3	130
	1900	0	1	1	117
16	100	-2	3	4	109
	700	-1	0	2	67
	1300	1	11	11	164
	1900	0	6	6	148
17	100	0	0	0	
	700	3	-9	10	324
	1300	3	-2	4	296
	1900	4	-20	21	331
18	100	3	-4	5	308
	700	3	-5	7	309
	1300	1	0	1	246
	1900	2	-6	8	324
19	100	0	-4	5	338
	700	3	-7	9	321
	1300	0	0	0	
	1900	1	-3	4	323
20	100	0	0	0	
	700	0	0	0	
	1300	0	1	1	152
	1900	0	0	0	
21	100	1	0	2	292
	700	0	3	3	146
	1300	2	6	6	180
	1900	0	4	4	151
22	100	0	-3	4	339
	700	-2	0	4	51
	1300	0	1	1	154
	1900	0	2	3	129
23	100	1	-1	2	324
	700	0	3	3	140
	1300				
	1900	0	3	3	151
24	100	1	-1	2	323
	700				
	1300	0	-1	2	350
	1900	2	-2	4	313
25	100	2	-8	9	327
	700	2	-3	4	311
	1300	1	-7	8	333
	1900	1	0	1	262
26	100	0	-3	4	337
	700				
	1300	-6	-6	10	25
	1900	-2	0	3	76
27	100	0	4	4	143
	700	0	23	23	159
	1300	0	21	21	157
	1900	1	15	15	163
28	100	-1	14	14	153
	700	-2	16	16	151
	1300	-2	0	3	51
	1900	0	3	3	166
29	100	-1	2	3	105
	700	-1	1	2	101
	1300	0	-1	2	4
	1900	2	-18	19	334
30	100	4	-10	11	322
	700	3	-10	12	324
	1300	0	-2	4	0
	1900	-1	-19	20	346
31	100	0	0	0	
	700	-1	-1	3	29
	1300	-2	7	8	133
	1900	0	10	10	156

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

May 1995

	Pier End				Mid-Surf Zone				Beach		
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	0	55	55	160	0	55	55	160	North	24	S
2	0	13	13	160	0	68	68	160	no observation		
3	0	41	41	160	0	76	76	160	no observation		
4	0	0	0		6	21	22	143	no observation		
5	4	-12	12	357	4	-11	11	359	South	15	S
6	0	44	44	160	0	61	61	160	North	14	S
7	-9	47	48	171	7	44	44	151	North	12	S
8	-9	44	44	171	-20	102	104	171	North	64	S
9	0	0	0		17	55	58	143	North	35	S
10	8	-27	28	357	10	-8	12	31	South	24	S
11	19	-6	21	52	6	-18	19	357	South	0	
12	-7	34	35	171	0	14	14	160	North	26	S
13	8	55	56	151	4	15	16	146	North	5	S
14	-16	16	23	250	-3	-23	23	331	South	43	N
15	3	32	32	154	27	-15	31	41	North	5	S
16	0	29	29	160	7	7	10	70	North	0	
17	20	-51	55	2	12	-41	42	357	South	24	N
18	28	-47	55	11	12	-34	36	359	South	10	N
19	9	-30	32	357	13	-44	45	357	South	11	N
20	1	-8	8	346	5	-36	36	349	South	11	S
21	0	47	47	160	9	-14	16	13	South	27	N
22	0	-30	30	340	0	5	5	160	North	11	S
23	-5	13	14	182	0	-30	30	340	South	14	S
24	0	0	0		9	-20	22	4	South	3	N
25	9	-7	11	33	9	-15	17	11	South	17	N
26	2	-13	13	349	8	-9	12	20	South	5	N
27	-5	51	51	166	0	41	41	160	North	30	S
28	-11	32	34	179	0	68	68	160	North	35	S
29	11	-10	15	28	30	-47	56	13	South	52	N
30	15	10	18	70	20	-51	55	2	South	15	N
31	-5	-4	7	290	5	-34	34	349	North	4	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

