REPORT

FLOOD INSURANCE STUDY

CHARLESTON COUNTY, SOUTH CAROLINA

Study for
Federal Insurance Administration
U.S. Department of Housing and Urban Development
by
U.S. National Oceanic and Atmospheric Administration
U.S. Department of Commerce

March 1973

00424

CONTENTS

	Page
1. Authorization for Study	1
2. Study Area	1
3. Flood Situation	3
4. Tide Frequency Analysis for Open Coast	3
a. Area of application	3
b. Summary of procedures for tide frequency analysis	6
c. Evaluation of results	6
5. Variation of Stage Frequency Within Project Area	7
a. Procedure in analysis	7
b. Flood hazard factors (FHF)	8
6. Demarcation of Flood Zones	9
Bibliography	11
Figures	
1. General map for flood insurance studies	2
2. Total tide frequency curves	4
3. Interpolated tide frequencies for 10-, 25-, 100- and 500-year floods	5

Appendix I - Hurricanes Affecting Charleston County

Appendix II - Tide Frequency Analysis for Open Coast of Charleston County

REPORT

FLOOD INSURANCE STUDY
FOR CHARLESTON COUNTY, SOUTH CAROLINA
INCLUDING INCORPORATED AREAS

1. Authorization for Study

This report summarizes a study on flooding for Charleston County, South Carolina, done by the National Oceanic and Atmospheric Administration (NOAA) for the Federal Insurance Administration (FIA) of the Department of Housing and Urban Development (HUD). Supportive data and materials of the study are filed within NOAA, some of which will be used in a more comprehensive report for a later time.

The study was conducted by NOAA for HUD on a reimbursable basis (Agreement No. IAA-H-29-70, Project Orders No. 2, dated June 8, 1970, and No. 3, dated July 6, 1970, and Agreement No. IAA-H-20-71 Project Order No. 1, dated October 14, 1970). The study was updated in 1972-73 by a comprehensive review of climatology and analysis. Organizational units within NOAA involved in this study were the National Ocean Survey (NOS) and the National Weather Service (NWS).

The purpose of the study was to obtain stage frequency relationships within Charleston County, including incorporated areas, and to demarcate on maps the zones of flooding for standard reference stage frequencies. These zones are for reference in defining actuarial rates of flood insurance and for use by local planners within the flood plain.

2. Study Area

This study covers tidal flooding for all of Charleston County, an area of 942 square miles. The County extends along the Atlantic Ocean about 75 miles and varies in width from 10 to 25 miles. See figure 1.

The population for Charleston County for 1970 was about 248,000 with Charleston, the principal city, having a population of about 67,000. In addition, there are ten small incorporated towns in the County which are: McClellanville, Mt. Pleasant, Isle of Palms, Sullivans Island, Edisto Beach, Folly Beach, Ravenel, Meggett, Hollywood, and Lincolnville. North Charleston is a developed urban area of about 20,000 population that is not incorporated. Much of the remainder of the county is rural.

The County generally is a low flat coastal plain with most of the area being below 20 feet mean sea level--the very highest

