US Army Corps
of Engineers
Waterways Experiment
Station

Preliminary Data Summary for February 1994 CERC Field Research Facility

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Coastal Engineering Research Center

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February 1994
Preliminary Data Summary

by Field Research Facility

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

Preface iv
1 — Introduction 1
2 — Meteorological Data 7
3 — Wave Data 12
4 — Current Data 17
5 — Visual Observations 20
6 — Water Levels 22
7 — Bathymetry 24

List of Figures

No.
1 FRF Location Map 2
2 Month at a Glance 3
3 Instrument Locations at FRF 6
4 Meteorological Monthly Summary 8
5 Time History of Wave Heights and Periods 16
6 Water Level Time History 22
7 CRAB Profiles 24
8 CRAB Profile Envelope 25
9 FRF Bathymetry (24 January 94) 26

List of Tables

No.
1 Instrument Status/Data Availability 4
2 Gauge Locations 5
3 Meteorological Data 9
4 Wave Data 13
5 Current Meter Data 18
6 Visually Observed Current Data 19
7 Visual Observations 21
8 Water Levels 23

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).

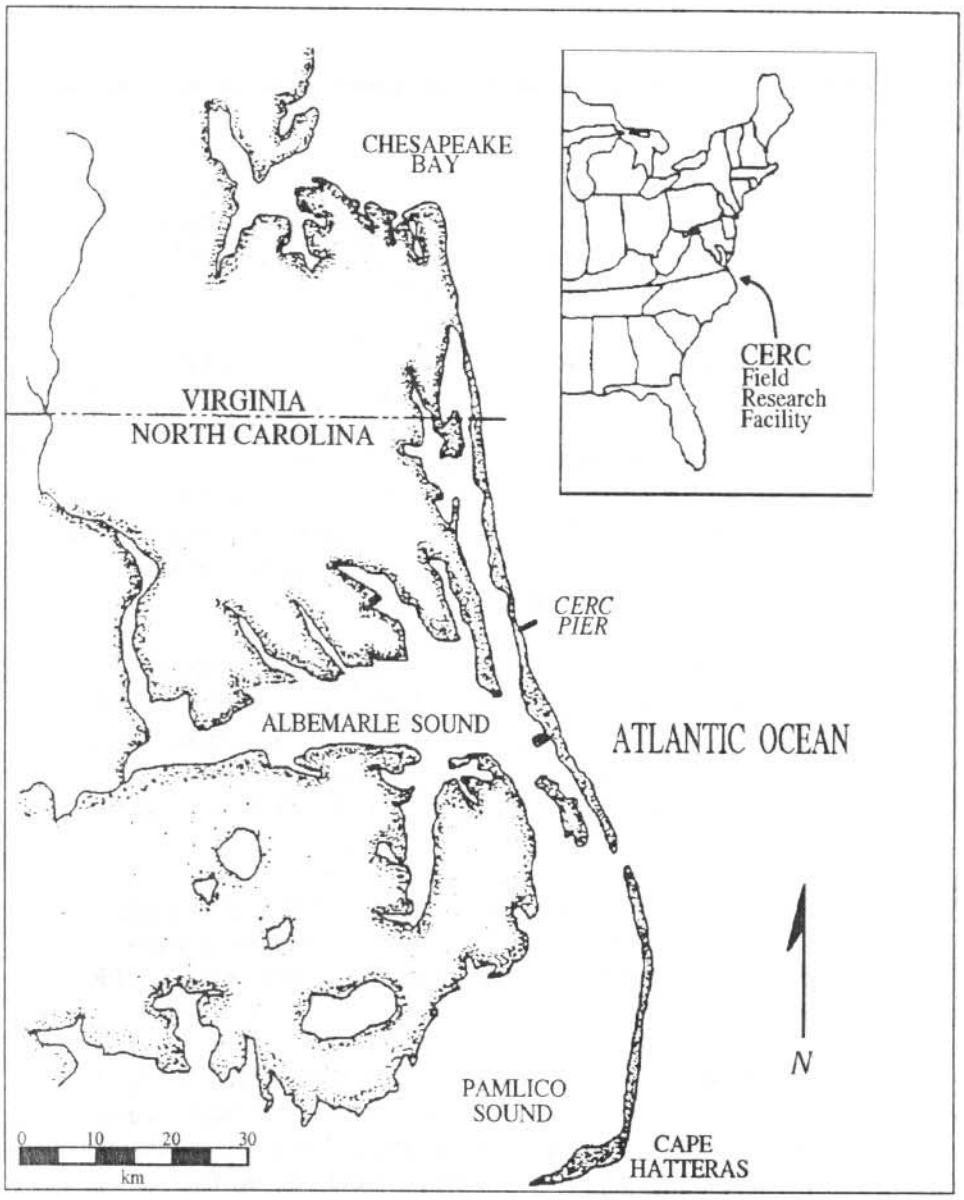

Figure 1. FRF Location Map

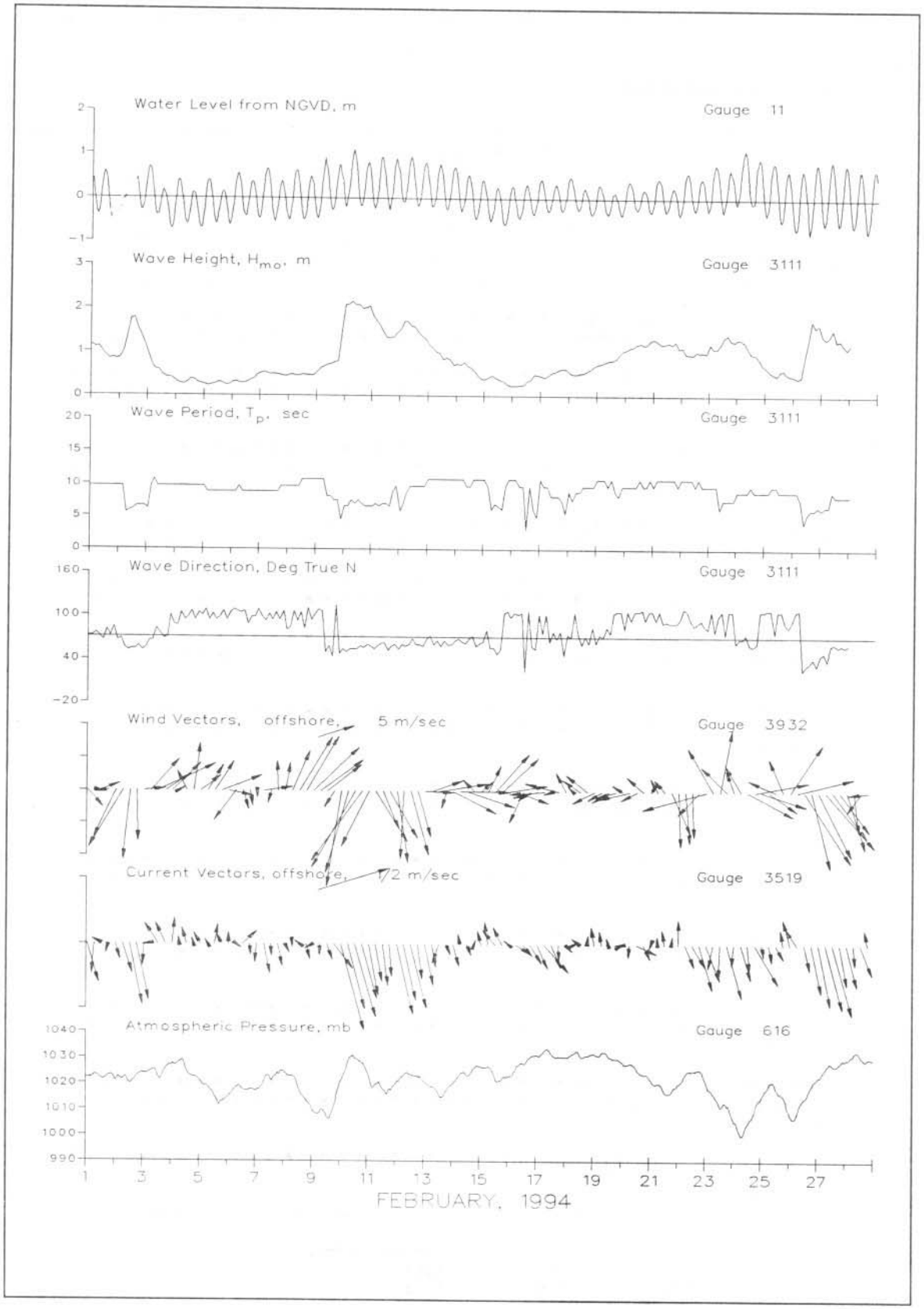

Figure 2. Month at a Glance

Table 1
Instrument Status/Data Availability

February 1993

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
616	Atmospheric Pressure	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
604	Precipitation	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
624	Air Temperature	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	/	/	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	/	/	*	*	*	*	*	*
632	Anemometer on top of building	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
932	Anemometer at seaward end of pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
641	Pressure Gauge at station 780 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
625	Baylor staff at station 1860 on FRF pier	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
3111	8 Meter Array 309 m north of FRF	Gauge Status	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
		Data Collected	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
511	Pressure Gauge 434 m north of FRF pier (0.9 km offshore)	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 station at seaward end of FRF 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	Barometer	36 10′ 45.48"	75 44′ 37.39"	11.60	569.00	-----	-----
632	Building Anemometer	36 10′ 45.24"	75 44′ 39.53"	21.45	515.83	19.94	-----
932	EOP Anemometer	36 11′ 2.64"	75 44′ 46.50"	585.20	517.30	19.50	-----
641	780 Pressure	36 10′ 51.96"	75 44′ 42.21"	239.11	516.64	-1.64	-1.96
625	1860 Baylor	36 11′ 2.10"	75 44′ 46.31"	568.00	516.64	Surface	-8.36
3111	8m Array	36 11′ 15.90"	75 44′ 38.88"	914.43	825.52	-7.76	-8.08
511	Pressure N Tripod	36 11′ 17.17"	75 44′ 34.15"	914.76	950.00	-6.70	-7.90
630	Waverider	36 12′ 16.44"	75 47′ 19.23"	3934.96	-2400.81	Surface	-17.00
519	Current N tripod	36 11′ 17.17"	75 44′ 34.15"	914.76	950.00	-5.30	-7.90
11	NOAA Tide	36 11′ 2.95"	75 44′ 46.76	596.49	514.20	Surface	-7.62

