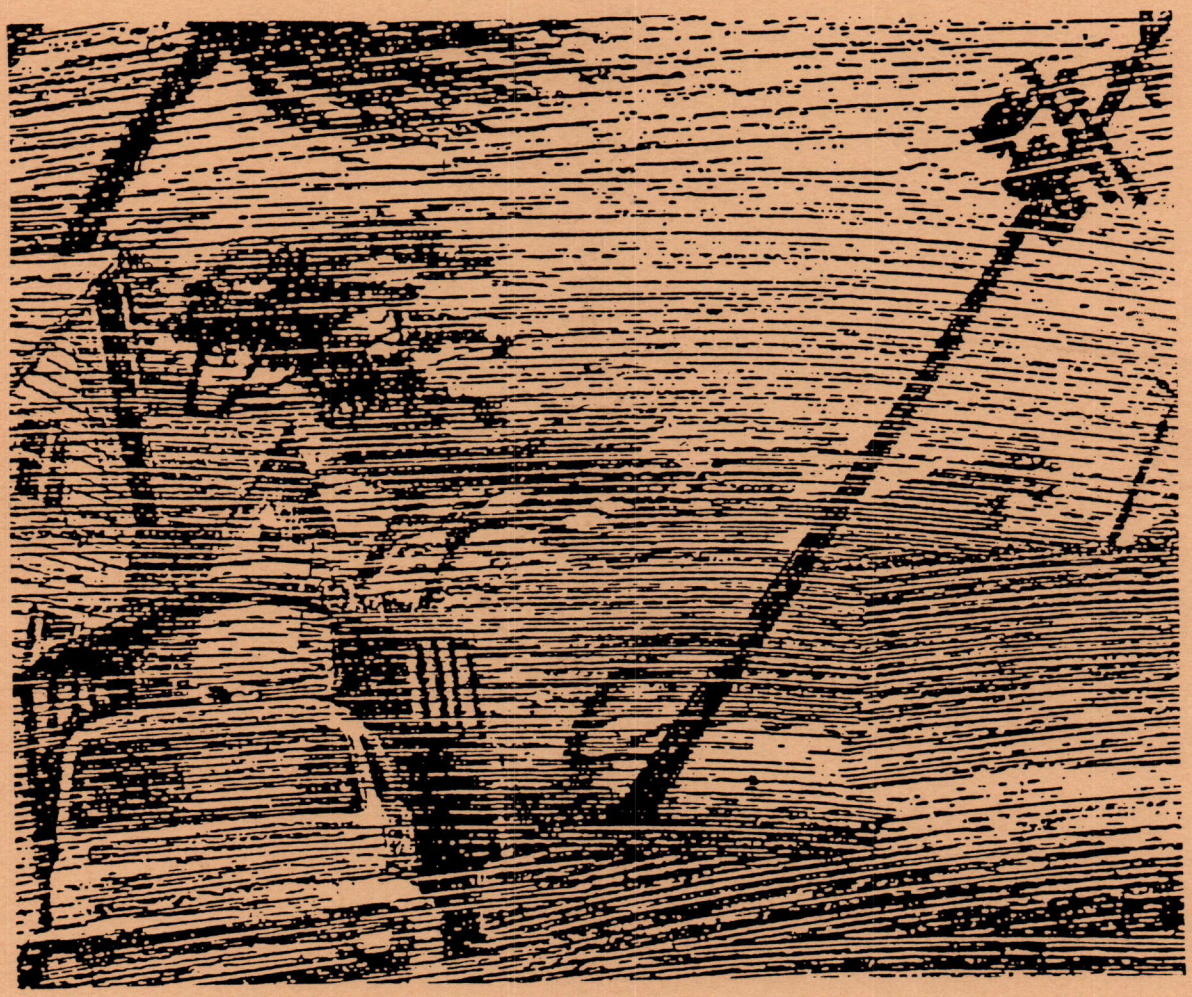
SOUTH CAROLINA Hurricane Evacuation Study



Technical Data Report

December 1986

SOUTH CAROLINA Hurricane Evacuation Study

Prepared for

The South Carolina Emergency Preparedness Division

Prepared by

The U.S. Army Engineer District, Charleston

Corps of Engineers

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PREFACE

SOUTH CAROLINA HURRICANE EVACUATION STUDY

The purpose of this study is to provide state and local Emergency Preparedness decision-makers with the quantitative, realistic (real time) data necessary for effecting safe, efficient evacuation of communities-at-risk in hurricane emergencies.

In early 1984, the Federal Emergency Management Agency (FEMA) received a request from the Director of the South Carolina Emergency Preparedness Division to initiate a hurricane evacuation study for coastal South Carolina. The Charleston District of the Corps of Engineers was subsequently requested to participate with FEMA in this effort and to serve as the study manager. In May of 1984, Interagency Agreement No. EMA-84-E-0031 was signed between FEMA and the Charleston District of the Corps of Engineers initiating the Grand Strand Hurricane Evacuation Study. The study initially included only Horry and Georgetown counties but was expanded in May of 1985 to include the remaining coastal counties of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Hampton and Jasper.

The South Carolina Hurricane Evacuation Study is authorized by the Disaster Relief Act of 1974 (Public Law 93-288). It was funded by the Federal Emergency Management Agency, Region IV, the U.S. Army Corps of Engineers, and the South Carolina Coastal Council. The study was conducted by the Charleston District, U.S. Army Corps of Engineers.

The technical information in this report does not replace detailed operations plans developed by the respective counties and communities. The data presented here was designed as a framework for evaluating, updating, refining and revising the operational planning already in place. The State of South Carolina Emergency Preparedness Division will utilize this information to revise and update existing local county hurricane response plans.

Appreciation is expressed for participation and direct contributions by the National Hurricane Center, Miami; the South Carolina Water Resources Commission, Columbia; the National Weather Service, Charleston; the South Carolina Emergency Preparedness Division; the county directors in the study area, and many other state and local officials.

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*Limited number of copies printed. Copies available for review at individual county emergency preparedness offices and the State of South Carolina Emergency Preparedness Division in Columbia.

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CHAPTER ONE

INTRODUCTION

I. GENERAL

The area covered by this study includes the nine counties of Beaufort, Berkeley, Charleston, Colleton, Dorchester, Georgetown, Hampton, Horry, and Jasper. Allendale County was included in the shelter analysis to resolve a deficit in evacuee shelter spaces in the Lower Coast area.

As with other coastal areas of the southeast, South Carolina is and has been in a state of rapid flux as a result of increases in population, population density, and necessary service and support development along its north-eastern shore--the Grand Strand--and on the sea islands of the lower coast. Between 1960 and 1980 the population of the five coastal counties increased by almost one-third and is expected to increase by over 50 percent between 1980 and 2000.

1987 population projections indicate over 860,000 permanent residents in the nine-county study area ranging from 16,300 in Jasper County to 300,120 in Charleston County (Table 6-1). Records show 17,895,264 tourists visited the study area counties from September 1, 1984 to August 31, 1985 ranging from 31,497 in Hampton County to 9,549,809 in Horry County. Expenditures by tourists during the same time period range from $1,394,749 in Hampton County to $1,072,057,078 in Horry County and a total of $1,965,740,829 in the nine counties. 1985 nine-county population-at-risk figures, including permanent and tourist population, range from 288,000 during a low category storm and low tourist occupancy to 647,000 during a high category storm and high tourist occupancy (Table 3-1).

Much of the permanent and tourist population in the study area is located near the coast in areas vulnerable to hurricane damage. Bridging the gap between the coastal developments and the relative safety of the mainland is a somewhat skimpy network of primary, secondary, or light duty hard surface all weather roads. In some instances an island and the mainland are linked by a single road and/or bridge and in most instances all must cross estuaries and marshes at elevations not much above that of the salt marshes themselves.

An average of one hurricane or tropical storm makes landfall on South Carolina's coast every four to five years, making it among the more storm-prone coastal areas in the United States. In the past quarter century (1960-1985) only two hurricanes and two tropical storms made landfall on South Carolina's coast. Additional storms made landfall in other states and affected South Carolina causing wind and/or flood damage (Tables 1-1 and 1-2).

Within such factors as these lies the potential for widespread destruction and significant loss of life in the event of a direct hit by a major hurricane.

The objective of the South Carolina Hurricane Evacuation Study is to provide pertinent quantitative information for state and local agency use in the development of local and regional hurricane evacuation plans.

II. GEOGRAPHY AND TOPOGRAPHY

Coastal South Carolina reflects three geographical areas: the long concave strand stretching from the North Carolina state line south to Winyah Bay; the Santee River delta and barrier islands of Cape Romain-Bulls Bay; and the sea islands of the central and southern coast. While physiographically different, these three areas share two commonalities. All are more or less low-lying; and all are separated from the mainland by wide expanses of salt marshes, estuaries, and tide-influenced rivers, and/or belts of rivers and marshes paralleling the coastline. South Carolina has approximately 190 miies of open coastline, but its numerous bays, estuaries, inlets, and rivers create an actual shoreline of over 3000 miles.

Behind the barrier islands and beaches is a complex system of creeks, estuaries, tidal rivers and thousands of acres of salt marshes whose vast expanses are broken occasionally by hummocks of varying sizes. All along the coast a series of cuts and channels tie rivers, sounds, and bays into the Intracoastal Waterway. Inland the marshes and hummocks gradually give way to the terrestrial environment of the coastal plain. The outer coastal plain (to 80 miles inland and less than 100 feet above sea level) is marked by extensive freshwater swamps grading into the coastal salt marshes. Its northern coastline in the Grand Strand is fronted by a smooth hard shore cut by a few small inlets. The lower coast is fringed by sea islands and salt marshes.

Tides are higher - and the range between high and low tide levels greater - in the lower coast area than along the Grand Strand. This is significant only in terms of awareness of probabilities for increased flooding along South Carolina's southern coast should a hurricane strike during normal high tides or spring tides.

III. HURRICANE ACTIVITY IN SOUTH CAROLINA

A. General.

A tropical cyclone is a nonfrontal low pressure system that develops over tropical or subtropical waters and has a definite organized cyclonic (counterclockwise) circulation. On the basis of the speed of sustained (one minute average) winds near the center of the storm system, tropical cyclones are classified as: Tropical Depressions, $\leq$33 knots ($\leq$38 mph); Tropical Storms, 34 to 63 knots (39-73 mph); or Hurricanes, $\geq$64 knots (>74 mph).

Geographic regions affected by tropical cyclones are known as tropical cyclone basins. The Atlantic tropical cyclone basin is one of six in the world and includes much of the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico.

The official Atlantic hurricane "season" begins June 1 and ends November 30 each year; occasionally, however, the season begins earlier or ends later than its ordained time.

Early season tropical cyclones generally form in the western Caribbean Sea and the Gulf of Mexico. By the end of June or early July, the area of formation begins shifting eastward, accompanied by a slight decline in overall storm frequency. By late July, the area of formation has shifted further eastward and storm frequency increases.

In late August, tropical cyclones are forming over a broad area of the eastern Atlantic, extending eastward to the area of the Cape Verde Islands off the coast of Africa. The period from about August 20 through about September 15 encompasses the maximum of these "Cape Verde" storms. Most "Cape Verde" storms cross vast areas of the Atlantic Ocean before dying in the north Atlantic or making landfall in northern Europe. Those which make landfall in the United States are generally severe. Since 1906, twelve "Cape Verde" storms have made landfall in the United States, eight of them being category 3 or 4 hurricanes.

By mid-September, storm frequency begins to decline, the formative area retreats westward to the Caribbean Sea and Gulf of Mexico, and storm frequency in that area increases. Usually, by mid-November frequency of tropical cyclone occurrence has ceased.

B. Atlantic Tropical Cyclone Basin.

Records of tropical cyclone occurrences within the Atlantic tropical cyclone basin are kept by the National Climatic Data Center in cooperation with the National Hurricane Center. Records are updated annually and are available from the National Climatic Data Center. For the 115-year period 1871-1985, a total of 928 tropical cyclones have been recorded within the Atlantic tropical cyclone basin. For some of those years, however, the existing data do not allow accurate determinations of the types of tropical cyclones (tropical storms or hurricanes) nor the intensities of the storms. Other researchers have compiled the fragmentary data on tropical cyclones dating back to the 15th century, and are available in some libraries.

C. Historical Hurricanes in South Carolina.

Despite the once every 4-5 year landfall average, hurricanes and tropical storms are irregular visitors to coastal South Carolina. In the past 85 years, 1901-1985, only 20 tropical cyclones (tropical storm or hurricane) have made landfall on the South Carolina coast. Of these, only eight were category 2 to category 4 intensity. Since 1900 no category 5 hurricane has hit South Carolina; there has been one category 4 (Hazel, 1954); and two category 3's (Sept. 17, 1945 and Gracie, 1959). It is possible that the "Great Storm of 1893" which struck the southern coast in August of that year was at least a category 4 storm, but there is no way of knowing since measures of tropical cyclone intensity are not available before 1900.

In the colonial period, tropical storms and hurricanes were known as "September gales" probably because the ones people remembered and wrote about

were those which damaged or destroyed crops just before they were to be harvested. Historical accounts of some of these events are presented below.

> One that struck "Charles Town" September 25, 1686 was "wonderfully horrid and distructive...corne is all beaten down and lyes rotting on the ground... Aboundance of our hoggs and cattle were killed in the Tempest by the falls of Trees...". The writer goes on to say that the storm also prevented a Spanish assault upon Charles Town by destroying one of their galleys and killing the commander in chief.

> In Autumn of 1700, "a dreadful hurricane happened at Charles Town which did great damage and threatened the total destruction of the Town, the lands on which it is built being low and level and not many feet above high water mark, the swelling sea rushed in with amazing impetuosity, and obliged the inhabitants to fly for shelter..." A ship, Rising Sun, out of Glasgow and filled with settlers had made port just prior to the storm's landfall. It was dashed to pieces and all on board perished.

> Of a storm which passed inland along the coast September 7-9, 1854, Adele Pettigru Allston wrote from Pawleys Island, "The tide was higher than has been known since the Storm of 1822. Harvest had just commenced and the damage to the crops is immense. From Waverly to Pee Dee not a bank nor any appearance of land was to be seen...(just) one rolling, dashing Sea, and the water was Salt as the Sea."

By 1893, major population centers could be telegraphically alerted to storms moving along the coast, but there were no warnings for the sea islands and other isolated areas.

The "Great Storm of 1893" struck the south coast at high tide, pushing an enormous storm surge ahead of it, creating a "tidal wave" that swept and submerged whole islands. Maximum winds in the Beaufort area were reported at 125 mph; those in Charleston at 120 mph. Water from the first wave probably stacked up in the marshes, held there by the winds until the next high tide, which was after the storm had passed. Lowered barometric pressure and the amount of "stacked" water caused destruction equal to that of a "tidal wave." At least 2000 people lost their lives, and an estimated 20,000-30,000 were left homeless and with no means of subsistence. Property damage was estimated at $10-million.

Hazel, (October, 1954) and Gracie, (September, 1959), have been the most memorable storms in recent years. Hazel, a category 4 storm, made landfall near Little River, South Carolina with 106 mph winds and tides up to 16.9 feet. One person was killed and damage was estimated at $27-million.

Gracie, a category 3 hurricane, made landfall on St. Helena Island, and continued north-northwest maintaining hurricane strength for more than a hundred miles inland. Damage of disaster proportions occurred along the coast from Beaufort to Charleston. Heavy rains caused flooding through much of the state, crop damage was severe, but there was no loss of life.

Overland and exiting storms - those which have made landfall in other parts of the southeast - occasionally cause heavy rains and significant flooding in South Carolina, but damage from these storms is usually less severe than that caused by the hurricanes and tropical storms which occasionally make a direct hit on South Carolina's coast. (Tables 1-1, 1-2).

TABLE 1-1

HISTORICAL TROPICAL STORMS AND HURRICANES ENTERING THE SOUTH CAROLINA COAST

YEAR	DATE IN S.C.	SOUTH CAROLINA LANDFALL AREA	TYPE OF STORM HIGHEST CATEGORY	NAME	DAMAGE
1878	September 12	South Coast	---	---	unknown
1883	September 11	North Coast	---	---	unknown
1885	August 25	South Coast	---	---	severe
1893	June 16	Parallel the entire coast	---	---	unknown
1893	August 27	South Coast	-H-	---	catastrophic
1893	October 13	South Central	-H-	---	severe
1894	September 27	Central	-H-	---	unknown
1898	August 31	South Coast	-H-	---	unknown
1899	October 31	North Coast	-H-	---	unknown
1904	September 14	Central Coast	H-1	---	unknown
1906	September 17	North Central	H-3	---	moderate-severe
1908	October 23	Central	TS	---	moderate
1911	August 28	South Central Coast	H-2	---	severe
1913	October 8-10	Central	TS	---	minor
1916	July 14	Central	H-1	---	unknown
1916	October 4	South Coast	TS	---	minor
1927	October 2-3	South Coast	TS	---	minor
1934	May 28	South Coast	TS	---	minor
1940	August 11	South Coast	H-2	---	severe
1944	October 19-20	South Central	TS	---	light
1945	September 17	South Coast	H-3	---	severe

TABLE 1-1 (Continued)

YEAR	DATE IN S.C.	SOUTH CAROLINA LANDFALL AREA	TYPE OF STORM HIGHEST CATEGORY	NAME	DAMAGE
1946	July 5	North Coast	TS	---	minor
1947	October 15	South Coast	H-2	---	light
1952	August 30	South Coast	H-1	Able	light
1954	October 15	North Coast	H-4	Hazel	extreme
1959	July 8-9	Central Coast	H-1	Cindy	light
1959	September 29	South Coast	H-3	Gracie	very severe
1976	August 20-21	Central Coast	TS	Dottie	minor
1979	September 4	South Coast	H-2	David	severe
1985	July 25	South Coast	H-1	Bob	minor

Damage

Minor, Light - Tropical Storm, Category 1

Moderate, Severe - Category 2

Very Severe - Category 3

Extreme - Category 4

Catastrophic - Category 5

Refer to Table 2-1 for description of categories of storms and damage potential

TS - Tropical Storm

H - Hurricane

TABLE 1-2

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1871	August 18	Cape Canaveral, FL	---	---	Moved northward along coast, out to sea S of Wilmington, NC.
1871	October 6	Appalachicola, FL	---	---	Moved northeastward to SC coast and out to sea.
1872	October 24	Cedar Key, FL	---	---	Moved out to sea near Jacksonville, FL,; second landfall S of Wilmington, NC.
1873	September 19	Appalachicola, FL	---	---	Moved out to sea about Savannah, GA, and NE along coast.
1874	September 28	Cedar Key, FL	---	---	Moved out to sea near Jacksonville; second landfall S of Wilmington, NC.
1877	October 3	Panama City, FL	---	---	Moved across South Carolina midlands; out to sea about Norfolk, VA.
1878	September 12	Beaufort, SC	---	---	Moved directly N through SC.
1881	August 27	Savannah, GA	---	---	Moved W across GA; peripheral NE quadrant effects: rainfall, winds, storm surge.
1882	September 10	Pensacola, FL	---	---	Moved across upper NW South Carolina.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1882	October 12	Cedar Key, FL	---	---	Moved out to sea S of Savannah, GA, then NE along coast.
1883	September 11	Myrtle Beach, SC	---	---	Moved directly N; 53 dead in NC.
1884	September 12	Savannah, GA	---	---	Moved out to sea near Georgetown, SC.
1885	August 25	Beaufort, SC	---	---	Moved inland, out to sea about Manteo, NC; severe damage along storm path.
1885	October 12	Tampa-St. Petersburg, FL	---	---	Moved N, across SC midlands; heavy rains.
1886	June 22	Appalachicola, FL	H	---	NE across SC midlands; heavy rains.
1886	July 1	Tallahassee, FL	H	---	Entered SC near Hampton; heavy rains across coastal plain.
1888	September 9	Tampa-St. Petersburg, FL	TS	---	Across SC midlands heavy rains.
1889	September 23	Pensacola, FL	H	---	NE, across SC Piedmont.
1893	June 15-16	N. Cedar Key, FL	H	---	NE, along SC coast, out to sea near Norfolk, VA.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1893	August 27-28	Savannah, GA	H	---	NNE through SC midlands. 96-120 mph winds, tremendous storm surge; major damage; moved N near Columbia, then NE. 2,000 dead, $10 million damage.
1893	October 3	Biloxi, MS	H	---	Moved NE across SC Piedmont; heavy rains; out to sea about Manteo, NC.
1893	October 13	near Charleston, SC	H	---	Moved NNE, caused loss of life in Georgetown.
1894	September 27	Tampa-St. Petersburg, FL	H	---	Moved NE; second landfall S of Edisto Island, dissipating inland.
1894	October 9	Panama City, FL	H	---	NE inland along SC coast and out to sea about Norfolk, VA.
1896	September 29	Cedar Key, FL	H	---	NNE through SC midlands; heavy rains
1897	September 22	Wilmington, NC	TS	---	Passed offshore.
1898	August 31	Savannah, GA	H	---	Inland along Savannah River, then through Georgia-Alabama.
1899	October 31	Myrtle Beach, SC	H	---	N into NC, becoming an extratropical* storm.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1901	July 12-13	Manteo, NC	H-1	---	Weakened to tropical storm; out to sea S of Morehead City, NC. Second landfall as tropical depression, Myrtle Beach, SC; heavy rains.
1901	September 18	Pensacola, FL	TS	---	Entered SC as extratropical storm; NE and out to sea near Myrtle Beach, heavy rains.
1901	September 28	Tallahassee, FL	TS	---	N across extreme western SC, across mountains.
1902	June 15	Tallahassee, FL	TS	---	Entered SC Aiken area, weakening to extratopical stage; entered NC Charlotte area.
1902	October 11	Pascagoula, MS	TS	---	Entered SC mountains as extratropical storm moving NE.
1903	September 16	Panama City, FL	TS	---	NW, then E across SC as tropical depression.
1904	September 14	Charleston-Georgetown, SC	H-1	---	NW, then turned NE; high winds, heavy rains $1.5 million damage.
1904	November 5	Biloxi, MS	TS	---	Entered SC NW of Savannah, moved NE and out to sea; heavy rains.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1906	September 17	Georgetown, SC	H-3	---	TS after passing coastline; heavy rains; considerable damage to shipping.
1907	September 22	New Orleans, LA	TS	---	Moved NE, weakened to extratropical storm; crossed upper SC piedmont.
1907	September 28-29	Panama City, FL	TS	---	Entered SC above Savannah, GA; moved NE along coast and out to sea.
1908	October 23	Charleston-Georgetown, SC	TS	---	Weakening, moved inland and dissipated; heavy rains in NE SC.
1910	October 29	Ft. Myers, FL	H-3	---	Weakened rapidly to TS, moved NE and passed off SC coast; some damage to shipping.
1911	August 28	Savannah, GA-Beaufort, SC	H-2	---	106 mph winds, high tides; 17 dead; $1 million damage at Charleston; moved W into Georgia, recurved to NE.
1912	June 13-14	Lafayette, LA	TS	---	Moved NE through NW SC and out to sea near Cape Hatteras, NC.
1912	July 15	Brunswick, GA	TS	---	Winds and heavy rain in lower SC.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1913	September 4	Morehead City, NC	H-1	---	Rapidly dissipating storm; heavy rain in SC mountains.
1913	October 8-10	Charleston, SC	TS	---	Curved sharply NE, exited Cheraw, SC area; heavy rains in NE SC.
1915	August 2-3	Daytona Beach, FL	TS	---	Curved NNE, entered Aiken area, SC.
1916	July 14	Bulls Bay, SC	H-1	---	Moved NW as tropical storm; record rainfall, $10-11 million damage, mostly flooding.
1916	September 5-6	Wilmington, NC	TS	---	Caused some rain in NE SC, but passed well to NNE.
1916	October 4	Savannah, GA	TS	---	Tropical depression at landfall; moderate gales and rainfall in lower SC.
1920	September 22-23	Wilmington, NC	H-1	---	Weakening tropical storm; rain squalls NW SC.
1924	September 16	Panama City, FL	H-1	---	Moved out to sea, Savannah, GA; along coast as TS. Winds and rain, lower SC coast.
1924	September 29	Cedar Key, FL	TS	---	NE across coastal SC as extratropical storm. Winds, rain.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1927	October 2-3	Savannah, GA	TS	---	50 mph winds at Charleston, SC; rain.
1928	August 10-11	Melbourne, FL	H-2	---	Passed NE over SC Piedmont as extratropical storm; heavy rain, wind, two tornadoes.
1928	September 18	Melbourne, FL	H-4	---	Recurved NE across lower coastal plain, Jacksonville, FL to Greenville, NC, then N to Canada. At H strength into SC; TS into Pa. 5 dead. 10-12" rainfall; severe flooding; $4-6 million damage.
1929	October 1-2	Apalachicola, FL	H-3	---	Entered SC, Aiken area, as extratropical storm. Heavy rains on already saturated soil caused severe flooding, and established many new high water marks.
1933	September 7	Palm Beach, FL	H-3	---	Recurved NE after landfall on 9/3; dissipated in SC.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1934	May 28-31	Ft. Myers, FL	TS	---	Second landfall at Savannah, Ga. Circular track NW to mountains, then made loop through GA, then E near Aiken and dissipated.
1935	September 5	Cedar Key, FL	H-2	---	Skirted W FL coast, curved NE over GA, SC and NC as tropical storm. Heavy rains, 55 mph winds, four tornadoes in SC.
1938	October 24	Cedar Key, FL	TS	---	Extratropical storm along SC coast.
1939	August 18	Melbourne and Apalachicola, FL	H-1	---	Entered SC as tropical depression. Heavy rains western SC.
1940	August 11	Beaufort, SC	H-2	---	WNW tract; 34 dead, $9.9 million property and crop damage in SC. Hurricane force maintained over most of coast.
1941	October 7-8	Miami and Apalachicola, FL	H-2	---	Tropical storm through GA and SC; out to sea at Charleston, SC. Heavy rains.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1944	August 1-2	Wilmington, NC	H-1	---	Heavy rains in NE SC.
1944	October 19-20	Edisto Island-Charleston, SC	H-2	---	Moved across FL into the Atlantic, entered SC as TS. $350,000 property and crop damage. Heavy rains.
1945	June 24-25	Crystal River, FL	H-1	---	Moved across FL and NE well offshore; regained strength; gale winds and heavy rains.
1945	September 17	Savannah, GA-Hilton Head, SC	H-3	---	Moved N out of FL, offshore then N through SC coastal plain. High winds, severe flooding, tornado; $6-7 million damage.
1946	July 5	NC/SC State Line	TS	---	Heavy rain in NE SC.
1946	October 8	Tampa- St. Petersburg, FL	H-1	---	TS through SC lower piedmont. Heavy to excessive rains, moderate winds.
1947	November 2-3	Palm Beach, FL	TS	---	Dissipating through eastern SC and out to sea. Moderate winds and rainfall.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1947	September 24	Cedar Key, FL	TS	---	Moved NE as extratropical storm through east-central SC.
1947	October 8	Jacksonville, FL	TS	---	Circled N and across SC upper piedmont in dissipation state.
1947	October 15	Savannah, GA	H-2	---	High tides, gale winds, light-to-moderate rainfall.
1949	August 28	Palm Beach, FL	H-3	---	NNE through west central SC as TS.
1950	September 7	Crystal River, FL	H-3	Easy	Peripheral effect of dissipation stage on SC upper piedmont; heavy rains and gale winds.
1950	October 18-19	Miami, FL	H-3	King	Peripheral effects; heavy intermittent rain in SE SC.
1950	October 21	Cedar Key, FL	H	Love	Peripheral effects; moderate-heavy intermittent rain.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1952	August 30-31	Beaufort, SC	H-1	Able	80-90 mph winds, excessive rains; 2 deaths, $3 million damage.
1953	August 31 - September 1	Savannah, GA	TS	---	NNE across state a as weak TS.
1953	September 20-21	Cedar Key, FL	TS	---	Dissipating, moved across N FL, E GA, and offshore SC coast. Scattered rainfall, moderate winds.
1953	September 27	Panama City, FL	H-1	Florence	NE over FL, GA; weakened to extratropical storm. Gale winds; heavy to excessive rainfall.
1954	October 15	SC-NC State Line	H-4	Hazel	One of the most severe storms to hit SC to date. 1 dead; highest 16.9 ft (MLW) tides; $27 million damage.
1955	August 11-12	Cape Lookout, NC	H-3	Connie	Passed well offshore; two tornadoes in NE SC.
1955	August 17	Wilmington, NC	H-1	Diane	Moved NNW into NC; heavy rains, high tides, $100,000 damage in SC.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1955	September 18-19	Morehead City, NC	H-3	Ione	Passed offshore; moderately higher tides north coast, heavy rains NE SC.
1956	September 25	Ft. Walton, FL	H-1	Flossy	Moved NE as TS; extratropical storm across coastal plain of SC.
1957	June 8-9	Apalachicola, FL	TS	---	Moved NE and out to sea off Beaufort-Edisto Island, SC. Damaging rains.
1958	September 27	None	H	Helene	Approached N coastal area, curved NE. Minor damage from storm's fringe effects.
1959	July 8-9	McClellanville, SC	H-1	Cindy	1 dead, gale winds, high tides, heavy rains (to 10" some areas) caused considerable flash flooding.
1959	September 29	St. Helena Isl., SC	H-3	Gracie	Moved NW at H strength, 100 mph winds; weakened to TS, passed Columbia, turned NNW and into NC near Gastonia. Winds 140 mph at landfall; tides near 6 ft. above normal; several fatalities; disaster-proportion property damage S coast; heavy crop damage; moderate to heavy flooding from 6-8" rainfall.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1960	July 29	Cedar Key, FL	TS	Brenda	Moved NE, passed just offshore SC coast. Heavy to excessive rain; little damage.
1960	September 11	Tampa-St. Petersburg, FL	H-4	Donna	Passed NNE-NE offshore; gale winds, rain squalls; two tornadoes did minor damage.
1961	September 13	Wilmington, NC	TS	---	Tropical depression well offshore; TS at landfall; no significant effects on SC.
1963	October 25	Offshore	H	Ginny	Stayed 50+ mi. offshore; heavy rains along coast; slight damage.
1964	August 29-30	Palm Beach, FL	H-2	Cleo	Moved NNW as dying TS, turned NNE over upper piedmont SC; gale winds along coast, several tornadoes; 3-8" rainfall, some flooding; crop damage.
1964	September 12-13	Jacksonville, FL	H-2	Dora	Moved W as TS, turned NE thru SC coastal plain. 3-8" rainfall; one tornado; minor damage.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1964	October 4-5	New Iberia, LA	H-3	Hilda	Heavy peripheral rains from mountains to midlands and NE. Flash floods, stream flooding; one dead; livestock and crop damage.
1965	June 15-16	Panama City, FL	TS	---	Extratropical storm across SC midlands; generally heavy rainfall.
1966	June 10	Apalachee Bay, FL	H-2	Alma	Crossed SE SC as TS. Heavy rains, flooding; 90% of cotton crop lost.
1968	June 7-11	Tampa-St. Petersburg, FL	TS	Abby	Entered SC near Aiken, N into NC; curved NE, then SE, into NE SC. Minor flooding, crop and property damage; 3-10" rain and beach erosion.
1968	October 19-20	Cedar Key, FL	H-1	Gladys	Passed offshore, at full strength, closest in NE SC. Rain, minor flooding.
1970	May 25-26	Cedar Key, FL	TS	Alma	Heavy rains in dissipation after landfall; NE across SC midlands as tropical depression, flooding; $50,000 crop damage.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1972	June 20-21	Panama City, FL	H-1	Agnes	Passed across SC causing heavy rains in western SC.
1972	September 13-14	None	H	Dawn	Erratic in movement well offshore, recurved before dissipating while moving NE along GA and S coast of SC. Rain and wind.
1975	June 27-28	None	TS	Amy	Weak tropical depression NE off SC coast; tides 1-2' above normal.
1975	October 25-28	None	TS	Hollie	NE path about 100 miles off SC coast; no significant damage.
1976	August 20-21	Charleston, SC	TS	Dottie	N from FL Keys to Charleston; higher than usual tides, beach erosion, rains.
1976	September 14-15	None	---	---	Subtropical storm moved N from central FL; offshore near Jacksonville; on shore near Charleston; 3-4" rain; 2-3 feet higher tides; beach erosion and minor street flooding.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1977	September 7-8	Morgan City, LA	H-1	Babe	Dissipation stage moved E across SC upper piedmont, out to sea over Cape Hatteras. Heavy rains.
1979	September 4	Savannah, GA	H-2	David	NNE through SC $10 million damage; five tornadoes, 6-8" rains, much beach erosion.
1981	August 19-20	N Myrtle Beach, SC	TS	Dennis	Heavy rains, 6" or more; significant flood damage in low-lying areas. Reached hurricane strength after exiting.
1984	September 11-14	near Wilmington, NC	H-2	Diana	Minimal category 2 at landfall; heavy rains, high winds; minor damage in SC.
1984	September 29-30	Palm Beach, FL	TS	Isidore	Moved NE well offshore; Heavy rains.
1985	July 25	Fripp Island, SC	H-1	Bob	Minimal hurricane came ashore at Fripp Island and moved northward.

TABLE 1-2 (Continued)

HURRICANES AND TROPICAL STORMS AFFECTING SOUTH CAROLINA

YEAR	DATES IN SC	GENERAL LANDFALL AREA	TYPE OF STORM & HIGHEST CATEGORY	STORM NAME	COMMENTS
1985	August 17	Beacon Island, LA	H	Danny	Danny dissipated into large disorganized area that passed across the NW tip of the state causing four tornadoes in Spartanburg, York, and Union Counties.
1985	November 22	Panama City, FL	H	Kate	Downgraded to a TS; moved eastward across the southern tip of SC. The storm turned NE and passed up the coast before moving out to sea. Damage minor

TS - Tropical Storm

H - Hurricane

Refer to Table 2-1 for description of categories of storms and damage potential.

* - An extratropical storm is of less intensity than a tropical storm, but causes some damage.

BIBLIOGRAPHY FOR INTRODUCTION

Dabbs, Edith M.
1983 Sea Island Diary. A History of St. Helena Island. Reprint Company Publishers, Spartanburg, S.C. pp. 195-196.

Davis, Richard A. Jr.
1978 Beach and Nearshore Zone. Coastal Sedimentary Environments. Richard A. Davis, Jr., ed. Springer-Verlag, New York. p. 262

Dunlop, J. G.
1929 Spanish Depredations. South Carolina Historical and Genealogical Magazine. Vol 30-2. pp. 83-85.

Easterby, J. H., ed.
1945 The South Carolina Rice Plantation as Revealed in the Papers of Robert F. W. Allston. University of Chicago Press, Chicago. p. 120.

Fenneman, Nevin M.
1938 Physiography of Eastern United States. McGraw-Hill, New York. pp. 44-45.

Frey, Robert W. and Paul B. Basan
1978 Coastal Salt Marshes. Coastal Sedimentary Environments. Richard A. Davis, Jr., Ed. Springer-Verlag, New York. pp. 134, 138.

Hebert, Paul J., Glenn Saylor and Robert A. Case
1984 Hurricane Experience Levels of Coastal County Populations - Texas to Maine, NOAA Technical Memorandum NWS NHC24. National Hurricane Centar, Miami.

Hunt, Charles B.
1974 Natural Regions of the United States and Canada. W.H. Freeman Company, San Francisco. pp. 209-226.

Oertal, George F.
1979 Barrier Island Development During the Holocene Recession. Barrier Islands From the Gulf of St. Lawrence to the Gulf of Mexico. Stephen P. Leatherman, ed. Academic Press, New York. pp. 273-290.

Purvis, John C. and H. Landers
1973 South Carolina Hurricanes. South Carolina Disaster Preparedness Agency.

Snowden, Yates, ed.
1920 History of South Carolina. Vol. I. Lewis Publishing Company, New York & Chicago. pp. 215, 248-249.

South Carolina Division of Research and Statistical Services
1985 South Carolina Statistical Abstract. Columbia.

U.S. Department of Commerce
1981 Tropical Storms of the North Atlantic Ocean. 1871-1980. National Oceanic and Atmospheric Administration. U.S. Government Printing Office, Washington, D.C. pp. 21-23, 33-146.

South Carolina Division of Research and Statistical Service
Population Projections for South Carolina by County 1985-2010.

CHAPTER TWO

HAZARDS ANALYSIS

I. PURPOSE

The hazards analysis is a means of describing, evaluating, and quantifying "meteorological events" of hurricanes, high winds, high tides, storm surges, saltwater flooding (an effect of combined high tides and storm surge), heavy rainfall before, during, and after hurricane passage, and accompanying freshwater flooding. Tornadoes often occur during hurricane events, but because of the uncertainty of determining where or when they may develop, no attempt was made to include them in evacuation planning.

The primary objective of the hazards analysis is to project a worst-case scenario for hurricanes of varying intensities having a reasonable meteorological probability of penetrating the South Carolina coast or passing within certain distances offshore. For the purpose of the study, "worst-case" describes peak storm surges, wind speeds, tidal effects and rainfall from hurricanes for all locations in the project area, regardless of specific landfall. Worst-case effects are used because of the uncertainty in accurately forecasting precise tracks, landfall, and other parameters of hurricanes. Sections II, III, IV, V, and VI treat each of the hazards associated with hurricanes affecting South Carolina.

II. STORM SURGE

A. General.

The greatest loss of life during the passage of a hurricane is from drowning. The sudden rise of water accompanying the arrival of a hurricane cuts off escape routes, trapping residents who have not moved to safe areas. The greatest hurricane disasters, including the complete destruction of large towns, have been attributed to the sudden innundation produced by these storms.

A hurricane traveling along or across the continental shelf develops a "fan" of water ahead of and accompanying the storm. The greatest buildup of water usually is to the immediate right of the center or eye of the hurricane. This buildup of water is called the storm surge.

Winds accompanying a hurricane are the greatest single factor in the buildup of storm surges. As they blow across the surface of the sea, they exert a horizontal force creating a surface current in the general direction of the wind. In turn, the surface current creates a subsurface current...a process recurring to some depths, depending on the intensity and forward motion of the hurricane. A fast-moving hurricane of moderate intensity, for example, may create subsurface currents only to a depth of one hundred feet; whereas subsurface currents of a slow-moving, moderate intensity storm can exist to depths of several hundred feet.

As the hurricane approaches a coastline, subsurface currents are slowed by the upward slope of the sea floor, causing the water level to rise. The amount of rise increases shoreward, reaching a maximum at the shore, or inland if bays, estuaries or rivers are present.

Elevation of the storm surge within a coastal basin is a function of both meteorological parameters of the hurricane and physical characteristics peculiar to the particular basin. Meteorological parameters include: intensity of the hurricane (determined by the differential between central and ambient barometic pressures), path or track of the storm, forward speed of the hurricane, and storm size (determined by wind speed the radius of maximum winds).

In general, the highest storm surges occur in the radius of maximum winds - the region to the immediate right of the center of the eye - where the highest winds come ashore. While normal storm surges can occur over distances of 100 miles along a coast, distances of maximum storm surge can encompass as little as four miles or as much as 50 miles.

Physical characteristics affecting storm surge include bathymetry (water depth) irregularity of the sea floor, coastal configuration, existence of significant natural or man-made barriers, and to a lesser extent, the energy-absorbing effect of large expanses of marsh grasses.

Another significant factor affecting storm surge height is the water level within the basin at the time of the hurricane's arrival including the astronomical tide plus any anomalous (abnormal) sea surface height.

B. The Saffir/Simpson Hurricane Scale.

The primary factor determining hurricane intensity, thereby categorizing them by expected severity of damage, is the difference between barometric pressure within the storm (central barometric pressure) and barometric pressure outside the storm system (ambient barometric pressure). The greater the difference between these figures, the more intense the hurricane and the greater its damage potential.

The Saffir/Simpson Hurricane Scale (Table 2-1) is probably the best known and most widely used method or model for quantifying hurricanes. It is both descriptive and quantitative, providing types of expected damage plus windspeeds and storm surge heights for each intensity category. The Scale assumes an average uniform coastline for the continental United States and does not reflect effects of local features such as bathymetry, coastal configuration, barriers and other factors which can affect surge heights in specific locales.

TABLE 2-1
SAFFIR/SIMPSON HURRICANE SCALE

CATEGORY 1. Winds of 74 to 95 miles per hour. Damage primarily to shrubbery, trees, foliage and unanchored mobile homes. No real damage to other structures. Some damage to poorly constructed signs. And/or: storm surge 4 to 5 feet above normal. Low-lying coastal roads inundated, minor pier damage, some small craft in exposed anchorage torn from moorings.

CATEGORY 2. Winds of 96 to 110 miles per hour. Considerable damage to shrubbery and tree foliage; some trees blown down. Major damage to exposed mobile homes. Extensive damage to poorly constructed signs. Some damage to roofing materials of buildings; some window and door damage. No major damage to buildings. And/or: storm surge 6 to 8 feet above normal. Coastal roads and low-lying escape routes inland cut by rising water 2 to 4 hours before arrival of hurricane center. Considerable damage to piers. Marinas flooded. Small craft in unprotected anchorages torn from moorings. Evacuation of some shoreline residences and low-lying island areas required.

CATEGORY 3. Winds of 111 to 130 miles per hour. Foliage torn from trees; large trees blown down. Practically all poorly constructed signs blown down. Some damage to roofing materials of buildings; some window and door damage. Some structural damage to small buildings. Mobile homes destroyed. And/or: storm surge 9 to 12 feet above normal. Serious flooding at coast and many smaller structures near coast destroyed; larger structures near coast damaged by battering waves and floating debris. Low-lying escape routes inland cut off by rising water 3 to 5 hours before hurricane center arrives. Flat terrain 5 feet or less above sea level flooded inland 8 miles or more. Evacuation of low-lying residences within several blocks of shoreline possibly required.

CATEGORY 4. Winds of 131 to 155 miles per hour. Shrubs and trees blown down; all signs down. Extensive damage to roofing materials, windows and doors. Complete failure of roofs on many small residences. Complete destruction of mobile homes. And/or: storm surge 13 to 18 feet above normal. Flat terrain 10 feet or less above sea level flooded inland as far a 6 miles. Major damage to lower floors of structures near shore due to flooding and battering by waves and floating debris. Low-lying escape routes inland cut off by rising water 3 to 5 hours before hurricane center arrives. Major erosion of beaches. Massive evacuation of all residences within 500 yards of shore possibly required, and of single-story residences on low ground within 2 miles of shore.

CATEGORY 5. Winds greater than 155 miles per hour. Shrubs and trees blown down; considerable damage to roofs of buildings; all signs down. Very severe and extensive damage to windows and doors. Complete failure of roofs on many residences and industrial buildings. Extensive shattering of glass in windows and doors. Some complete building failures. Small buildings overturned or blown away. Complete destruction of mobile homes. And/or: storm surge greater than 18 feet above normal. Major damage to lower floors of all structures less than 15 feet above sea level within 500 yards of shore. Low-lying escape routes inland cut off by rising water 3 to 5 hours before hurricane center arrives. Massive evacuation of residential areas on low ground within 5 to 10 miles of shore possibly required.

More recently, the National Hurricane Center added to the Saffir/Simpson Hurricane Scale a table of ranges of central barometric pressures associated with each intensity category of hurricane (Table 2-2).

TABLE 2-2
SAFFIR/SIMPSON HURRICANE SCALE
WITH
CENTRAL BAROMETRIC PRESSURE RANGES

CATEGORY	CENTRAL PRESSURE MILLIBARS	CENTRAL PRESSURE INCHES	WINDS (MPH)	SURGE (FT.)
1	>980	>28.94	74 - 95	4 - 5
2	965-979	28.50-28.91	96 - 110	6 - 8
3	945-964	27.91-28.47	111 - 130	9 - 12
4	920-944	27.17-27.88	131 - 155	13 - 18
5	<920	<27.17	>155	>18

C. Maximum Elevation of Water.

For planning purposes it is extremely desirable to know the maximum level of innundation produced by a hurricane as well as an indication of when critical escape routes will be cut off. Historical information lacks the detail needed for adequate hurricane preparedness planning. To overcome this difficulty the National Weather Service has for many years experimented with various simulations of hurricane events using both laboratory and computer models. The most comprehensive computer model, Sea, Lake, and Overland Surge from Hurricanes (SLOSH), and an earlier useful model, Special Program to List the Amplitude of Surge from Hurricanes (SPLASH), were used in the South Carolina Hurricane Evacuation Study. Details of these models and their usage may be found in Appendix One, Part Three of this Technical Report.

1. Grand Strand Region - The reader is referred to Appendix One to see the portions of the Grand Strand that would be innundated when hurricanes of various categories strike the coast. Part One shows these maximum elevations by direction of storm movement, while Part Two includes the maximum elevation by category of hurricane irrespective of the direction the hurricane is moving.

Part Two of Appendix One has an added feature...it also shows the additional area that would be innundated if the hurricane arrived at time of high tide.

It is obvious from an inspection of these charts that a major hurricane striking the northeast coast would cut off escape routes making it mandatory that evacuation be completed in advance of the storm's arrival.

Time history and hourly history information is also provided as Appendix Three, Parts Three, Four, and Five. This data gives a chronology of storm surge and wind data that may be expected during the passage of hurricanes of various categories and directions.

2. Lower Coast Region - Similar information is also included for the lower coastal region in Appendix Three, Parts One and Two. It becomes immediately obvious from these data that a hurricane striking the lower coastal region has a potential of affecting a much larger area due to the flat terrain, exposed coastal islands, and extensive water-marsh areas.

III. DESTRUCTIVE WINDS

Hurricanes produce the strongest sustained surface winds known to man. A few anemometers, specially constructed for hurricane measurements, have recorded winds above 160 mph. It is believed that over the sea and at a distance of a few hundred feet above the ground the wind speed during an intense hurricane may attain 200 mph in a very small area.

Damage caused by hurricane produced winds may be extensive and at times unbelievable. The pressure that wind exerts on buildings is roughly proportional to the kinetic energy of the wind and therefore to the square of the wind speed. Buildings used for hurricane shelters should be of reinforced construction so as to better withstand the high winds associated with a hurricane.

Wind damage to multi-story buildings is usually greater over the top part of the structure because frictional effects tend to reduce the wind speed at and near the ground. For example during the passage of a tropical storm along the coast during 1985, a building in the Grand Strand area suffered considerable damage to the inner walls near the top of the building while near the ground there was little damage. Glass plated buildings are particularly vulnerable to damage from high winds.

Since most hurricanes display a high degree of circular symmetry, the highest and most destructive winds are usually found in a narrow ring around the eye of the hurricane.

At larger distances from the eye, the strongest winds are usually concentrated within spiral rainbands that radiate out counterclockwise from the wall clouds surrounding the hurricane's eye.

The sustained wind speeds decrease rapidly as the storm moves inland. However, damaging wind speeds in squalls may occur for more than 100 miles inland.

The combination of high winds and heavy rain causes extensive limb breakage as well as overturned trees. For this reason power outages may be expected to always occur during the passage of hurricanes.

The direction of movement of storms affecting the coastal counties has an important bearing on the amount of damage that the storm produces. If a hurricane moves northeastward along and off the coast the amount of damage is usually

minimized. A similar storm moving northwestward or westward would cause considerable damage. Historical information indicates a large percentage of tropical storms and hurricanes are from the southwest or are moving northeast, although a significant percentage are from the east to southeast quadrant. Such were the cases when Hazel (1954), Gracie (1959), and Diana (1984) caused major damage in South Carolina.

IV. TIDAL INFORMATION

A. General.

Tides have a noticeable effect on the elevation of water during the passage of a hurricane. A storm making landfall at high tide will produce higher surges and flood larger areas than a similar storm making landfall at low tide.

Along the Gulf and Florida coasts (where the first SLOSH computer runs were made), daily tidal fluctuations are generally quite small and provide only a small contribution to the final storm surge elevation. Along the South Carolina coast, however, there is considarable difference in the range of the height between low and high tide. These differences are generally greater along the south coast near Savannah as compared to those of the Grand Strand area of the northeastern coast.

1. Grand Strand Region - Along the outer coastline of Horry County the range between the height of low and high tide is usually between 4.5 and 5.2 feet; while during spring tide the range increases to 4.5 to 6.0 feet. The spring tide range is the semidiurnal range occurring semi-monthly as a result of the moon being new or full.

2. Lower Coast Region - Southward along the outer coastline from near Beaufort to Savannah, the range between the low and high tide increases generally to 6 to 8 feet; while during spring tide the range is greater, being mostly 6.5 to 9.5 feet.

B. Surge Elevation Including Tidal Changes.

The initial sea-surface heights set in the SLOSH models for the study was mean sea level (msl) plus one (1) foot. A tide anomaly of approximately one (1) foot above normal levels occurs several days prior to the arrival of a hurricane.

In order to estimate the effect of tides on final water elevations, the SLOSH models were run assuming that the various hurricanes struck at time of high tide. Charleston basin high tide simulations were based on a +3 feet msl datum. Savannah/Hilton Head Island high tide simulations were based on a +5 feet msl datum.

The next step was to compare the runs of a plus 1 foot datum with those made at time of high tide, noting differences in water level elevations produced at each grid point. Appendix One, Part Two shows those additional areas that would be flooded if a storm struck at time of high tide.

V. FLOODING FROM HEAVY RAINFALL

A. General.

Hurricane evacuation may be complicated by freshwater flooding resulting from rains preceding, as well as associated with, the passage of the storm. Rainfall exerts only a minor influence on transient water levels of the storm surge itself and does not normally necessitate emergency evacuation of large numbers of people during the passage of a hurricane, as does the storm surge. Heavy rains, however, cause early innundation of roadways used as evacuation routes by persons attempting to escape from hurricane storm surge flooding.

The amount and arrival time of rainfall associated with hurricanes are highly unpredictable. For most hurricanes, the heaviest rainfall begins near the time of arrival of sustained gale-force winds. However, heavy rains in amounts exceeding five to ten inches can precede an approaching hurricane by as much as 24 hours. Unrelated weather systems can also contribute significant rainfall amounts in advance of a storm.

The intensity of the hurricane is not necessarily an indication of the amount of rainfall; for example, the passage of tropical storm Dennis (August, 1981) caused four to ten inches over portions of the Grand Strand area, although winds and tides produced little damage.

B. Flood Prone Areas.

Due to the unpredictability of rainfall from hurricanes, no attempt was made to employ sophisticated modeling or analysis in quantifying effects of rainfall for the South Carolina Hurricane Evacuation Study area. Areas and facilities which have historically flooded during periods of heavy rainfall were identified throughout the study area. These flood prone areas for the coastal counties are shown as follows:

1. Grand Strand Region - Figure 2-1, Georgetown County, shows freshwater flood prone areas. In the unlikely event that the Great Pee Dee River were in flood at the time hurricane rains fall, additional areas would be innundated. Some of the more flood prone areas of the county are as follows:

(A) A main evacuation route, US 17A and SC 521 in uptown Georgetown, requiring a detour of several blocks.

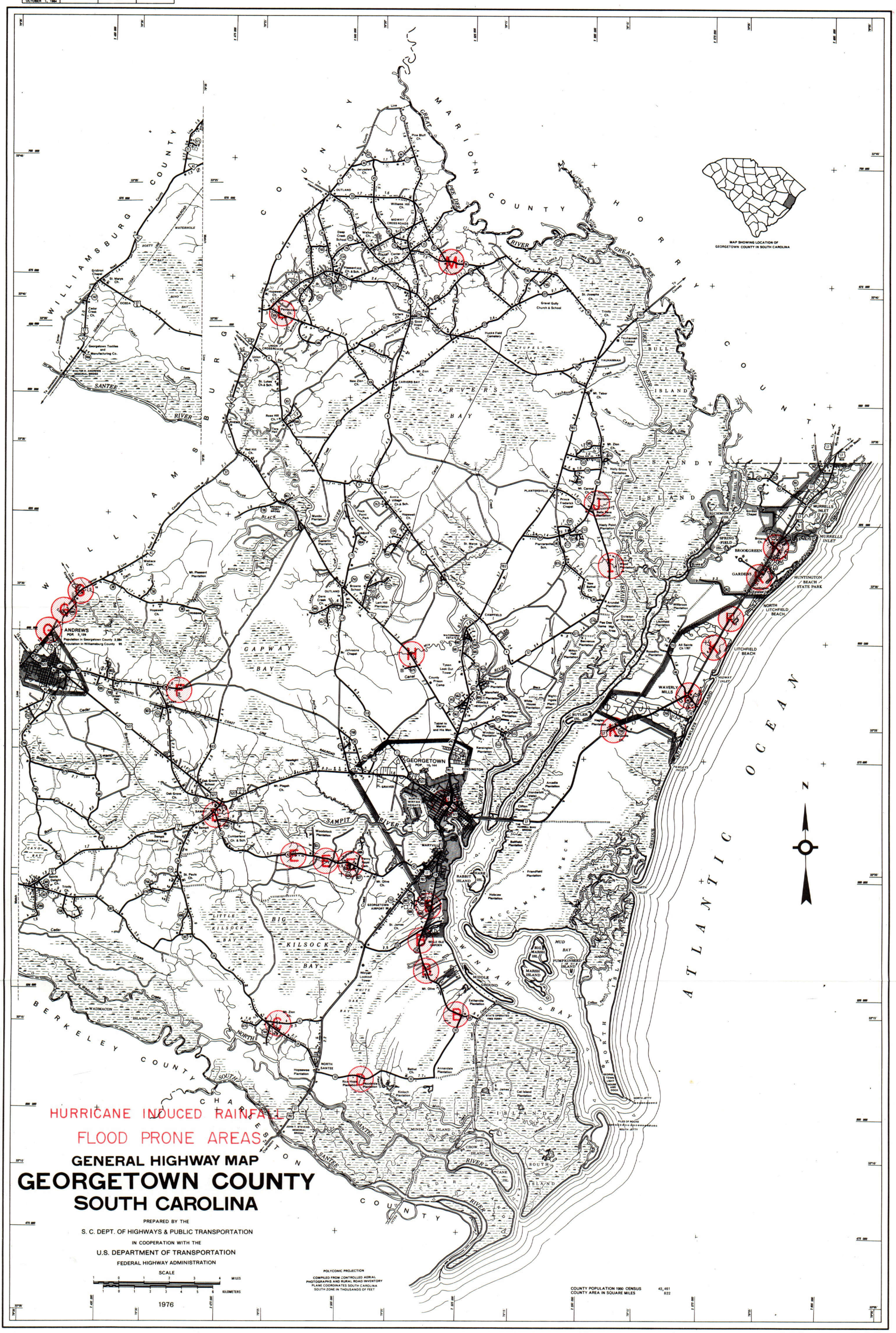
(B) Several areas along SC 18 south of Maryville and Georgetown.

