HURRICANE FRAN HIGH WATER MARKS AND INUNDATION MAPPING

Purpose

Hurricane Fran made landfall along the North Carolina coast in the vicinity of Carolina Beach, NC on September 5, 1996. As a result of this storm, The Wilmington District of the Corps of Engineers (COE) was tasked by the Federal Emergency Management Agency (FEMA) to locate high water marks along the coastal area impacted by the storm and produce inundation mapping based on these high water marks. The purpose of this report is to present the high water mark data and the inundation maps produced using this data.

High Water Marks

High water mark data was collected following the hurricane at various locations along the coastal areas of North Carolina impacted by the surge from Hurricane Fran. This data was collected by personnel from three organizations. Dewberry and Davis, a consulting engineering firm under contract to FEMA, collected preliminary data on the coastal beaches immediately following the storm. The data they collected was compiled in a report for FEMA titled Hurricane Fran North Carolina High Water Mark Survey and Coastal Inundation Mapping, dated September, 1996. The U.S. Geological Survey (USGS) also collected high water mark data along the beaches following the storm. The COE was tasked with the mission of collecting additional high water marks where needed and producing inundation maps. Most of the data collected by the COE was in areas which were inaccessible immediately following the storm and along the coastal creeks along the west side of the Atlantic Intracoastal Waterway(AIWW) impacted by the storm surge. Data was collected from Southport, NC north to Beaufort, NC. In collecting the high water marks an attempt was made to collect both inside and outside marks. A total of 211 high water marks were collected.

Method of Collection High water data was collected based on visual observations by personnel who were familiar with collection of highwater mark data. The high water marks were identified in the field and the location along with other pertinent information was described on data forms. A Picture of the high water mark was taken at each location.

Coordinates The geographic location of the HWM's were described using latitude and longitude. The coordinates of the high water marks were determined in the field using the Geographic Positioning System(GPS). The coordinates of the marks taken by Dewberry and Davis were determined based on a dual frequency Differential Geographic Positioning System(DGPS). The procedure is described in their report. The coordinates of the marks taken by the USGS and COE were determined using a hand held GPS unit. The locations were later verified in the office with the use of topographic maps.

Elevations: Elevation of high water marks taken by Dewberry and Davis were determined using DGPS as mentioned above and described in their report. The elevation of marks taken by the USGS and COE were determined using conventional survey methods. Bench mark elevation data from USGS and various other sources was obtained and used for vertical control. Elevations were obtained by conventional leveling using two 2 man survey teams. Representatives of the COE were in the field with the survey teams to coordinate the effort.

Table 1 summarizes the pertinent data for each high water mark obtained. Data on the HWM's along with pictures are shown in sections 2 through 9 of the report. HWM field numbers shown in the table can be used to cross reference the data sheets.

Table 1
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
SOUTHPORT-KURE BEACH-CAROLINA BEACH AREA								
1	hwm 2010	O	Debris	Southport	33°55’01.38282”	78°01’04.07487”	5.4	Dewberry and Davis
2	hwm 2011	O	Debris	Southport	33°53’59.41651”	78°03’51.12476”	11.2	Dewberry and Davis
3	hwm 2013	O	Debris	Southport	33°53’59.41651”	78°03’51.30939”	12.2	Dewberry and Davis
4	NH-2F	O	Mud	Kure Beach	33°57’51.11887	77°55’17.31822’	8.4	U.S. Geological Survey
5	hwm2014	O	Debris	Kure Beach	33°58’10.66001”	77°55’08.05241”	12.5	Dewberry and Davis
6	NH-60-KB	I	Mud	Kure Beach	33°58’25.92355”	77°54’52.85720”	14.1	U.S. Army Corps of Engineers
7	NP-3P	O	Debris	Kure Beach	33°58’51.55023”	77°54’48.18686”	14.0	U.S. Geological Survey
8	NH-4P	O	Mud	Kure Beach	33°58’54.67583”	77°54’42.74307”	14.8	U.S. Geological Survey
9	NH-61-KB	I	Mud	Kure Beach	33°59’00.65651”	77°54’42.32002”	14.0	U.S. Army Corps of Engineers
10	hmw2018	O	Debris	Kure Beach	33°59’12.64196”	77°54’42.01731”	15.1	Dewberry and Davis
11	NH-5F	O	Mud	Kure Beach	33°59’15.81296”	77°54’37.14494”	14.5	U.S. Geological Survey
12	hwm2017	O	Debris	Kure Beach	33°59’21.23023”	77°54’36.26851”	15.4	Dewberry and Davis
13	hwm2015	O	Debris	Kure Beach	33°59’32.48636”	77°54’33.77071”	15.3	Dewberry and Davis
14	NH-6P-B	O	Debris	Carolina Beach	34°00’19.38965”	77°54’14.67800”	15.2	U.S. Geological Survey
15	NH-6P-C	O	Mud	Carolina Beach	34°00’20.04577”	77°54’13.95665”	14.9	U.S. Geological Survey
16	NH-6P-A	O	Debris	Carolina Beach	34°00’22.04308”	77°54’14.93977”	10.3	U.S. Geological Survey
17	NH-8P	O	Mud	Carolina Beach	34°00’42.57287”	77°54’04.64222”	13.5	U.S. Geological Survey
18	NH-7G	O	Mud	Carolina Beach	34°00’40.51155”	77°54’04.23011”	13.2	U.S. Geological Survey
19	NH-9P	O	Mud	Carolina Beach	34°00’42.34586”	77°54’03.62369”	13.6	U.S. Geological Survey
20	NH-62-CB	I	Mud	Carolina Beach	34°00’58.80906”	77°53’57.52466”	13.5	U.S. Army Corps of Engineers
21	NH-11P	0	Mud	Carolina Beach	34°01’27.76556”	77°53’44.99743”	11.5	U.S. Geological Survey
22	NH-10G	O	Mud	Carolina Beach	34°01’28.76047”	77°53’47.75225”	9.0	U.S. Geological Survey