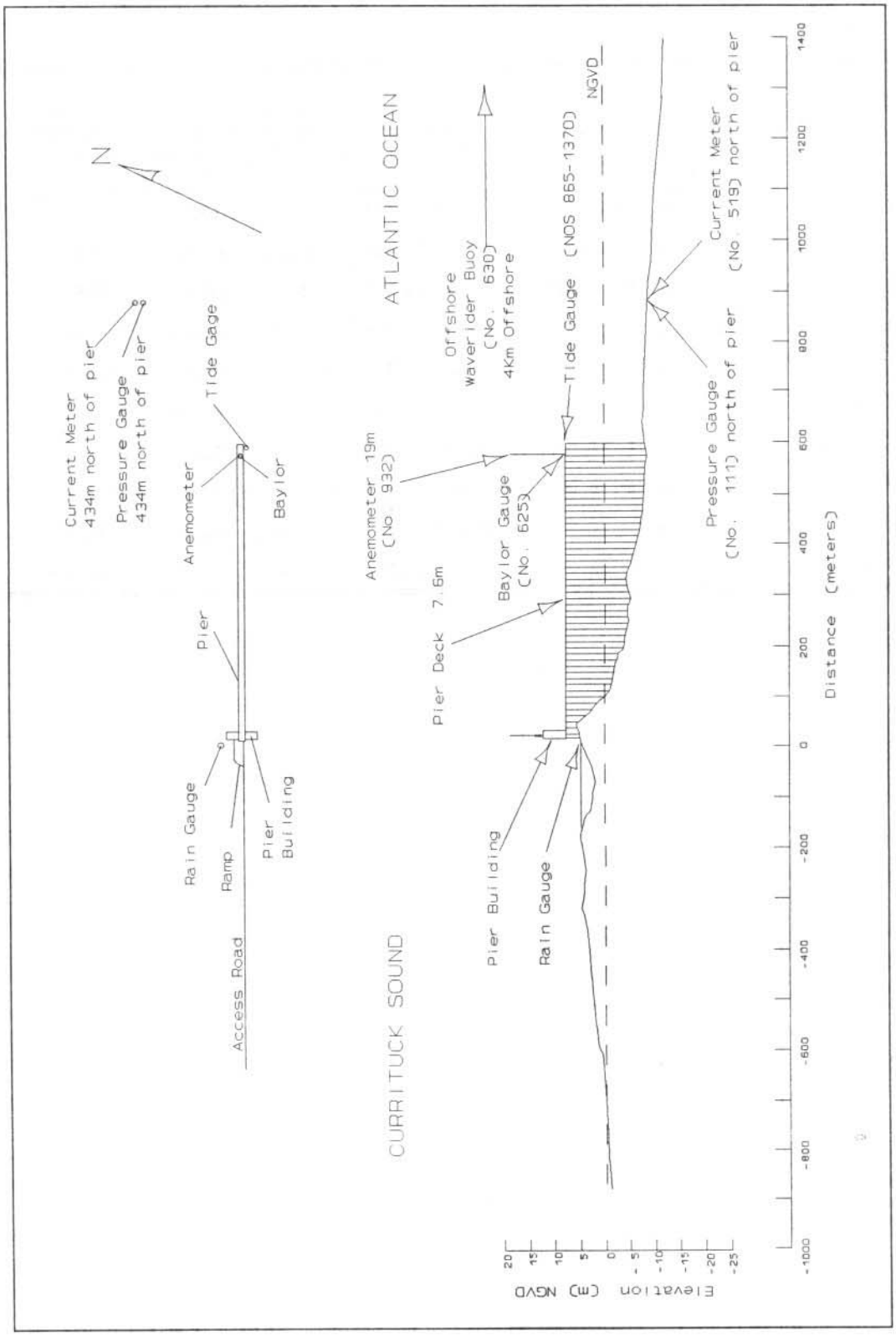

Figure 3. Instrument Locations, Elevations From NGVD

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

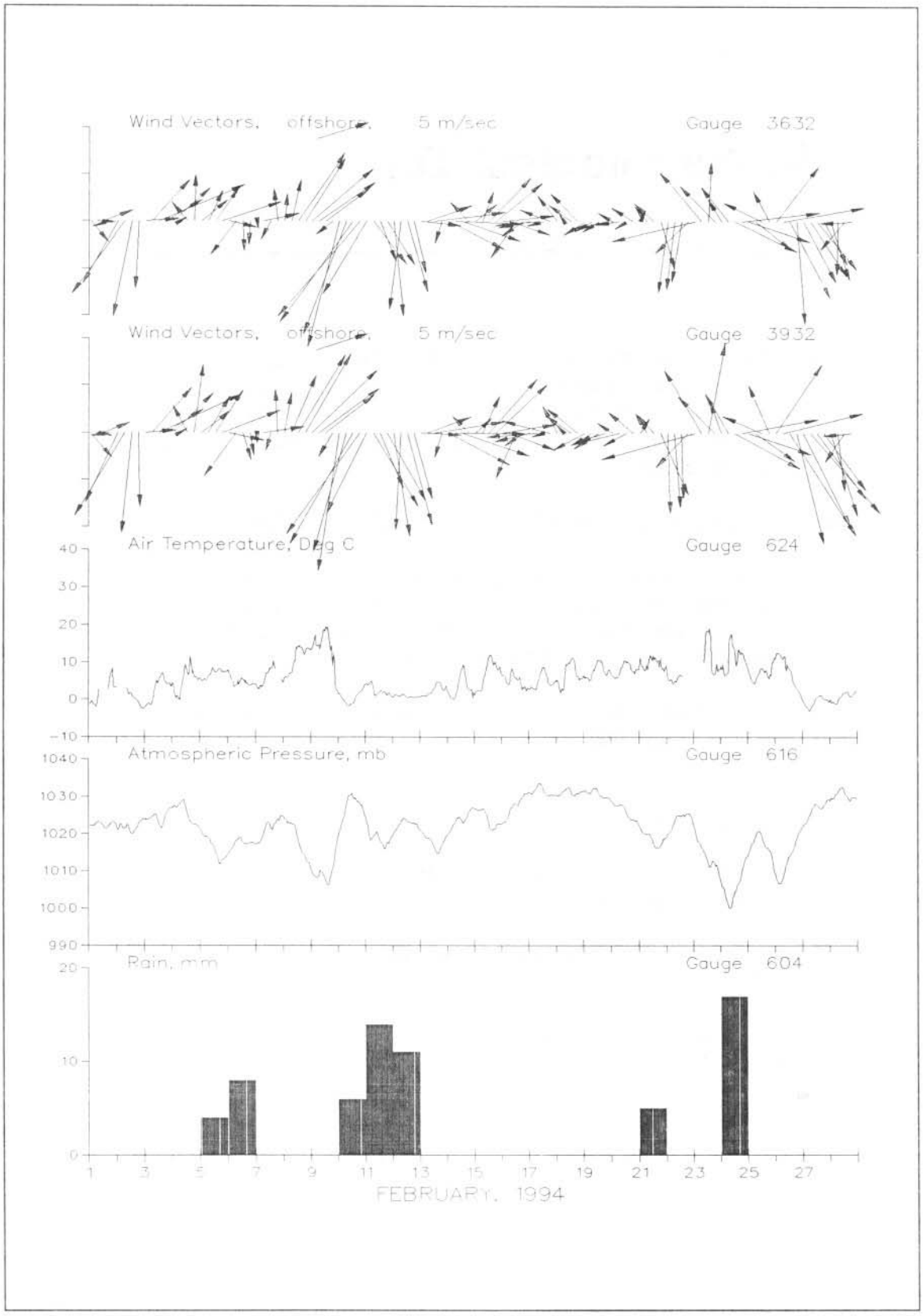

Figure 4. Meteorological Monthly Summary

Table 3
Meteorological Data

Feb 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	3	323	-1.1	1022.3	0
	700	1	282	-1.6	1023.0	0
	1300	3	245	inoperative	1022.1	0
	1900	2	80	6.8	1022.9	0
2	100	8	21	inoperative	1021.0	0
	700	10	26		1021.5	0
	1300	11	4	1.4	1020.1	0
	1900	8	359	-0.6	1022.6	0
3	100	3	264	-2.2	1023.9	0
	700	6	216	-1.0	1024.6	0
	1300	8	240	5.5	1022.6	0
	1900	4	233	4.6	1025.4	0
4	100	5	220	4.1	1027.1	0
	700	1	236	-0.2	1028.2	0
	1300	3	156	7.4	1025.6	0
	1900	7	186	6.5	1022.5	0
5	100	3	228	5.1	1020.9	0
	700	4	206	6.0	1019.0	0
	1300	5	209	7.4	1015.4	0
	1900	6	245	7.3	1012.9	4
6	100	3	284	7.0	1014.8	0
	700	5	31	3.7	1018.2	8
	1300	3	345	5.3	1017.8	0
	1900	2	351	3.8	1017.6	0
7	100	1	357	3.4	1017.2	0
	700	4	260	4.0	1020.3	0
	1300	2	12	8.2	1021.6	0
	1900	5	177	inoperative	1024.1	0
8	100	4	188	5.7	1024.1	0
	700	6	200	6.9	1022.9	0
	1300	9	207	14.4	1017.8	0
	1900	9	206	12.5	1013.8	0
9	100	9	221	13.8	1009.6	0
	700	7	229	14.8	1008.7	0
	1300	6	228	19.5	1007.2	0
	1900	3	27	9.1	1010.7	0
10	100	15	7	1.7	1020.6	0
	700	13	13	-1.1	1027.8	0
	1300	13	26	-1.0	1029.8	0
	1900	13	31	1.9	1028.2	6

Table 3
Meteorological Data (continued)

Feb 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
11	100	9	23	4.1	1023.4	6
	700	9	332	3.2	1019.5	0
	1300	6	340	2.0	1018.2	0
	1900	8	333	1.0	1017.7	8
12	100	11	352	0.5	1020.3	11
	700	10	2	1.1	1023.1	0
	1300	10	347	0.4	1023.4	0
	1900	7	346	0.6	1022.8	0
13	100	4	273	0.9	1020.7	0
	700	4	246	1.3	1018.8	0
	1300	6	259	3.2	1016.1	0
	1900	3	13	3.0	1017.2	0
14	100	7	300	1.8	1020.2	0
	700	6	270	0.5	1023.3	0
	1300	7	291	8.5	1023.3	0
	1900	2	139	2.8	1026.0	0
15	100	2	223	2.0	1026.8	0
	700	4	202	3.4	1026.9	0