(C) A bridge on SC 31 as well as intersecting SC 24 and SC 744 all of which cross a creek that feeds into the North Santee River.

(D) A bridge across Kinlock Creek on SC 30 near Rice Hope and Doar Plantations.

(E) Several areas along SC 42 west of Maryville including the Sampit area.

COMPLETED APRIL 1976			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
MAY 1, 1978	FEBRUARY 1, 1980	MARCH 1, 1986	
JULY 1, 1978	FEBRUARY 1, 1982		
JULY 1, 1977	OCTOBER 1, 1984		
OCTOBER 1, 1979	MARCH 1, 1986		
FEBRUARY 1, 1980			
FEBRUARY 1, 1982			
OCTOBER 1, 1984			



GENERAL HIGHWAY MAP GEORGETOWN COUNTY SOUTH CAROLINA 22

FIGURE 2-1

(F) A bridge on SC 20 which crosses a creek stemming from Indian Hut Swamp.

(G) Several areas on or near the Williamsburg County line just north of Andrews along SC 41.

(H) A bridge on SC 51 which crosses Six Mile Creek.

(I) A bridge on SC 52 near Chicora Wood Plantation.

(J) An area on SC 264 which crosses Cypress Creek near Glenmore

(K) Several areas along US 17; near Marysville Church and SC 759, Waverly Mills, near Litchfield Beach, Brookgreen Gardens, and the area of SC 392.

(L) A bridge crossing a creek on SC 306 near the juncture of SC 513 in the northern part of the county.

(M) SC 36 crossing Port Creek and near SC 55 juncture in the northern part of the county.

Figure 2-2, Horry County, indicates roads subject to freshwater flooding during and following periods of heavy rainfall. There are extensive areas near the Waccamaw River that are subject to river flooding. The Waccamaw is very slow to respond to rainfall. It is not likely that river flooding resulting from rainfall associated with the hurricane in progress would become a problem during the passage of the hurricane involved although it could and most likely would be a consideration during recovery efforts. Some of the flood prone areas of the county are as follows:

(A) Flash flooding during and immediately following heavy rains affects and in some cases blocks a number of streets in Conway. While such flooding would not halt evacuation, in some instances it would cause delays, detours, and disruptions to traffic moving along streets and highways.

(B) An extensive stretch of Garden City Beach ocean-front road, several streets in Surfside Beach, and US 17 Business at Surfside Beach.

(C) Several areas along SC 544 from Socastee north to Conway and SC 707 east of Socastee.

(D) SC 137 and SC 992 west southwest of US 501 near Socastee Swamp and Forestbrook and along US 501 about 2 miles from Myrtle Beach Raceway toward Conway.

(E) SC 90 near Riverside Club east of US 501, the juncture of SC 90 and SC 901 area, and SC 901 near Lee's Landing.

(F) The area of SC 106 and SC 165 juncture just north of Conway.

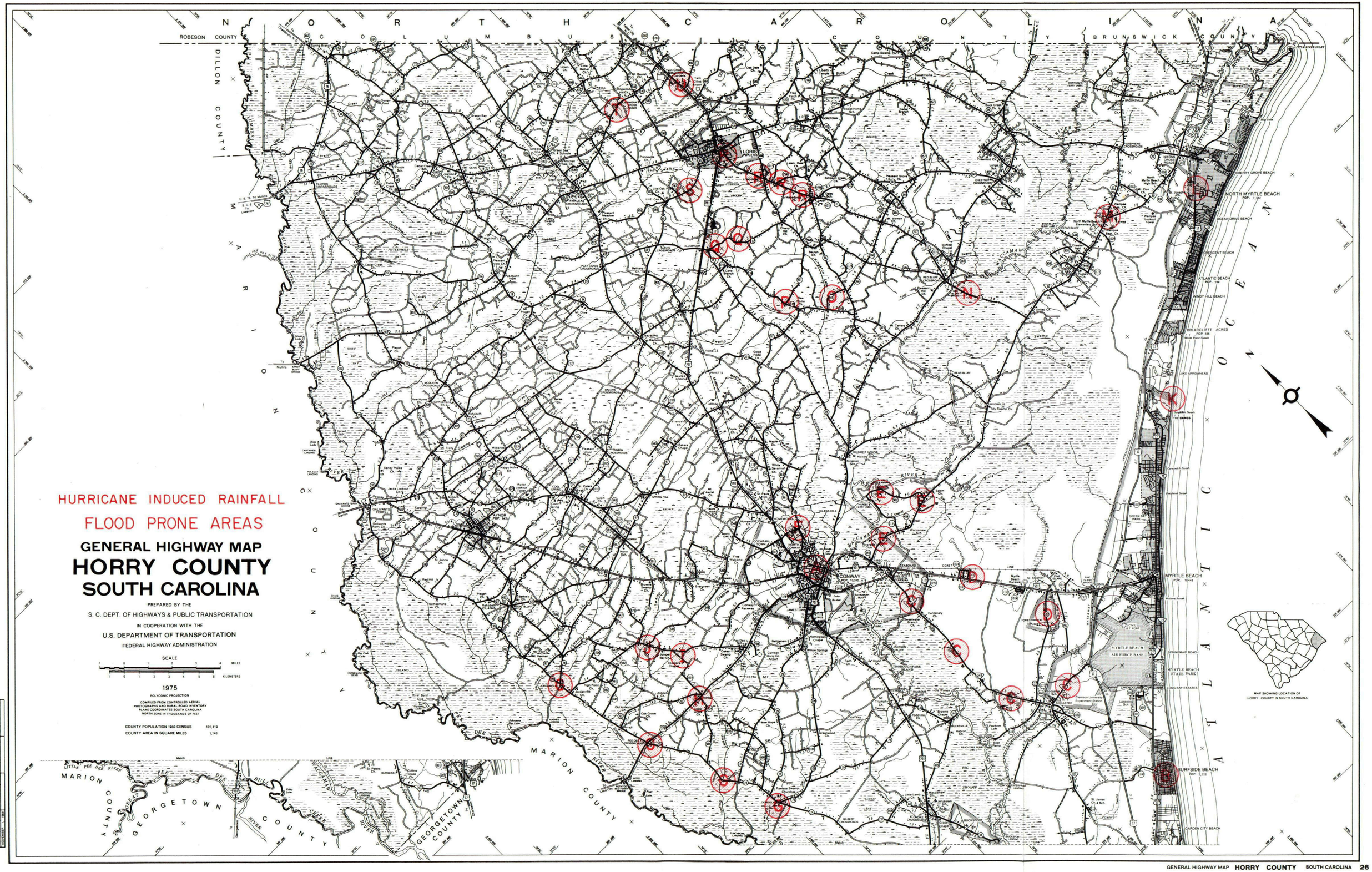

HURRICANE INDUCED RAINFALL
FLOOD PRONE AREAS
GENERAL HIGHWAY MAP
HORRY COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1975
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA NORTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 101,419
COUNTY AREA IN SQUARE MILES 1,143
N O R T H C A R O L I N A
ROBESON COUNTY
COLUMBUS COUNTY
BRUNSWICK COUNTY
DILLON COUNTY
MARION COUNTY
GEORGETOWN COUNTY
LORIS
CONWAY
AYNOR
NORTH MYRTLE BEACH
MYRTLE BEACH
SURFSIDE BEACH
MYRTLE BEACH AIR FORCE BASE
ATLANTIC OCEAN
MAP SHOWING LOCATION OF HORRY COUNTY IN SOUTH CAROLINA

FIGURE 2-2

(G) Several stretches of SC 24; a bridge which crosses Pawleys Swamp at Dongola, northward of SC 135 juncture, the intersection of US 378 and SC 24 at Pee Dee Crossroads, and the intersection of SC 24 and SC 99 at Jordanville.

(H) The intersection area of SC 934, SC 63, SC 1019, and US 378 in the Forney area.

(I) A stretch of SC 78, SC 1019, and an unidentified road, all of which form a triangle south of Brown Swamp.

(J) The bridge crossing Brown Swamp and the intersection area of SC 78 and SC 548.

(K) An area of ocean-front road between The Dunes and Lake Arrowhead.

(L) A section of US 17 at North Myrtle Beach.

(M) A section of SC 90 and SC 57 which intersect near North Myrtle Beach Elementary School.

(N) The area of Red Bluff Crossroads and extending southward on SC 31 across Waccamaw River and several bridges crossing the swamp.

(O) SC 545 in the area south of Kingston Lake Swamp.

(P) An area at the intersection of SC 911 and SC 139 near White Oak Swamp.

(Q) Several areas eastward from SC 19 along SC 112 east of Allsbrook.

(R) Several stretches of SC 31 from Daisy northward into Loris and including portions of intersecting SC 754, SC 568 at Longpoint, and SC 9 eastward in Loris.

(S) Numerous roads off of and including SC 45 westerly near Loris and south of Pleasant Meadow Swamp.

(T) Several roads near Jernigans Crossroads along SC 103, SC 646, and other unidentified roads.

(U) A section of US 701 and SC 842 which intersect near Twin Cities Airport.

2. Lower Coast Region - Figure 2-3, Beaufort County, shows several areas that may be affected by flooding from heavy rains. These areas are:

(A) In and near the traffic circle at Forest Beach on Hilton Head Island. Runoff during and immediately following heavy rains may cause flooding up to the axles of cars. This is largely a result of inadequate drainage.

COMPLETED	JULY 1, 1976
REVISED	
STATE SYSTEM	COUNTY SYSTEM
FEBRUARY 1, 1980	FEBRUARY 1, 1980
AUGUST 1, 1981	AUGUST 1, 1981
NOVEMBER 1, 1983	NOVEMBER 1, 1983
MARCH 1, 1985	MARCH 1, 1985

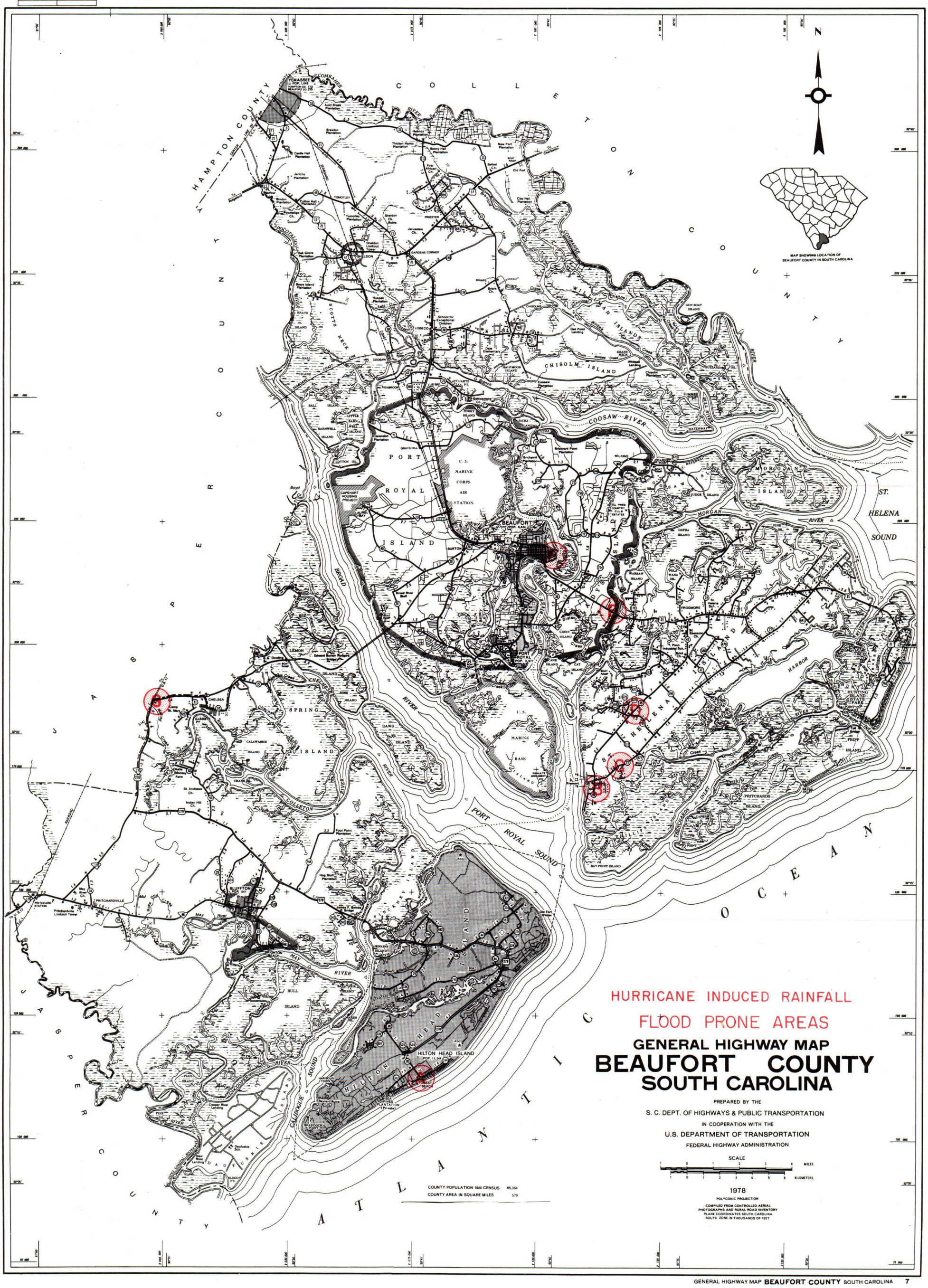


FIGURE 2-3

GENERAL HIGHWAY MAP BEAUFORT COUNTY SOUTH CAROLINA 7

(B) SC 45 near Port Royal Sound is subject to flooding during periods of high tides.

(C) Also, about 2 miles north of this location, on SC 77, flooding may occur during periods of high water.

(D) Flooding also occurs on SC 45 a short distance north of the intersection with SC 169.

(E) US 21, a main evacuation route from Hunting Island, has been flooded during unusually high tides in the lower areas near the intersection with SC 170.

(F) High tides along with heavy rains at times flood several streets in Beaufort east of US 21.

(G) Some flooding has also been reported on SC 170 south of Chelsea.

Figure 2-4, Colleton County, shows several flood prone areas. These areas are:

(A) Flash flooding begins in uptown Walterboro. On secondary road #335 near the Ivanhoe Center, Ireland Creek fails to carry off the additional runoff.

(B) High stages of more than 6 feet along the Edisto River at Canadys will block several secondary roads along the lower Edisto River.

(C) The Baptist Branch bridge on SC 45 is also subject to flooding.

(D) US 17, under extreme conditions of heavy rains and high tides, has been troubled by water on the road east of the Ashepoo River as well as near the Combahee River.

(E) SC 174, in Edisto Beach, is subject to flooding during heavy rain.

(F) Flooding has washed out the bridges on SC 40 approximately 3 miles north of the intersection at SC 64.

Figure 2-5, Charleston County, shows several areas that are affected by flooding from heavy rains that may precede the passage of hurricanes. Obviously a very critical area is the Charleston peninsula where there are many built up areas, areas of poor drainage and areas of little topographic relief. As a result runoff from any heavy rain will interfere with the normal movement of traffic at many places within the city. These flood prone areas are:

(A) The access to I-26 in uptown Charleston is flooded by runoff from rains of two or more inches within a short time. While the interstate is not flooded, traffic can not enter nor exit properly.

COMPLETED NOVEMBER 1975			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
MAR. 1, 1976	JAN. 1, 1976	SEPTEMBER 1, 1982	
JULY 1, 1976	MARCH 1, 1979	NOVEMBER 1, 1983	
APRIL 1, 1977	DECEMBER 1, 1980	MARCH 1, 1985	
JULY 1, 1978	SEPTEMBER 1, 1982		
MARCH 1, 1979	NOVEMBER 1, 1983		
DECEMBER 1, 1980	MARCH 1, 1985		

FIGURE 2-4

GENERAL HIGHWAY MAP COLLETON COUNTY SOUTH CAROLINA 15

HURRICANE INDUCED RAINFALL
FLOOD PRONE AREAS
GENERAL HIGHWAY MAP
CHARLESTON COUNTY
SOUTH CAROLINA
PREPARED BY THE
S.C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1978
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
SOUTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 276,274
COUNTY AREA IN SQUARE MILES 988
MAP SHOWING LOCATION OF CHARLESTON COUNTY IN SOUTH CAROLINA
CHARLESTON
NORTH CHARLESTON
MOUNT PLEASANT
FOLLY BEACH
ISLE OF PALMS
SULLIVANS ISLAND
JOHNS ISLAND
WADMALAW ISLAND
DORCHESTER COUNTY
BERKELEY COUNTY
GEORGETOWN COUNTY
FRANCIS MARION NATIONAL FOREST
ATLANTIC OCEAN
A
B
C
D
E
F
G
H
I
J
K
L
M
N

FIGURE 2-5

(B) Lockwood, Calhoun, and East Bay Streets are affected by unusually high tides of the magnitude that might precede the arrival of a hurricane. Also heavy rains flood portions of these streets.

(C) SC 20 near Stono River is affected by spring tides or higher as well as by heavy rainfall.

(D) SC 174 is affected by high tides and heavy rains at the Dawhoo River bridge over the Intracoastal Waterway.

(E) US 52 near the Charleston Air Force Base is affected by unusually heavy rain runoff.

(F) US 52 north near Goose Creek Bridge is affected by extremely heavy rains, such as those which accompanied Hurricane David (1979). Runoff may make driving hazardous.

(G) SC 171 to Folly Beach and Harborview Road off SC 171 is flooded in several places during periods of extremely heavy rains.

(H) US 17 North, a short distance south of SC 584, floods during heavy rains. Also runoff from heavy rains from the Francis Marion National Forest disrupts traffic on US 17.

(I) Portions of midtown US 17 are flooded following rain of 3 or more inches within a short time.

(J) SC 171 at the bridge into Folly Beach is cut off during high water.

(K) SC 703 between Sawyer Memorial Bridge and Simmons Seafood floods during very high tides.

(L) SC 703 at Breach Inlet - separating Isle of Palms and Sullivan's Island - may flood during very high tides.

(M) US 17 approaches to the Cooper River Bridge, both north and south, are cut off during high water.

BIBLIOGRAPHY FOR HAZARDS ANALYSIS

Dabbs, Edith M.
1983 Sea Island Diary, A History of St Helena Island. Reprint Company Publishers. Spartanburg. S.C. pp. 195-196.

Davis, Richard A. Jr.
1978 Beach and Nearshore Zone. In Coastal Sedimentary Environments. Richard A. Davis, Jr.. ed. Springer-Verlag. New York. p. 262

Dunlop, J. G.
1929 Spanish Depredations. In South Carolina Historical and Geneological Magazine. Vol 30-2. pp. 83-85.

Easterby, J. H., ed.
1945 The South Carolina Rice Plantation as Revealed in the Papers of Robert F. W. Allston. University of Chicago Press, Chicago. p. 120.

Fenneman, Nevin M.
1938 Physiography of Eastern United States. McGraw-Hill, New York. pp. 44-45.

Frey, Robert W. and Paul B. Basan
1978 Coastal Salt Marshes. In Coastal Sedimentary Environments. Richard A. Davis, Jr., Ed. Springer-Verlag, New York. pp. 134, 138.

Hebert, Paul J., Glenn Saylor and Robert A. Case
1984 Hurricane Experience Levels of Coastal County Populations - Texas to Maine, NOAA Technical Memorandum NWS NHC24. National Hurricane Center, Miami.

Hunt, Charles B.
1974 Natural Regions of the United States and Canada. W.H. Freeman Company, San Francisco. pp. 209-226.

Oertal, George F.
1979 Barrier Island Development During the Holocene Recession. In Barrier Islands From the Gulf of St. Lawrence to the Gulf of Mexico. Stephen P. Leatherman, ed. Academic Press, New York. pp. 273-290.

Purvis, John C. and H. Landers
1973 South Carolina Hurricanes. South Carolina Disaster Preparedness Agency.

Snowden, Yates, ed.
1920 History of South Carolina. Vol. I. Lewis Publishing Company, New York & Chicago. pp. 215, 248-249.

South Carolina Division of Research and Statistical Services
1985 South Carolina Statistical Abstract. Columbia.

U.S. Department of Commerce
1981 Tropical Storms of the North Atlantic Ocean, 1871-1980. National Oceanic and Atmospheric Administration. U.S. Government Printing Office, Washington, D.C. PP. 21-23, 33-146.

CHAPTER THREE

VULNERABILITY ANALYSIS

I. PURPOSE

The purpose of the vulnerability analysis is to identify the areas, populations, and facilities which are potentially vulnerable to the effects of hurricanes. The storm surge data from the hazards analysis are used to develop evacuation zones and scenarios for traffic modeling each of the study area counties; quantify the population at risk under a range of hurricane intensities; and to identify major institutional/medical facilities that are potentially vulnerable to storm surge. Evacuation zones are described in Chapter 6, Transportation Analysis, with accompanying tables and maps.

II. VULNERABLE POPULATION

A. General.

South Carolina's coastal population is - and will continue to be - of two types: resident and transient. Both have increased dramatically in the past few years and are expected to nearly double by the turn of the century.

1960-1980 was a period of rapid increase in resident populations of all five coastal counties. While the population of the five coastal counties grew by 32.3%, most of that growth was concentrated in the resort areas of the Grand Strand (Horry County) on the northern coast, and Beaufort-Hilton Head (Beaufort County) on the southern coast. Charleston, Georgetown, and Colleton Counties (in that order) grew steadily, but at a slower pace.

During the years 1980 - 2000, the population of the five coastal counties is expected to increase by over 50%, again with the greatest growth occurring in Horry and Beaufort Counties (123% and 132%, respectively) followed by Georgetown, Colleton, and Charleston Counties.

Some of this population increase will occur in inland areas, but the greater portion of it is expected to take place along the coast and on the Sea Islands. There competition and high prices for desirable and increasingly scarce waterfront property will lead to very high population densities and extensive vertical housing.

While much of the growth in the coastal counties is the result of South Carolinians or other southerners moving to these areas in response to industrial, residential, and resort development, there have been sizeable in-migrations of persons from northeastern, north central, and western states, who have little or no hurricane experience. It has been estimated that since the last major (category 3 or above) hurricane penetrated the South Carolina coast (Gracie, 1959) 173,528 persons have moved to coastal areas of South Carolina. This in-migration from other areas, births since the late 1950's, and older natives of the state who have never been in the path of a storm indicates a very small percentage of the population has experienced a direct hit by a major hurricane.

During this time period (1960-1985) only two hurricanes and two tropical storms - all minimal and causing light-to-minor damage - penetrated South Carolina's coastline. Such low storm incidence, plus the minimal intensity and damage, tends to create a false sense of security among newer residents and lowers awareness levels of those with hurricane experience.

In addition, South Carolina's beaches and sea islands attract more than eight million visitors annually, over six million of whom are here during the hurricane season.

The high population densities in resort areas create problems moving such numbers of persons and their vehicles away from exposed coastal communities in a short period of time, and notifying some persons of the storm's approach and the need for evacuation presents another of the many problems encountered by local officials before and during a storm.

There are still some extremely rural areas along the coast. Families, some migrant or resident agricultural workers, others simply elderly poor, live almost in isolation, far from main roads at the ends of little dirt lanes. Since many of them lack electricity and telephones the only way to notify them is door-to-door word of mouth. Such notification takes time and the people needing to be notified in this manner are frequently those needing assistance in order to evacuate at all.

Many persons, both residents and transients, are reluctant or refuse to be evacuated because:

- they've never experienced a hurricane and wish to do so;
- they feel their property will not be protected in their absence;
- based on prior experience they expect the hurricane to be minimal;
- they live in substantial houses on higher elevations and feel evacuation is unnecessary for them;
- no one else in their area is evacuating, why should they?;
- they are unfamiliar with the area and don't know where to go;
- they have neither a means of evacuating nor a place to go;
- they did not learn of the emergency in time to evacuate;
- the most common individual adjustment to the hurricane hazard is apathy, to do nothing and accept the results.

Population size, location, presence or absence of hurricane experience, willingness or reluctance to evacuate, and inability to evacuate without assistance can create problems unless defined and dealt with during pre-emergency planning. Awareness of the needs and attitudes of the populations with which emergency officials will be dealing means easier, more efficient evacuations in hurricane emergencies.

B. Vulnerable Population.

The vulnerable population within each of the study area counties constitutes the number of residents within the evacuation zones identified as vulnerable to storm surge as well as the mobile home residents of non-vulnerable zones. The mobile home residents are included due to their vulnerability to the winds associated with all categories of hurricanes.

Total potential tourist population is also included for each of the counties based on the number of existing tourist units. The total tourist population within each county included those within vulnerable as well as non-vulnerable zones since it is expected that all tourists within a county would evacuate under a hurricane threat.

Table 3-1 contains the vulnerable population for each of the hurricane categories at varying levels of tourist occupancy. The population shown for each county is projected 1987 population data.

TABLE 3-1

VULNERABLE POPULATION

GRAND STRAND COUNTIES

County	Category	Tourist Occupancy	Vulnerable Population
Georgetown	1 & 2	Low Occupancy	19,212
	1 & 2	High Occupancy	24,535
	3	Low Occupancy	23,439
	3	High Occupancy	28,761
	4 & 5	Low Occupancy	38,713
	4 & 5	High Occupancy	44,034
Horry	1 & 2	Medium Occupancy	109,364
	1 & 2	High Occupancy	149,410
	3	Medium Occupancy	119,271
	3	High Occupancy	160,139
	4 & 5	Medium Occupancy	138,506
	4 & 5	High Occupancy	179,374

TABLE 3-1 (continued)

VULNERABLE POPULATION

LOWER COAST COUNTIES

County	Category	Tourist Occupancy	Vulnerable Population
Beaufort	1	Low Occupancy	41,590
	1	Medium Occupancy	58,043
	1	High Occupancy	74,492
	2	Low Occupancy	51,405
	2	Medium Occupancy	67,858
	2	High Occupancy	84,309
	3	Low Occupancy	65,926
	3	Medium Occupancy	82,378
	3	High Occupancy	98,828
	4 & 5	Low Occupancy	73,556
	4 & 5	Medium Occupancy	90,009
	4 & 5	High Occupancy	106,460
Berkeley	1 - 3		24,901
	4 - 5		30,599
Charleston	Weak 1	Medium Occupancy	64,431
	Weak 1	High Occupancy	68,437
	1 & 2	Medium Occupancy	111,005
	1 & 2	High Occupancy	115,072
	3	Medium Occupancy	188,694
	3	High Occupancy	192,762
	4 & 5	Medium Occupancy	248,910
	4 & 5	High Occupancy	252,979
Colleton	1 & 2	Low Occupancy	6,647
	1 & 2	High Occupancy	7,438
	3 - 5	Low Occupancy	6,990
	3 - 5	High Occupancy	7,781
Dorchester	1 - 5		15,187
Hampton	1 - 5		2,196
Jasper	1 & 2		4,864
	3 - 5		8,131

III. HURRICANE EVACUATION SCENARIOS

A. General.

Hurricane evacuation scenarios have been developed for each of the South Carolina Hurricane Evacuation Study area counties. The evacuation scenarios are groups of evacuation zones that will potentially require evacuation under specific hurricane intensities due to the threat of storm surge. In many instances, the evacuation zones threatened by storm surge are the same for more than one intensity of hurricane. In those cases, the evacuation zones requiring evacuation have been combined into evacuation scenarios based on combinations of hurricane intensities. The evacuation zones mentioned here were developed for use in the transportation analysis and represent traffic modeling zones. Local emergency management officials may wish to combine these zones into larger operational evacuation zones.

B. Hurricane Evacuation Scenarios.

Table 3-2 contains the hurricane evacuation scenarios developed for each of the study area counties and lists the evacuation zones comprising each scenario. Maps illustrating each hurricane evacuation scenario are contained in Chapter 6, Transportation Analysis, Figures 6-2 through 6-10.

TABLE 3-2

HURRICANE EVACUATION SCENARIOS

GRAND STRAND COUNTIES

GEORGETOWN

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 & 2	1 - 7
B	CAT 3	1 - 13
C	CAT 4 & 5	1 - 22

HORRY

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 & 2	1 - 12
B	CAT 3	1 - 16
C	CAT 4 & 5	1 - 28

TABLE 3-2 (continued)

HURRICANE EVACUATION SCENARIOS

LOWER COAST COUNTIES

BEAUFORT

Scenario	Storm Categories	Evacuation Zones
A	CAT 1	1 - 29
B	CAT 2	1 - 39
C	CAT 3	1 - 54
D	CAT 4 & 5	1 - 64

BERKELEY

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 - 3	1 - 2
B	CAT 4 & 5	1 - 6

CHARLESTON

Scenario	Storm Categories	Evacuation Zones
A	WEAK CAT 1	1 - 22
B	CAT 1 - 2	1 - 22
C	CAT 3	1 - 45
D	CAT 4 & 5	1 - 63

COLLETON

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 & 2	1 - 2
B	CAT 3 - 5	1 - 3

DORCHESTER

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 - 5	1

HAMPTON

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 - 5	1

JASPER

Scenario	Storm Categories	Evacuation Zones
A	CAT 1 & 2	1 - 3
B	CAT 3 - 5	1 - 7

IV. ROAD AND HIGHWAY NETWORKS

Roadways providing direct routing away from exposed coastal communities are the most critical component in evacuation of at-risk populations. They must be of sufficient elevation as to be clear of flood waters for the longest-possible period of time; have few or no large trees nearby; have both pavement and berms sufficiently wide to accommodate expected vehicular traffic. While emergency planners in other states may be able to establish evacuation routes using only those roadways which most closely match the above criteria, such options are generally not available in South Carolina.

The present highway network of South Carolina's outer coastal plain is a direct reflection of its topography. Along the northern coast roads near to and paralleling the coastline are connected to each other by ones perpendicular to the coastline. On the southern coast the islands are connected to the mainland by perpendicular roads which continue to the paralleling highways which are much further inland than those in the northern section.

In terms of two-and four-lane, hard-surface all-weather roads, South Carolina's coastal highway network is quantitatively and qualitatively sufficient for the at-risk resident population.

The Edisto Beach-Edisto Island at-risk resident population has a two-lane paved highway connecting it to the mainland. Charleston at-risk resident population, is connected to the "mainland" by state and U.S. highways and an interstate. The Grand Strand-Georgetown-Waccamaw Neck section, total at-risk resident population, has several two and four-lane state and U.S. highways leading inland. Hilton Head Island at-risk resident population is linked to the mainland by a two and four lane paved highway. Similarly, the at-risk residents of the Beaufort-Port Royal-St. Helena area have one two-to-four lane highway directly linking them to the mainland.

Within the network all but three of the connecting highways cross rivers and the Intracoastal Waterway via fixed spans. The exceptions are SC 544 at Socastee, in the Grand Strand area; SC 174 connecting Edisto Beach and Edisto Island to the mainland; and SC 21 at Hunting Island.

Coastal South Carolina attracts large numbers of visitors each year, most of them during the normal hurricane season. This transient population probably has little to no hurricane experience, is unfamiliar with the local road networks, and arrives by car, frequently with a boat or trailer in tow. Some of the transient population arrives by air and depends on a rental car or local taxi service (neither of which may be available in a hurricane emergency) for ground transportation.

However they arrive, evacuation needs of the transient population must be considered in pre-emergency planning, keeping in mind that the size of the at-risk transient population is expected to increase annually for the foreseeable future.

Absentee owners of coastal properties also need to be taken into consideration when planning evacuations. These owners of second homes or houses purchased for investment/rental purposes frequently live in nearby mainland communities and will want or need to get to their property to secure it before the hurricane arrives, necessitating planning for two-way vehicular traffic in some areas.

While the present network of coastal access/evacuation routes is adequate for residents, its sufficiency in a hurricane emergency, with an at-risk population enlarged - sometimes enormously so - by a transient population with little or no hurricane experience has not been tested by a full scale evacuation during a major hurricane event.

Roadway network and traffic control assumptions are discussed in detail in Chapter 6, Transportation Analysis, along with maps illustrating the network utilized in traffic modeling.

V. INSTITUTIONS/MEDICAL FACILITIES

A. General.

Inventories of institutions/medical facilities have been conducted for each of the study area counties (Tables 3-3 through 3-11). The purpose of this analysis is to determine which of these institutions may require evacuation under various hurricane threats. The first floor elevations of all hospitals in or near areas potentially vulnerable to storm surge have been established.

No attempt was made to establish the first floor elevations of nursing homes, community residential care facilities, schools providing campus housing, or dentention centers within the study area; however, the potential vulnerability of nursing homes and detention centers to storm surge under specific hurricane categories is indicated in the tables. If a nursing home or detention center is located in or near an area vulnerable to storm surge, then the potential storm surge heights in feet above mean sea level are given.

Residential care facilities do not provide nursing care as do nursing homes. However, to qualify for placement in one of these boarding homes a person must, among other requirements, be ambulatory and require supervision. Clients are usually old or disabled and over 90% have no means of transportation of their own. The South Carolina Department of Social Services (DSS) oversees these operations and requires that only one vehicle per facility be provided to transport a resident as may become necessary.

Schools which provide on-campus student housing are listed on the tables to indicate a possible need for evacuation assistance.

Some of the county directors in the study area preferred their counties' detention centers not be shown in the tables. The remaining counties' centers are shown on the tables and centers potentially vulnerable to storm surge are located on maps.

B. Institutions/Medical Facilities.

The inventories, capacities and other pertinent data for the institutions/ medical facilities within each of the South Carolina Hurricane Evacuation Study area counties are contained within the following tables. The locations of hospitals, nursing homes, and applicable detention centers are shown on Figures 3-1 through 3-9.

TABLE 3-3

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
GEORGETOWN COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Georgetown County Memorial Black River Rd., Georgetown	Hospital	142	17.0	Dry	Dry	Dry	15.0	* 19.0
2	Winyah Extended Care Center S. Island Rd., Maryville	Nursing	84	**	4.0	9.0	14.0	16.0	19.0

*Potential vulnerability to storm surge based upon established first floor elevation.

**Potential vulnerability determined from facility location in or near surge inundation areas.

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
GEORGETOWN COUNTY

No.	Facility	Address	Capacity
1	Sunny Pines Community Res. Care	Route 3, Box 317-F, Andrews	17

COMPLETED APRIL 1976			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
MAY 1, 1978	FEBRUARY 1, 1980	MARCH 1, 1986	
JULY 1, 1976	FEBRUARY 1, 1982		
JULY 1, 1977	OCTOBER 1, 1984		
OCTOBER 1, 1978	MARCH 1, 1986		
FEBRUARY 1, 1980			
FEBRUARY 1, 1982			
OCTOBER 1, 1984			

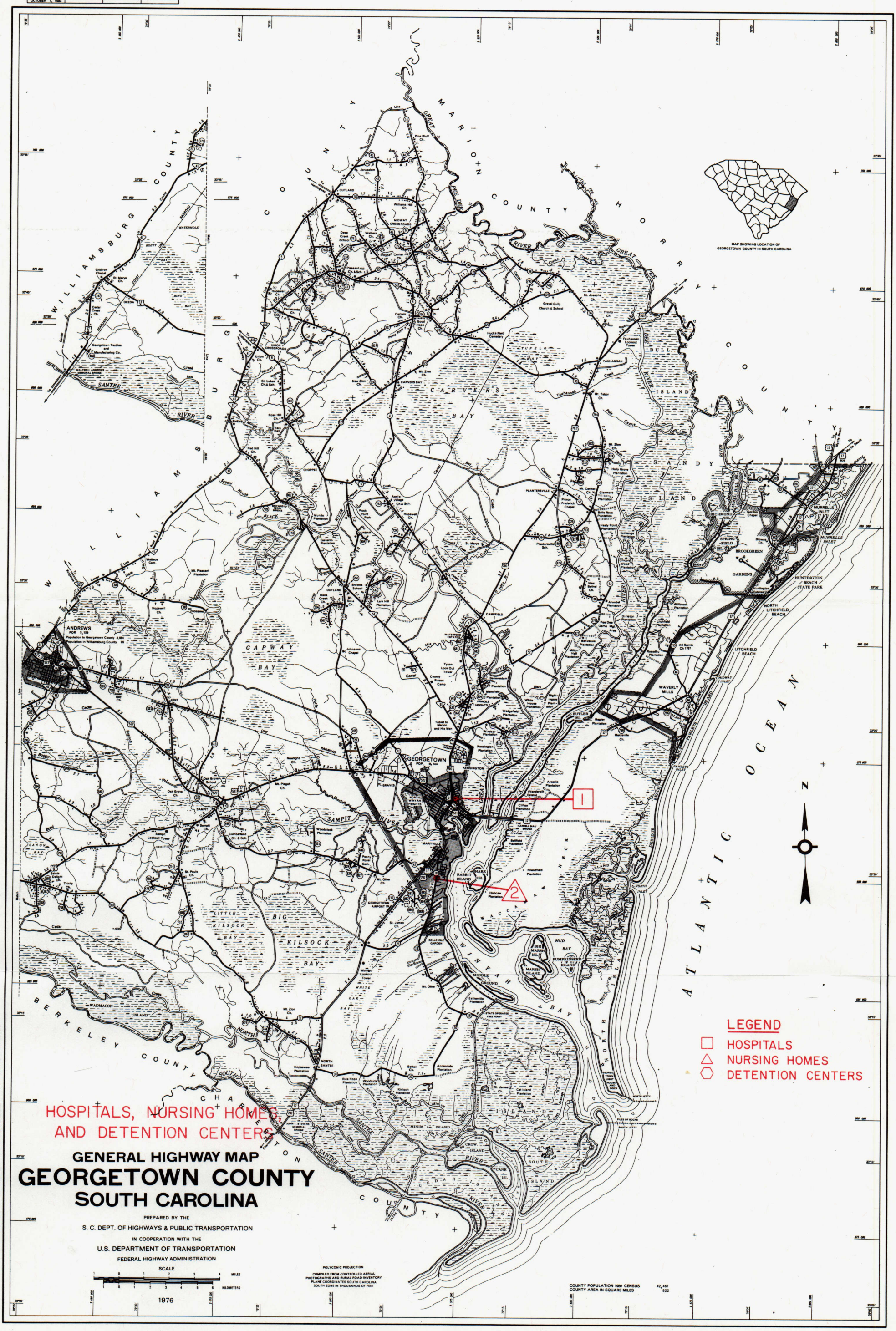


FIGURE 3-1

TABLE 3-4

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
HORRY COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Conway Hospital 300 Singleton Ridge Rd., Conway	Hospital	160	***	Dry	Dry	Dry	Dry	Dry
2	Grand Strand General Hospital 809 82nd Parkway, Myrtle Beach	Hospital	134	40.0	Dry	Dry	Dry	Dry	Dry
3	HSA Coastal Carolina Hospital 7010 Waccamaw Medical Park Rd. Conway	Hospital	98	43.75	Dry	Dry	Dry	Dry	Dry
4	Loris Community Hospital 3212 Casey St., Loris	Hospital	130	***	Dry	Dry	Dry	Dry	Dry
5	Conway Nursing Center 3300 Fourth Ave., Conway	Nursing	130	***	Dry	Dry	Dry	Dry	Dry
6	Loris Hospital Extended Care Facility 3212 Casey St., Loris	Nursing	40	***	Dry	Dry	Dry	Dry	Dry
7	Myrtle Beach Manor **** Highway 17, N. Myrtle Beach	Nursing	50	***	5.5	10.0	14.5	16.5	18.5
8	Sandstrom Home Hawthorne Lane, Myrtle Beach	Nursing	30	***	6.0	11.0	15.0	17.0	19.0
9	Horry County Jail P.O. Box 68, Conway	Detention	42	***	Dry	Dry	Dry	Dry	Dry
10	Horry County Prison Rt. 4, Box 80, Conway	Detention	80	***	Dry	Dry	Dry	Dry	Dry
11	Loris Overnight Lockup 5931 Walnut St., Loris	Detention	20	***	Dry	Dry	Dry	Dry	Dry
12	Myrtle Beach Overnight Lockup 1201 Oak St., Myrtle Beach	Detention	117	***	Dry	Dry	Dry	Dry	Dry
13	N. Myrtle Beach Overnight Lockup 421 Main St., N. Myrtle Beach	Detention	7	***	Dry	Dry	Dry	Dry	Dry

***First floor elevation not established due to facility location away from potential surge inundation areas.

****See Horry Community Residential Care Facilities Table

TABLE 3-4 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
HORRY COUNTY

No.	Facility	Address	Capacity
1	Chasteen's Rest Home	200 Pine Street, Myrtle Beach	2
2	Countryside Community Care Home	Route 3, Longs	4
3	Lois Eargle Community Residence	406 Webb Street, Conway	8
4	Waccamaw Acres Community Care Home	Longs	6
5	Bellamy's Community Care Home	Route 1, Box 32, N. Myrtle Beach	10
6	Covenant Towers Residential Care Facility	5001 Old Little River Road, Myrtle Beach	17
7	Myrtle Beach Manor ****	Highway 17, N. Myrtle Beach	30
8	Pinedale Residential Care	1201 Creel Street, Conway	36

***See Institutions/Medical Facilities Table

****See Horry Hospitals, Nursing Homes, and Detention Centers Table

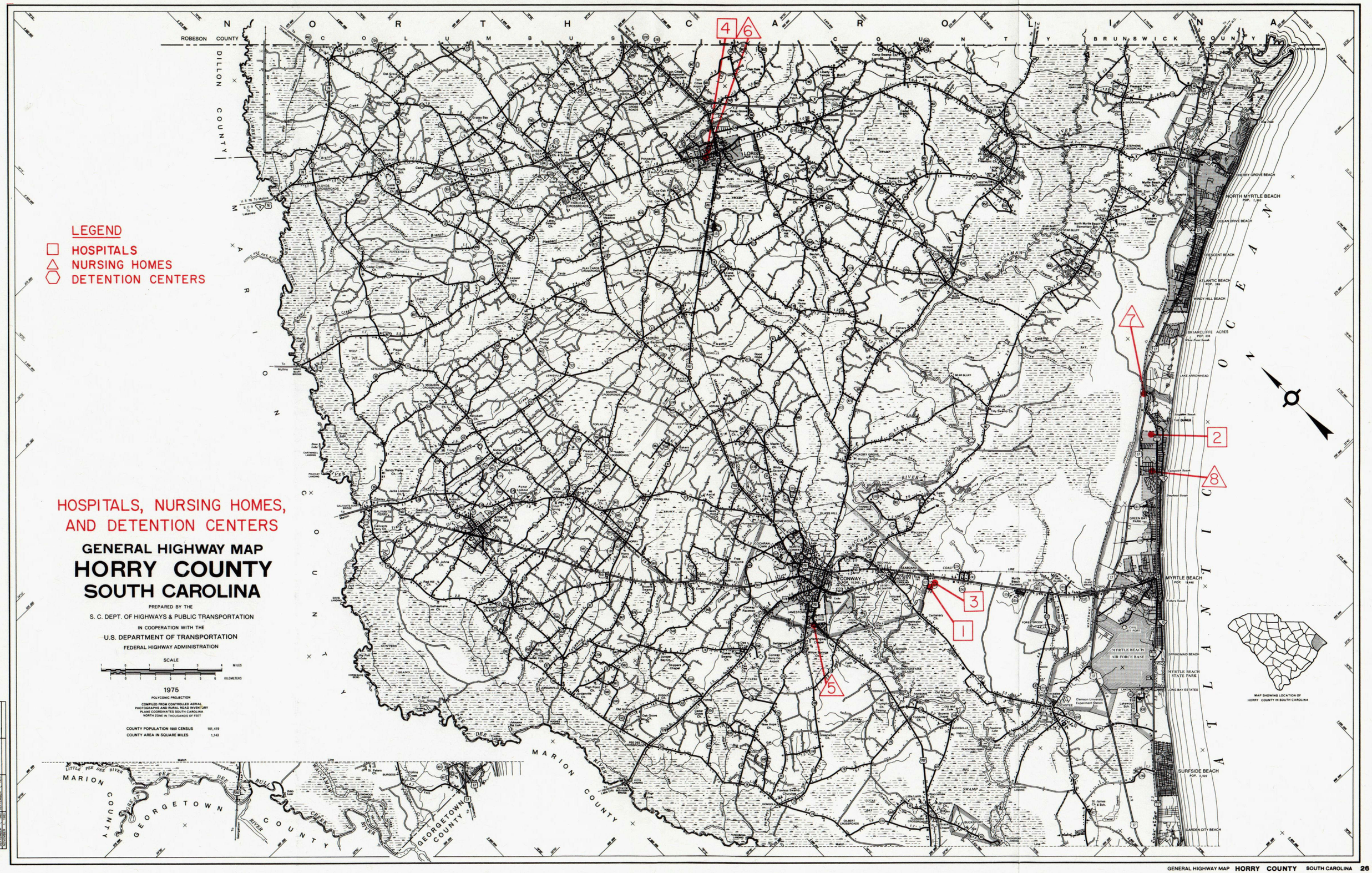

HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
GENERAL HIGHWAY MAP
HORRY COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1975
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA NORTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 101,419
COUNTY AREA IN SQUARE MILES 1,143
LEGEND
HOSPITALS
NURSING HOMES
DETENTION CENTERS
NORTH CAROLINA
ROBESON COUNTY
COLUMBUS COUNTY
BRUNSWICK COUNTY
DILLON COUNTY
MARION COUNTY
GEORGETOWN COUNTY
ATLANTIC OCEAN
LORIS
CONWAY
MYRTLE BEACH
NORTH MYRTLE BEACH
SURFSIDE BEACH
MYRTLE BEACH AIR FORCE BASE
MAP SHOWING LOCATION OF HORRY COUNTY IN SOUTH CAROLINA
1
2
3
4
5
6
7
8

FIGURE 3-2

TABLE 3-5

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
BEAUFORT COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Beaufort Memorial County Hospital 121 Ribaut Rd., Beaufort	Hospital	99	15.94	Dry	Dry	Dry	* 16.5	* 19.5
2	Hilton Head Hospital Bill Fries Dr., Hilton Head	Hospital	64	25.5 1st Flr 26.0 Gen.	Dry	Dry	Dry	Dry	Dry
3	U.S. Naval Hospital Ribaut Rd., Beaufort	Hospital	60	31.0	Dry	Dry	Dry	Dry	Dry
4	Bay View Nursing Facility S. Todd Dr., Beaufort	Nursing	132	30.0	Dry	Dry	Dry	Dry	Dry
5	Hilton Head Nursing Center 37 Bill Fries Dr., Hilton Head	Nursing	44	**	4.0	9.0	13.0	17.0	21.0
6	Port Royal Community Residence 1508 Old Shell Rd.,Port Royal	Nursing	16	**	5.5	7.0	12.0	16.5	19.5
7	Seabrook of Hilton Head, Inc. 300 Wood Haven Dr. Hilton Head Island	Nursing	44	**	5.0	10.0	14.0	18.0	22.0

* Potential vulnerability to storm surge based upon established first floor elevation.

** Potential vulnerability determined from facility location in or near surge inundation areas.

TABLE 3-5 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
BEAUFORT COUNTY

No.	Facility	Address	Capacity
1	Bostick's Adult Residential Care Facility	1912 Duke St., Beaufort	20
2	Phoenix Res. Community ADA	Rt. 1, Box 285-AD, Laurel Bay	10
3	Oakhurst Community Care Home	P.O. Box 900, Seabrook	10

COMPLETED	JULY 1, 1978
REVISED	
STATE SYSTEM	COUNTY SYSTEM
FEBRUARY 1, 1980	FEBRUARY 1, 1980
AUGUST 1, 1981	AUGUST 1, 1981
NOVEMBER 1, 1983	NOVEMBER 1, 1983
MARCH 1, 1985	MARCH 1, 1985

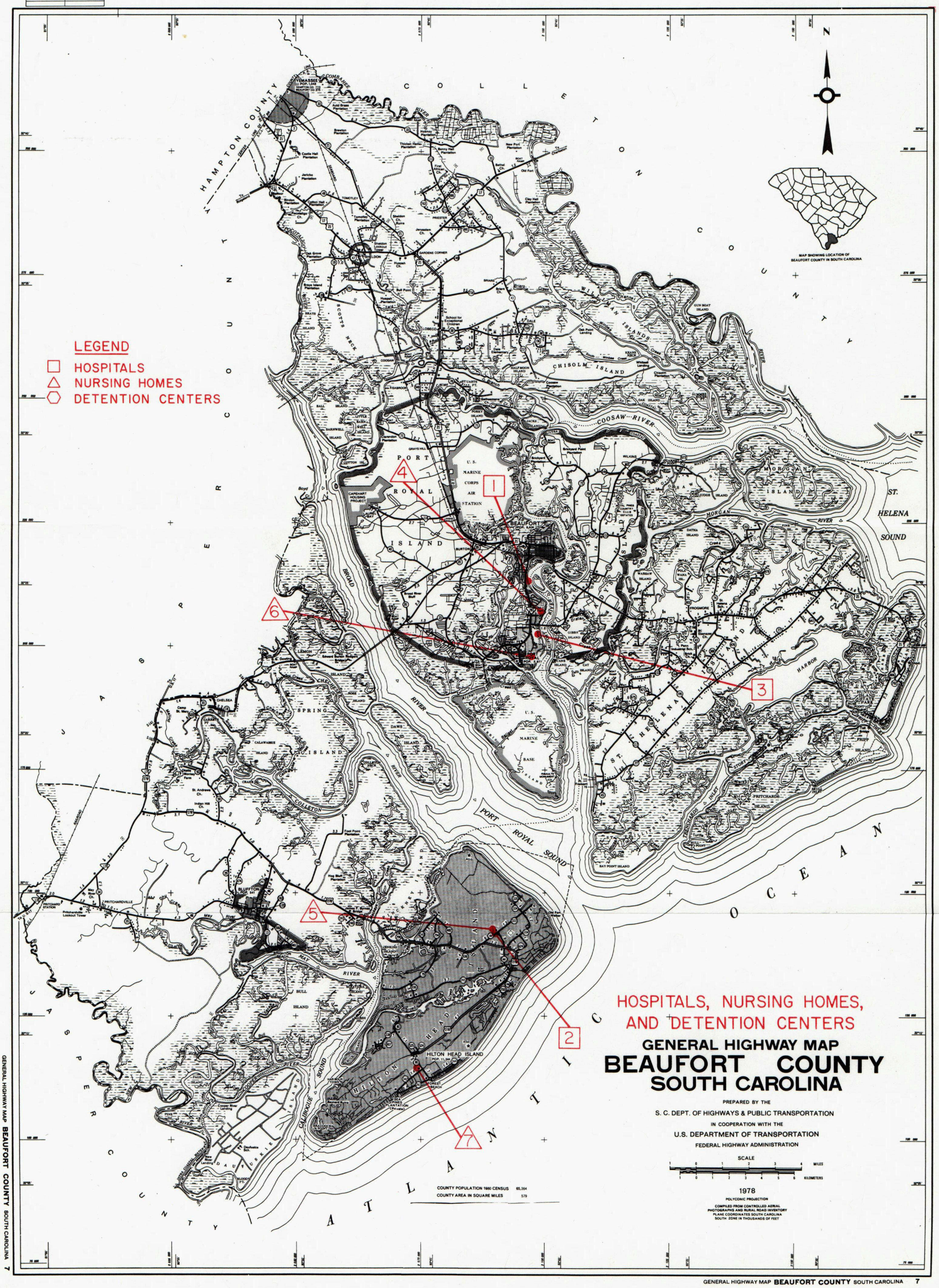


FIGURE 3-3

TABLE 3-6

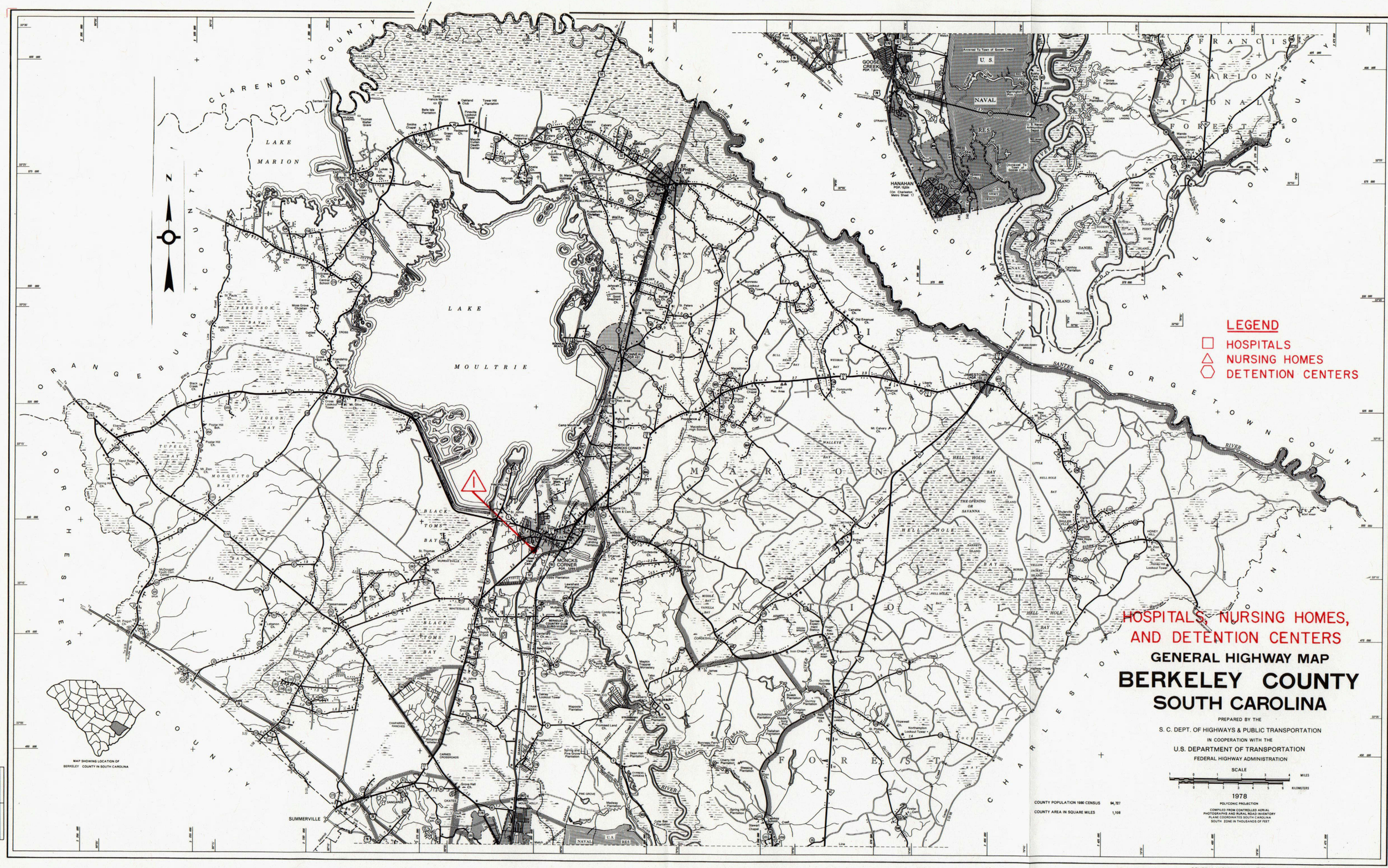
INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
BERKELEY COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Berkeley Convalescent Center S. Live Oak Dr., Moncks Corner	Nursing	132	***	Dry	Dry	Dry	Dry	Dry
2	Berkeley County Prison/Jail 300 California Avenue Moncks Corner	Detention	55	***	Dry	Dry	Dry	Dry	Dry

*** First floor elevation not established due to facility location away from potential surge inundation areas.

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
BERKELEY COUNTY

No.	Facility	Address	Capacity
1	Oakview Boarding Home	Highway 17-A South, Moncks Corner	5
2	Omoooo Community Care Home	Route 2, Box 480-B, Summerville	18
3	Dehay House	121 West Main St., Moncks Corner	8



GENERAL HIGHWAY MAP BERKELEY COUNTY SOUTH CAROLINA 8

FIGURE 3-4

TABLE 3-7

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
CHARLESTON COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD) CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Baker Hospital 2750 Speissegger Dr., N.Chas.	Hospital	104	13.0	Dry	Dry	* 14.5	* 16.0	* 18.0
2	Charleston Memorial Hospital 326 Calhoun St., Charleston	Hospital	172	14.0	Dry	Dry	13.0	* 16.0	* 18.0
3	AMI East Cooper Community Hospital Hwy 17 By-pass, Mt.Pleasant	Hospital	100	20.0	Dry	Dry	Dry	Dry	17.5
4	Fenwick Hall Hospital 1709 River Rd., Johns Island	Hospital	40	25.0	Dry	Dry	Dry	Dry	Dry
5	Medical University of SC 171 Ashley Ave., Charleston	Hospital	510	11.27	Dry	9.0	* 13.0	* 16.0	* 18.0
6	Roper Hospital 316 Calhoun St., Charleston	Hospital	421	9.13	Dry	* 9.0	* 13.0	* 16.0	* 18.0
7	St. Francis Hospital 135 Rutledge Ave., Charleston	Hospital	362	8.04	Dry	* 9.0	* 13.0	* 16.0	* 18.0
8	Southern Pines Hospital 2777 Speissegger Dr., N.Chas.	Hospital	102	11.5	Dry	9.5	* 14.5	* 16.0	* 18.0
9	Trident Regional Medical Center 9330 Medical Plaza Dr., Chas.	Hospital	266	***	Dry	Dry	Dry	Dry	Dry
10	Veterans Administration Med. Ctr. 109 Bee Street, Charleston	Hospital	280	12.68	Dry	Dry	* 13.0	* 16.0	* 18.0
11	Naval Regional Medical Center 3650 Rivers Ave., Charleston	Hospital	184	Gen. 21.6 1st Fl. 34.0	Dry	Dry	Dry	Dry	Dry

* Potential vulnerability to storm surge based upon established first floor elevation.