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

May 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	0645	40		58	21	12.8	1.0244	1.8
2	0626	55		55	154	13.1	1.0244	1.2
3	0625	60	25	55	165	12.8	1.0233	0.9
4	0618	70		70	221	13.3	1.0232	2.1
5	0615	80			187	12.8	1.0240	1.8
6	1040	65	20	65	89	13.9	1.0237	2.1
7	0933	75			93	15.0	1.0228	3.7
8	0620	35		50	130	15.3	1.0218	2.7
9	0621	60	75		122	14.7	1.0225	2.7
10	0626	75	145	75	128	13.6	1.0243	1.2
11	0602	85			67	13.1	1.0257	1.5
12	0707	25	80		9	13.9	1.0253	3.0
13	0758	55			11	17.5	1.0214	3.0
14	0825	80	115	75	8	18.1	1.0204	3.7
15	0606	75	65		74	18.1	1.0198	3.7
16	0620	70	30		87	18.3	1.0200	3.4
17	0619	75	135	75	67	17.5	1.0218	3.7
18	0638	125	80		23	14.2	1.0252	2.4
19	0651	130			4	13.9	1.0252	3.0
22	0621	115			49	17.2	1.0237	3.4
21	0952	85			7	17.5	1.0230	4.6
20	0918	45			10	14.4	1.0252	5.5
23	0630	70			40	19.2	1.0226	5.2
24	0640	120	80		9	20.0	1.0222	5.2
25	0630	105	75		8	14.7	1.0251	3.4
26	0620	80	105		6	14.2	1.0252	4.6
27	0745	40	80	40	66	18.9	1.0214	3.4
28	0739	55	75	75	146	18.9	1.0209	2.4
29	1019	85			141	18.3	1.0240	1.8
30	0720	75			99	13.9	1.0252	1.8
31	0730	80	20		23	18.3	1.0245	4.3

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.

