STORM-TIDE ELEVATIONS PRODUCED BY HURRICANE ANDREW ALONG THE LOUISIANA COAST, AUGUST 25-27, 1992

U.S. GEOLOGICAL SURVEY
Open-File Report 94-371

Prepared in cooperation with the
FEDERAL EMERGENCY MANAGEMENT AGENCY

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Baton Rouge, Louisiana

1994

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

GORDON P. EATON, Director

For additional information write to:

District Chief
U.S. Geological Survey
3535 S. Sherwood Forest Blvd.
Suite 120
Baton Rouge, LA 70816

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[Plates are in pocket]

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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
foot per second (ft/s)	0.3048	meter per second
mile (mi)	1.609	kilometer
mile per hour (mi/h)	1.609	kilometer per hour

Temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) as follows: $°F = 1.8(°C) + 32$.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Storm-Tide Elevations Produced by Hurricane Andrew along the Louisiana Coast, August 25-27, 1992

By John K. Lovelace

Abstract

Hurricane Andrew made landfall at Point Chevreuil, Louisiana, on August 26, 1992, at approximately 3:30 a.m. The hurricane produced a storm tide that affected much of the Louisiana coastline, including many coastal waterways and lakes hydraulically connected to the coast.

Data were collected on high-water marks, resulting from the storm tide, at 69 sites in coastal areas of southeastern and south-central Louisiana, in addition to the data recorded at 76 gaging stations located near or on the coast. High-water-mark data and gaging-station data are presented on a series of 12 quadrangle maps and in tabular form. Line graphs of time-series data from 24 gaging stations also are presented.

The counter-clock-wise motion of the hurricane winds pushed water landward in areas east of landfall, producing a positive storm tide along the Louisiana coast from the Mississippi State line to landfall. West of landfall, the winds pushed the water seaward, producing a negative storm tide in areas along the Louisiana coast to the Texas State line. The storm tide peaked at 9.3 feet above sea level near Cocodrie, La., and at 8.2 feet above sea level near landfall. Other approximate storm-tide elevations (in feet above sea level) along the Louisiana coast were as follows: Lake Pontchartrain, 4; Breton Sound, 5; Barataria Bay, 4; Grand Isle, 4; Terrebonne Bay, 9; Atchafalaya Bay, 8; East Cote Blanche Bay, 8; Vermilion Bay, -3; and Calcasieu Pass, -1.

INTRODUCTION

Hurricane Andrew made landfall at Point Chevreuil, La., on August 26, 1992, at approximately 3:30 in the morning (Rappaport, 1992). The hurricane struck the sparsely populated coastal area with 115 mi/h sustained winds and hurricane-force winds (greater than or equal to 73 mi/h) extending 70 mi outward from the eye (National Oceanic and Atmospheric Administration, 1992). The path of Andrew through Louisiana and the areal extent of hurricane- and tropical storm-force winds are shown in figure 1. (Tropical storm-force winds have wind speeds greater than or equal to 39 mi/h but less than 73 mi/h.) The U.S. Geological Survey (USGS), in cooperation with the Federal Emergency Management Agency (FEMA), collected elevation data in Louisiana on the storm tide produced by Hurricane Andrew.

Purpose and Scope

This report presents data collected on high-water marks at 69 sites and stage data recorded at 24 gaging stations located on or near the Louisiana coast. Eight of these gages are maintained by the USGS and 16 of the gages are maintained jointly by the USGS and the Louisiana Department of Natural Resources (DNR). In addition, this report presents peak-stage data compiled and provided by the U.S. Army Corps of Engineers (COE) for 52 gaging stations located on or near the coast. Data presented in this study were collected in coastal parishes in Louisiana and the parishes surrounding Lake Pontchartrain. The data presented may be useful for flood-insurance purposes, storm-tide modeling, and planning future development in areas impacted by Hurricane Andrew's storm tide. All data presented in this report are on file at the USGS office in Baton Rouge, Louisiana.

Description of Study Area

Along the coast of south-central Louisiana where Hurricane Andrew made landfall, the shallow seafloor slopes gently up to meet the low marshlands that characterize coastal areas of southern Louisiana. These marshes extend inland for distances ranging from 10 to 30 mi. Barrier islands exist along much of the coasts of Terrebonne and Lafourche Parishes (fig. 1). In the past, it was thought that these islands may provide some protection from the wave action of storms. Today, however, these islands are generally low, thin, and broken from previous storms and do little to buffer the effects of hurricanes. It was also thought that the marshes may reduce the inland movement of a storm tide. However, the numerous canals and bayous throughout the coastal marshes provide unrestricted access for the movement of high water.

Most of the population residing close to the coast in south-central Louisiana live along a few naturally occurring levees or have built private levees to protect their property. Many homes and the numerous fishing camps are built several feet off of the ground on pilings for protection against flooding. In areas farther from the coast, hurricane-protection levees have been constructed to protect larger populations.

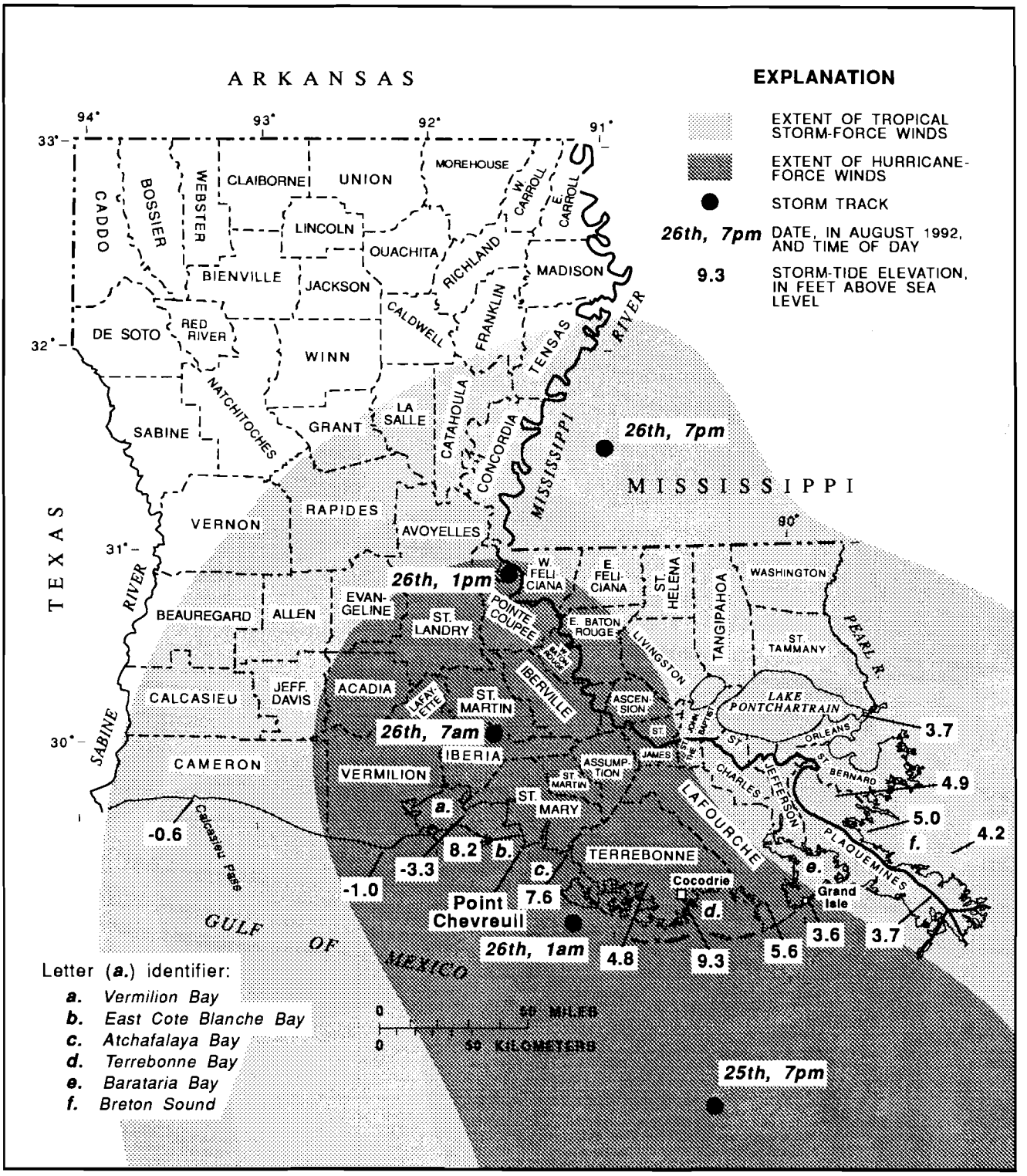

Figure 1. The path of Hurricane Andrew, extent of tropical storm- and hurricane-force winds, and storm-tide elevations at selected sites in Louisiana.

Presentation of Data

Data for the high-water marks are presented in tables and plotted on twelve 30 X 60-minute quadrangle maps as a series of plates. Tabular data include plate number, quadrangle name, mark number, nearest town, latitude, longitude, quality and reliability of mark (good, plus or minus 0.10 ft; fair, plus or minus 0.25 ft; poor, greater than 0.25 ft), type of mark, location of mark (inside or outside), water-surface elevation, and ground-surface elevation. The plates show the locations and elevations of the high-water marks. Locations and boundaries of the 30 X 60-minute quadrangle maps are shown in figure 2.

Storm-tide data from 76 continuous gaging stations also are presented in tabular form and plotted on the quadrangle maps. Tabular data include the plate number, quadrangle name, gaging-station number, owner, owner number, station name, latitude, longitude, and the date, time, and elevation of the peak storm-tide measurement. The quadrangle maps show the gage locations and date, time, and elevations of peak storm-tide measurements. In addition, time-series data of stage and either specific conductivity or stream velocity from 24 of the 76 continuous gaging stations are shown as line graphs. The locations of these gaging stations are shown in figure 3.

Acknowledgments

This report was made possible with the assistance and cooperation of many home and property owners who allowed high-water-elevation surveys to be made. Special thanks are extended to Dennis Lee, FEMA; John Miller, COE; and Bob Zurflugh, National Geodetic Survey.

METHODS

Immediately after Hurricane Andrew passed, USGS crews located and documented high-water marks in the coastal areas of Louisiana. Each high-water mark was flagged or marked, described in detail, and photographed. The description of each mark included its geographical and physical location, type of mark (seedline, washline, driftline, stainline, or debris), and an assessment of the quality of the mark. The quality of each mark was determined as follows (Shuck-Kolben, 1990, p. 4):

Quality of mark	Description	Reliability
Good	A level, well-defined line of densely accumulated fine debris or a distinct stain	0.10 ft
Fair	A level, but less distinct band of fine to coarse debris or stain	0.25 ft
Poor	A poorly defined band of sparsely accumulated coarse debris that may undulate due to surface-wave action. Other examples include a discontinuous scatter of coarse debris on a structure, a coarse groundline of heavy-vegetative drift, or debris hung in the branches of a tree.	>0.25 ft

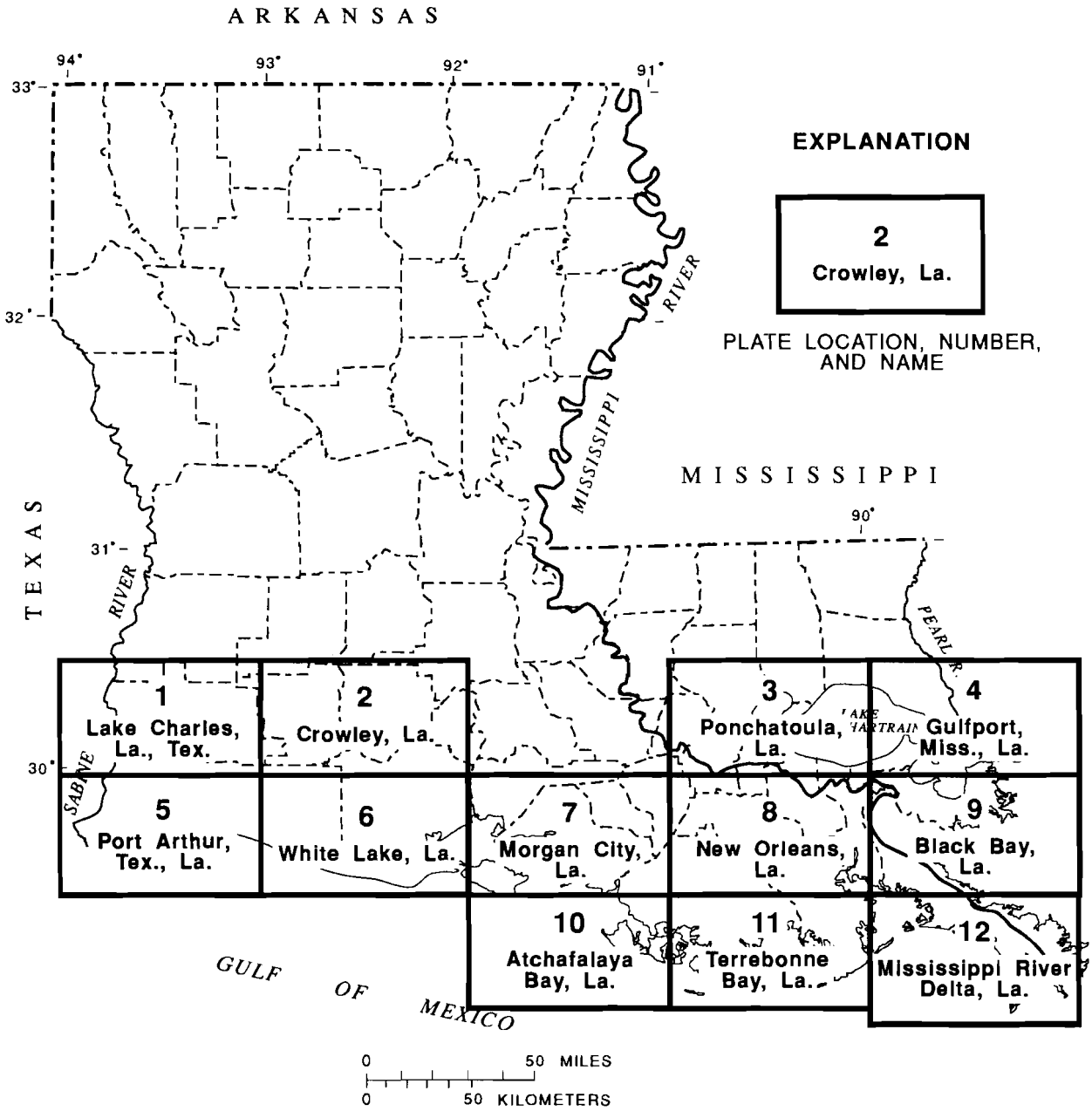

Figure 2. Locations and boundaries of quadrangles for which storm-tide elevations are shown.

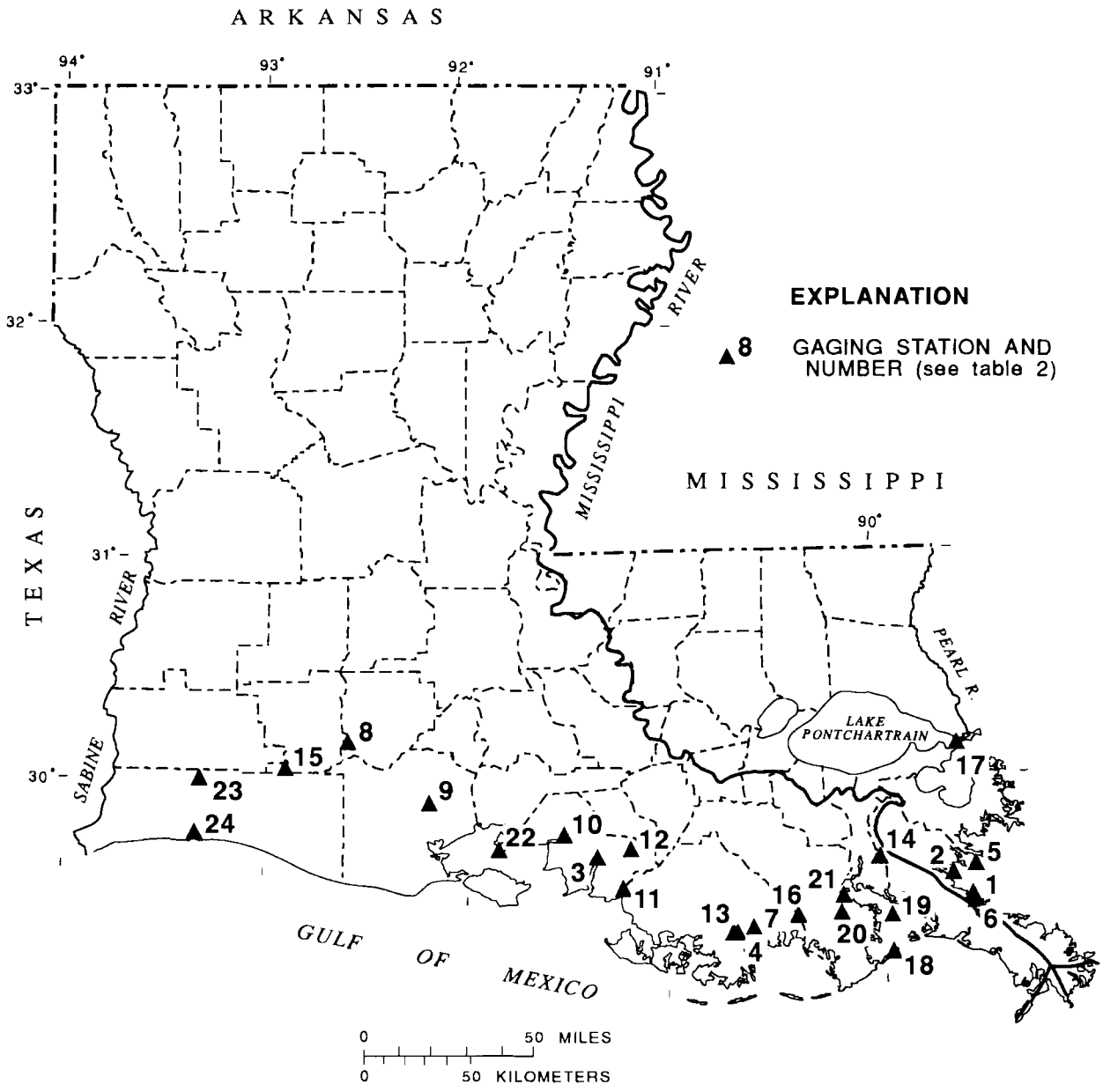

Figure 3. Location of selected gaging stations from which time-series data are presented.