*** First floor elevation not established due to facility location away from potential surge inundation areas.

TABLE 3-7 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
CHARLESTON COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
12	Charleston Nursing Center 921 Bowman Rd., Mt.Pleasant	Nursing	132	**	5.0	9.0	11.5	15.0	18.0
13	Driftwood on the Ashley 2375 Baker Hosp.Blvd., N. Chas.	Nursing	160	**	5.0	9.5	14.5	16.0	18.0
14	Firestone Road Community Res. 3641 Firestone Rd., N. Chas.	Nursing	14	**	4.5	7.5	13.0	16.0	19.0
15	Hermina Traeye Mem. Nursing Home 3627 Maybank Hwy., Johns Island	Nursing	88	**	4.5	7.5	11.5	14.0	17.0
16	Manor Care Nursing Center of Chas. 1137 Sam Rittenburg, Charleston	Nursing	132	**	5.0	9.5	14.5	16.5	18.0
17	N. Charleston Convalescent Center 9319 Medical Plaza Dr., Chas.	Nursing	132	***	Dry	Dry	Dry	Dry	Dry
18	Rutledge Avenue Comm. Residence 887 Rutledge Ave., Charleston	Nursing	8	**	5.0	9.0	13.5	16.0	18.0
19	Sandpiper Convalescent Center 1049 Anna Knapp Blvd. Mt. Pleasant	Nursing	110	**	5.0	9.0	12.5	15.5	18.5
20	Charleston County Detention Center 2466 Leeds Ave., Charleston	Detention	128	**	5.0	9.0	15.0	16.0	18.0
21	Charleston Cty. Juvenile Detention 4358 Headquarters Rd, Charleston	Detention	20	**	5.0	9.0	13.0	17.0	19.0
22	Charleston Overnight Lockup 180 Lockwood Blvd., Charleston	Detention	21	**	5.0	9.0	13.0	17.0	19.0

** Potential vulnerability determined from facility location in or near surge inundation areas.

*** First floor elevation not established due to facility location away from potential surge inundation areas.

TABLE 3-7 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
CHARLESTON COUNTY

No.	Facility	Address	Capacity
1	Addison's Boarding Home	2529 Lupine St., Charleston	8
2	Bowles Community Care Home	Route 17, Box 127, McClellanville	16
3	Brown's Residential Care Facility	89 Alabama St., Charleston	2
4	Carter-May Home	1660 Ingram Road, Charleston	12
5	Charleston County Commission ADA	25 Courtenay Drive, Charleston	20
6	Charleston County Commission ADA	25 Courtenay Drive, Charleston	12
7	Christian Boarding Home	2117 Commander Road, Charleston	12
8	Cochran's Boarding Home	380 Huger Street, Charleston	7
9	Cord's Residential Care	61 Tenth Street, Charleston	2
10	Evergreen Residential Care	1612 Evergreen St., Charleston	8
11	Farmfield Community Residence	1 Farmfield Road, Charleston	10
12	Foster's Boarding Home	134 Fishburne St., Charleston	10
13	Fraiser's Adult Residential Care Home	1134 Main Road, Johns Island	10
14	Franke Home	261 Calhoun Street, Charleston	77
15	Friendship House	1333 North Sherwood Drive, Charleston	10

TABLE 3-7 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
CHARLESTON COUNTY

No.	Facility	Address	Capacity
16	Gadsden & Felder Comm. Care Home	197 West Poplar Street, Charleston	6
17	Genesis Community Care Home 1,2,3	1917 Cosgrove Avenue, North Charleston	30
18	Green's Boarding Home	2009 Cosgrove Avenue, Charleston	10
19	Hazel's Rest Home	432-A Sumter Street, Charleston	7
20	Helen McGill Boarding Home	31 Coming Street, Charleston	6
21	James Island Residential Home	237 Fleming Road, James Island	9
22	James Residential Care	2529 Lupine Street, Charleston	5
23	Langit's	1263 Remount Road, North Charleston	5
24	Lamb's Road Community Residence	4788 Lambs Road, Charleston	9
25	Loving Care	4822 Upjohn Street, North Charleston	10
26	M & S Adult Care	320 Sumter Street, Charleston	6
27	Maple Manor	164 Maple Street, Charleston	20
28	Majorie's Community Care Home	207 West Poplar Street, Charleston	8
29	McTeels Rest Home	1927 Calvert Street, North Charleston	9
30	Mohammed's Boarding Home	Post Office Box 116, Johns Island	8

TABLE 3-7 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
CHARLESTON COUNTY

No.	Facility	Address	Capacity
31	Rhode's Boarding Home	942 River Road, Johns Island	4
32	Salley's Boarding Home	23 Race Street, Charleston	8
33	Sampson Community Residential Care	4018 S. Rhett Avenue, North Charleston	10
34	Shamrock House Inc.	1812 Orvid Street, North Charleston	8
35	Sherman's Boarding Home #1	937 5th Avenue, Charleston	7
36	Sherman's Boarding Home #2	920 5th Avenue, Charleston	6
37	Spell's Boarding Home	3577 Walter Drive, Johns Island	10
38	St. Jude Community Residential Care	533 Rutledge Avenue, Charleston	6
39	St. Margaret St. Community Res.	227 St. Margaret Street, Charleston	6
40	St. Mark Community Care Home	1140 Fifth Avenue, Charleston	12
41	St. Mark's Boarding Home	1222 Brody Street, Charleston	10
42	TLC For Adults	1928 Baxter Street, Charleston Heights	4
43	Tri-Can Rehabilitation Center	2125 Cosgrove Avenue, Charleston	5
44	West Ashley Boarding Home	836 Magnolia Road, Charleston	9
45	Westerlin Resident Care	36 Magnolia Road, Charleston	8

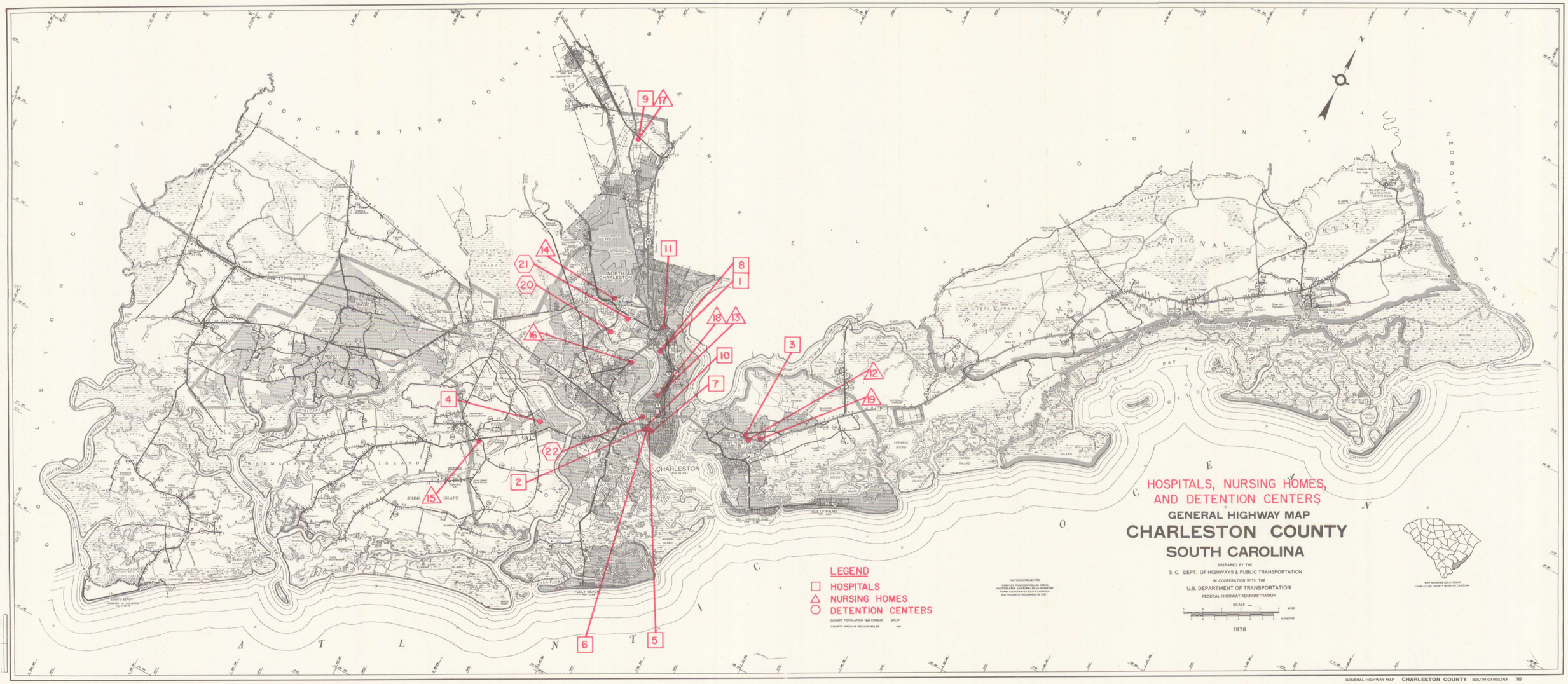
TABLE 3-7 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
SCHOOLS
CHARLESTON COUNTY

No.	Facility	Facility Type	Total* Enrollment	Campus** Housing	Campus** Housing Vehicles
1	College of Charleston 66 George Street, Charleston	College	5323	1450	325
2	The Citadel Charleston	College	3040	1980	1000
3	Medical University of S.C. 171 Ashley Avenue, Charleston	University	2254	130	74
4	Baptist College at Charleston I-26 and Hwy. 76, Charleston	College	1940	520	385
5	Nielsen Electronics Institute	College	355	55	40-45

*1983-1984 School Year
Source: South Carolina Division of Research and Statistical Services
1985 - South Carolina Statistical Abstract. Columbia

**1986-1987 School Year
Source: Telephone


HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
GENERAL HIGHWAY MAP
CHARLESTON COUNTY
SOUTH CAROLINA
PREPARED BY THE
S.C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1978
LEGEND
HOSPITALS
NURSING HOMES
DETENTION CENTERS
COUNTY POPULATION 1980 CENSUS 276,274
COUNTY AREA IN SQUARE MILES 988
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA
SOUTH ZONE IN THOUSANDS OF FEET
MAP SHOWING LOCATION OF CHARLESTON COUNTY IN SOUTH CAROLINA
CHARLESTON
NORTH CHARLESTON
WADMALAW ISLAND
JOHNS ISLAND
FOLLY BEACH
ISLE OF PALMS
SULLIVANS ISLAND
MOUNT PLEASANT
SEWEE BAY
CAPERS ISLAND
TOPSAIL SOUND
DORCHESTER COUNTY
BERKELEY COUNTY
COLLETON COUNTY
GEORGETOWN COUNTY
ATLANTIC OCEAN
FRANCIS MARION NATIONAL FOREST
HAMPTON PLANTATION STATE PARK
MEDITERRANEAN
1
2
3
4
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21
22

FIGURE 3-5

TABLE 3-8

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
COLLETON COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Colleton Regional Hospital 501 Robertson Blvd., Walterboro	Hospital	145	***	Dry	Dry	Dry	Dry	Dry
2	Oakwood Health Care Center, Inc. 401 Witsell St., Walterboro	Nursing	132	***	Dry	Dry	Dry	Dry	Dry
3	Walterboro Community Residence 505 Forest Circle, Walterboro	Nursing	8	***	Dry	Dry	Dry	Dry	Dry

*** First floor elevation not established due to facility location away from potential surge inundation areas.

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
COLLETON COUNTY

No.	Facility	Address	Capacity
1	Palmetto Boarding Home	Route 2, Walterboro	26
2	Samaritan's Way, Incorporated	212 Josie Drive, Walterboro	9
3	Low Country Crossroads ADA	P.O. Box 1017, Walterboro	6
4	Bright's Estate Residential Care	Route 1, Box 284, Green Pond	4

COMPLETED NOVEMBER 1975			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
MAR. 1, 1976	JAN. 1, 1976	SEPTEMBER 1, 1982	
JULY 1, 1976	MARCH 1, 1979	NOVEMBER 1, 1983	
APRIL 1, 1977	DECEMBER 1, 1980	MARCH 1, 1985	
JULY 1, 1978	SEPTEMBER 1, 1982		
MARCH 1, 1979	NOVEMBER 1, 1983		
DECEMBER 1, 1980	MARCH 1, 1985		

FIGURE 3-6

GENERAL HIGHWAY MAP COLLETON COUNTY SOUTH CAROLINA 15

TABLE 3-9

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
DORCHESTER COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Coastal Center 12 Jamison Rd., Ladson	Nursing	135	***	Dry	Dry	Dry	Dry	Dry
2	Coastal Center-Bldgs. D,E,F Jamison Road, Ladson	Nursing	376	***	Dry	Dry	Dry	Dry	Dry
3	Presbyterian Home of S.C. **** 912 N. Cedar St., Summerville	Nursing	90	***	Dry	Dry	Dry	Dry	Dry
4	St. George Health Care Center 905 Dukes St., St. George	Nursing	88	***	Dry	Dry	Dry	Dry	Dry
5	Dorchester County Annex North Main St., Summerville	Detention	5	***	Dry	Dry	Dry	Dry	Dry
6	Dorchester County Jail	Detention	19	***	Dry	Dry	Dry	Dry	Dry

***First floor elevation not established due to facility location away from potential surge inundation areas.

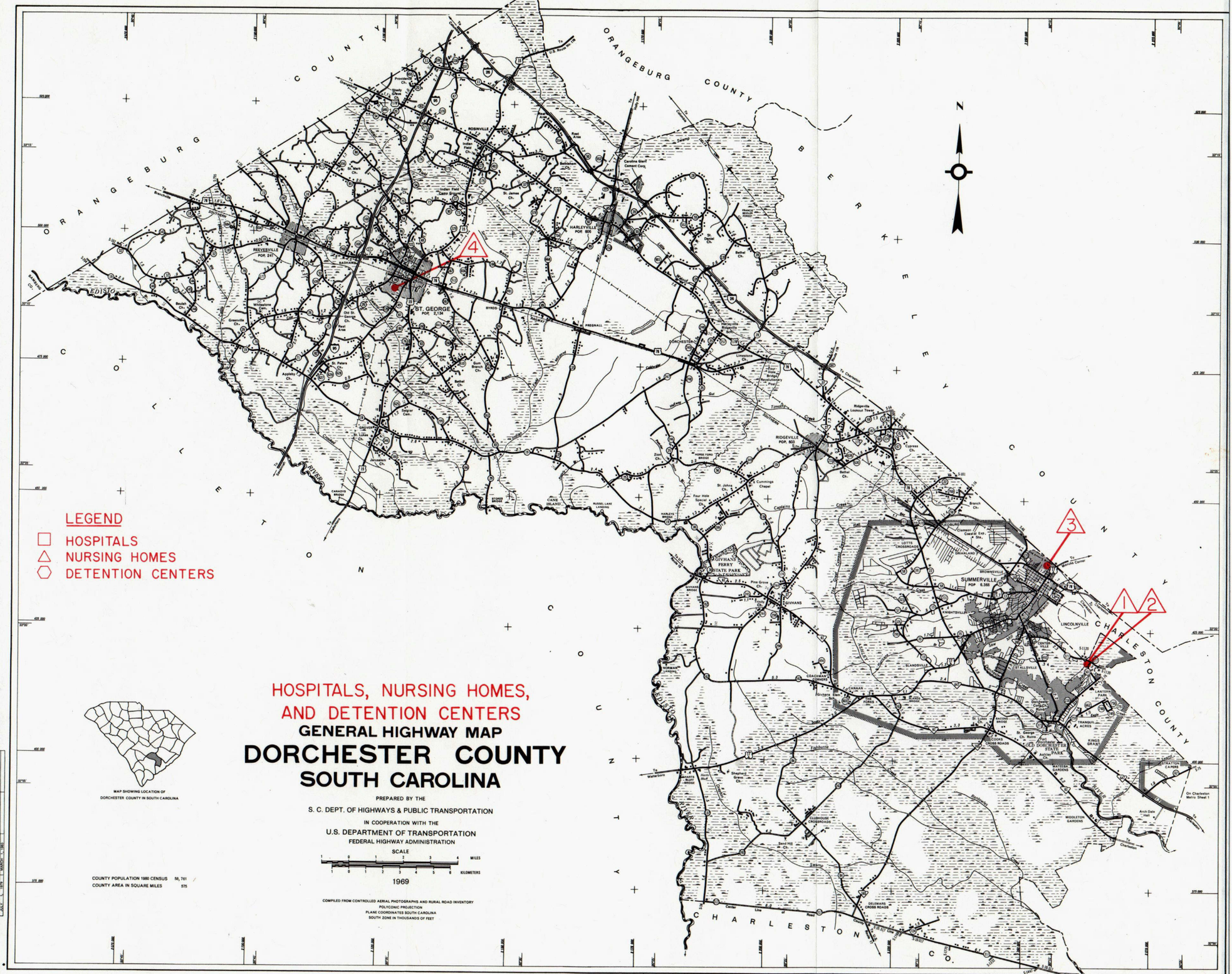
****See Dorchester Community Residential Care Facilities Table

TABLE 3-9 (Cont'd)

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
DORCHESTER COUNTY

No.	Facility	Address	Capacity
1	Dorchester County Rest Home, Inc.	821 Central Avenue, Summerville	9
2	Walsh Rest Home	780 East Butternut St., Summerville	20
3	James Community Residential Care	207 North Palmetto St., Summerville	8
4	Presbyterian Home of S.C. ****	912 N. Cedar Street, Summerville	120

****See Dorchester Hospitals, Nursing Homes, and Detention Centers Table



GENERAL HIGHWAY MAP DORCHESTER COUNTY SOUTH CAROLINA 18

FIGURE 3-7

TABLE 3-10

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
HAMPTON COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Hampton General Hospital P. O. Box 338, Varnville	Hospital	68	***	Dry	Dry	Dry	Dry	Dry
2	Stiles M. Harper Convalescent Ctr. P. O. Box 386, Estill	Nursing	44	***	Dry	Dry	Dry	Dry	Dry
3	Hampton County Jail P.O. BOX 633, Hampton	Detention	19	***	Dry	Dry	Dry	Dry	Dry

***First floor elevation not established due to facility location away from potential surge inundation areas.

INSTITUTIONS/MEDICAL FACILITIES
COMMUNITY RESIDENTIAL CARE FACILITIES
HAMPTON COUNTY

No.	Facility	Address	Capacity
1	Mary Allen Residential Care	Brunson	7
2	Hampton County Jail	P. O. Box 633, Hampton	19

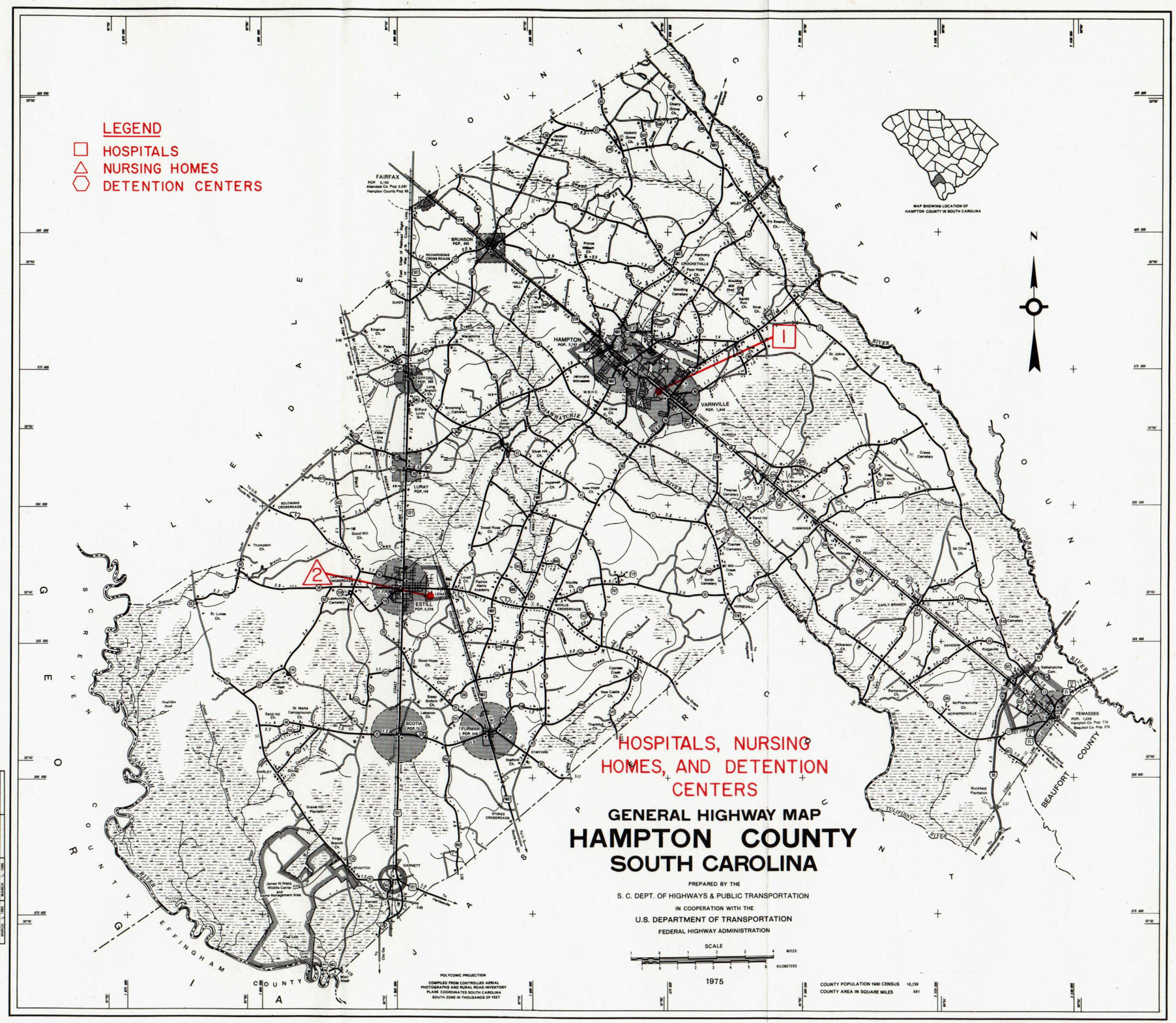

LEGEND
HOSPITALS
NURSING HOMES
DETENTION CENTERS
MAP SHOWING LOCATION OF HAMPTON COUNTY IN SOUTH CAROLINA
N
FAIRFAX
BRUNSON
HAMPTON
VARNVILLE
LURAY
ESTILL
SCOTIA
FURMAN
YEMASSEE
BEAUFORT COUNTY
COLLETON COUNTY
ALLENDALE COUNTY
GREENVILLE COUNTY
EFFINGHAM COUNTY
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
GENERAL HIGHWAY MAP
HAMPTON COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1975
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA SOUTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 18,159
COUNTY AREA IN SQUARE MILES 561

FIGURE 3-8

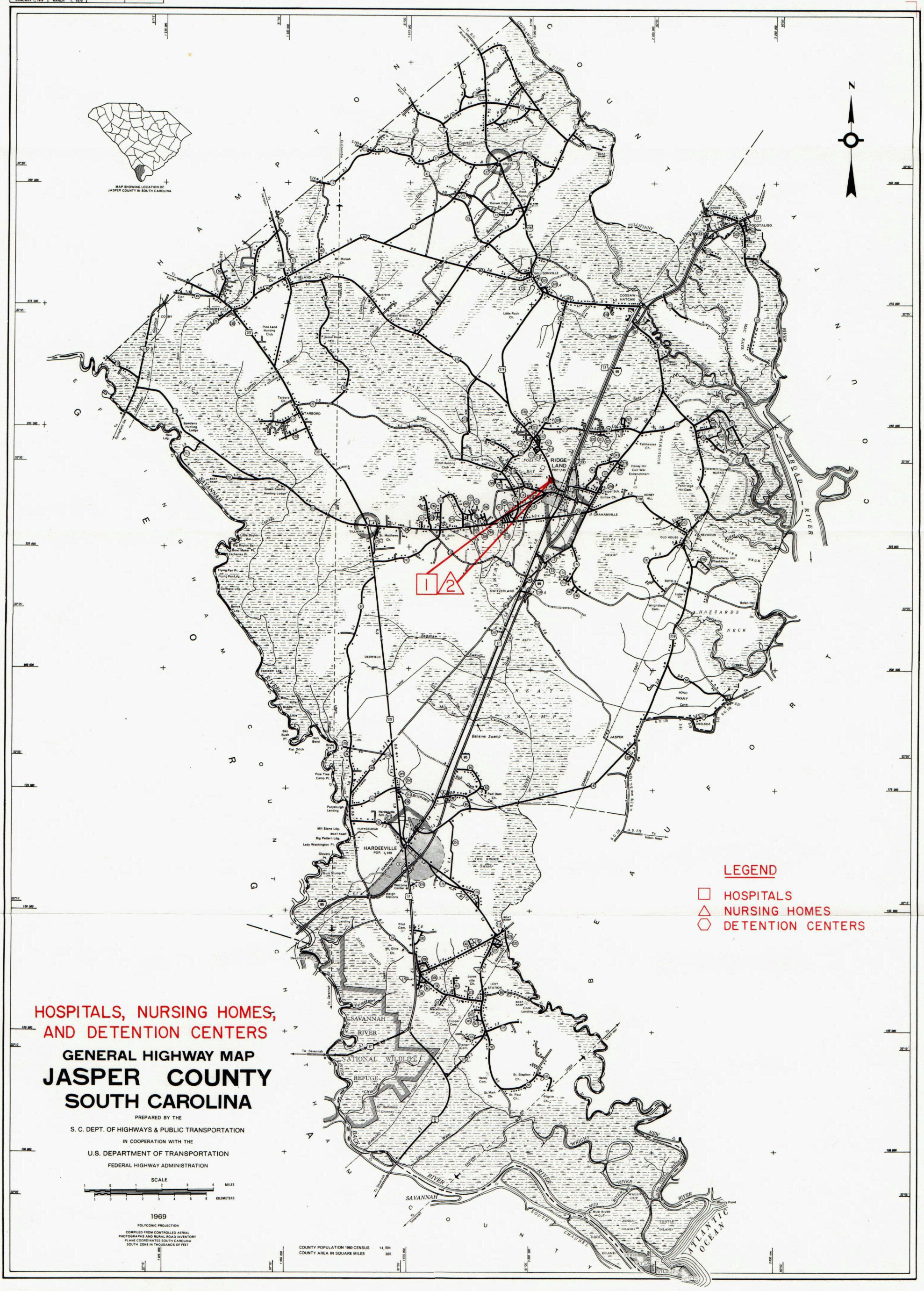
TABLE 3-11

INSTITUTIONS/MEDICAL FACILITIES
HOSPITALS, NURSING HOMES, AND DETENTION CENTERS
JASPER COUNTY

Map Key	Facility	Facility Type	Bed Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
					CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Live Oaks Hospital Grays Road, Ridgeland	Hospital	31	***	Dry	Dry	Dry	Dry	Dry
2	Ridgecrest Convalescent Center Grays Road, Ridgeland	Nursing	88	***	Dry	Dry	Dry	Dry	Dry
3	Jasper County Jail P.O. Box 1366, Ridgeland	Detention	12	***	Dry	Dry	Dry	Dry	Dry

*** First floor elevation not established due to facility location away from potential surge inundation areas.

COMPLETED JULY 1969			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
JULY 1, 1969	JAN. 1, 1969	MARCH 1, 1979	JUNE 1, 1980
OCT. 1, 1970	JAN. 1, 1970	JUNE 1, 1980	APRIL 1, 1981
OCT. 1, 1972	JAN. 1, 1972	APRIL 1, 1981	SEPTEMBER 1, 1982
JUNE 1, 1974	JAN. 1, 1974	SEPTEMBER 1, 1982	NOVEMBER 1, 1983
MAY 1, 1976	JAN. 1, 1976	NOVEMBER 1, 1983	MARCH 1, 1985
JULY 1, 1976	JANUARY 1, 1978	MARCH 1, 1985	
JANUARY 1, 1978	MARCH 1, 1979		



HOSPITALS, NURSING HOMES, AND DETENTION CENTERS

GENERAL HIGHWAY MAP

JASPER COUNTY
SOUTH CAROLINA

PREPARED BY THE

S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION

IN COOPERATION WITH THE

U.S. DEPARTMENT OF TRANSPORTATION

FEDERAL HIGHWAY ADMINISTRATION

SCALE

1 0 1 2 3 4 MILES

1 0 1 2 3 4 5 6 KILOMETERS

1969

POLYCONIC PROJECTION

COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY PLANE COORDINATES SOUTH CAROLINA SOUTH ZONE IN THOUSANDS OF FEET

COUNTY POPULATION 1980 CENSUS 14,504

COUNTY AREA IN SQUARE MILES 655

FIGURE 3-9

BIBLIOGRAPHY FOR VULNERABILITY ANALYSIS

South Carolina Division of Research and Statistical Services
1985 South Carolina Statistical Abstract. Columbia.

U.S. Department of Commerce
1981 Tropical Storms of the North-Atlantic Ocean, 1871-1980. National Oceanic and Atmospheric Administration. U.S. Government Printing Office, Washington, D.C. pp. 21-23, 33-146.

South Carolina Division of Research and Statistical Services
Population Projections for South Carolina by County 1985 - 2010.

CHAPTER FOUR

PUBLIC SHELTER ANALYSIS

I. PURPOSE

Evacuees who are fleeing from a potentially threatening hurricane will generally go to a home of a friend or relative, a hotel/motel unit, or a local public shelter. Recognizing the importance of public shelter availability to a successful evacuation, a public shelter analysis was performed for the South Carolina Hurricane Evacuation Study. Information from local emergency preparedness directors, the hazards analysis, and behavioral research were used to study shelter vulnerability and shelter demand. Shelter inventories, locations and capacities were furnished by the emergency management officials within each of the study area counties. Shelter demand data were then incorporated in the transportation modeling analysis of the hurricane study.

II. SHELTER INVENTORIES AND VULNERABILITY ANALYSIS

Tables 4-1 through 4-10 provide a listing of public shelters and capacities for each county in the study area. First floor elevations of public shelters in or near potential surge inundation areas are provided where appropriate. Charleston District Corps of Engineers staff consulted with local emergency preparedness staff and school board personnel to establish capacities. The Corps also sent survey crews out into the study area to take first floor elevations where there was no existing data. The tables also provide potential surge heights at each shelter location. The word "dry" on the tables indicates the floor elevation is at least three feet higher than the projected storm surge. Such hazards data, when coupled with first floor elevation, provides an important look at potential vulnerability of shelters for each of the five categories of hurricane intensity.

It is important to note that no attempt was made to assess the vulnerability of any public shelter as to the effect of hurricane force winds. Therefore, those shelters whose first floor elevation is above the projected storm surge height do not necessarily have sufficient structural integrity to withstand the windspeeds associated with high intensity hurricanes. For transportation analysis purposes, a shelter was considered useable if its first floor elevation was at least three feet higher than the projected storm surge height for a particular category of hurricane.

Locations of public shelters are shown on Figures 4-1 through 4-10. Each figure is keyed to the tables discussed above for shelter identification purposes.

III. PUBLIC SHELTER DEMAND/CAPACITY

Tables 4-11 and 4-12 provide the shelter demand assumptions and resulting statistics for each county. Behavioral assumptions were developed (regarding percent going to public shelter) through discussions with disaster preparedness directors during the transportation analysis. The tables list the specific per-

centage of evacuees assumed to go to public shelters from different geographic areas or dwelling unit types in a particular county.

Shelter demand figures should be considered a potential range of maximum shelter demands that could exist in a county for a particular category of hurricane. Ranges of numbers resulted from testing different tourist occupancies and in Beaufort and Charleston Counties, testing more than three storm scenarios. It is important to note that the shelter demand figures assume the following factors:

* An adequate warning period for an approaching hurricane
* Sufficient public knowledge concerning the locations and availability of public shelter facilities
* 1987 population projections
* 100% evacuation of vulnerability areas relating to the Maximum Envelope of Water limits for all hurricane directions and speeds
* 100% evacuation of mobile homes in non-surge areas
* 5-10% evacuation of the theoretical non-vulnerable population

Recent hurricanes in the study area have generally been paralleling storms where a limited or partial evacuation occurred. Thus it is difficult to compare recent shelter demand figures with ones calculated in this study.

The Transportation Analysis Chapter discusses in detail demand statistics and capacity figures. However, in general, public shelter capacity is adequate for in-county demand throughout the study area. The only exceptions to this are for a Category 4-5 hurricane where a deficit of space occurs in Horry, Beaufort and Charleston Counties.

TABLE 4-1

PUBLIC SHELTER FACILITIES
GEORGETOWN COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Georgetown High School	2000	17.5	Dry	Dry	Dry	Dry	* 19.0
2	Georgetown Career Center	500	17.5	Dry	Dry	Dry	Dry	* 19.0
3	Maryville Elementary School	1000	10.0	Dry	9.5	* 13.0	* 16.0	* 19.5
4	Beck Middle School	1500	18.0	Dry	Dry	Dry	Dry	* 19.0
5	Kensington Elementary School	800	22.0	Dry	Dry	Dry	Dry	Dry
6	McDonald Elementary School	800	**	Dry	Dry	Dry	Dry	Dry
7	Andrews High School	1500	21.0	Dry	Dry	Dry	Dry	Dry
8	Andrews Primary School	1800	21.0	Dry	Dry	Dry	Dry	Dry
9	Rosemary Middle School	1200	21.0	Dry	Dry	Dry	Dry	Dry
10	Waccamaw Elementary and Middle School	1500	11.0	Dry	Dry	Dry	Dry	* 12.0
11	Pleasant Hill Middle School	800	17.0	Dry	Dry	Dry	Dry	Dry
12	Chopee Middle and High School	900	22.0	Dry	Dry	Dry	Dry	Dry
13	Brown's Ferry Elementary School	700	20.0	Dry	Dry	Dry	Dry	Dry

* Potential vulnerability to storm surge based upon established first floor elevation.

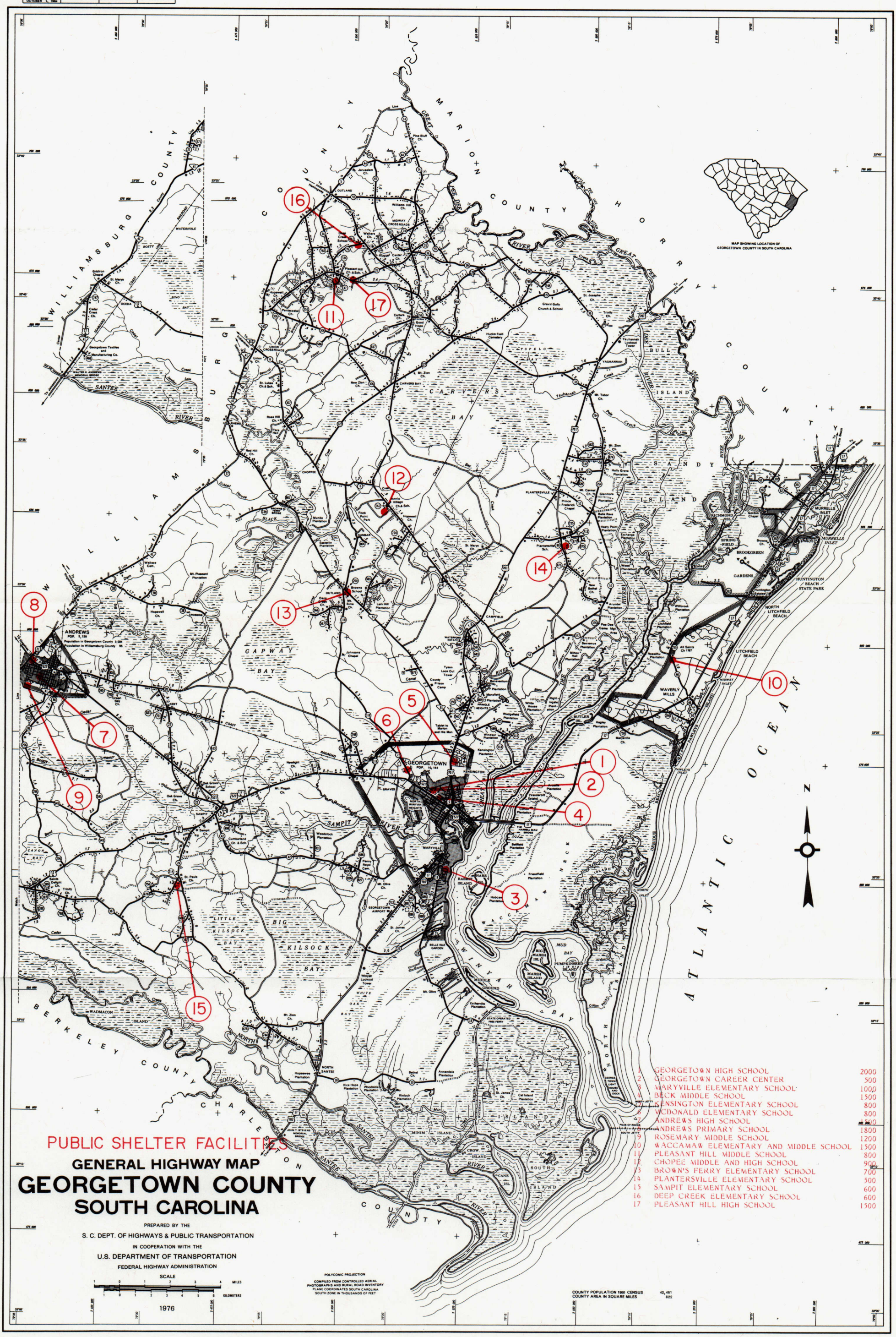
** First floor elevation not established due to facility location away from potential surge inundation areas.

TABLE 4-1 (Cont'd)

PUBLIC SHELTER FACILITIES
GEORGETOWN COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
14	Plantersville Elementary School	500	17.0	Dry	Dry	Dry	Dry	Dry
15	Sampit Elementary School	600	18.5	Dry	Dry	Dry	Dry	Dry
16	Deep Creek Elementary School	600	20.0	Dry	Dry	Dry	Dry	Dry
17	Pleasant Hill High School	1500	20.0	Dry	Dry	Dry	Dry	Dry

COMPLETED APRIL 1976			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
MAY 1, 1976	FEBRUARY 1, 1980	MARCH 1, 1985	
JULY 1, 1976	FEBRUARY 1, 1982		
JULY 1, 1977	OCTOBER 1, 1984		
OCTOBER 1, 1978	MARCH 1, 1986		
FEBRUARY 1, 1980			
FEBRUARY 1, 1982			
OCTOBER 1, 1984			



PUBLIC SHELTER FACILITIES

1	GEORGETOWN HIGH SCHOOL	2000
2	GEORGETOWN CAREER CENTER	500
3	MARYVILLE ELEMENTARY SCHOOL	1000
4	BECK MIDDLE SCHOOL	1500
5	KENSINGTON ELEMENTARY SCHOOL	800
6	MCDONALD ELEMENTARY SCHOOL	800
7	ANDREWS HIGH SCHOOL	1500
8	ANDREWS PRIMARY SCHOOL	1800
9	ROSEMARY MIDDLE SCHOOL	1200
10	WACCAMAW ELEMENTARY AND MIDDLE SCHOOL	1500
11	PLEASANT HILL MIDDLE SCHOOL	800
12	CHOPEE MIDDLE AND HIGH SCHOOL	900
13	BROWN'S FERRY ELEMENTARY SCHOOL	700
14	PLANTERSVILLE ELEMENTARY SCHOOL	500
15	SAMPIT ELEMENTARY SCHOOL	600
16	DEEP CREEK ELEMENTARY SCHOOL	600
17	PLEASANT HILL HIGH SCHOOL	1500

GENERAL HIGHWAY MAP
GEORGETOWN COUNTY
SOUTH CAROLINA

PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

SCALE
1 0 1 2 3 4 MILES
1 0 1 2 3 4 5 6 KILOMETERS

1976

POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA SOUTH ZONE IN THOUSANDS OF FEET

COUNTY POPULATION 1960 CENSUS 42,461
COUNTY AREA IN SQUARE MILES 822

FIGURE 4-1

TABLE 4-2

PUBLIC SHELTER FACILITIES
HORRY COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD) CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Myrtle Beach High School ***	2000	**	Dry	Dry	Dry	Dry	Dry
2	Myrtle Beach Primary School ***	805	**	Dry	Dry	Dry	Dry	Dry
3	Myrtle Beach Elementary School ***	910	**	Dry	Dry	Dry	Dry	Dry
4	Myrtle Beach Middle School ***	1190	**	Dry	Dry	Dry	Dry	Dry
5	Myrtle Beach High School (Proposed) ***	1300	**	Dry	Dry	Dry	Dry	Dry
6	Grand Strand Career Center ***	665	**	Dry	Dry	Dry	Dry	Dry
7	North Myrtle Beach Primary School ***	805	**	Dry	Dry	Dry	Dry	Dry
8	North Myrtle Beach Convention Center ***							
	Corridors, Rooms	6000	**	Dry	Dry	Dry	Dry	Dry
	Exhibition Hall/Gym (Post Storm)	8000	**					
9	Myrtle Beach Convention Center ***							
	Exhibit Hall	18,000	**	Dry	Dry	Dry	Dry	Dry
	Meeting Rooms	8,000	**	Dry	Dry	Dry		
10	North Myrtle Beach Elementary & Middle Sch.	1435	**	Dry	Dry	Dry	Dry	Dry
11	North Myrtle Beach High School	1470	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

*** All Horry County Shelters usable in Categories 1, 2, & 3. No shelters will be opened east of intracoastal waterway in Categories 4 or 5.

TABLE 4-2 (Cont'd)

PUBLIC SHELTER FACILITIES
HORRY COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
12	Socastee Middle School ***	735	**	Dry	Dry	Dry	Dry	Dry
13	Socastee High School ***	2000	**	Dry	Dry	Dry	Dry	Dry
14	Lakewood Elementary School ***	1505	**	Dry	Dry	Dry	Dry	Dry
15	Forest Brook Elementary School (Proposed)	800	**	Dry	Dry	Dry	Dry	Dry
16	Waccamaw Elementary School	792	**	Dry	Dry	Dry	Dry	Dry
17	Midland Elementary School	385	**	Dry	Dry	Dry	Dry	Dry
18	Finklea Career Center	1050	**	Dry	Dry	Dry	Dry	Dry
19	Green Sea Floyd High School (Proposed)	500	**	Dry	Dry	Dry	Dry	Dry
20	Green Sea Floyd Middle School	1015	**	Dry	Dry	Dry	Dry	Dry
21	Green Sea Floyd Elementary School	440	**	Dry	Dry	Dry	Dry	Dry
22	Green Sea Floyd High School	1015	**	Dry	Dry	Dry	Dry	Dry
23	Loris Elementary School	1050	**	Dry	Dry	Dry	Dry	Dry
24	Loris Middle School	1575	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

*** All Horry County Shelters usable in Categories 1, 2, & 3. No shelters will be opened east of intracoastal waterway in Categories 4 or 5.

TABLE 4-2 (Cont'd)

PUBLIC SHELTER FACILITIES
HORRY COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
25	Loris High School	1645	**	Dry	Dry	Dry	Dry	Dry
26	Loris High School (Proposed)	1000	**	Dry	Dry	Dry	Dry	Dry
27	Daisy Elementary School	770	**	Dry	Dry	Dry	Dry	Dry
28	South Conway Elementary School	910	**	Dry	Dry	Dry	Dry	Dry
29	West Conway Middle School	1470	**	Dry	Dry	Dry	Dry	Dry
30	Conway Elementary School	1820	**	Dry	Dry	Dry	Dry	Dry
31	Kingston Elementary School	610	**	Dry	Dry	Dry	Dry	Dry
32	Pee Dee Elementary School	515	**	Dry	Dry	Dry	Dry	Dry
33	Conway High School	2345	**	Dry	Dry	Dry	Dry	Dry
34	Homewood Elementary School	1695	**	Dry	Dry	Dry	Dry	Dry
35	Aynor-Conway Career Center	440	**	Dry	Dry	Dry	Dry	Dry
36	Horry Elementary School	210	**	Dry	Dry	Dry	Dry	Dry
37	Aynor High School	1260	**	Dry	Dry	Dry	Dry	Dry
38	Aynor Elementary School	875	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

*** All Horry County Shelters usable in Categories 1, 2, & 3. No shelters will be opened east of intracoastal waterway in Categories 4 or 5.