Table 1 - continued
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft,msl)	Obtained By
SOUTHPORT-KURE BEACH-CAROLINA BEACH AREA-Continued								
23	hmw2021	I	Mud	Carolina Beach	34°01’34.57467’	77°53’44.43306”	9.8	Dewberry and Davis
24	hwm2022	O	Mud	Carolina Beach	34°01’34.57480”	77°53’44.43260”	9.9	Dewberry and Davis
25	NH-12F	O	Mud	Carolina Beach	34°01’36.15060”	77°53’58.54808”	8.7	U.S. Geological Survey
26	hwm2023	I	Mud	Carolina Beach	34°01’36.52508”	77°53’56.32880”	9.9	Dewberry and Davis
27	NH-13P	O	Mud	Carolina Beach	34°02’01.27577”	77°53’32.87011”	9.5	U.S. Geological Survey
28	NH-14G	O	Mud	Carolina Beach	34°02’03.43045”	77°53’42.27529”	9.1	U.S. Geological Survey
29	NH-15F	O	Mud	Carolina Beach	34°02’27.73558”	77°53’24.23328”	10.5	U.S. Geological Survey
30	NH-16F	O	Mud	Carolina Beach	34°02’26.79605”	77°53’22.13079”	9.6	U.S. Geological Survey
31	NH-63-CB	I	Mud	Carolina Beach	34°02’57.17433”	77°53’31.70492”	10.1	U.S. Army Corps of Engineers
32	NH-18F	O	Mud	Carolina Beach	34°03’13.41853”	77°53’09.57214”	10.2	U.S. Geological Survey
33	NH-17E	O	Mud	Carolina Beach	34°03’24.08027”	77°52’56.68776”	10.7	U.S. Geological Survey
34	hwm2026	I	Mud	Carolina Beach	34°03’29.32635”	77°52’56.16151”	10.0	Dewberry and Davis
35	hwm2027	I	Mud	Carolina Beach	34°03’29.46301”	77°52’53.85263”	11.1	Dewberry and Davis
36	hwm2028	O	Mud	Carolina Beach	34°03’29.59386”	77°52’53.87509”	11.1	Dewberry and Davis
SOUTHERN NEW HANOVER COUNTY								
37	NH-49-NH	O	Mud	Wrightsville Beach	34°07’54.80”	77°52’10.95”	11.1	U.S. Army Corps of Engineers
38	NH-70-NH	O	Debris	Wrightsville Beach	34°09’22.35”	77°51’22.47”	11.1	U.S. Army Corps of Engineers
39	NH-55-NH	I	Mud	Wrightsville Beach	34°09’22.38”	77°51’26.04”	11.2	U.S. Army Corps of Engineers
40	NH-51-NH	O	Debris	Wrightsville Beach	34°09’33.64”	77°52’01.73”	11.0	U.S. Army Corps of Engineers
41	NH-52-NH	O	Debris	Wrightsville Beach	34°09’37.92”	77°52’04.56”	11.0	U.S. Army Corps of Engineers
42	NH-53-NH	O	Debris	Wrightsville Beach	34°09’38.22”	77°52’07.02”	11.6	U.S. Army Corps of Engineers
43	NH-58-WI	I	Mud	Wrightsville Beach	34°11’19.92”	77°52’06.30”	11.1	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
SOUTHERN NEW HANOVER COUNTY								
44	NH-57-WI	I	Mud	Wrightsville Beach	34°11’42.54”	77°51’58.32”	10.9	U.S. Army Corps of Engineers
45	NH-56-WI	I	Mud	Wrightsville Beach	34°11’42.82”	77°51’57.96”	12.2	U.S. Army Corps of Engineers
46	NH-64-WI	I	Mud	Wrightsville Beach	34°11’50.83”	77°51’47.90”	11.9	U.S. Army Corps of Engineers
47	NH-65-WI	I	Mud	Wrightsville Beach	34°11’50.53”	77°51’47.91”	12.3	U.S. Army Corps of Engineers
48	NH-68-NH	I	Mud	Wrightsville Beach	34°11’54.36”	77°49.35.04”	10.4	U.S. Army Corps of Engineers
49	NH-66-NH	I	Mud	Wrightsville Beach	34°11’57.54”	77°49’48.06”	10.8	U.S. Army Corps of Engineers
50	NH-67-NH	I	Mud	Wrightsville Beach	34°11’58.68”	77°49’47.70”	10.5	U.S. Army Corps of Engineers
51	NH-69-NH	I	Mud	Wrightsville Beach	34°12’48.78”	77°49’54.72”	10.9	U.S. Army Corps of Engineers
WRIGHTSVILLE SOUND-WRIGHTSVILLE BEACH AREA								
52	NH-75-WB	O	Debris	Wrightsville Beach	34°12’50.40”	77°49’04.56”	10.6	U.S. Army Corps of Engineers
53	NH-74-WB	O	Mud	Wrightsville Beach	34°12’56.69”	77°48’56.22”	10.7	U.S. Army Corps of Engineers
54	NH-73-WB	I	Mud	Wrightsville Beach	34°12’56.93”	77°48’57.12”	10.6	U.S. Army Corps of Engineers
55	NH-72-WB	I	Mud	Wrightsville Beach	34°13”00.29”	77°48’53.53”	10.5	U.S. Army Corps of Engineers
56	NH-76-WB	O	Debris	Wrightsville Beach	34°13’05.61”	77°48’47.99”	10.8	U.S. Army Corps of Engineers
57	wr2007	O	Debris	Wrightsville Beach	34°13’08.96461”	77°48’49.95187”	10.6	Dewberry and Davis
58	NH-38G	O	Mud	Wrightsville Beach	34°12’28.69988”	77°48’16.44004”	10.2	U.S. Geological Survey
59	NH-70-WB	I	Mud	Wrightsville Beach	34°12’28.46770”	77°48’08.07292”	10.3	U.S. Army Corps of Engineers
60	NH-39G	O	Mud	Wrightsville Beach	34°12’26.89778”	77°48’07.38131”	10.0	U.S. Geological Survey
61	wr1003	I	Mud	Wrightsville Beach	34°12’38.61291”	77°47’54.07096”	9.5	Dewberry and Davis
62	wr1004	O	Mud	Wrightsville Beach	34°12’38.61507”	77°47’54.07518”	11.0	Dewberry and Davis
63	NH-40F	O	Mud	Wrightsville Beach	34°12’56.69431”	77°47’45.79993”	10.5	U.S. Geological Survey
64	NH-32G	I	Mud	Wrightsville Beach	34°11’20.53121”	77°48’44.15260”	10.3	U.S. Geological Survey