During the next phase of the study, surveying crews obtained elevations for each of the high-water marks flagged. All of the elevations documented in this report were obtained using conventional level equipment and vertical control stations (bench marks).

Global Positioning System (GPS) equipment also was used to determine elevations for many high-water marks located in marsh areas, on barrier islands, and in other remote areas without bench marks. However, the elevations obtained using GPS were not included in the data set because they were not as reliable as most of the elevations that were obtained by conventional methods.

VERTICAL DATUM

The National Geodetic Vertical Datum of 1929 (NGVD of 1929) was used as the datum for this study. NGVD of 1929 is a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada. Although the datum was derived from the average sea level over a period of many years at 26 tide stations along the Atlantic, Gulf of Mexico, and Pacific Coasts, NGVD of 1929 does not necessarily represent local mean sea level at any particular place (Arcement and others, 1991, p. 35). NGVD of 1929 is referred to as "sea level" in the remainder of this report.

Bench-mark elevations used for this study were obtained from the National Geodetic Survey and the Terrebonne Parish Department of Public Works. Because coastal regions of southern Louisiana are subsiding (Andel and Curray, 1960), bench-mark elevations need to be adjusted regularly. An enormous effort is required for updating bench-mark elevations and was beyond the scope of this study. Consequently, the accuracy of high-water-mark elevations is limited by the accuracy of the bench-mark elevations used as vertical control points.

STORM-TIDE ELEVATIONS

Hurricane Andrew made landfall in Louisiana at Point Chevreuil near high tide. The storm tide affected much of the Louisiana coastline, including many coastal waterways and lakes hydraulically connected to the coast. The counter-clock-wise motion of the hurricane winds produced a positive storm tide along the Louisiana coast east of landfall, and a negative storm tide west of landfall. Approximate storm-tide elevations (in feet above sea level) along the Louisiana coast were as follows: Lake Pontchartrain, 4; Breton Sound, 5; Barataria Bay, 4; Grand Isle, 4; Terrebonne Bay, 9; Atchafalaya Bay, 8; East Cote Blanche Bay, 8; Vermilion Bay, -3; and Calcasieu Pass, -1 (fig. 1).

East of the eye of the hurricane, the counter-clock-wise motion of the winds pushed water landward, causing an abnormally high tide along the coast. From the Mississippi State line to Grand Isle, La., the elevation of the storm tide along the Louisiana coast generally ranged from 3 to 5 ft above sea level. From Grand Isle to Point Chevreuil, La., the elevation of the storm tide along the coast generally ranged from 4 to 9 ft above sea level. The storm tide peaked at 8.2 ft above sea level near landfall and at 9.3 ft above sea level near Cocodrie, La., which is located about 60 mi east-southeast of the point of landfall (fig. 1).

West of the eye of the hurricane, the winds pushed water southward, away from the coast, producing a negative storm tide that left no marks, but was recorded by gages along the coast. From landfall to the Texas State line, the negative storm tide generally ranged from 0.5 to 3 ft be-

low sea level. The lowest measurement, 3.3 ft below sea level, was recorded at a gage located at Cypremort Point, La., about 10 mi east of landfall (fig. 1).

Most of the flood damage caused by the storm tide in Louisiana occurred in southern Terrebonne Parish where the storm tide was highest and the levees are low and discontinuous. Much of this area is comprised of marsh and other wetlands that are mostly unoccupied. The few roads in this area were built on top of naturally occurring levees that trend north-south and most of the population in southern Terrebonne Parish lives along these roads. Most of the high-water marks collected for this report were obtained from houses and other structures located along these ridges. A few high-water marks were documented at fishing camps and other structures in remote locations in the wetlands and along the barrier islands of southern Terrebonne Parish. However, attempts to survey these sites using GPS did not result in the desired level of accuracy, and, consequently, these sites were omitted from this report.

The high-water-mark elevations are shown on 30 X 60-minute quadrangle maps (pls. 1-12). The location, storm-tide elevation, and ground-surface elevation at each high-water mark are shown on plates 1 to 12. Symbols on the plates indicate whether the mark was located inside or outside a structure. Information about each mark, including plate number, water-surface elevation, ground-surface elevation, mark number, mark quality and reliability, type of mark, location of mark (inside or outside), latitude, longitude, quadrangle name, and nearest town are listed in table 1.

High-water marks found inside of structures were generally of much better quality than those found outside because of reduced wind and wave action. If the structure is fairly well closed off from the water, the structure acts as a stilling well, and the "inside" mark represents the still water level, unaffected by the waves. Forty-one (59 percent) of the 69 high-water marks documented in this report were found inside of structures. Of the 69 high-water marks, 54 (78 percent) were considered to be of good quality, 8 (12 percent) were considered fair, and 7 (10 percent) were poor (table 1).

Seventy-six continuous gaging stations documented the storm-tide configuration along the coast. Station locations, and date and time of positive and negative peak-storm-tide occurrence are shown on plates 1 to 12. Information about each gaging station, including plate number, quadrangle name, gaging station number, owner, owner identification number, station name, latitude, longitude, and the date, time, and elevation of the peak storm-tide measurement are listed in table 2.

The water-surface elevation and either specific conductance or stream velocity, if available, for each of the 24 gaging stations during the period of August 22-31, 1992, are shown in hydrographs (figs. 4-27). Some peaks in the hydrographs primarily are due to rainfall runoff, not the storm tide, and the data are not included as maximum positive storm-tide elevations in table 2 and on plates 1 to 12. In general, gages located east of landfall show a positive storm tide, and gages west of landfall show a negative storm tide. However, a few stations located near landfall, most notably stations 3, 11, and 12 (figs. 6, 14, and 15), recorded both a positive and negative storm tide as the storm moved past them from east to west.

Elevations at gages 1, 2, 5, and 6, for which hydrographs are shown in figures 4, 5, 8, and 9, were estimated because these gages have not been referenced to sea level. The elevations were estimated by matching pre-storm water levels at each gage to pre-storm water levels at gage 59 which is nearby. This estimation is valid with the assumption that the water surface in Breton Sound forms a smooth, continuous surface between the gages. Gage heights at station 7 (fig. 10) were not corrected to sea level and only gage height measurements are shown.

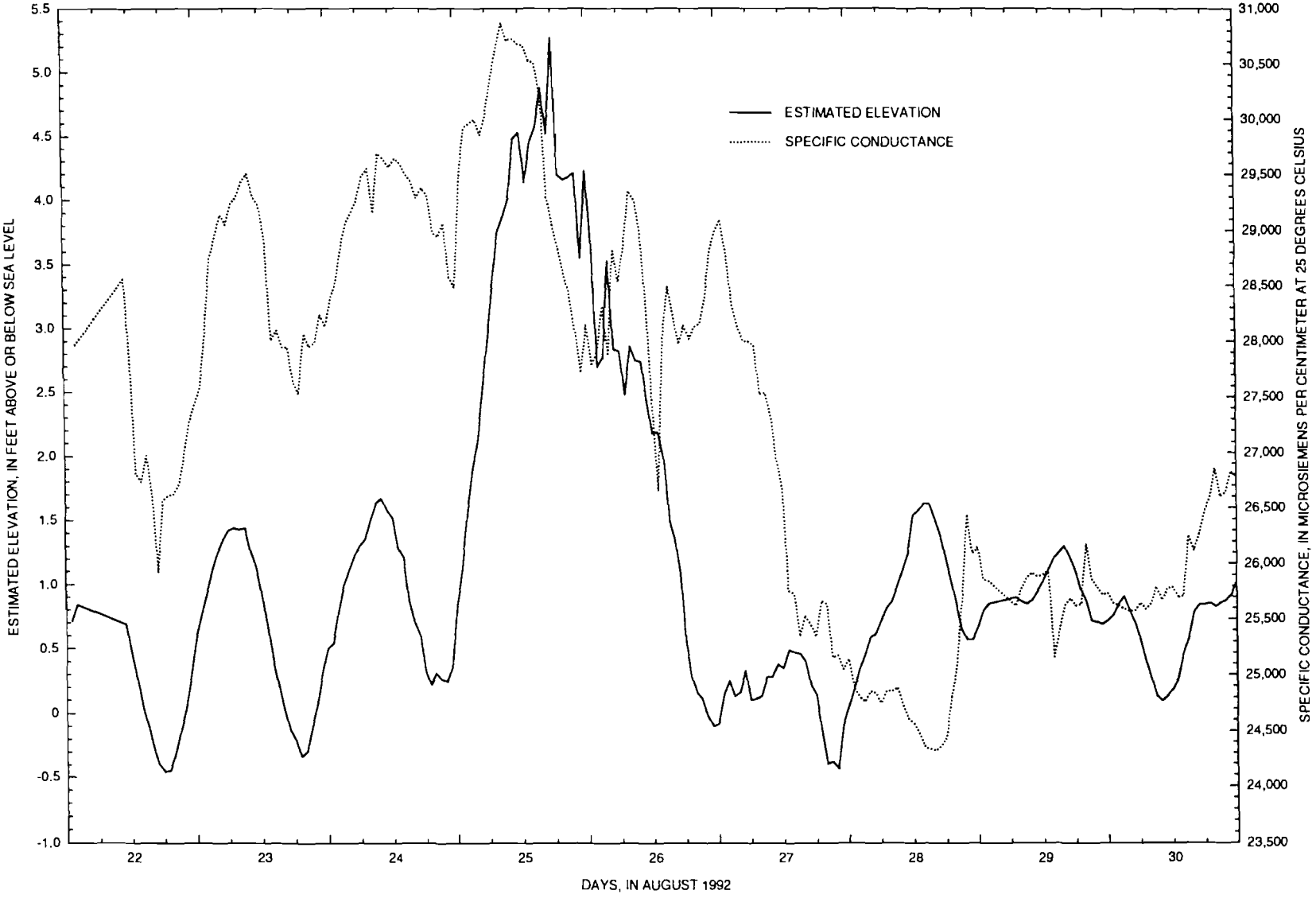

Figure 4. Estimated elevation and specific conductance at gaging station 1, north California Bay near Pointe-a-la-Hache, Louisiana.

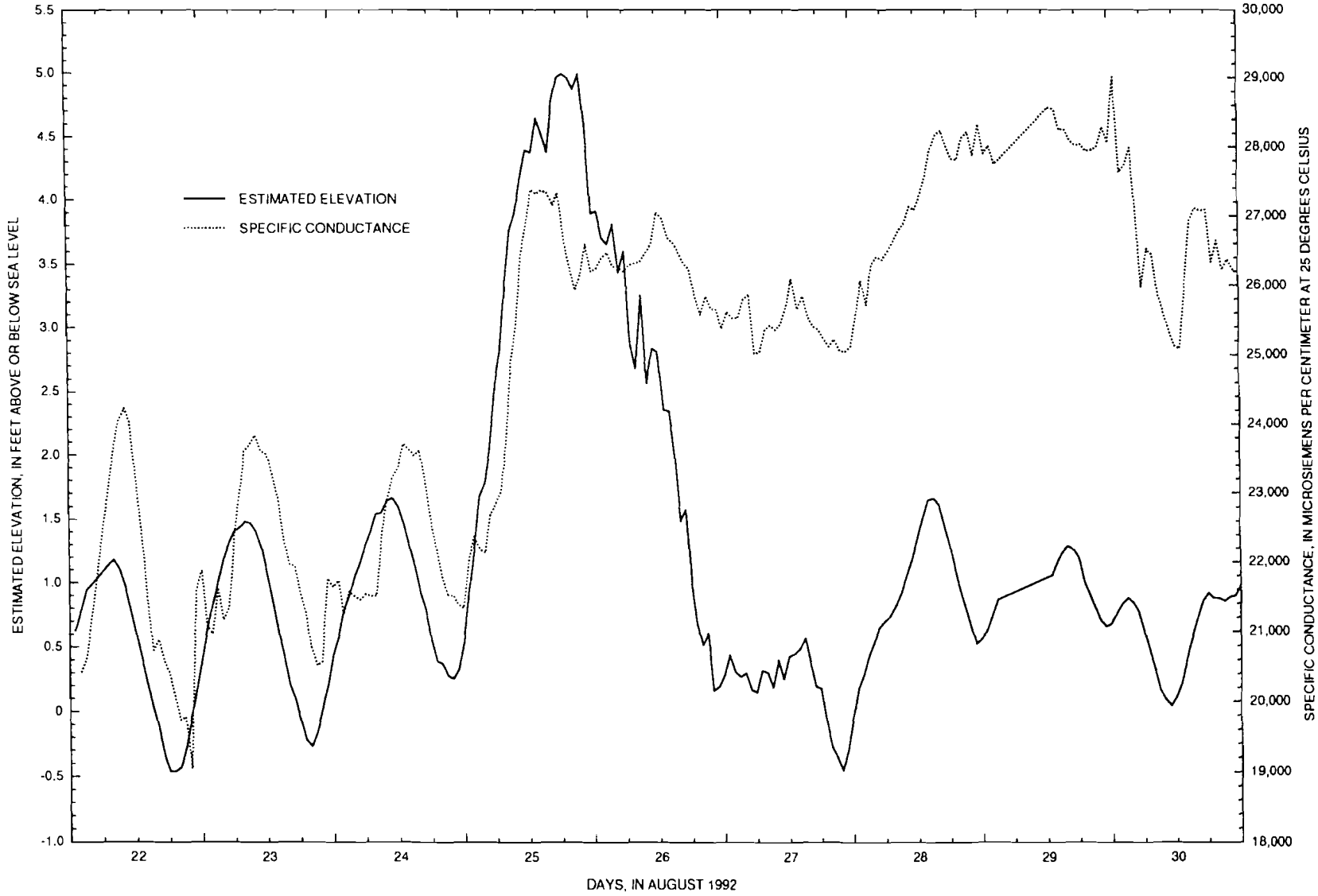

Figure 5. Estimated elevation and specific conductance at gaging station 2, northeast Bay Gardene near Pointe-a-la-Hache, Louisiana.

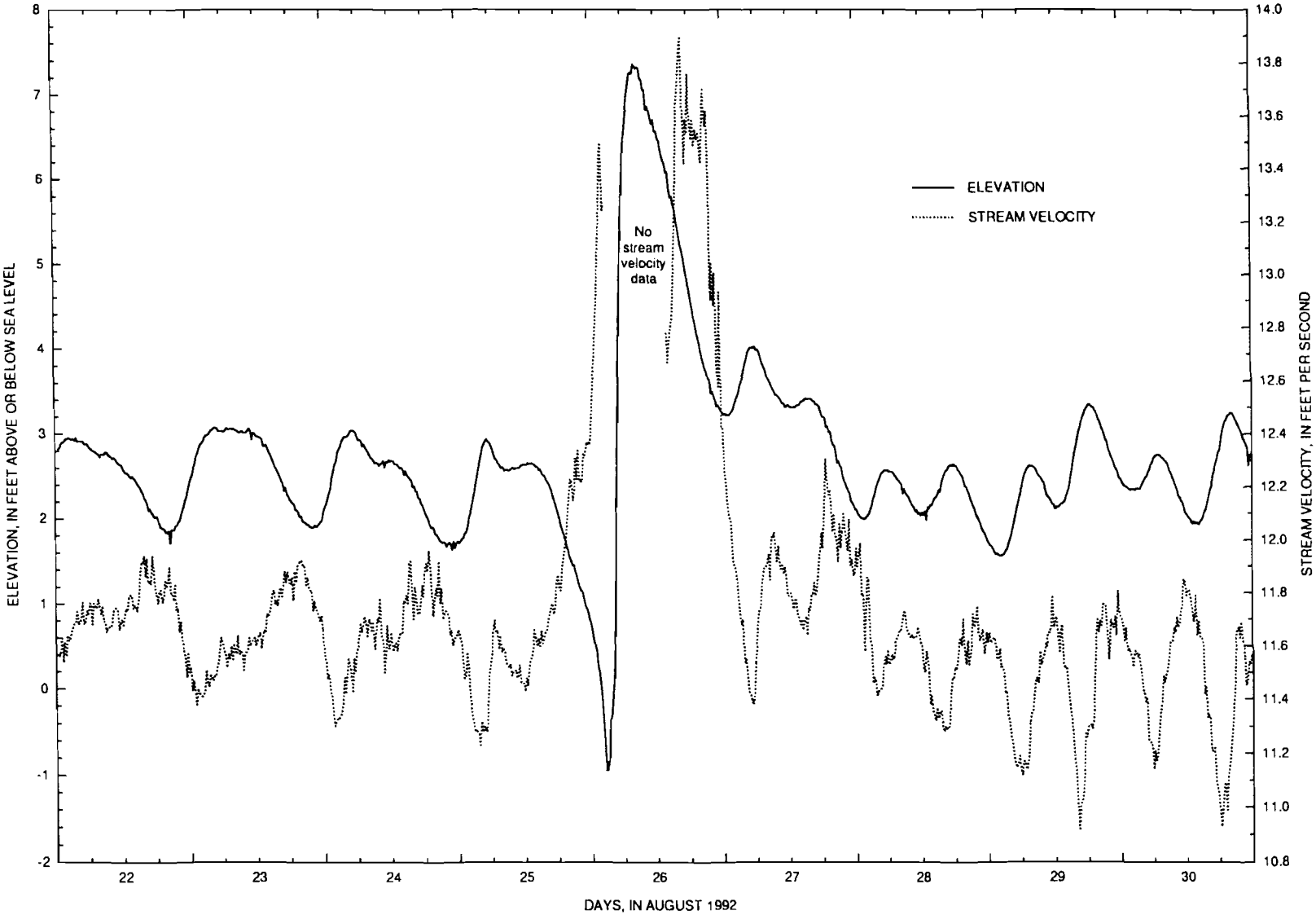

Figure 6. Elevation and stream velocity at gaging station 3, Wax Lake Outlet at Calumet, Louisiana.