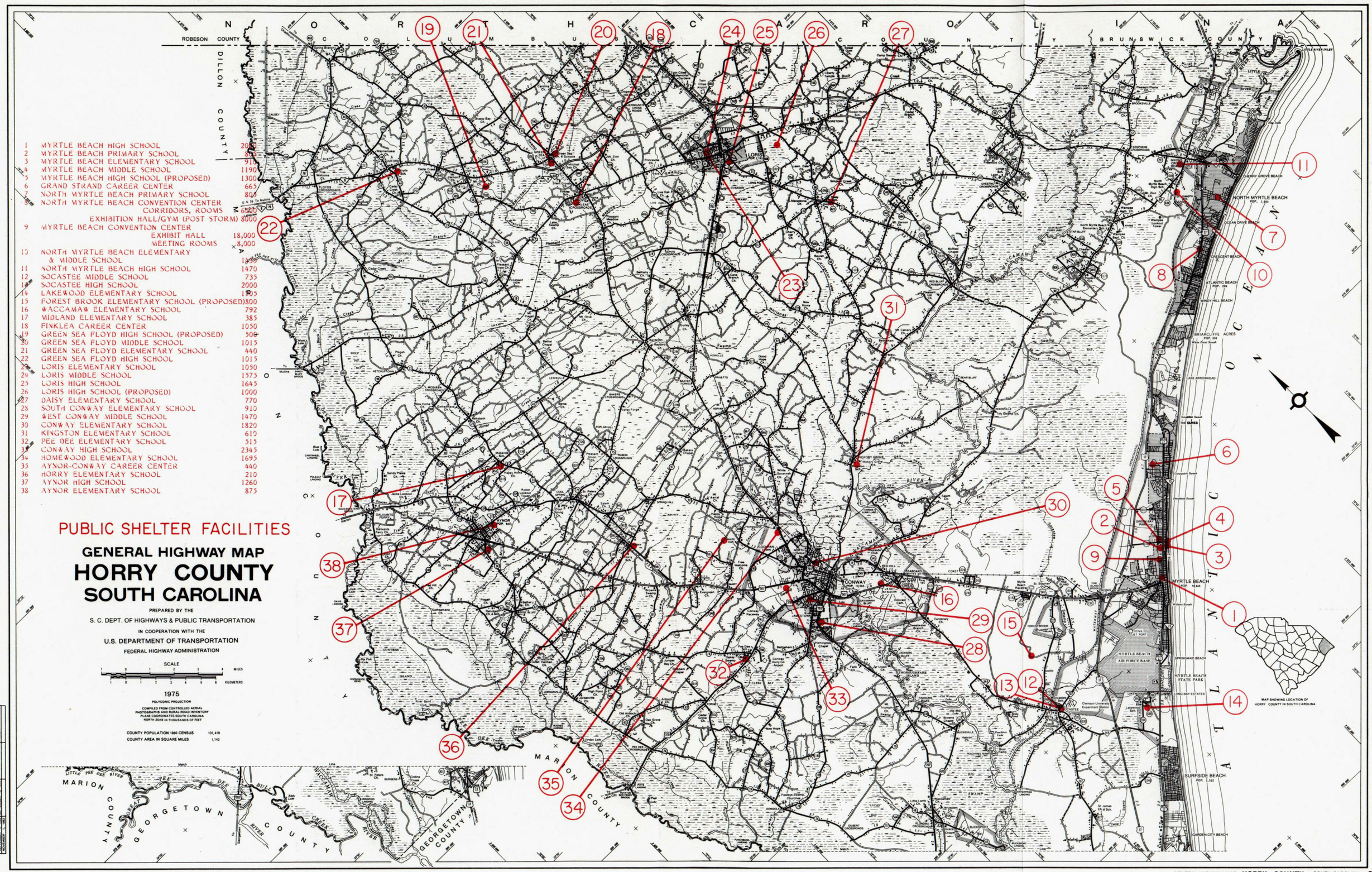

PUBLIC SHELTER FACILITIES
GENERAL HIGHWAY MAP
HORRY COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1975
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA NORTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 101,419
COUNTY AREA IN SQUARE MILES 1,143
1 MYRTLE BEACH HIGH SCHOOL 2000
2 MYRTLE BEACH PRIMARY SCHOOL 835
3 MYRTLE BEACH ELEMENTARY SCHOOL 910
4 MYRTLE BEACH MIDDLE SCHOOL 1190
5 MYRTLE BEACH HIGH SCHOOL (PROPOSED) 1300
6 GRAND STRAND CAREER CENTER 665
7 NORTH MYRTLE BEACH PRIMARY SCHOOL 800
8 NORTH MYRTLE BEACH CONVENTION CENTER
CORRIDORS, ROOMS 6,000
EXHIBITION HALL/GYM (POST STORM) 8000
9 MYRTLE BEACH CONVENTION CENTER
EXHIBIT HALL 18,000
MEETING ROOMS 8,000
10 NORTH MYRTLE BEACH ELEMENTARY & MIDDLE SCHOOL 1600
11 NORTH MYRTLE BEACH HIGH SCHOOL 1470
12 SOCASTEE MIDDLE SCHOOL 735
13 SOCASTEE HIGH SCHOOL 2000
14 LAKEWOOD ELEMENTARY SCHOOL 1305
15 FOREST BROOK ELEMENTARY SCHOOL (PROPOSED) 800
16 WACCAMAW ELEMENTARY SCHOOL 792
17 MIDLAND ELEMENTARY SCHOOL 385
18 FINKLEA CAREER CENTER 1050
19 GREEN SEA FLOYD HIGH SCHOOL (PROPOSED) 500
20 GREEN SEA FLOYD MIDDLE SCHOOL 1015
21 GREEN SEA FLOYD ELEMENTARY SCHOOL 440
22 GREEN SEA FLOYD HIGH SCHOOL 1015
23 LORIS ELEMENTARY SCHOOL 1050
24 LORIS MIDDLE SCHOOL 1575
25 LORIS HIGH SCHOOL 1645
26 LORIS HIGH SCHOOL (PROPOSED) 1000
27 DAISY ELEMENTARY SCHOOL 770
28 SOUTH CONWAY ELEMENTARY SCHOOL 910
29 WEST CONWAY MIDDLE SCHOOL 1470
30 CONWAY ELEMENTARY SCHOOL 1820
31 KINGSTON ELEMENTARY SCHOOL 610
32 PEE DEE ELEMENTARY SCHOOL 515
33 CONWAY HIGH SCHOOL 2345
34 HOMEWOOD ELEMENTARY SCHOOL 1695
35 AYNOR-CONWAY CAREER CENTER 440
36 HORRY ELEMENTARY SCHOOL 210
37 AYNOR HIGH SCHOOL 1260
38 AYNOR ELEMENTARY SCHOOL 875
ROBESON COUNTY
DILLON COUNTY
BRUNSWICK COUNTY
MARION COUNTY
GEORGETOWN COUNTY
LORIS
CONWAY
AYNOR
MYRTLE BEACH
NORTH MYRTLE BEACH
CHERRY GROVE BEACH
OCEAN DRIVE BEACH
CRESCENT BEACH
ATLANTIC BEACH
WINDY HILL BEACH
BRIARCLIFFE ACRES
LAKE ARROWHEAD
THE DUNES
SURFSIDE BEACH
GARDEN CITY BEACH
MYRTLE BEACH AIR FORCE BASE
MYRTLE BEACH STATE PARK
SPRINGMAID BEACH
LONG BAY ESTATES
SOCASTEE
MAP SHOWING LOCATION OF HORRY COUNTY IN SOUTH CAROLINA

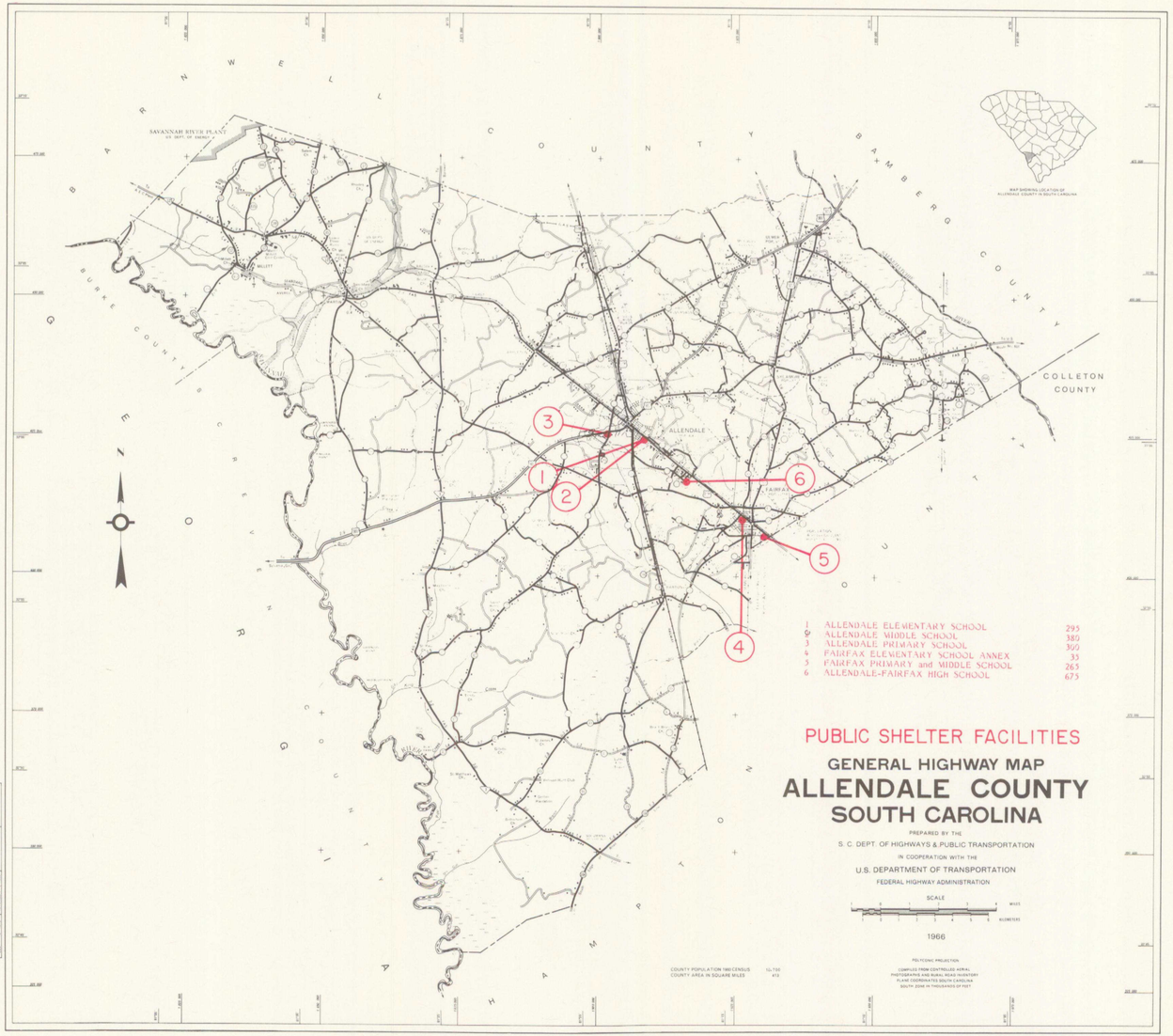
FIGURE 4-2

TABLE 4-3

PUBLIC SHELTER FACILITIES
ALLENDALE COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Allendale Elementary School	295	**	Dry	Dry	Dry	Dry	Dry
2	Allendale Elementary School (Formerly Middle)	380	**	Dry	Dry	Dry	Dry	Dry
3	Allendale Primary School	300	**	Dry	Dry	Dry	Dry	Dry
4	Fairfax Elementary School (Formerly Elementary Annex)	35	**	Dry	Dry	Dry	Dry	Dry
5	Fairfax Elementary School (Formerly Primary and Middle)	265	**	Dry	Dry	Dry	Dry	Dry
6	Allendale-Fairfax High School	675	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.



1	1/2/66		
2	1/2/66		
3	1/2/66		
4	1/2/66		
5	1/2/66		

TABLE 4-4

PUBLIC SHELTER FACILITIES
BEAUFORT COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	St. Helena Jr. High School	2140	23.65	Dry	Dry	Dry	Dry	Dry
2	Beaufort High School	2447	19.73	Dry	Dry	Dry	Dry	* 19.0
3	Battery Creek High School	3400	28.85	Dry	Dry	Dry	Dry	Dry
4	Davis Elementary School	1000	16.19	Dry	Dry	Dry	16.0	* 19.5
5	Michael C. Riley Elementary School	710	26.80	Dry	Dry	Dry	Dry	Dry
6	H. E. McCracken High School	1457	24.70	Dry	Dry	Dry	Dry	Dry
7	Battery Creek Elementary School	600	17.61	Dry	Dry	Dry	16.3	* 19.4
8	Mossy Oaks Elementary School	930	17.50	Dry	Dry	Dry	15.9	* 19.0
9	Robert Smalls Junior High School	1800	20.5	Dry	Dry	Dry	Dry	19.0
10	Hilton Head High School	1800	16.0	Dry	Dry	14.0	* 17.3	* 21.0
11	Lady's Island Junior High School	1200	15.48	Dry	Dry	13.0	* 15.9	* 19.1
12	Beaufort Elementary School	1842	25.67	Dry	Dry	Dry	Dry	Dry
13	Hilton Head Elementary School (Under Construction)	1909	17.0	Dry	Dry	14.0	* 17.3	* 21.0

* Potential vulnerability to storm surge based upon established first floor elevation.

COMPLETED	JULY 1, 1978
REVISED	
STATE SYSTEM	COUNTY SYSTEM
FEBRUARY 1, 1980	FEBRUARY 1, 1980
AUGUST 1, 1981	AUGUST 1, 1981
NOVEMBER 1, 1983	NOVEMBER 1, 1983
MARCH 1, 1985	MARCH 1, 1985

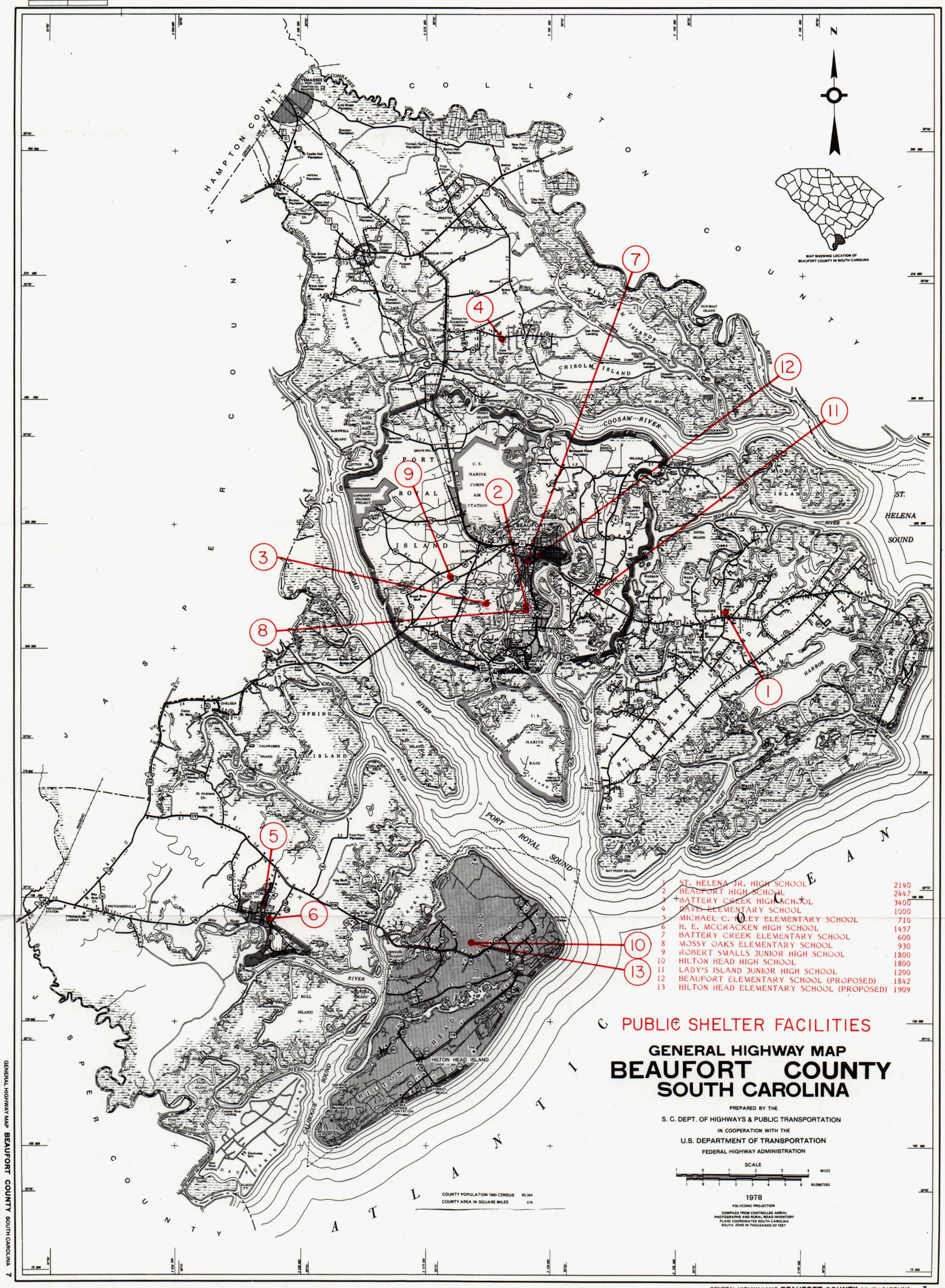

HAMPTON COUNTY
COLLETON COUNTY
JASPER COUNTY
ATLANTIC OCEAN
YEMASSEE
POP. 1,048
HAMPTON CO. 772
BEAUFORT CO. 276
COMBAHEE RIVER
Auld Brass Plantation
Brewton Plantation
Castle Hall Plantation
Jericho Plantation
Bindon Plantation
Cotton Hall Plantation
Pocotaligo Ch.
Tomotley Plantation
Sheldon Ch. Ruins
Sheldon Lookout Tower
SHELDON
Jerusalem Ch.
GARDENS CORNER
Oak Grove Plantation
Brays Island Plantation
Huspah Plantation
Huspah Ch.
Bull Point
School for Exceptional Children
Case Elementary
LOBECO
COOSAW
SEABROOK
Gethsemane Ch.
FORKY ISLAND
JACKS ISLAND
Clarendon Plantation
GRAYS HILL
COTTON ISL.
Brickyard Plantation
Brickyard Point Plantation
WILKINS
COOSAW RIVER
CHISOLM ISLAND
Chisolm Plantation
Coosaw Plantation
Oak Point Landing
Whitehall Landing
Thicket Plantation
Bonny Hall Plantation
Hobcaw Plantation
First African Ch.
Bethel Ch.
New Port Plantation
Old Fort
Clay Hall Plantation
PRIESTER
Jerusalem Ch.
BRIARS
Briars Ch.
CHISOLM
DALE
GUN BOAT ISLAND
HUZZARD ISL.
OAK ISLAND
BARNWELL ISLAND
LITTLE BARN
WEST ISLAND
BALL ISLAND
PORT ROYAL ISLAND
U. S. MARINE CORPS AIR STATION
CAPEHART HOUSING PROJECT
LAURE BAY
BEAUFORT
BURTON
Broad River Bluff
Old Fort
LEMON
Edward Burton Rodgers School
CHELSEA
CHEHAW
SPRING ISLAND
CALAWASSIE ISLAND
Camp St. Mary
GARRETT PT.
Gardens Corner Farm
St. Andrews Ch.
Indian Hill Ch.
COLLETON RIVER
Foot Point Plantation
Hog Bluff Plantation
BLUFFTON
POP. 541
PRITCHARD STATION
Pritchardville Lookout Tower
PRITCHARDVILLE
May River Ch.
MAY RIVER
BRIGHTON BEACH
BULL ISLAND
Bull River
Cooper River Landing
COOPER RIVER
PAGE ISLAND
Deufuskie Sch.
New River Landing
DAUFUSKIE ISLAND
BLOODY PT.
CALIBOGUE SOUND
DAWS ISLAND
U. S. MARINE BASE
PORT ROYAL SOUND
ST. HELENA SOUND
ST. HELENA ISLAND
MORGAN ISLAND
MORGAN RIVER
DATHA ISLAND
WARSAW ISLAND
POLLWANA ISL.
FROGMORE
St. Helena's
Brownsville Ch.
Industrial Sch.
Brick Ch.
GIBBS ISLAND
CAT ISLAND
CANE ISLAND
HUNTING ISLAND STATE PARK
FRIPP ISLAND
STORY RIVER
PRITCHARDS ISLAND
BAY POINT ISLAND
TRENCHARDS INLET
HILTON HEAD ISLAND
POP. 11,344
HILTON HEAD ISLAND
FOREST BEACH
Bayard Ruins
Sea Pines Plantation (Private)
BRADDOCKS POINT
JENKINS ISLAND
Abbt.
Alma
Fort Mitchel
Fort Walker
Turtle Point
Bull Point
Boyd
Lawton
Stoney
Ball
Barnwell
Little Barn
West Island
Cotton Isl.
Gardens Corner
Sheldon
Lobeco
Seabrook
Coosaw
Forky Island
Jacks Island
Gethsemane Ch.
Clarendon Plantation
Grays Hill
Brickyard Plantation
Brickyard Point Plantation
Wilkins
Coosaw River
Chisolm Island
Chisolm Plantation
Coosaw Plantation
Oak Point Landing
Whitehall Landing
Thicket Plantation
Bonny Hall Plantation
Hobcaw Plantation
First African Ch.
Bethel Ch.
New Port Plantation
Old Fort
Clay Hall Plantation
Priester
Jerusalem Ch.
Briars
Briars Ch.
Chisolm
Dale
Gun Boat Island
Huzzard Isl.
Oak Island
Rubbers Point
Bell Point
Intra
Boat Road
Boat Ramp
Port Royal Island
Burton
Broad River Bluff
Old Fort
Lemon
Chehaw
Chelsea
Spring Island
Calawassie Island
Camp St. Mary
Garrett Pt.
Gardens Corner Farm
St. Andrews Ch.
Indian Hill Ch.
Colleton River
Foot Point Plantation
Hog Bluff Plantation
Bluffton
Pritchard Station
Pritchardville Lookout Tower
Pritchardville
May River Ch.
May River
Brighton Beach
Bull Island
Bull River
Cooper River Landing
Cooper River
Page Island
Deufuskie Sch.
New River Landing
Daufuskie Island
Bloody Pt.
Calibogue Sound
Daws Island
U. S. Marine Base
Port Royal Sound
St. Helena Sound
St. Helena Island
Morgan Island
Morgan River
Datha Island
Warsaw Island
Pollwana Isl.
Frogmore
St. Helena's
Brownsville Ch.
Industrial Sch.
Brick Ch.
Gibbs Island
Cat Island
Cane Island
Hunting Island State Park
Fripp Island
Story River
Pritchards Island
Bay Point Island
Trenchards Inlet
Hilton Head Island
Hilton Head Island
Forest Beach
Bayard Ruins
Sea Pines Plantation (Private)
Braddocks Point
Jenkins Island

TABLE 4-5

PUBLIC SHELTER FACILITIES
BERKELEY COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Berkeley High School	1650	99.35	Dry	Dry	Dry	Dry	Dry
2	R. A. Ready Intermediate School	575	55.5	Dry	Dry	Dry	Dry	Dry
3	Whitesville Elementary School	625	51.96	Dry	Dry	Dry	Dry	Dry
4	Sangaree Elementary School	975	51.0	Dry	Dry	Dry	Dry	Dry
5	Stratford High School	2975	48.4	Dry	Dry	Dry	Dry	Dry
6	Sandridge Elementary School	300	**	Dry	Dry	Dry	Dry	Dry
7	Cross High School	1325	90.61	Dry	Dry	Dry	Dry	Dry
8	St. Stephen High School	625	51.0	Dry	Dry	Dry	Dry	Dry
9	St. Stephen Middle School	450	102.5	Dry	Dry	Dry	Dry	Dry
10	Cainhoy High School	875	50.5	Dry	Dry	Dry	Dry	Dry
11	Macedonia High School	925	54.67	Dry	Dry	Dry	Dry	Dry
12	Hanahan Middle School	975	83.5	Dry	Dry	Dry	Dry	Dry
13	Hanahan High School	675	20.55	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

TABLE 4-5 (Cont'd)

PUBLIC SHELTER FACILITIES
BERKELEY COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
14	Goose Creek High School	1950	41.0	Dry	Dry	Dry	Dry	Dry
15	Boulder Bluff Elementary School	600	20.0	Dry	Dry	Dry	Dry	Dry
16	Men-Riv Elementary School	850	18.0	Dry	Dry	Dry	Dry	Dry

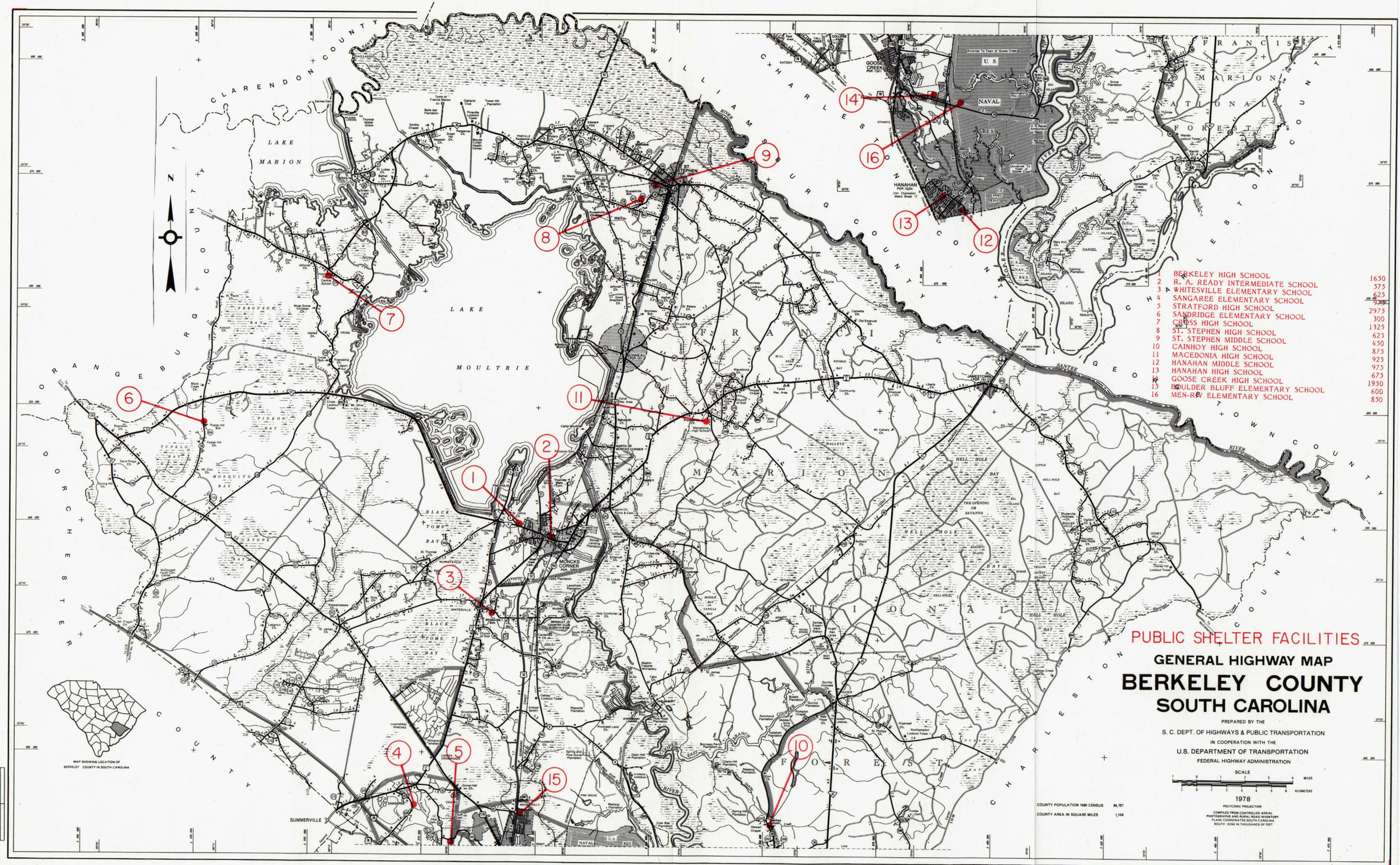

PUBLIC SHELTER FACILITIES
GENERAL HIGHWAY MAP
BERKELEY COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1978
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA
SOUTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 94,727
COUNTY AREA IN SQUARE MILES 1,108
1 BERKELEY HIGH SCHOOL 1650
2 R. A. READY INTERMEDIATE SCHOOL 575
3 WHITESVILLE ELEMENTARY SCHOOL 625
4 SANGAREE ELEMENTARY SCHOOL 2975
5 STRATFORD HIGH SCHOOL 300
6 SANDRIDGE ELEMENTARY SCHOOL 1325
7 CROSS HIGH SCHOOL 625
8 ST. STEPHEN HIGH SCHOOL 450
9 ST. STEPHEN MIDDLE SCHOOL 875
10 CAINHOY HIGH SCHOOL 925
11 MACEDONIA HIGH SCHOOL 975
12 HANAHAN MIDDLE SCHOOL 675
13 HANAHAN HIGH SCHOOL 1950
14 GOOSE CREEK HIGH SCHOOL 600
15 BOULDER BLUFF ELEMENTARY SCHOOL 850
16 MEN-REV ELEMENTARY SCHOOL
MAP SHOWING LOCATION OF BERKELEY COUNTY IN SOUTH CAROLINA
LAKE MARION
LAKE MOULTRIE
CLARENDON COUNTY
ORANGEBURG COUNTY
DORCHESTER COUNTY
CHARLESTON COUNTY
WILLIAMSBURG COUNTY
FRANCIS MARION NATIONAL FOREST
NAVAL RES
SUMMERVILLE
MONCKS CORNER
HANAHAN
GOOSE CREEK
ST. STEPHEN
WHITESVILLE
JAMESTOWN
COMPILED
APRIL, 1978
S.C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
REVISED
JUNE, 1980
MARCH, 1981
SEPTEMBER, 1981

FIGURE 4-5

TABLE 4-6

PUBLIC SHELTER FACILITIES
CHARLESTON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Alice Birney Middle School	1325	34.83	Dry	Dry	Dry	Dry	Dry
2	Angel Oak Elementary School	825	23.00	Dry	Dry	Dry	Dry	Dry
3	Ben Tillman Elementary School	1150	38.5	Dry	Dry	Dry	Dry	Dry
4	C. C. Blaney Elementary School	650	32.66	Dry	Dry	Dry	Dry	Dry
5	Brentwood Middle School	1300	18.19	Dry	Dry	Dry	17.5	* 19.2
6	Burke High School	2000	13.12	Dry	Dry	* 13.3	* 16.2	* 18.3
7	Chicora Elementary School	1175	21.55	Dry	Dry	Dry	Dry	Dry
8	E. B. Ellington Elementary School	400	14.5	Dry	Dry	Dry	11.7	* 15.8
9	Fort Johnson Middle School	1000	16.9	Dry	Dry	Dry	15.1	* 17.7
10	W. J. Fraser Elementary School	775	22.0	Dry	Dry	Dry	Dry	Dry
11	Frierson Elementary School	300	16.70	Dry	Dry	Dry	15.0	* 17.4
12	Garrett High School	1450	31.5	Dry	Dry	Dry	Dry	Dry
13	Harbor View Elementary School	425	11.0	Dry	9.6	* 13.2	* 16.0	* 18.2

* Potential vulnerability to storm surge based upon established first floor elevation.

TABLE 4-6 (Cont'd)

PUBLIC SHELTER FACILITIES
CHARLESTON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
14	Haut Gap Middle School	850	25.86	Dry	Dry	Dry	Dry	Dry
15	James Island High School	2075	15.83	Dry	Dry	12.9	15.8	* 18.1
16	James Island Middle School	900	24.00	Dry	Dry	Dry	Dry	Dry
17	James Simons Elementary School	875	16.0	Dry	Dry	Dry	16.2	* 18.2
18	Jane Edwards Elementary School	325	17.5	Dry	Dry	Dry	Dry	17.0
19	Ladson Elementary School	875	47.1	Dry	Dry	Dry	Dry	Dry
20	Laing Middle School	950	20.43	Dry	Dry	Dry	Dry	19.0
21	Lincoln High & Middle Schools	1175	20.53	Dry	Dry	Dry	Dry	19.5
22	Mary Ford Elementary School	900	35.5	Dry	Dry	Dry	Dry	Dry
23	Middleton High School	1675	32.0	Dry	Dry	Dry	Dry	Dry
24	Minnie Hughes Elementary School	400	22.0	Dry	Dry	Dry	Dry	20.0
25	Moultrie Middle School	700	22.75	Dry	Dry	Dry	Dry	Dry
26	Murray-Lasaine Elementary School	800	11.13	Dry	8.2	* 12.6	* 14.6	* 17.4

* Potential vulnerability to storm surge based upon established first floor elevation.

TABLE 4-6 (Cont'd)

PUBLIC SHELTER FACILITIES
CHARLESTON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
27	North Charleston Elementary School	825	11.3	Dry	Dry	9.1	* 12.0	* 15.5
28	North Charleston High School	2925	29.0	Dry	Dry	Dry	Dry	Dry
29	Oakland Elementary School	650	12.0	Dry	Dry	10.1	* 14.1	* 17.2
30	Pepperhill Elementary School	850	28.0	Dry	Dry	Dry	Dry	Dry
31	Rivers Middle School	1250	19.0	Dry	Dry	Dry	16.2	18.1
32	Schroder Middle School	1400	33.00	Dry	Dry	Dry	Dry	Dry
33	Springfield Elementary School	600	16.0	Dry	Dry	14.4	15.5	* 18.5
34	Stall High School	1250	33.5	Dry	Dry	Dry	Dry	Dry
35	St. Andrews Elementary School	725	13.5	Dry	Dry	11.7	* 14.5	* 18.0
36	St. Andrews High School	1700	20.0	Dry	Dry	Dry	Dry	17.5
37	Stiles Point Elementary School	625	18.66	Dry	Dry	Dry	Dry	18.2
38	St. Johns High and Vocational Schools	1250	13.0	Dry	Dry	Dry	* 13.8	* 16.5
39	Norman C. Toole Middle School	1450	26.0	Dry	Dry	Dry	Dry	Dry

* Potential vulnerability to storm surge based upon established first floor elevation.

TABLE 4-6 (Cont'd)

PUBLIC SHELTER FACILITIES
CHARLESTON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
40	Ashley River Middle School	825	18.0	Dry	Dry	Dry	Dry	17.4
41	Wando High School	2375	22.0	Dry	Dry	Dry	Dry	Dry
42	C. E. Williams Middle School	1400	11.5	Dry	Dry	9.6	* 13.7	* 16.8
43	Drayton Hall Middle School	1400	21.0	Dry	Dry	Dry	Dry	Dry
44	St. James-Santee Elementary School	825	17.92	Dry	Dry	Dry	17.6	* 20.2
45	Gaillard Municiple Auditorium (Post-Storm Shelter)	1065	12.7	Dry	Dry	* 12.9	* 16.2	* 18.4

* Potential vulnerability to storm surge based upon established first floor elevation.

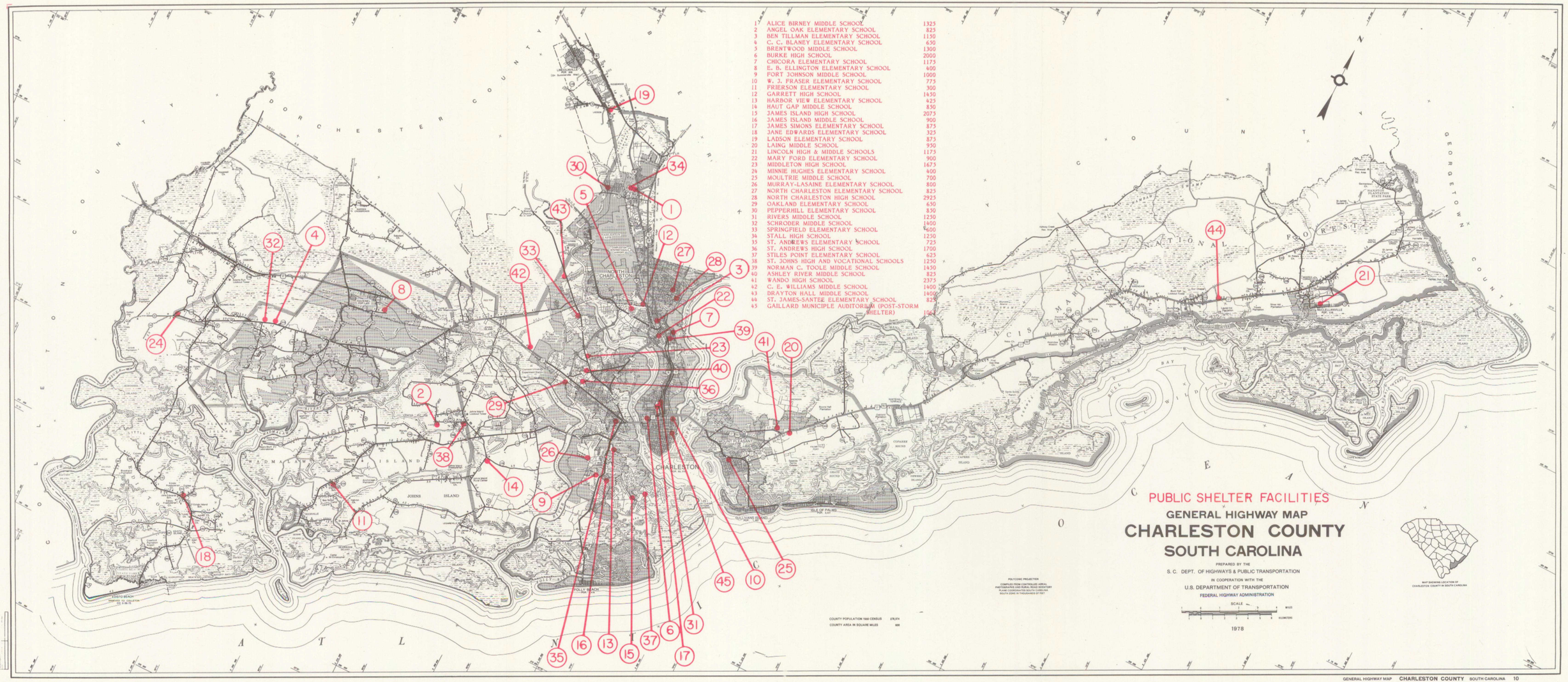

PUBLIC SHELTER FACILITIES
GENERAL HIGHWAY MAP
CHARLESTON COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1978
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL
PHOTOGRAPHS AND OTHER SUPPLEMENTARY
PLANE COORDINATES SOUTH CAROLINA
SOUTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 276,274
COUNTY AREA IN SQUARE MILES 908
MAP SHOWING LOCATION OF
CHARLESTON COUNTY IN SOUTH CAROLINA
CHARLESTON
NORTH CHARLESTON
MOUNT PLEASANT
SULLIVANS ISLAND
ISLE OF PALMS
SEABROOK ISLAND
JOHNS ISLAND
FOLLY BEACH
KIAWAH ISLAND
SEABROOK ISLAND
CAPERS ISLAND
COPAHEE SOUND
HAMLIN SOUND
DEWEES ISLAND
BULL ISLAND
SHOVELER ISLAND
CAPERS ISLAND
SANDY ISLAND
TAYLOR ISLAND
LOCKWOOD
MOSQUITO CREEK
BOONE HALL PLANTATION
CHARLESTON NATIONAL FOREST
FRANCIS MARION NATIONAL FOREST
SANTEE NATIONAL WILDLIFE REFUGE
SANTEE STATE PARK
MOUNT PLEASANT
BULL WILLIAMS MARSH
CAPERS ISLAND
DORCHESTER COUNTY
BERKELEY COUNTY
GEORGETOWN COUNTY
COLLETON COUNTY
ATLANTIC OCEAN
1 ALICE BIRNEY MIDDLE SCHOOL 1325
2 ANGEL OAK ELEMENTARY SCHOOL 825
3 BEN TILLMAN ELEMENTARY SCHOOL 1130
4 C. C. BLANEY ELEMENTARY SCHOOL 630
5 BRENTWOOD MIDDLE SCHOOL 1300
6 BURKE HIGH SCHOOL 2000
7 CHICORA ELEMENTARY SCHOOL 1175
8 E. B. ELLINGTON ELEMENTARY SCHOOL 400
9 FORT JOHNSON MIDDLE SCHOOL 1000
10 W. J. FRASER ELEMENTARY SCHOOL 775
11 FRIERSON ELEMENTARY SCHOOL 300
12 GARRETT HIGH SCHOOL 1450
13 HARBOR VIEW ELEMENTARY SCHOOL 425
14 HAUT GAP MIDDLE SCHOOL 850
15 JAMES ISLAND HIGH SCHOOL 2075
16 JAMES ISLAND MIDDLE SCHOOL 900
17 JAMES SIMONS ELEMENTARY SCHOOL 875
18 JANE EDWARDS ELEMENTARY SCHOOL 325
19 LADSON ELEMENTARY SCHOOL 875
20 LAING MIDDLE SCHOOL 930
21 LINCOLN HIGH & MIDDLE SCHOOLS 1175
22 MARY FORD ELEMENTARY SCHOOL 900
23 MIDDLETON HIGH SCHOOL 1675
24 MINNIE HUGHES ELEMENTARY SCHOOL 400
25 MOULTRIE MIDDLE SCHOOL 700
26 MURRAY-LASAINE ELEMENTARY SCHOOL 800
27 NORTH CHARLESTON ELEMENTARY SCHOOL 825
28 NORTH CHARLESTON HIGH SCHOOL 2925
29 OAKLAND ELEMENTARY SCHOOL 630
30 PEPPERHILL ELEMENTARY SCHOOL 830
31 RIVERS MIDDLE SCHOOL 1250
32 SCHRODER MIDDLE SCHOOL 1400
33 SPRINGFIELD ELEMENTARY SCHOOL 600
34 STALL HIGH SCHOOL 1250
35 ST. ANDREWS ELEMENTARY SCHOOL 725
36 ST. ANDREWS HIGH SCHOOL 1700
37 STILES POINT ELEMENTARY SCHOOL 625
38 ST. JOHNS HIGH AND VOCATIONAL SCHOOLS 1250
39 NORMAN C. TOOLE MIDDLE SCHOOL 1450
40 ASHLEY RIVER MIDDLE SCHOOL 825
41 WANDO HIGH SCHOOL 2375
42 C. E. WILLIAMS MIDDLE SCHOOL 1400
43 DRAYTON HALL MIDDLE SCHOOL 1400
44 ST. JAMES-SANTEE ELEMENTARY SCHOOL 825
45 GAILLARD MUNICIPLE AUDITORIUM (POST-STORM SHELTER) 1000

FIGURE 4-6

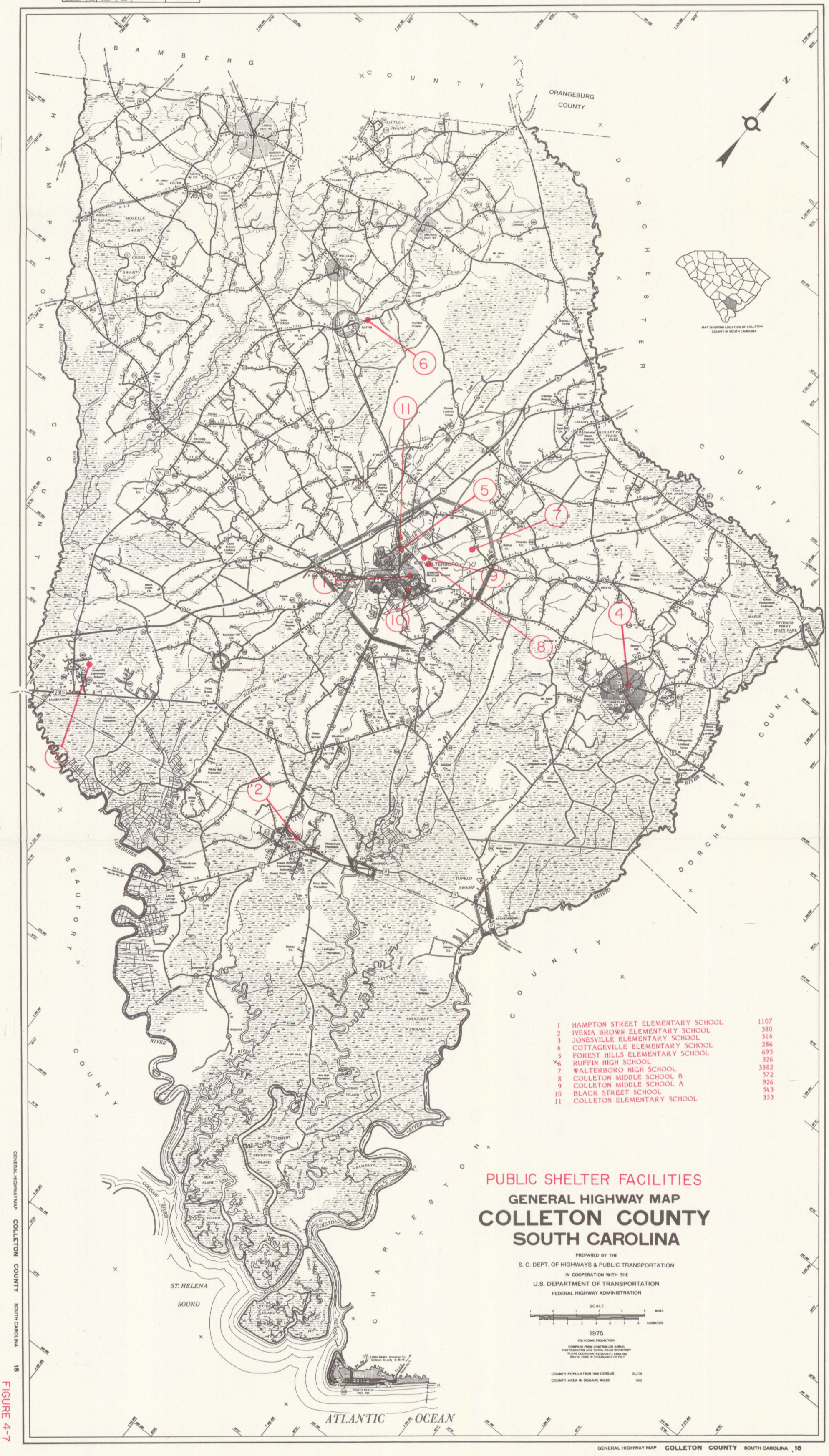
TABLE 4-7

PUBLIC SHELTER FACILITIES
COLLETON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Hampton Street Elementary School	1107	**	Dry	Dry	Dry	Dry	Dry
2	Ivenia Brown Elementary School	380	**	Dry	Dry	Dry	Dry	Dry
3	Jonesville Elementary School	314	**	Dry	Dry	Dry	Dry	Dry
4	Cottageville Elementary School	286	**	Dry	Dry	Dry	Dry	Dry
5	Forest Hills Elementary School	695	**	Dry	Dry	Dry	Dry	Dry
6	Ruffin High School	326	**	Dry	Dry	Dry	Dry	Dry
7	Walterboro High School	3382	**	Dry	Dry	Dry	Dry	Dry
8	Colleton Middle School B	572	**	Dry	Dry	Dry	Dry	Dry
9	Colleton Middle School A	926	**	Dry	Dry	Dry	Dry	Dry
10	Black Street Elementary School	543	**	Dry	Dry	Dry	Dry	Dry
11	Colleton Elementary School	353	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

COMPLETED NOVEMBER 1975			
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
MAR. 1, 1976	JAN. 1, 1976	SEPTEMBER 1, 1982	
JULY 1, 1976	MARCH 1, 1979	NOVEMBER 1, 1983	
APRIL 1, 1977	DECEMBER 1, 1980	MARCH 1, 1985	
JULY 1, 1978	SEPTEMBER 1, 1982		
MARCH 1, 1979	NOVEMBER 1, 1983		
DECEMBER 1, 1980	MARCH 1, 1985		



PUBLIC SHELTER FACILITIES

GENERAL HIGHWAY MAP

COLLETON COUNTY SOUTH CAROLINA

PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

SCALE
MILES
KILOMETERS

1975
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA SOUTH ZONE IN THOUSANDS OF FEET

COUNTY POPULATION 1980 CENSUS 31,776
COUNTY AREA IN SQUARE MILES 1052

FIGURE 4-7

TABLE 4-8

PUBLIC SHELTER FACILITIES
DORCHESTER COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	St. George Elementary School	450	**	Dry	Dry	Dry	Dry	Dry
2	Williams Memorial School	700	**	Dry	Dry	Dry	Dry	Dry
3	St. George High School	775	**	Dry	Dry	Dry	Dry	Dry
4	Rollins Elementary School	700	**	Dry	Dry	Dry	Dry	Dry
5	Knightsville Elementary School	575	**	Dry	Dry	Dry	Dry	Dry
6	Summerville Intermediate School	2125	**	Dry	Dry	Dry	Dry	Dry
7	Alston Junior High School	1300	**	Dry	Dry	Dry	Dry	Dry
8	Flowertown Elementary	1100	**	Dry	Dry	Dry	Dry	Dry
9	Summerville Elementary	900	**	Dry	Dry	Dry	Dry	Dry
10	Newington Elementary	1675	**	Dry	Dry	Dry	Dry	Dry
11	Givhans Elementary School	325	**	Dry	Dry	Dry	Dry	Dry
12	Spann Elementary	500	**	Dry	Dry	Dry	Dry	Dry
13	Summerville High School	1800	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

TABLE 4-8 (Cont'd)

PUBLIC SHELTER FACILITIES
DORCHESTER COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
14	Dubose Middle School	1825	**	Dry	Dry	Dry	Dry	Dry
15	Jenkins Hill School	575	**	Dry	Dry	Dry	Dry	Dry
16	Harleyville-Ridgeville High School	475	**	Dry	Dry	Dry	Dry	Dry
17	Clay Hill Elementary School	550	**	Dry	Dry	Dry	Dry	Dry
18	Dorchester Vocational School	925	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

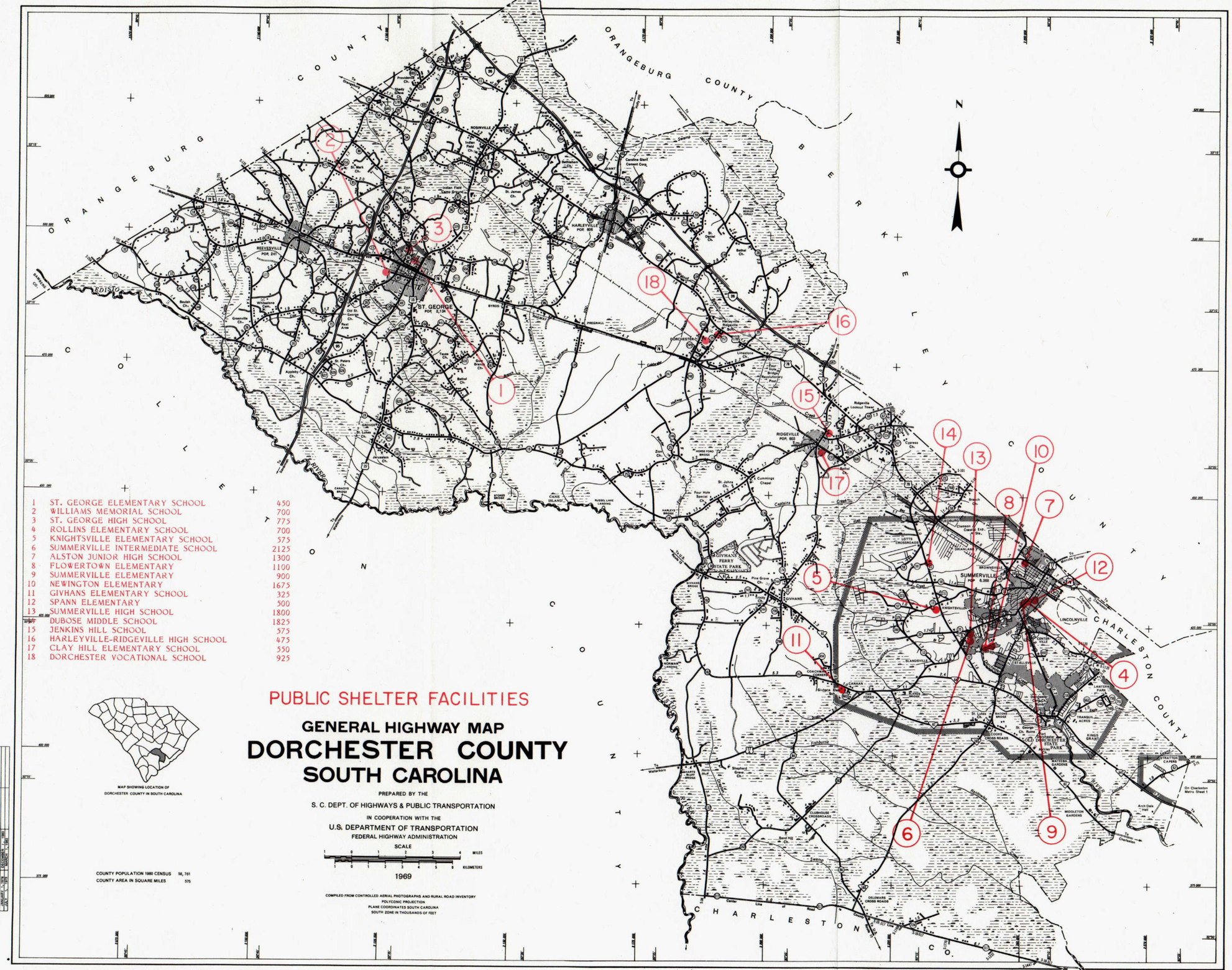

ORANGEBURG COUNTY
BERKELEY COUNTY
CHARLESTON COUNTY
COLLETON COUNTY
ST. GEORGE
POP. 2,139
HARLEYVILLE
POP. 826
RIDGEVILLE
POP. 903
SUMMERVILLE
POP. 6,368
DORCHESTER
GIVHANS
LINCOLNVILLE
N
1 ST. GEORGE ELEMENTARY SCHOOL 450
2 WILLIAMS MEMORIAL SCHOOL 700
3 ST. GEORGE HIGH SCHOOL 775
4 ROLLINS ELEMENTARY SCHOOL 700
5 KNIGHTSVILLE ELEMENTARY SCHOOL 575
6 SUMMERVILLE INTERMEDIATE SCHOOL 2125
7 ALSTON JUNIOR HIGH SCHOOL 1300
8 FLOWERTOWN ELEMENTARY 1100
9 SUMMERVILLE ELEMENTARY 900
10 NEWINGTON ELEMENTARY 1675
11 GIVHANS ELEMENTARY SCHOOL 325
12 SPANN ELEMENTARY 500
13 SUMMERVILLE HIGH SCHOOL 1800
14 DUBOSE MIDDLE SCHOOL 1825
15 JENKINS HILL SCHOOL 575
16 HARLEYVILLE-RIDGEVILLE HIGH SCHOOL 475
17 CLAY HILL ELEMENTARY SCHOOL 550
18 DORCHESTER VOCATIONAL SCHOOL 925
MAP SHOWING LOCATION OF DORCHESTER COUNTY IN SOUTH CAROLINA
COUNTY POPULATION 1980 CENSUS 58,761
COUNTY AREA IN SQUARE MILES 575
PUBLIC SHELTER FACILITIES
GENERAL HIGHWAY MAP
DORCHESTER COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1969
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
POLYCONIC PROJECTION
PLANE COORDINATES SOUTH CAROLINA
SOUTH ZONE IN THOUSANDS OF FEET

FIGURE 4-8

TABLE 4-9

PUBLIC SHELTER FACILITIES
HAMPTON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Fennel Elementary School	650	**	Dry	Dry	Dry	Dry	Dry
2	Varnville Elementary School	525	**	Dry	Dry	Dry	Dry	Dry
3	Wade Hampton High School	600	**	Dry	Dry	Dry	Dry	Dry
4	North District Middle School	650	**	Dry	Dry	Dry	Dry	Dry
5	Hampton Elementary School	550	**	Dry	Dry	Dry	Dry	Dry
6	Ben Hazel Elementary School	225	**	Dry	Dry	Dry	Dry	Dry
7	Brunson Elementary School	175	**	Dry	Dry	Dry	Dry	Dry
8	Allen Elementary School	150	**	Dry	Dry	Dry	Dry	Dry
9	New Estill High School	475	**	Dry	Dry	Dry	Dry	Dry
10	Old Estill High School	375	**	Dry	Dry	Dry	Dry	Dry
11	Estill Middle School	450	**	Dry	Dry	Dry	Dry	Dry
12	Estill Elementary School	400	**	Dry	Dry	Dry	Dry	Dry
13	Dixon Elementary School	200	**	Dry	Dry	Dry	Dry	Dry

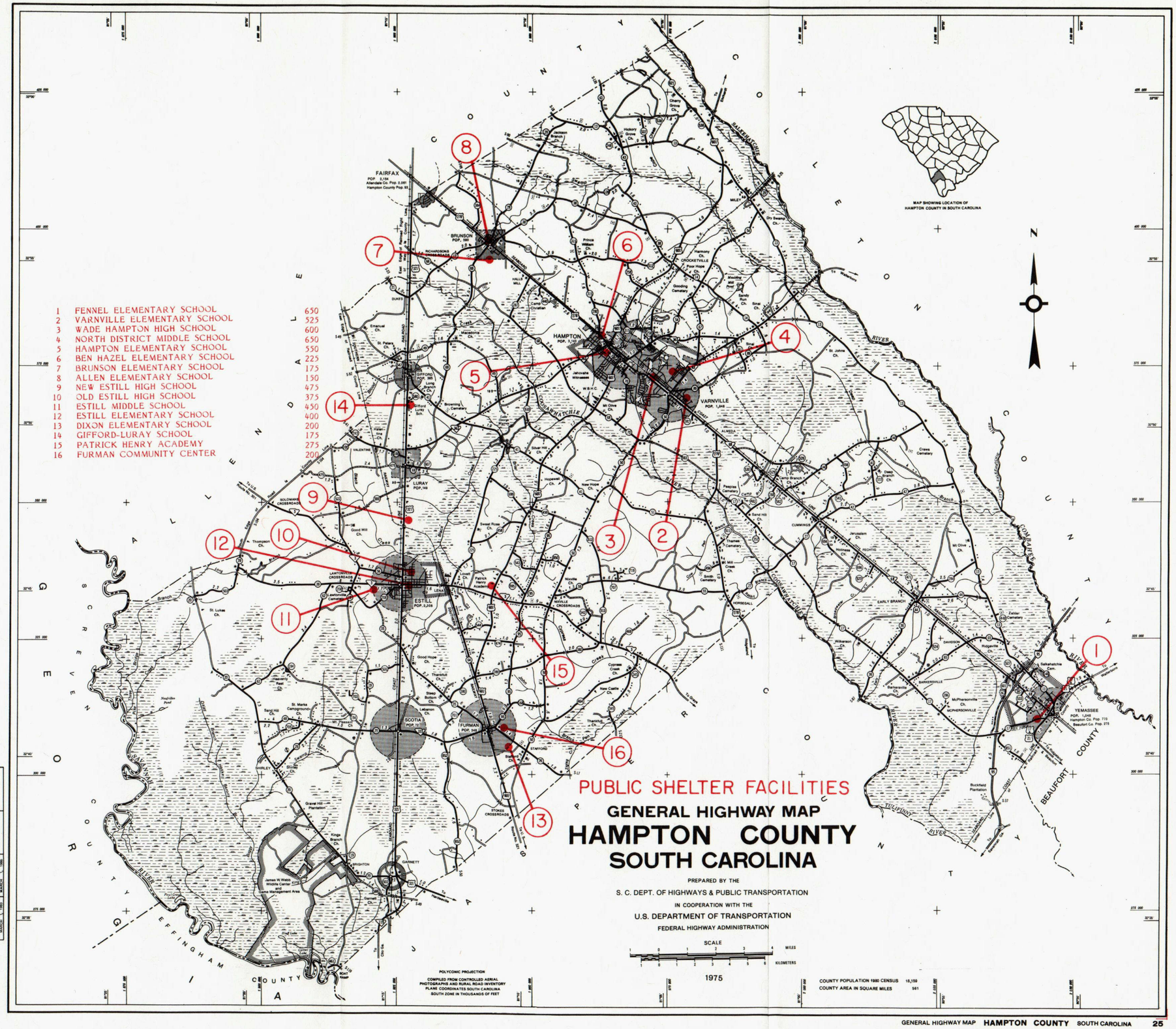
** First floor elevation not established due to facility location away from potential surge inundation areas.