Table 1 - continued
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
WRIGHTSVILLE SOUND-WRIGHTSVILLE BEACH AREA-continued								
65	wr1012	O	Debris	Wrightsville Beach	34°11’19.79831”	77°48’35.41748”	10.7	Dewberry and Davis
66	wr1011	I	Mud	Wrightsville Beach	34°11’20.35347”	77°48’36.80383”	10.7	Dewberry and Davis
67	wr1013	I	Mud	Wrightsville Beach	34°11’21.13817”	77°48’34.49076”	10.6	Dewberry and Davis
68	wr1014	I	Mud	Wrightsville Beach	34°11’21.60020”	77°48’40.29231”	10.9	Dewberry and Davis
69	NH-54-WB	O	Mud	Wrightsville Beach	34°11’31.78862”	77°48’30.24077”	10.2	U.S. Army Corps of Engineers
70	wr1005	I	Mud	Wrightsville Beach	34°12’33.25027”	77°47’41.57267”	9.3	Dewberry and Davis
71	wr1006	O	Mud	Wrightsville Beach	34°12’33.10967”	77°47’41.68870”	10.7	Dewberry and Davis
72	wr1007	I	Mud	Wrightsville Beach	34°12’33.36276”	77°47’42.29988”	10.7	Dewberry and Davis
73	NH-55-WB	O	Mud	Wrightsville Beach	34°11’33.37931”	77°48’32.02729”	10.4	U.S. Army Corps of Engineers
74	NH-33G	O	Mud	Wrightsville Beach	34°11’49.73886”	77°48’14.95701”	10.2	U.S. Geological Survey
75	NH-53-WB	I	Mud	Wrightsville Beach	34°12’24.55992”	77°47’46.38811”	10.2	U.S. Army Corps of Engineers
76	NH-51-WB	O	Mud	Wrightsville Beach	34°12’31.94054”	77°47’42.55349”	10.1	U.S. Army Corps of Engineers
77	NH-31G	O	Mud	Wrightsville Beach	34°13’20.16793”	77°47’20.24605”	10.5	U.S. Geological Survey
78	NH-37P	O	Mud	Wrightsville Beach	34°12’47.75249”	77°47’24.34200”	11.6	U.S. Geological Survey
79	NH-36F	O	Mud	Wrightsville Beach	34°12’49.98912”	77°47’28.34589”	10.1	U.S. Geological Survey
80	NH-35F	O	Mud	Wrightsville Beach	34°12’53.03768”	77°47’34.38610”	10.3	U.S. Geological Survey
81	NH-34P	O	Mud	Wrightsville Beach	34°12’54.99915”	77°47’36.61988”	10.2	U.S. Geological Survey
82	NH-26F	O	Mud	Wrightsville Beach	34°13’04.44328”	77°47’18.71456”	10.6	U.S. Geological Survey
83	NH-28F	O	Mud	Wrightsville Beach	34°13’01.70204”	77°47’17.63547”	9.4	U.S. Geological Survey
84	NH-27G	O	Mud	Wrightsville Beach	34°13’02.61297”	77°47’17.71735”	10.8	U.S. Geological Survey
85	NH-30E	O	Mud	Wrightsville Beach	34°13’11.69381”	77°47’19.63218”	10.3	U.S. Geological Survey
86	NH-50-WB	I	Mud	Wrightsville Beach	34°13’21.18548”	77°47’20.11202”	10.4	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
WRIGHTSVILLE SOUND-WRIGHTSVILLE BEACH AREA-continued								
87	NH-29E	O	Mud	Wrightsville Beach	34°13’26.22552”	77°47’23.51546”	10.3	U.S. Geological Survey
88	wr2003	I	Mud	Wrightsville Beach	34°13’25.61844”	77°47’06.58416”	10.8	Dewberry and Davis
89	wr2004	O	Mud	Wrightsville Beach	34°13’25.61910”	77°47’06.58427”	11.1	Dewberry and Davis
90	wr2005	I	Mud	Wrightsville Beach	34°13’26.76112”	77°47’06.62424”	10.7	Dewberry and Davis
91	wr2006	I	Mud	Wrightsville Beach	34°13’26.48461”	77°47’03.90724”	11.3	Dewberry and Davis
92	NH-23G	O	Mud	Wrightsville Beach	34°13’31.47157”	77°47’04.32394”	10.1	U.S. Geological Survey
93	NH-25F	O	Mud	Wrightsville Beach	34°13’29.69894”	77°46’57.33549”	10.4	U.S. Geological Survey
94	NH-24F	O	Mud	Wrightsville Beach	34°13’29.91997”	77°47’00.58347”	10.2	U.S. Geological Survey
95	NH-22E	I	Mud	Wrightsville Beach	34°13’49.86164”	77°46’45.88991”	10.3	U.S. Geological Survey
96	NH-21G	O	Mud	Wrightsville Beach	34°13’51.75267”	77°46’47.98193”	10.4	U.S. Geological Survey
97	NH-19E	I	Mud	Wrightsville Beach	34°14’06.55221”	77°46’35.44718”	10.4	U.S. Geological Survey
98	NH-20P	O	Debris	Wrightsville Beach	34°14’09.18177”	77°46’32.37088”	10.8	U.S. Geological Survey
NORTHERN NEW HANOVER COUNTY								
99	NH-83-MS	I	Mud	Scotts Hill	34°15’19.86”	77°47’44.34”	8.7	U.S. Army Corps of Engineers
100	NH-81-MS	I	Mud	Scotts Hill	34°15’30.12”	77°46’47.10”	11.3	U.S. Army Corps of Engineers
101	NH-82-MS	I	Mud	Scotts Hill	34°15’30.12”	77°46’47.10”	10.9	U.S. Army Corps of Engineers
102	NH-85-MS	I	Mud	Scotts Hill	34°15’55.32”	77°46’23.22”	11.1	U.S. Army Corps of Engineers
103	NH-84-MS	O	Debris	Scotts Hill	34°16’31.52”	77°46’45.81”	11.5	U.S. Army Corps of Engineers
104	NH-88-PN	O	Mud	Scotts Hill	34°16’35.52”	77°46’30.24”	11.3	U.S. Army Corps of Engineers
105	NH-87-PN	O	Mud	Scotts Hill	34°16’36.72”	77°45’42.18”	11.3	U.S. Army Corps of Engineers
106	NH-86-MS	O	Mud	Scotts Hill	34°16’37.98”	77°48’01.92”	12.1	U.S. Army Corps of Engineers
107	NH-86A-MS	O	Mud	Scotts Hill	34°16’38.10”	77°47’58.38”	11.3	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
NORTHERN NEW HANOVER COUNTY-continued								
111	NH-89-PN	I	Mud	Scotts Hill	34°18'00.72"	77°44'33.48"	12.1	U.S. Army Corps of Engineers
FIGURE EIGHT ISLAND								
108	NH-102-PN	I	Mud	Scotts Hill	34°15'15.00"	77°45'28.80"	12.2	U.S. Army Corps of Engineers
109	NH-100-PN	I	Mud	Scotts Hill	34°15'26.76"	77°45'23.58"	10.5	U.S. Army Corps of Engineers
110	NH-107-PN	I	Mud	Scotts Hill	34°15'41.58"	77°45'09.00"	10.4	U.S. Army Corps of Engineers
112	NH-101-PN	O	Debris	Scotts Hill	34°16'17.78"	77°44'54.24"	10.9	U.S. Army Corps of Engineers
113	f8i 1018	I	Mud	Hampstead	34°16'16.74826"	77°44'32.64324"	12.7	Dewberry and Davis
114	NH-104-PN	I	Mud	Hampstead	34°16'22.80"	77°44'29.28"	10.8	U.S. Army Corps of Engineers
115	NH-105-PN	I	Mud	Hampstead	34°16'23.58"	77°44'28.92"	10.4	U.S. Army Corps of Engineers
116	f8i 1017	O	Debris	Hampstead	34°16'23.57256"	77°44'28.91051"	10.0	Dewberry and Davis
117	f8i 1016	I	Mud	Hampstead	34°16'24.98817"	77°44'27.11464"	11.9	Dewberry and Davis
118	f8i 1019	O	Debris	Hampstead	34°16'32.34257"	77°44'42.57412"	11.6	Dewberry and Davis
PENDER COUNTY, NC								
119	PEN-90-SC	O	Mud	Hampstead	34°18'42.53"	77°43'53.62"	11.3	U.S. Army Corps of Engineers
120	PEN-92-WA	O	Debris	Hampstead	34°20'26.64"	77°42'21.66"	11.4	U.S. Army Corps of Engineers
121	PEN-93-WA	O	Mud	Hampstead	34°20'52.20"	77°42'23.40"	11.6	U.S. Army Corps of Engineers
122	PEN-94-HA	O	Debris	Hampstead	34°21'20.82"	77°41'08.34"	11.7	U.S. Army Corps of Engineers
123	hmp 1015	O	Debris	Hampstead	34°21'20.89775"	77°41'06.10811"	12.6	Dewberry and Davis
124	PEN-95-OP	I	Mud	Hampstead	34°22'17.90"	77°40'04.27"	11.2	U.S. Army Corps of Engineers
125	PEN-97-OP	I	Mud	Hampstead	34°22'16.98"	77°39'21.36"	11.1	U.S. Army Corps of Engineers
126	PEN-99-SP	I	Mud	Topsail	34°23'22.56"	77°37'48.96"	9.1	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal North Carolina

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
PENDER COUNTY, NC-continued								
127	PEN-98-SP	O	Mud	Holly Ridge	34°24'24.72"	77°36'15.90"	9.3	U.S. Army Corps of Engineers
128	PEN-100-SP	O	Debris	Holly Ridge	34°24'58.20"	77°36'57.00"	8.2	U.S. Army Corps of Engineers
129	PEN-101-WL	I	Mud	Holly Ridge	34°25'16.86"	77°34'58.50"	9.1	U.S. Army Corps of Engineers
130	tsl 1303	O	Debris	Holly Ridge	34°25'19.84188"	77°35'10.85800"	9.6	Dewberry and Davis
TOPSAIL ISLAND								
	TOPSAIL BEACH							
131	tsl 1024	I	Mud	Holly Ridge	34°25'39.7353"	77°32'39.02698"	8.1	Dewberry and Davis
132	A1	O	Mud	Hampstead	34°20'58.38"	77°38'52.38"	10.3	U.S. Geological Survey
133	A2	O	Mud	Hampstead	34°21'05.34"	77°38'56.40"	10.2	U.S. Geological Survey
134	A3	O	Mud	Hampstead	34°21'08.70"	77°39'00.42"	9.5	U.S. Geological Survey
135	tsl 1023	O	Debris	Hampstead	34°21'42.66183"	77°38'06.31168"	10.7	Dewberry and Davis
136	tsl 1022	I	Mud	Hampstead	34°21'45.90405"	77°38'06.01514"	10.4	Dewberry and Davis
137	B1	O	Mud	Hampstead	34°22'10.14"	77°37'33.54"	8.7	U.S. Geological Survey
138	B3	O	Mud	Hampstead	34°22'11.88"	77°37'36.00"	9.1	U.S. Geological Survey
139	B2	O	Mud	Hampstead	34°22'14.04"	77°37'33.12"	9.2	U.S. Geological Survey
140	C1	O	Debris	Holly Ridge	34°24'06.06"	77°35'01.32"	13.9	U.S. Geological Survey
141	C3	O	Mud	Holly Ridge	34°24'08.64"	77°35'00.96"	8.3	U.S. Geological Survey