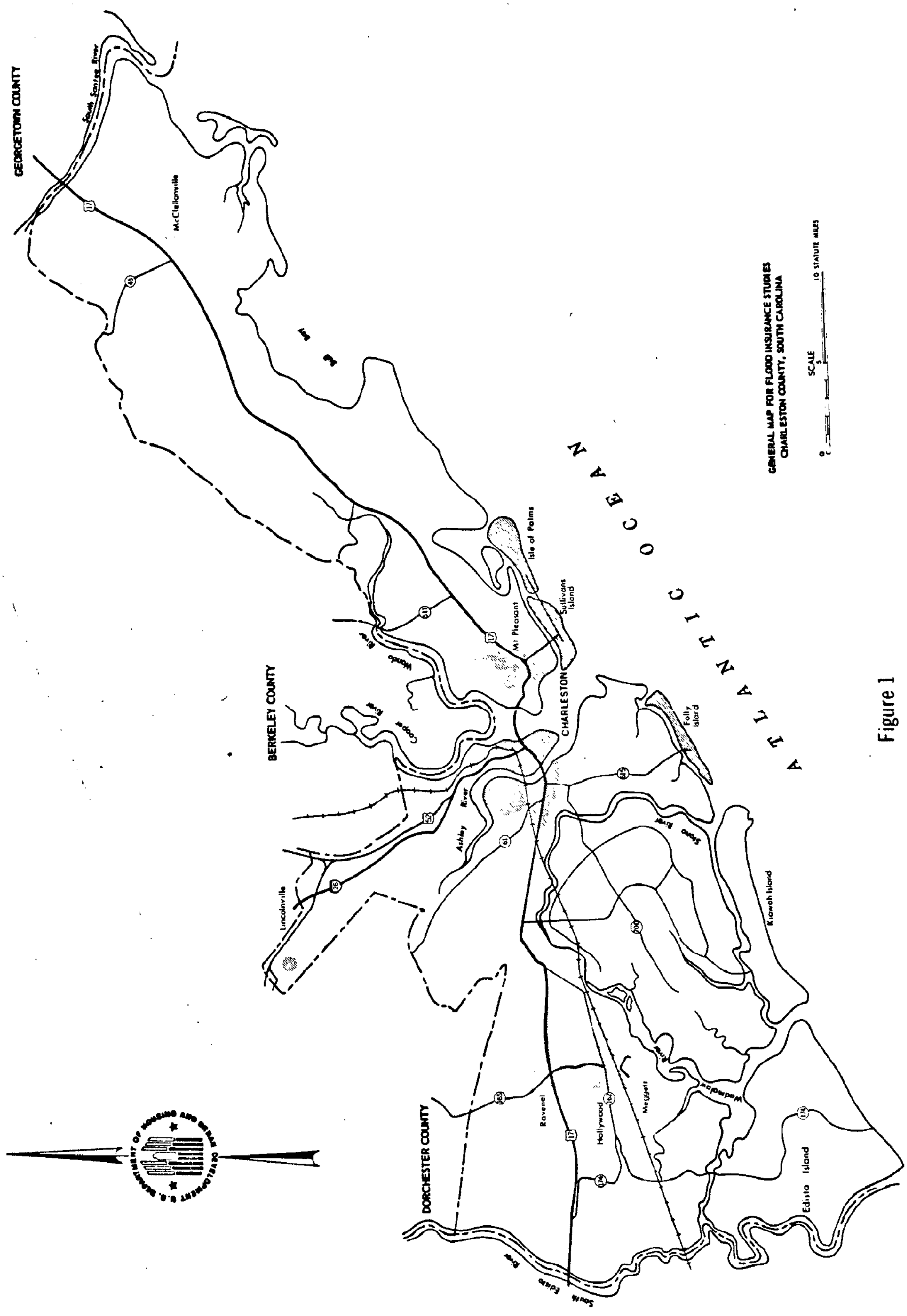

GENERAL MAP FOR FLOOD INSURANCE STUDIES
CHARLESTON COUNTY, SOUTH CAROLINA
SCALE
0
5
10 STATUTE MILES
GEORGETOWN COUNTY
South Santee River
McClellanville
Bull Bay
ATLANTIC OCEAN
Isle of Palms
Sullivans Island
Mt Pleasant
Wando River
BERKELEY COUNTY
Cooper River
CHARLESTON
Folly Island
Ashley River
Stono River
Lincolnville
Kiawah Island
DORCHESTER COUNTY
Ravenel
Hollywood
Meggett
Wadmalaw
River
Edisto Island
South Edisto River

Figure 1

terrain is only at about 70 feet. The area is much dissected by large marsh flats and numerous tidal streams.

3. Flood Situation

The physiography combines with the distribution of population to make most residents of Charleston County vulnerable to severe tidal floods, especially hurricanes. The drainage of the County is largely estuarine and thus subject to tidal flooding. Most drainage basins do not extend beyond the County boundaries and thus riverine flooding is of lesser consequence. Rainfall generally would not be the cause of major flooding.

The largest incorporated areas--Charleston, Mt. Pleasant, Folly Beach, Sullivans Island and Isle of Palms are very open to coastal flooding. Charleston and Mt. Pleasant are just inside a wide inlet and Folly Beach, Sullivans Island, and Isle of Palms are on low barrier islands. Much of North Charleston (unincorporated) is open to flooding via Cooper and Ashley Rivers.

The smaller incorporated towns of Meggett, Ravenel, Hollywood, McClellanville, and Lincolnville have much less tidal flooding problems. The other remaining towns fringe the coastal marshes and swamps, are low and flat, and have areas subject to flooding in severe storms.

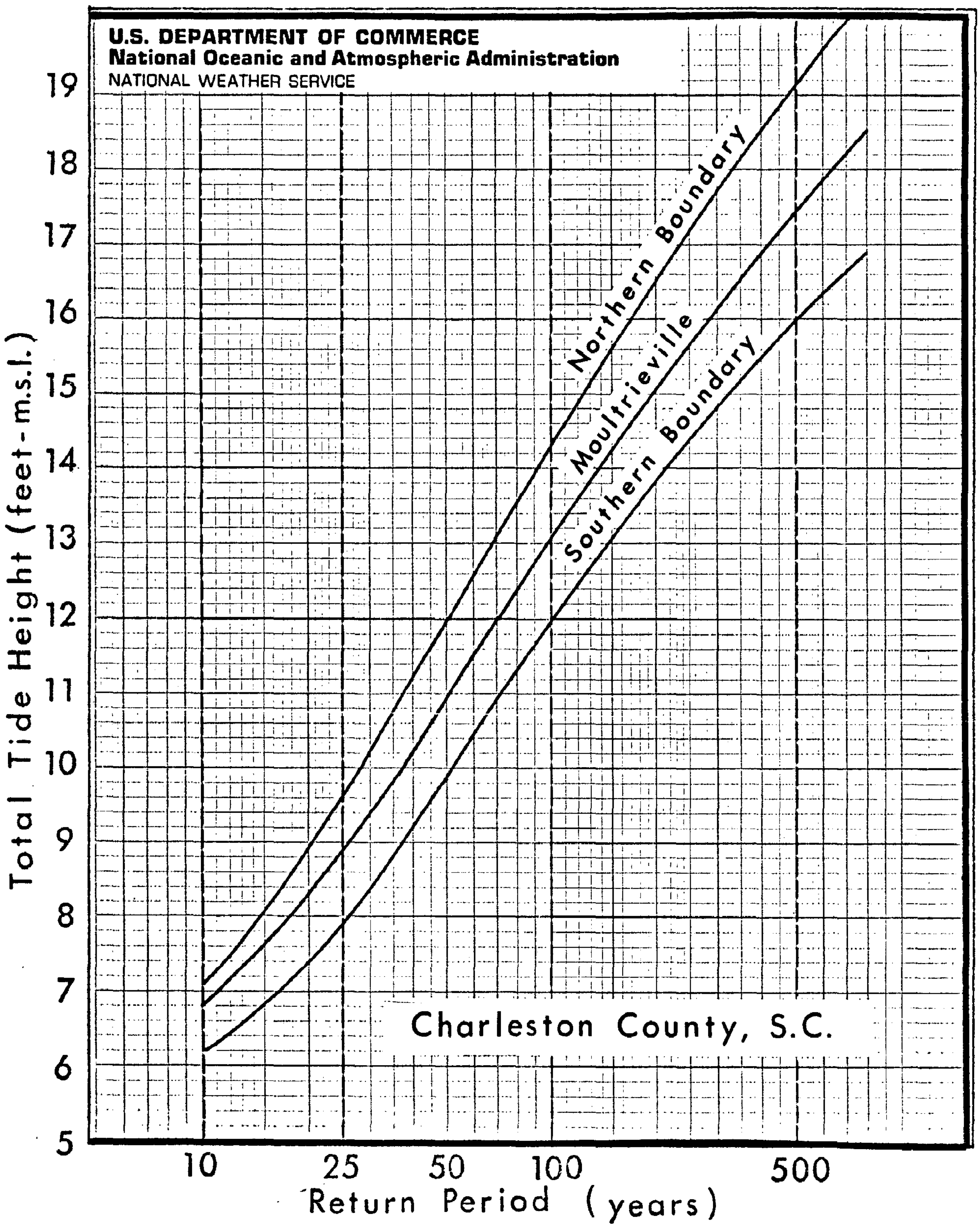
Charleston County has experienced many hurricanes with the earliest record being 1700. These have caused loss of life and incurred economic damages in millions of dollars. Early records were sketchy or lacking in quantitative data, but some surge and damage records are available for the severe storms from about 1900 and were considered in this study. See Appendix I for more details.