TABLE 4-9 (Cont'd)

PUBLIC SHELTER FACILITIES
HAMPTON COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
14	Gifford-Luray School	175	**	Dry	Dry	Dry	Dry	Dry
15	Patrick Henry Academy	275	**	Dry	Dry	Dry	Dry	Dry
16	Furman Community Center	200	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.



STATE SYSTEM			
COUNTY SYSTEM			

TABLE 4-10

PUBLIC SHELTER FACILITIES
JASPER COUNTY

Map Key	Facility	Capacity	First Floor Elevation (NGVD)	Potential Surge Heights (NGVD)				
				CAT 1	CAT 2	CAT 3	CAT 4	CAT 5
1	Robertsville Community Center	348	**	Dry	Dry	Dry	Dry	Dry
2	Grays School	348	**	Dry	Dry	Dry	Dry	Dry
3	Coosawhatchie Community Center	267	**	Dry	Dry	Dry	Dry	Dry
4	Ridgeland High School	2053	**	Dry	Dry	Dry	Dry	Dry
5	Jasper Middle School	1192	**	Dry	Dry	Dry	Dry	Dry
6	Beaufort-Jasper Career Education Center	2430	23.9	Dry	Dry	Dry	Dry	Dry
7	Hardeeville West High School	700	**	Dry	Dry	Dry	Dry	Dry
8	Hardeeville Elementary School	200	**	Dry	Dry	Dry	Dry	Dry
9	Thomas Heyward Academy	864	**	Dry	Dry	Dry	Dry	Dry

** First floor elevation not established due to facility location away from potential surge inundation areas.

	COMPLETED JULY 1969		
REVISED		REVISED	
STATE SYSTEM	COUNTY SYSTEM	STATE SYSTEM	COUNTY SYSTEM
JULY 1, 1969	JAN. 1, 1969	MARCH 1, 1979	JUNE 1, 1980
OCT. 1, 1970	JAN. 1, 1970	JUNE 1, 1980	APRIL 1, 1981
OCT. 1, 1972	JAN. 1, 1972	APRIL 1, 1981	SEPTEMBER 1, 1982
JUNE 1, 1974	JAN. 1, 1974	SEPTEMBER 1, 1982	NOVEMBER 1, 1983
MAY 1, 1976	JAN. 1, 1976	NOVEMBER 1, 1983	MARCH 1, 1985
JULY 1, 1976	JANUARY 1, 1978	MARCH 1, 1985	
JANUARY 1, 1978	MARCH 1, 1979		

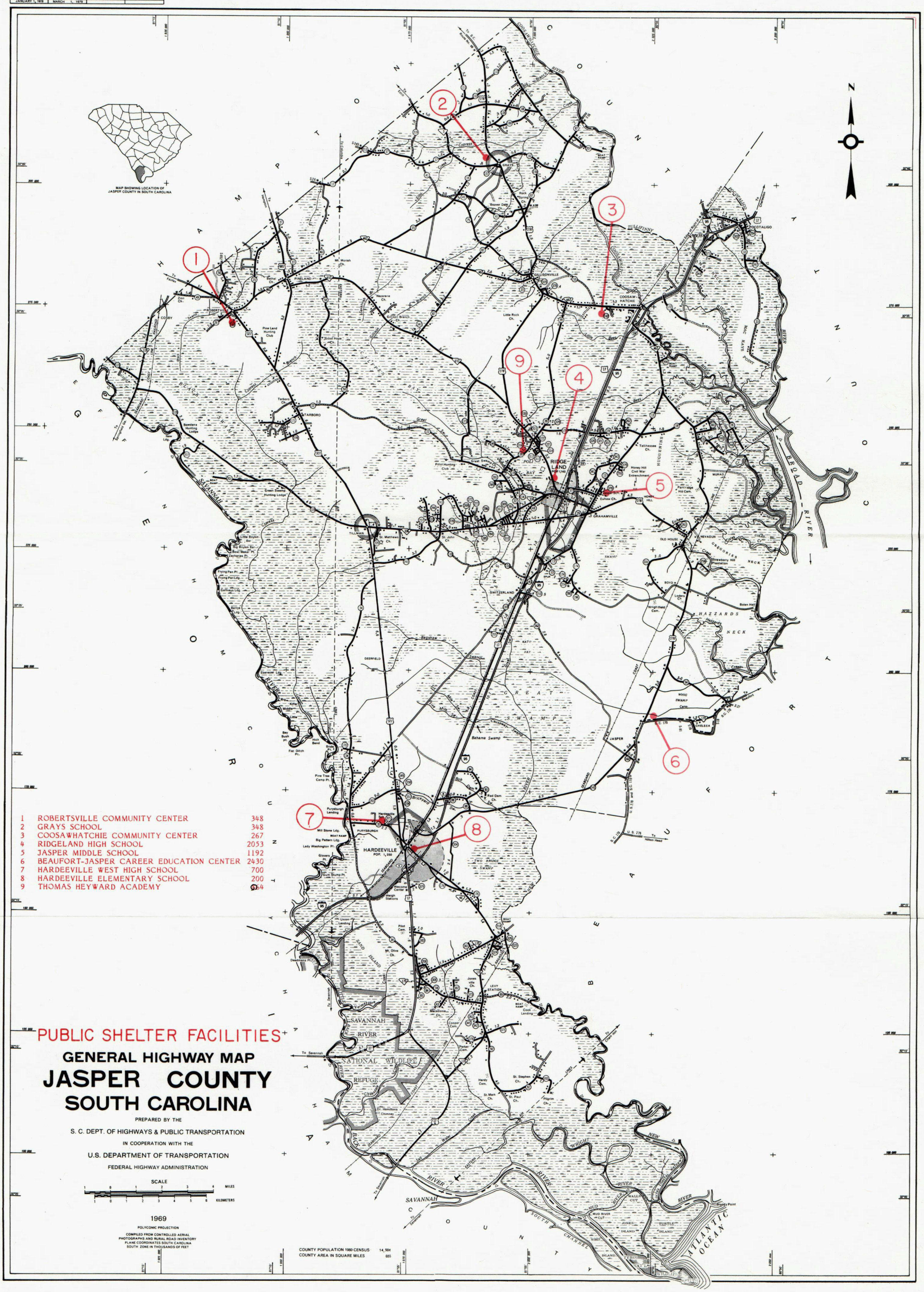

MAP SHOWING LOCATION OF JASPER COUNTY IN SOUTH CAROLINA
1 ROBERTSVILLE COMMUNITY CENTER 348
2 GRAYS SCHOOL 348
3 COOSAWHATCHIE COMMUNITY CENTER 267
4 RIDGELAND HIGH SCHOOL 2053
5 JASPER MIDDLE SCHOOL 1192
6 BEAUFORT-JASPER CAREER EDUCATION CENTER 2430
7 HARDEEVILLE WEST HIGH SCHOOL 700
8 HARDEEVILLE ELEMENTARY SCHOOL 200
9 THOMAS HEYWARD ACADEMY 254
PUBLIC SHELTER FACILITIES
GENERAL HIGHWAY MAP
JASPER COUNTY
SOUTH CAROLINA
PREPARED BY THE
S. C. DEPT. OF HIGHWAYS & PUBLIC TRANSPORTATION
IN COOPERATION WITH THE
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
SCALE
MILES
KILOMETERS
1969
POLYCONIC PROJECTION
COMPILED FROM CONTROLLED AERIAL PHOTOGRAPHS AND RURAL ROAD INVENTORY
PLANE COORDINATES SOUTH CAROLINA SOUTH ZONE IN THOUSANDS OF FEET
COUNTY POPULATION 1980 CENSUS 14,504
COUNTY AREA IN SQUARE MILES 655
N
ROBERTSVILLE
GRAYS
COOSAWHATCHIE
RIDGELAND
HARDEEVILLE
GRAHAMVILLE
TILLMAN
SAVANNAH NATIONAL WILDLIFE REFUGE
ATLANTIC OCEAN
SAVANNAH RIVER
BROAD RIVER
COOSAWHATCHIE RIVER
TULLIFINNY RIVER
POCOTALIGO
JASPER
CHELSEA
HAZZARDS NECK
GREGORIES NECK
HUGUENINS
GREAT SWAMP
Bahama Swamp
SAND ISLAND
JONES ISLAND
TURTLE ISLAND
BIRD ISLAND
SOUTH CHANNEL
WRIGHT RIVER
MUD RIVER
WALL CUT
NEW RIVER
Bloody Point
To Savannah
To Hilton Head
To Charleston
To Beaufort
To Ridgeland
To Hardeeville
To Tillman
To Grahamville
To Coosawhatchie
To Pocotaligo
To Robertsville
To Grays
To Tarboro
To Pineland
To Gillisonville
To Switzerland
To Deerfield
To Jasper
To Chelsea
To Knowles
To Murat
To Nevadun
To Old House
To Honey Hill
To Levy Station
To Cooks Landing
To Purrysburgh
To Purrysburgh Landing
To Mill Stone Ldg.
To Big Pattern Ldg.
To Lady Washington Pt.
To Glovers Pt.
To Gum Stump Pt.
To Deadmans Pt.
To Clyde Bay
To Dr. Hamiltons Chimney
To Clyde Bay
To Ebenezer Ldg.
To Big Killer Pt.
To Middle Pt.
To Little Killer Pt.
To Bay Bush Pt.
To Hick Bend
To Flat Ditch Pt.
To Pine Tree Camp Pt.
To Big Boykin Bar
To Big Boykin Bar
To Bowl Maker Pt.
To Zacharias Pt.
To Frying Pan Pt.
To Frying Pan Ldg.
To Gallways Ldg.
To Berrys Ldg.
To Green Swamp Hunting Lodge
To Bowdens Hunting Lodge
To Springfield
To Savannah
To Tarboro
To Pineland
To Ridgeland
To Grahamville
To Tillman
To Hardeeville
To Robertsville
To Grays
To Coosawhatchie
To Gillisonville
To Pocotaligo
To Jasper
To Chelsea
To Knowles
To Murat
To Nevadun
To Old House
To Honey Hill
To Levy Station
To Cooks Landing
To Charleston
To Beaufort
To Hilton Head
To Savannah
To Savannah
To Savannah

TABLE 4-11

SHELTER DEMAND ASSUMPTIONS AND STATISTICS
GRAND STRAND COUNTIES

County	Behavioral Assumption % of Total Evacuees Going to Public Shelter	Public Shelter Demand (People)*		
		Cat. 1-2	Cat. 3	Cat. 4-5
Horry	20% of people from surge vulnerable areas 70% of mobile home residents from non-surge areas	29,040 - 36,640	32,680 - 40,860	36,530 - 44,700
Georgetown	10% of people from surge-vulnerable areas 70% of mobile home residents from non-surge areas	3,810 - 4,340	4,230 - 4,760	6,280 - 6,810

*Figures are based on 1987 population projections and 100% evacuation of vulnerable areas relating to the Maximum Envelope of Water limits for all hurricane directions and speed. Evacuating people figures include all mobile home residents and a small percentage of people who will evacuate although theoretically not vulnerable. Ranges of numbers are results of different storm scenarios and varying occupancy of tourist units.

TABLE 4-12

SHELTER DEMAND ASSUMPTIONS AND STATISTICS
LOWER COAST COUNTIES

County	Behavioral Assumption % of Total Evacuees Going to Public Shelter	Public Shelter Demand (People)*		
		Cat. 1-2	Cat. 3	Cat. 4-5
Beaufort	15% of evacuees from beachfront, and riverfront surge vulnerable areas 20% of evacuees from other surge vulnerable areas 10% of evacuees from Daufuskie/ Hilton Head surge vulnerable areas 30% of evacuees from Beaufort surge vulnerable areas 65% of evacuees from St. Helena Island surge vulnerable areas 60% of mobile home residents from non-surge areas	7,350 - 12,210	11,790 - 15,530	13,550 - 17,280
Berkeley **	25% of evacuees from surge vulnerable areas 40% of mobile home residents from non-surge areas	8,590	8,590	10,010(1)
Charleston	10% of evacuees from beachfront, and riverfront surge vulnerable areas 20% of evacuees from other surge vulnerable areas 5% of evacuees from Kiawah/Isle of Palms surge vulnerable areas 35% of East Charleston surge vulnerable areas 50% of mobile home residents from non-surge areas	16,350 - 25,210	44,720 - 46,030	57,470 - 58,760

(1)Plus additional 5,000 from Charleston
**Demand figures will be revised in an addendum to the Technical Date Report.

TABLE 4-12 (continued)

SHELTER DEMAND ASSUMPTIONS AND STATISTICS
LOWER COAST COUNTIES

County	Behavioral Assumption % of Total Evacuees Going to Public Shelter	Public Shelter Demand (People)*		
		Cat. 1-2	Cat. 3	Cat. 4-5
Colleton**	25% of evacuees from surge vulnerable areas 5% of Edisto Beach evacuees 50% of mobile home residents from non-surge areas	2,990 - 3,250	3,070 - 3,340	3,070 - 3,340
Dorchester	25% of evacuees from surge vulnerable areas 30% of mobile home residents from non-surge areas	4,300	4,300	4,300 (2)
Hampton	25% of mobile home residents	550	550	550* (3)
Jasper	25% of evacuees from surge vulnerable areas 25% of mobile home residents from non-surge areas	1,220	2,040	2,040* (4)

*Figures are based on 1987 population projections and 100% evacuation of vulnerable areas relating to the Maximum Envelope of Water limits for all hurricane directions and speed. Evacuating people figures include all mobile home residents and a small percentage of people who will evacuate although theoretically not vulnerable. Ranges of numbers are results of different storm scenarios and varying occupancy of tourist units.

**Demand figures will be revised in an addendum to the Technical Date Report as noted previously.

(2)Plus additional 4,000-12,000 from Charleston; (3)Plus additional 3,000 from Beaufort;
(4)Plus additional from Beaufort.

CHAPTER FIVE

BEHAVIORAL ANALYSIS

I. PURPOSE

The purpose of the behavioral analysis is to determine the response of the threatened population to a hurricane threat. The response of the threatened population refers to the percentages of persons in specific locations which can be expected to evacuate; when they will evacuate relative to an evacuation order or advisory; where they will go for shelter; and additional behavioral data which were utilized in conducting other analyses for the study.

II. OBJECTIVES

The major objective of the South Carolina Hurricane Evacuation Study behavioral analysis was to provide public evacuee response data for use in the shelter analysis, transportation analysis and for guidance in emergency decision-making and public awareness efforts. The specific objectives of the behavioral analysis were to determine the following:

A. The percentages of the affected and non-affected population that will evacuate under a range of hurricane threat situations or in response to given evacuation orders or advisories. The affected population refers to those persons residing near the coastline, the shorelines of bays, or in areas of low elevation near those locations. The affected population also refers to those persons residing in mobile homes or substandard housing which may be at risk from the winds associated with a hurricane.

The non-affected population is considered to be those individuals who are not threatened by storm surge or freshwater flooding and have substantial housing affording protection against winds of intensities expected to occur during a hurricane. It is known that certain percentages of these individuals evacuate along with the vulnerable population and contribute to the evacuating traffic and shelter demand during a hurricane evacuation.

B. When the evacuating population will leave in relation to a given evacuation order or advisory by local officials or other persons of authority.

C. The number of vehicles that the evacuating population will utilize during a hurricane evacuation.

D. The percentage of the total number of evacuating vehicles which may be towing boats, camper trailers or other vehicular equipment.

E. The probable destinations of the evacuating households. These data consist of percentages of the total number of evacuees utilizing public shelter locally, staying locally with friends or relatives, staying locally in a hotel/motel, or leaving the county for out-of-region destinations.

F. How the threatened population will respond based upon forecasts of hurricane intensity, probability, or other forecast information provided during a hurricane emergency.

G. The evacuation response of tourists.

III. DATA SOURCES

Several data sources were utilized for the South Carolina Hurricane Evacuation Study behavioral analysis. These data sources are as follows:

A. Surveys.

Telephone and personal surveys of area residents were conducted to investigate likely evacuation responses under a variety of hurricane threat situations. Telephone surveys were conducted in all the selected areas except on St. Helena Island and some in the Myrtle Beach area where personal interviews were utilized. The interview questionnaires conformed to the specific objectives to be accomplished by the study and addressed the respondents' actions in past hurricane threats. The questionnaires used in the surveys are contained in Appendix 3, Behavioral Analyses, to this Technical Data Report. The purpose of the interviews was to investigate residents' anticipated response during hurricane threats and to develop data from the lower risk areas not included in post-hurricane response studies.

Two behavioral analyses were conducted for the South Carolina Hurricane Evacuation Study. The Grand Strand analysis encompassed selected areas of Georgetown and Horry counties. The Lower Coast analysis included selected areas in the seven counties of Beaufort, Berkeley, Dorchester, Charleston, Colleton, Hampton, and Jasper. Detailed results of these analyses can be found in Appendix 3, Behavioral Analyses, to this report. Selected areas and number of interviews are as follows:

GRAND STRAND REGION

1. 200 residents in the Georgetown and Myrtle Beach areas (100 in each area) were questioned as to what they would do during a hurricane threat.

2. About 80% of the same interviewees were questioned as to what they did during the Diana storm (September 1984). Also, seven of the largest campground operators were asked about the campers' response to Diana.

3. 150 vacationers in the Myrtle Beach area (half face-to-face, half by telephone) were asked what they would do during a hurricane threat.

4. Questionnaires were mailed to about 400 members of the Hotel/Motel Association in the Grand Strand area.

In practical terms, the samples of 100 employed in most of the surveys in South Carolina yield population value estimates which one can be 90% "sure" are within 5 to 8 percentage points of the figures which would have been obtained if interviews had been conducted with everyone in the population from which samples

were taken. For example, if it is found that 80% of the Myrtle Beach sample evacuated in Diana, we can be 90% "sure" that 80% + or - 8% (i.e., 72% to 88%) of all Myrtle Beach residents evacuated.

LOWER COAST REGION

1. In the Charleston area, about 75 telephone interviews were conducted west of the Ashley River and the same number on the peninsula asking residents what they would do during a hurricane threat.

2. 100 residents in the city of Beaufort were questioned as to their hypothetical response to a threat.

3. 148 door-to-door interviews were conducted on St. Helena Island asking what they would do if they were threatened by a hurricane.

The estimates made from samples in the St. Helena Island and Charleston areas are 90% confident they are accurate within 4 to 7 percentage points. In the Beaufort sample, the estimate is 90% confident they are accurate within 5 to 8 percentage points. Were the Charleston sample halved (peninsula and west of the Ashley), the estimates for each is 90% accurate within 6 to 10 percentage points. For example, if post-hurricane sample results indicate that 80% evacuated say Charleston, it is 90% sure that 80% + or - 10% (70% to 90%) of all Charleston residents evacuated.

B. Other Hypothetical Surveys.

Several thousand interviews comparable to those conducted for this study have been conducted as parts of hurricane evacuation studies in other areas. Most of those studies have been reviewed and generalizations made about their findings for comparison to the South Carolina study.

C. Post-Hurricane Response Studies.

The most reliable behavioral forecasts concerning how the public will respond to hurricane threats are made by examining the patterns of past hurricane response, including the reasons for variations in responses from place to place and from storm to storm.

A national model has been developed to predict most public responses. This model is based on carefully and systematically documented studies of how the public responded in approximately 18 past hurricane threats dating to Carla in 1961 and including Diana in 1984 in South Carolina. The database upon which the model is constructed includes threats in Texas, Louisiana, Mississippi, Alabama, several areas of Florida, South Carolina, and North Carolina. The list of studies is large enough that a number of clear conclusions can be drawn about behavioral tendencies in a variety of hurricane threat situations. Although the studies show social variations from place to place, there are greater variations in public response between differing hurricane threats in the same location than there are between similar events in differing locations. Moreover, attempts to detect response differences along socioeconomic lines among residents of a given

location have generally turned up very little. These findings permit considerable confidence in the ability to generalize to one location from the experiences in another.

IV. ANALYSIS RESULTS

A. General.

The following paragraphs address each of the specific objectives established for the behavioral analysis and present generalized results for each objective. More detailed results are contained in Appendix 3, Behavioral Analyses, to this Technical Data Report.

B. Evacuation Participation Rates.

Evacuation participation rates refer to the percentages of residents in high, moderate, and low risk areas that can be expected to evacuate under varying hurricane threats. Post-hurricane response studies indicate that a great amount of variation has occurred in evacuation participation from place-to-place in the same event as well as from storm-to-storm in the same location. However, generalizations can be drawn from the existing data from historic storms as well as from the sample surveys conducted for the study.

In the high-risk areas of South Carolina - especially beachfront areas - the evacuation rate will be over 90% if major efforts are made to get word to those residents that they should leave, particularly if any order is issued or if the advisory is very strongly worded and the message is disseminated relatively personally. Rates closer to 80% will probably result in moderately severe storms if only moderate efforts are made to get people to leave. These figures would apply to the Myrtle Beach area east of Highway 17.

In moderate-risk areas - low-lying but several blocks from the open coast or near inlets and other water bodies - the evacuation rate will be around 60% if slight to moderate efforts are made to evacuate the areas and up to 80% or 85% if serious efforts are made. This is a risk area which probably merits closer attention from public officials during a threat in the future than they have generally received in the past. These figures would apply to the higher risk areas of Georgetown to parts of the Myrtle Beach area west of Highway 17.

Low-risk areas will evacuate significantly less than high-risk areas, and the extent will depend upon how low the risk is (40 feet elevation vs. 20 feet, for example), how distant the area is from high-risk areas where evacuation is occurring, whether the storm is expected to affect the area, and how substantial the construction is believed to be in the areas. The latter point could be correlated with socioeconomic characteristics of the area. Given the most likely warning scenario, a rate of 20% for the lowest risk areas of coastal communities and 40% for the "highest of the low risk" would apply.

C. Evacuee Response Rates.

Evacuee response rates refer to the timing of evacuation by the threatened population or when the evacuating residents will leave relative to a given evacuation order or advisory. These rates are expressed as cumulative percentages of the total number of evacuees evacuating at time intervals preceding and following an evacuation order or advisory. Evacuation response rates for hurricane evacuations are shown graphically as evacuation response curves in Figure 6-11, page 6-26.

Post-hurricane response studies show a diversity of slopes and shapes inherent in the response curves. This diversity can be primarily attributed to factors such as action by local officials, severity of the threatening hurricane, residents' perception of the probability of the hurricane striking their location, and the evacuation difficulties for their location. The primary factor consistent with most of the historic response curves is the sharp increase in evacuation response following the advice of local officials to evacuate. These increases in evacuation response following local advisements or orders show consistency regardless of location, relative magnitude of the threat, or information previously furnished to the threatened population in the form of hurricane watches, warnings, or other meteorological information.

D. Destinations of Evacuating Households.

The destinations or types of refuge most commonly utilized by the evacuating population are local public shelter facilities, local friends or relatives, local hotels/motels, or out-of-county locations. Significant variation in the percentages of persons utilizing various types of refuge can occur. Historically this has occurred from storm to storm as well as from location to location. Based upon surveys made on hypothetical and post-storm responses and the array of historical response data available, Table 5-1 shows the average percentages of evacuees utilizing the various types of refuge within the South Carolina Hurricane Evacuation Study area.

TABLE 5-1

EVACUEE PERCENTAGE OF REFUGE TYPE

GRAND STRAND REGION

Location	Local Public Shelters	Hotel/Motel	Friend/Relative/ Out-Of-County
Myrtle Beach	20%	15%	65%
Georgetown	25%	5%	70%

LOWER COAST REGION

Location	Local Public Shelters	Hotel/Motel	Friend/Relative/ Out-Of-County
Charleston Peninsula	30% to 35%	10%	55% to 60%
West Ashley	15%	18%	67%
Beaufort	15%	12%	73%
St. Helena Island	45% to 50%	10%	40% to 45%

The percentages listed above are considered to be good averages that may occur under the majority of hurricane threats; however, wide variation in these percentages have occurred on a locational as well as a storm threat basis. This variation probably has much to do with the severity of the storm and the fact that many evacuees decide late to leave and have insufficient time to reach other destinations.

The actions of local officials can greatly influence the sheltering rates within a county. If, for example, public shelters are opened early and advertised, the public shelter use rates will most likely be significantly higher than for areas where the public is strongly advised to leave the county or where shelter locations and availability are not widely publicized.

Generally, persons living in areas of high vulnerability near the coastline tend to utilize public shelter less than persons residing in more inland locations. This is probably attributable to the fact that in the South Carolina Hurricane Evacuation Study area, persons residing near the water tend to have higher personal income and are thereby able to afford out of county accommodations more readily. Also, persons living in the more vulnerable locations usually evacuate earlier than those of less vulnerable areas and have sufficient time to seek out-of-county refuge.

E. Evacuation Response of Tourists.

Very little research has been conducted and no historical information is available concerning tourists' response to a hurricane evacuation. Some hypothetical surveys have been conducted, however, results are not conclusive. There is no data to indicate that tourists' response to a hurricane threat varies significantly from that of the permanent resident population.

The vast majority (70% to 80%) of vacationers in the Grand Strand area will return to their homes in response to a hurricane threat. About 10% of vacationers will seek public shelter and about the same number will find a hotel or

motel in a nearby safe location. A small percentage will continue vacation plans to another location if storm conditions, track, and location permit.

The same approximate percentages apply to the Lower Coast area except that instead of returning home, many vacationers in the Hilton Head area will attempt to travel further south toward their pre-planned destination. Also, fly-ins to Hilton Head, especially for conventions, pose the problem of inadequate ground and air transportation to evacuate everyone at once.

Assumptions concerning the actions of tourists should take into account such considerations as distance tourists have traveled to reach a particular area, mode of travel, and likely actions by hotel/motel managers or local officials.

F. Vehicle Use.

Vehicle use is necessary for transportation modeling in three primary ways. Estimates are needed of the number of total vehicles which will be on the evacuation routes, rather than simply the number of evacuees. This section provides a number of vehicles per evacuating household. Estimates of the number of motorhomes are needed because they pose special traffic flow and safety problems. Estimates of the number of trailers are needed for the same reasons.

The number of vehicles used per evacuating household was developed primarily from the telephone and face-to-face behavioral interviews, surveys of other areas, and, apparently for the first time, a post-storm survey after Diana.

Results show that 70 to 75% of available vehicles would be used in the Grand Strand Region. Six percent in the Myrtle Beach areas and four percent in the Georgetown areas would take motor homes and one percent in both locations would take trailers.

In the Lower Coast Region, figures indicate that residents plan to take about 65% of the available vehicles. Not all vehicles are used in an evacuation due to the unwillingness to separate the family.

From a policy standpoint the most important revelation is that 12% of the Charleston sample anticipates using some form of public transportation, and another 12% don't know how they will reach their destinations. Almost 20% of the St. Helena respondents anticipate riding with friends or relatives.

In east Charleston two percent of the respondents said they would be pulling a trailer when they evacuated, compared to six percent in west Ashley, two percent in Beaufort, and six percent on St. Helena. No one in the Charleston peninsula or Beaufort samples said they would be taking a motorhome, but three percent west Ashley and five percent on St. Helena said they would.

The Charleston peninsula and St. Helena have the highest incidence of people not expecting to take any vehicles at all. St. Helena, however, also had the highest incidence of people planning to take two or more cars, possibly because of the greater perceived risk of leaving vehicles behind.

Care should be taken to assess whether some locations have an unusual number of motorhomes and trailers. While not a major problem overall, it could be locally.

CHAPTER SIX

TRANSPORTATION ANALYSIS

I. PURPOSE

During a hurricane evacuation effort, it is widely recognized that a large number of vehicles have to be moved across a road network in a relatively short period of time. The number of vehicles and evacuees becomes particularly significant for an area such as the South Carolina coast, where at least three major urban areas and many barrier island communities are located. The magnitude of evacuating vehicles varies depending upon the intensity of the hurricane, direction of approach, presence of tourists, and certain behavioral response characteristics of the vulnerable population.

Vehicles enter the road network at different times depending on the evacuees' response relative to an evacuation order or advisory. Conversely, vehicles leave the road network depending on both the planned destinations of evacuees and the availability of acceptable destinations such as public shelters, hotel/motel units and friends' or relatives' homes in non-flooded areas. Vehicles move across the road network from trip origin to destination at a speed dependent on the traffic loadings on various roadway segments and the ability of the segments to handle a certain volume of vehicles each hour.

The overall goals of the transportation analysis performed for the South Carolina Hurricane Evacuation Study were to estimate clearance times (the time it takes to clear a county's roadways of all evacuating vehicles), to define the evacuation road network, and to look at general traffic control measures that could improve traffic flow along critical roadway segments. Clearance time is a value resulting from transportation engineering analysis performed under a specific set of assumptions. It must be coupled with pre-landfall hazards time to derive overall evacuation order time (the time before hurricane eye landfall at which the evacuation order must be issued to allow all evacuees time to reach safe shelter before the arrival of sustained gale force winds). Factors that influence clearance time and thus overall evacuation order time must be studies intensively to determine which factors have the strongest influence. Therefore, a sensitivity analysis was performed and approximately 36 clearance times calculated for each county by varying key input parameters. In Beaufort County, over 70 clearance times were calculated due to that county's unique geography and vulnerability to hurricanes.

The transportation analysis task initially identified the kinds of traffic movements associated with a hurricane evacuation that must be considered in the development of clearance times. Basic assumptions for the transportation analysis were then developed related to storm scenarios, population-at-risk, behavioral and socioeconomic characteristics, the roadway system and traffic control. A transportation modeling methodology and a roadway system representation were developed for each county in the study area to facilitate model application and development of clearance times. General information and data related to the transportation analysis are presented in summary form in the Technical Data Report. A Transportation Analysis Documentation Appendix is

available through the Charleston District Corps of Engineers and includes a detailed account of all transportation analysis activities and zone by zone data listings for each county.

II. EVACUATION TRAVEL PATTERNS

Traffic movements associated with hurricane evacuation have been identified for the purposes of this analysis by five general patterns:

A. In-County Origins to In-County Destinations.

Trips made from storm surge vulnerable areas, mobile home units, and historically heavy rain flooded areas in an individual county to destinations within the same county, such as public shelters, hotel and motel units, and friends or relatives outside the storm surge vulnerable areas.

B. In-County Origins to Out-of-County Destinations.

Trips made as in category A that originate in an individual county, but have destinations in other counties of the study area or outside the study area entirely.

C. Out-of-County Origins to In-County Destinations.

Trips made as in category A that enter an individual county from other counties in the study area.

D. Out-of-County Origins to Out-of-County Destinations.

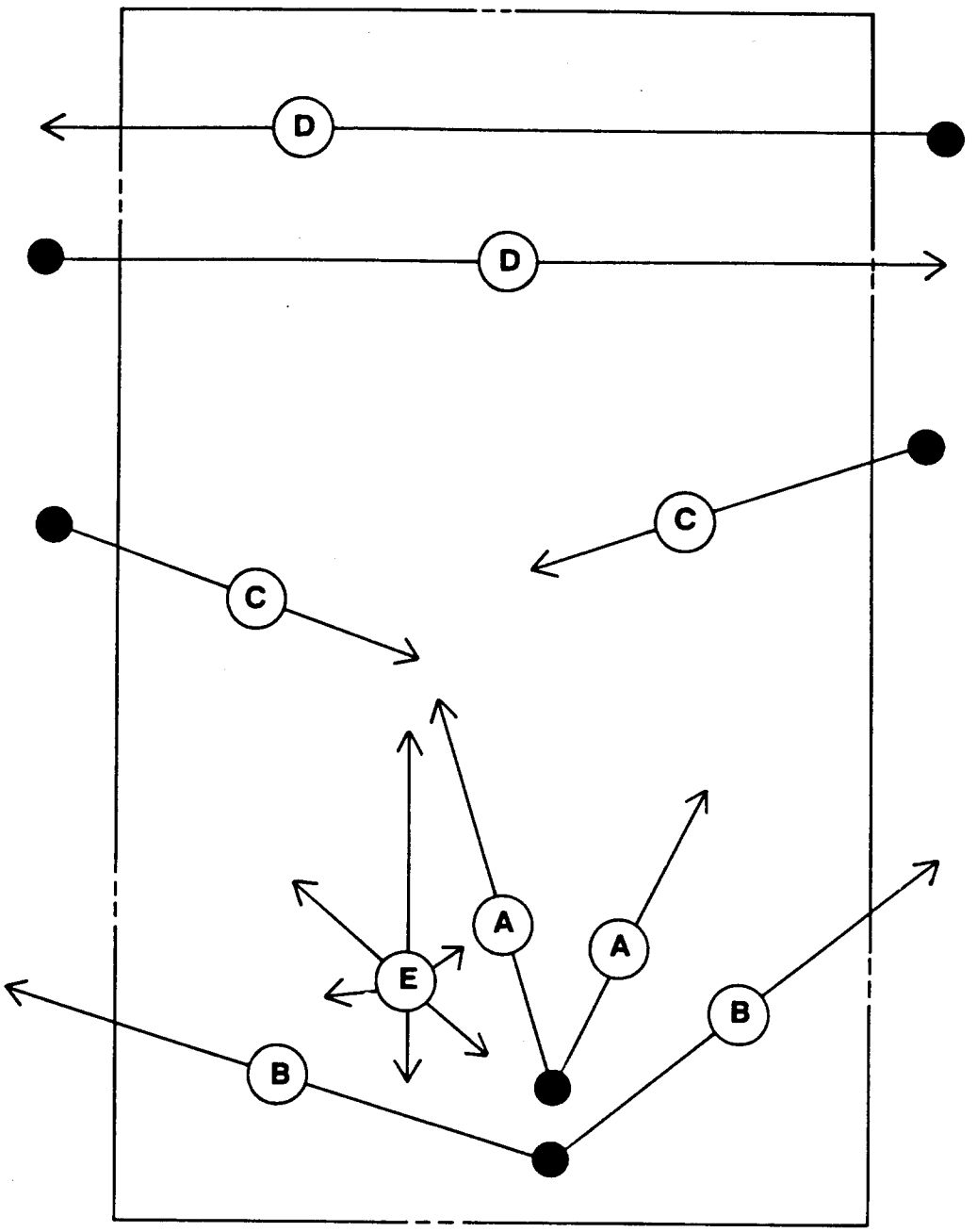
Trips passing through an individual county while traveling from another county in the study area to either another county or outside the study area entirely.

E. Background Traffic.

Trips made by persons preparing for the arrival of hurricane conditions; these trips may be shopping trips to gather supplies and/or trips from work to home to assist the family in evacuation. This traffic also includes transit vehicles (buses) used to pick up evacuees without personal transportation.

Figure 6-1, Evacuation Travel Patterns, graphically depicts these traffic movement patterns associated with hurricane evacuation situations in South Carolina. It is important to recognize that three of the five defined patterns involve traffic movement patterns generated outside one county's boundaries. It is evident that, depending on the assumed storm track, these inter-county movements result in a number of regional traffic impacts. During the transportation analysis task, these movements were quantified to facilitate estimation of demand for roadway segments and resulting clearance times.

EVACUATION TRAVEL PATTERNS



ATLANTIC OCEAN

A IN-COUNTY ORIGINS TO IN-COUNTY DESTINATIONS
B IN-COUNTY ORIGINS TO OUT-OF-COUNTY DESTINATIONS
C OUT-OF-COUNTY ORIGINS TO IN-COUNTY DESTINATIONS
D OUT-OF-COUNTY ORIGINS TO OUT-OF-COUNTY DESTINATIONS
E BACKGROUND TRAFFIC

FIGURE 6-1

III. TRANSPORTATION ANALYSIS INPUT ASSUMPTIONS

Since all hurricanes differ from one another in some respect, it becomes necessary to set forth clear assumptions about storm characteristics and evacuees' expected response before transportation modeling can begin. Not only does a storm vary in its track, intensity and size, but also in the way it is perceived by residents in potentially vulnerable areas. These factors cause a wide variance in the behavior of the vulnerable population. Even the time of day at which a storm makes landfall influences the time parameters of an evacuation response.

The transportation analysis results in clearance times based on a set of assumed conditions and behavioral responses. It is not only likely, but almost certain that an actual storm will differ from an simulated storm for which clearance times are calculated in this report. Therefore, a sensitivity analysis was performed during the transportation modeling. Those variables having the greatest influence on clearance time were identified and then varied to establish the logical range within which the actual input assumption values might fall.

Key assumptions guiding the transportation analysis are grouped into five area:

A. Permanent and Tourist Population Data
B. Storm Scenarios
C. Evacuation Zones
D. Behavioral Characteristics of the Evacuating Population
E. Roadway network and traffic Control Assumptions.

These five areas and their assumed parameters are described in the following paragraphs. Those parameters which were varied for sensitivity analysis are noted.

A. Permanent and Tourist Population Data.

A data base for each county was initially developed using 1987 census projections provided by the Charleston District Corps of Engineers. Data was then supplemented with traffic analysis zonal data obtained from the Metropolitan Planning Organization for each urbanized area and from the applicable urban area transportation study. These sources of data provided a reliable base for permanent population parameters on a sub-county basis. Census tract estimates and traffic analysis zonal estimates of population and dwelling unit data often provide a check on each other for reliability. Since data is regularly updated for each of these geographic units, their use provides a means to facilitate updating of the evacuation study in the future.

To develop a data base regarding tourist related dwelling units and population, PBS&J contacted many different agencies and associations both in the Grand Strand area (Horry, Georgetown Counties) and the Lower Coast area (Beaufort, Berkeley, Charleston, Colleton, Dorchester, Hampton, and Jasper Counties). State, regional and local planning agencies, travel bureaus, trade associations

and chanbers of commerce were either visited or telephoned to establish population and dwelling unit parameters for the tourist population. Key data sources used in developing tourist as well as permanent population statistics are listed below:

* South Carolina State Data Center - Division of Research and Statistical Services

* South Carolina Department of Highways and Public Transportation

* U.S. Army Corps of Engineers, Charleston District Hydraulics and Flood Plain Management Branch

* Waccamaw Regional Planning and Development Council (The Grand Strand Tourist Accommodations Study, September 1985)

* Town of Hilton Head Island, South Carolina

* Beaufort County Joint Planning Commission

* Berkeley-Charleston-Dorchester Council of Governments (Charleston Area Transportation Study)

* Wilbur Smith and Associates (Transportation Element of the Comprehensive Plan, Hilton Head Island, South Carolina, October 1985)

* Horry County Planning Commission

* Post, Buckley, Schuh & Jernigan, Inc. (Interstate 95 to U.S. 17 Near Myrtle Beach Corridor Feasibility Study, December 1984)

* Grand Strand Area Transportation Study

As can be seen in Table 6-1, Projected Permanent Population by County, current permanent population estimates range from 15,700 in Jasper County to 294,800 people in Charleston County. It is projected that in 1987 (the base year for the transportation analysis) population will range from 16,300 in Jasper County to 300,120 people in Charleston County. In the Grand Strand area, the 1987 projected permanent population for Horry County is 138,920 people. However, with the rapid building and development of seasonal/tourist dwelling units, one must add a large seasonal population figure to the permanent population to get a true picture of how many people could be in Horry County at the time of an approaching hurricane. The largest percentage increase in population growth has occurred in Beaufort County where the rapid development of Hilton Head Island and other nearby resort areas have contributed significantly.

TABLE 6-1

PROJECTED PERMANENT POPULATION BY COUNTY

County	1970 Population	1980 Population	1985 Estimated Population	1990 Projected Population	1987 Interpolated Population	% Increase 1970-1980	% Increase 1980-1987
Grand Strand Counties							
Georgetown	33,500	42,461	47,500	53,100	49,740	26.8%	17.1%
Horry	69,992	101,419	127,000	156,800	138,920	44.9	37.0
Lower Coast Counties							
Beaufort	51,136	65,364	83,800	104,900	92,240	27.8	41.1
Berkeley	56,199	94,727	117,700	144,000	128,220	68.6	35.4
Charleston	247,650	276,712	294,800	308,100	300,120	11.7	8.5
Colleton	27,622	31,776	34,300	36,800	35,300	15.0	11.1
Dorchester	32,276	59,023	74,300	92,900	81,740	82.9	38.5
Hampton	15,878	18,159	19,200	20,000	19,520	14.4	7.5
Jasper	11,885	14,504	15,700	17,200	16,300	22.0	12.4

Source: South Carolina Division of Research and Statistical Services
1985 South Carolina Statistical Abstract. Columbia
South Carolina Division of Reserach and Statistical Services
Population Projections for South Carolina by County 1985 - 2010.

Table 6-2, 1987 Projected Permanent and Tourist/Seasonal Dwelling Unit Data, lists the 1987 total number of permanent and tourist dwelling units estimated for each county in the study area. Charleston and Horry Counties have the largest number of permanent dwelling units, which Beaufort and Horry Counties have the largest estimated number of tourist related units. All of the counties have a significant number of mobile home units which could be vulnerable to the high winds of a hurricane. Because of the large number of tourist units being constructed year to year in the coastal areas of South Carolina, any update of technical data should include a careful look at these figures. (An addendum to the Technical Data Report will be prepared incorporating revised mobile home dwelling unit figures provided by each county.)

TABLE 6-2

1987 PROJECTED PERMANENT AND TOURIST/SEASONAL DWELLING UNIT DATA

County	Number of Dwelling Units		
	Total Permanent[1]	Mobile Homes	Tourist/Seasonal[2]
Grand Strand Counties			
Georgetown	17,047	2,674	3,275
Horry	55,384	8,436	46,707
Lower Coast Counties			
Beaufort	29,282	4,823	18,801
Berkeley	42,142	6,499	700
Charleston	105,288	8,466	4,650
Colleton	12,354	1,487	486
Dorchester	27,998	3,089	200
Hampton	7,127	654	100
Jasper	5,836	710	1,400

1 Includes year-round housing units and mobile homes.

2 Includes seasonal and tourist related condominiums, time share units, and hotel/motel units.

In addition to number of dwelling units, data was gathered concerning number of people and number of vehicles per dwelling unit. This data was crucial to translating hurricane vulnerable housing units to vehicle demand for roadways and people demand for shelter. Based on 1980 census data, the number of people per permanent dwelling unit ranged from 2.43 in Beaufort County to 3.04 in Berkeley County. The number of vehicles per permanent dwelling unit ranged from 1.45 in Charleston to 1.75 in Dorchester County.

Although data obtained from state travel and tourism bureaus was scarce, the data indicated an average of approximately 2.5 people per tourist unit throughout the study area. This figure fluctuates relative to the occurrence of "family vacation season" versus retired couples or golf holiday vacation seasons. In Georgetown County beach areas, this figure can be as much as an average of 2.8 people per tourist unit due to fraternity and sorority "house parties." Although data is sketchy concerning number of vehicles per tourist

unit, an assumption was made that approximately 10% of the tourist parties would have more than one vehicle. In Beaufort County, this figure was reduced for Hilton Head Island to account for convention visitors without autos. Table 6-3, Key Population Parameters, summarizes all key population and vehicle parameters used in the transportation analysis.

TABLE 6-3

KEY POPULATION PARAMETERS

County	Number of People Per		Number of Vehicles Per	
	Permanent Unit[1]	Tourist Unit	Permanent Unit[1]	Tourist Unit
Grand Strand Counties				
Georgetown	2.98	2.50	1.60	1.10
Horry	2.54	2.50	1.62	1.10
Lower Coast Counties				
Beaufort	2.43*	2.50	1.55	1.10**
Berkeley	3.04	2.50	1.70	1.10
Charleston	2.80	2.50	1.45***	1.10
Colleton	2.76	2.50	1.55	1.10
Dorchester	2.92	2.50	1.75	1.10
Hampton	2.74	2.50	1.46	1.10
Jasper	2.79	2.50	1.49	1.10

[1]Includes occupied and unoccupied dwelling units.

*2.39 Used for Hilton Head; 3.10 used for St. Helena Island
**0.94 Used for Hilton Head Island and Daufuskie Island
***1.06 Used in east Charleston

B. Storm Scenarios.

The hazards analysis identified those storm tracks causing the worst possible and probable storm surge in each county of the study area for each of five hurricane intensity categories (corresponding to the Saffir-Simpson scale). When five storm intensities are factored by several varying behavioral parameters, the number of hypothetical hurricane situations can quickly reach 100 to 200. Calculation of clearance times for this many storm situations would be cumbersome and unusable by local emergency preparedness officials and would be inappropriate given the relative level of accuracy of hurricane storm forecasting. Storm forecasting for the period 12 to 24 hours prior to eye landfall is generally not precise enough to allow for more than 2 to 3 storm scenarios (grouping by intensity) per county. However, due to the unique geography of Beaufort and Charleston Counties, four storm scenarios were developed and are presented below.

Census tracts and traffic analysis zones (where appropriate) were mapped and then overlaid with storm surge limits corresponding to the five hurricane categories. This procedure identified where major differences in storm surge limits and number of vulnerable population exist relative to each progressive step in hurricane intensity. Table 6-4, Transportation Analysis Storm Scenarios, provides the storm scenarios developed in the transportation analysis for each county.

TABLE 6-4

TRANSPORTATION ANALYSIS STORM SCENARIO

County	Storm Scenario	Saffir-Simpson Category
Grand Strand Counties		
Georgetown	A	1-2
	B	3
	C	4-5
Horry	A	1-2
	B	3
	C	4-5
Lower Coast Counties		
Beaufort	A	1
	B	2
	C	3
	D	4-5
Berkeley	A	1-3
	B	4-5
Charleston	A	Weak 1
	B	1-2
	C	3
	D	4-5
Colleton	A	1-2
	B	3-5
Dorchester	A	1-5
Hampton	A	1-5
Jasper	A	1-2
	B	3-5

C. Evacuation Zones.

Through the hazards analysis, those areas which will receive hurricane storm surge were identified and graphically shown on the MEOW maps. This information became one of the key inputs to the transportation analysis. Those residents who must evacuate as well as those residents who should not evacuate were defined.

Within the transportation analysis it was assumed that all persons living in areas flooded by storm surge should be evacuated. This evacuee group included permanent residents living in single-family, multi-family, or mobile home units, as well as tourists staying in hotel/motel, condominium, and time share units located in storm surge vulnerable areas. In addition, all mobile home residents living outside the hurricane flooded areas of each county were assumed to evacuate due to high wind vulnerability. A final group of residents included in the evacuating population of each county consisted of persons living in areas that historically flood due to heavy rainfall or major areas of substandard housing. These areas of concern were identified by local emergency management officials.

Having established those persons who should evacuate during a particular storm situation, it was then necessary to develop a series of zones to geographically locate and quantify the vulnerable population. Evacuation zones also provide a base to model traffic movements from one geographic area to another. A series of zones was established for each county based on the following factors:

* Zones should relate to expected surge flooding limits (based on MEOWs) for each storm scenario.

* Zones should relate well to census, traffic analysis zone, or other data base unit.

* Zones should be set up, if possible, for ease of use in issuing an evacuation order or advisory.

* Zonal boundaries should include identifiable natural features, roadways, landmarks, et.

* Rural counties should have no more than 20 zones and counties with major urban areas should have no more than 35 zones. (This rule of thumb was unachievable in Beaufort and Charleston Counties due to geography.)

* Small "pocket" zones that would be isolated by surrounding surge should be avoided.

* Zones should be able to be served by major evacuation routes.

* Zones should have relatively balanced population levels.

* Zones must allow for appropriate transportation modeling.

Table 6-5, Transportation Analysis Evacuation Zones - Assumed Vulnerability by Storm Scenario and County, provides the number of evacuation zones for the transportation analysis and assumed vulnerability of each zone for storm scenarios in each county of the study area. Number of zones range from 10 zones in Hampton County to 70 zones in Charleston County. Figures 6-2 through 6-10 illustrate the evacuation zones established in each county for the transportation analysis.