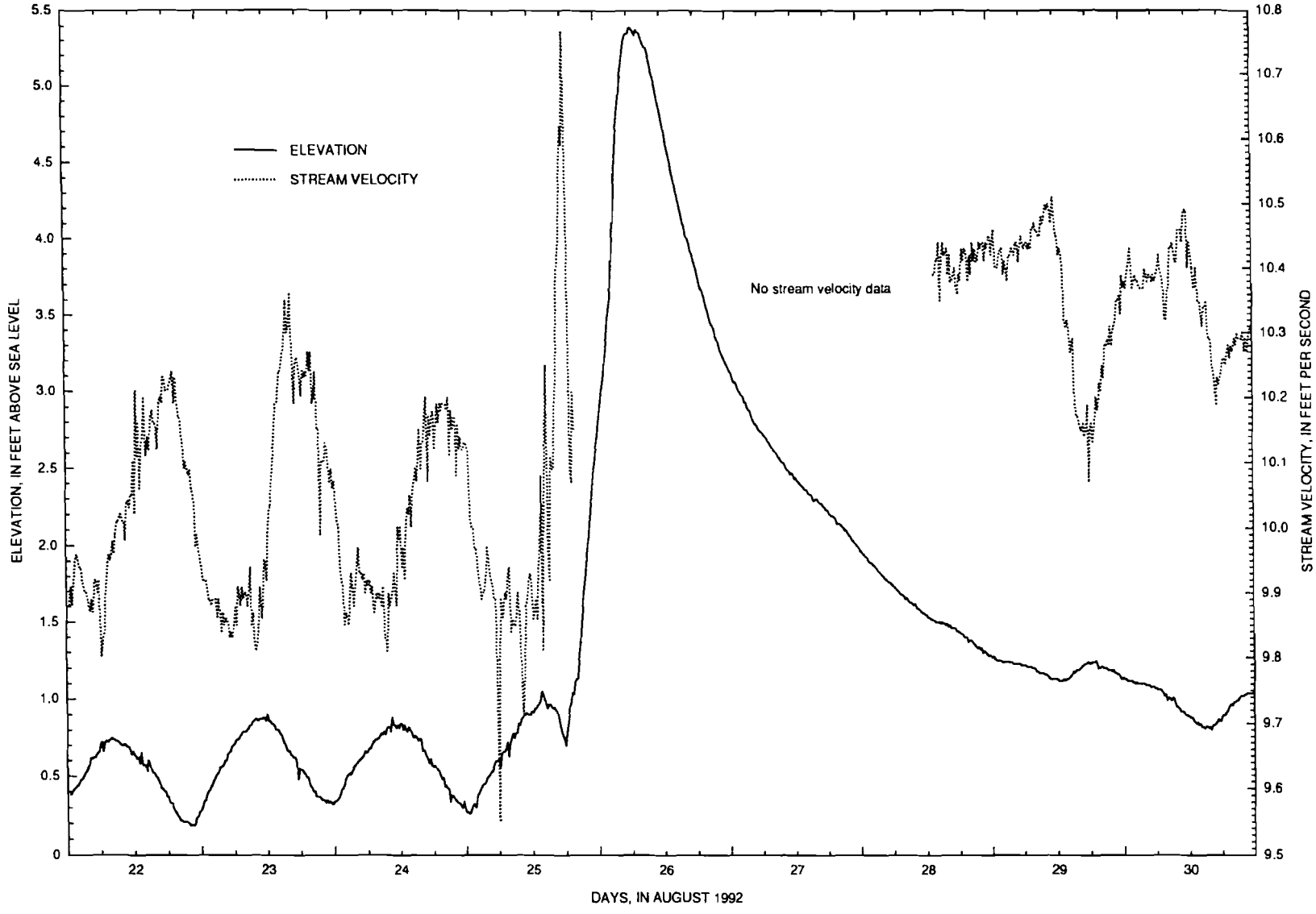

Figure 7. Elevation and stream velocity at gaging station 4, Bayou Grand Caillou at Dulac, Louisiana.

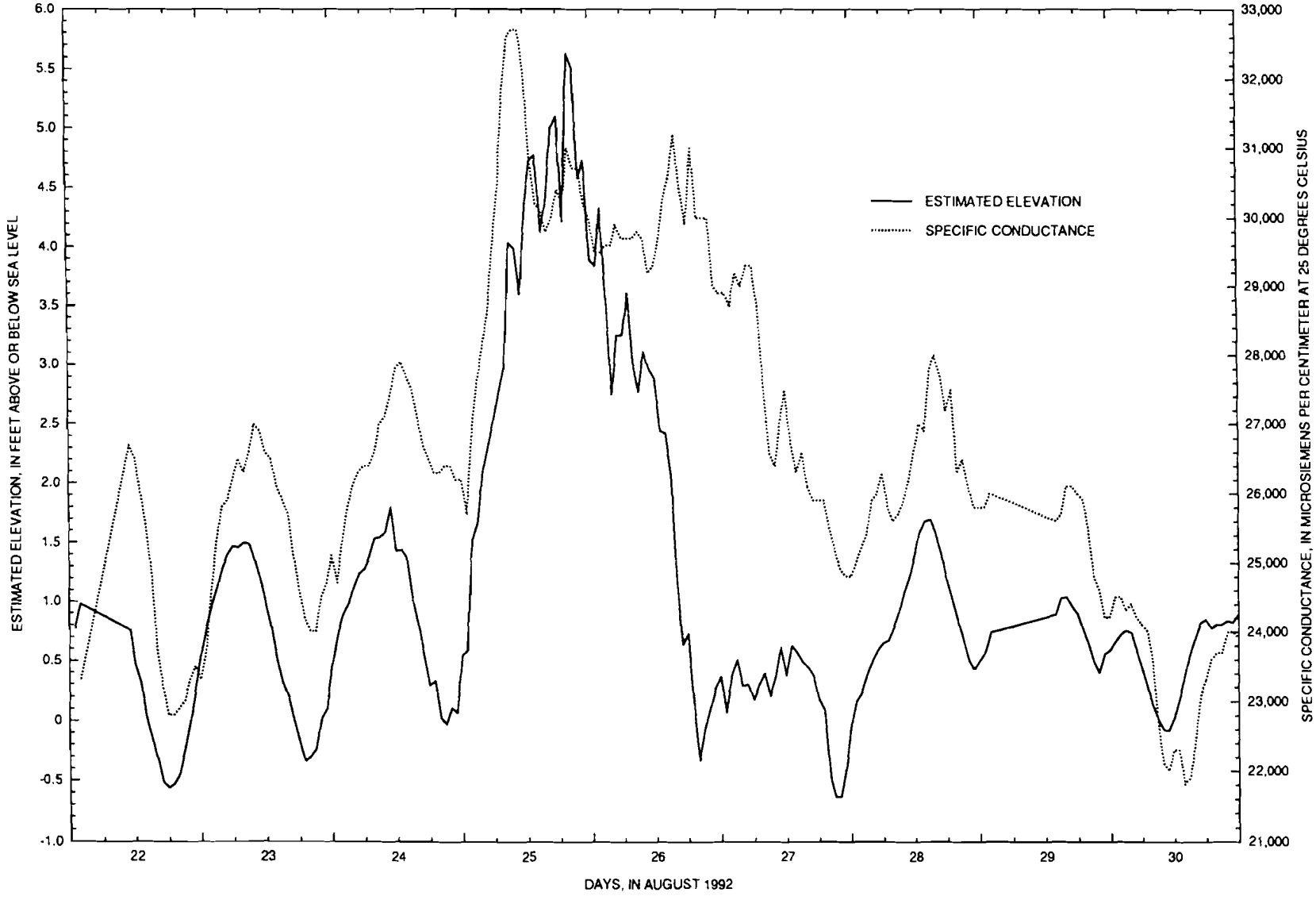

Figure 8. Estimated elevation and specific conductance at gaging station 5, Black Bay near Snake Island and Pointe-a-la-Hache, Louisiana.

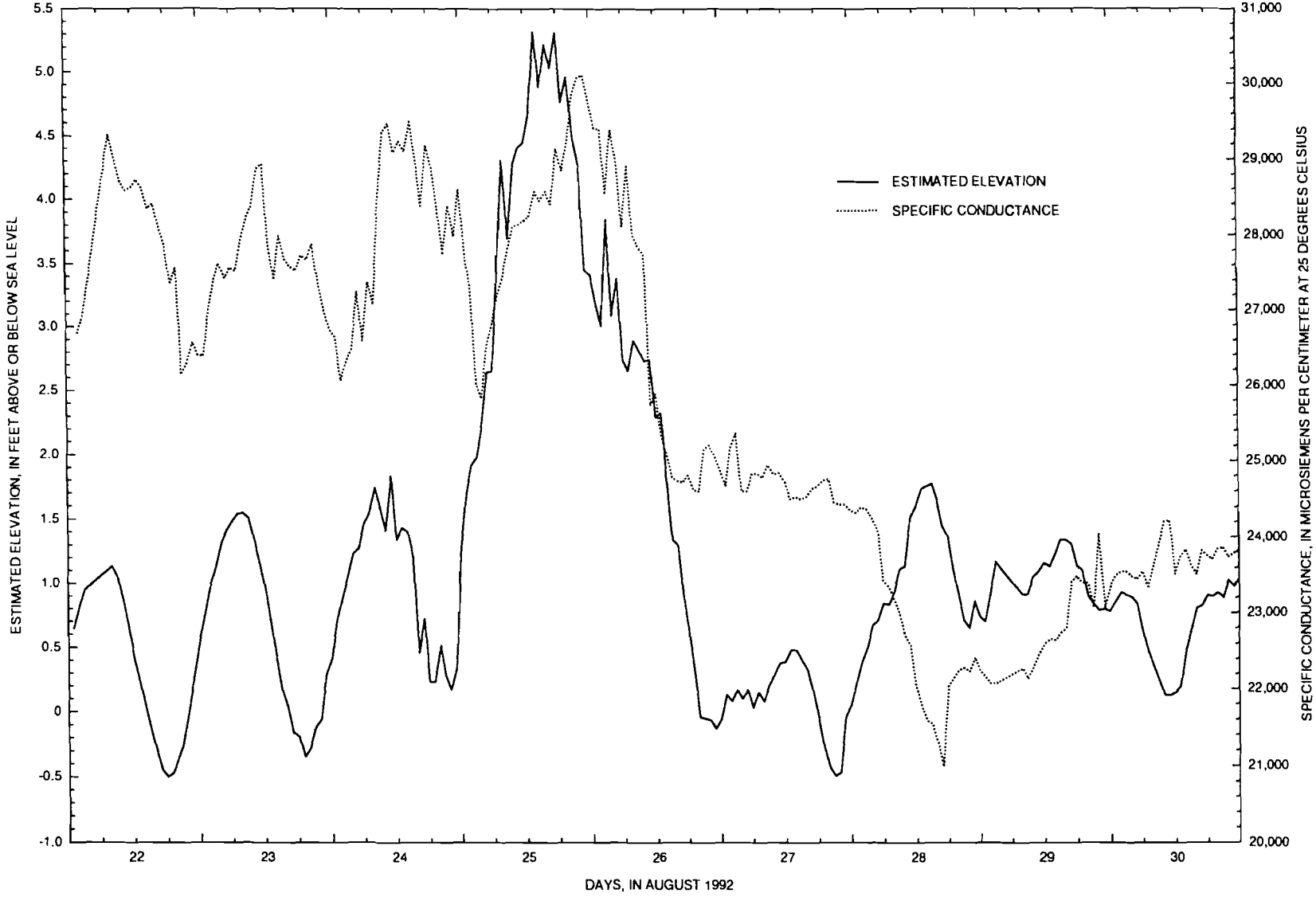

Figure 9. Estimated elevation and specific conductance at gaging station 6, California Bay near Sunrise Point, northeast of Nairn, Louisiana.

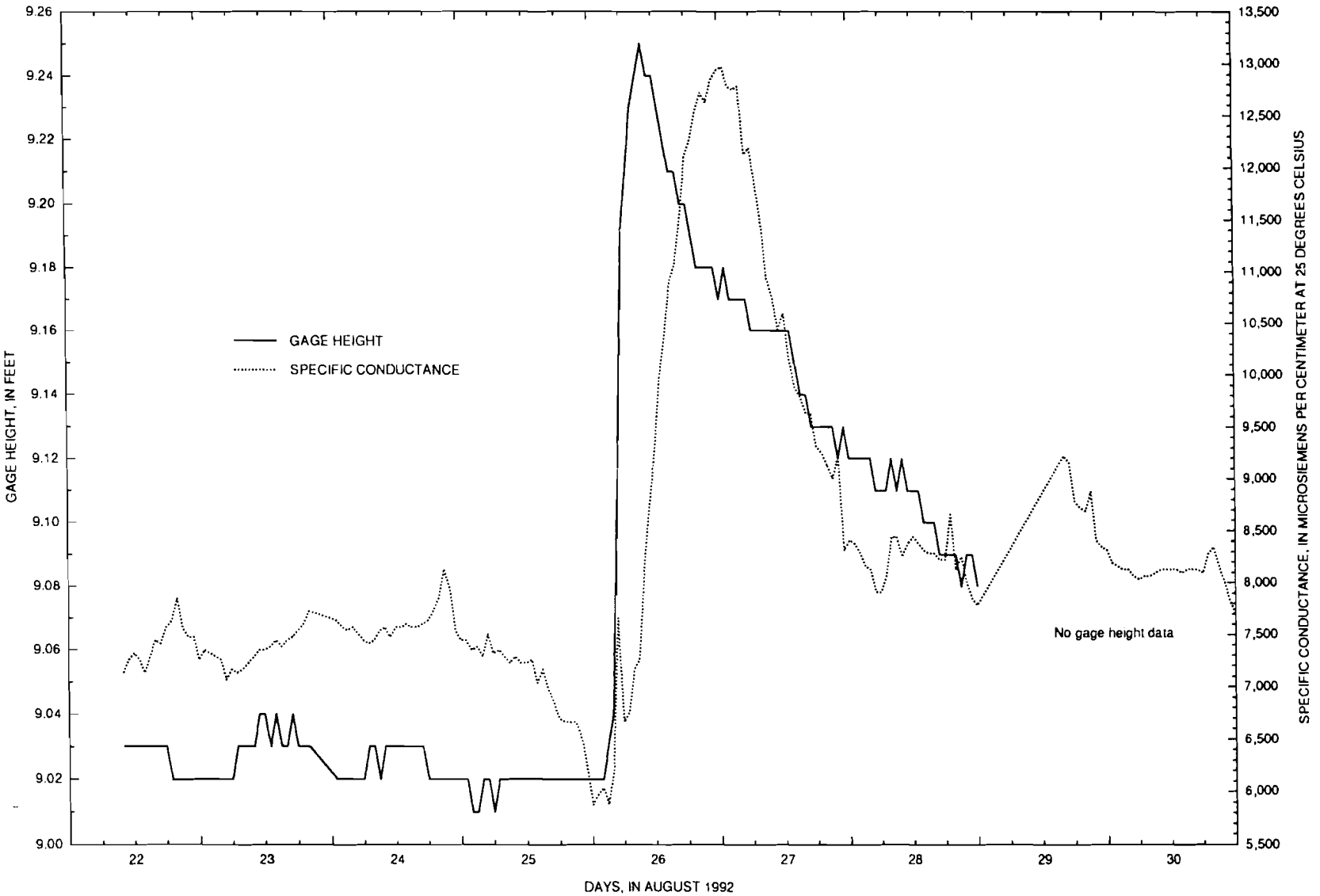

Figure 10. Gage height and specific conductance at gaging station 7, unnamed lake tributary to Lake Boudreaux, southwest of Chauvin, Louisiana.