4. Tide Frequencey Analysis for Open Coast

a. Area of application

Tide frequencies were determined for representative points at the open coast of Charleston County. These results are summarized in figures 2 and 3.

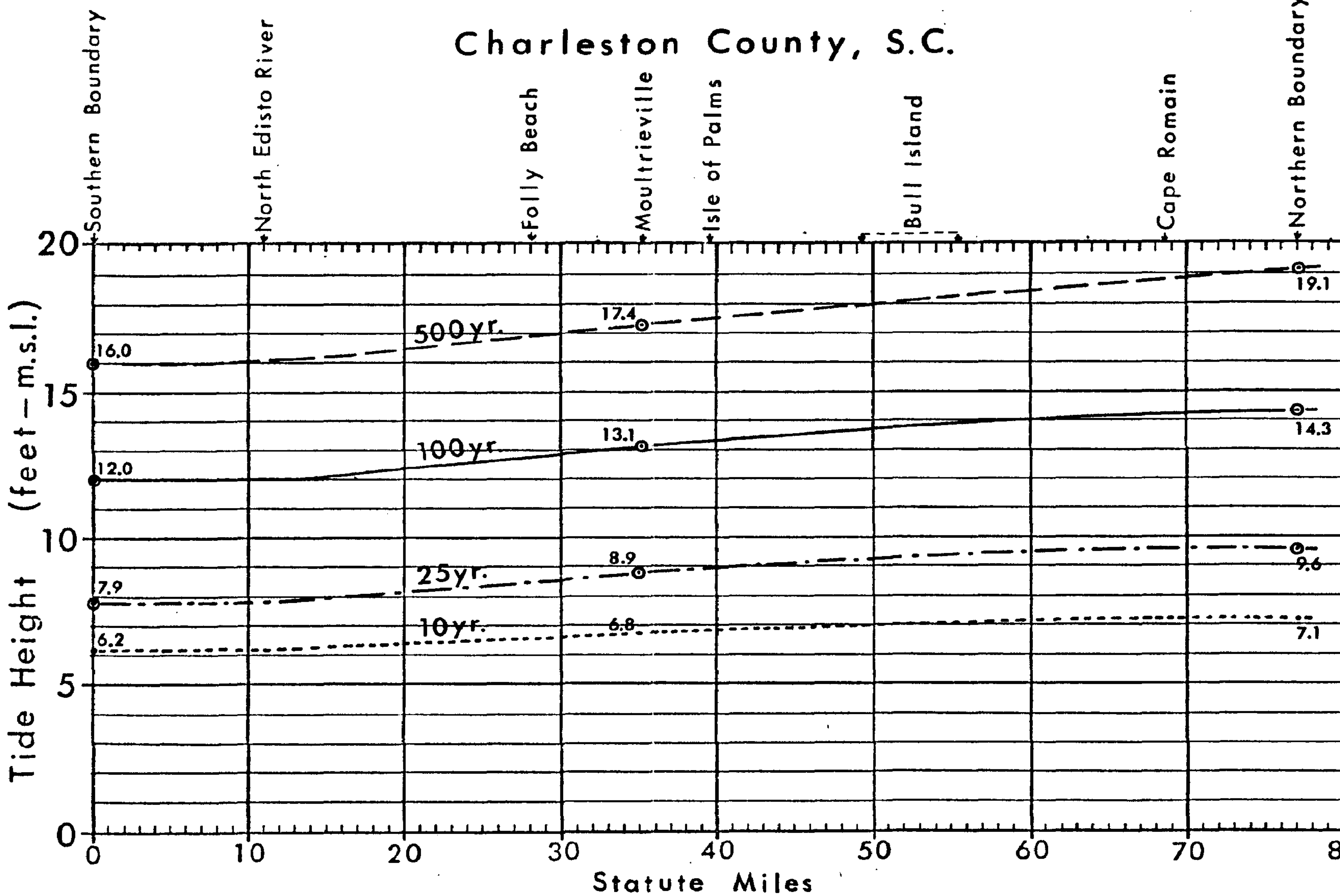
In the prior study by NOAA only one set of representative values were derived for the entire coast of Charleston County. For this study three location points were chosen to show the variation along the coast. Also the new values differ from the old ones for various reasons, such as new evaluation of climatology and finer analysis by computer.