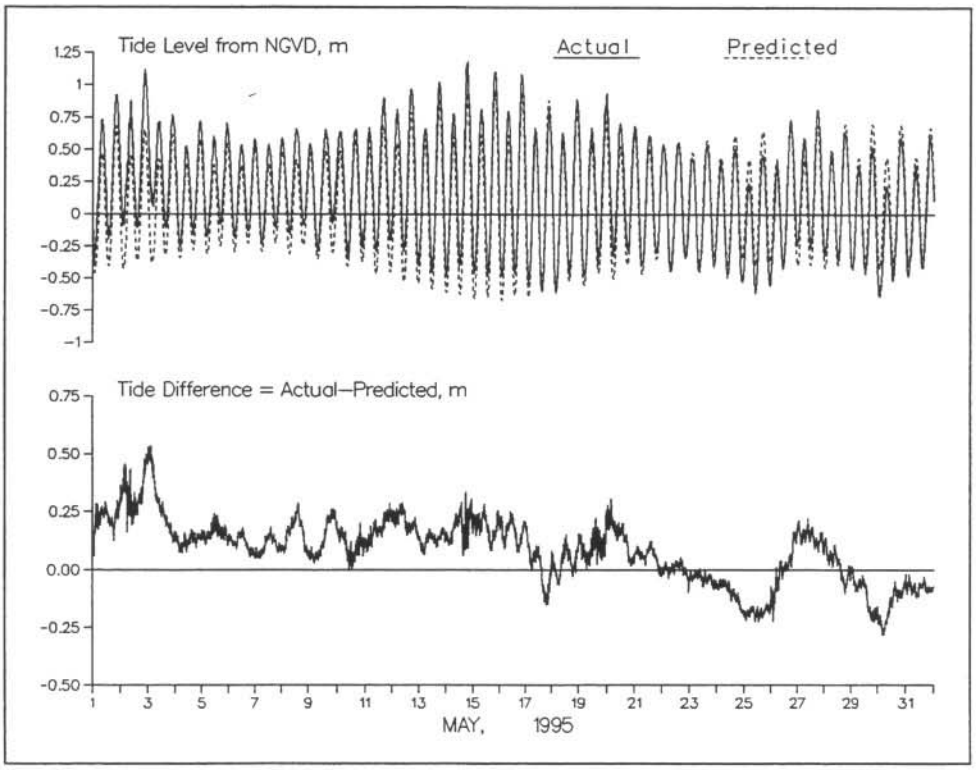

Figure 6. Water Level Variation

Table 8
Water Levels, m NGVD

MAY 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	0830	0.74	1	0200	-0.40	0.22	1.13	16	2012	1.08	16	1418	-0.46	0.30	1.55
1	2018	0.92	1	1348	-0.20	0.36	1.12	17	0842	0.67	17	0306	-0.55	0.06	1.22
2	0900	0.88	2	0236	-0.10	0.33	0.97	17	2106	0.81	17	1536	-0.61	0.09	1.42
2	2124	1.12	2	1412	-0.11	0.50	1.23	18	1012	0.63	18	0406	-0.62	0.01	1.25
3	0954	0.71	3	0424	0.05	0.38	0.66	18	2218	0.89	18	1612	-0.47	0.19	1.37
3	2112	0.77	3	1530	-0.11	0.32	0.88	19	1112	0.67	19	0442	-0.47	0.09	1.14
4	0954	0.52	4	0400	-0.26	0.14	0.79	20	0000	0.94	19	1618	-0.39	0.27	1.33
4	2224	0.72	4	1606	-0.17	0.28	0.89	20	1200	0.70	20	0542	-0.33	0.21	1.03
5	1036	0.60	5	0442	-0.18	0.20	0.78	21	0018	0.69	20	1854	-0.29	0.19	0.98
5	2236	0.71	5	1648	-0.08	0.29	0.79	21	1312	0.61	21	0618	-0.40	0.12	1.01
6	1200	0.53	6	0518	-0.18	0.17	0.72	22	0106	0.54	21	1918	-0.30	0.12	0.84
6	2336	0.58	6	1800	-0.14	0.21	0.72	22	1442	0.56	22	0724	-0.45	0.07	1.00
7	1230	0.54	7	0618	-0.24	0.16	0.77	23	0154	0.44	22	2036	-0.34	0.06	0.79
8	0030	0.59	7	1842	-0.11	0.23	0.70	23	1518	0.54	23	0848	-0.45	0.05	0.99
8	1318	0.66	8	0742	-0.16	0.26	0.82	24	0312	0.40	23	2118	-0.41	0.00	0.81
9	0118	0.55	8	1948	-0.09	0.22	0.63	24	1554	0.51	24	0930	-0.50	0.01	1.00
9	1436	0.66	9	0800	-0.30	0.19	0.96	25	0406	0.24	24	2242	-0.54	-0.14	0.77
10	0224	0.64	9	2036	-0.08	0.29	0.72	25	1642	0.46	25	1012	-0.62	-0.07	1.08
10	1606	0.66	10	0936	-0.35	0.17	1.01	26	0506	0.43	25	2324	-0.56	-0.09	0.99
11	0342	0.67	10	2130	-0.26	0.20	0.93	26	1724	0.73	26	1042	-0.43	0.17	1.16
11	1636	0.90	11	1024	-0.29	0.30	1.19	27	0536	0.59	26	2330	-0.24	0.17	0.83
12	0430	0.81	11	2148	-0.20	0.28	1.01	27	1824	0.81	27	1124	-0.27	0.28	1.08
12	1706	0.97	12	1042	-0.29	0.33	1.25	28	0618	0.49	28	0030	-0.32	0.09	0.82
13	0536	0.66	12	2324	-0.40	0.15	1.06	28	1824	0.62	28	1224	-0.38	0.14	1.00
13	1754	1.02	13	1142	-0.45	0.28	1.48	29	0736	0.38	29	0142	-0.43	-0.04	0.80
14	0630	0.78	14	0024	-0.48	0.16	1.26	29	1930	0.52	29	1312	-0.47	0.01	0.99
14	1906	1.18	14	1200	-0.41	0.35	1.59	30	0748	0.21	30	0154	-0.64	-0.21	0.85
15	0648	0.81	15	0124	-0.46	0.20	1.28	30	2000	0.60	30	1318	-0.52	0.05	1.12
15	1948	1.10	15	1312	-0.48	0.32	1.59	31	0836	0.37	31	0218	-0.49	-0.06	0.86
16	0806	0.80	16	0224	-0.48	0.16	1.28								