Table 1 - continued
Pertinent High Water Mark Data-Coastal, NC

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
TOPSAIL ISLAND-continued								
	SURF CITY, NC							
142	D1	O	Debris	Holly Ridge	34°24’52.38”	77°33’48.60”	11.1	U.S. Geological Survey
143	D3	O	Debris	Holly Ridge	34°24’54.36”	77°33’48.72”	7.8	U.S. Geological Survey
144	E1	O	Debris	Holly Ridge	34°25’33.94”	77°32’44.05”	8.1	U.S. Geological Survey
145	E2	I	Mud	Holly Ridge	34°25’39.00”	77°32’49.68”	7.7	U.S. Geological Survey
146	E3	I	Mud	Holly Ridge	34°25’42.90”	77°32’52.77”	7.7	U.S. Geological Survey
147	tsl 1302	I	Mud	Holly Ridge	34°26’00.04332”	77°33’06.37888”	9.2	Dewberry and Davis
148	tsl 1301	I	Mud	Holly Ridge	34°26’00.46678”	77°33’04.50006”	8.8	Dewberry and Davis
149	PEN-103-SC	I	Mud	Holly Ridge	34°26’01.56”	77°33’06.30”	7.7	U.S. Army Corps of Engineers
150	F1	I	Mud	Holly Ridge	34°26’10.14”	77°31’37.80”	11.2	U.S. Geological Survey
151	F2	I	Mud	Holly Ridge	34°26’15.54”	77°31’39.72”	7.2	U.S. Geological Survey
	NORTH TOPSAIL BEACH							
152	ON-205-NT	I	Mud	Holly Ridge	34°26’40.26”	77°30’50.64”	9.4	U.S. Army Corps of Engineers
153	ON-204-NT	I	Mud	Holly Ridge	34°26’40.44”	77°30’50.46”	8.8	U.S. Army Corps of Engineers
154	ON-203-NT	I	Mud	Holly Ridge	34°27’10.50”	77°31’08.04”	7.2	U.S. Army Corps of Engineers
155	ON-202-NT	I	Mud	Spicer Bay	34°27’21.72”	77°29’37.44”	10.5	U.S. Army Corps of Engineers
156	ON-200-NT	I	Mud	Spicer Bay	34°27’23.28”	77°29’38.64”	8.3	U.S. Army Corps of Engineers
157	ON-201-NT	I	Mud	Spicer Bay	34°27’24.78”	77°29’39.18”	7.2	U.S. Army Corps of Engineers
158	tsl 1020	I	Mud	Spicer Bay	34°27’29.73729”	77°29’23.99367”	11.5	Dewberry and Davis
159	ON-151-NT	I	Mud	Spicer Bay	34°27’38.88”	77°29’03.00”	11.0	U.S. Army Corps of Engineers
160	ON-150-NT	I	Mud	Spicer Bay	34°27’40.20”	77°29’04.68”	7.8	U.S. Army Corps of Engineers
161	ON-111-NT	I	Mud	Spicer Bay	34°28’14.16”	77°27’59.94”	7.9	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal, NC

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangel Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
NORTH TOPSAIL BEACH-continued								
162	ON-110-NT	I	Mud	Spicer Bay	34°28’15.30”	77°27’56.70”	14.6	U.S. Army Corps of Engineers
163	ON-109-NT	I	Mud	Spicer Bay	34°28’17.52”	77°27’58.26”	7.4	U.S. Army Corps of Engineers
164	O-9F	O	Mud	Spicer Bay	34°28’36.00”	77°27’13.68”	9.0	U.S. Geological Survey
165	ON-108-NT	O	Mud	Spicer Bay	34°28’45.30”	77°26’49.68”	12.6	U.S. Army Corps of Engineers
166	ON-107-NT	O	Mud	Spicer Bay	34°28’52.02”	77°26’49.26”	9.9	U.S. Army Corps of Engineers
167	O-8F	O	Mud	Spicer Bay	34°28’59.10”	77°26’52.74”	7.2	U.S. Geological Survey
168	ON-106-NT	O	Mud	Spicer Bay	34°29’07.65”	77°26’05.76”	8.9	U.S. Army Corps of Engineers
169	O-7F	O	Debris	Spicer Bay	34°29’30.18”	77°25’33.12”	8.8	U.S. Geological Survey
170	ON-105-NT	O	Debris	Spicer Bay	34°29’36.60”	77°25’32.40”	6.6	U.S. Army Corps of Engineers
171	O-3F	O	Mud	Spicer Bay	34°29’41.64”	77°24’57.00”	6.4	U.S. Geological Survey
172	O-4F	I	Mud	Spicer Bay	34°29’48.12”	77°24’43.26”	10.1	U.S. Geological Survey
173	O-6F	O	Mud	Sneads Ferry	34°30’04.51”	77°24’04.15”	8.8	U.S. Geological Survey
174	tsl 1021	I	Mud	Sneads Ferry	34°30’05.69617”	77°24’03.15934”	10.9	Dewberry and Davis
175	O-5F	O	Mud	Sneads Ferry	34°30’07.74”	77°24’00.44”	8.6	U.S. Geological Survey
176	tsl 1306	O	Debris	Sneads Ferry	34°30’24.30156”	77°25’57.43703”	8.6	Dewberry and Davis
177	ON-104-NT	I	Mud	Sneads Ferry	34°30’44.46”	77°22’46.44”	7.6	U.S. Army Corps of Engineers
178	ON-103-NT	O	Mud	Sneads Ferry	34°30’41.52”	77°22’43.62”	12.0	U.S. Army Corps of Engineers
179	ON-102-NT	I	Mud	New River Inlet	34°31’03.36”	77°21’54.30”	9.4	U.S. Army Corps of Engineers
180	ON-101-NT	I	Mud	New River Inlet	34°31’05.46”	77°21’55.92”	7.5	U.S. Army Corps of Engineers
182	ON-100-NT	I	Mud	New River Inlet	34°31’43.50”	77°20’41.46”	8.7	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal, NC

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
ONSLOW COUNTY, NC								
183	tsl 1304	O	Debris	Holly Ridge	34°28’16.70391”	77°30’36.34420”	8.8	Dewberry and Davis
184	ON-3A	O	Debris	Holly Ridge	34°28’19.92”	77°30’34.20”	6.9	U.S. Army Corps of Engineers
185	ON-4A	I	Mud	Spicer Bay	34°29’12.90”	77°28’36.90”	8.1	U.S. Geological Survey
186	tsl 1305	O	Debris	Spicer Bay	34°29’14.99212”	77°28’35.56652”	9.4	Dewberry and Davis
181	ON-6A	I	Mud	Sneads Ferry	34°31’20.82”	77°25’27.24”	8.1	U.S. Geological Survey
187	ON-121-ON	I	Mud	Sneads Ferry	34°32’35.22”	77°23’09.48”	9.2	U.S. Army Corps of Engineers
188	ON-8A	I	Mud	New River Inlet	34°32’35.82”	77°21’40.32”	7.3	U.S. Geological Survey
189	tsl 1307	O	Debris	Sneads Ferry	34°34’36.41389”	77°23’56.52506”	7.3	Dewberry and Davis
190	ON-14F	O	Debris	Sneads Ferry	34°34’36.42”	77°24’00.06”	5.4	U.S. Geological Survey
191	hwm 3000	O	Debris	Hubert	34°40’19.00739”	77°08’14.29337”	8.9	Dewberry and Davis
SWANSBORO, NC								
192	CAR-109-SW	I	Mud	Swansboro	34°40’42.54”	77°06’30.72”	7.2	U.S. Army Corps of Engineers
193	hwm 2029	O	Debris	Swansboro	34°40’46.85708”	77°04’02.43145”	7.4	Dewberry and Davis
194	hwm 3001	O	Debris	Swansboro	34°41’16.16202”	77°07’01.83573”	8.1	Dewberry and Davis
195	ON-12F	O	Mud	Swansboro	34°41’13.68”	77°07’12.96”	8.4	U.S. Geological Survey
196	ON-10F	I	Mud	Swansboro	34°41’12.30”	77°07’05.28”	7.9	U.S. Geological Survey
197	ON-11F	O	Debris	Swansboro	34°41’15.66”	77°07’01.80”	8.6	U.S. Geological Survey
EMERALD ISLE, NC								
198	hwm 2030	O	Debris	Swansboro	34°38’41.69710”	77°05’52.30890”	7.3	Dewberry and Davis
199	CAR-101-EI	I	Debris	Swansboro	34°38’48.42”	77°05’50.82”	7.5	U.S. Army Corps of Engineers
200	CAR-100-EI	O	Debris	Swansboro	34°39’13.50”	77°03’50.16”	11.4	U.S. Army Corps of Engineers