	1300	7	217	11.3	1022.7	0
	1900	7	222	9.1	1021.9	0
16	100	5	259	6.3	1023.0	0
	700	5	293	4.3	1026.0	0
	1300	5	21	5.6	1028.0	0
	1900	2	51	3.4	1030.1	0
17	100	3	73	2.7	1031.1	0
	700	5	84	3.3	1032.6	0
	1300	1	69	8.6	1031.8	0
	1900	5	105	3.9	1030.5	0
18	100	3	154	5.3	1030.3	0
	700	1	141	3.0	1031.7	0
	1300	3	128	10.6	1031.2	0
	1900	4	132	6.4	1031.0	0
19	100	3	58	5.7	1031.7	0
	700	2	54	6.3	1031.7	0
	1300	3	53	10.5	1030.8	0
	1900	3	71	7.0	1029.9	0
20	100	2	126	6.5	1028.6	0
	700	4	73	6.6	1027.9	0
	1300	3	57	9.9	1025.8	0
	1900	3	134	7.4	1023.8	0

Table 3
Meteorological Data (concluded)

Feb 1994

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
21	100	2	208	11.3	1021.9	0
	700	2	152	9.5	1020.3	5
	1300	2	142	10.7	1017.3	0
	1900	7	338	11.0	1016.8	0
22	100	8	358	5.9	1020.1	0
	700	8	355	4.8	1023.4	0
	1300	7	358	6.4	1025.1	0
	1900	5	39		1025.4	0
23	100	9	71	inoperative	1021.1	0
	700	7	152		1016.4	0
	1300	10	189	18.1	1012.1	0
	1900	5	138	7.0	1012.2	0
24	100	4	161	8.4	1006.3	0
	700	5	152	7.4	1000.7	17
	1300	7	302	13.2	1004.5	0
	1900	7	258	12.8	1009.9	0
25	100	6	291	7.6	1014.9	0
	700	5	309	4.8	1019.4	0
	1300	4	116	8.2	1018.7	0
	1900	5	159	5.7	1015.6	0
26	100	8	209	12.0	1008.3	0
	700	8	253	10.9	1008.4	0
	1300	12	330	8.1	1014.3	0
	1900	12	348	3.1	1019.0	0
27	100	11	336	-0.7	1022.6	0
	700	11	323	-2.7	1025.7	0
	1300	8	327	0.7	1027.7	0
	1900	7	327	0.1	1028.0	0
28	100	9	344	-0.4	1029.7	0
	700	6	353	-0.5	1031.2	0
	1300	4	30	1.8	1031.0	0
	1900	3	83	0.9	1029.8	0
		Resultant		Mean	Mean	Total
		2	326	5.3	1021.7	65

3 Wave Data

Wave data are collected from a Baylor staff gauge (Gauge 625), two pressure wave gauges (641 and 511) and a Waverider buoy (Gauge 630) as shown in Table 1 and Figure 3. The data are collected, analyzed, and stored on optical disc using a Digital Equipment Corporation VAX 11/750 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.