Total Tide Frequency Curve

Figure 1.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE



Interpolated tide frequencies for the 10-, 25-, 100- and 500-year return period (Charleston County, S.C.)

Figure 2.

12/14/72

b. Summary of procedures for tide frequency analysis

The basic approach for computing the tide frequencies is the same as that used by Myers in a tide frequency study for Atlantic City and Long Beach Island, New Jersey (1). Stated briefly, the approach is to first determine the climatology of hurricane parameters in the region of the study area. Then for various combinations of these parameters (intensity, extent, speed, and direction of motion), the large number of hypothetical storm surges are computed. These computations are made through time and space with a numerical model by Jelesnianski (2) and (3). Finally, the hypothetical surges are combined with numerous phasings of the astronomical tide (a joint probability method) to obtain the frequency distribution of total tides.

More details of this method are presented in Appendix II of this report, and the method will be detailed more fully at a later date in a NOAA technical report covering the coast of South Carolina.

c. Evaluation of results

The climatology of hurricanes and tropical storms is the integral part of this analysis and this is based on the total recorded observations available to the National Weather Service. The parameters which describe hurricanes, including frequency distribution, are derived by considering them over a large geographical region instead of for a point. The randomness of distribution in time and in space of severe storms necessitates this procedure and generally other prior methods did not use this approach.

The Jelesnianski method of computing surge heights, using meteorological parameters, has been validated by tests in which actual observations for some storms of record were used. The comparisons were very close (3).

Although the City of Charleston is in the hurricane region, the city has not had a direct hit by a severe hurricane. The highest recorded surge at Charleston was 8.9 ft. MSL in 1940, but this same storm gave Edisto Beach over 14 ft. Also, Myrtle Beach, some 70 miles northward, had surges of 15.5 ft. MSL in hurricane Hazel 1954 and areas of Georgia about 80 miles southward reported surges of 19.5 ft. MSL during the storm of 1893.

The randomness of occurrence of the storms, relative to periodic astronomic tides, indicates that the meteorological surge be handled as a separate phenomenon which was done in this study. This is more critical with the small sample of data which is generally the case. In most studies, the total observed flood elevation has been used as the basic statistic regardless of the relationship to the periodic tide. For Charleston, with a mean range of 5.2 ft. and a spring range of 6.1 ft., this is very significant in the analysis. Thus, hurricane Gracie 1959 occurred at low water and produced surges at Charleston of 8 ft. or 6 ft. MSL, but it would have been about 12 ft. MSL at astronomic high water--3 ft. higher than the highest surge of record.

5. Variation of Flood Frequency Within Project Area

a. Procedure in analysis

The variation of stage-frequencies along the outer coast is depicted in figures 2 and 3. The analysis by which these values were derived is given in Appendix II.

The decay of the storm surge inland is governed much by the local physiography and terrain elevations. This presently cannot be rigorously analyzed but must be largely handled by subjective analysis with limited guidelines. There is much variation in the features in the coastal areas of Charleston County to cuase differences in the heights of the storm surge and critical features are discussed below.

St. Helena Sound at the southern boundary, Charleston Harbor, Bull Bay, and Cape Romain Harbor all are much open to coastal flooding. The outer barrier areas from Edisto Beach to Folly Island are generally sufficiently solid and continuous and high enough to impede much of the reference flood surge. However, the surge would readily enter into the North Edisto River and the Stono River but would be much dissipated by the large storage areas provided by the extensive marshlands.

Northward of Charleston Harbor to Bull Island is another coastal barrier area that would impede surge. Here the four inlets would allow much flow but this would be reduced by extensive storage areas of the marshlands. Northward from Bull Island it was assumed there would be little barrier effect.

The main drainage features which would allow entrance of the surge inland are mentioned above. However, extensive marsh areas of the County are dissected by a network of small estaurine drainage much of which parallels the coast and would not favor the inland flow of surge. Also inland flow for some other areas is impeded by terrain features and by bridges and causeway constructions. The effects for these were estimated in establishing the reaches.

Establishing the flood gradients for overland or solid barrier areas was done according to some preliminary studies in the NWS. Flood gradients for the open water courses were based on other indicators such as high marks and by analogy with other areas with flood experience.

During this study, the U. S. Army Corps of Engineers initiated a study to predict inland flooding from hurricanes for Charleston

County. It is suggested that the values derived herein be reviewed when this C. of E. study is completed. However, the values are believed to be reasonable and representative.

b. Flood hazard factors (FHF)

The table below shows FHF's for each zone or reach delineated on the flood insurance maps. These values define the actuarial rates and were derived according to guidelines from FIA and refer to Sea Level Datum of 1929.

(1) Charleston County

Zone	100-year flood	FHF
V1	14 feet	070C
A2	13	"
A3	12	"
A4	11	"
A5	10	"
A6	9	"
A7	8	"
V8	13	065E
A9	12	"
A10	11	"
A11	10	"
A12	9	"
A13	8	"
A14	7	""
V15	12	060F
A16	11	"
A17	10	"
A18	9	"
A19	8	"
A20	7	"
A21	11	070C
A22	8	065E
A23	9	"
A24	10	"
A25	7	"
A26	9	060F
A27	8	"

(2) City of Charleston

A1	12	065E
A2	11	"
A3	10	"
A4	9	"
A5	10	"
A6	12	"

(3) Town of Edisto Beach

Zone	100-year flood	FHF
V1	12 feet	060F
A2	11	"

(4) Township of Sullivans Island

Zone	100-year flood	FHF
V1	13 feet	065E
A2	12	"

(5) Town of Mount Pleasant

Zone	100-year flood	FHF
A1	12 feet	065E
A2	11	"
A3	10	"
A4	10	"

(6) Township of Folly Beach

Zone	100-year flood	FHF
V1	13 feet	065E
A2	12	"

(7) City of Isle of Palms

Zone	100-year flood	FHF
V1	13 feet	065E
A2	12	"

6. Demarcation of Flood Zones

The basis for geographic features of the insurance maps are the United States Geological Survey with some revision for new features.