Table 1 - continued
Pertinent High Water Mark Data-Coastal NC

HWM ID	HWM Field Number	Inside(I) or Outside(O)	Type Line	Quadrangle Sheet	Latitude	Longitude	Elevation (ft, msl)	Obtained By
EMERALD ISLE, NC-continued								
201	CAR-102-EI	O	Debris	Swansboro	34°40’00.42”	77°03’46.53”	7.0	U.S. Army Corps of Engineers
202	CAR-103-EI	O	Debris	Salter Path	34°40’29.20”	76°58’57.99”	7.1	U.S. Army Corps of Engineers
203	CAR-104-EI	O	Debris	Salter Path	34°40’28.05”	77°59’06.04”	6.2	U.S. Army Corps of Engineers
204	CAR-105-EI	I	Mud	Salter Path	34°40’48.78”	76°55’33.41”	11.5	U.S. Army Corps of Engineers
205	CAR-106-EI	I	Debris	Salter Path	34°40’55.68”	76°54’48.05”	6.1	U.S. Army Corps of Engineers
FORT MACON, NC								
206	ftm 1029	O	Debris	Beaufort	34°41’42.53932”	76°40’40.97776”	5.9	Dewberry and Davis
MOREHEAD CITY-BEAUFORT, NC								
207	mhc 1030	O	Debris	Mansfield	34°43’31.45305”	76°47’04.70947”	7.3	Dewberry and Davis
208	mc 1025	I	Mud	Beaufort	34°43’10.46738”	76°42’55.78974”	5.2	Dewberry and Davis
209	mc 1026	O	Debris	Beaufort	34°43’11.97029”	76°42’56.68453”	4.8	Dewberry and Davis
210	mc 1027	O	Debris	Beaufort	34°43’09.27416”	76°42’59.16731”	4.9	Dewberry and Davis
211	buf 1028	O	Debris	Beaufort	34°42’46.93747”	76°39’28.83090”	4.5	Dewberry and Davis

Inundation Mapping

Storm surge mapping was accomplished using the Arc-Info 7.04 Unix Geographic Information System (GIS) software and constructed GIS datasets. The base GIS datasets were obtained from the State of North Carolina Center for Geographic Information and Analysis (NCCGIA) and consisted of the following:

1. NC County Lines
2. NC Roads (primary and secondary)
3. NC Hydrography (water and land)

These datasets were used for the overall base mapping of the inundated areas.

The inundation line for the storm was developed using USGS 1:24000 scale quadrangle sheets. The line was first delineated on the quad sheets utilizing the HWM elevations and locations obtained in the field. The line was then digitized and entered into the Arc-Info data base and overlaid on the base maps. HWM location points collected in the field were also converted to a GIS dataset and overlaid on the maps. The limits of mapping for the inundation line were set at points where the inundation became insignificant.

Listed below are the Quadrangle sheets use to produce the inundation limits.

Table 2
USGS Quadrangle Sheets Utilized

Southport, NC	Spicer Bay, NC
Kure Beach, NC	Sneads Ferry, NC
Carolina Beach, NC	New River Inlet, NC
Wrightsville Beach, NC	Hubert, NC
Scotts Hill, NC	Browns Inlet, NC
Hampstead, NC	Swansboro, NC
Topsail, NC	Salter Path, NC
Holly Ridge, NC	

The inundation maps are included in section 10 of the report. The maps are printed at a scale of 1:24000 and are identified the by the same name as the USGS quad sheets used to produce the inundation limits. The HWM numbers shown on the map are referenced to Table 1 of this report as HWM ID numbers.

Storm Surge

Tide Levels Tide levels along the North Carolina and South Carolina Coast for the time period during the storm were available at five locations. Location information on the five gages is listed in table 3 below.

Table 3
Tide Gage Data

Gage Name	Gage Locality	Position		Mean Tide Level (ft)	Peak During Fran (ft)
		Latitude	Longitude		
Myrtle Beach, Springmaid Pier	Surfside Beach, SC south of Myrtle Beach, SC	33°39.3’	78°51.1’	2.73	7.3
Wilmington, NC	Cape Fear River at Wilmington, NC	34°14’	77°57’	2.20	7.1
Beaufort, Duke Marine Lab	Duke Marine Lab, Beaufort, NC	34°43’	76°40’	1.60	6.4
Hatteras Ocean Gage	West of Hatteras Inlet	35°12’	75°42’	1.90	4.0
Oregon Inlet	USGG Station at Oregon Inlet	35°46’	75°32’	1.00	2.9

The tide range for the period at each gage is shown graphically in figures 1 through 5.

Storm Surge The storm surge was also recorded at one location along the AIWW by Mr. Spencer Rogers, NC Sea Grant at his residence which is located on the western side of the AIWW between Carolina Beach and Wrightsville Beach, NC. These observations give a very accurate record of the storm surge along the New Hanover County coast line. Table 5 gives the time and elevations associated with the measurements. The plot of the surge is shown on figure 6.

Table 4
Storm Surge Data - Southern New Hanover County

Time in Hours	Elevation (feet, msl)	Time in Hours	Elevation (feet, msl)	Time in Hours	Elevation (feet, msl)
4:30 PM	6.70	7:30 PM	10.74	9:13 PM	10.57
5:00 PM	7.52	7:40 PM	10.16	9:18 PM	10:16
5:54 PM	7.80	8:12 PM	10.74	9:25 PM	9.88
6:07 PM	7.86	8:33 PM	10:16	9:54 PM	9.12
6:41 PM	8.35	8:36 PM	10.74	10:40 PM	7.52
6:48 PM	8.66	8:51 PM	10.99	11:57 PM	5.05
7:23 PM	10.16	9.02 PM	10.74		

Maximum elevation = 11.2 feet, msl

Visual observations recorded by resident:

Waves in middle of canal were less than 6 inches high and short period. At water marks there were no periodic waves but gusting wind deflected off surrounding trees and houses caused typically 3 inches high irregular surges.