TABLE 6-5

TRANSPORTATION ANALYSIS EVACUATION ZONES:
ASSUMED VULNERABILITY BY STORM SCENARIO AND COUNTY

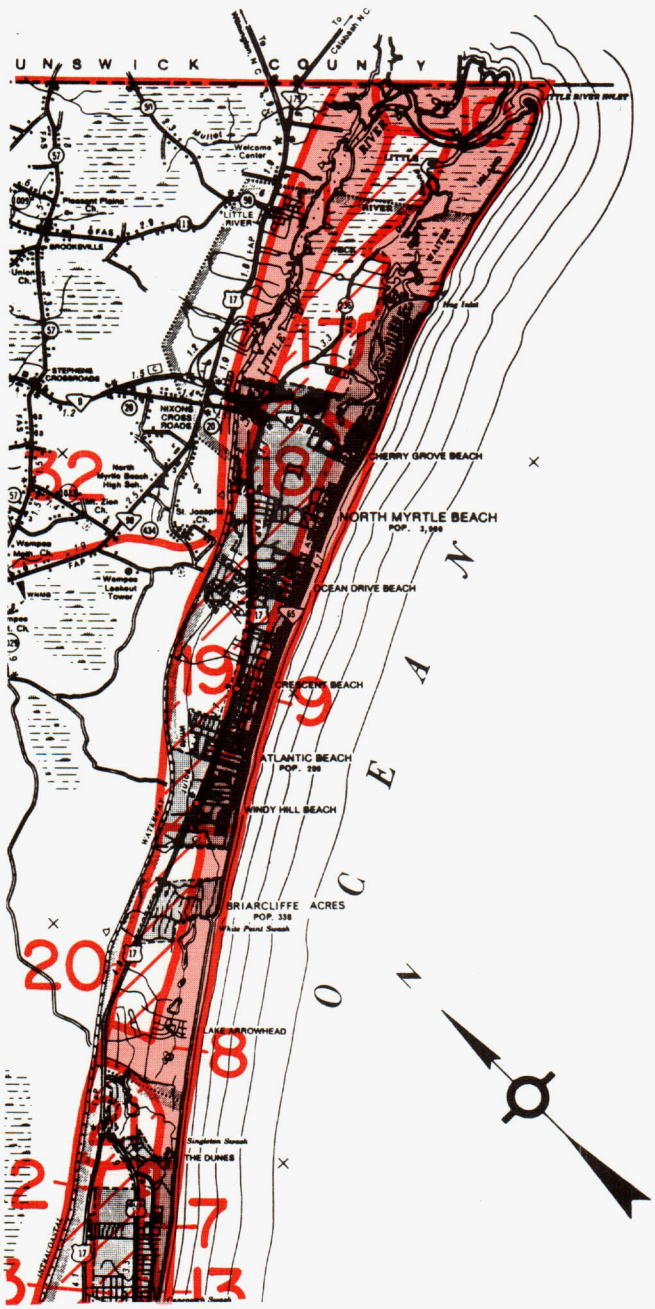
County	Number of Zones*	Storm Scenarios	All Residents in Zones	Mobile Homes Residents in Zones
Grand Strand Counties				
Georgetown	28	A	GE1-GE7	GE8-GE28
		B	GE1-GE13	GE14-GE28
		C	GE1-GE22	GE23-GE28
Horry	43	A	HO1-HO12	HO13-HO43
		B	HO1-HO16	HO17-HO43
		C	HO1-HO28	HO29-HO43
Lower Coast Counties				
Beaufort	64	A	BE1-BE29	BE30-BE64
		B	BE1-BE39	BE40-BE64
		C	BE1-BE54	BE55-BE64
		D	BE1-BE62	BE63-BE64
Berkeley	25	A	BR1-BR2	BR3-BR25
		B	BR1-BR6	BR7-BR25
Charleston	70	A	CH1-CH22**	CH23-CH70
		B	CH1-CH22	CH23-CH70
		C	CH1-CH45	CH46-CH70
		D	CH1-CH63	CH64-CH70
Colleton	13	A	CO1-CO2	CO3-CO13
		B	CO1-CO3	CO4-CO13
Dorchester	15	A	DO1	DO2-DO15
Hampton	10	A	- -	HA1-HA10
Jasper	15	A	JA1-JA3	JA4-JA15
		B	JA1-JA7	JA8-JA15

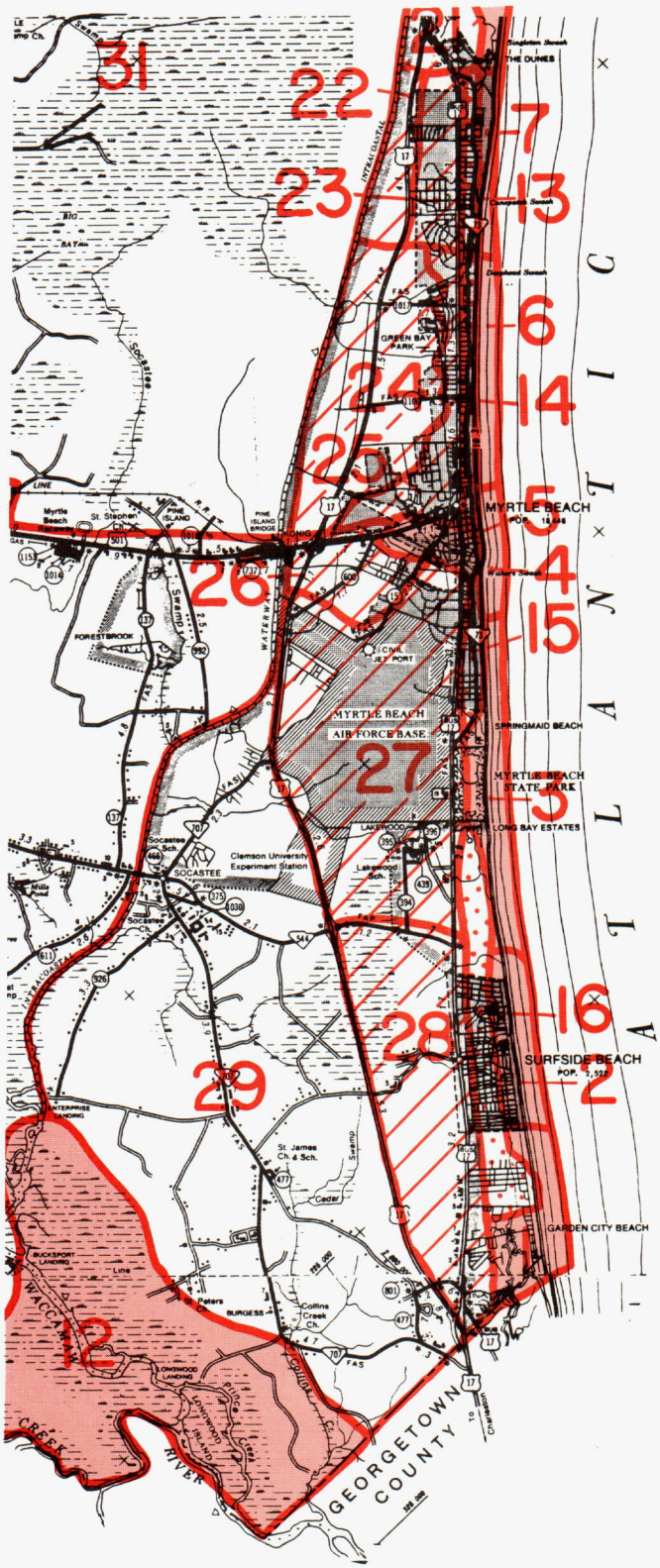
*See Figures 6-2 through 6-10 for graphic illustration

**In this scenario only 40% of the residents in zones CH1-CH22 are assumed to evacuate.

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- 12 EVACUATION ZONE NUMBER





TRAFFIC EVACUATION ZONES

HORRY COUNTY, S.C.
(east of intracoastal waterway)

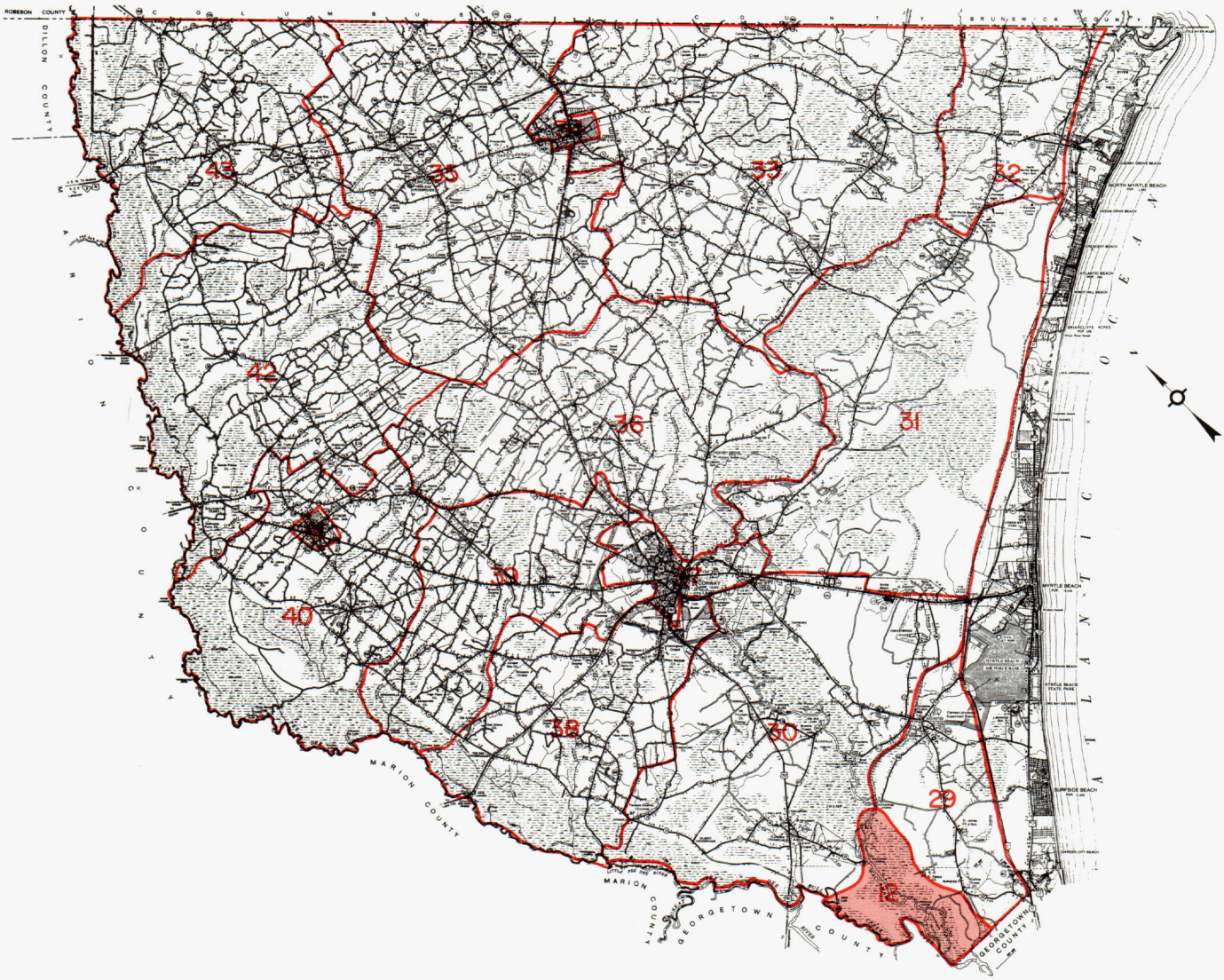
FIGURE 6-2

PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- 12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

HORRY COUNTY, S.C.
(west of intracoastal waterway)

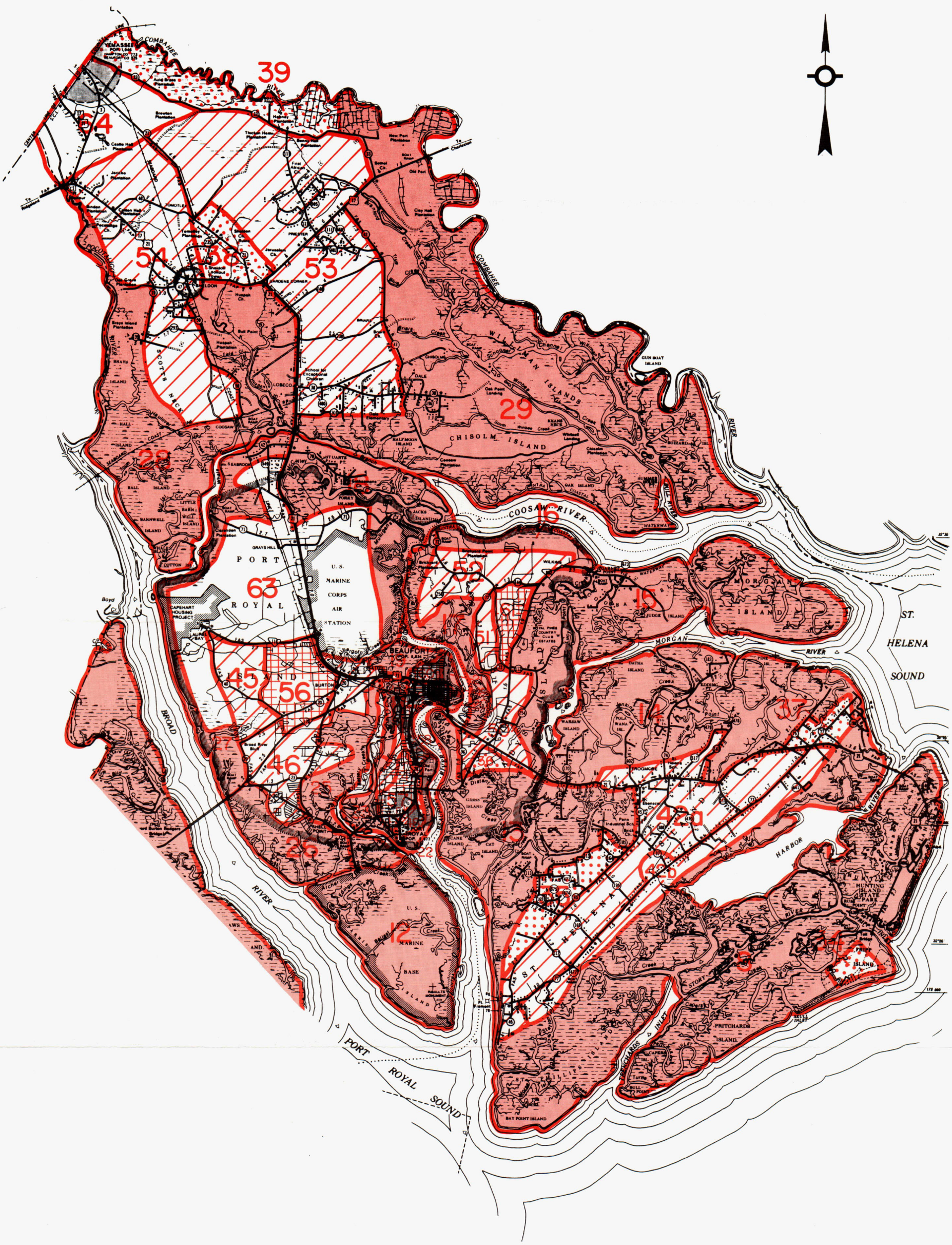
PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-2

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- STORM SCENARIO "D" FLOODING
- 12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

BEAUFORT COUNTY, S.C.
(north of Broad River)

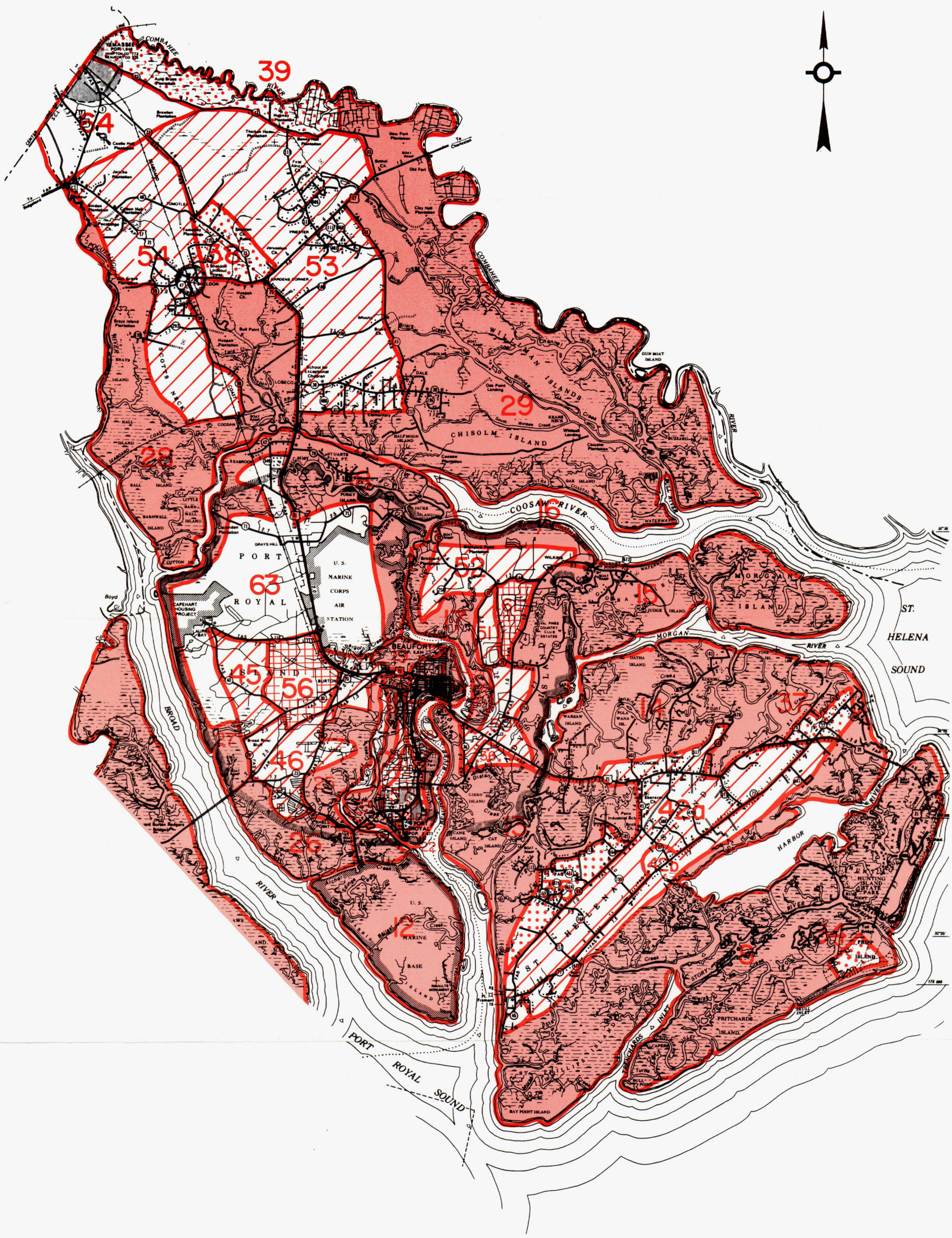
FIGURE 6-4

PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- STORM SCENARIO "D" FLOODING
- 12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

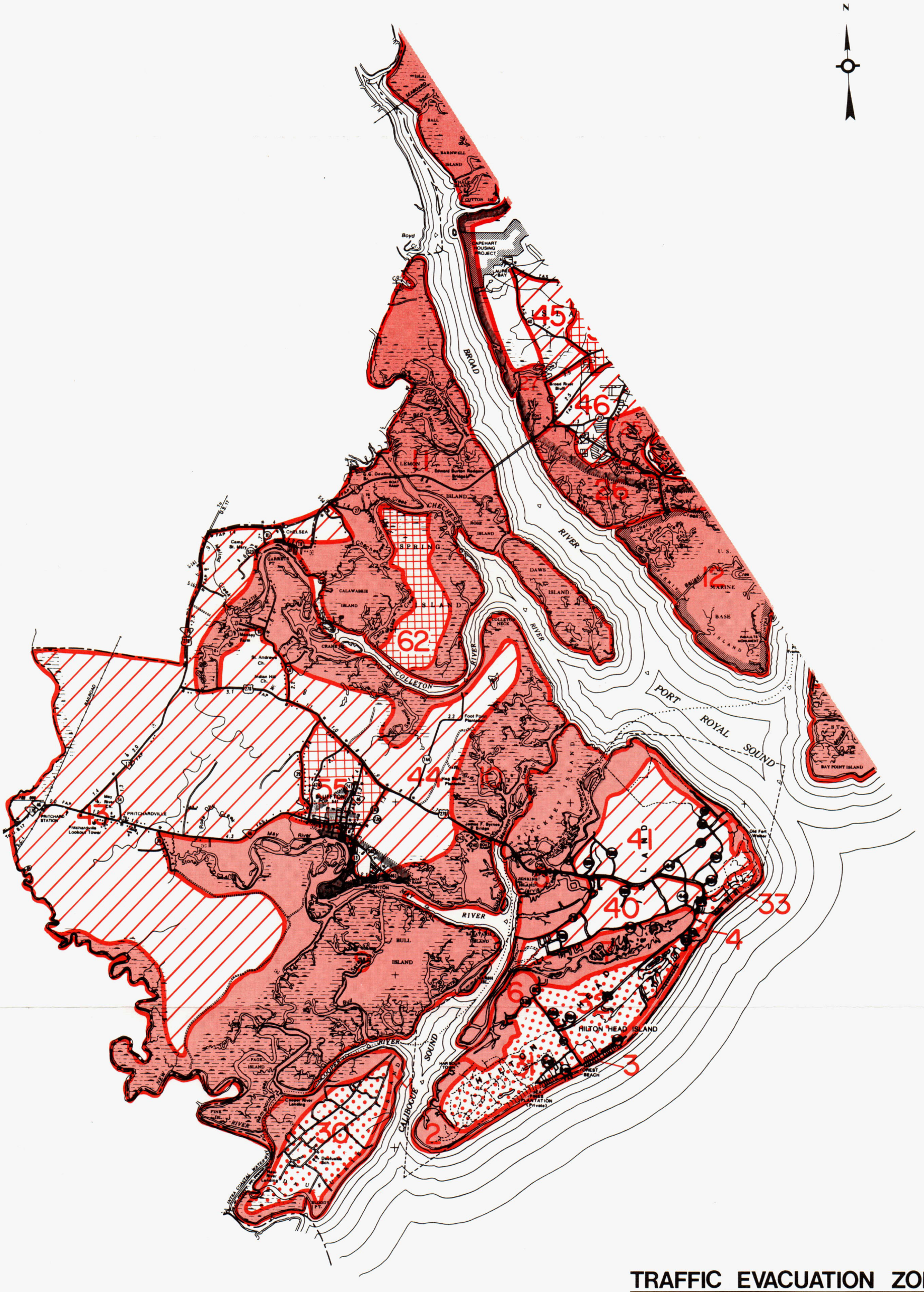
BEAUFORT COUNTY, S.C.
(north of Broad River)
FIGURE 6-4

PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- STORM SCENARIO "D" FLOODING
- 12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

BEAUFORT COUNTY, S.C.
(south of Broad River)

FIGURE 6-4

PBSJ

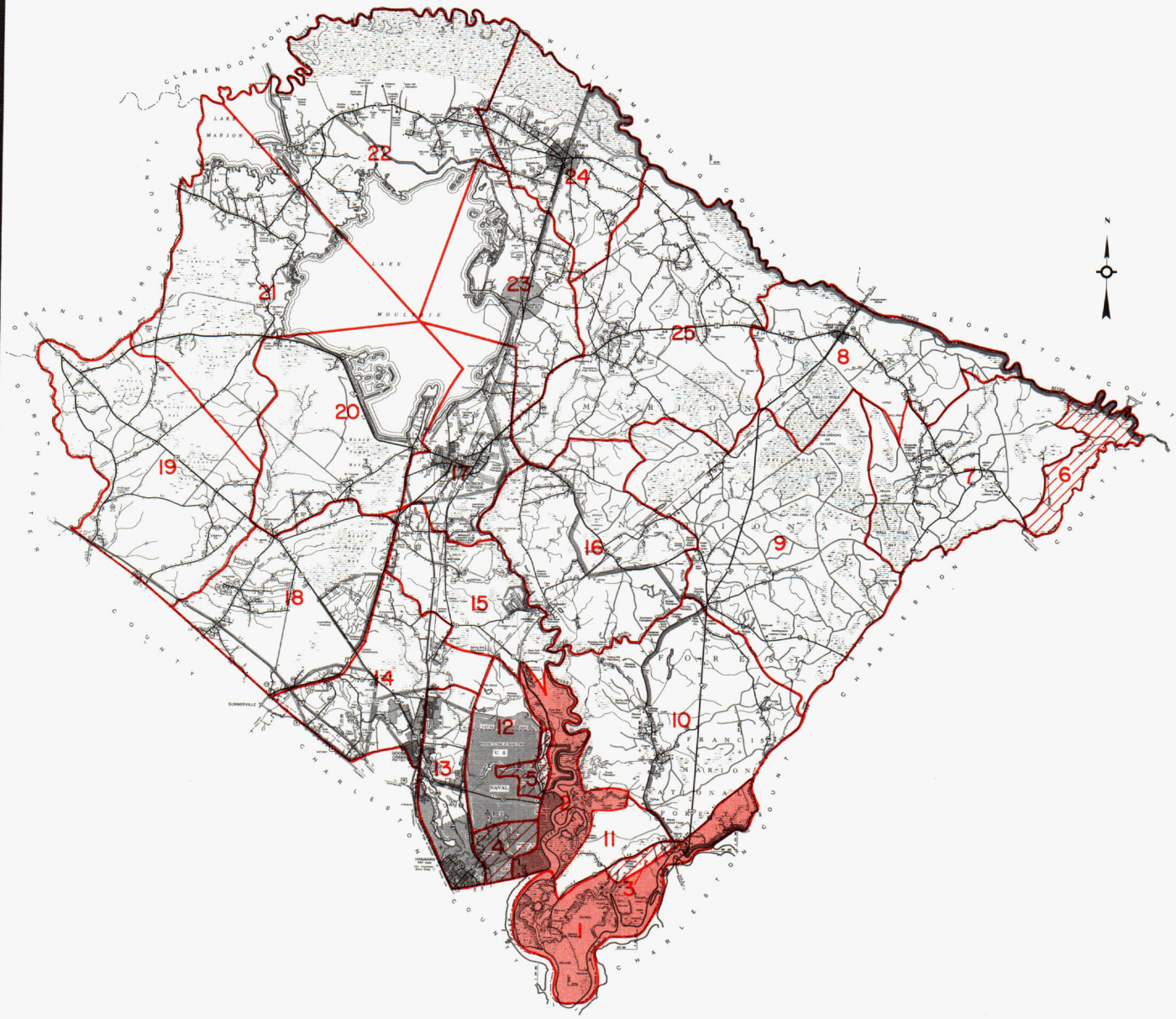
TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

STORM SCENARIO "A" FLOODING

STORM SCENARIO "B" FLOODING

12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

BERKELEY COUNTY, S.C.

PBSJ

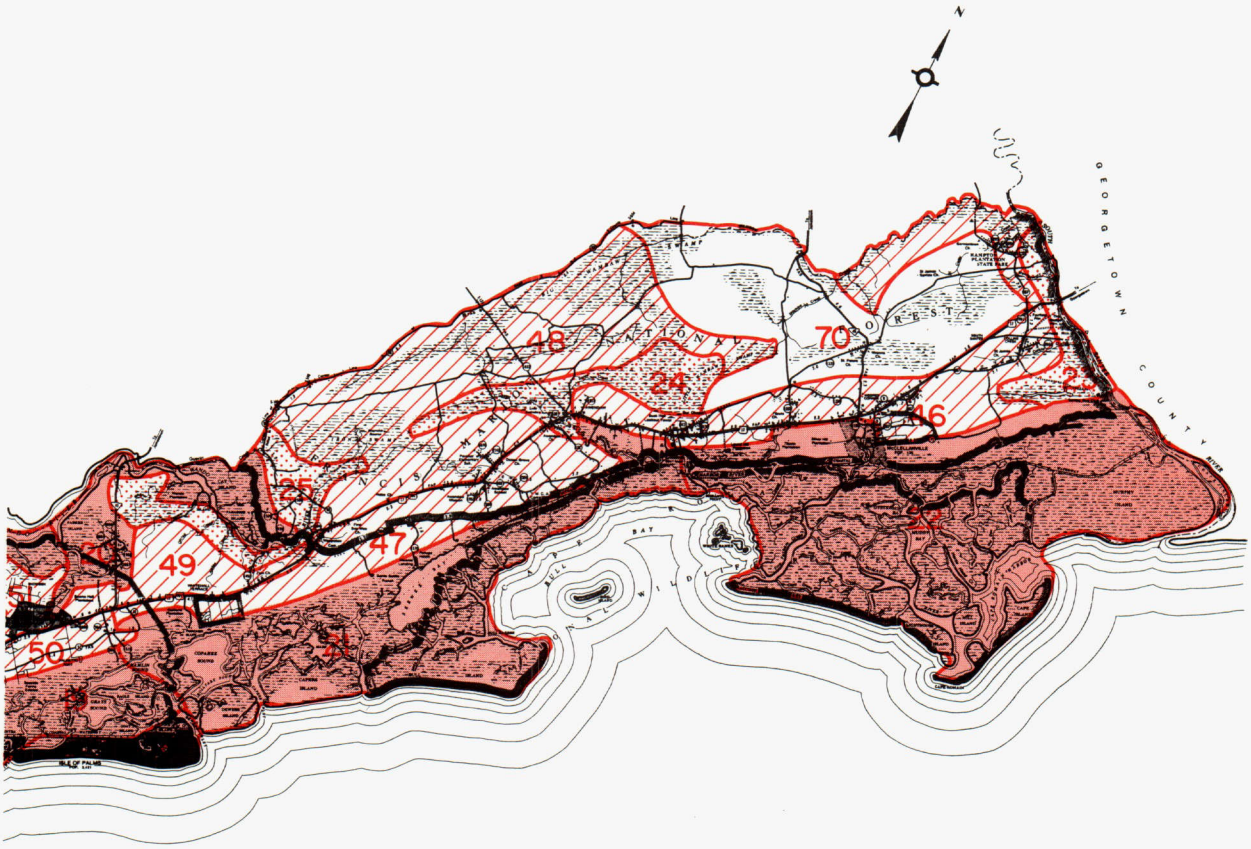
TRANSPORTATION ANALYSIS

SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-5

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- 12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

CHARLESTON COUNTY, S.C.
(eastern county)

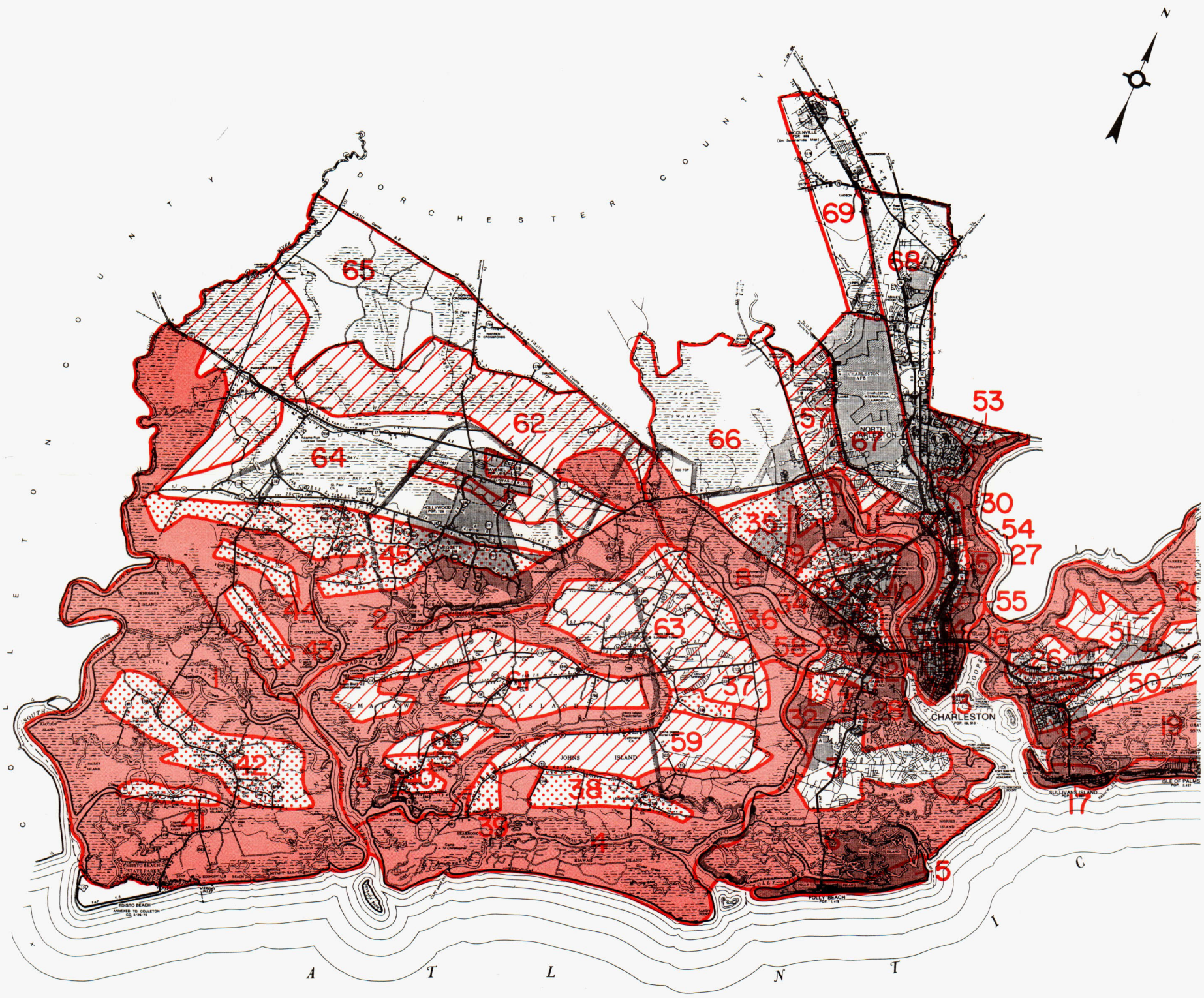
TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-6

PBSJ

LEGEND

- STORM SCENARIO "A" FLOODING
- STORM SCENARIO "B" FLOODING
- STORM SCENARIO "C" FLOODING
- 12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

CHARLESTON COUNTY, S.C.
(peninsula and western county)
FIGURE 6-6

PBSJ

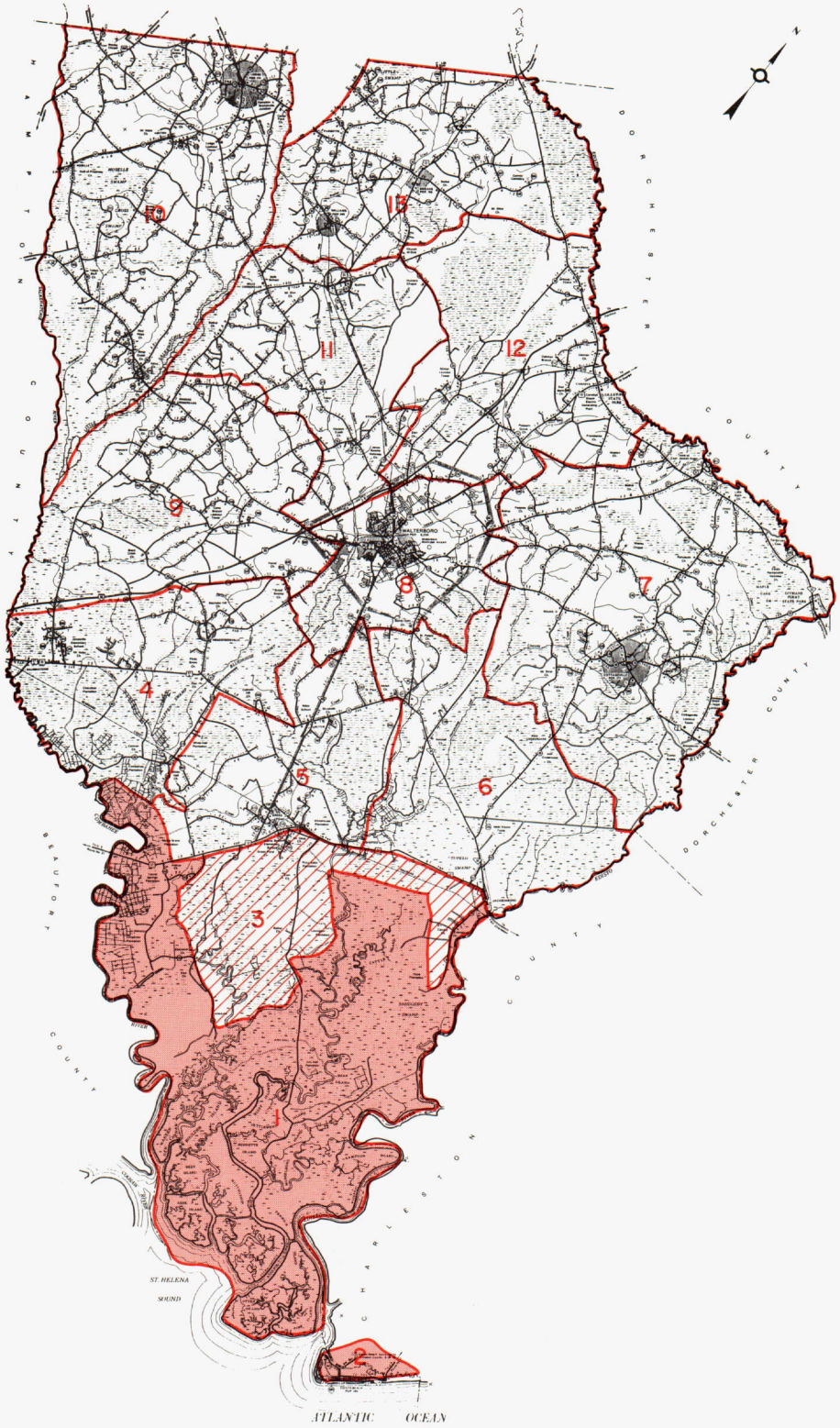
TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

STORM SCENARIO "A" FLOODING

STORM SCENARIO "B" FLOODING

12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

COLLETON COUNTY, S.C.

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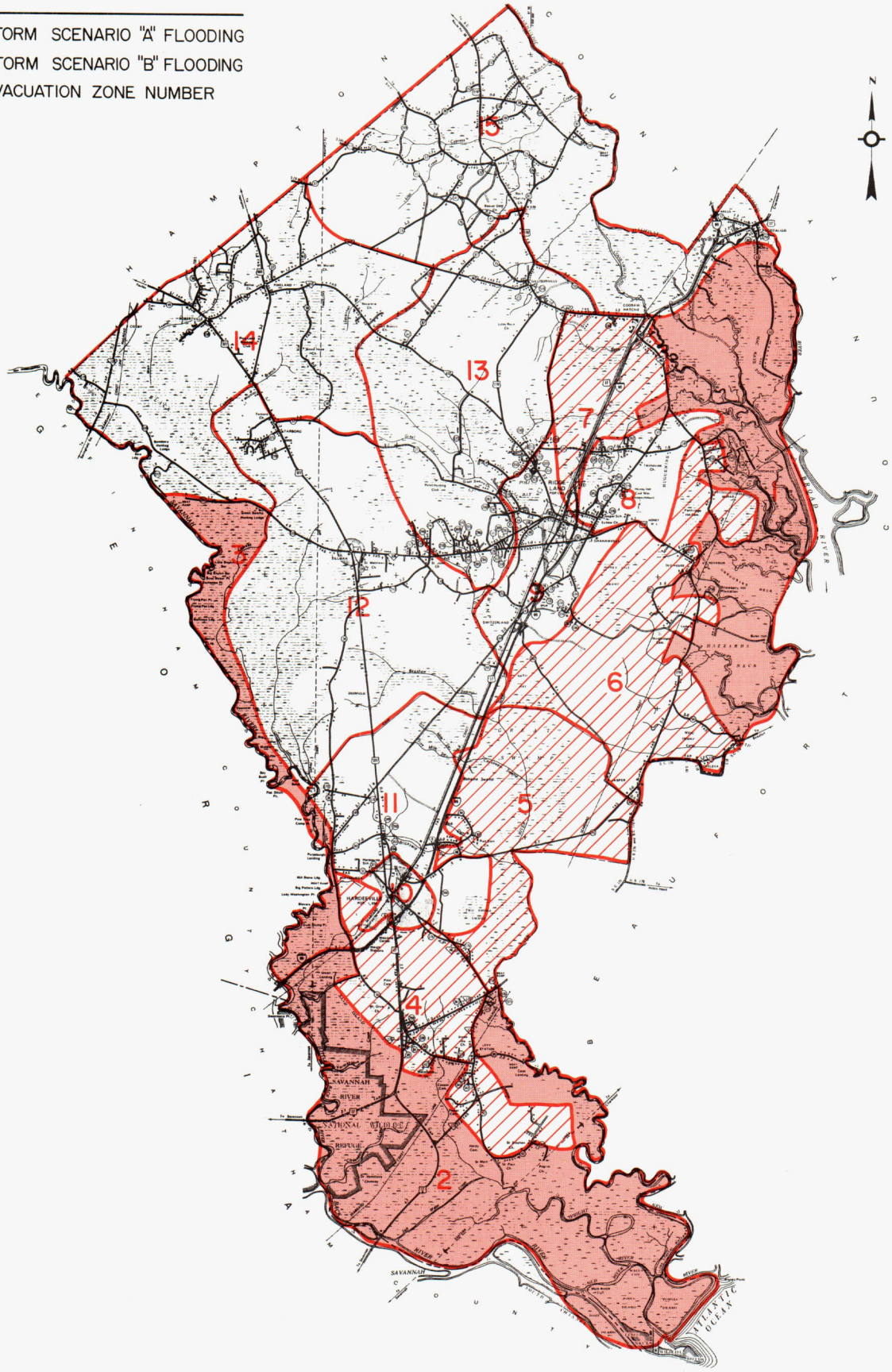
TRANSPORTATION ANALYSIS

SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-7



TRAFFIC EVACUATION ZONES

JASPER COUNTY, S.C.

PBSJ

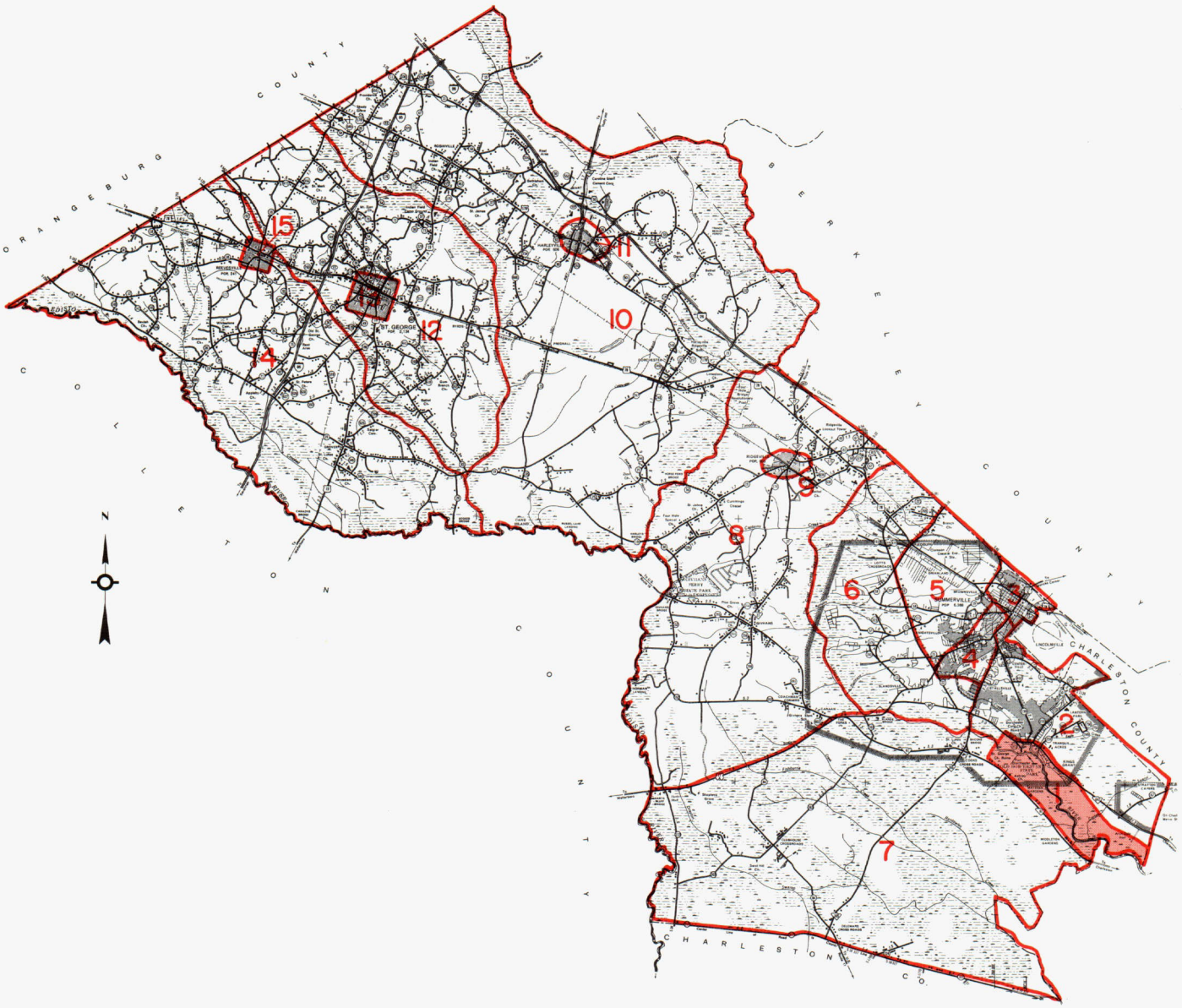
TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-8

LEGEND

STORM SCENARIO "A" FLOODING

12 EVACUATION ZONE NUMBER



TRAFFIC EVACUATION ZONES

DORCHESTER COUNTY, S.C.

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TRANSPORTATION ANALYSIS

SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-9

LEGEND

12 EVACUATION ZONE NUMBER

TRAFFIC EVACUATION ZONES

HAMPTON COUNTY, S.C.

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TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-10

D. Behavioral Assumptions.

Recognizing that the future evacuation of an endangered population due to a hurricane approaching the South Carolina study area involves the coordinated action of thousands of individuals, the Hazards Management Group gathered detailed information through a behavioral survey pertaining to the tendencies and intended choices of the evacuation population. PBS&J reviewed this data as well as current behavioral research nationwide to derive the best assumptions possible for the transportation analysis. Specifically, for transportation purposes, the following behavioral aspects were addressed:

* Occupancy of tourist units
* Participation rates
* Evacuation rates
* Destination desires
* Vehicle Usage

As a hurricane approaches the study area, the number of tourists who may be required to evacuate along with the permanent residents could be significant. Discussions at workshop meetings with disaster preparedness committees revealed a number of widely varying opinions regarding this iusse. Some individuals felt strongly that most tourists will leave prior to the start of an evacuation. Others felt that tourists would take a "wait and see" attitude, resulting in a significant number of tourists present at the start of an evacuation. To address these differing opinions, a sensitivity analysis was performed. The percentage of tourists assumed to remain to be evacuated with permanent residents are listed below:

	Test 1	Test 2	Test 3
Grand Strand			
Horry	50%	85%	
Georgetown	15%	80%	
Lower Coast			
Charleston	50%	85%	
Beaufort	15%	50%	85%
Colleton (Edisto Area)	15%	80%	

These tested assumptions were agreed upon by local officials as the appropriate maximum and minimum figures to use for tourist occupancy.

Another important behavioral aspect is that of participation rates. Two concepts were employed in the transportation analysis regarding participation in the evacuation. First, a 100 percent participation by those evacuees living in surge inundated areas and mobile homes outside the surge flooded areas was assumed. In addition, a small percentage (5 to 10% depending on storm intensity) of the non-vulnerable population was assumed to evacuate their dwelling units. Behavioral research confirms this behavioral phenomenon. The Transportation Modeling Appendix provides a listing of all participation rates assumed by storm scenarios for each county in the study area.

Perhaps the most critical behavioral aspect that must be considered for the transportation analysis is the evacuation rate of the evacuating population. Behavioral data from research of past hurricane evacuations show that mobilization and actual departures of the evacuating population occur over a period of many hours and sometimes several days. For the South Carolina Study, clearance times were tested for three evacuation rates represented by three different behavioral response curves. Behavioral response curves describing mobilization by the vulnerable population define the rate at which evacuating vehicles load onto the evacuation street network for each hourly interval relative to an evacuation order or strong advisory. The percentage of evacuees leaving dwelling units is then available for the calculations relating to traffic loadings at critical links along the evacuation network.

The behavioral response curves shown in Figure 6-11 are intended to include the most probable range of possible mobilization times that might be experienced in a future hurricane evacuation situation. The rapid response curve is intended to depict the quickest mobilization response by vulnerable households. For analysis purposes, the rapid response curve includes the one hour of mobilization occurring before the evacuation order and only three hours of mobilization time occurring after the evacuation order for a total of four hours of mobilization time. For the medium response curve, mobilization time is two hours before the evacuation order, and four hours after the evacuation order, for a total of six hours of mobilization time. The slow response curve includes three hours of mobilization before the evacuation order and six hours of mobilization after the evacuation order, for a total of nine hours of mobilization time. Therefore, for sensitivity analysis, the mobilization time was varied between four hours and nine hours.

BEHAVIORAL RESPONSE CURVES

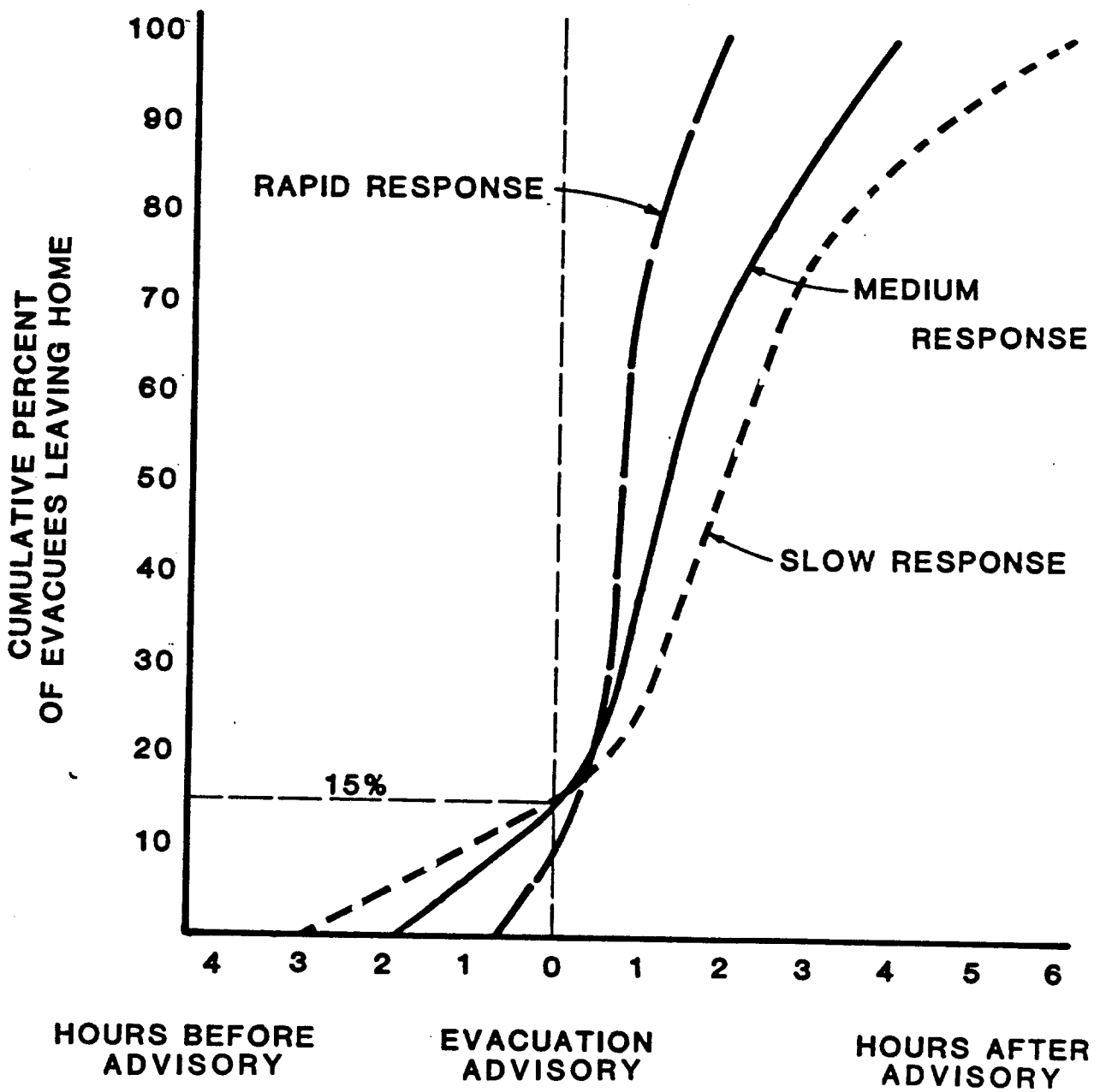


FIGURE 6-11

The percentage of evacuees assumed to go to one of four general destination types was another important behavioral input to the transportation analysis. Evacuee destination percentages were developed with disaster preparedness committees in each area after careful review of information available in past behavioral research. Figures were developed for the expected percent of evacuees going to public shelters, hotel/motel units, the home of a friend or relative, or out of the county entirely. Destination percentages were varied for each evacuation zone in each county depending on category of risk (distance from coastline) or special characteristics of a zone such as high number of substandard housing units or low income residents. Specific assumptions are provided in the Transportation Analysis Documentation Appendix. It should be noted that these destination percentages refer to destination desires. Where destination desires could not be satisfied with in-county shelter capacities, the transportation analysis assumed that these evacuees would have to leave the county to find acceptable shelter.

A final behavioral assumption refers to vehicle usage and the percent of households expected to pull a trailer or recreational vehicle during an evacuation. Review of the behavioral survey and discussions with review committees produced the needed parameters. Vehicle usage percentages refer to the percent of vehicles available at the home origin that are assumed to be used in the evacuation. Vehicle usage percentages were approximately 70% for the South Carolina study transportation analysis. The percent of households expected to pull a boat, trailer or RV was approximately 10 percent in the immediate coastal area zones.

E. Roadway Network and Traffic Control Assumptions.

A final group of assumptions used for input to the transportation analysis related to the roadway system chosen for the evacuation network and traffic control measures selected for traffic movement. Although the assumptions developed for the transportation analysis are general, the efforts at county and municipal levels regarding traffic control and roadway selection must be quite detailed. Detailed manpower allocations to major intersections involve extensive coordination among local and state officials. This study does not presume to replace those efforts, but seeks to quantify the time elements within which such manpower would operate.

In choosing roadways to be used for the evacuation network, an effort was made to include only street facilities with sufficient elevations, little or no adjacent tree coverage, substantial shoulder width and surface, and roadways already contained in existing hurricane evacuation plans. Another objective was to include east-west arterials and bridge combinations that would provide the smoothest (least disjointed) possible traffic low.

In order to determine the routing of evacuation traffic a representation of the roadway system was developed. A traditional "link-node" system was developed to identify roadway sections. Nodes are used to identify the intersection of two roadways or changes in roadway characteristics. Links are the roadway segments as defined by the nodes when connected. Each link is identified by a letter designation.

Once the links and nodes for the evacuation routes were identified, roadway characteristics were specified for each link. The characteristics of each link were defined by the following features.

* Number of travel lanes
* Type of facility (arterial, collector, freeway, etc.)
* Area type (surrounding land use)

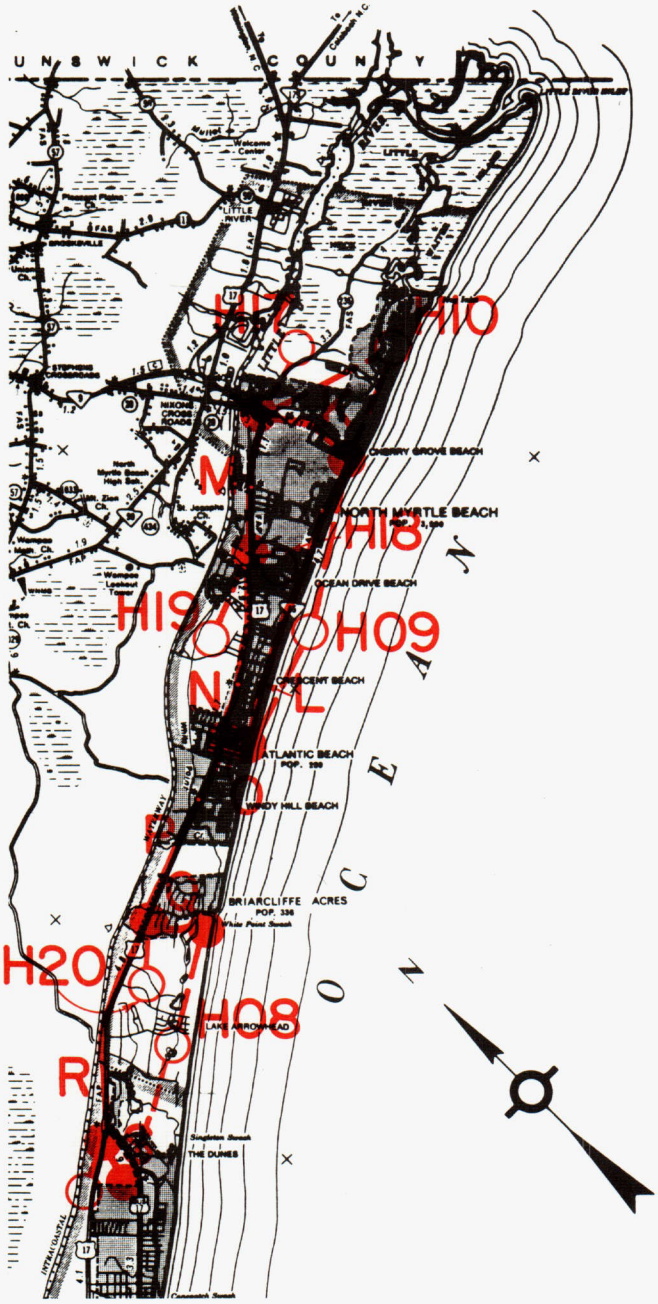
Figures 6-12 through 6-20, Evacuation Network Maps, show the roadway system representations (evacuation networks) for each county in the study area. The significance of link node segments and centroid connectors (dashed lines) is explained in the Transportation Analysis Documentation Appendix. The figures consist of base maps showing all the major streets in the study area with identification of the nodes and centroid connectors in color. Detailed roadway link information is contained in the Transportation Analysis Documentation Appendix.