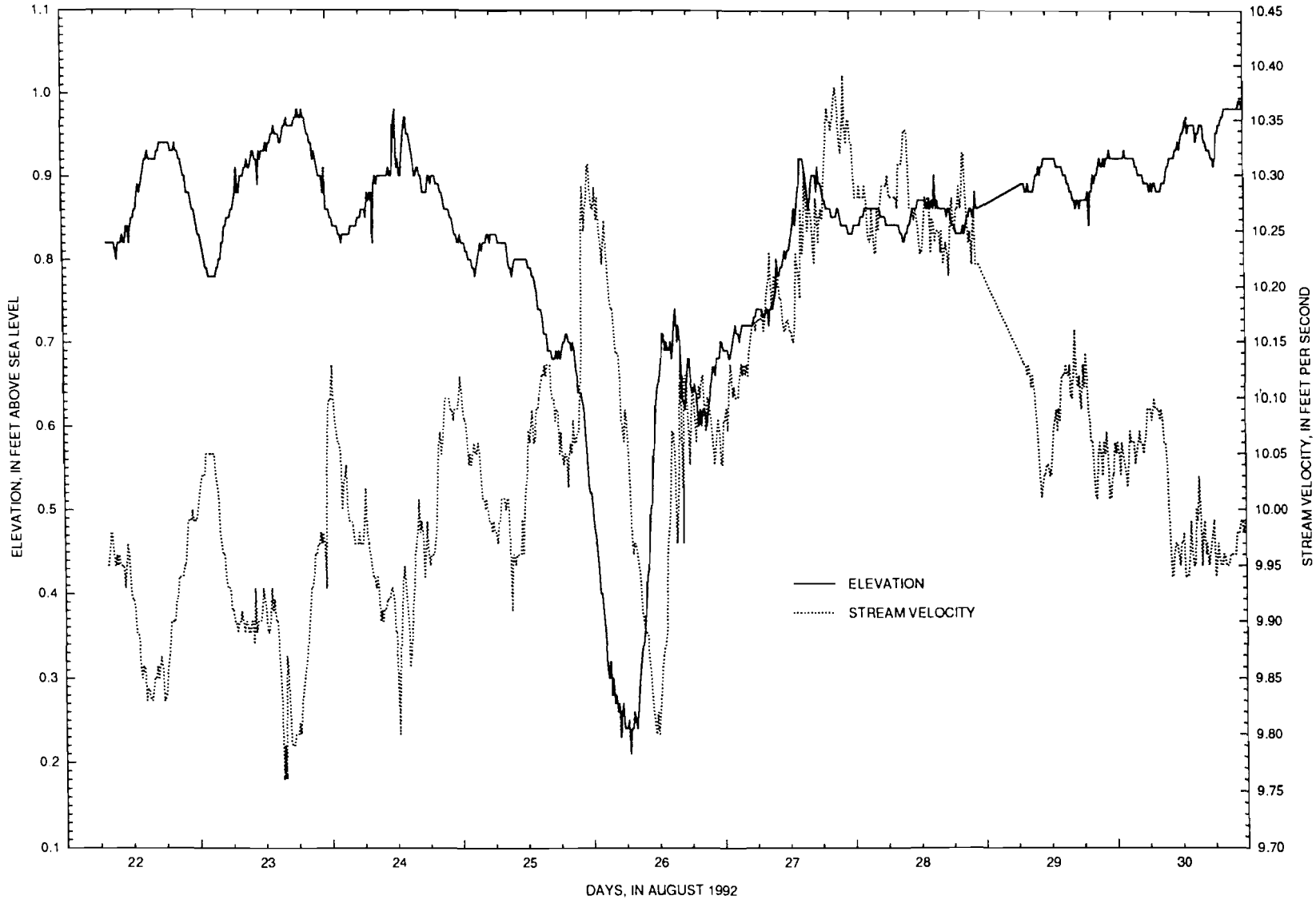

Figure 11. Elevation and stream velocity at gaging station 8, Mermentau River at Mermentau, Louisiana.

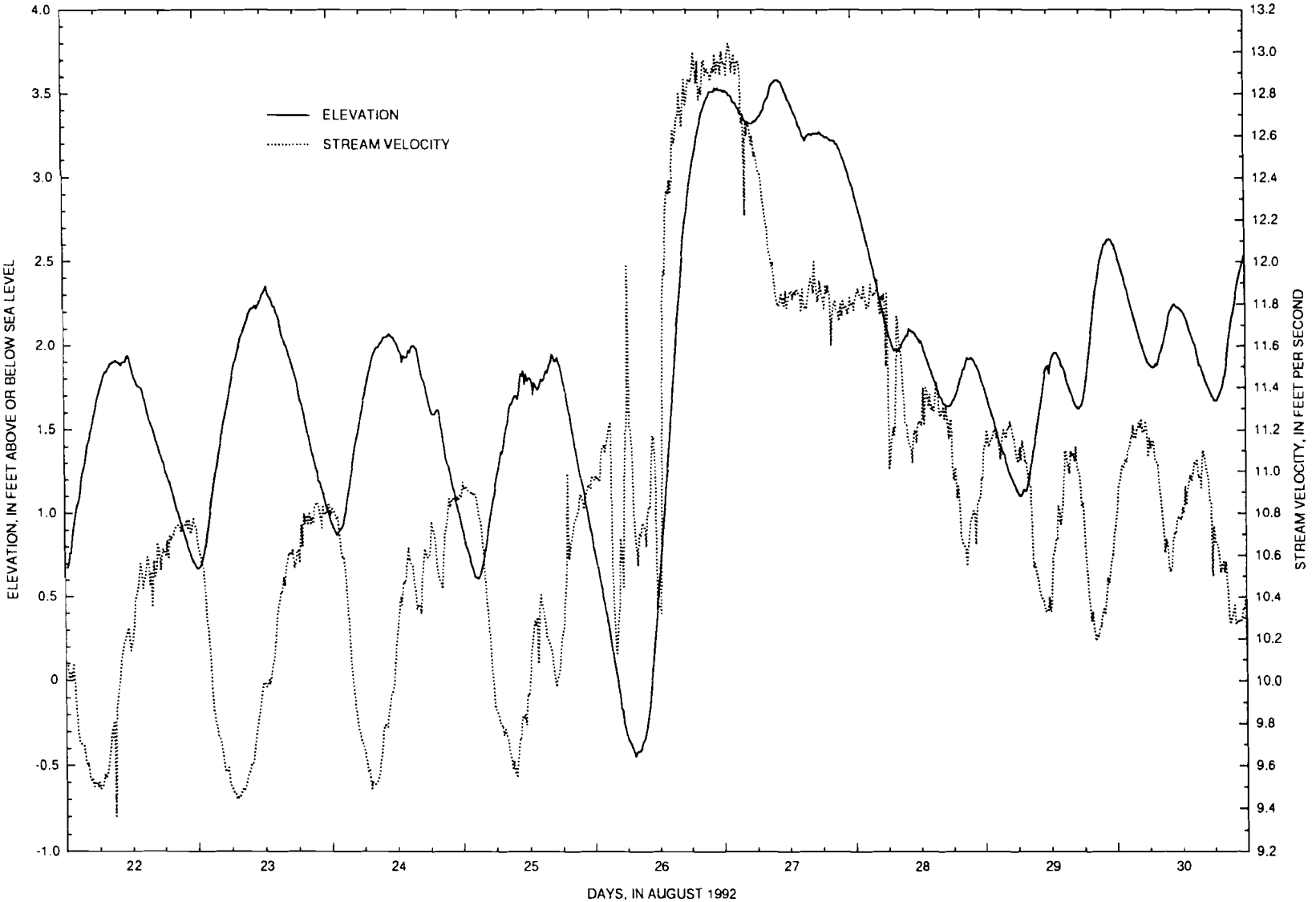

Figure 12. Elevation and stream velocity at gaging station 9, Vermilion River at Perry, Louisiana.

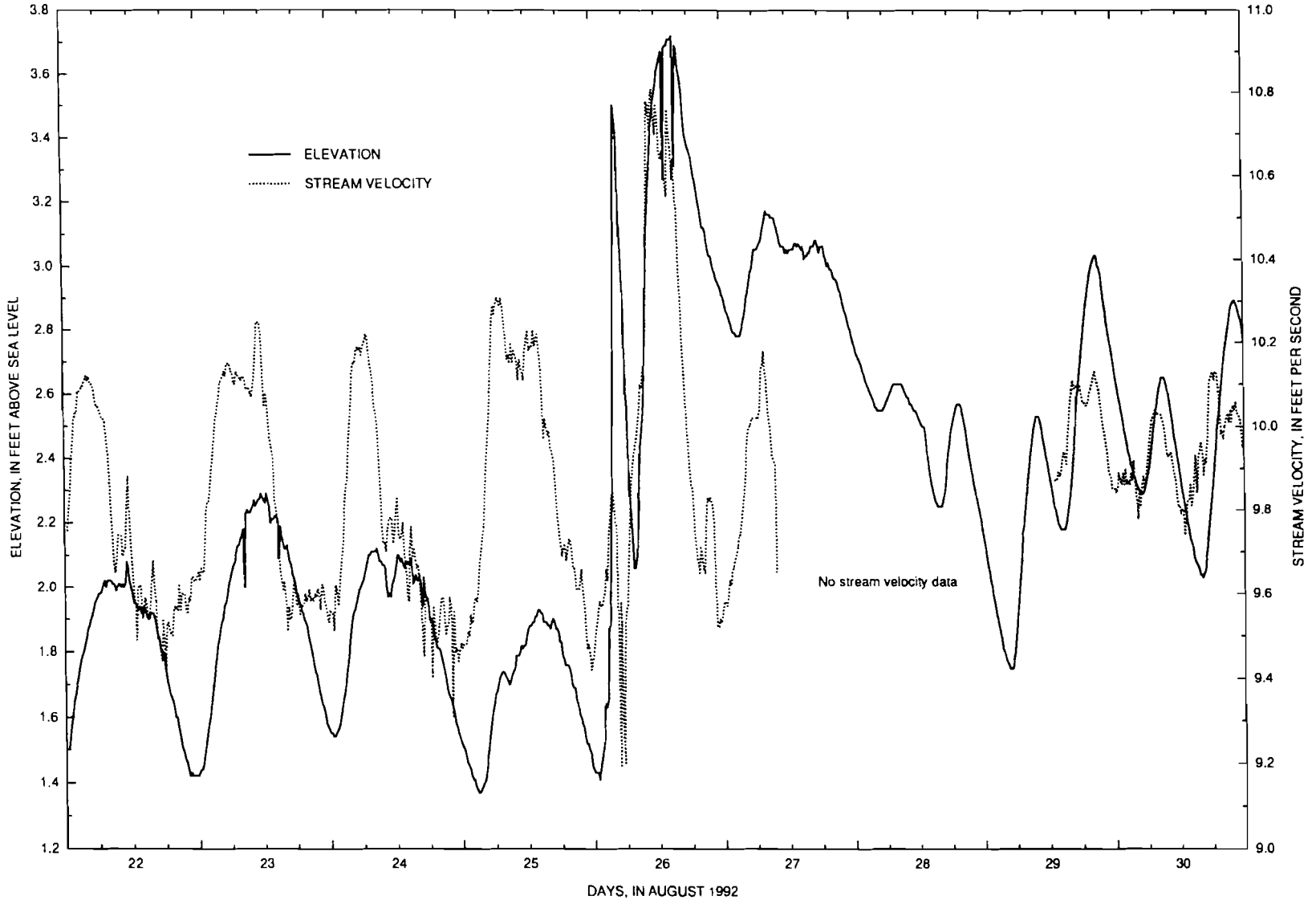

Figure 13. Elevation and stream velocity at gaging station 10, Bayou Teche near Franklin, Louisiana.

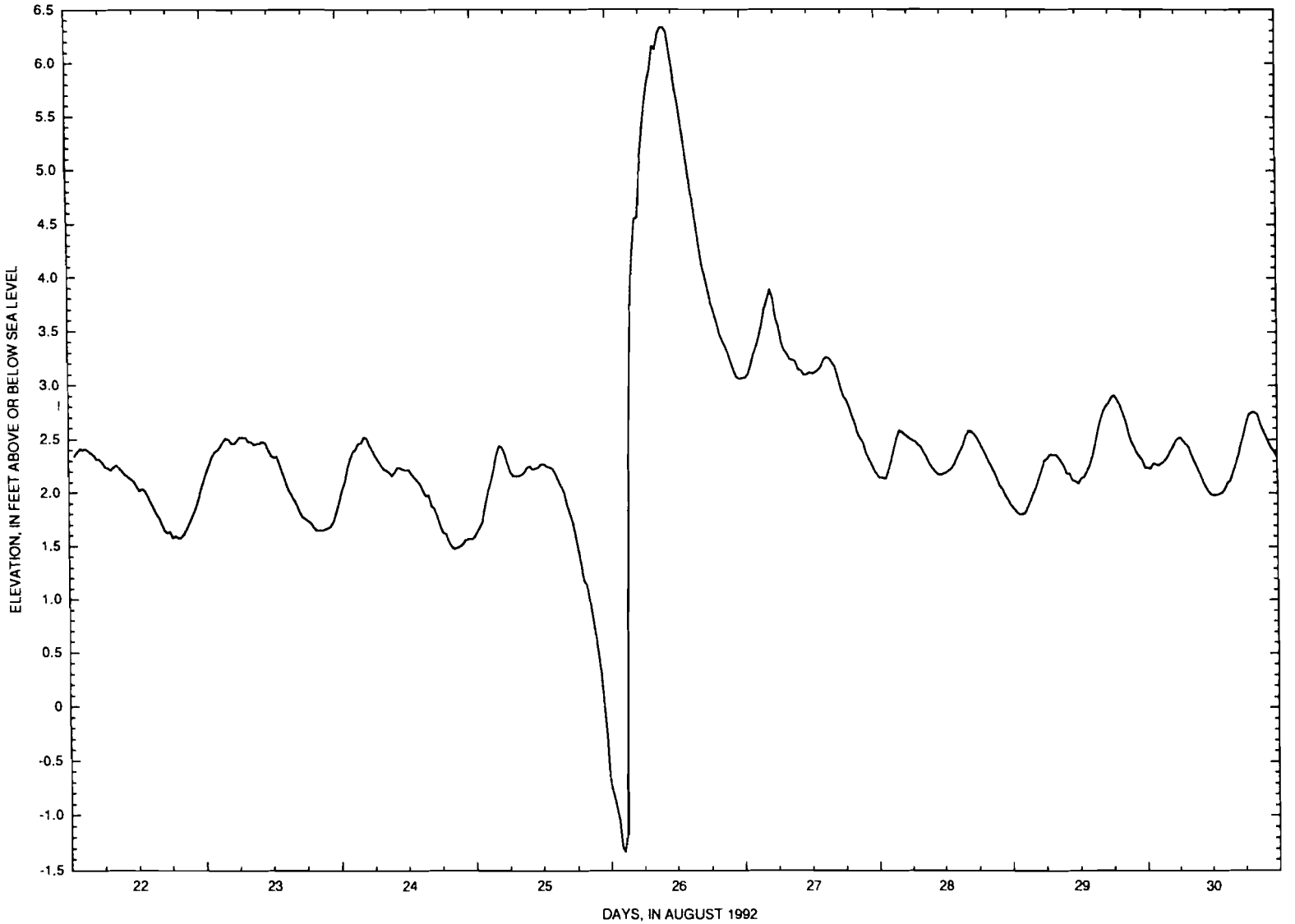

Figure 14. Elevation at gaging station 11, Lower Atchafalaya River below Sweet Bay Lake, near Morgan City, Louisiana.

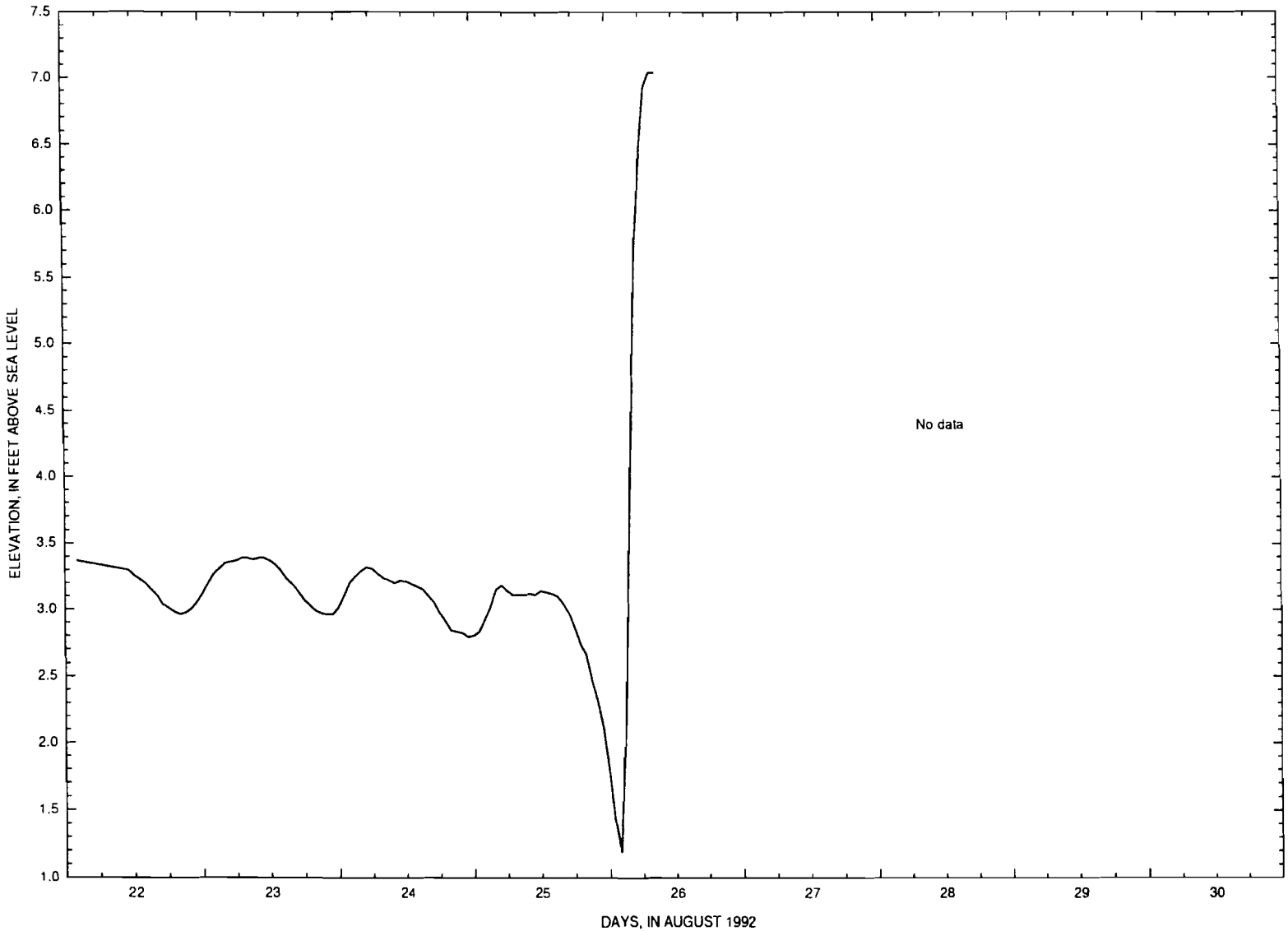

Figure 15. Elevation at gaging station 12, Lower Atchafalaya River at Morgan City, Louisiana.