WATER LEVEL AT SPRINGMAID PIER

HURRICANE FRAN

SEP 5 - 6, 1996

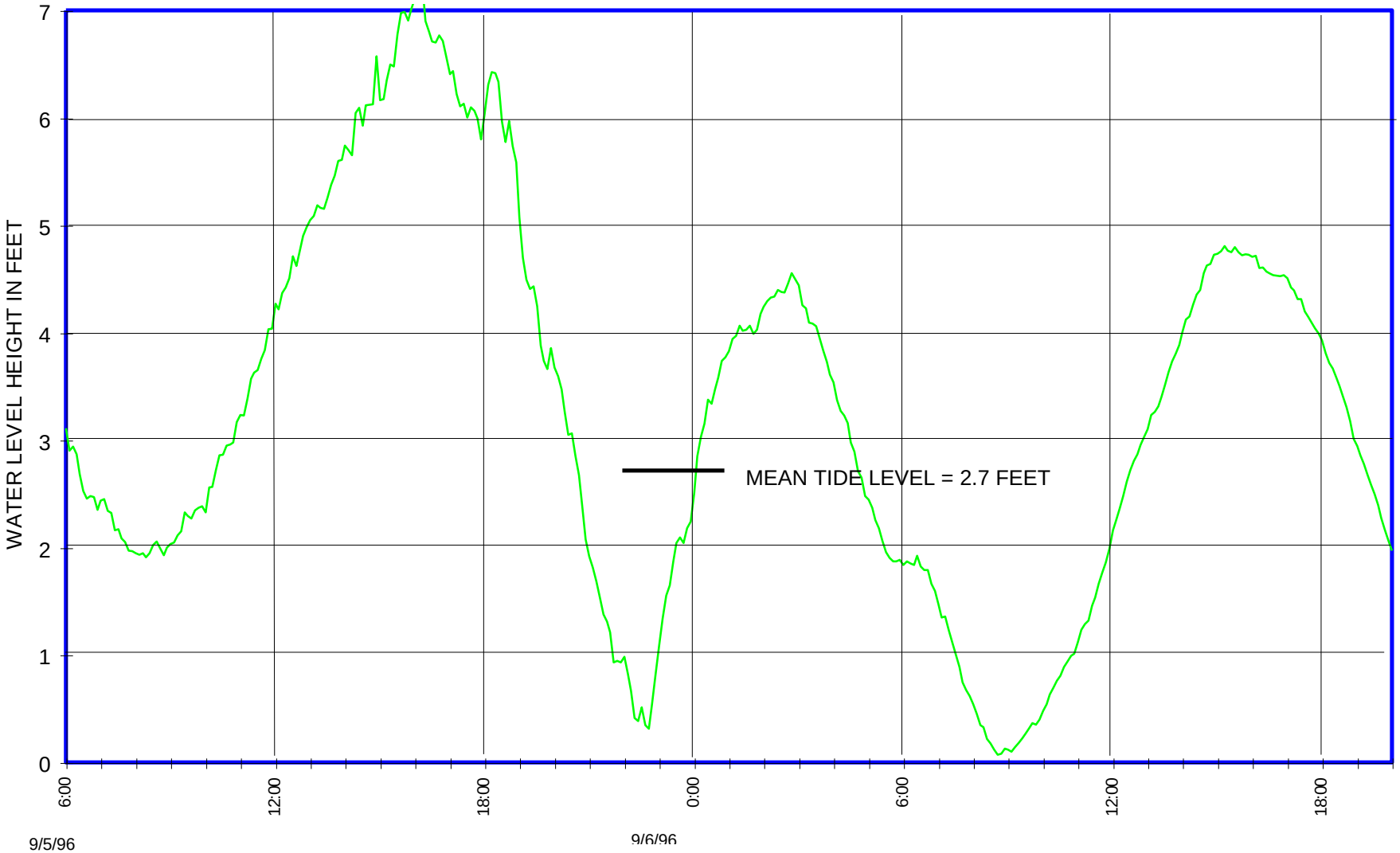


Figure 1

WATER LEVEL AT WILMINGTON

HURRICANE FRAN

SEP 5 - 6, 1996

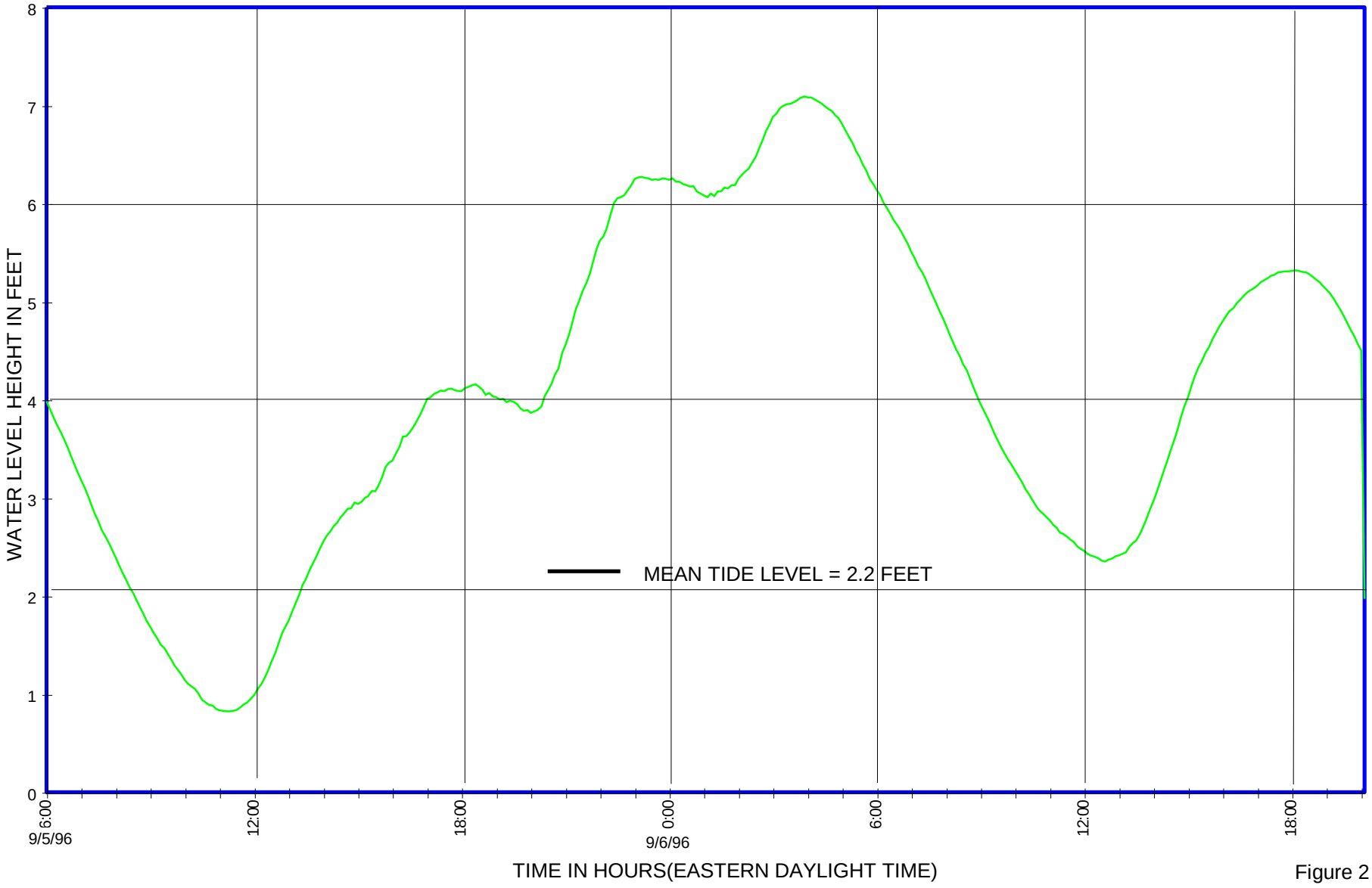


Figure 2

WATER LEVEL DUKE LAB

HURRICANE FRAN

SEP 5 - 7, 1996

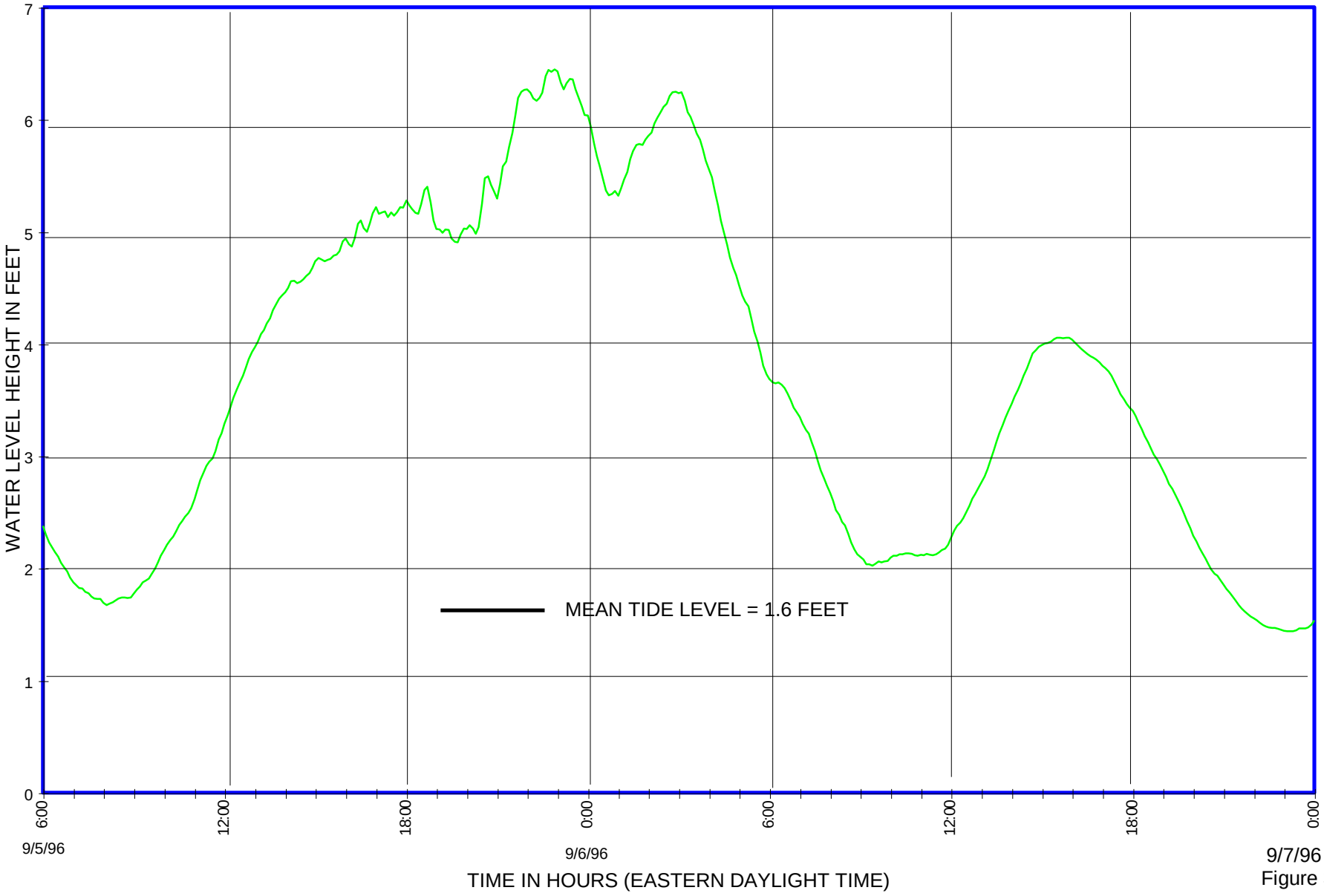


Figure 3

WATER LEVEL HATTERAS NOS GAGE

HURRICANE FRAN

SEP 5 - 7 1996

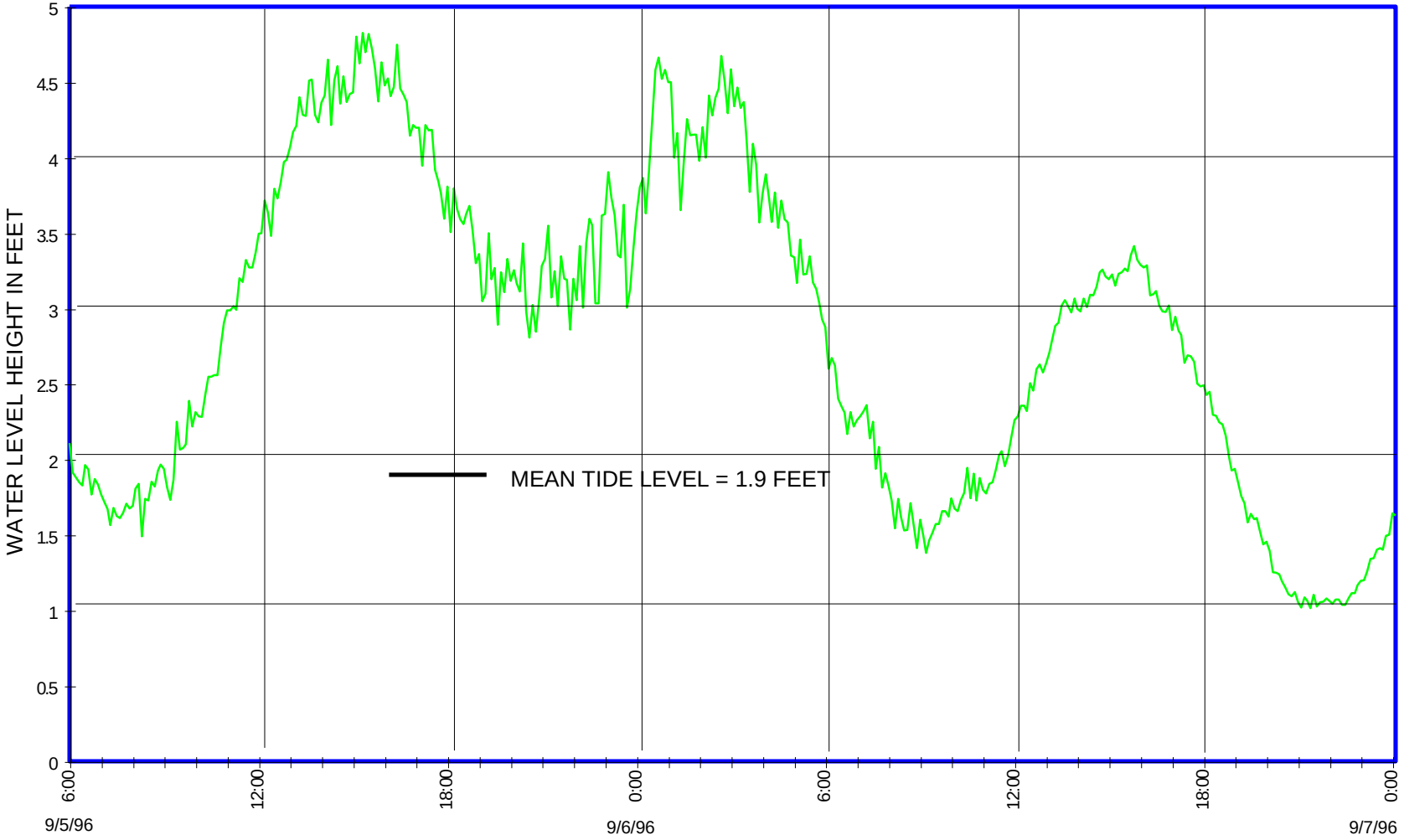


Figure 4

WATER-LEVEL OREGON INLET NOS GAGE

HURRICANE FRAN

SEP 5 - 7, 1996

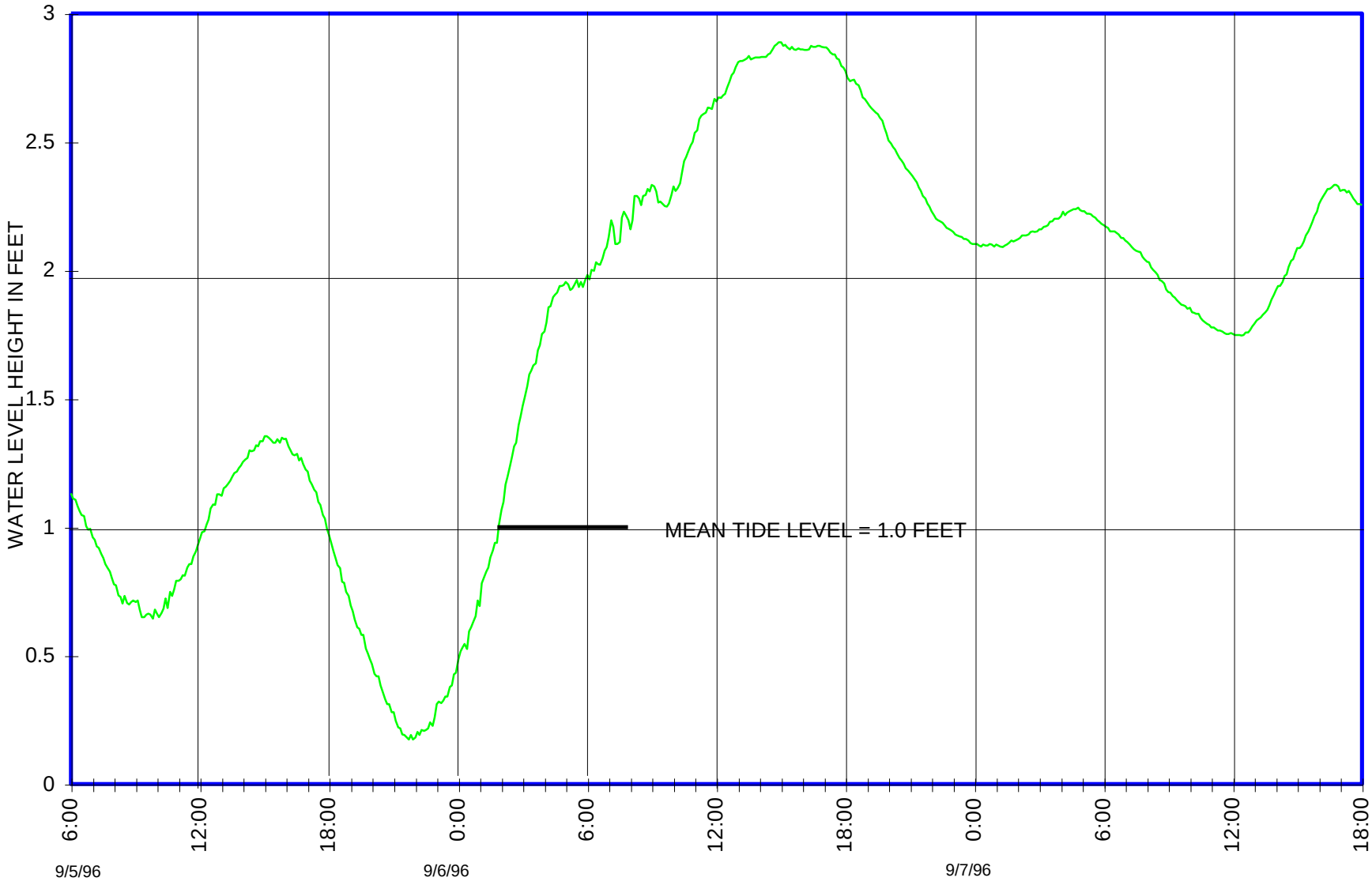
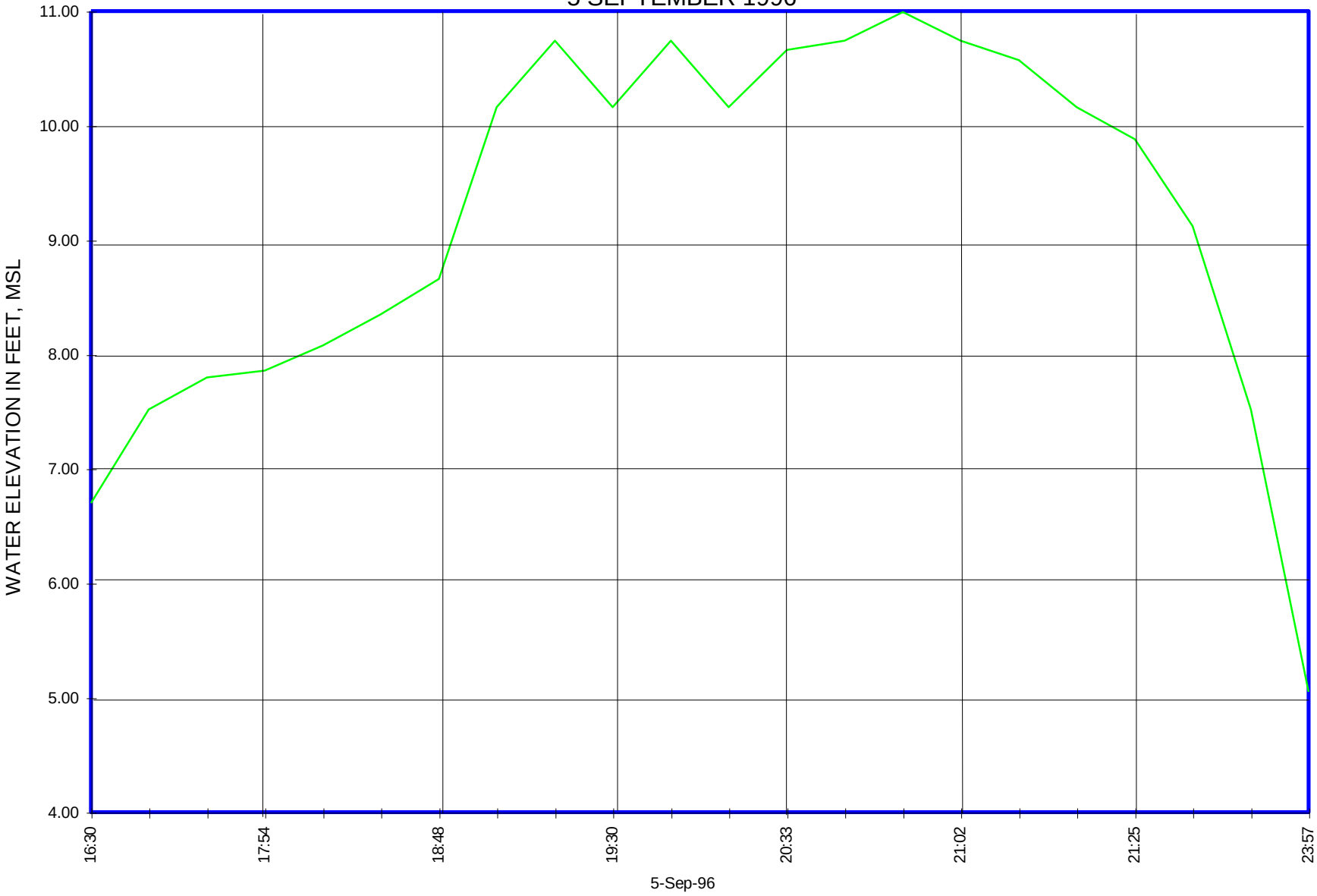


Figure 5

HURRICANE FRAN SURGE

5 SEPTEMBER 1996



SURGE RECORDED BY
SPENCER ROGERS AT RESIDENCE

TIME IN HOURS (EASTERN DAYLIGHT TIME)

Figure 6

Stream Gages