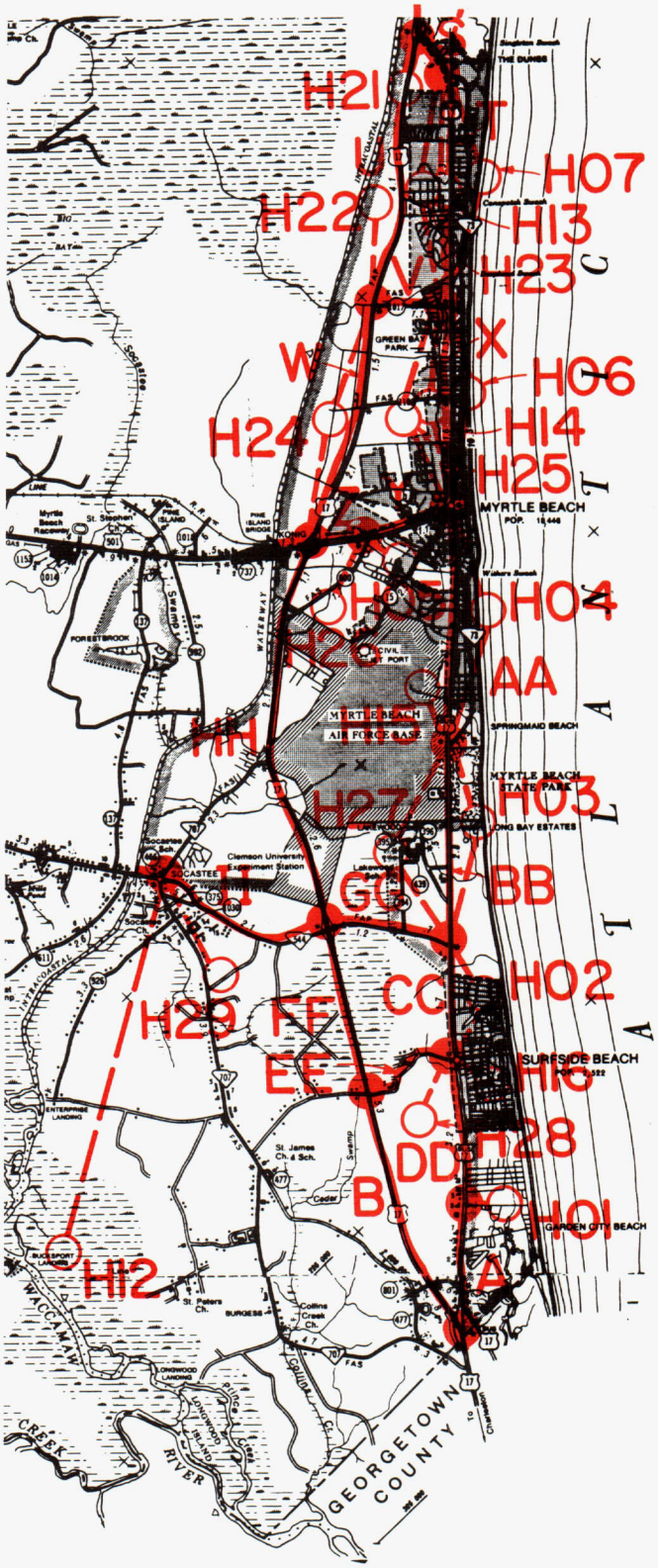
LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME





EVACUATION ROAD NETWORK

HORRY COUNTY, S.C.
(east of intracoastal waterway)

FIGURE 6-12

PBSJ

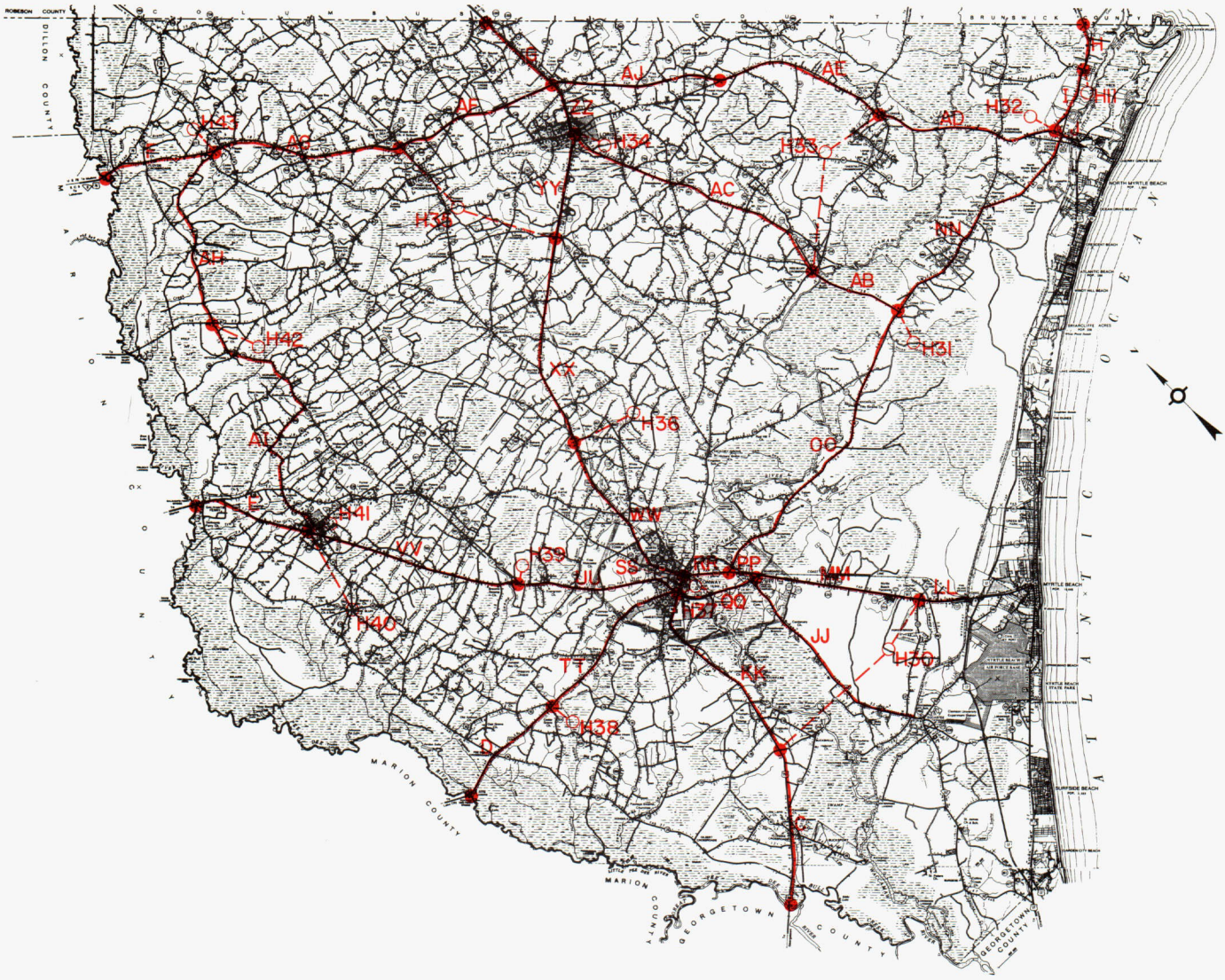
TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME



EVACUATION ROAD NETWORK

HORRY COUNTY, S.C.
(west of intracoastal waterway)

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-12

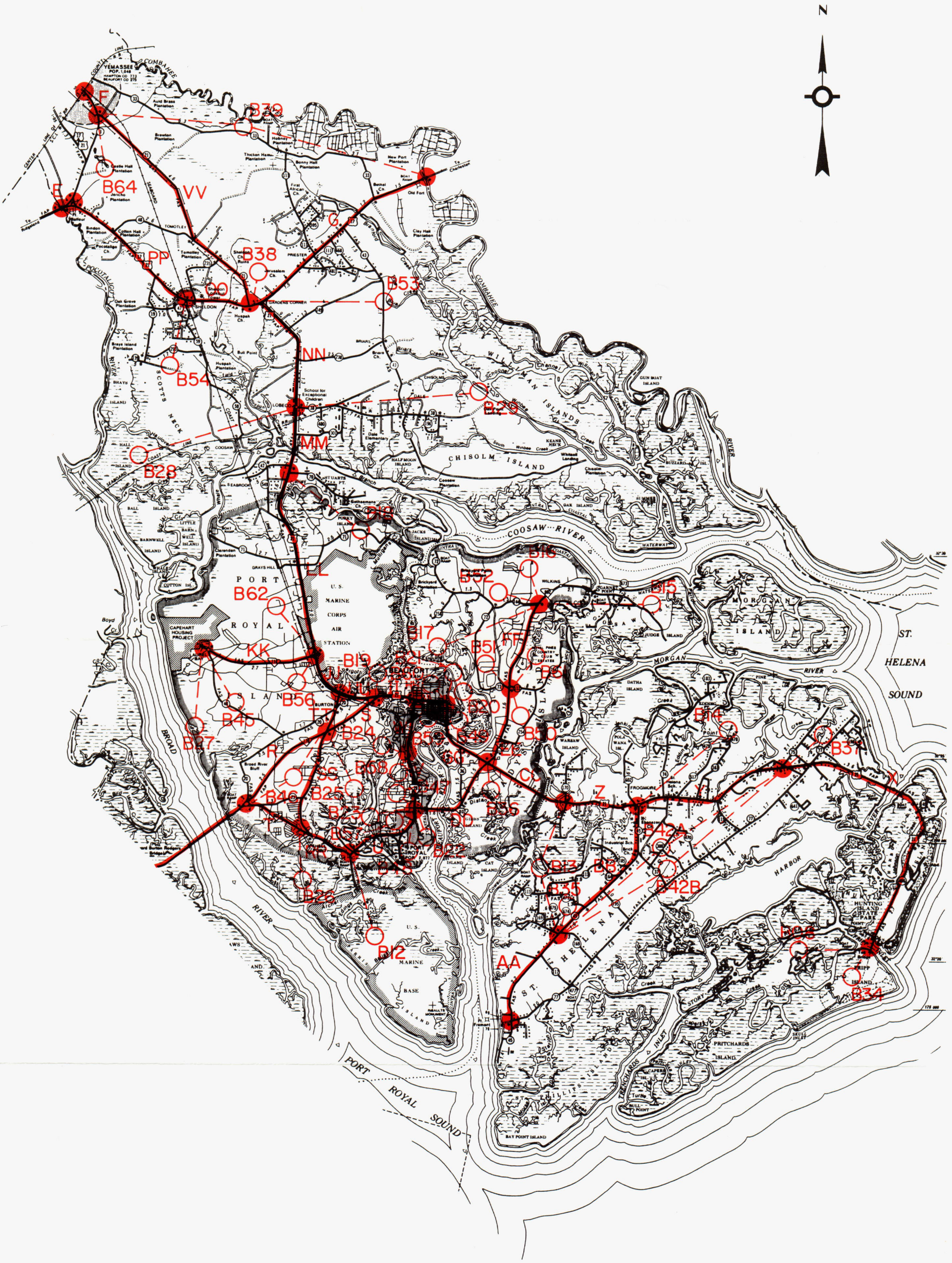
PBSJ

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME

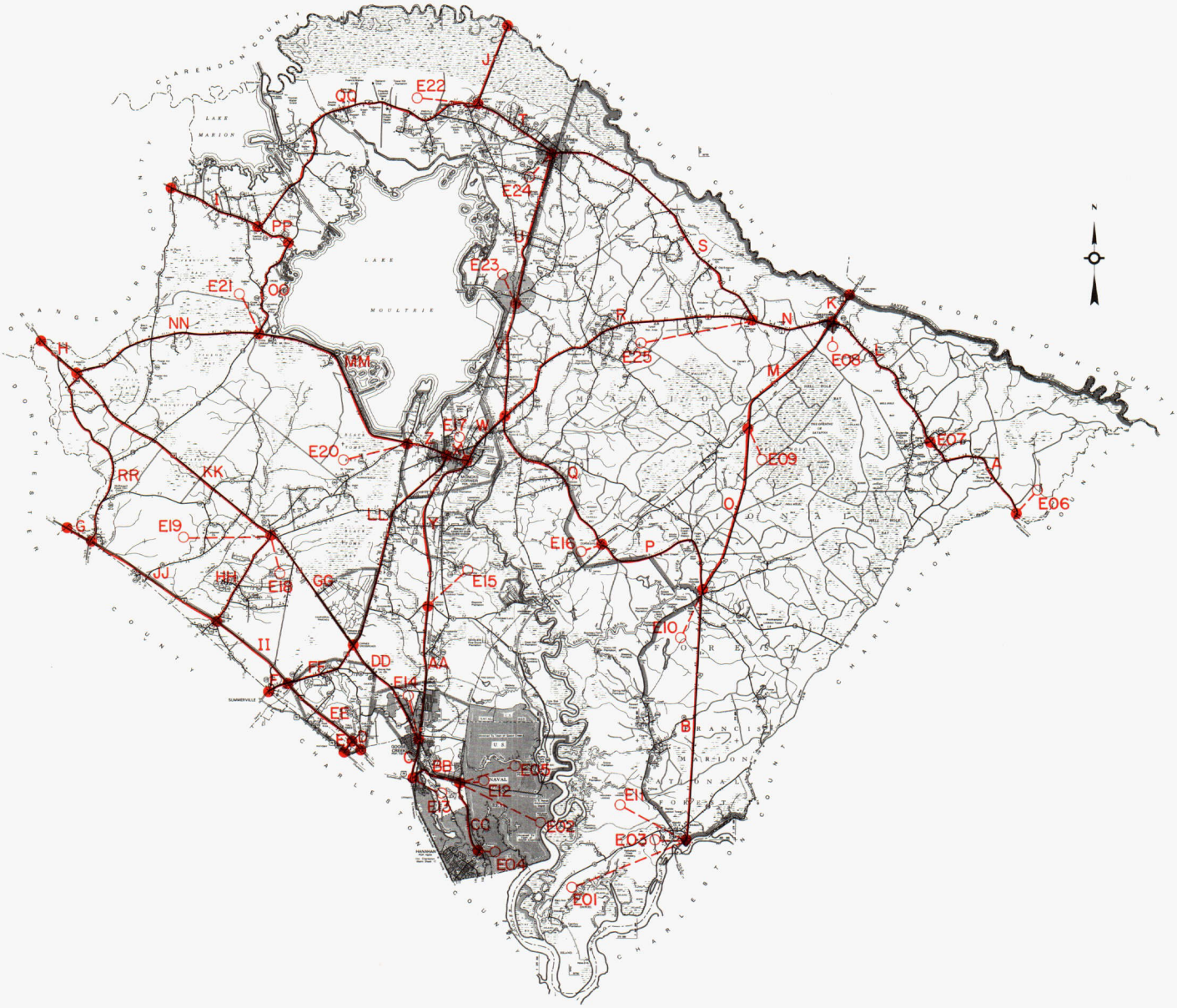


LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME



EVACUATION ROAD NETWORK

BERKELEY COUNTY, S.C.

PBSJ

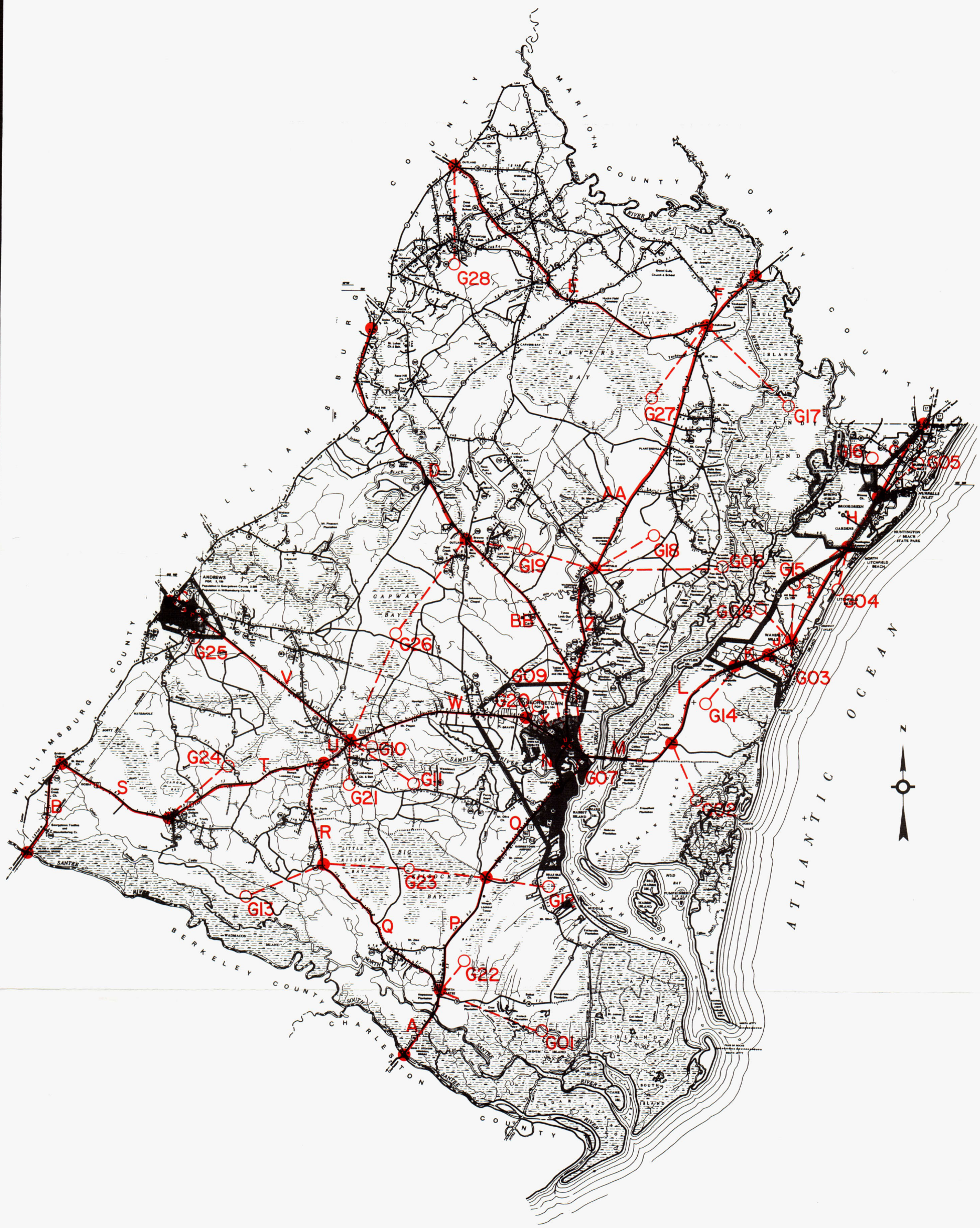
TRANSPORTATION ANALYSIS

SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-14

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)
- H03 CENTROID NUMBER
- B LINK NAME



EVACUATION ROAD NETWORK

GEORGETOWN COUNTY, S.C.

PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-15

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME

EVACUATION ROAD NETWORK

CHARLESTON COUNTY, S.C.
(eastern county)

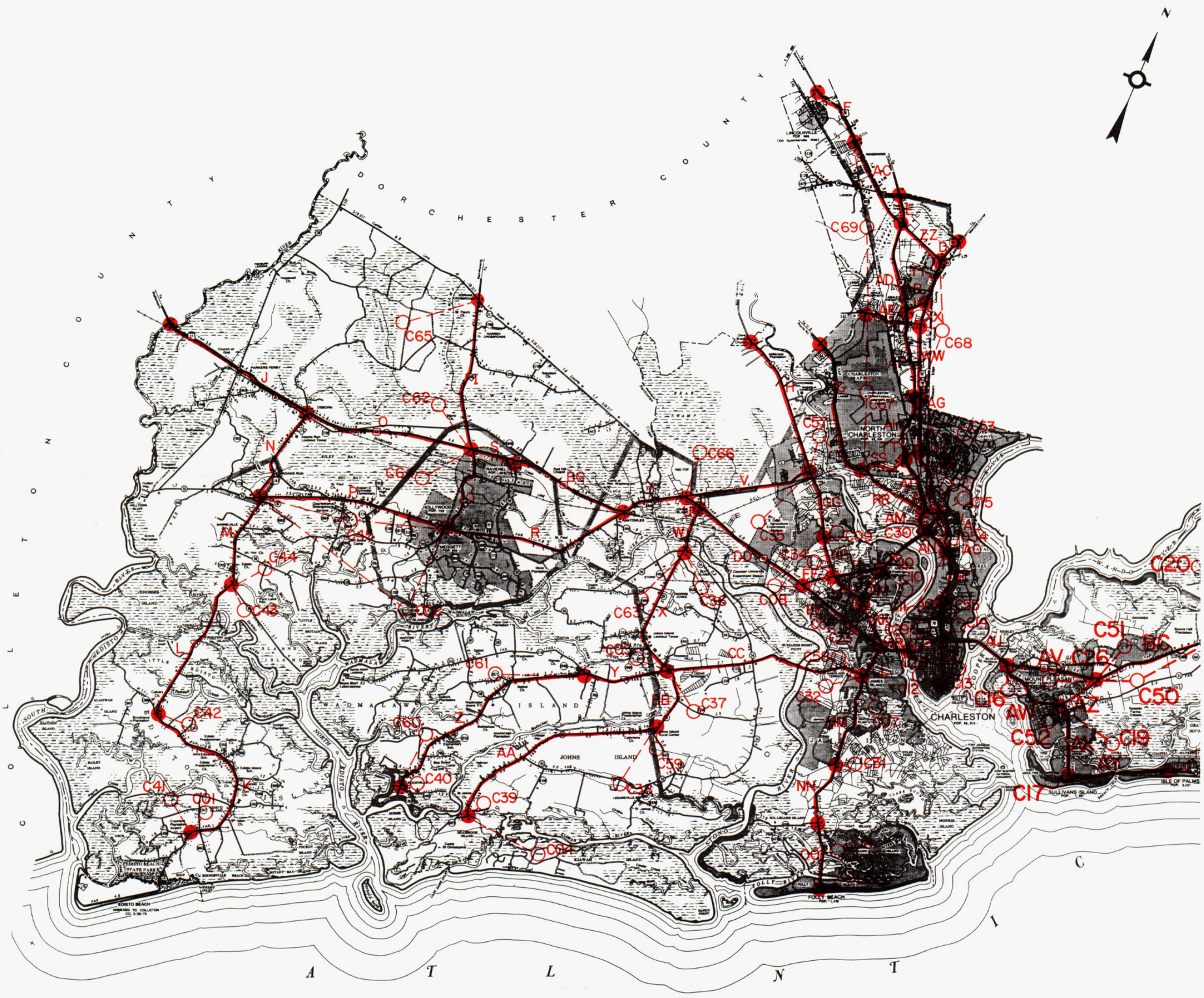
PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-16

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)
- H03 CENTROID NUMBER
- B LINK NAME



EVACUATION ROAD NETWORK

CHARLESTON COUNTY, S.C.
(peninsula and western county)

FIGURE 6-16

PBSJ

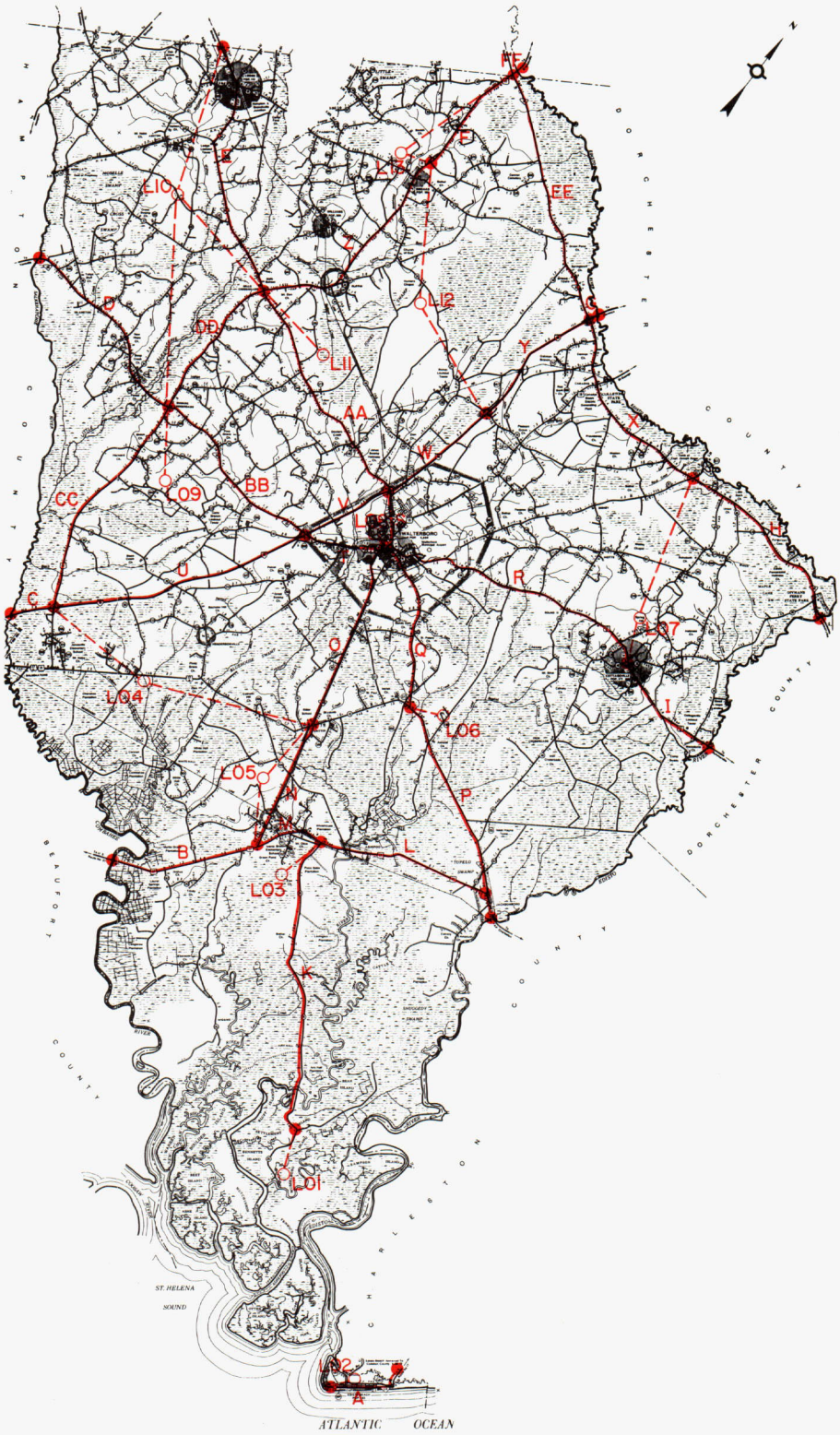
TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME



EVACUATION ROAD NETWORK

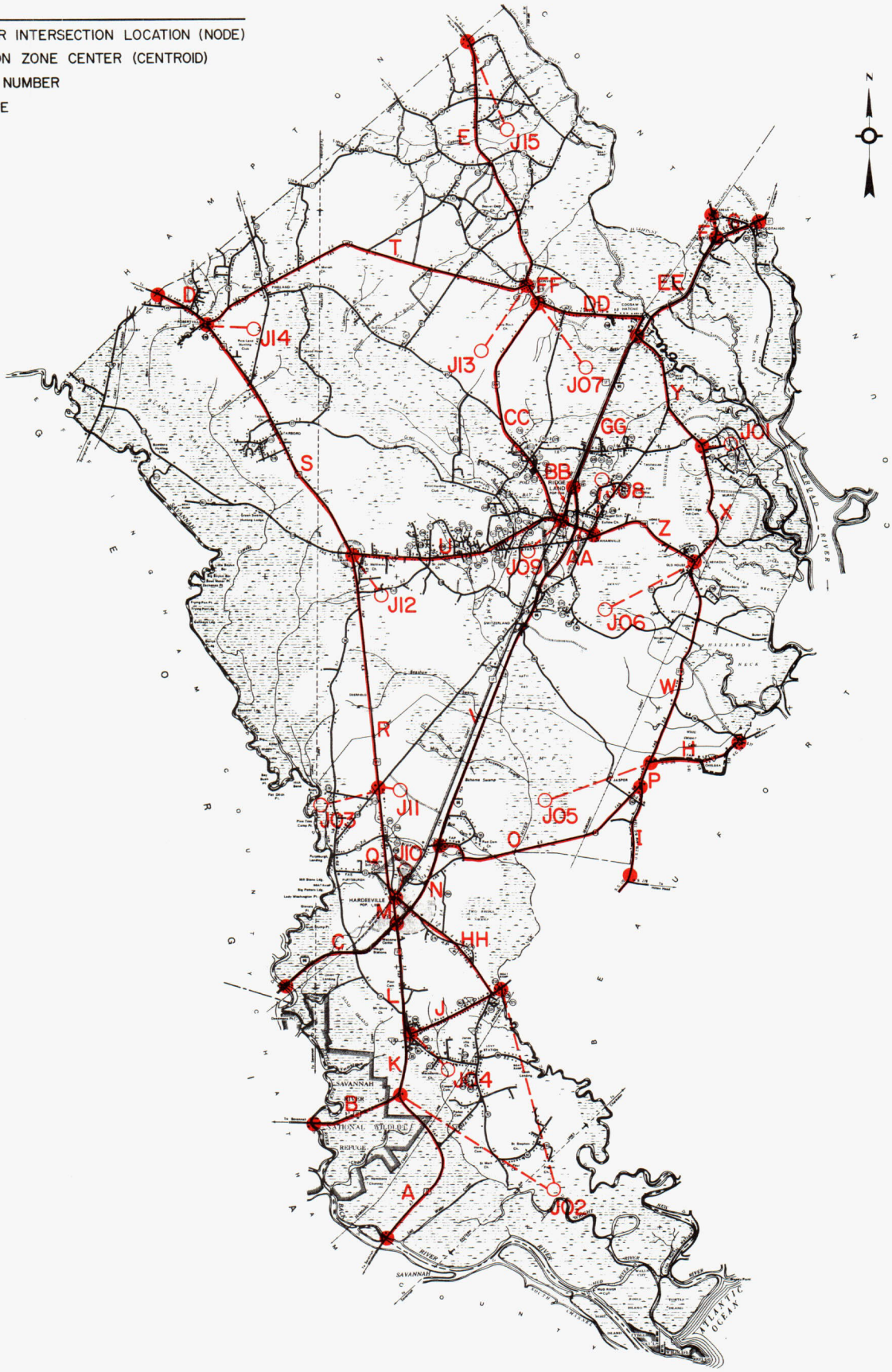
COLLETON COUNTY, S.C.

PBSJ

TRANSPORTATION ANALYSIS

SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-17



EVACUATION ROAD NETWORK

JASPER COUNTY, S.C.

PBSJ

TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

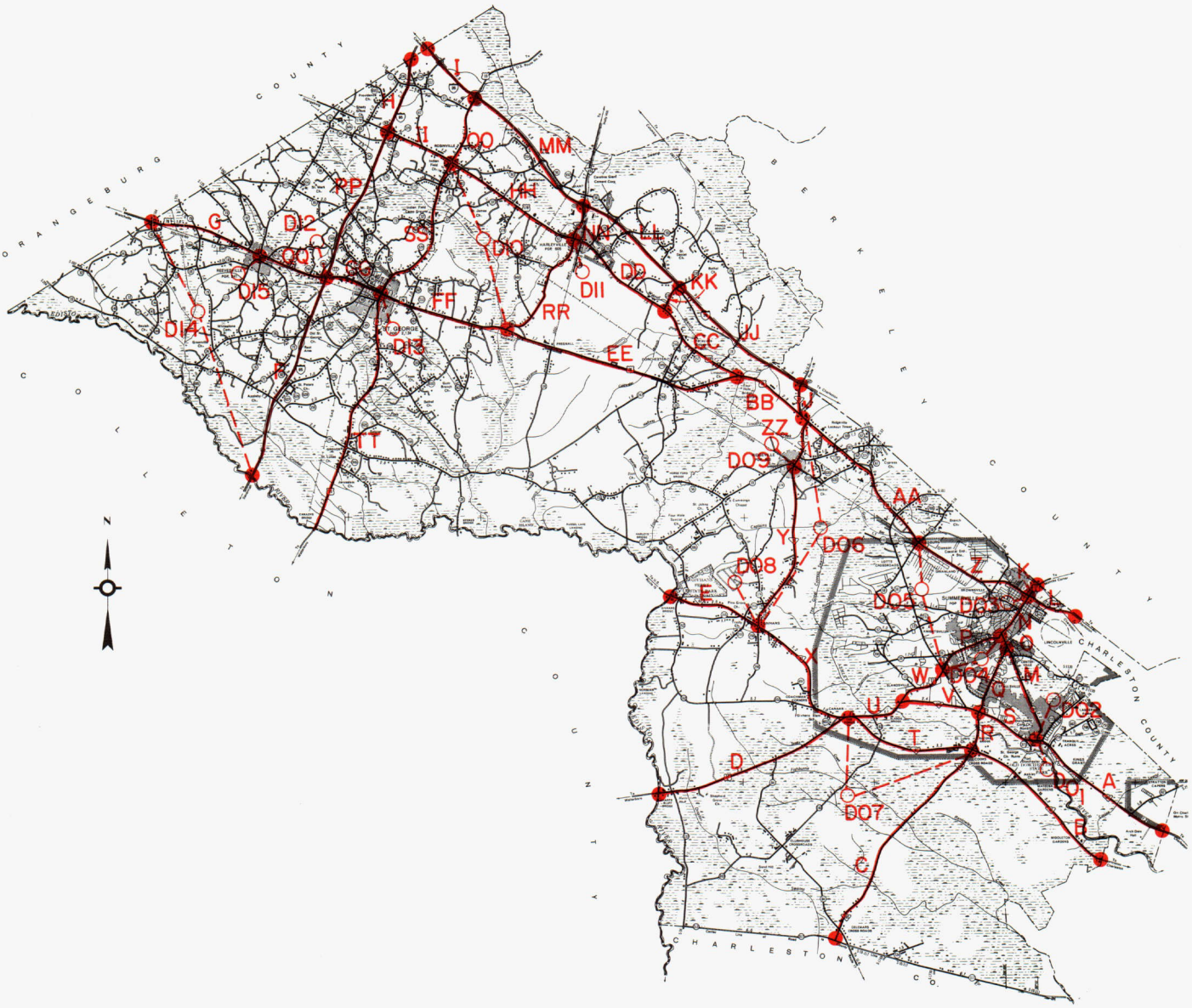
FIGURE 6-18

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME



EVACUATION ROAD NETWORK

DORCHESTER COUNTY, S.C.

PBSJ

TRANSPORTATION ANALYSIS

SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-19

LEGEND

- ● STREET OR INTERSECTION LOCATION (NODE)
- ○ EVACUATION ZONE CENTER (CENTROID)

H03 CENTROID NUMBER

B LINK NAME

EVACUATION ROAD NETWORK

HAMPTON COUNTY, S.C.

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TRANSPORTATION ANALYSIS
SOUTH CAROLINA HURRICANE EVACUATION STUDY

FIGURE 6-20

An important assumption for the transportation modeling was that all bridges would remain down during a Hurricane Warning period. U.S. Coast Guard regulation 33-117.1(c) may give civil defense authorities the ability to implement this procedure. At the present time, request for closure prior to a major disaster occurring (and prior to the warning period) must be directed to the Coast Guard. The Coast Guard, however, has the capability of acting on these requests immediately. It is essential that appropriate bridge regulations be interpreted and implemented to allow for immediate response to an evacuation order. It may be prudent in some areas for boat owners to find safe harbor prior to or during a Hurricane Watch period. The lives of citizens evacuating in vehicles could be at great risk if bridges are not allowed to operate at full capacity during a Hurricane Warning. Bridge openings obviously result in less than full hourly capacity for vehicular movement. In Horry County, the opening of the drawbridge at Socastee could jeopardize an evacuation effort due to the tendency of the bridge to not close down properly.

It was assumed that special manpower (local policemen, sheriffs, highway patrolmen) will be assigned to critical intersections in the study area. This would allow for smoother traffic flow and would allow east-west traffic movements more intersection "green time." The transportation modeling task also assumes that provisions would be made for removal of vehicles in distress during the evacuation.

Assumptions concerning the road network are that all vehicles will evacuate prior to the arrival of sustained gale force winds and storm surge inundation.

In summary, data inputs to the transportation analysis can be classified into one of four categories:

* Hazards Data
* Socioeconomic Data
* Behavioral Data
* Roadway Network

Table 6-6, Transportation Analysis Data Inputs, provides a listing of each major data input for each of the four categories.

TABLE 6-6

TRANSPORTATION ANALYSIS DATA INPUTS

Hazards Data

* Land Areas Flooded for each Category Hurricane
* Public Shelter Useability by Hurricane Category
* Time of Arrival of Gale Force Winds/Roadway Inundation

Behavioral Data

* Rapidity of Response
* Participation Rates
* Destination Percentages
* Vehicle Usage
* Percent Pulling Trailer/Boat
* Presence of Tourists

Socioeconimic Data

* Housing Unit Data
* People Per Housing Unit
* Vehicles per Housing Unit
* Occupancy Information

Roadway Network

* Number of Lanes by Link
* Area Types by Link (surrounding land use)
* Facility Types by Link (function of roadway)
* Drawbridge Operations
* Traffic Count Data
* Elevation - "Low Spots"
* Critical Links/Intersections Capacity Data

IV. OVERVIEW OF TRANSPORTATION MODELING METHODOLOGY

The work tasks involved in performing the transportation analysis are illustrated in Figure 6-21, Transportation Analysis Work Flow Diagram. In addition to the front end development of population data, evacuation zones, and scenarios, the diagram provides the transportation modeling steps in the upper right hand box.

The transportation modeling methodology developed and employed for the South Carolina Study Area involved a number of manual and microcomputer techniques. The methodology, while very technical, was designed to be consistent with the accuracy level of the modeling inputs and assumptions. The methodology is unique in that it is sensitive to the key behavioral aspects of evacuees.

The Transportation Analysis Documentation, Appendix Four, specifies and explains the steps carried out in the transportation modeling at a detailed technical level. In summary, the modeling methodology involved seven major steps. These steps are briefly described below:

A. Evacuation Zonal Data Development.

Data gathered by census tract and traffic analysis zone were stratified by evacuation zone. Number of permanent residential dwelling units, mobile homes, and tourist units were compiled by zone and formatted for input into trip generation.

B. Evacuation Road Network Preparation.

This step involved developing information for those roadways selected for inclusion in the evacuation road network. Information was coded into a "link file" for use by the assignment computer module. The end product of the step was a computerized representative of the roadway system.

C. Trip Generation.

Specific dwelling unit variables were used in the trip generation calculations to produce total evacuating people and vehicles originating from each evacuation zone. Originating vehicles and people were stratified by destination type based on behavioral and population parameters previously established. Hotel/motel information coupled with public shelter capacity information were used to develop estimates of the number of evacuating vehicles that would find acceptable destinations in each zone.

D. Trip Distribution.

This step concentrated only on those trips originating in a county and finding acceptable destinations within the same county. Productions from each zone were matched with available attractions in all zones. The end product of the step was a trip table showing trips between each zone and all other zones for each evacuation destination type. A unique trip table was developed for each storm scenario, and for each tested behavioral assumption.

E. Roadway Capacity Development.

Number of lanes, area type, and facility type information for each roadway link in the evacuation network were translated into a general 24-hour service volume for comparative purposes. Specific hourly flow rates were then developed for the most critical roadway segments and intersections.

F. Trip Assignment.

This step included the use of another microcomputer program to assign zone to zone trips onto the road segments included in the computerized roadway system. All other categories of evacuation travel patterns (in-county to out-of-county, out-of-county to in-county, out-of-county to out-of-county, and background) were then added in to arrive at total evacuation vehicles per roadway segment. This step then developed a series of volume to capacity ratios to determine which roadway segments would be most congested by evacuation vehicles. Those links with the highest volume to capacity ratio were identified for each county.

G. Calculation of Clearance Times - Travel Time/Queuing Delay Analysis.

This step involved a detailed look at the critical links and intersections identified for the nine counties of the study area. Initially, evacuation zones using the critical link of interest were identified. Evacuation vehicles from each zone were then released to the network in accordance with a behavioral response curve. Based on an assumed hourly flow rate for the critical link, the hourly volume desiring to use the link was then translated into a queuing delay time at the link and an evacuation travel time. The end product of this major step was a set of clearance times for each storm scenario.

WORK FLOW DIAGRAM

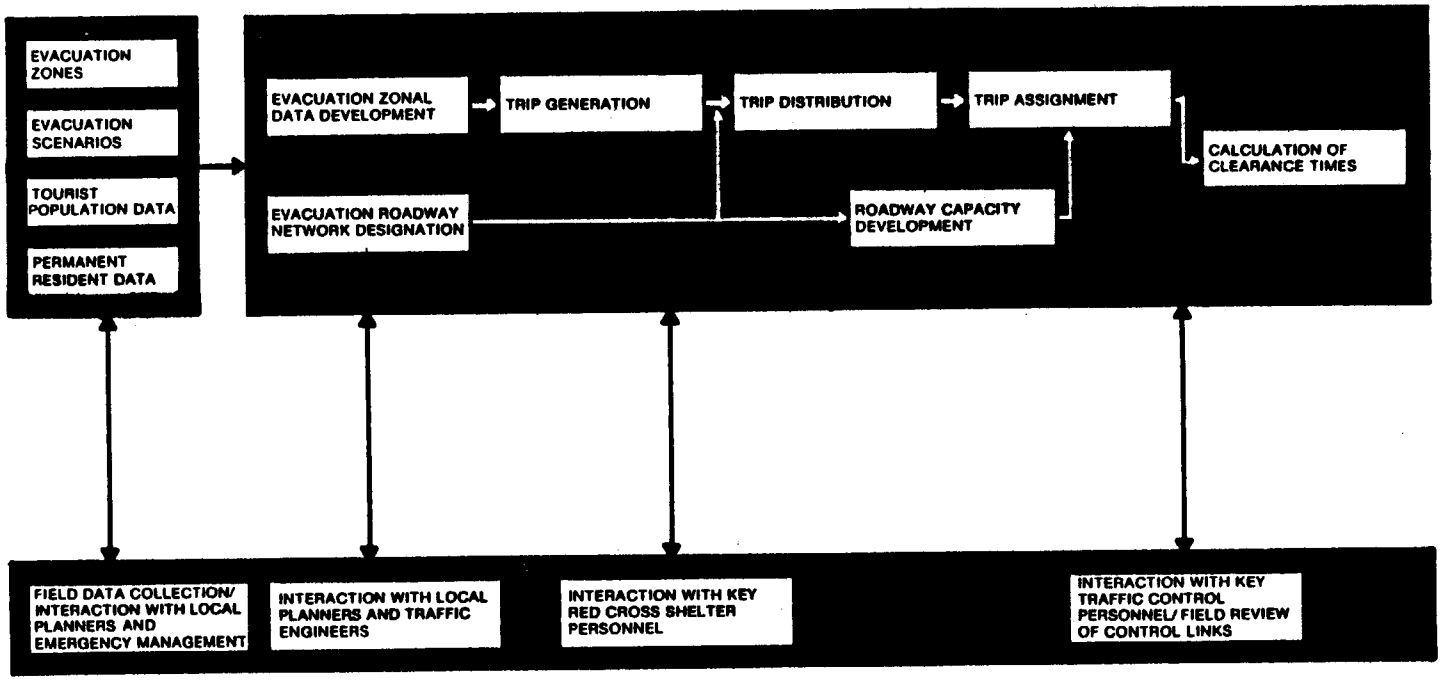

FIGURE 6-21

V. MODEL APPLICATION

Application of the transportation modeling methodology produced several key data items for hurricane evacuation planning and preparedness. Completion of the transportation modeling produced the following:

1. Evacuating people and vehicle parameters
2. Shelter demand and capacity considerations
3. Traffic volumes and critical roadway segments
4. Estimated clearance times

Although many pieces of information are produced in the transportation analysis, these data items are most critical to planning shelter needs, developing traffic control measures, and defining the timing requirements of an evacuation.

A. Evacuating People and Vehicle Parameters.

Using a microcomputer process, total evacuating vehicles and people produced by each zone were split by destination type (public shelter, hotel/motel unit, friend or relative's home, or out of the region). This was accomplished for each storm scenario and further refined by assumed behavioral characteristics of the population-at-risk. The Transportation Analysis Documentation, Appendix Four, provides this data for the zones of each county.

1. Grand Strand Region - Table 6-7 provides the evacuating people and vehicle statistics for Horry and Georgetown Counties. The number of evacuating people and vehicles is given in a range due to the effort of testing different storm scenarios and tourist unit occupancies. For transportation analysis purposes, 128,500 to 223,500 people were assumed to evacuate their dwelling units in the Grand Strand two-county area. Specific figures were assumed for a particular hurricane intensity and tourist occupancy. Appendix Four, Transportation Modeling Documentation, provides this data by scenario and zone for each county.

TABLE 6-7

TRANSPORTATION ANALYSIS EVACUATING PEOPLE AND VEHICLE STATISTICS BY COUNTY - GRAND STRAND AREA

County	Number of People Evacuating Dwelling Units*	Number of Vehicles Evacuating Dwelling Units
Georgetown	19,212 - 44,034	8,206 - 17,593
Horry	109,364 - 179,374	49,052 - 78,344
Grand Strand Counties	128,576 - 223,408	57,258 - 95,937

* Figures are based on 1987 population projections and 100% evacuation of vulnerability areas relating to the Maximum Envelope of Water limits for all hurricane directions and speeds. Evacuating people figures include all mobile home residents and a small percentage of people who will evacuate although theoretically not vulnerable. Ranges of numbers are results of different storm scenarios and varying occupancy of tourist units.

It is important to point out that these figures are based upon 1987 population projections and a 100 percent evacuation of storm surge vulnerability areas relating to the Maximum Envelope of Water (MEOW) limits for all hurricane directions and speeds. Evacuating people figures include all mobile home residents within Horry and Georgetown Counties and a small percentage of people who will evacuate, although theoretically not vulnerable. Thus clearance times (which will be presented subsequently) calculated in the study relate to worst case vulnerability for each category of hurricane. Recent hurricanes affecting the Grand Strand area have generally been paralleling storms with a limited or partial evacuation occurring -- these type hurricane threats generally produce much fewer evacuees than what are calculated under the MEOW concept.

2. Lower Coast Region - Table 6-8 provides the evacuating people and vehicle statistics for Beaufort, Berkeley, Charleston, Colleton, Dorchester, Hampton and Jasper Counties. Due to the effect of testing different storm scenarios and tourist unit occupancies, the number of evacuating people and vehicles is given in a range. For transportation analysis purposes, 159,800 to 423,300 people were assumed to evacuate their dwelling units in the Lower Coast seven-county area. Specific figures were developed for a particular hurricane intensity and tourist occupancy. The Transportation Modeling Appendix provides this data by scenario and zone for each county.

TABLE 6-8

TRANSPORTATION ANALYSIS EVACUATING PEOPLE AND VEHICLE STATISTICS BY COUNTY - LOWER COAST AREA

County	Number of People Evacuating Dwelling Units*	Number of Vehicles Evacuating Dwelling Units
Beaufort	41,590 - 106,460	20,599 - 44,661
Berkeley	24,901 - 30,599	9,871 - 12,870
Charleston	64,431 - 252,979	25,498 - 93,151
Colleton	6,647 - 7,781	2,719 - 3,169
Dorchester	15,187	6,970
Hampton	2,196	816
Jasper	4,864 - 8,131	2,003 - 3,226
Lower Coast Study Area	159,816 - 423,333	68,476 - 164,863

* Figures are based on 1987 population projections and 100% evacuation of vulnerable areas relating to the Maximum Envelope of Water limits for all hurricane directions and speeds. Evacuating people figures include all mobile home residents and a small percentage of people who will evacuate although theoretically not vulnerable. Ranges of numbers are results of different storm scenarios and varying occupancy of tourist units.

Just as in the Grand Strand counties, it is very important to point out that these figures are based upon 1987 population projections and a 100 percent evacuation of storm surge vulnerability areas relating to the Maximum Envelope of Water (MEOW) limits for all hurricane directions and speeds. Evacuating people figures include all mobile home residents within the seven counties and a small percentage of people who will evacuate although theoretically not vulnerable. Thus clearance times (which will be presented subsequently) calculated in the study relate to worst case vulnerability for each category of hurricane. Recent hurricanes affecting the Lower Coast counties have generally been paralleling storms with a limited or partial evacuation occurring. These type hurricane threats generally produce many fewer evacuees than those calculated under the MEOW concept.

B. Shelter Demand/Capacity Considerations.

While the data discussed above is extremely important, it is most useful when matched with available sheltering. It is important to note that evacuating people and vehicle statistics generated by each county, evacuation zone, and destination type reflect where evacuees would go assuming enough safe destinations were available. After matching evacuees' destination desires with available shelters, the transportation analysis revealed that hotel/motel space will not be as widely available within the entire study area as perceived by the evacuating population. For transportation modeling purposes, those evacuees unable to be accommodated by in-county and study area hotel/motel space were assumed to find hotel/motel space outside the study area.

1. Grand Strand Region - Public shelter space is generally adequate for in-county demand in Horry and Georgetown Counties. Table 6-9 provides the calculated public shelter demand and available capacity by storm scenario. In a worst case category 4 or 5 hurricane (Storm Scenario C), there may be a lack of safe public shelter space in Horry County. This is particularly true if there is a high tourist occupancy at the time an evacuation begins. Inland counties such as Marion, Florence, and Dillon would need to assist in meeting public shelter demand from Horry County in the scenario C situation. Again, it is important to remember that the public shelter demand figures are based upon the MEOW concept, include a large portion of mobile home evacuees, and would be much lower for a paralleling storm with a limited or partial evacuation of scenario A zones.

2. Lower Coast Region - Table 6-10 provides the calculated public shelter demand and available capacity by storm scenario for Beaufort, Berkeley, Charleston, Colleton, Dorchester, Hampton and Jasper Counties. Public shelter is generally adequate for in-county demand in each of these seven counties. However, in a category 4-5 hurricane Beaufort County will have a deficit of safe public shelter space which will require assistance from Jasper, Hampton and possibly Allendale Counties. In a category 3-5 worst case hurricane, Charleston County will have a deficit of space which will require assistance from Berkeley and Dorchester Counties. Public shelter demand could be lower (then the figures calculated) for a paralleling storm with a limited or partial evacuation. It is important to note that public shelter demand figures are based upon the MEOW concept and include a large portion of mobile home evacuees.

TABLE 6-9

PUBLIC SHELTER DEMAND/CAPACITY STATISTICS
GRAND STRAND AREA*

County	County Storm Scenario A	B	C	
Georgetown	3,810 - 4,340	4,230 - 4,760	6,280 - 6,810	(Demand)
	18,200	17,200	11,700	(Capacity)
Horry	29,040 - 36,640	32,680 - 40,860	36,530 - 44,700	
	79,007	79,007	27,092	

*See footnote for Table 6-7

TABLE 6-10

PUBLIC SHELTER DEMAND/CAPACITY STATISTICS
LOWER COAST AREA*

County	County Storm Scenario A	B	C	D	
Beaufort	7,350 - 11,088	8,468 - 12,210	11,790 - 15,530	13,550 - 17,280	(Demand)
	21,756	21,756	18,756	10,522	(Capacity)
Berkeley	8,590	10,010(1)	--	--	
	16,350	16,350	--	--	
Charleston	16,350 - 17,634	23,898 - 25,210	44,720 - 46,030	57,470 - 58,760	
	48,665	48,665	44,375	32,150	
Colleton	2,990 - 3,250	3,070 - 3,340	--	--	
	8,804	8,804	--	--	
Dorchester	4,300(2)	--	--	--	
	17,275	--	--	--	
Hampton	550(3)	--	--	--	
	5,875	--	--	--	
Jasper	1,220	2,040(4)	--	--	
	5,972	5,972	--	--	

*See footnote for Table 6-8

(1)Plus additional 5,000 from Charleston in Cat. 4-5
(2)Plus additional 4,000-12,000 from Charleston in Cat. 4-5
(3)Plus additional 3,000 from Beaufort in Cat. 4-5
(4)Plus additional 3,500 from Beaufort in Cat. 4-5

C. Traffic Volumes and Critical Roadway Segments.

The Transportation Analysis Documentation Appendix C provides the assigned evacuating vehicle figures for all roadway segments in each county's evacuation network. In addition, the appendix provides the volume to capacity ratios calculated for each link. Those roadway segments with the highest volume to capacity ratios were identified as the critical links for each county. Table 6-11 lists the critical roadway segments by county. Critical links and intersections are listed in order of severity. These links control the flow of evacuation traffic during a hurricane evacuation and are key area for special traffic control.

TABLE 6-11

CRITICAL ROADWAY SEGMENTS BY COUNTY

South Carolina Hurricane Evacuation Study Transportation Analysis

GRAND STRAND REGION

Georgetown County

Merriman and H-Market St. intersection
U.S. 521/Alternate 17 intersection
Main Street (U.S. 521) in Andrews
U.S. 701/U.S. 521/U.S. 17 intersection in Georgetown
Bridges over Great Pee Dee and Waccamaw Rivers

Horry County

S.R. 544 Drawbridge near Socastee
Church St. (U.S. 501) and Wright Blvd. (U.S. 378) intersection in Conway
U.S. 378 (2-lane section) west of Conway
S.R. 9 at Stephens Crossroads
S.R. 9 bridge over Waccamaw River
Pine Island Bridge
Little River Neck Rd./Sea Mountain Rd. intersection just east of Little River
Kings Highway/U.S. 501 intersection
17 Bypass and U.S. 501 interchange
S.R. 544 and U.S. 501 interchange
S.R. 544 and U.S. 17

TABLE 6-11 (Continued)

CRITICAL ROADWAY SEGMENTS BY COUNTY

South Carolina Hurricane Evacuation Study Transportation Analysis

LOWER COAST REGION

Beaufort County

South of Broad River:
- S.R. 170 and U.S. 278 intersection west of Bluffton
- S.R. 46 and S.R. 170 intersection
- Sea Pines Circle
- Beach City Rd./Whooping Crane Way/U.S. 278 intersections
- Palmetto Dunes and U.S. 278
- (U.S. 278 and S.R. 46 intersection)
- (Callawassie Dr. and S.R. 170 intersection)

North of Broad River:
- U.S. 21 at Gardens Corner
- Boundary St./Ribaut Rd. intersection
- S.R. 280/U.S. 21 intersection
- Lady's Island Bridge
- U.S. 21/S.R. 802 intersection

Berkeley County

I-26
Alternate 17/I-26 interchange
Redbank Road east of U.S. 52

Charleston County

Ashley River Rd. and Savage Rd. intersection just south of Mark Clark Expressway
Folly Rd. and Savannah Hwy. (U.S. 17) intersection
Sawyer Bridge north of Sullivans Island
Meeting Street south of U.S. 17
I-26 north of U.S. 52 turnoff
Cooper River Bridge
I-26 from Dorchester Rd. to Airport Blvd.
Maybank Highway and Folly Road intersection
Maybank Highway and U.S. 17
U.S. 52/I-26 intersection
S.R. 174 and U.S. 17 intersection

TABLE 6-11 (continued)

CRITICAL ROADWAY SEGMENTS BY COUNTY

South Carolina Hurricane Evacuation Study Transportation Analysis

LOWER COAST COUNTIES (continued)

Dorchester County

S.R. 61 from Charleston County line to Colleton County line
Carolina and Main St. intersection in Summerville
I-95
I-26
Alternative 17/I-26 interchange (in Berkeley County)

Colleton County

S.R. 61 east of I-95
I-95
Padgett Loop (S.R. 64) and Wichman St. (Alt. 17) intersection
S.R. 174 and U.S. 17 intersection (in Charleston County)
S.R. 174 and S.R. 162 (Adams Run in Charleston County)

Hampton County

I-95
U.S. 278 and S.R. 68 intersection
Hickory Hill and Carolina St. (U.S. 278) intersection

Jasper County

S.R. 462 and I-95 interchange
Jacob Smart Blvd. and Main St. (U.S. 278) intersection
U.S. 278 north of Beaufort County line
U.S. 17 and I-95 interchange
I-95 north of Ridgeland
S.R. 170 and U.S. 17 intersection
S-88 road east of I-95

D. Estimated Clearance Times.

The most important product of the transportation analysis is the clearance times developed by storm scenario and by behavioral characteristic by county. Clearance time is one of two major time components involved in issuing an evacuation order or storm advisory. Clearance time must be added to prelandfall hazards time to arrive at an evacuation order time which ensures that evacuees can reach safe shelter before the arrival of hazardous conditions. Figure 6-22 illustrates the two compoments of evacuation time and the relation of clearance time to overall evacuation time.