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

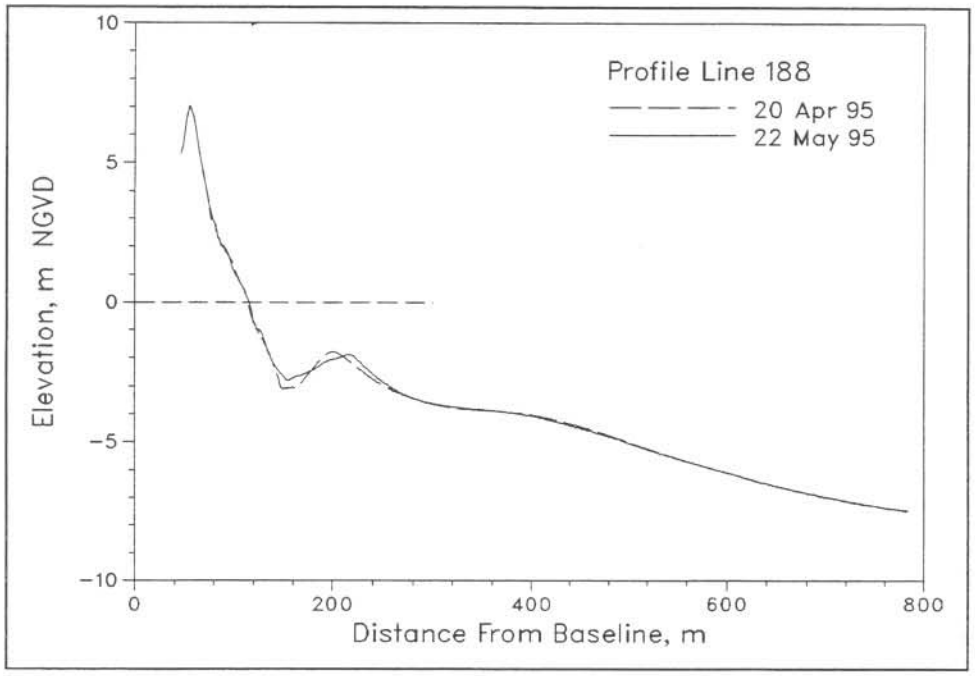

Figure 7. Monthly CRAB Profiles on Profile Line 188.

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 May.

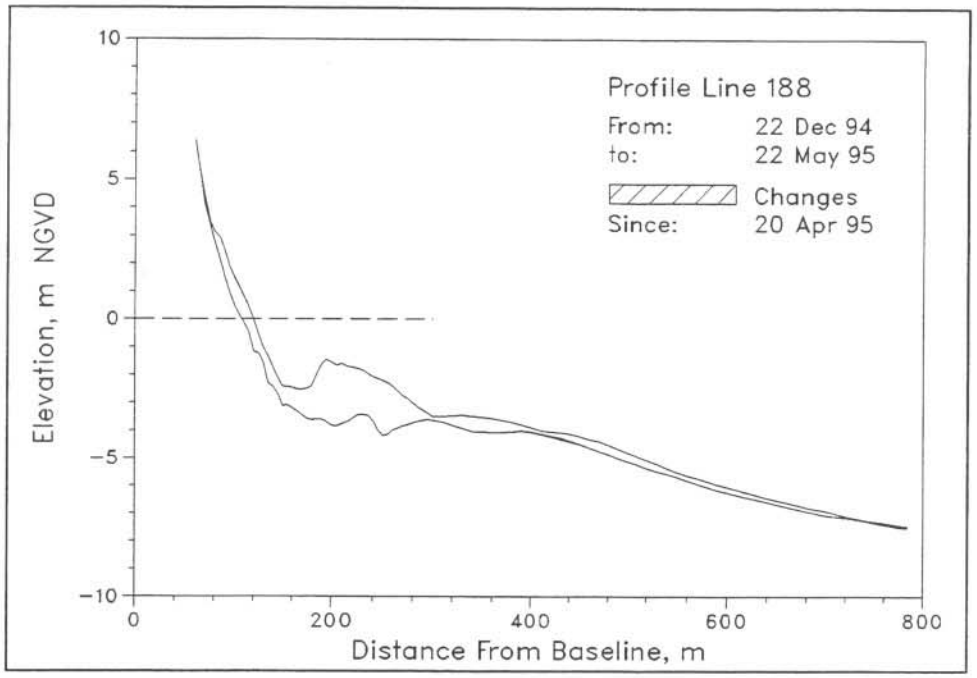

Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 21 April. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

There was no bathymetric survey in May. Figure 9 is included for reference only.