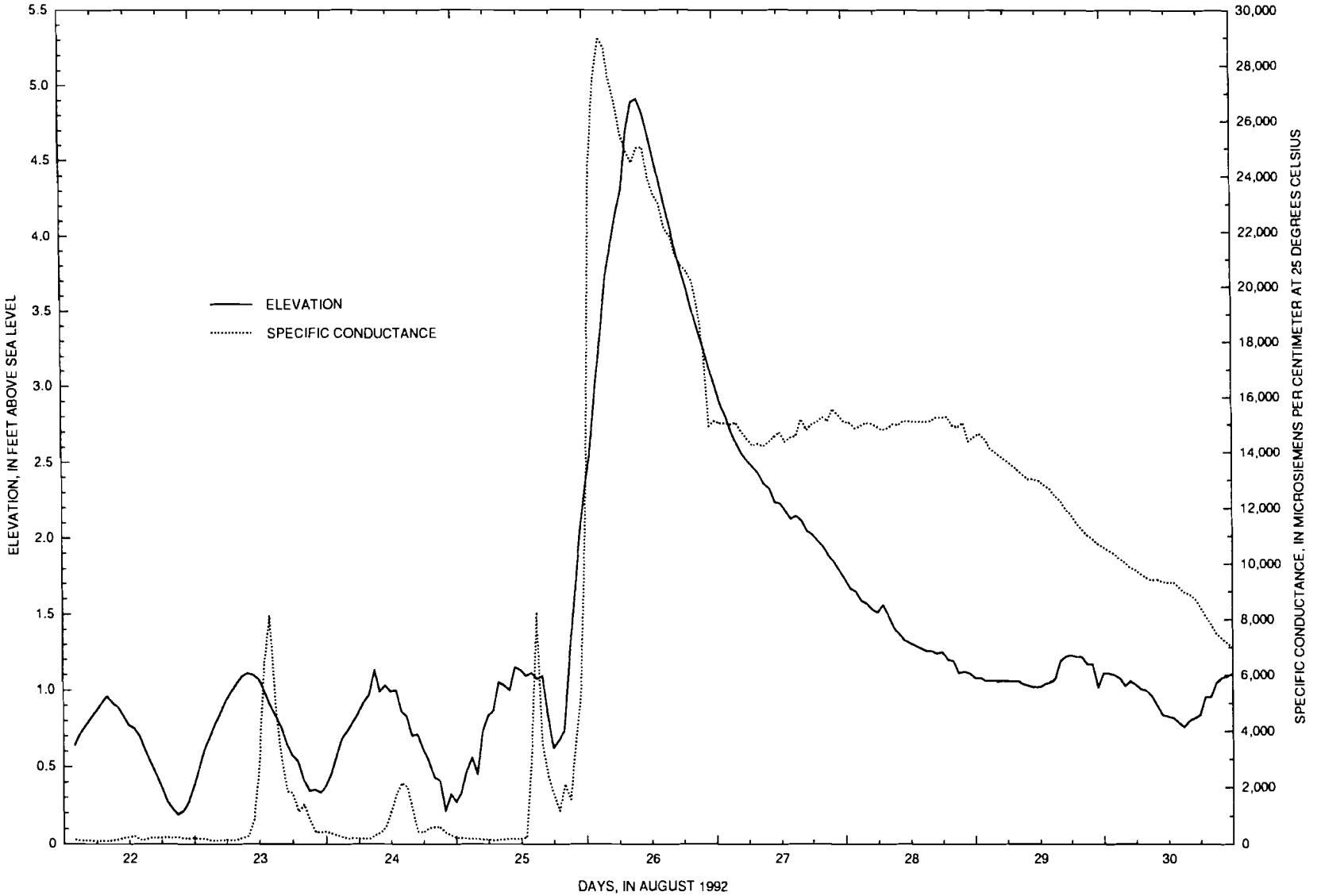

Figure 16. Elevation and specific conductance at gaging station 13, Houma Navigation Canal at Dulac, Louisiana.

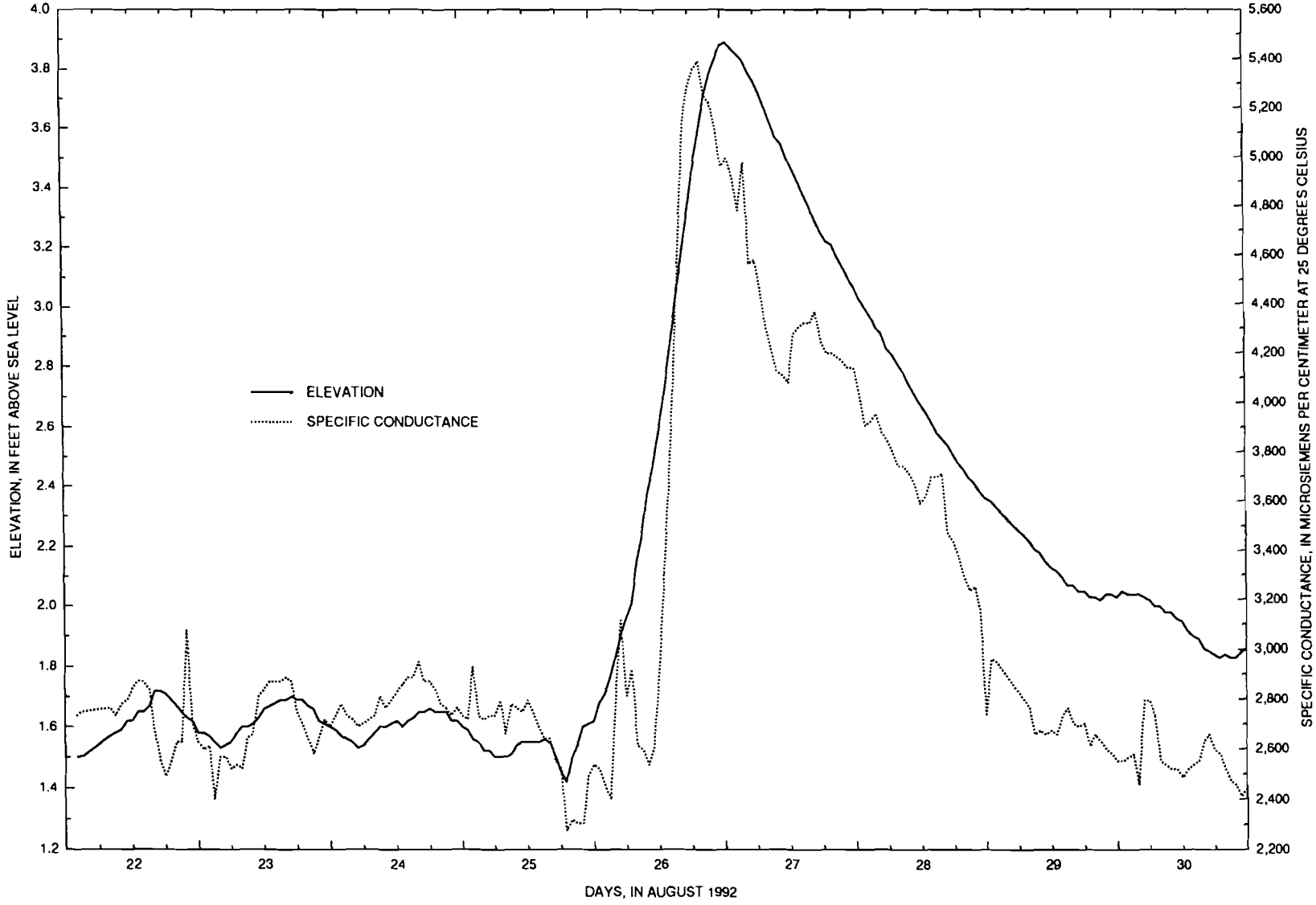

Figure 17. Elevation and specific conductance at gaging station 14, Lareussite Canal near Naomi, Louisiana.

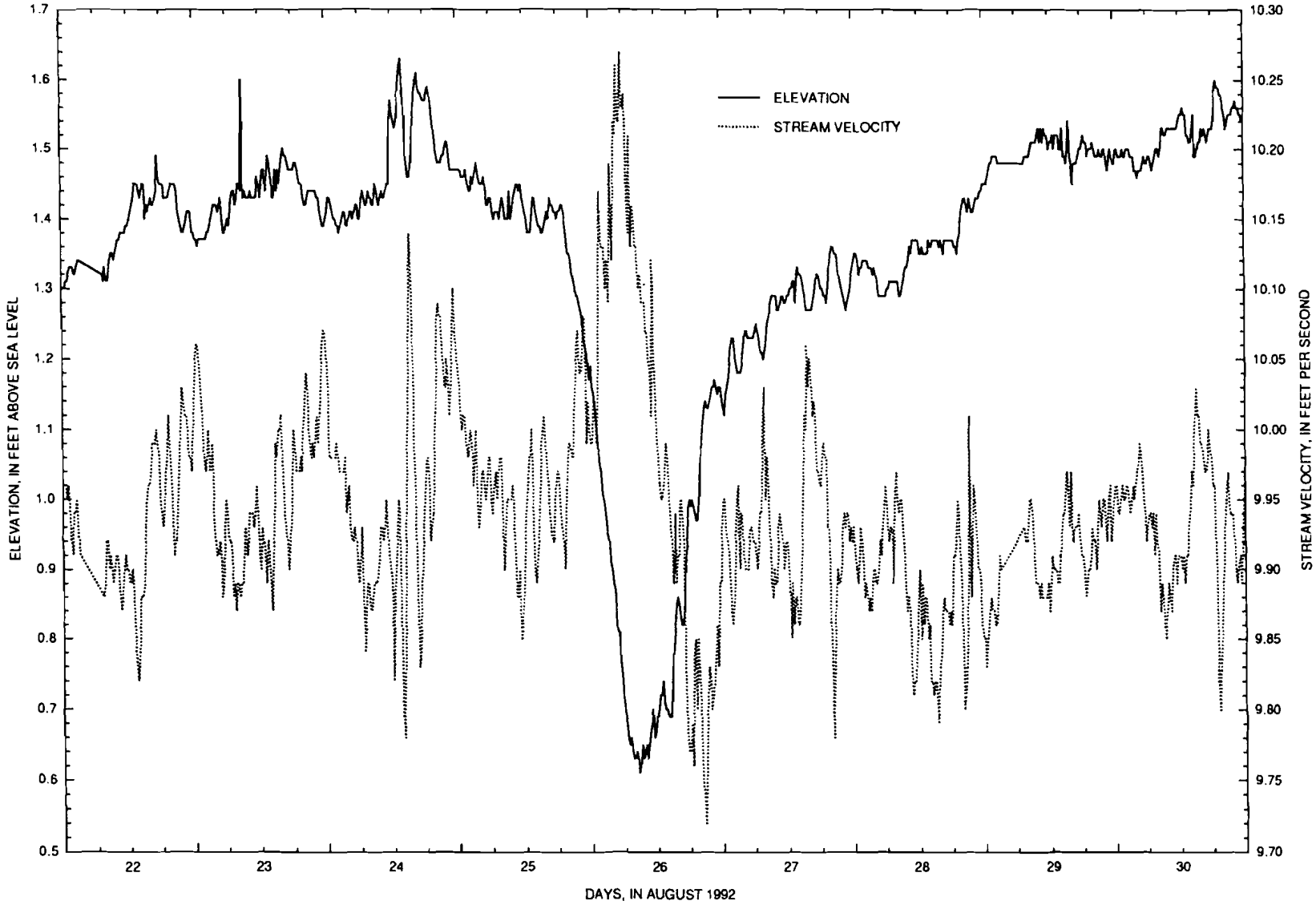

Figure 18. Elevation and stream velocity at gaging station 15, Bayou Lacassine near Lake Arthur, Louisiana.

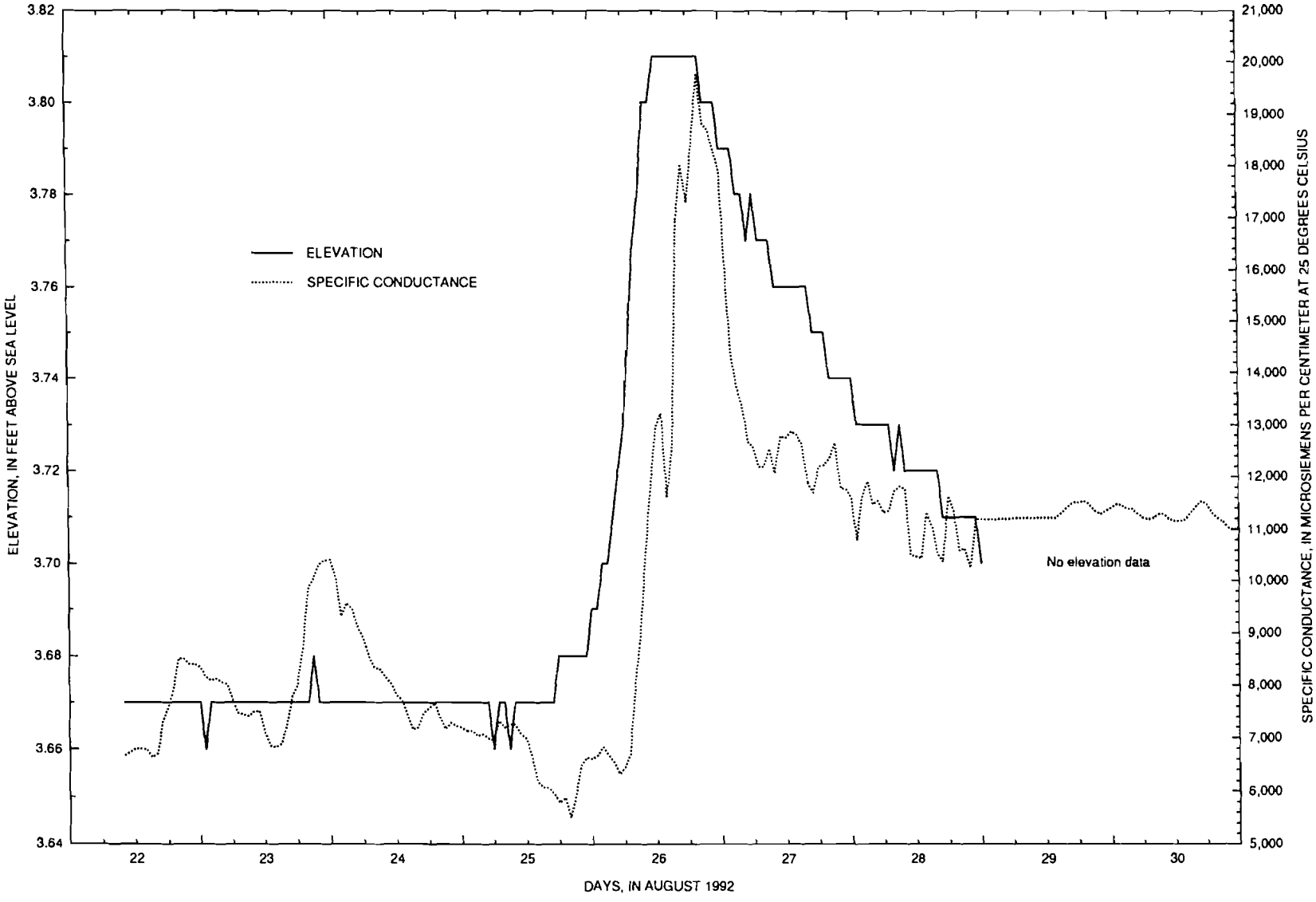

Figure 19. Elevation and specific conductance at gaging station 16, Grand Bayou Tributary, west of Galliano, Louisiana.