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

Feb 1994

Day	Hour	641 Pressure Gage Hmo,m	Tp,sec	625 Baylor 1860 Hmo,m	Tp,sec	111 Pressure Gage Hmo,m	Tp,sec	630 Waverider Hmo,m	Tp,sec
1	0100	0.52	4.5	1.00	9.5	1.16	9.5	1.12	9.2
	0700	0.41	9.9	0.92	9.9	1.10	10.3	1.13	10.3
	1300	0.28	9.5	0.80	10.7	0.89	10.3	0.93	10.3
	1900	0.23	9.9	0.75	9.9	0.81	10.3	inoperative	
2	0100	0.43	3.5	0.80	9.9	0.81	9.9		
	0700	0.60	5.2	1.34	4.8	1.34	4.7	1.46	5.7
	1300	0.88	6.5	1.66	6.1	1.96	6.5	1.99	6.5
	1900	0.59	6.3	1.38	6.6	1.49	6.6	1.63	6.8
3	0100	0.53	5.4	0.92	6.1	0.97	6.3	1.02	7.0
	0700	0.14	11.2	0.54	10.3	0.58	10.7	0.62	9.9
	1300	0.17	9.9	0.46	10.3	0.52	10.3	0.58	10.3
	1900	0.18	4.2	0.35	9.9	0.38	9.9	0.46	9.5
4	0100	0.21	5.3	0.29	9.2	0.31	9.9	0.36	9.9
	0700	0.13	3.8	0.25	9.5	0.26	9.2	0.31	9.5
	1300	0.20	4.2	0.38	4.1	0.34	9.2	0.41	9.2
	1900	0.15	3.1	0.32	8.9	0.31	9.5	0.38	9.9
5	0100	0.12	9.5	0.22	10.3	0.25	9.5	0.28	9.2
	0700	0.10	9.5	0.23	9.5	0.24	8.9	0.28	9.5
	1300	0.14	9.5	0.29	8.9	0.31	8.6	0.34	9.2
	1900	0.12	9.5	0.22	9.5	0.23	9.9	0.26	8.9
6	0100	0.15	7.5	0.28	9.2	0.29	8.6	0.36	9.5
	0700	0.17	7.5	0.29	8.9	0.29	9.5	0.30	9.9
	1300	0.14	9.5	0.27	9.2	0.29	9.5	0.34	9.2
	1900	0.16	3.1	0.39	9.5	0.34	9.2	0.42	9.2
7	0100	0.22	3.7	0.50	9.9	0.51	8.9	0.56	8.9
	0700	0.24	5.0	0.45	8.6	0.53	8.6	0.54	8.9
	1300	0.20	4.3	0.45	9.2	0.50	9.2	0.53	9.9
	1900	0.17	10.7	0.43	9.9	0.47	9.5	0.54	9.5
8	0100	0.14	9.5	0.42	9.5	0.48	9.5	0.52	9.5
	0700	0.18	10.3	0.43	9.9	0.46	10.3	0.53	9.9
	1300	0.16	11.7	0.43	11.2	0.51	10.3	0.58	10.7
	1900	0.26	10.3	0.42	10.7	0.48	10.7	0.67	11.2
9	0100	0.24	11.2	0.48	10.3	0.48	10.7	0.60	10.7
	0700	0.44	8.1	0.58	8.1	0.67	10.7	0.86	7.4
	1300	0.37	4.5	0.67	8.3	0.74	8.1	0.83	8.1
	1900	0.55	5.7	0.70	8.3	0.80	7.8	0.91	7.8
10	0100	0.71	6.0	1.78	6.0	2.00	5.7	2.16	6.1
	0700	1.07	6.8	1.98	6.6	2.08	7.6	2.13	7.2
	1300	0.65	7.2	1.92	6.8	2.21	6.8	2.11	7.0
	1900	1.03	6.3	1.81	7.2	1.96	6.6	2.00	6.8

Table 4
Wave Data (continued)

Feb 1994

Day	Hour	641 Pressure Gage Hmo,m	Tp,sec	625 Baylor 1860 Hmo,m	Tp,sec	111 Pressure Gage Hmo,m	Tp,sec	630 Waverider Hmo,m	Tp,sec
11	0100	0.65	7.2	1.78	6.6	1.88	6.8	1.94	6.8
	0700	1.03	6.8	1.49	6.5	1.63	6.8	1.71	6.8
	1300	0.70	7.0	1.16	7.2	1.35	7.2	1.40	7.2
	1900	0.90	7.6	1.25	8.1	1.34	8.1	1.51	7.4
12	0100	0.74	5.3	1.37	9.9	1.56	6.0	1.65	9.2
	0700	1.00	5.7	1.49	8.3	1.74	7.4	1.86	8.9
	1300	0.70	6.5	1.42	9.5	1.71	9.5	1.62	9.5
	1900	0.85	5.9	1.26	8.9	1.44	9.9	1.50	9.5
13	0100	0.64	5.4	1.05	9.9	1.27	10.3	1.19	10.3
	0700	0.55	9.9	0.94	9.9	1.05	10.3	1.15	10.7
	1300	0.39	11.7	0.77	10.3	0.91	10.3	1.01	10.7
	1900	0.35	11.2	0.70	11.2	0.81	10.7	0.96	10.7
14	0100	0.36	11.7	0.69	11.2	0.74	11.2	0.74	10.7
	0700	0.56	5.1	0.73	10.3	0.78	10.3	0.85	9.2
	1300	0.42	5.0	0.63	8.1	0.64	9.5	0.75	6.0
	1900	0.25	5.0	0.48	10.3	0.46	10.3	0.54	10.3
15	0100	0.21	4.6	0.36	10.3	0.39	10.3	0.46	11.2
	0700	0.20	5.6	0.42	5.6	0.45	6.6	0.50	6.0
	1300	0.17	5.0	0.35	7.2	0.40	6.8	0.47	6.8
	1900	0.17	4.5	0.29	9.5	0.31	10.3	0.36	9.9
16	0100	0.14	6.1	0.23	10.7	0.25	9.9	0.27	11.2
	0700	0.13	5.6	0.22	11.2	0.23	9.2	0.28	9.9
	1300	0.26	3.1	0.45	2.9	0.30	3.3	0.48	2.9
	1900	0.26	4.0	0.54	6.3	0.50	6.3	0.56	4.8
17	0100	0.29	4.9	0.49	4.3	0.46	4.6	0.57	6.1
	0700	0.23	5.0	0.47	8.9	0.47	9.2	0.53	9.9
	1300	0.26	4.2	0.54	4.9	0.56	9.2	0.61	5.9
	1900	0.30	5.5	0.63	5.9	0.62	6.0	0.68	5.5
18	0100	0.31	4.4	0.51	5.7	0.56	6.3	0.58	6.8
	0700	0.20	4.4	0.47	7.8	0.49	7.4	0.52	8.6
	1300	0.24	9.5	0.52	10.3	0.53	9.9	0.58	9.5
	1900	0.25	10.7	0.59	10.7	0.65	10.3	0.66	9.5
19	0100	0.35	10.7	0.63	11.2	0.70	10.3	0.75	10.3
	0700	0.35	11.7	0.67	10.7	0.76	11.2	0.89	10.7
	1300	0.48	10.7	0.75	9.9	0.82	10.7	0.90	6.3
	1900	0.41	6.4	0.85	10.3	0.93	8.6	1.00	8.9
20	0100	0.65	9.5	0.93	10.3	0.98	10.3	1.17	9.5
	0700	0.51	10.7	1.07	10.7	1.10	10.3	1.23	10.7
	1300	0.64	10.7	1.18	10.7	1.20	10.3	1.39	9.9
	1900	0.53	10.3	1.22	10.3	1.18	10.3	1.44	10.3