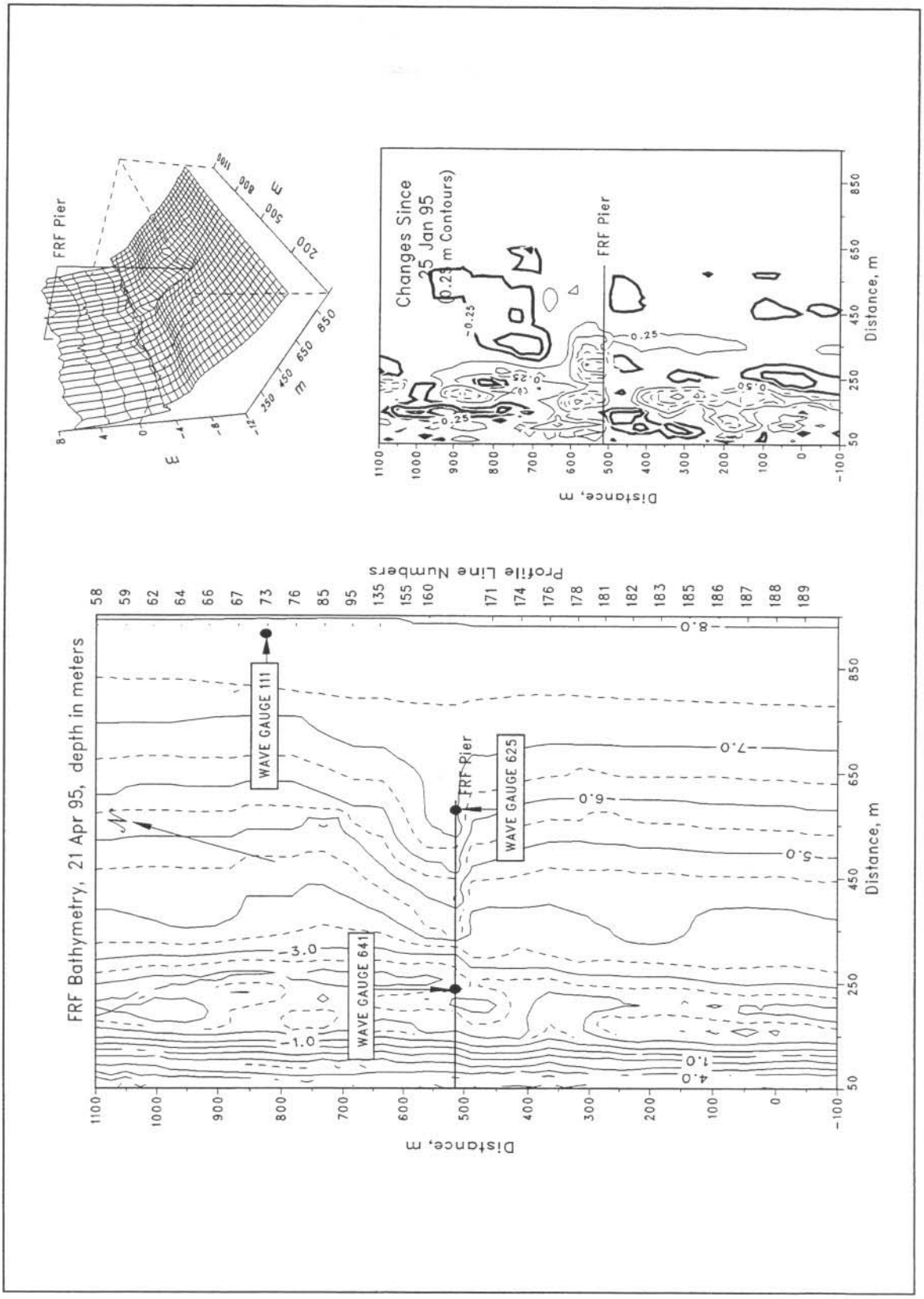

Figure 9. FRF Bathymetry, Depths Relative to NGVD

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)