The basic flood zones depicted are as follows:

Zone A - Area of special hazard as defined by the 100-year flood.

Zone V - Exposed area of Zone A that is subject to the impact of waves and water with velocity. Extent of area depends on characteristics of waves and terrain at the shore and would affect structures at a higher elevation than the 100-year flood.

Zone B - Area of moderate flood hazard as defined by the 500-year flood.

Zone C - Area of minimal flood hazard.

Zone D - Area of undetermined, but possible, flood hazard.

The upper limit of the Zone A was based on terrain elevation, e.g., the 100-year flood elevation at that location. This line was then adjusted generally upward for easy reference to some identifiable feature and also was generalized to more practically depict the zone on an insurance map. Thus, the zone limits only approximate the flood contour for the 100-year flood.

This study attempted to define all areas of Charleston County that were subject to severe tidal flooding. Some inland areas were excluded on this basis and are shown on the maps as unsurveyed. Some of these areas are largely swamp and are subject to rainfall flooding. However, there is no apparent need at present for flood insurance studies in these areas.

BIBLIOGRAPHY

1. Myers, Vance., "Joint Probability Method of Tide Frequency Analysis, Applied to Atlantic City and Long Beach Island, N. J." ESSA Technical Memorandum, WBTM HYDRO 11, Weather Bureau, Washington, D. C., April 1970.

2. Jelesnianski, Chester P., "Estimation of Hurricane Surge Hydrographs," Journal of the Waterways and Harbors Division, Proceedings of ASCE, No. 5945, May 1968.

3. Jelesnianski, Chester P., "SPLASH (Special Program to List Amplitudes of Surges from Hurricanes)--I. Landfall Storms," NOAA Technical Memorandum NWS TDL-46, Silver Spring, Maryland, April 1972.

4. Corps of Engineers, U. S. Army, "Appraisal Report-Investigation on Hurricanes and Associated Problems Along the South Carolina Coast," January 1957.

APPENDIX I

HURRICANES AFFECTING CHARLESTON COUNTY, SOUTH CAROLINA

Storm tides of flood-producing proportions on the Charleston County coast are caused by hurricanes. Figure A1 shows the tracks of hurricanes that have passed over or near the county. Dates of hurricanes are shown along their respective tracks. Dates of major hurricanes are underlined. A dashed line indicates that the intensity had decreased to that of a tropical storm.

The information on hurricane tracks is taken from the charts of North Atlantic tropical cyclones compiled by Cry [1] for the years 1871 to 1963. For 1964 through 1972, similar tracks are published in the Monthly Weather Review, a professional journal of the National Oceanic and Atmospheric Administration. However, no tracks crossed the county during this period. Nine hurricanes passed through Charleston County during 100 years, five of which entered the coast from the Atlantic Ocean.

Storms affecting Charleston County and vicinity, 1871-1972, are tabulated with certain parameters in table A1. Brief description of each given below. This information is abstracted from the published works of Tannehill [2] and Dunn and Miller [3] and, for the most recent storms, from the Monthly Weather Review. Damage figures are those determined for values at the time of the storm; no attempt has been made to adjust these figures to present-day values.

August 16-19, 1871

After moving overland across Florida and Georgia, the center of the tropical cyclone passed through South Carolina, some 30 miles inland, in a direction almost parallel to the coast. It passed through Georgetown County and crossed the coast into the Atlantic. The storm caused damage along the Florida, Georgia, and South Carolina coasts.

September 30-October 6, 1871

This tropical storm originated in the southwest portion of the Gulf of Mexico, moved northward toward Texas, and then turned sharply eastward and entered the Florida coast near Appalachicola. It then turned northeastward, passing through extreme southeast Georgia, and finally crossed into the Atlantic at a point near Charleston, South Carolina. Its center moved in a northeasterly direction along the South Carolina coast.

September 1-13, 1878

This hurricane moved almost due north from the Florida Keys to Lake Erie. The storm exited Florida near Daytona Beach and re-entered the coast near Beaufort, South Carolina, on September 12. A great many ships were damaged and wrecked. A few persons were killed in this storm.

August 21-29, 1881

This major hurricane developed northeast of Puerto Rico on August 22. Its center entered the coast south of Savannah, Georgia, on August 27. The lowest pressure recorded at Savannah was 29.08 inches. Over 700 people lost their lives in this hurricane, about 335 in and near Savannah. Nearly 100 vessels were wrecked along the coast. Damage was very heavy on Tybee and other coastal islands near Savannah. Highest tide at Savannah Beach, Georgia, was estimated at 16.5 feet above mean sea level (MSL).

August 21-26, 1885

First discovered near the Bahamas, this major hurricane moved to near southern Florida and then turned sharply northward, entering the South Carolina coast near Beaufort on August 25. The storm caused heavy damage in the Carolinas. The death toll reached 21 in Charleston, South Carolina. Total damage was estimated at about $1.7 million.

June 12-20, 1893

After crossing northern Florida and Georgia from the Gulf of Mexico, the center of this hurricane moved into the Atlantic and re-entered the coast near Charleston, South Carolina, on June 16. It passed through Georgetown County and moved across the coastal area of North Carolina. Damage was apparently light in this storm.