Table 4
Wave Data (concluded)

Feb 1994

Day	Hour	641 Pressure Gage Hmo,m	641 Pressure Gage Tp,sec	625 Baylor 1860 Hmo,m	625 Baylor 1860 Tp,sec	111 Pressure Gage Hmo,m	111 Pressure Gage Tp,sec	630 Waverider Hmo,m	630 Waverider Tp,sec
21	0100	0.75	10.3	1.20	10.7	1.21	9.9	1.45	10.3
	0700	0.59	10.7	1.10	10.7	1.15	10.3	1.37	10.7
	1300	0.62	11.2	1.14	9.9	1.11	10.7	1.31	10.3
	1900	0.55	11.7	1.07	10.7	1.25	10.3	1.30	11.2
22	0100	0.63	9.9	1.04	9.2	1.11	10.3	1.23	9.9
	0700	0.60	10.3	0.90	10.7	0.96	10.3	1.11	10.7
	1300	0.56	10.7	0.96	10.3	1.00	9.9	1.13	10.3
	1900	0.51	9.9	0.95	10.3	1.04	10.3	1.13	9.9
23	0100	0.60	9.5	1.18	9.5	1.18	9.5	1.32	9.5
	0700	0.61	9.5	0.97	9.5	1.04	9.9	1.15	6.1
	1300	0.56	6.6	1.18	6.8	1.27	6.6	1.72	6.8
	1900	0.76	7.6	1.18	8.9	1.32	8.1	1.46	7.8
24	0100	0.71	7.6	1.28	7.8	1.30	7.8	1.50	7.8
	0700	0.95	9.2	1.27	8.9	1.35	9.2	1.35	9.5
	1300	0.51	9.5	0.87	9.5	0.94	8.6	1.14	9.5
	1900	0.67	9.2	0.83	9.2	0.87	9.9	0.90	8.6
25	0100	0.39	9.5	0.68	8.9	0.66	8.3	0.77	9.2
	0700	0.36	9.2	0.49	9.5	0.54	8.9	0.62	9.2
	1300	0.26	8.6	0.49	9.5	0.56	9.2	0.60	6.8
	1900	0.34	8.6	0.56	9.5	0.50	9.2	0.68	9.2
26	0100	0.20	8.9	0.47	9.5	0.46	8.3	0.60	8.1
	0700	0.34	6.8	0.43	9.2	0.48	7.4	0.60	6.8
	1300	0.31	5.7	1.14	5.7	1.26	5.7	1.50	5.6
	1900	0.98	6.3	1.42	6.5	1.57	6.5	1.80	6.6
27	0100	0.46	6.5	1.34	6.3	1.44	6.1	1.79	6.3
	0700	0.88	6.1	1.14	7.0	1.12	6.1	1.51	6.5
	1300	0.46	5.3	1.22	8.6	1.43	8.9	1.46	8.9
	1900	0.78	6.6	1.12	6.6	1.23	8.1	1.29	8.1
28	0100	0.46	6.1	1.15	8.9	1.24	6.6	1.33	5.9
	0700	0.67	6.3	1.00	7.2	1.02	5.9	1.22	7.2
	1300	0.40	5.0	0.82	8.1	0.88	8.6	0.94	8.3
	1900	0.41	5.4	0.86	7.2	0.80	7.6	0.84	7.4
Mean		0.44	7.5	0.81	8.8	0.87	8.8	0.97	8.7
Std dev		0.25	2.5	0.43	1.8	0.48	1.7	0.50	1.7