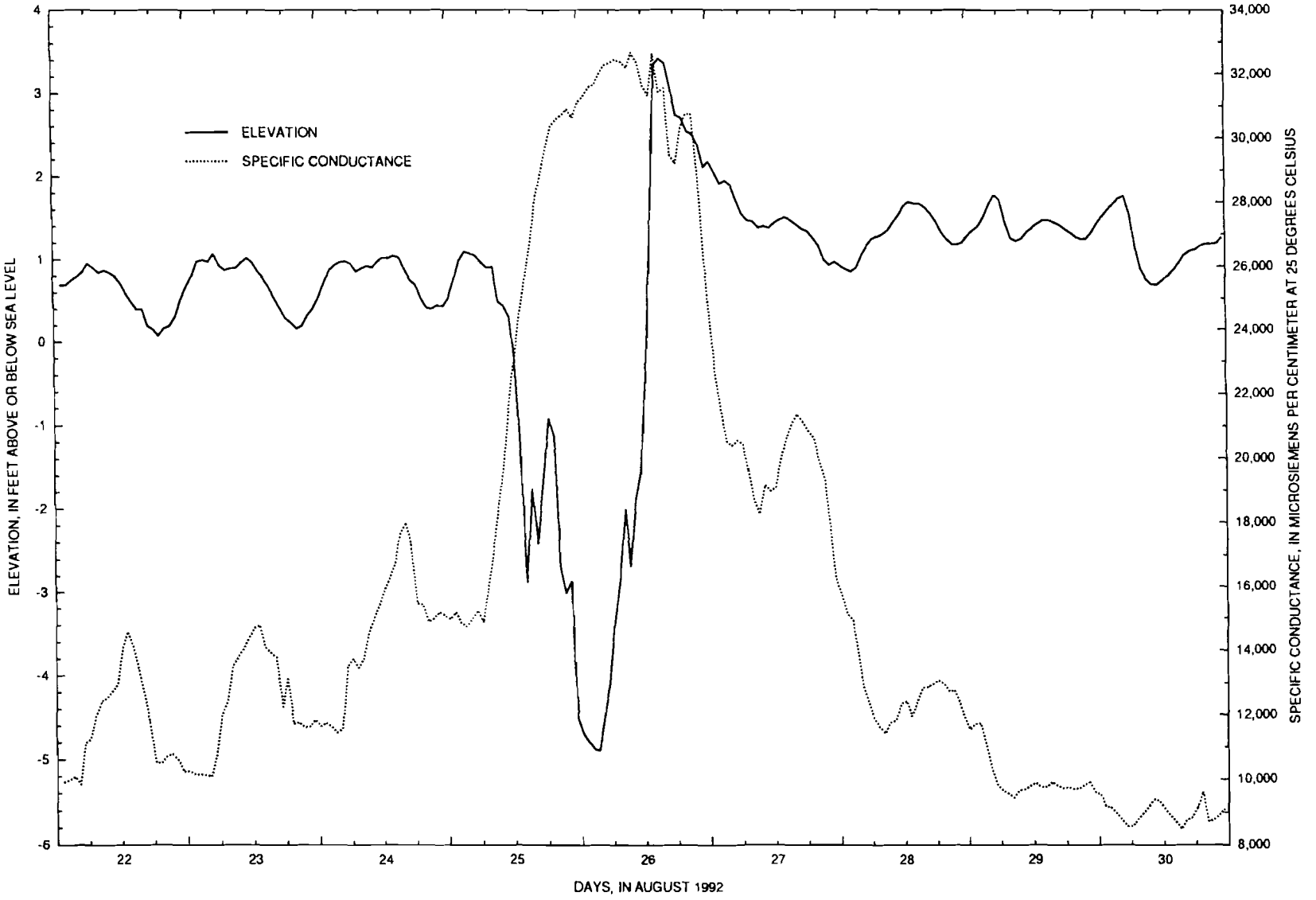

Figure 20. Elevation and specific conductance at gaging station 17, The Rigolets near Slidell, Louisiana.

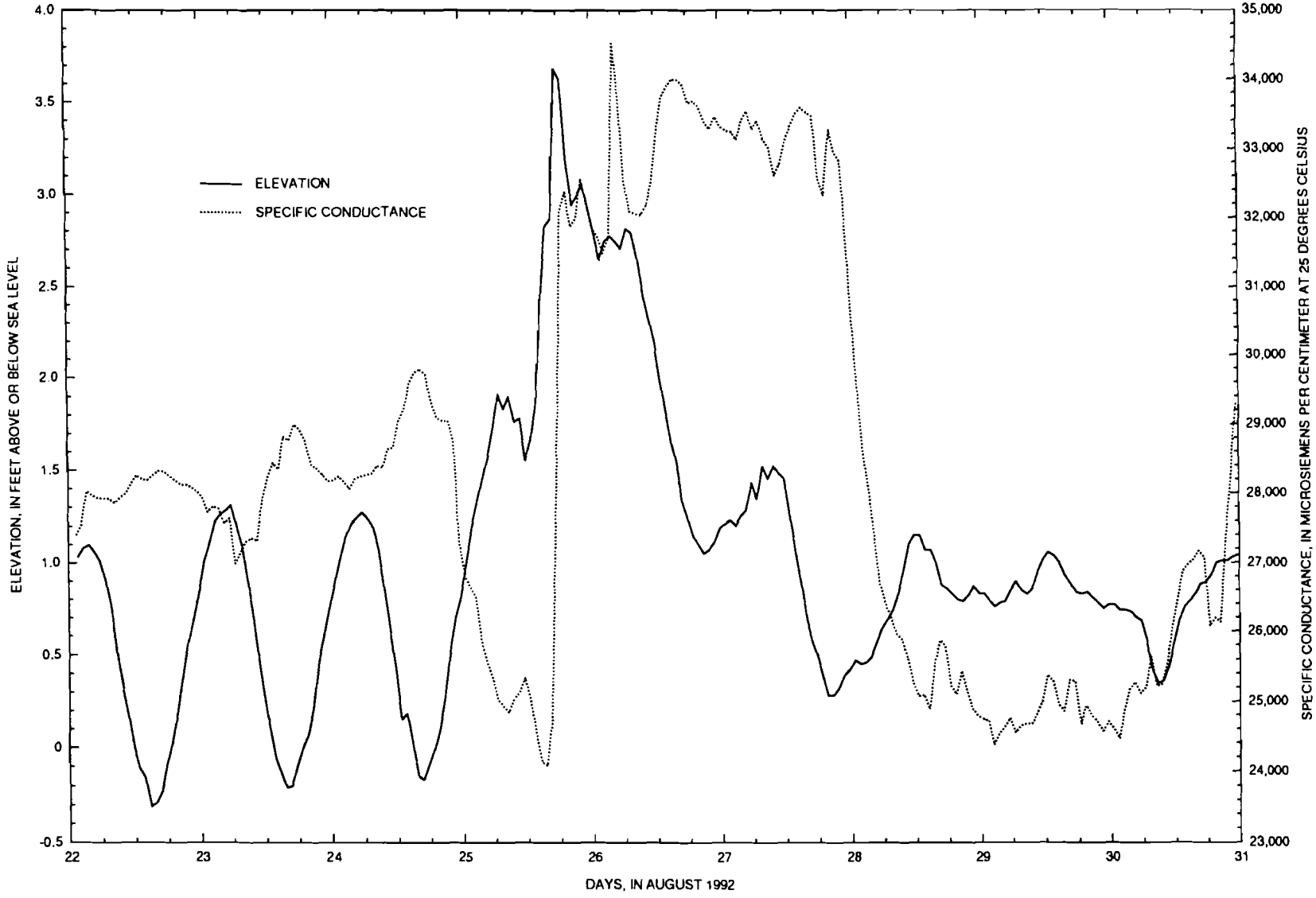

Figure 21. Elevation and specific conductance at gaging station 18, Barataria Pass, east of Grand Isle, Louisiana.

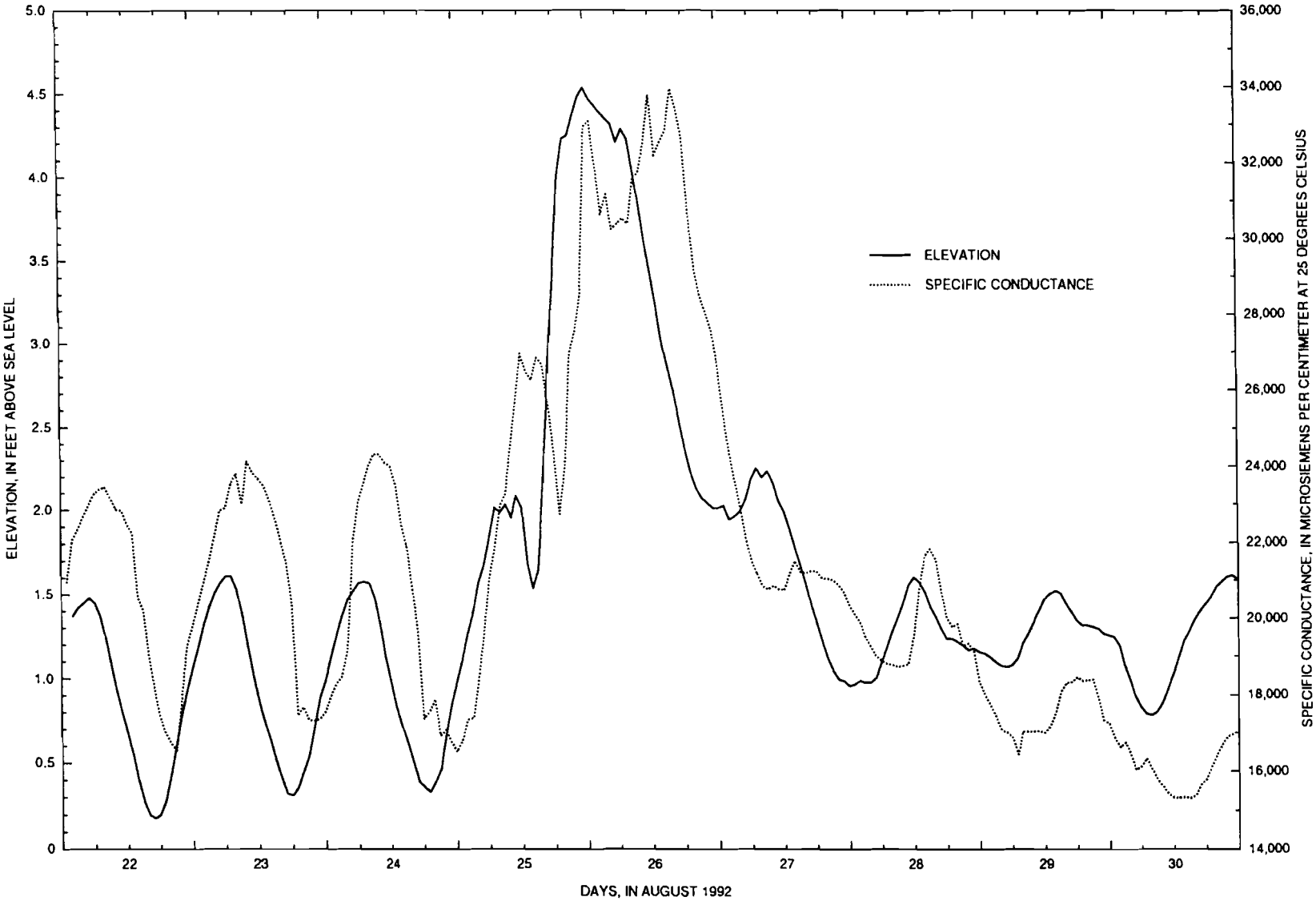

Figure 22. Elevation and specific conductance at gaging station 19, Barataria Bay, north of Grand Isle, Louisiana.

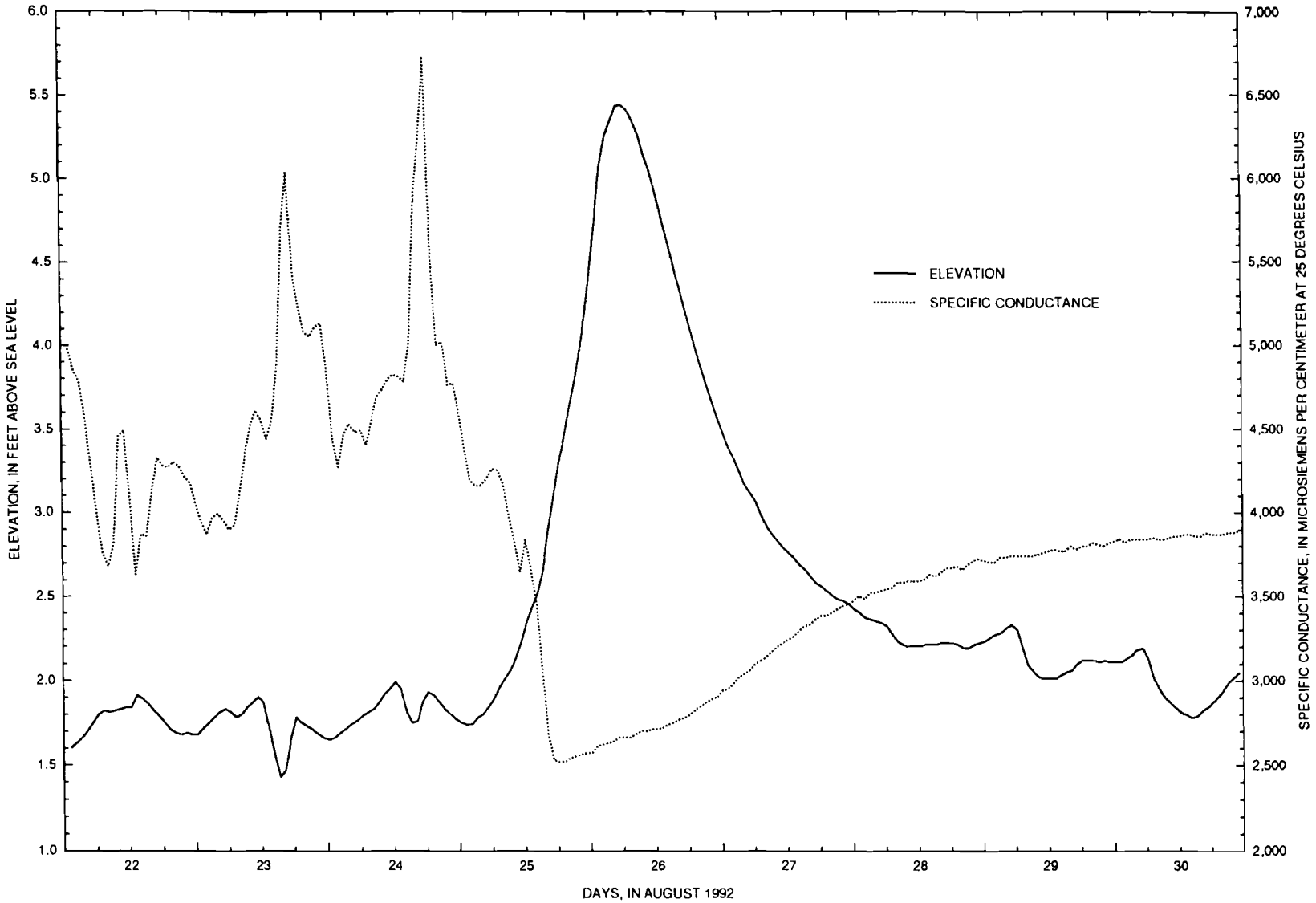

Figure 23. Elevation and specific conductance at gaging station 20, Tennessee Canal near Cut Off, Louisiana.

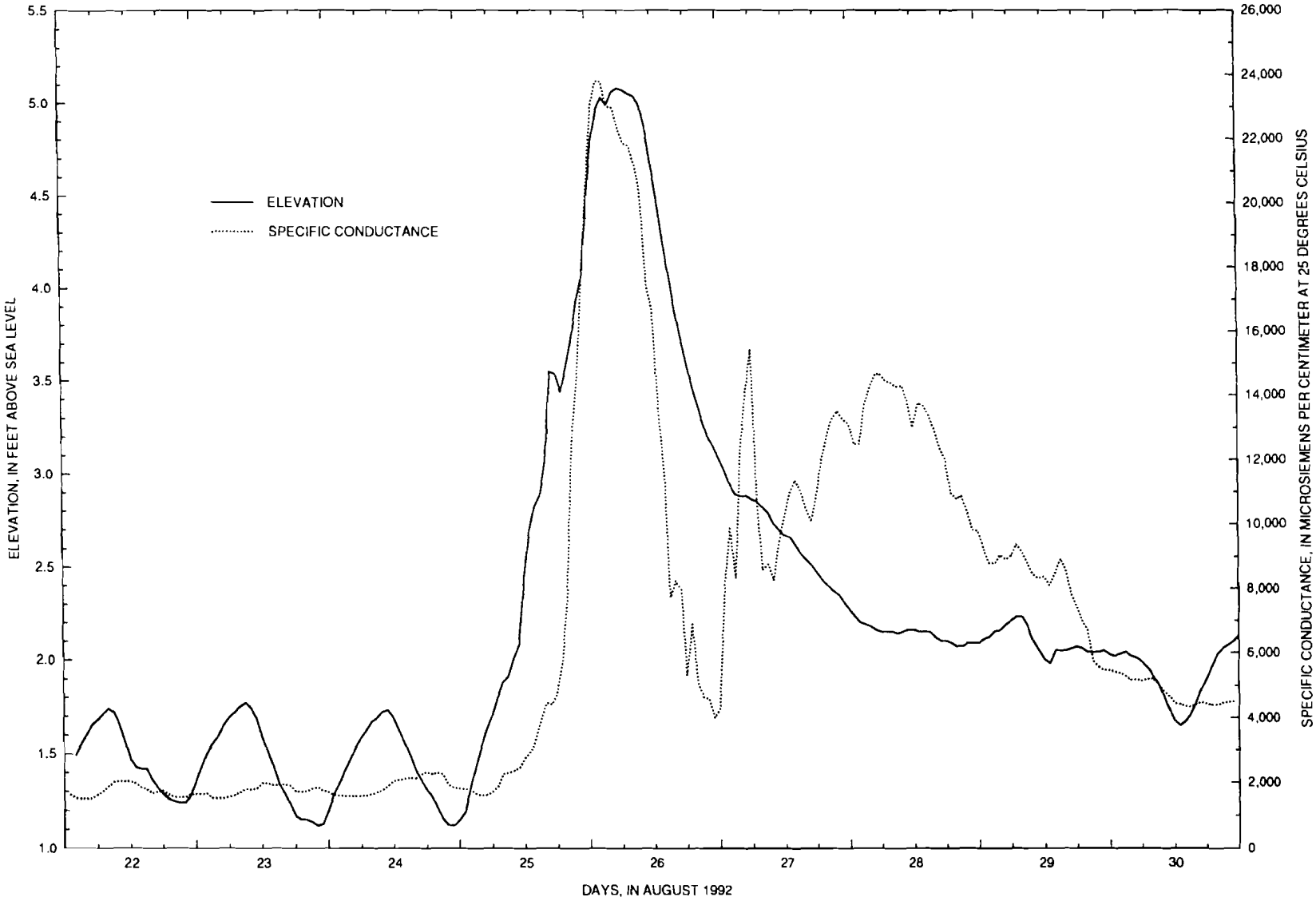

Figure 24. Elevation and specific conductance at gaging station 21, Little Lake near Cut Off, Louisiana.