September 25-October 15, 1893

This was a second hurricane that entered the South Carolina coast near Charleston in the same year. After crossing the coast between Charleston and Georgetown, South Carolina, the center of this storm moved northward into North Carolina. Winds of 94 miles per hour were reported at Southport, North Carolina.

September 18-30, 1894

The center of this hurricane entered the coast over Edisto Island, South Carolina, and reached Charleston on September 27. The lowest barometric pressure recorded at Charleston was 29.11 inches. The center moved in a north-northeastward direction, through Georgetown County, into North Carolina.

August 30-September 1, 1898

This hurricane entered the Georgia-South Carolina coast and passed to the north of Savannah, Georgia, on August 30. Winds of Tybee Island, Georgia, were estimated at about 100 miles per hour. The storm surges were not high enough to cause extensive damage. However, the hurricane was accompanied by very heavy rains and the countryside was flooded for 100 miles around Savannah. Most roads and railroads were impassable because of high water.

September 8-15, 1904

After entering the coast north of Charleston, South Carolina, the center of the storm recurved and moved northeastward. Hurricane force winds were reported at points along the Atlantic coast. A number of lives were lost and many vessels were wrecked. There was much damage to seaside property along the path of the storm.

August 23-30, 1911

Heavy damage was inflicted by this hurricane along the coast between Charleston, South Carolina, and Savannah, Georgia, when the storm entered the coast on August 28. The center of the hurricane passed just south of Beaufort, South Carolina. At Charleston, the barometric pressure fell to 29.30 inches and winds reached 106 miles per hour. Lowest pressure recorded at Savannah was 29.02 inches. Seventeen persons lost their lives in the storm near Charleston. Damage in Charleston was estimated at $1 million.

July 11-15, 1916

The storm was first observed to the northeast of the Bahama Islands on July 12. Its center moved northwestward and entered the coast between Charleston and Georgetown, South Carolina, on July 14. The storm was of small diameter; property damage was not great and no lives were lost. Heavy rainfalls associated with the storm caused severe floods as the storm filled over the North Carolina mountains on the 16th.

August 5-15, 1940

The center of this hurricane entered the coast of Beaufort County, South Carolina, on August 11. At Beaufort, the maximum sustained wind was estimated to be 75 to 85 miles per hour and the highest tide, 12.4 feet MSL. The high tide together with the waves overtopped the seawall along Beaufort River and flooded the entire business area of the town to depths of 2 to 3 feet. The outlying islands (St. Helena, Hilton Head, Daufuskie, and Pinckney) were inundated by storm tides to a depth of 10 feet in some low areas. Total damage from this storm was estimated at about $7 million. Damage in Beaufort and vicinity was estimated at about $3 million.

October 9-16, 1947

Maximum windspeed of 77 miles per hour and the lowest surface pressure of 28.77 inches were reported at Savannah, Georgia, as the center of this hurricane entered the coast, south of the city, on October 15. Heavy losses were sustained at Savannah and Savannah Beach, where more than 1,500 buildings were substantially damaged. Total damage in the coastal area was estimated at more than $2 million. Damage in South Carolina was relatively light.

<u>August 18-September 2, 1952--ABLE</u>

Hurricane ABLE moved inland from the south on August 30. Its center passed near Beaufort, South Carolina, with maximum winds of about 100 miles per hour. The area of hurricane force winds from this storm was very small. At Charleston, South Carolina, about 50 miles east of the center, the winds reached 63 miles per hour, while at Savannah, Georgia, 30 to 40 miles to the west, the highest gusts were only 35 miles per hour. Two persons lost their lives in this hurricane in South Carolina. Total damage from this hurricane was estimated at $2.75 million. Damage in South Carolina amounted to about $2 million.

<u>September 20-October 2, 1959--GRACIE</u>

Hurricane GRACIE crossed the coast near St. Helena Sound and Edisto Island, about 10 miles east of Beaufort, South Carolina. The lowest surface pressure overland for this hurricane was 28.35 inches, recorded at the Marine Corps Auxiliary Air Station near Beaufort. Winds of 125 miles per hour were reported along Kiawah Island (northeast of Edisto Island). The storm surge, which occurred during a low-tide period, was not high enough to cause severe destruction. At Edisto Beach, high-water marks indicated that the tide ranged from 7.3 to 8.8 feet MSL. Wind damage in the Beaufort-St. Helena-Parris Island area was the worst in history, estimated at more than $3 million. Total damage in South Carolina was estimated to be $13 million.

REFERENCES--APPENDIX I

1. Cry, George C., "Tropical Cyclones of the North Atlantic Ocean--Tracks and Frequencies of Hurricanes and Tropical Storms, 1871-1963," Weather Bureau Technical Paper No. 55, Washington, D.C., 1965.