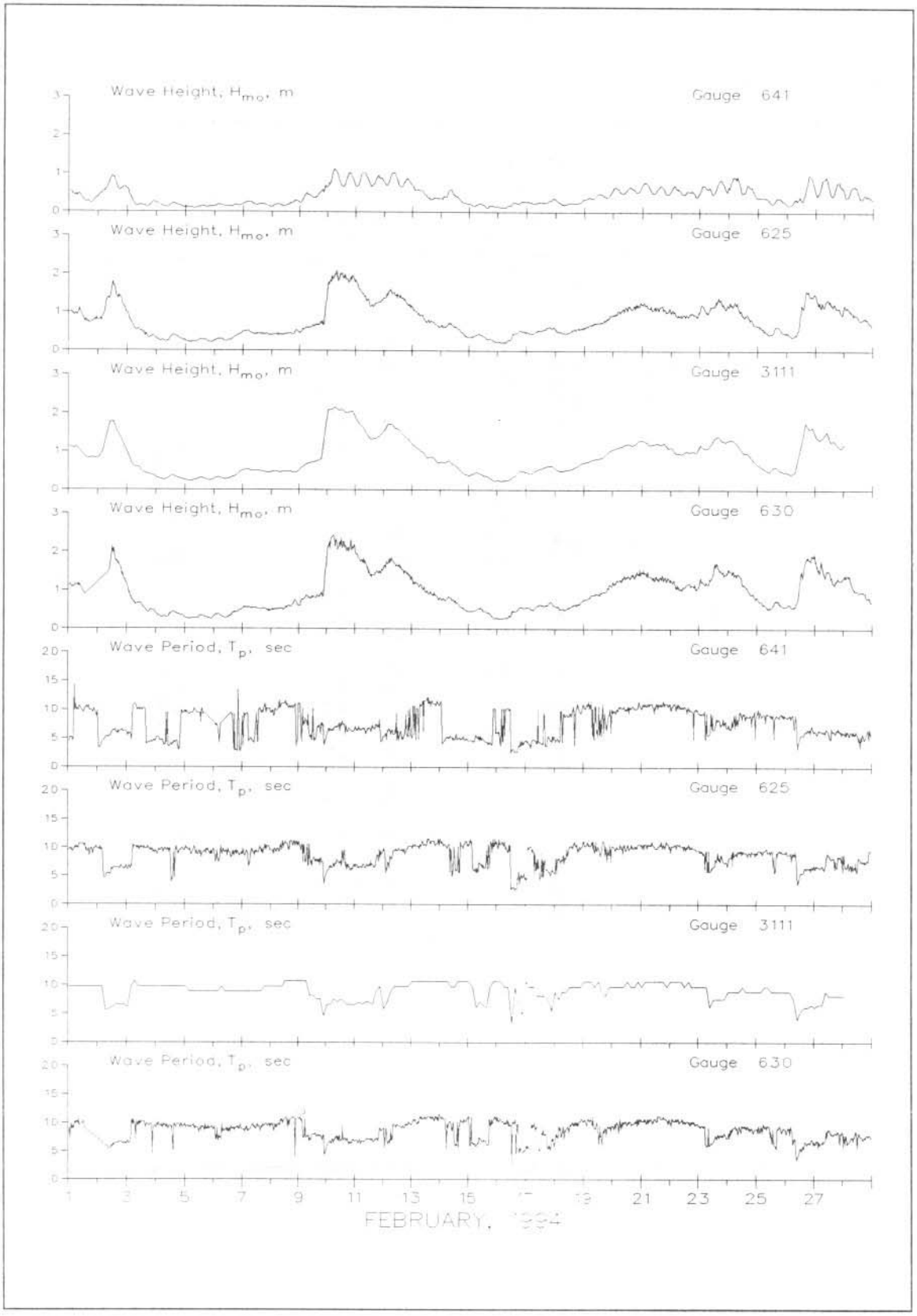

Figure 5. Time History of Wave Heights and Periods

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

FEBRUARY 1994

Day	Time	Cross Shore	Long Shore	Speed	Dir
1	100	-2	31	31	166
	700	-9	21	23	184
	1300	-3	-4	7	300
	1900	-3	7	8	193
2	100	0	13	13	166
	700	-1	24	24	164
	1300	-8	48	48	170
	1900	-7	44	45	170
3	100	-6	16	17	182
	700	-4	0	5	261
	1300	-2	-16	17	330
	1900	0	-16	17	338
4	100	8	-16	19	4
	700	1	-4	5	352
	1300	1	-11	12	345
	1900	0	-3	4	344
5	100	-1	-8	9	330
	700	0	-3	4	332
	1300	7	-12	15	10
	1900	0	-7	8	335
6	100	3	-7	9	0
	700	3	5	5	130
	1300	12	-5	13	45
	1900	-1	9	9	175
7	100	-5	14	15	184
	700	-3	23	24	170
	1300	-2	9	10	177
	1900	-2	17	18	171
8	100	0	7	7	157
	700	0	2	3	176
	1300	-1	-2	4	311
	1900	-1	12	12	168
9	100	-6	1	7	239
	700	-3	8	9	183
	1300	0	13	13	163
	1900	5	22	23	146
10	100	-7	68	68	167
	700	-5	51	51	167
	1300	-5	58	58	166
	1900	-4	43	44	166
11	100	-6	40	40	171
	700	-5	28	29	172
	1300	-7	31	32	173
	1900	-6	24	25	177
12	100	-7	55	55	169
	700	-6	44	44	169
	1300	-6	50	51	168
	1900	-5	26	27	174
13	100	-4	31	32	170
	700	-2	18	18	171
	1300	-8	12	15	196
	1900	0	8	8	159
14	100	-1	17	17	167
	700	2	-7	8	351
	1300	0	9	9	161
	1900	2	-2	4	16
15	100	1	-10	11	347
	700	4	-16	18	352
	1300	-3	-12	14	323
	1900	0	-14	15	336
16	100	-1	-3	5	312
	700	7	10	12	128
	1300	3	10	11	146
	1900	2	16	16	152
17	100	0	19	19	159
	700	8	25	26	143
	1300	0	18	18	161
	1900	-3	11	12	179
18	100	3	7	7	139
	700	4	0	4	57
	1300	-2	-5	7	312
	1900	3	-5	7	6
19	100	3	-12	14	352
	700	3	-9	11	354
	1300	1	-4	5	346
	1900	0	0	0	
20	100	2	0	2	59
	700	-3	9	9	185
	1300	10	11	15	118
	1900	0	12	12	159
21	100	-1	2	3	197
	700	2	-5	6	358
	1300	2	-10	11	351
	1900	3	-5	6	5
22	100	7	-17	19	0
	700	0	18	18	160
	1300	3	19	19	152
	1900	-2	35	36	165
23	100	0	29	29	161
	700	-8	16	18	190
	1300	-8	24	25	181
	1900	-4	42	42	166
24	100	-6	15	16	185
	700	-2	27	28	166
	1300	-5	19	20	177
	1900	4	34	34	153
25	100	-1	9	9	171
	700	-1	13	13	171
	1300	1	12	12	155
	1900	3	-11	12	352
26	100	2	-19	20	346
	700	-2	-15	16	329
	1300	-2	19	20	169
	1900	-5	37	38	170
27	100	-8	47	48	170
	700	-5	50	51	167
	1300	-5	55	55	166
	1900	-5	31	32	171
28	100	-3	32	33	168
	700	-3	15	16	176
	1300	0	24	24	161
	1900	2	-11	12	351
	1900	2	-11	12	351

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

Feb 1994

	Pier End				Mid-Surf Zone				Beach		
Day	Cross Shore	Long Shore	Speed	Dir	Cross Shore	Long Shore	Speed	Dir	Location	Speed	Dir
1	0	9	9	160	26	-44	51	11	North	30	S
2	0	36	36	160	0	55	55	160	North	30	S
3	11	-14	18	17	0	-44	44	340	South	10	N
4	0	-47	47	340	2	-5	5	357	South	9	N
5	22	-44	49	7	0	-11	11	340	South	10	N
6	0	25	25	160	0	0	0		North	3	S
7	0	61	61	160	0	10	10	160	South	5	S
8	14	-8	16	40	5	-15	16	357	South	4	N
9	5	16	17	70	0	-5	5	340	South	23	N
10	0	87	87	160	0	152	152	160	North	91	S
11	0	76	76	160	0	76	76	160	North	51	S
12	0	87	87	160	0	122	122	160	North	51	S
13	5	15	16	143	10	34	35	143	North	38	S
14	7	24	25	143	11	38	40	143	North	20	S
15	3	-19	19	349	0	-4	4	340	North	0	
16	-3	23	23	169	0	17	17	160	North	2	S
17	-24	11	26	225	0	15	15	160	North	0	
18	-3	-4	5	303	12	24	27	133	South	7	N
19	0	-32	32	340	0	-44	44	340	South	10	N
20	0	-27	27	340	0	-55	55	340	South	23	N
21	0	-51	51	340	0	-30	30	340	South	23	N
22	6	19	20	143	0	-16	16	340	South	20	N
23	0	15	15	160	0	-25	25	340	South	20	N
24	10	17	20	70	0	-55	55	340	South	76	N
25	0	36	36	160	0	9	9	160	North	20	S
26	0	16	16	160	0	28	28	160	North	20	S
27	0	102	102	160	0	122	122	160	North	91	S
28	0	41	41	160	0	61	61	160	3	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 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

Feb 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	0855	50	85		94	2.8	1.0200	0.6
2	0730	50	80		146	3.7	1.0220	0.6
3	0805	55	85		19	2.8	1.0229	0.6
4	0815	110			5	3.3	1.0239	2.1
5	1020	105			9	4.4	1.0254	0.9
6	1055	105			6	4.7	1.0248	2.1
7	0900	50		Radar	2832	4.2	1.0232	2.7
8	0900	75			52	4.7	1.0232	1.8
9	0720	80	130	Inoperative	17	0.6	1.0260	1.5
10	0720	40			137	5.0	1.0231	0.9
11	0745	40	100	all	165	4.2	1.0218	0.6
12	0840	45			162	3.6	1.0229	0.9
13	0750	50		month	76	3.6	1.0236	0.6
14	0735	20	40		12	3.3	1.0230	1.2
15	0830	50			40	3.3	1.0232	1.5
16	0905	none	visible		2	3.8	1.0249	3.0
17	0730	95	50		5	3.3	1.0206	4.0
18	0830	75	65		62	3.6	1.0193	7.6
19	0730	105	80		24	4.4	1.0200	3.4
20	0745	100			125	6.1	1.0166	2.1
21	0830	95			143	6.7	1.0180	2.7
22	0720	40	90		123	6.9	1.0120	1.5
23	0715	90	50		119	6.4	1.0120	2.4
24	0750	100	55		113	6.7	1.0200	1.8
25	0720	40	95		12	7.0	1.0200	2.1
26	0830	120			3	7.2	1.0256	0.9
27	0905	40			122	4.4	1.0235	0.9
28	0730	40			73	4.2	1.0202	0.9

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 Leupold-Stevens digital recording float-type tide gauge is used to collect instantaneous 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.