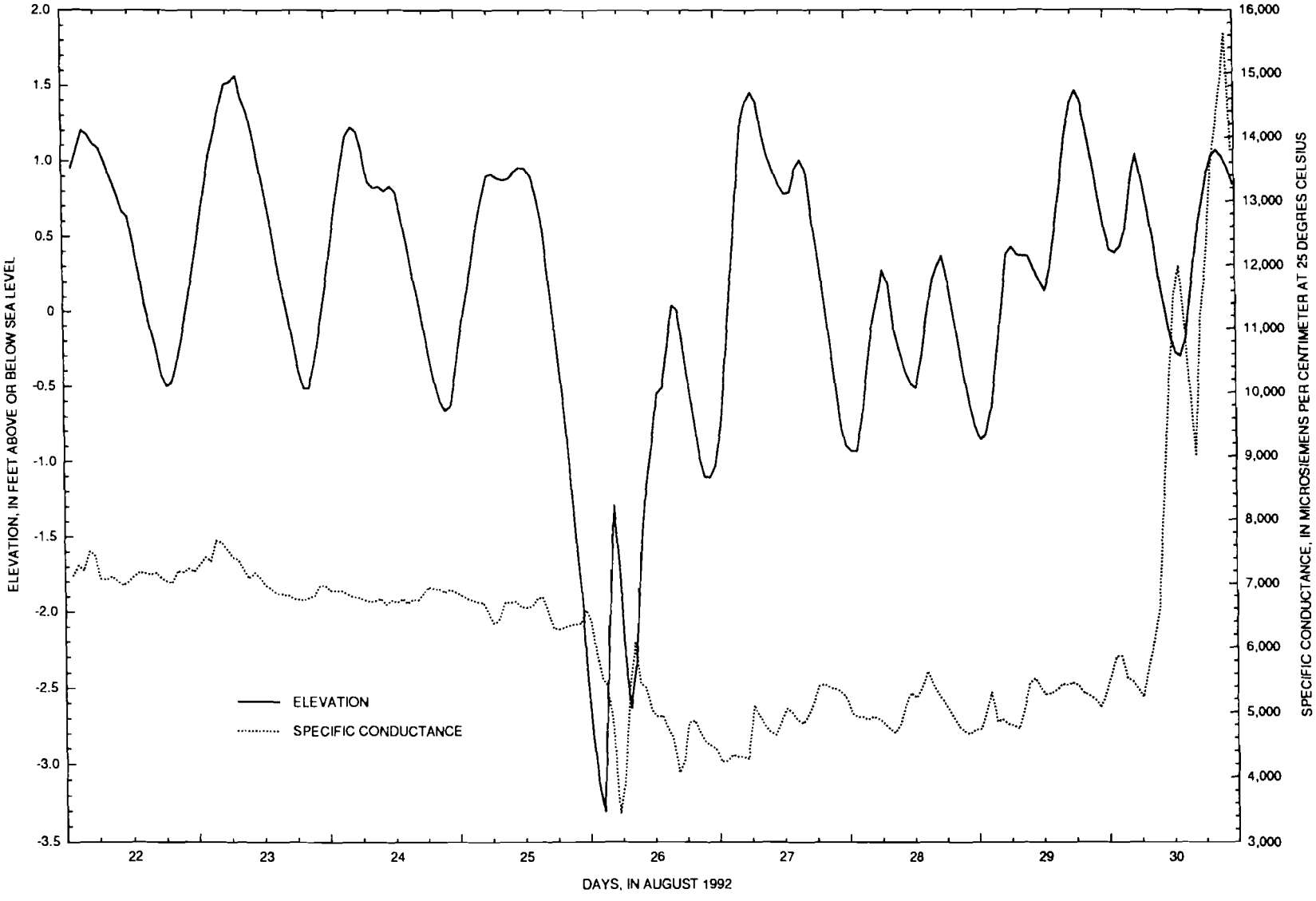

Figure 25. Elevation and specific conductance at gaging station 22, Vermilion Bay near Cypremort Point, Louisiana.

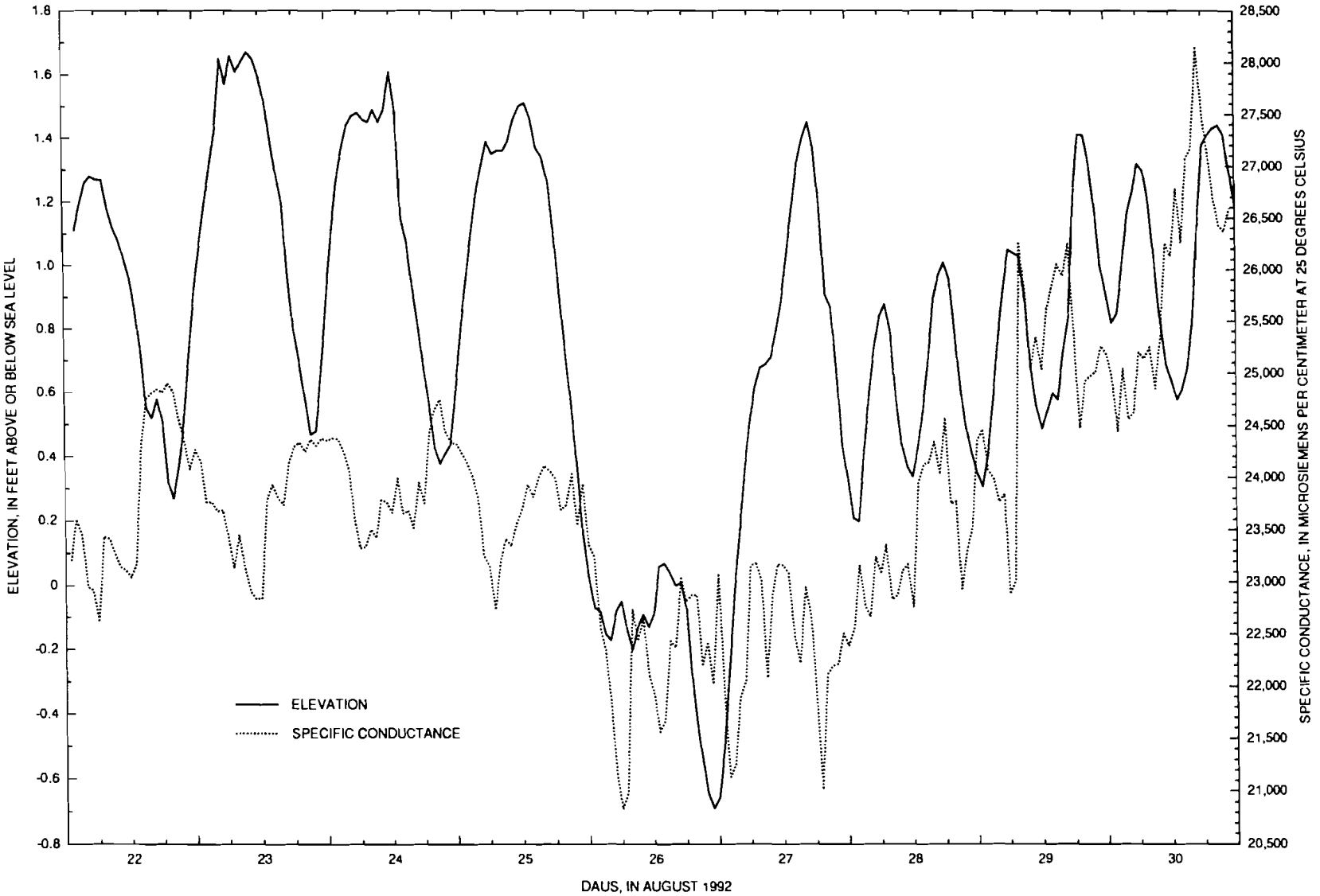

Figure 26. Elevation and specific conductance at gaging station 23, north Calcasieu Lake near Hackberry, Louisiana.

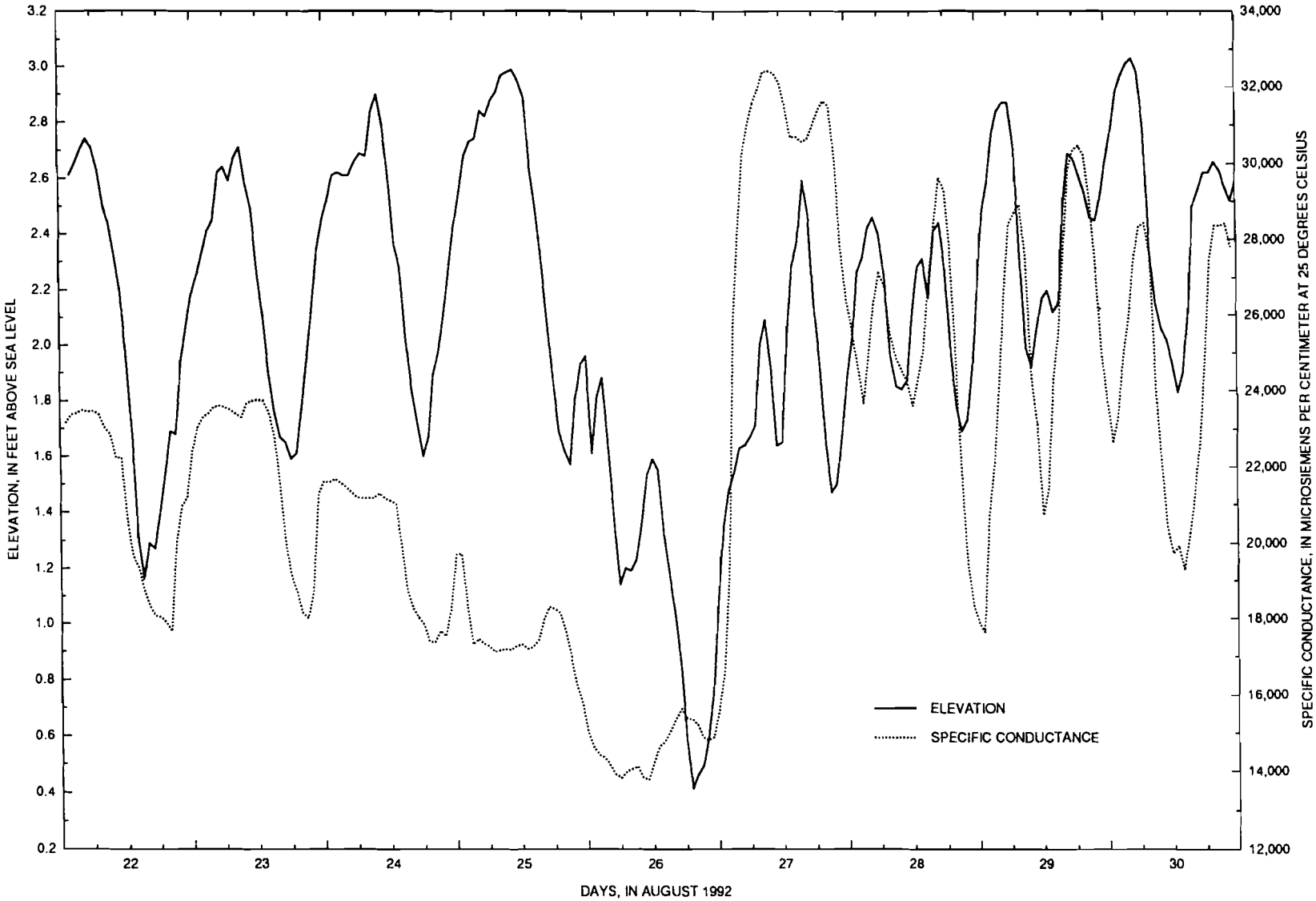

Figure 27. Elevation and specific conductance at gaging station 24, East Fork Tributary near Cameron, Louisiana.

SUMMARY

On August 26, 1992, at approximately 3:30 a.m., Hurricane Andrew made landfall at Point Chevreuil, La. The hurricane produced a storm tide that affected much of the Louisiana coast, including many coastal waterways and lakes hydraulically connected to the coast. High-water marks resulting from the storm tide on August 25-27, 1992, were located, documented, and surveyed in coastal areas of southeastern and south-central Louisiana. Storm-tide data from 69 high-water marks and 76 gaging stations are presented in tabular form and plotted on twelve 30 X 60-minute quadrangle maps as a series of plates. Time-series data from the 24 of the 76 gaging stations are presented as hydrographs.

The counter-clock-wise motion of the hurricane winds pushed water landward in areas east of landfall. From the Mississippi State line to Grand Isle, La., the elevation of the storm tide along the Louisiana coast, generally ranged from 3 to 5 feet above sea level. From Grand Isle to Point Chevreuil, La., the elevation of the storm tide along the coast generally ranged from 4 to 9 feet above sea level. Maximum storm-tide elevations recorded were 9.3 feet above sea level near Cocodrie, La., and 8.2 feet above sea level near landfall at Point Chevreuil, La. West of landfall, the winds pushed the water southward, producing a negative storm tide in areas along the coast to the Texas State line. From landfall to the Texas State line, the negative storm tide generally ranged from 0.5 to 3 feet below sea level. The lowest measurement, 3.3 feet below sea level, was recorded by a gage located at Cypremort Point, La., about 10 miles west of landfall. Other approximate storm-tide elevations (in feet above sea level) along the Louisiana coast were as follows: Lake Pontchartrain, 4; Breton Sound, 5; Barataria Bay, 4; Grand Isle, 4; Terrebonne Bay, 9; Atchafalaya Bay, 8; East Cote Blanche Bay, 8; Vermilion Bay, -3; and Calcasieu Pass, -1.

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Table 1. Location, description, and elevation of high-water marks along the Louisiana coast

[P, poor; G, good; F, fair; O, outside; I, inside]

Plate number (figure 2)	Water-surface elevation (feet above sea level)	Land-surface elevation (feet above sea level)	High-water marks				Latitude	Longitude	Quadrangle	Nearest town
			Number	Quality	Type	Inside or outside				
7	8.00	4.24	1	P	seed	O	293333	913133	Morgan City	Burns
7	6.68	4.24	2	G	seed	O	293334	913130	Morgan City	Burns
7	6.55	5.45	3	G	seed	I	293422	913213	Morgan City	Burns
7	6.48	5.59	4	G	stain	I	293559	913119	Morgan City	Gordy
8	4.03	6.02	5	F	seed	O	293025	904033	New Orleans	Ashland
8	4.28	1.67	6	G	stain	O	294106	900613	New Orleans	Lafitte
9	4.08	.56	7	G	drift	O	293802	895707	Black Bay	Myrtle Grove
12	3.61	2.37	8	G	stain	I	292057	893218	Mississippi River Delta	Buras
12	2.65	[a]2.00	9	G	stain	I	291542	895745	Mississippi River Delta	Grand Isle
11	3.14	[a]2.00	10	F	stain	O	292004	901431	Terrebonne Bay	Golden Meadow
11	3.39	1.79	11	G	debris	I	291525	901253	Terrebonne Bay	Leeville
11	4.89	[a]2.00	12	F	drift	O	292035	901449	Terrebonne Bay	Golden Meadow
11	4.59	[a]2.00	13	G	stain	I	292017	901438	Terrebonne Bay	Golden Meadow
11	3.11	1.02	14	G	drift	I	292027	901445	Terrebonne Bay	Golden Meadow
11	3.55	[a]2.00	15	G	drift	I	291932	901427	Terrebonne Bay	Golden Meadow
11	3.57	[a]2.00	16	G	wash	I	291715	901352	Terrebonne Bay	Leeville

Table 1. Location, description, and elevation of high-water marks along the Louisiana coast--Continued

Plate number (figure 2)	Water-surface elevation (feet above sea level)	Land-surface elevation (feet above sea level)	High-water marks				Latitude	Longitude	Quadrangle	Nearest town
			Number	Quality	Type	Inside or outside				
11	7.50	2.52	17	G	stain	I	292504	902654	Terrebonne Bay	Montegut
11	7.71	3.33	18	G	debris	I	292527	902704	Terrebonne Bay	Montegut
11	8.03	3.33	19	G	debris	O	292545	902726	Terrebonne Bay	Montegut
11	7.01	3.30	20	G	debris	O	292614	902736	Terrebonne Bay	Montegut
11	7.23	3.15	21	G	debris	I	292728	902842	Terrebonne Bay	Montegut
11	6.46	3.14	22	G	debris	I	292745	902916	Terrebonne Bay	Montegut
11	5.78	2.98	23	G	seed	I	292348	904227	Terrebonne Bay	Dulac
11	6.05	3.84	24	G	seed	I	292457	904159	Terrebonne Bay	Boudreaux
11	6.02	2.69	25	G	seed	I	292509	904159	Terrebonne Bay	Boudreaux
11	7.37	4.77	26	G	seed	I	292613	904207	Terrebonne Bay	Boudreaux
11	5.63	4.34	27	F	stain	I	292717	904209	Terrebonne Bay	Boudreaux
11	4.37	2.81	28	F	stain	I	292919	904146	Terrebonne Bay	Ashland
11	3.32	2.28	29	G	stain	O	292952	904058	Terrebonne Bay	Ashland
11	6.88	4.53	30	G	stain	O	292313	903707	Terrebonne Bay	Chauvin
11	4.56	2.21	31	G	debris	I	292312	903715	Terrebonne Bay	Chauvin
11	4.23	3.29	32	G	debris	O	292411	903634	Terrebonne Bay	Chauvin
11	4.58	3.00	33	G	debris	I	292553	903550	Terrebonne Bay	Chauvin
11	4.46	2.64	34	G	debris	I	292655	903536	Terrebonne Bay	Chauvin
11	6.80	4.18	35	G	debris	I	292834	903016	Terrebonne Bay	Montegut
11	5.44	5.35	36	G	debris	O	292924	903110	Terrebonne Bay	Montegut