There are no USGS recording stream gages in the coastal area impacted by the storm which would have recorded the storm surge. There are however gages on all of the major inland rivers which recorded stream flow data during the storm which show the effects of the rainfall associated with the storm on the inland rivers and streams. Data was furnished by the USGS at the gages shown in table 5.

Table 5

USGS Gages

Gage Location	Drainage Area (sq. mi)	September Discharges (cfs) Mean	Min.	Max.
Tar River near Tar River, NC	167	62.2	.28	671
Neuse River near Falls, NC	771	182	67.8	463
Neuse River near Clayton, NC	1150	339	136	661
Trent River near Trenton, NC	168	122	4.56	1577
New River near Gum Branch, NC	94	86.5	4.25	887
Deep River near Ramseur, NC	349	227	17.7	1934
Deep River at Moncure, NC	1434	740	24.1	10580
Cape Fear River at Fayetteville, NC	4395			
Cape Fear River at William O. Husk L&D	4852	1601	935	2927
Cape Fear River at Lock # 1 nr Kelly, NC	5255	1976	985	3609
Hood Creek near Leland, NC	21.6	27.1	.51	75.1
Black River near Tomahawk, NC	676	544	13.4	3319
Waccamaw River at Freeland, NC	680	621	.31	4825

Tide elevation data was available at the gage at New Bern NC. Data on that gage is given in table 6 below. Plots of the stages and discharges at the above gages during the period of Hurricane Fran are shown in figures 7 through 19.

Table 6

New Bern Gage Data

Mean September Stage (feet)	Min. September Stage (feet)	Max. September Stage (feet)
1.02	2.03	.30

The plot of the stage at the New Bern during the period of Hurricane Fran is shown in figure 20.