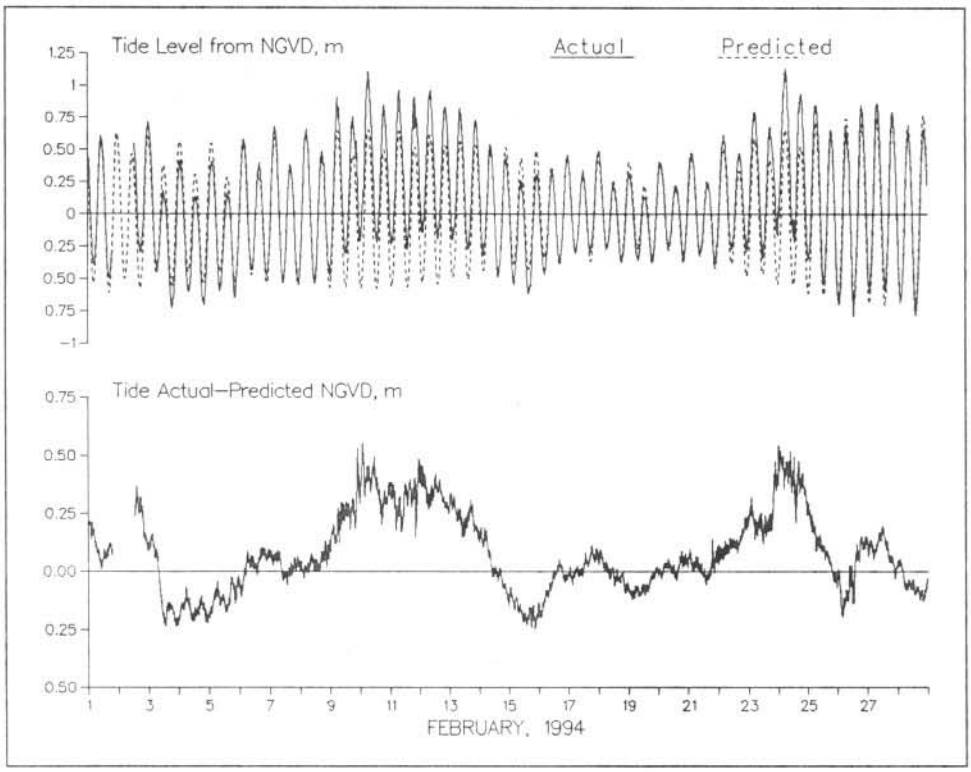

Figure 6. Water Level Time History

Table 8
Water Levels, m NGVD

FEB 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	1024	0.61	1	0506	-0.40	0.12	1.01	15	2318	0.31	15	1548	-0.62	-0.17	0.93
1	1226	No data for this tide cycle						16	1112	0.35	16	0454	-0.47	-0.08	0.82
2	51	No data for this tide cycle						16	2306	0.44	16	1700	-0.38	0.03	0.82
3	0024	0.72	2	1818	-0.31	0.20	1.02	17	1136	0.34	17	0524	-0.30	0.01	0.65
3	0242	0.44	3	0654	-0.42	-0.07	0.86	18	0030	0.49	17	1724	-0.30	0.09	0.79
4	0118	0.41	3	1906	-0.73	-0.18	1.14	18	1124	0.24	18	0618	-0.28	-0.01	0.52
4	0336	0.19	4	0800	-0.60	-0.20	0.80	19	0042	0.32	18	1824	-0.38	-0.03	0.70
5	0254	0.41	4	2042	-0.70	-0.17	1.11	19	1306	0.13	19	0800	-0.36	-0.09	0.50
5	0424	0.31	5	0848	-0.60	-0.16	0.91	20	0124	0.41	19	1854	-0.38	0.01	0.78
6	0342	0.58	5	2024	-0.64	-0.06	1.23	20	0436	0.22	20	0854	-0.26	0.00	0.48
6	0518	0.47	6	0936	-0.44	0.00	0.90	21	0236	0.48	20	2036	-0.35	0.07	0.83
7	0436	0.68	6	2148	-0.48	0.06	1.15	21	0524	0.28	21	0930	-0.33	-0.01	0.61
7	0606	0.56	7	1100	-0.54	-0.03	1.10	22	0412	0.61	21	2042	-0.39	0.10	1.01
8	0548	0.66	7	2306	-0.53	0.02	1.18	22	1648	0.48	22	1018	-0.27	0.11	0.75
8	0654	0.54	8	1236	-0.52	0.01	1.06	23	0430	0.80	22	2212	-0.30	0.25	1.10
9	0600	0.91	9	0012	-0.48	0.15	1.39	23	1718	0.68	23	1106	-0.34	0.20	1.02
9	1900	0.76	9	1218	-0.31	0.23	1.07	24	0548	1.13	23	2330	-0.17	0.48	1.30
10	0654	1.11	10	0006	-0.22	0.42	1.32	24	1830	0.93	24	1248	-0.22	0.40	1.15
10	0842	0.88	10	1354	-0.23	0.34	1.11	25	0554	0.85	24	2348	-0.36	0.26	1.21
11	0736	0.97	11	0106	-0.24	0.32	1.21	25	1848	0.65	25	1242	-0.53	0.08	1.19
11	1954	0.91	11	1354	-0.28	0.32	1.19	26	0706	0.66	26	0100	-0.70	-0.05	1.36
12	0848	0.97	12	0142	-0.15	0.40	1.11	26	1918	0.85	26	1300	-0.80	0.06	1.64
12	2048	0.83	12	1436	-0.20	0.34	1.03	27	0800	0.86	27	0136	-0.59	0.14	1.45
13	0836	0.83	13	0224	-0.20	0.29	1.03	27	2012	0.79	27	1412	-0.60	0.11	1.39
13	2112	0.73	13	1524	-0.28	0.23	1.01	28	0830	0.65	28	0254	-0.66	-0.01	1.32
14	0906	0.54	14	0330	-0.33	0.13	0.87	28	2142	0.66	28	1454	-0.78	-0.05	1.44
14	2148	0.43	14	1518	-0.49	-0.02	0.92	28	2342	0.28	28	2354	0.22	0.25	0.05
15	1006	0.26	15	0424	-0.55	-0.12	0.81								

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 1994 and the survey(s) in February 1994 on profile line 188, located 517 m south of the pier.