Table 1. Location, description, and elevation of high-water marks along the Louisiana coast--Continued

Plate number (figure 2)	Water-surface elevation (feet above sea level)	Land-surface elevation (feet above sea level)	High-water marks				Latitude	Longitude	Quadrangle	Nearest town
			Number	Quality	Type	Inside or outside				
11	8.74	1.28	37	G	seed	I	292339	903516	Terrebonne Bay	Lapeyrouse
11	9.45	2.89	38	G	stain	I	292351	903707	Terrebonne Bay	Lapeyrouse
11	7.55	3.72	39	F	drift	O	292424	903437	Terrebonne Bay	Lapeyrouse
11	7.91	4.41	40	G	stain	I	292534	903401	Terrebonne Bay	Point Barre
11	6.96	[a]4.96	41	G	debris	O	292616	903360	Terrebonne Bay	Point Barre
11	7.00	4.94	42	G	seed	I	292731	903345	Terrebonne Bay	Montegut
11	5.73	[a]4.98	43	G	seed	I	292854	903340	Terrebonne Bay	Montegut
11	[b]4.38	[a]3.00	44	P	drift	I	292259	903702	Terrebonne Bay	Chauvin
11	[b]4.40	[a]3.00	45	P	drift	I	292252	903706	Terrebonne Bay	Chauvin
11	[c]8.48	[a]3.00	46	P	drift	O	292249	903705	Terrebonne Bay	Chauvin
11	[c]9.78	[a]3.00	47	P	drift	O	292247	903657	Terrebonne Bay	Chauvin
11	[d]9.66	[a]3.00	48	P	drift	O	292247	903654	Terrebonne Bay	Chauvin
11	[e]5.98	[a]3.00	49	P	drift	O	292308	903702	Terrebonne Bay	Chauvin
11	9.06	3.46	50	G	stain	I	291513	903938	Terrebonne Bay	Cocodrie
11	9.34	2.58	51	G	debris	I	291540	903920	Terrebonne Bay	Cocodrie
11	8.13	2.39	52	G	debris	I	291556	903842	Terrebonne Bay	Cocodrie
11	7.81	1.97	53	G	debris	I	291756	903857	Terrebonne Bay	Cocodrie
11	6.78	1.89	54	F	stain	O	291912	903844	Terrebonne Bay	Cocodrie
11	5.88	3.18	55	G	debris	I	292010	903826	Terrebonne Bay	Cocodrie
11	6.76	2.51	56	G	seed	I	292226	904254	Terrebonne Bay	Cocodrie

Table 1. Location, description, and elevation of high-water marks along the Louisiana coast--Continued

Plate number (figure 2)	Water-surface elevation (feet above sea level)	Land-surface elevation (feet above sea level)	High-water marks				Latitude	Longitude	Quadrangle	Nearest town
			Number	Quality	Type	Inside or outside				
11	6.90	2.63	57	G	seed	I	292202	903730	Terrebonne Bay	Chauvin
11	3.79	2.97	58	G	seed	O	292544	904541	Terrebonne Bay	Theriot
11	4.98	2.35	59	G	seed	O	292441	904702	Terrebonne Bay	Theriot
11	4.57	[a]3.97	60	G	seed	O	292326	904804	Terrebonne Bay	Theriot
11	3.65	1.80	61	G	seed	O	292156	904860	Terrebonne Bay	Theriot
11	4.92	[a]2.00	62	G	stain	I	292102	904950	Terrebonne Bay	Theriot
11	4.92	[a]2.00	63	F	stain	O	292044	905003	Terrebonne Bay	Theriot
11	3.60	2.41	64	G	stain	O	292156	904860	Terrebonne Bay	Theriot
11	3.42	2.11	65	G	seed	O	292154	904904	Terrebonne Bay	Theriot
11	4.84	2.58	66	G	seed	O	292022	905017	Terrebonne Bay	Theriot
11	5.00	1.60	67	G	stain	I	292141	904915	Terrebonne Bay	Theriot
11	3.19	1.19	68	G	drift	I	291347	901245	Terrebonne Bay	Leeville
11	2.97	1.34	69	G	drift	I	291152	900411	Terrebonne Bay	Grand Isle

[a] Estimated.

[b] The high-water mark was located on the inner, protected side of the hurricane protection levee.

[c] The high-water mark was located on the outer, unprotected side of the hurricane protection levee. The high elevations could be the result of the wind and wave action pushing water up the levee.

[d] The high-water mark was located on the top of the hurricane protection levee.

[e] The high-water mark was located on the outer, unprotected side of the hurricane protection levee, but in a leeward area near the floodgate and is probably a more accurate measure of the storm tide in this area.

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast

[Quadrangles are in Louisiana, except as noted. USGS-DNR, U.S. Geological Survey and Louisiana Department of Natural Resources; COE, U.S. Army Corps of Engineers; --, no event occurred; N.D., no data]

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
9	Black Bay	1	USGS-DNR	07374528	North California Bay near Point-a-la-Hache	293100	893500	25	1800	5.27[a]	--	--	--
9	Black Bay	2	USGS-DNR	07374527	Northeast Bay Gardene near Point-a-la-Hache	293600	894000	25	1900	4.99[a]	--	--	--
7	Morgan City	3	USGS	07381590	Wax Lake Outlet at Calumet	294152	912222	26	0825	7.36	26	0240	-0.93
11	Terrebonne Bay	4	USGS	07381324	Bayou Grand Caillou at Dulac	292258	904255	26	0629	5.39	--	--	--
9	Black Bay	5	USGS-DNR	07374526	Black Bay near Snake Island near Point-a-la-Hache	293800	893400	25	2000	5.63[a]	--	--	--
12	Mississippi River Delta	6	USGS-DNR	07374529	California Bay near Sunrise Point, northeast of Nairn	292908	893405	25	1400	5.32[a]	--	--	--
11	Terrebonne Bay	7	USGS-DNR	07381347	Unnamed lake tributary to Lake Boudreaux, southwest of Chauvin	292537	903718	26	1000	[b].00	--	--	--
2	Crowley	8	USGS	08012150	Mermentau River at Mermentau	301123	923525	--	--	--	26	0600	.21
6	White Lake	9	USGS	07386980	Vermilion River at Perry	295704	920922	--	--	--	26	0727	-.45
7	Morgan City	10	USGS	07385800	Bayou Teche near Franklin	294730	912956	26	1515	3.72	--	--	--
7	Morgan City	11	USGS	07381650	Lower Atchafalaya River below Sweet Bay Lake near Morgan City	293306	911441	26	1000	6.33	26	0230	-1.33

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast--Continued

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
7	Morgan City	12	USGS	07381600	Lower Atchafalaya River at Morgan City	294209	911207	26	0800	7.04	26	0200	1.19
11	Terrebonne Bay	13	USGS -DNR	07381328	Houma Navigation Canal at Dulac	292306	904347	26	1000	4.91	--	--	--
8	New Orleans	14	USGS -DNR	073802376	Lareussite Canal near Naomi	294130	900100	27	0100	3.89	--	--	--
2	Crowley	15	USGS	08012470	Bayou Lacassine near Lake Arthur	300412	925243	--	--	--	26	0830	.61
11	Terrebonne Bay	16	USGS -DNR	07381314	Grand Bayou tributary, west of Galliano	292720	902520	26	1200	3.81	--	--	--
4	Gulfport, Miss., La.	17	USGS -DNR	073802336 5	The Rigolets near Slidell	301010	894320	26	1520	3.42	26	0320	-4.90
12	Mississippi River Delta	18	USGS -DNR	073802515	Barataria Pass, east of Grand Isle	291631	895630	25	1740	3.68	--	--	--
12	Mississippi River Delta	19	USGS -DNR	07380251	Barataria Bay, north of Grand Isle	292511	895649	25	2400	4.54	--	--	--
11	Terrebonne Bay	20	USGS -DNR	07380340	Tennessee Canal near Cut Off	292720	901145	26	0620	5.44	--	--	--
8	New Orleans	21	USGS -DNR	07380335	Little Lake near Cut Off	293056	901103	26	0900	5.08	--	--	--
7	Morgan City	22	USGS -DNR	07387040	Vermilion Bay near Cypremort Point	294250	915254	--	--	--	26	0240	-3.30
1	Lake Charles, La., Tex.	23	USGS -DNR	08017095	North Calcasieu Lake near Hackberry	300154	931758	--	--	--	26	2300	-.69

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast--Continued

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
5	Port Arthur, Tex., La.	24	USGS -DNR	08017115	East Fork tributary near Cameron	294942	931958	--	--	--	26	1900	.41
12	Mississippi River Delta	25	COE	01480	Mississippi River at Venice	291622	892110	25	1700	3.74	--	--	--
7	Morgan City	26	COE	03555	Grand Lake at Charenton	295420	913126	26	1330	7.30	--	--	--
7	Morgan City	27	COE	03645	Six Mile Lake near Verdunville	294549	912335	26	0800	7.53	--	--	--
7	Morgan City	28	COE	03720	Wax Lake Outlet at Calumet	294209	912207	26	0700	6.68	26	0200	-.69
7	Morgan City	29	COE	03750	Lower Atchafalaya River at Berwick Lock (west)	294305	911329	26	1300	3.75	--	--	--
7	Morgan City	30	COE	03780	Lower Atchafalaya River at Morgan City	294140	911239	26	0830	6.80	26	0200	1.10
10	Atchafalaya Bay	31	COE	03850	Round Bayou at Deer Island	292828	911546	26	0700	7.65	26	0100	-.46
7	Morgan City	32	COE	52800	Bayou Boeuf at Amelia	294006	910550	26	2015	3.40	26	0200	.60
7	Morgan City	33	COE	64400	Charenton Drainage Canal near floodgate	295330	913132	26	1200	3.08	26	0400	-.13
7	Morgan City	34	COE	64450	Charenton Drainage Canal at Baldwin	294923	913230	26	1030	3.90	26	0200	-.56
7	Morgan City	35	COE	64650	Bayou Teche at West Calumet Floodgate	294213	912231	26	1700	3.40	26	0500	-.11

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast--Continued

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
6	White Lake	36	COE	67875	Vermilion River at Banker	295021	920736	--	--	--	26	1330	.65
9	Black Bay	37	COE	76005	Bayou Dupre at floodgate (west) (gate closed)	295628	895024	27	0300	1.72	--	--	--
9	Black Bay	38	COE	76010	Bayou Dupre at floodgate (east) (estimated)	295635	895024	25	N.D.	5.50[c]	--	--	
9	Black Bay	39	COE	76020	Bayou Bienvenue at Paris Road (gate closed)	295855	895647	26	1700	2.35	--	--	--
9	Black Bay	40	COE	76025	Bayou Bienvenue at floodgate (east)	295952	895455	25	1800	5.75	--	--	--
4	Gulfport, Miss., La.	41	COE	76040	Intracoastal Waterway near Paris Road bridge, New Orleans	300024	895605	25	1930	6.00	--	--	--
3	Ponchatoula	42	COE	76060	Inner Harbor Navigation Canal near Seabrook bridge, New Orleans	300145	900158	25	1900	4.06	--	--	--
8	New Orleans	43	COE	76120	Inner Harbor Navigation Canal at Florida Avenue bridge, New Orleans	295853	900115	25	1900	5.80	--	--	--
9	Black Bay	44	COE	76240	Intracoastal Waterway at Algiers Lock	295443	895828	26	0900	3.40	--	--	--
7	Morgan City	45	COE	76360	Bayou Boeuf (Intracoastal Waterway) at Bayou Boeuf Lock (east)	294059	911025	26	0800	3.59	--	--	--

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast--Continued

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
7	Morgan City	46	COE	76440	Intracoastal Waterway at Wax Lake (east control structure)	293827	911922	26	1200	6.15	--	--	--
6	White Lake	47	COE	76590	Freshwater Canal above Beef Ridge	293318	921819	--	--	--	26	1400	0.18
6	White Lake	48	COE	76593	Freshwater Canal at Freshwater Bayou Lock (south)	293309	921821	--	--	--	25	2000	-1.78
6	White Lake	49	COE	76600	Schooner Bayou (Inland Waterway) at east control structure	294528	921548	--	--	--	26	1100	-.55
6	White Lake	50	COE	76720	Intracoastal Waterway at Leland Bowman Lock (east auto)	294700	921140	--	--	--	26	0800	-1.83
11	Terrebonne Bay	51	COE	82250	Bayou Lafourche at Golden Meadow Floodgate (north)	292033	901444	27	1500	2.08	--	--	--
11	Terrebonne Bay	52	COE	82260	Bayou Lafourche at Golden Meadow Floodgate (south)	292030	901444	26	0600	6.19	--	--	--
11	Terrebonne Bay	53	COE	82310	Bayou Blue near Catfish Lake	292331	902049	26	1030	5.62	--	--	--
11	Terrebonne Bay	54	COE	82350	Bayou Lafourche at Leeville	291452	901232	26	0400	5.61	--	--	--
10	Atchafalaya Bay	55	COE	88600	Atchafalaya Bay at Eugene Island	292245	912254	N.D.	N.D.	N.D.	25	2200	-3.20
8	New Orleans	56	COE	82700	Bayou Des Allemandes at Des Allemandes	294926	902836	27	1230	2.78	--	--	--

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast--Continued

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
8	New Orleans	57	COE	82750	Bayou Barataria at Barataria	294429	900756	26	2400	3.50	--	--	--
8	New Orleans	58	COE	82875	Bayou Barataria at Lafitte	294006	900636	26	1230	4.20	--	--	--
9	Black Bay	59	COE	85111	Black Bay near Breton Sound	293500	893800	25	1800	5.02	--	--	--
12	Mississippi River Delta	60	COE	85222	Breton Sound at Breton Island	292730	891100	25	0900	4.17	--	--	--
3	Ponchatoula	61	COE	85420	Pass Manchac near Ponchatoula	301653	902401	26	1700	4.19	--	--	--
3	Ponchatoula	62	COE	85550	Lake Pontchartrain near Frenier	300622	902517	26	0100	4.16	--	--	--
3	Ponchatoula	63	COE	85564	Pipeline Canal at Illinois Central Railroad (north)	300144	901950	26	1800	3.19	--	--	--
3	Ponchatoula	64	COE	85566	Pipeline Canal at Illinois Central Railroad (south)	300144	901949	26	2000	2.65	--	--	--
3	Ponchatoula	65	COE	85575	Lake Pontchartrain at Mandeville	302131	900545	26	1400	4.64	--	--	--
3	Ponchatoula	66	COE	85600	Lake Pontchartrain at midlake near New Orleans	301116	900733	26	1800	4.35	--	--	--
3	Ponchatoula	67	COE	85625	Lake Pontchartrain at West End	300118	900657	26	1400	3.81	--	--	--

Table 2. Location, description, and elevation for peak storm-tide measurements at selected continuous gaging stations along the Louisiana coast--Continued

Plate number (figure 2)	Quadrangle	Gaging station number	Owner	Owner identification number	Station name	Latitude	Longitude	Maximum positive storm tide			Minimum negative storm tide		
								Day, August 1992	Time (hours)	Elevation (feet above sea level)	Day, August 1992	Time (hours)	Elevation (feet above sea level)
4	Gulfport, Miss., La.	68	COE	85675	Lake Pontchartrain (Irish Bayou) near south shore	300846	895141	26	1530	3.60	--	--	--
4	Gulfport, Miss., La.	69	COE	85700	The Rigolets near Lake Pontchartrain	301002	894413	26	1600	3.35	--	--	--
4	Gulfport, Miss., La.	70	COE	85750	Chef Menteur Pass near Lake Borgne	300404	894825	25	1800	3.90	--	--	--
9	Black Bay	71	COE	85780	Bayou Terre aux Boeuf at Delacroix	294550	894732	26	0600	4.90	--	--	--
9	Black Bay	72	COE	85800	Mississippi River Gulf Outlet at Shell Beach	295100	894100	25	1800	4.91	--	--	--
12	Mississippi River Delta	73	COE	88410	Bayou Rigaud at Grand Isle	291548	895724	25	1900	3.57	--	--	--
10	Atchafalaya Bay	74	COE	88550	Atchafalaya Bay near Eugene Island	292703	912028	26	0500	7.60	25	2200	-0.62
7	Morgan City	75	COE	88800	East Cote Blanche Bay at Lukes Landing	293548	913235	26	0600	8.19	N.D.	N.D.	N.D.
5	Port Arthur, Tex., La.	76	COE	73650	Calcasieu River and Pass near Cameron	294630	932046	--	--	--	26	1900	-.63

[a]Estimated.
[b]Gage heights not corrected to sea level. No elevation data available.
[c]Elevation estimated by U.S. Army Corps of Engineers.

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