2. Tannehill, I. Ray, "Hurricanes--Their Nature and History," Princeton University Press, Princeton, 1956.

3. Dunn, G. E., and B. I. Miller, "Atlantic Hurricanes," Louisiana State University Press, Louisiana, 1964.

Table A1. Hurricanes affecting Charleston County, South Carolina, and vicinity, 1871-1972

Storm date	Direction (a)**	Direction (b)**	Forward speed (knots)	Principal places in South Carolina affected and remarks
Aug. 18, 1871	240	210	9	Coastal areas, South Carolina. Center of storm moved a short distance inland along the coasts of Florida, Georgia, and South Carolina, and exited South Carolina near Georgetown.
Oct. 6, 1871	240	190	9	Beaufort-Charleston area, South Carolina. Center exited South Carolina near Charleston.
Sept. 19-20, 1873	240	200	15	Overland from Florida and Georgia. Center exited coast over southern tip of Beaufort County.
Sept. 12, 1878*	190	140	7	Carolinas. Center of storm entered coast near Beaufort, South Carolina. Few fatalities.
Aug. 27, 1881*	110	080	8	A major hurricane. Georgia and South Carolina. Over 700 killed (335 in Savannah).
Sept. 12, 1884	290	240	7	South Carolina and Georgia. Center entered Georgia coast, recurved sharply, and exited South Carolina near Georgetown.
Aug. 25, 1885*	190	140	10	A major hurricane. South Carolina. Center entered coast near Beaufort, South Carolina. Twenty-one killed in Charleston, South Carolina. Damage $1.7 million.

*Landfalling hurricane from Atlantic Ocean.
**Direction of hurricane movement at the time it crossed the coast: (a) clockwise from north.
(b) clockwise from coastline.

Table A1. Hurricanes affecting Charleston County, South Carolina, and vicinity, 1871-1972--Continued

Storm date	Direction (a)**	Direction (b)**	Forward speed (knots)	Principal places in South Carolina affected and remarks
June 16, 1893*	220	160	13	South Carolina. Center moved offshore along Georgia and South Carolina coast and entered the coast near Charleston, South Carolina.
Oct. 13, 1893*	190	140	15	Carolinas. Center entered coast near Charleston, South Carolina, and moved northward across North Carolina.
Sept. 27, 1894*	200	150	10	Coastal areas, Carolinas. Center entered coast south of Charleston, South Carolina, and passed through Georgetown County into North Carolina.
Aug. 30, 1898*	140	100	8	South Carolina and Georgia. Center entered Georgia-South Carolina coast. Heavy rains and flooding in the county.
Sept. 14, 1904*	150	090	12	Carolinas. Center entered coast north of Charleston, South Carolina, and recurved to a northeastward direction.
Aug. 28, 1911*	100	050	5	A major hurricane. South Carolina. Center entered coast near Beaufort. Seventeen killed. Damage in Charleston, $1 million.
July 14, 1916*	140	090	8	Carolinas. Center entered coast just north of Charleston, South Carolina. Associated heavy rainfalls caused severe floods in North Carolina.

Table A1. Hurricanes affecting Charleston County, South Carolina, and vicinity, 1871-1972--Continued

Storm date	Direction (a)**	Direction (b)**	Forward speed (knots)	Principal places in South Carolina affected and remarks
Aug. 11, 1940*	100	050	8	A major hurricane. Center entered coast of Beaufort County. Outlying islands were inundated by storm tides. Total damage from storm was estimated at $7 million. Damage in Beaufort and vicinity estimated at about $3 million.
Oct. 15, 1947*	080	040	8	South Carolina and Georgia coasts. Estimated damage from storm was $2 million; comparatively light in South Carolina.
Aug. 30, 1952*	190	140	10	South Carolina coast. Center passed near Beaufort. Estimated total damage, $2.75 million.
Sept. 29, 1959*	150	100	10	A major hurricane. South Carolina. Total damage in South Carolina estimated at $13 million. Wind damage in Beaufort and vicinity estimated at $3 million.