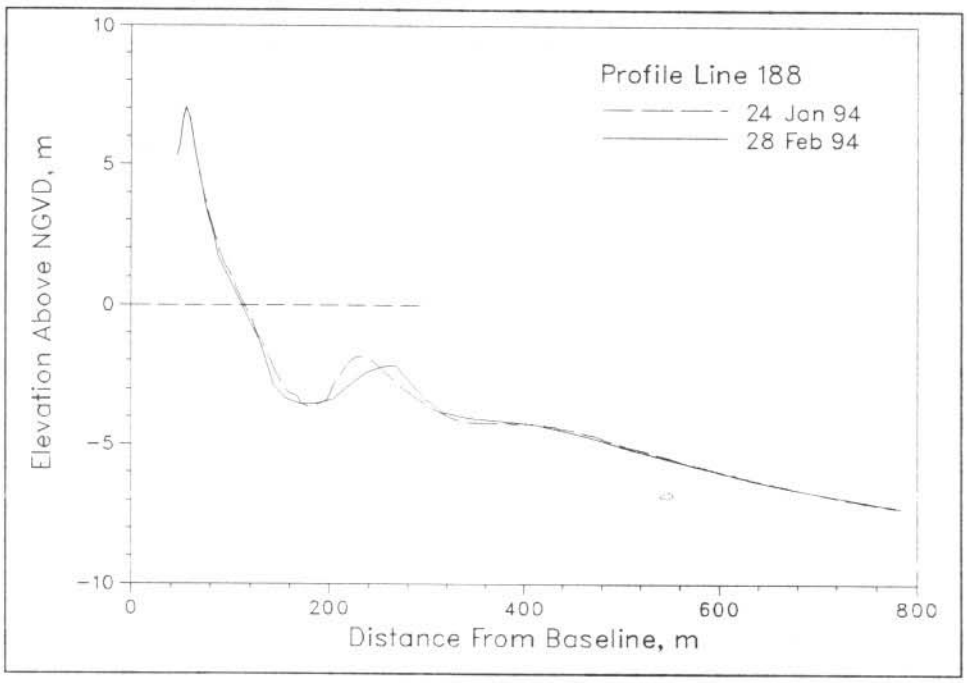

Figure 7. Monthly CRAB Profiles on Profile Line 188.

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

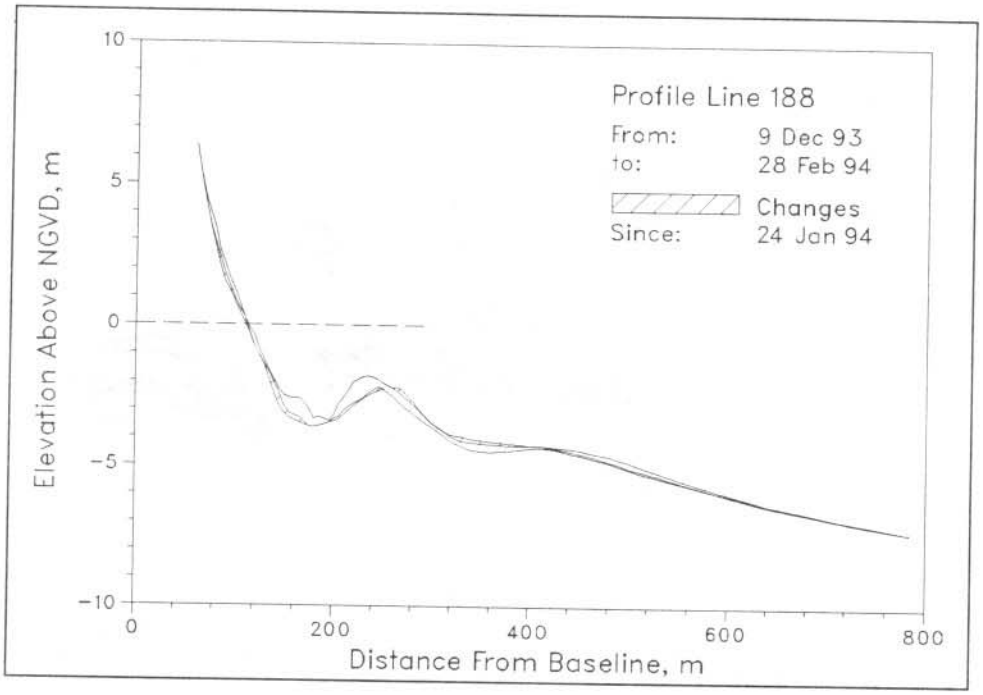

Figure 8. Profile Envelope - Profile Line 188.

B. Bathymetry. Figure 9 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 24 January. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition. There was no bathymetric survey in February. Figure 9 is included for reference only.

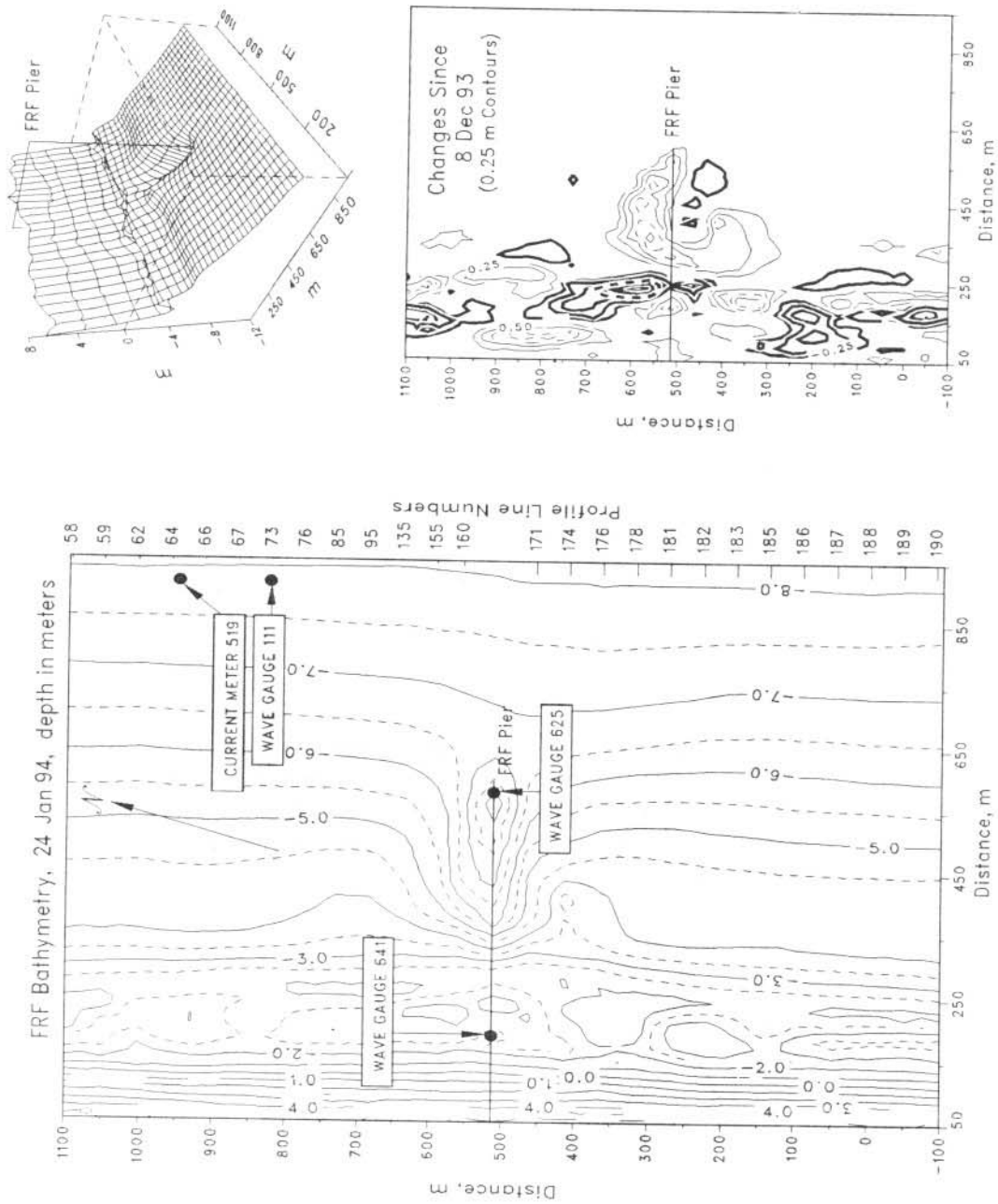

Figure 9. FRF Bathymetry, Depths Relative to NGVD

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)