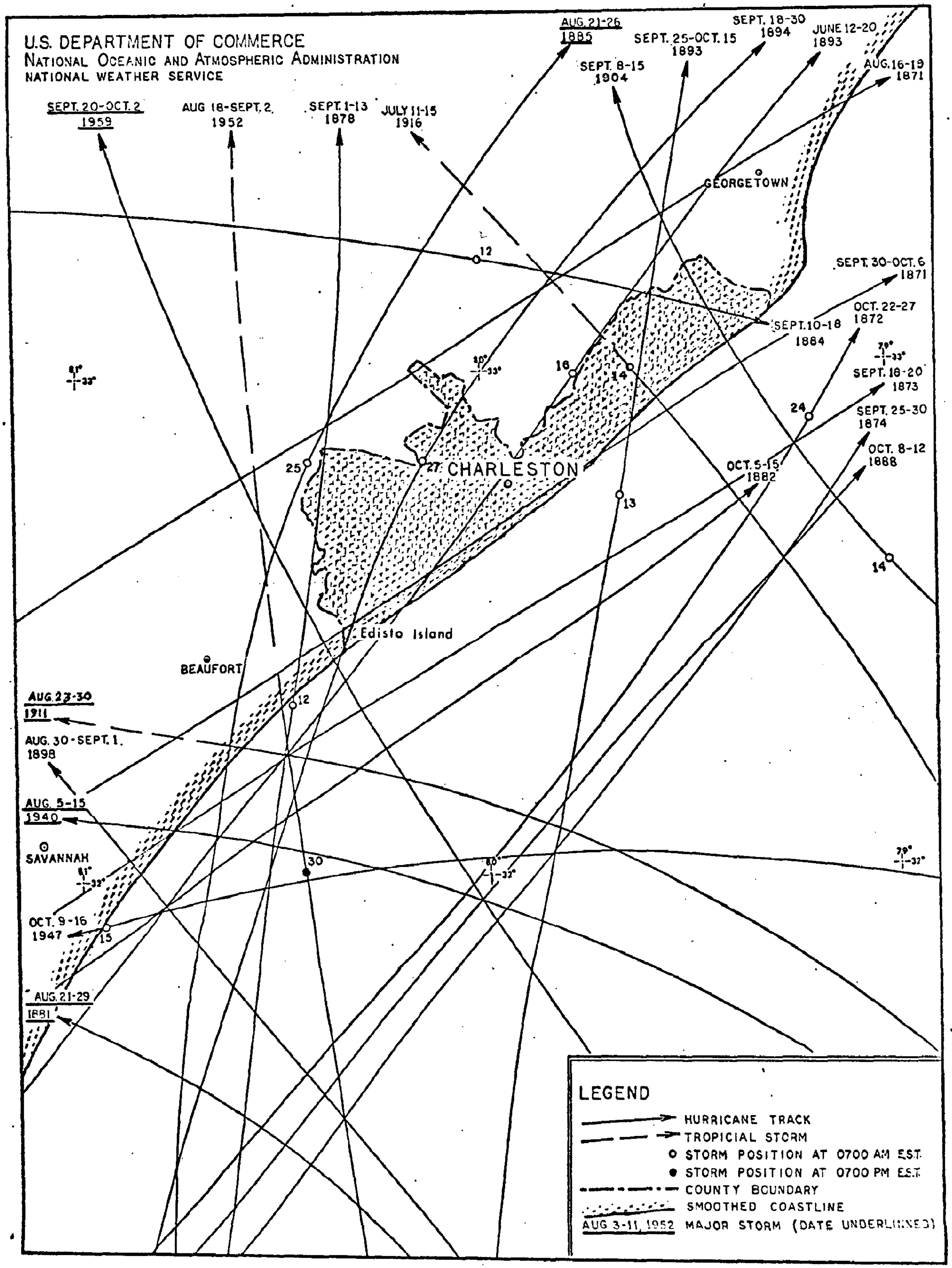


Figure A1.--Hurricane tracks passing through Charleston County, S.C., and vicinity during the period 1871-1972.

APPENDIX II

TIDE-FREQUENCY ANALYSIS FOR OPEN COAST OF CHARLESTON COUNTY, S.C.

The technique used in the tide-frequency analysis for the open coast of Charleston County, S.C., is basically the same as that developed earlier for portions of the New Jersey coast [1]. First, the behavior of hurricanes along the South Carolina coast, as well as adjoining portions of Georgia and North Carolina, was assessed from past records. Factors analyzed included depression of the atmospheric pressure at the storm center below surrounding value, forward speed and direction of motion of the storm, and distance from the storm center to the band of maximum winds. All these factors relate to a storm's potential to produce high tides. The resulting probability distributions of hurricane characteristics adjusted to the Charleston County coast are shown in table A2.

The second step in the tide-frequency analysis is to calculate the coastal tide levels that each of a number of hypothetical but representative hurricanes, from various combinations of the parameters in table A2, would produce. For this, a dynamic calculation method is used that has been demonstrated to reproduce observed surges of past hurricanes within acceptable tolerances. This model is described in references [2] and [3].

Finally, taking into account the assigned probability of each of the representative climatological hurricanes and the tide level it is calculated to produce, the various tides are assembled into a complete tide-frequency distribution. The details of this process are explained in [1].

The resulting estimated tide-frequency curves for the open coast of Charleston County are shown in the main text of this report (see figs. 1 and 2). Storm-tide levels change along the coast of the county primarily because of differences in slope of the sea-bottom offshore.

REFERENCES--APPENDIX II

1. Myers, Vance A., "Joint Probability Method of Tide Frequency Analysis Applied to Atlantic City and Long Beach Island, N.J.," ESSA Technical Memorandum WBTM HYDRO 11, Environmental Science Services Administration, Washington, D.C., April 1970.

2. Jelesnianski, Chester P., "Numerical Computations of Storm Surges With Bottom Stress," Monthly Weather Review, Vol. 95, No. 11, November 1967, pp. 740-756.

3. Jelesnianski, Chester P., "SPLASH (Special Program To List Amplitudes of Surges From Hurricanes)--I. Landfall Storms," NOAA Technical Memorandum NWS TDL-46, Silver Spring, Md., April 1972.

Table A2. Tropical storm parameters--Charleston County, S.C.

Landfalling storms F_n = .00132								By-passing storms				Exiting storms F_e = .0006			
D	P_i	f	P_f	R	P_r	θ_L	P_θ	L	F_b	R	P_r	D	P_i	θ_e	P_θ
73.7	.1	6	.1					4	.015			35.0	.1		
58.7	.1	7	.2	17	.33	62	.33	13	.023			26.6	.1		
45.2	.2	9	.2	23	.33	99	.33	22	.024	20	.5	20.6	.2	140	1.0
32.2	.2	12	.2	30	.33	144	.33	30	.025	27	.5	12.3	.2		
22.2	.2	15	.2					43	.054			6.0	.2		
16.0	.2	19	.1					61	.064			5.3	.2		

LEGEND

D = Central pressure deficit (mb.).
P_i = Proportion of total storms with indicated D value.
f = Forward speed of storm (knots).
P_f = Proportion of total storms with indicated f value.
R = Distance from center of storm to principal belt of maximum winds (nautical miles).
P_r = Proportion of total storms with indicated R value.
θ_L = Direction of entry, measured clockwise from the coast (degrees).
P_θ = Proportion of total storms with indicated θ_L value.
L = Effective distance perpendicularly outward from coast to storm track (nautical miles).
F_b = Average number of storms per year that pass at distance L.
θ_e = Direction of path of exiting storms, measured counterclockwise from coast (degrees).
P_θ = Proportion of total storms with indicated θ_e value.
F_n, F_e = Frequency of storm tracks crossing coast, landfalling and exiting, respectively (storm tracks per nautical mile of coast per year).

Notes: (1) By-passing storms have the same values of D, P_i, f, and P_f as those for landfalling.
(2) Exiting storms have the same values of f, P_f, R, and P_r as those for landfalling.