Clearance time is the time required to clear the roadways of all vehicles evacuating in response to a hurricane situation. Clearance time begins when the first evacuating vehicle enters the road network (as defined by a hurricane) evacuation behavioral response curve) and ends when the last evacuating vehicle reaches its destination. Clearance time includes the time required by evacuees to secure their homes and prepare to leave (referred to as mobilization time), the time spent by evacuees traveling along the road network (referred to as travel time), and the time spent by evacuees waiting along the road network due to traffic congestion (referred to as queuing delay time). Clearance time does not relate to the time any one vehicle spends traveling on the road network.

1. Grand Strand Region - Table 6-12 presents the clearance times estimated for Horry and Georgetown Counties. Clearance times are stratified by intensity of hurricane (storm scenario), by rate of response on the part of the evacuating population, and by level of tourist occupancy. Clearance times are also stratified by traffic control strategy.

Clearance times range from 11 3/4 hours to 20 1/2 hours in Horry County. In Georgetown County, clearance times range from 5 to 13 3/4 hours. At the suggestion of the local disaster preparedness committee, clearance times were examined for a category 4-5 hurricane situation in which Garden City and Surfside Beach traffic would be routed through Georgetown County. The intention was to lower clearance times in Horry County through this traffic control strategy. The resulting times show that approximately two hours could be saved in Horry County. However, Georgetown County times are increased by two to four hours using this approach. A paralleling storm with a minimal evacuation occurring would require clearance times less than those reported here. This is an important factor in comparing recent hurricane threats and their associated clearance times with clearance times developed in this study.

COMPONENTS OF EVACUATION TIME

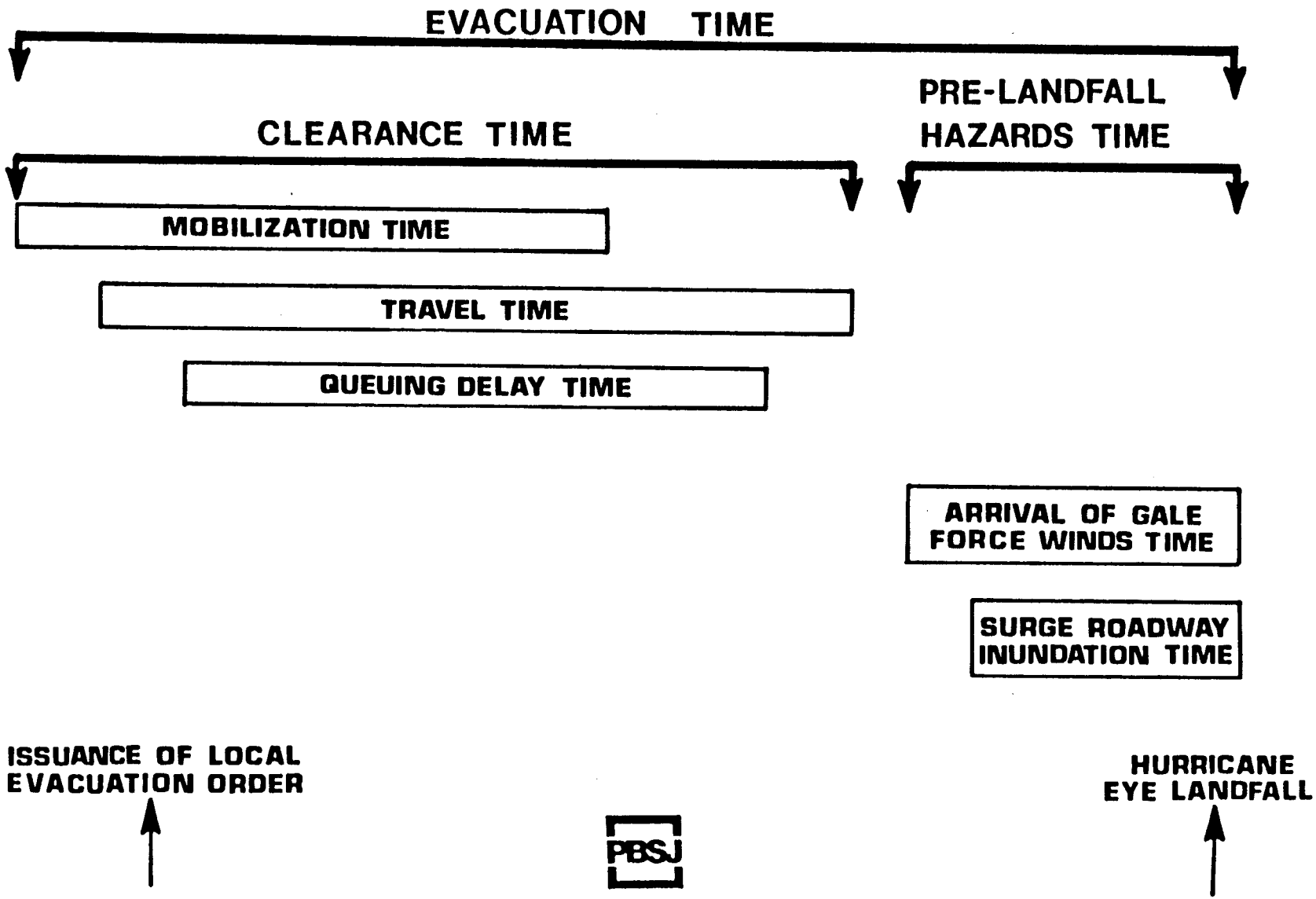

FIGURE 6-22

TABLE 6-12

CLEARANCE TIMES (IN HOURS)

GRAND STRAND COUNTIES

	Horry County		Georgetown County	
	Medium Tourist Occupancy	High Tourist Occupancy	Low Tourist Occupancy	High Tourist Occupancy
Category 1-2 Hurricane				
Rapid Response	11 3/4	13 1/2	5	5 3/4
Medium Response	12 1/4	14	6 1/2	6 1/2
Slow Response	13	14 3/4	9 1/2	9 1/2
Category 3 Hurricane				
Rapid Response	13 3/4	15 1/4	6	6 1/2
Medium Response	14 1/4	15 3/4	6 1/4	7 1/2
Slow Response	15	16 3/4	9 1/2	9 1/2
Category 4-5 Hurricane				
Rapid Response	15 1/2 (14 1/4)*	19 3/4 (17 3/4)	10 1/4 (13)	12 1/2 (16 3/4)
Medium Response	15 3/4 (14 1/2)	20 (18)	11 1/4 (14 1/2)	12 3/4 (17 1/2)
Slow Response	16 1/2 (15 1/4)	10 1/2 (18 1/2)	12 1/4 (14 1/4)	13 3/4 (18 1/4)

*Clearance times in parentheses are those times resulting from sending Garden City and Surfside Beach traffic through Georgetown County.

2. Lower Coast Region - Table 6-13 displays the clearance times estimated for Beaufort, Berkeley, Charleston, Colleton, Dorchester, Hampton, and Jasper Counties. The following ranges of times were developed for each county:

Beaufort (north of Broad)	4 3/4 to 13 3/4 hours
Beaufort (south of Broad)	6 to 18 3/4 hours
Berkeley	4 1/2 to 9 3/4 hours
Charleston	5 3/4 to 23 hours
Colleton	4 3/4 to 12 1/2 hours
Dorchester	6 to 15 3/4 hours
Hampton	4 1/2 to 9 hours
Jasper	7 1/4 to 12 1/4 hours

It should be noted that the upper end of clearance times for Colleton and Dorchester Counties are due almost entirely to Charleston County traffic. Once the Mark Clark Expressway is finished in Charleston County, significant reductions in clearance times could result for Charleston, Dorchester and Colleton Counties. In Beaufort County, a traffic control measure involving the splitting of traffic at Bluffton was examined to reduce clearance times south of the Broad River. This measure reduced clearance times up to 5½ hours in the worst case situation.

Since clearance time begins before an evacuation order is issued (due to people mobilizing and leaving before the order or advisory is issued), only that portion of clearance time assumed to be needed after the order should be used in calculating evacuation order times. To arrive at post-evacuation order clearance times for each county, the following adjustment has to be made:

Clearance time for:

Rapid Response	Subtract 1 Hour
Medium Response	Subtract 2 Hours
Slow Response	Subtract 3 Hours

For this reduction to be valid, 15 to 20 percent of the evacuating population must already be moving at the time an evacuatin order or strong advisory issued. This adjustment corresponds to the hours before the evacuation order previously illustrated in each behavioral response curve. Since it is difficult to measure how quickly the evacuating population is actually responding, it may be prudent to use the medium or slow behavioral response curve times in estimating evacuation order time.

TABLE 6-13

CLEARANCE TIMES (IN HOURS)

LOWER COAST COUNTIES

	Beaufort County (north of Broad River)			Beaufort County (south of Broad River)		
	Low Tourist Occupancy	Medium Tourist Occupancy	High Tourist Occupancy	Low Tourist Occupancy	Medium Tourist Occupancy	High Tourist Occupancy
Category 1 Hurricane						
Rapid Response	4 3/4	5	5 1/4	6	8 1/2	11 1/4
Medium Response	6	6	6	6 1/4	9	11 3/4
Slow Response	9	9	9	9	10 1/4	12 1/2
Category 2 Hurricane						
Rapid Response	5	5 1/4	5 1/4	8 1/4	10 1/4	13 3/4 (10 1/4)*
Medium Response	6	6	6	8 1/4	11 1/2	14 (11 1/2)*
Slow Response	9	9	9	9 1/4	12 1/4	14 3/4 (12 1/4)*
Category 3 Hurricane						
Rapid Response	6	6 1/4	6 1/4	10 1/2	13 3/4 (10 1/4)*	17 (11 1/2)*
Medium Response	6 3/4	7	7	11 1/4	14 (11 1/2)*	17 1/4 (12)*
Slow Response	9	9	9	12	14 3/4 (12 1/4)*	18 (12 1/4)*
Category 4-5 Hurricane						
Rapid Response	12	12 1/4	12 1/2	11 1/2	15 (11)*	18 (12)*
Medium Response	12 1/2	12 3/4	13	12	15 1/4 (11 1/4)*	18 1/4 (12 1/2)*
Slow Response	13 1/4	13 1/2	13 3/4	12 1/4	16 (12 1/2)	18 3/4 (13 1/4)*

*Numbers in parentheses indicate those times that might be achieved by achieving a 60/40 split of westbound traffic on U.S. 278 and S.R. 36 through Bluffton by means of special traffic control.

TABLE 6-13 (continued)

CLEARANCE TIMES (IN HOURS)

LOWER COAST COUNTIES

	Charleston County				Colleton County	
	Medium Tourist Occupancy	High Tourist Occupancy	Berkeley County	Dorchester County	Low Tourist Occupancy	High Tourist Occupancy
Weak Category 1						
Rapid Response	5 3/4	5 3/4	- -	- -	4 3/4	4 3/4
Medium Response	6 1/2	6 3/4	- -	- -	6	6
Slow Response	9 1/4	9 1/4	- -	- -	9	9
Category 1-2 Hurricane						
Rapid Response	9 3/4	10 3/4	4 1/2	6	4 3/4	4 3/4
Medium Response	10 1/2	11 1/2	6	6 3/4	6	6
Slow Response	12	13	9	9	9	9
Category 3 Hurricane						
Rapid Response	16*	16*	8 1/4	14 3/4**	11 1/4*	11 1/4*
Medium Response	16 3/4*	17*	8 3/4	15 1/4**	11 3/4**	11 3/4*
Slow Response	18 1/4*	18 1/4*	9 3/4	15 3/4**	12 1/2*	12 1/2*
Category 4 Hurricane						
Rapid Response	20 1/2*	20 1/2*	8 1/4	14 3/4**	11 1/4*	11 1/4*
Medium Response	21 1/2*	21 1/2*	8 3/4	15 1/4**	11 3/4*	11 3/4*
Slow Response	22 3/4*	23*	9 3/4	15 3/4**	12 1/2*	12 1/2*

*Times could be reduced by 20% to 25% once the Mark Clark Expressway is completed in Charleston County.
**Times could be reduced by 35% to 45% once the Mark Clark Expressway is completed in Charleston County.

TABLE 6-13 (continued)

CLEARANCE TIMES (IN HOURS)

LOWER COAST COUNTIES

	Jasper County	Hampton County
Category 1-2 Hurricane		
Rapid Response	7 1/4	4 1/2
Medium Response	8	6
Slow Response	9 1/4	9
Category 3-5 Hurricane		
Rapid Response	10 3/4*	5 3/4
Medium Response	11 1/4*	6 1/2
Slow Response	12 1/4*	9

*Clearance times for Jasper County could be as much as 20% lower if tourist occupancy is low in Beaufort County during a Category 3, 4, or 5 hurricane.

VI. TRAFFIC CONTROL MEASURES

The movement of evacuating vehicles during a hurricane evacuation requires extensive traffic control efforts to make maximum use of roadway capacity and to expediate safe escape from hurricane hazards. The development of traffic control techniques for critical evacuation roadway links should always involve the U.S. Coast Guard, local police, state highway patrolmen, fire and emergency management personnel. The following traffic control techniques/strategies were discussed with disaster preparedness study review committee members:

1. As manpower supply allows, ideally, two officers should be stationed at each critical intersection, one to move traffic, the other to assist disabled vehicles. Critical links and intersections discussed previously should be used as a starting point in developing manpower assignments.

2. All available two trucks should be positioned along key travel corridors and critical links. At a minimum, two trucks should be at major bridge crossings to remove disabled vehicles.

3. Where intersections will continue to have signalized control, signal patterns providing the most "green time" for the approach leading away from the coast should be actuated by the State Highway Department field office.

4. All draw/swing bridges needed for evacuation should be locked in the "down" position during a hurricane warning. Boat owners must be made aware of flotilla plans and time requirements for securing vessels. Optimally, industrial and recreational vehicles should be moved to safe harbor during or before a hurricane watch.

5. In densely populated coastal areas where expected traffic volumes greatly exceed available capacity, the use of reserve flow on roadway facilities with 3 or more lanes have been considered and used; however, one lane moving against the flow of evacuation traffic must always be kept open for emergency vehicles and transit vehicles picking up autoless evacuees. In the South Carolina study area, review committee members felt strongly that this would not be a good strategy. Many multi-lane highways become two-lane immediately outside the study area and requirements for traffic control personnel far surpass available manpower.

6. Manual direction of traffic should be supplemented by physical barriers/cones that are adequately weighted down and which are placed to channel traffic and prevent unnecessary turning and merging conflicts. This strategy can be used effectively at grade separated interchanges listed previously in the critical link/intersection tables.

7. The movement of mobile homes and campers along evacuation routes should be minimized after a hurricane warning is issued. A disabled mobile home could block the only escape route available for evacuation in some areas. Such vehicles are difficult to handle late in an evacuation due to sporadic wind gusts.

APPENDIX ONE, PART THREE
COMPUTER SIMULATION OF HURRICANES AFFECTING THE SOUTH CAROLINA COAST

I. COMPUTER MODELS

By the 1970s sophisticated computer models capable of reflecting local variables affecting surge heights were developed for specific coastal basins. The most notable of these is the Special Program to List the Amplitude of Surges from Hurricanes (SPLASH). Two versions of the model, SPLASH I and SPLASH II, were developed for selected basins along the Atlantic and Gulf Coasts. However, SPLASH models are limited in that they calculate storm surge heights for open coastlines only. The most recent mathematical model, Sea, Lake and Overland Surges from Hurricanes (SLOSH) is a variation of the SPLASH models and has expanded capability for calculating projected surge heights within specific coastal basins.

The Sea, Lake and Overland Surges from Hurricanes (SLOSH) model is the National Weather Service's latest and most sophisticated model for calculating potential surge heights associated with hurricanes. The SLOSH model not only furnishes forecasts of hurricane surge heights on open coastlines; after factoring in local variables it provides forecasts of surge heights produced by hurricanes in selected Atlantic and Gulf Coast basins. In addition, SLOSH is capable of simulating storm routes within bays, estuaries, and rivers, as well as calculating surge heights for inland locations. Significant natural and man-made barriers can be factored into the SLOSH model and their effects reflected in the calculations of surge heights.

Peculiar characteristics of local basins are constructed as input data within the SLOSH model. Typical characteristics include bathymetry of nearshore areas, inland topography, river basins, waterways, tidal estuaries and bays, large bodies of water inland (but within the coastal areas) and such natural or man-made barriers as roadbeds, levees, stabilized dunes and dune ridges, barrier islands, and segments of the continental shelf. With such variables factored in, the SLOSH model is capable of simulating saltwater flooding (inland flooding from storm surge with or without tidal effects), overtopping of barriers, flow through barrier gaps, "stacking" of water masses in upper marshes, estuaries, bays and waterways, and other hurricane-related events, resulting in more detailed, accurate simulations.

The SLOSH model is designed for use in an operation mode as well. Forecast and hindcast runs can be made without having controlled, locally calibrated or observed wind speeds. The rationale for this is it avoids having the user predict unavailable input data. The SLOSH model also contains a storm model accepting input of simple, time-dependent meteorological data from which the driving forces of simulated storms are calculated. These data are as follows:

1. Latitude and longitude of storm positions at six-hour intervals, for a 72-hour track;

2. Central barometric pressures at six-hour intervals;

3. Storm size, twice the distance measured from the center to the radius of maximum winds (RMW).

An additional requirement is the initial height of the water's surface taken well before the storm directly affects the area of interest. Initial water surface height is the observed, quiescent water surface height two days prior to the expected arrival of the storm, and includes any existing abnormal rise in water surface.

The values of functions for the coefficients within the SLOSH model are generalized to serve for modeling all storms within all basins, and are set empirically through comparison of expected and the observed meteorological surge height data from historical hurricanes. It is probable that the coefficients are a function of differing storm parameters and basin characteristics, therefore calibration of the model based on a single storm event within a basin is avoided since there is no guarantee the same coefficient values will apply to other storms.

II. SLOSH GRID CONFIGURATION

The SLOSH model utilizes a curvilinear (fan-shaped) polar coordinate grid system within which a particular coastal basin is represented (Fig. A-1, A-2). For most basins, resolutions of the model for inland locations near the focus is approximately 1/2-sq. mi. at the coastline, becoming progressively larger seaward (storm surge heights at sea are not of primary importance in evacuation planning). The advantage of this grid system is it offers good resolution in areas of primary interest while conserving computer resources by minimizing the numbers of calculations required to model a storm.

To produce computed surge lines on a line printer the basin's polar grid is transformed into equally-spaced lines, distorting latitude, longitude, and all geographic and topographic features within the basin.

III. MODEL VERIFICATION

After a SLOSH model has been constructed for a specific basin, verification experiments - real-time operational runs using available meteorological data from historical storms as input in the model - are conducted. The input data consists solely of observed or hindcast storm parameters and initial surface heights observed approximately 48 hours prior to the storm's landfall or effect on the basin. Expected surge heights are compared with observed heights from historical storms and adjustments to input or basin data made where necessary. Adjustments are made not to force agreement between expected and observed surge heights (from historical storms), but to more accurately represent basin characteristics and/or historical storm parameters.

Where realism of results produced was inconsistent across the basin, examination of basin data usually revealed inaccuracies in representation of barrier heights, missing or errant values in bathymetric charts or topographic maps, historical storm data which proved to be coarse, and/or prescribed parameters at variance with time or with an unrealistically smoothed storm track. Further analysis and subjective decisions amended storm tracks and other historical data used in the verification process.

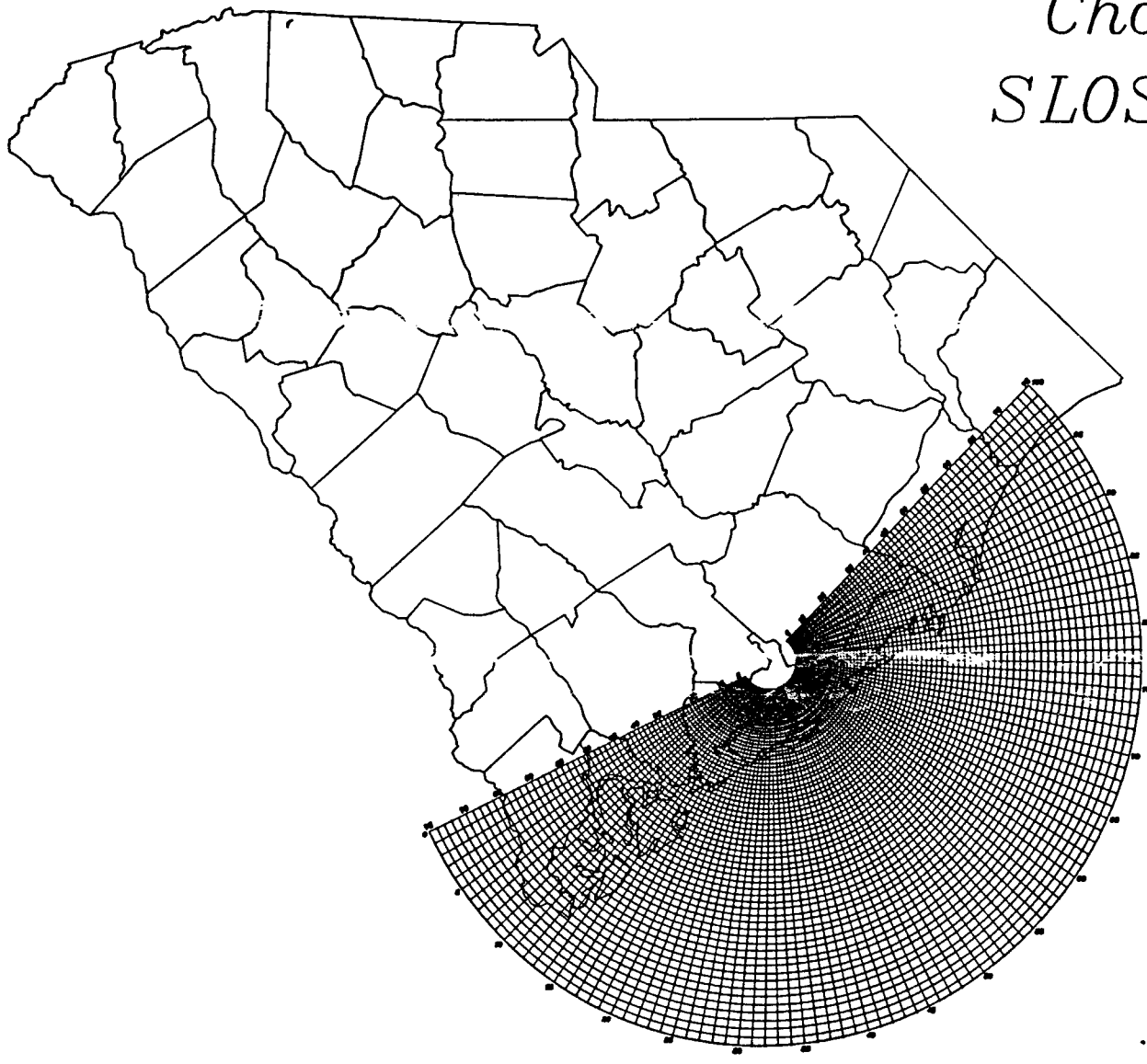
Charleston
SLOSH Basin
N
*Produced by the SCWRC Cartographic Laboratory

Figure A-1

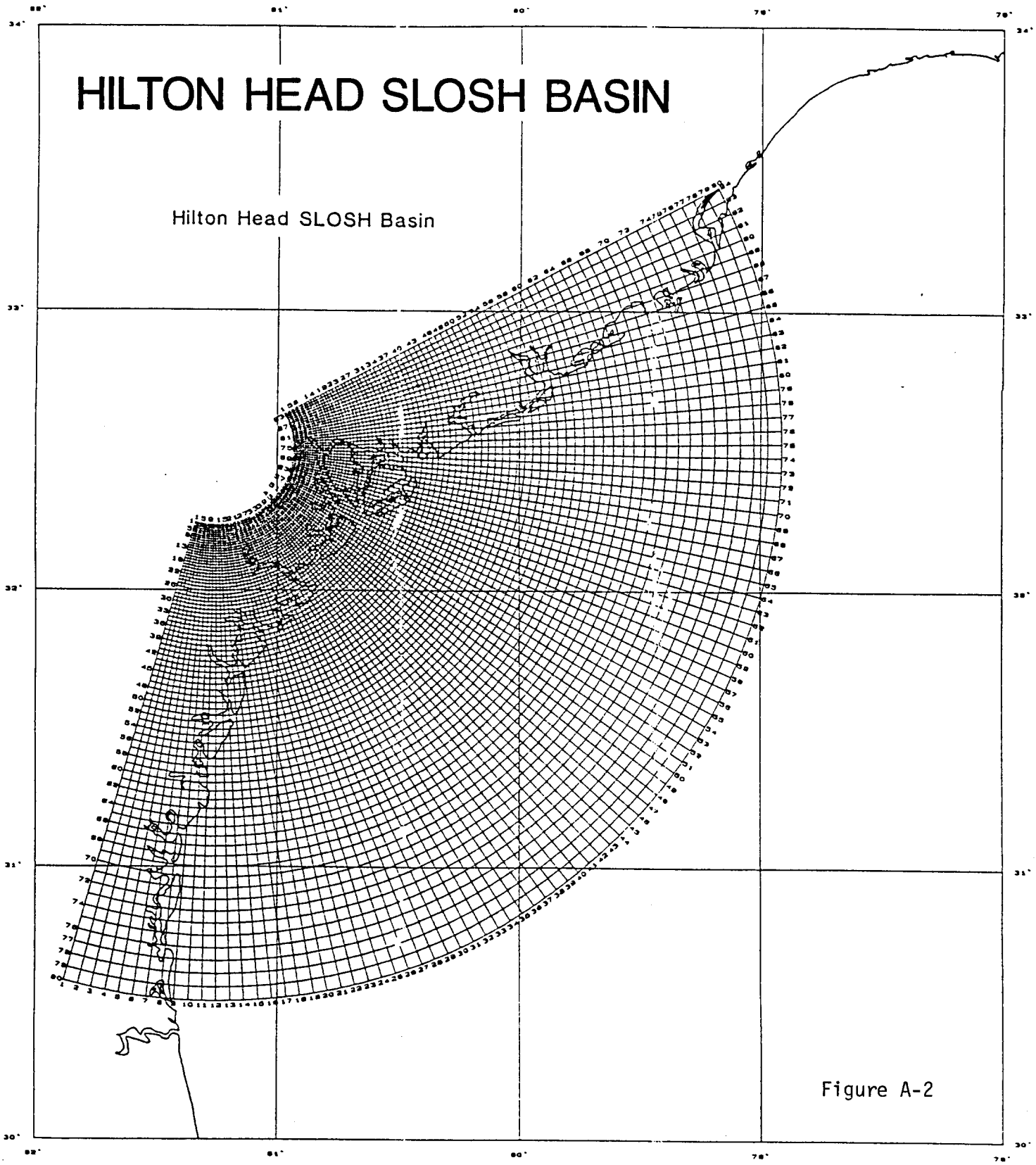

Figure A-2

Hurricanes used in the verification process were those which significantly affected the South Carolina coast in recent years: the 1940 hurricane, Hazel (1954), Gracie (1959) and David (1979).

IV. MODEL OUTPUT

SLOSH output for a modeled storm consists of a tabulated storm history with values for storm position, forward speed, direction of motion, drop in barometric pressures, radius of maximum winds, a surface envelope of surges and, for pre-selected grid points, time history tabulations of values for surge heights, wind speeds and wind direction. If desired the model can provide two-dimensional "snapshot" displays of surges at specific times during a simulation.

Maximum surges along coastlines do not necessarily occur simultaneously; several hours difference in times of maximum surge between grid points is not unusual. SLOSH model printouts of the surface envelope of highest surges contain the maximum surge height values calculated for each grid point in the model, irrespective of the time (in the simulation) the maximum surge height occurs.

A portion of a surface envelope of highest surges from the SLOSH model is shown in Fig. A-3. Computed surge heights above mean sea level are printed in the center of each grid square. "." and "wet" symbols mean dry land and water depths less than one foot above terrain, respectively. Other information includes symbols for natural and man-made geographic and/or topographic features, latitude and longitude, and storm path through the basin.

Time history data of surge heights, wind speed and wind directions are tabulated for each pre-selected grid point in the model. Data are listed at ten minute intervals, for a minimum 30-hour storm track, beginning approximately 18 hours prior to projected landfall or closest approach, and continuing for twelve hours afterwards. Surge heights are given in feet above mean sea level; wind speeds in miles per hour; and wind direction in degrees from which it is blowing (90.0 being due east). Figures A-4 through A-6 are tabular printouts of time history information provided by the SLOSH model.

NW/12MPH/C2/RS030 NW-BOUND HUR, LF 30 ST MI RIGHT OF SAVANNAH BEACH
DELTA P = 40 MB CAT = 2 RMW = 20 ST. MI. DATUMS = 1.0/1.0
CALCULATIONS PERFORMED AT DAY-TIME DEC 19, 1985 - 20:22:51.22

SURFACE ENVELOP OF HIGHEST SURGES ABOVE MEAN SEA LEVEL,COMPUTED DATA ON TRNSFRMD IMAGE SQUARES OF A POLAR GRID

++++=OUTLINE OF LAKE, OR LAND-WATER BOUNDARY
LLLL=LEVEE
IIII=INTRACOASTAL WATERWAY
SSSS=SPOIL BANK
PPPP=PASS BETWEEN LAKES
TTTT=LATITUDE LINE ON IMAGE PLANE
>>>>=STORM PATH + HRLY POSITNS

* =LOCATION OF CITY,TOWN,TIDE GAGE,ETC.
XXXX=RAILROAD
RRRR=ROAD,REEF
CCCC=CAUSEWAY
. =DRY LAND, WET=WATER LESS 1 FT ABOVE TERRAIN
GGGG=LONGITUDE LINE ON IMAGE PLANE

OBSERVER IS ON SEA AND FACING LAND. LAST COLUMN GIVES DISTANCES BETWEEN CIRCULAR ARCS IN ST MILES

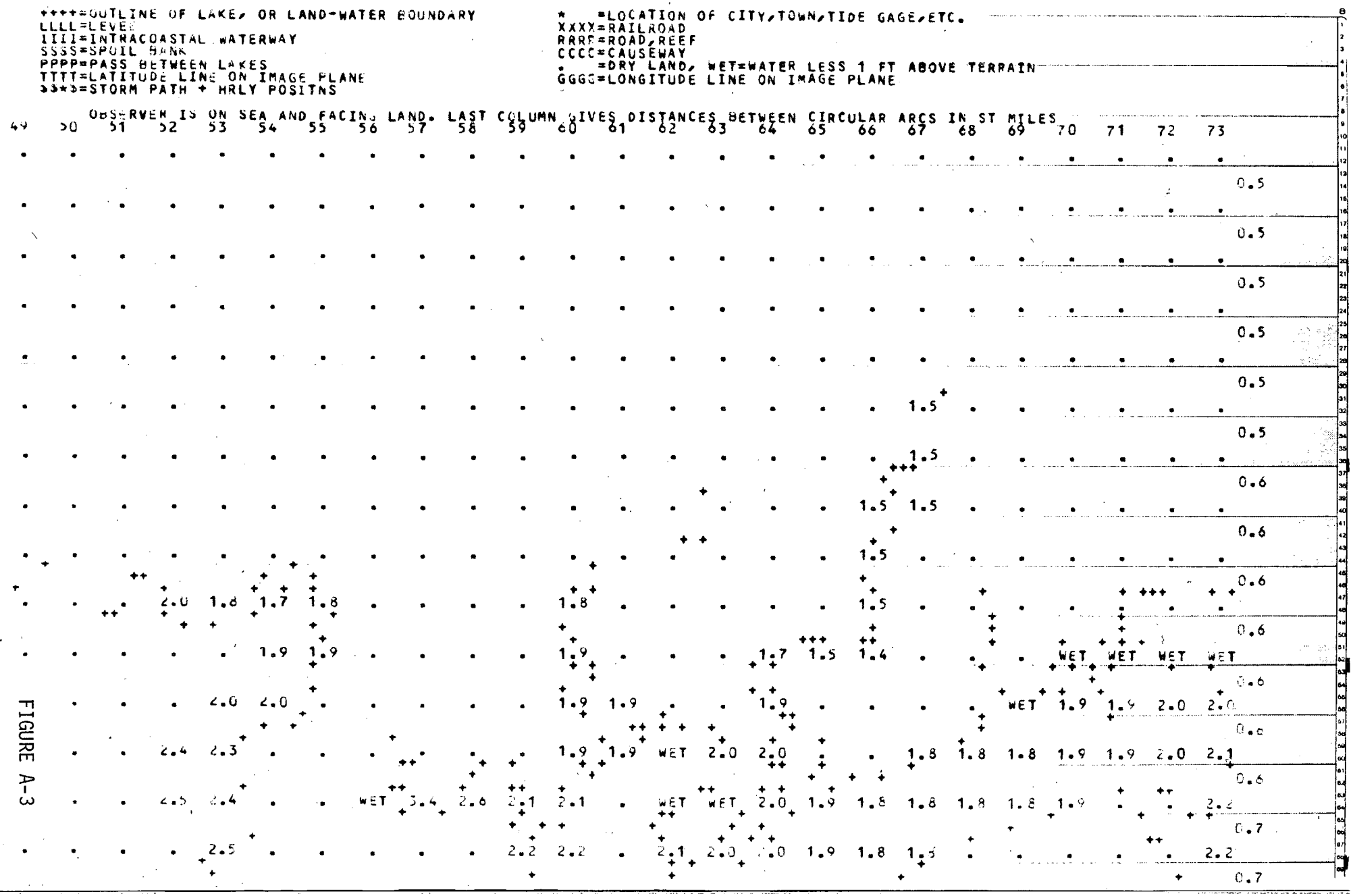

FIGURE A-3

FIGURE A-3 (Cont'd)

NW/12MPH/C2/RS030 NW-BOUND HUR, LF 30 ST MI RIGHT OF SAVANNAH BEACH
DELTA P = 40 MB CAT = 2 RMW = 20 ST. MI. DATUMS = 1.0/1.0
TIME HISTORIES OF SURGES AT SELECTED GAGES OR GRID P CINTS

HOUR	DAY	MTH	YEAR	TIVOLI R 38, 10	KILKENNY 40, 15	SUNBURY 41, 11	HMOON LDG 44, 10	YELLOW BL 47, 13	WALBURG I 44, 15	S.NEWPORT 46, 6	HARRIS NK 47, 12	MQUEEN IN 47, 17	ST.CATS S 50, 15
1400	15	SEP	1990	COMPUTATIONS BEGIN									
1430				3.00	1.00	1.00	4.00	1.00	1.02	4.00	2.00	1.03	1.03
1500	15	SEP	1990	3.00	1.03	1.00	4.00	1.00	1.03	4.00	2.00	1.03	1.03
1530				3.00	1.04	1.00	4.00	1.01	1.03	4.00	2.00	1.03	1.03
1600	15	SEP	1990	3.00	1.03	1.01	4.00	1.01	1.03	4.00	2.00	1.03	1.03
1630				3.00	1.02	1.01	4.00	1.02	1.03	4.00	2.00	1.03	1.03
1700	15	SEP	1990	3.00	1.02	1.02	4.00	1.02	1.03	4.00	2.00	1.04	1.04
1730				3.00	1.03	1.02	4.00	1.02	1.04	4.00	2.00	1.04	1.04
1800	15	SEP	1990	3.00	1.03	1.02	4.00	1.02	1.04	4.00	2.00	1.05	1.05
1830				3.00	1.04	1.02	4.00	1.03	1.05	4.00	2.00	1.05	1.05
1900	15	SEP	1990	3.00	1.04	1.02	4.00	1.03	1.05	4.00	2.00	1.06	1.06
1930				3.00	1.05	1.03	4.00	1.03	1.06	4.00	2.00	1.07	1.07
2000	15	SEP	1990	3.00	1.06	1.03	4.00	1.04	1.07	4.00	2.00	1.07	1.07
2030				3.00	1.06	1.03	4.00	1.04	1.07	4.00	2.00	1.08	1.08
2100	15	SEP	1990	3.00	1.07	1.04	4.00	1.05	1.08	4.00	2.00	1.08	1.08
2130				3.00	1.07	1.04	4.00	1.05	1.08	4.00	2.00	1.09	1.08
2200	15	SEP	1990	3.00	1.08	1.05	4.00	1.06	1.09	4.00	2.00	1.09	1.09
2230				3.00	1.08	1.05	4.00	1.06	1.09	4.00	2.00	1.09	1.09
2300	15	SEP	1990	3.00	1.08	1.06	4.00	1.07	1.09	4.00	2.00	1.09	1.09
2330				3.00	1.08	1.06	4.00	1.07	1.09	4.00	2.00	1.10	1.09
0000	16	SEP	1990	3.00	1.08	1.06	4.00	1.07	1.09	4.00	2.00	1.10	1.10
0030				3.00	1.08	1.07	4.00	1.08	1.10	4.00	2.00	1.10	1.10
0100	16	SEP	1990	3.00	1.09	1.07	4.00	1.08	1.10	4.00	2.00	1.10	1.10
0130				3.00	1.09	1.07	4.00	1.08	1.10	4.00	2.00	1.10	1.10
0200	16	SEP	1990	3.00	1.09	1.07	4.00	1.09	1.10	4.00	2.00	1.11	1.11
0230				3.00	1.09	1.08	4.00	1.09	1.11	4.00	2.00	1.11	1.11
0300	16	SEP	1990	3.00	1.10	1.08	4.00	1.09	1.11	4.00	2.00	1.12	1.11
0330				3.00	1.10	1.08	4.00	1.09	1.12	4.00	2.00	1.12	1.12
0400	16	SEP	1990	3.00	1.11	1.08	4.00	1.10	1.12	4.00	2.00	1.13	1.13
0430				3.00	1.11	1.09	4.00	1.10	1.13	4.00	2.00	1.13	1.13
0500	16	SEP	1990	3.00	1.12	1.09	4.00	1.11	1.13	4.00	2.00	1.13	1.13
0530				3.00	1.12	1.09	4.00	1.11	1.13	4.00	2.00	1.14	1.14
0600	16	SEP	1990	3.00	1.12	1.10	4.00	1.11	1.14	4.00	2.00	1.14	1.14
0630				3.00	1.12	1.10	4.00	1.12	1.14	4.00	2.00	1.15	1.14
0700	16	SEP	1990	3.00	1.13	1.11	4.00	1.12	1.14	4.00	2.00	1.15	1.15
0730				3.00	1.13	1.11	4.00	1.12	1.15	4.00	2.00	1.15	1.15
0800	16	SEP	1990	3.00	1.13	1.11	4.00	1.13	1.15	4.00	2.00	1.15	1.15
0830				3.00	1.13	1.11	4.00	1.13	1.15	4.00	2.00	1.16	1.16
0900	16	SEP	1990	3.00	1.14	1.12	4.00	1.13	1.16	4.00	2.00	1.16	1.16
0930				3.00	1.14	1.12	4.00	1.14	1.16	4.00	2.00	1.17	1.17
1000	16	SEP	1990	3.00	1.14	1.12	4.00	1.14	1.17	4.00	2.00	1.17	1.17
1030				3.00	1.15	1.12	4.00	1.14	1.17	4.00	2.00	1.18	1.18
1100	16	SEP	1990	3.00	1.16	1.13	4.00	1.15	1.18	4.00	2.00	1.19	1.18
1130				3.00	1.16	1.13	4.00	1.15	1.18	4.00	2.00	1.19	1.19
1200	16	SEP	1990	3.00	1.17	1.14	4.00	1.16	1.19	4.00	2.00	1.20	1.20
1230				3.00	1.17	1.14	4.00	1.16	1.20	4.00	2.00	1.21	1.20
1300	16	SEP	1990	3.00	1.18	1.14	4.00	1.17	1.20	4.00	2.00	1.21	1.21
1330				3.00	1.18	1.15	4.00	1.17	1.21	4.00	2.00	1.22	1.22
1400	16	SEP	1990	3.00	1.19	1.15	4.00	1.18	1.22	4.00	2.00	1.23	1.22
1430				3.00	1.19	1.16	4.00	1.18	1.22	4.00	2.00	1.23	1.23
1500	16		1990	3.00	1.20	1.16	4.00	1.19	1.23	4.00	2.00	1.24	1.24
1530				3.00	1.21	1.17	4.00	1.19	1.24	4.00	2.00	1.25	1.25
1600	16		1990	3.00	1.21	1.17	4.00	1.20	1.25	4.00	2.00	1.26	1.25
1630				3.00	1.22	1.18	4.00	1.20	1.26	4.00	2.00	1.27	1.26
1700	16		1990	3.00	1.23	1.18	4.00	1.21	1.26	4.00	2.00	1.28	1.27
1730				3.00	1.24	1.19	4.00	1.22	1.28	4.00	2.00	1.29	1.29
1800	16		1990	3.00	1.25	1.20	4.00	1.22	1.29	4.00	2.00	1.30	1.30
1830				3.00	1.26	1.20	4.00	1.23	1.30	4.00	2.00	1.32	1.31
1900	16		1990	3.00	1.27	1.21	4.00	1.24	1.31	4.00	2.00	1.33	1.32
1930				3.00	1.28	1.22	4.00	1.25	1.32	4.00	2.00	1.35	1.34
2000	16	SEP	1990	3.00	1.29	1.23	4.00	1.26	1.34	4.00	2.00	1.36	1.35
2030				3.00	1.30	1.23	4.00	1.27	1.35	4.00	2.00	1.38	1.37
2100	16	SEP	1990	3.00	1.32	1.24	4.00	1.28	1.37	4.00	2.00	1.39	1.38
2130				3.00	1.33	1.25	4.00	1.29	1.38	4.00	2.00	1.41	1.40
2200	16	SEP	1990	3.00	1.35	1.26	4.00	1.30	1.40	4.00	2.00	1.43	1.42

FIGURE A-4

NW/12MPH/C2/RS030 NW-BOUND HUR, LF 30 ST MI RIGHT OF SAVANNAH BEACH
DELTA P = 40 MB CAT = 2 RMW = 20 ST. MI. DATUMS = 1.0/1.0
COMPUTED WIND SPEEDS AT SELECTED GAGES OR GRID PTS

HOUR	DAY	MTH	YEAR	TIVOLI R 38, 10	KILKENNY 40, 15	SUNBURY 41, 11	HMOON LDG 44, 10	YELLOW BL 43, 13	WALBURG I 44, 15	S.NEWPORT 46, 6	HARRIS NK 47, 12	MQUEEN IN 47, 17	ST.CATS S 50, 15
1400	15	SEP	1990	COMPUTATIONS BEGIN									
1430				4.94	5.00	4.97	4.98	5.00	5.03	4.94	5.02	5.62	5.63
1500	15	SEP	1990	5.00	5.06	5.02	5.03	5.06	5.09	5.00	5.07	5.68	5.69
1530				5.05	5.11	5.08	5.09	5.11	5.14	5.05	5.13	5.75	5.75
1600	15	SEP	1990	5.11	5.17	5.14	5.14	5.17	5.20	5.11	5.19	5.81	5.82
1630				5.17	5.23	5.19	5.20	5.23	5.26	5.16	5.25	5.88	5.88
1700	15	SEP	1990	5.22	5.29	5.25	5.26	5.29	5.32	5.22	5.31	5.95	5.95
1730				5.28	5.35	5.31	5.32	5.35	5.38	5.28	5.37	6.02	6.02
1800	15	SEP	1990	5.35	5.41	5.38	5.38	5.41	5.45	5.34	5.43	6.09	6.10
1830				5.41	5.48	5.44	5.45	5.48	5.51	5.41	5.50	6.16	6.17
1900	15	SEP	1990	5.47	5.54	5.50	5.51	5.54	5.58	5.47	5.56	6.24	6.24
1930				5.54	5.61	5.57	5.58	5.61	5.64	5.54	5.63	6.32	6.32
2000	15	SEP	1990	5.61	5.68	5.64	5.65	5.68	5.71	5.60	5.70	6.40	6.40
2030				5.67	5.75	5.71	5.72	5.75	5.79	5.67	5.77	6.48	6.48
2100	15	SEP	1990	5.74	5.82	5.78	5.79	5.82	5.86	5.74	5.84	6.56	6.56
2130				5.82	5.89	5.85	5.86	5.90	5.93	5.81	5.92	6.64	6.65
2200	15	SEP	1990	5.89	5.97	5.93	5.94	5.97	6.01	5.89	6.00	6.73	6.74
2230				5.97	6.05	6.00	6.01	6.05	6.09	5.96	6.07	6.82	6.82
2300	15	SEP	1990	6.04	6.13	6.08	6.09	6.13	6.17	6.04	6.15	6.91	6.92
2330				6.12	6.21	6.16	6.17	6.21	6.25	6.12	6.24	7.01	7.01
0000	16	SEP	1990	6.21	6.30	6.25	6.26	6.30	6.34	6.20	6.32	7.10	7.11
0030				6.29	6.38	6.33	6.34	6.38	6.43	6.28	6.41	7.20	7.21
0100	16	SEP	1990	6.38	6.47	6.42	6.43	6.47	6.52	6.37	6.50	7.31	7.31
0130				6.46	6.56	6.51	6.52	6.56	6.61	6.46	6.59	7.41	7.41
0200	16	SEP	1990	6.56	6.66	6.60	6.61	6.66	6.71	6.55	6.68	7.52	7.52
0230				6.65	6.75	6.69	6.71	6.75	6.80	6.64	6.78	7.63	7.63
0300	16	SEP	1990	6.75	6.85	6.79	6.80	6.85	6.90	6.74	6.88	7.74	7.75
0330				6.84	6.95	6.89	6.90	6.95	7.01	6.84	6.98	7.86	7.86
0400	16	SEP	1990	6.95	7.06	7.00	7.01	7.06	7.11	6.94	7.09	7.98	7.99
0430				7.05	7.17	7.10	7.11	7.17	7.22	7.04	7.20	8.11	8.11
0500	16	SEP	1990	7.16	7.28	7.21	7.22	7.28	7.34	7.15	7.31	8.24	8.24
0530				7.27	7.39	7.32	7.34	7.39	7.45	7.26	7.43	8.37	8.37
0600	16	SEP	1990	7.39	7.51	7.44	7.45	7.51	7.58	7.37	7.55	8.51	8.51
0630				7.50	7.64	7.56	7.57	7.63	7.70	7.49	7.67	8.65	8.65
0700	16	SEP	1990	7.63	7.76	7.69	7.70	7.76	7.83	7.61	7.80	8.79	8.80
0730				7.75	7.89	7.81	7.83	7.89	7.96	7.74	7.93	8.95	8.95
0800	16	SEP	1990	7.88	8.03	7.94	7.96	8.03	8.10	7.87	8.06	9.10	9.10
0830				8.02	8.17	8.08	8.10	8.17	8.24	8.00	8.20	9.26	9.26
0900	16	SEP	1990	8.16	8.31	8.22	8.24	8.31	8.39	8.14	8.35	9.43	9.43
0930				8.30	8.46	8.37	8.38	8.46	8.54	8.28	8.50	9.60	9.60
1000	16	SEP	1990	8.45	8.62	8.52	8.54	8.61	8.70	8.43	8.66	9.78	9.78
1030				8.60	8.78	8.68	8.69	8.77	8.86	8.58	8.82	9.97	9.97
1100	16	SEP	1990	8.76	8.94	8.84	8.86	8.94	9.03	8.74	8.98	10.16	10.16
1130				8.93	9.12	9.01	9.02	9.11	9.20	8.90	9.16	10.36	10.36
1200	16	SEP	1990	9.10	9.30	9.18	9.20	9.29	9.39	9.07	9.34	10.57	10.57
1230				9.28	9.48	9.36	9.38	9.48	9.58	9.25	9.52	10.79	10.78
1300	16	SEP	1990	9.46	9.68	9.55	9.57	9.67	9.77	9.43	9.72	11.01	11.01
1330				9.65	9.88	9.75	9.76	9.87	9.98	9.62	9.92	11.25	11.24
1400	16	SEP	1990	9.86	10.09	9.95	9.97	10.08	10.19	9.82	10.13	11.49	11.49
1430				10.06	10.31	10.16	10.18	10.30	10.41	10.02	10.35	11.75	11.74
1500	16	[illegible]	1990	10.28	10.53	10.38	10.40	10.52	10.65	10.24	10.58	12.01	12.00
1530				10.51	10.77	10.61	10.63	10.76	10.89	10.46	10.81	12.29	12.28
1600	16		1990	10.74	11.02	10.86	10.87	11.01	11.14	10.69	11.06	12.58	12.57
1630				10.99	11.28	11.11	11.12	11.26	11.41	10.93	11.32	12.89	12.87
1700	16		1990	11.25	11.55	11.37	11.39	11.54	11.68	11.18	11.59	13.20	13.18
1730				11.52	11.84	11.64	11.66	11.82	11.97	11.45	11.88	13.54	13.51
1800	16		1990	11.80	12.14	11.93	11.95	12.11	12.28	11.72	12.18	13.89	13.86
1830				12.10	12.45	12.23	12.25	12.42	12.60	12.01	12.49	14.25	14.22
1900	16		1990	12.41	12.78	12.55	12.57	12.75	12.93	12.31	12.81	14.64	14.60
1930				12.73	13.12	12.88	12.90	13.09	13.28	12.63	13.16	15.05	15.00
2000	16		1990	13.07	13.49	13.23	13.25	13.45	13.66	12.96	13.52	15.47	15.43
2030				13.43	13.87	13.60	13.61	13.83	14.05	13.31	13.90	15.92	15.87
2100	16	SEP	1990	13.81	14.28	13.99	14.00	14.23	14.46	13.67	14.30	16.40	16.34
2130				14.21	14.70	14.39	14.40	14.65	14.89	14.06	14.72	16.90	16.83
2200	16	SEP	1990	14.64	15.16	14.83	14.83	15.10	15.36	14.46	15.16	17.43	17.35

FIGURE A-5

NW/12MPH/C2/RS030 NW-BOUND HUR, LF 30 ST MI RIGHT OF SAVANNAH BEACH
DELTA P = 40 MB CAT = 2 RMW = 20 ST. MI. DATUMS = 1.0/1.0
COMPUTED WIND DIRECTIONS AT SELECTED GAGES OR GRID POINTS

HOUR	DAY	MTH	YEAR	TIVOLI R 38, 10	KILKENNY 40, 15	SUNBURY 41, 11	HMOON LDG 44, 10	YELLOW BL 43, 13	WALBURG I 44, 15	S.NEWPORT 46, 6	HARRIS NK 47, 12	MQUEEN IN 47, 17	ST.CATS S 50, 15
1400	15	SEP	1990	COMPUTATIONS BEGIN									
1430				9.45	9.62	9.22	8.82	9.16	9.23	8.31	8.63	24.84	24.25
1500	15	SEP	1990	9.41	9.58	9.18	8.78	9.12	9.19	8.26	8.59	24.80	24.20
1530				9.38	9.55	9.14	8.74	9.08	9.15	8.21	8.54	24.75	24.15
1600	15	SEP	1990	9.34	9.51	9.10	8.69	9.04	9.11	8.16	8.49	24.70	24.09
1630				9.30	9.48	9.06	8.64	9.00	9.07	8.11	8.44	24.65	24.03
1700	15	SEP	1990	9.26	9.44	9.01	8.59	8.95	9.02	8.05	8.39	24.60	23.97
1730				9.22	9.40	8.97	8.54	8.91	8.98	8.00	8.34	24.54	23.91
1800	15	SEP	1990	9.17	9.35	8.92	8.49	8.86	8.93	7.94	8.28	24.49	23.85
1830				9.13	9.31	8.87	8.44	8.81	8.88	7.88	8.23	24.43	23.78
1900	15	SEP	1990	9.08	9.27	8.82	8.38	8.76	8.83	7.82	8.17	24.37	23.72
1930				9.03	9.22	8.77	8.33	8.71	8.78	7.75	8.11	24.30	23.64
2000	15	SEP	1990	8.98	9.17	8.72	8.27	8.65	8.72	7.69	8.04	24.24	23.57
2030				8.93	9.12	8.66	8.20	8.59	8.67	7.62	7.98	24.17	23.49
2100	15	SEP	1990	8.88	9.07	8.60	8.14	8.53	8.61	7.55	7.91	24.11	23.42
2130				8.82	9.01	8.54	8.07	8.47	8.55	7.47	7.84	24.04	23.34
2200	15	SEP	1990	8.76	8.96	8.48	8.01	8.41	8.48	7.40	7.77	23.96	23.26
2230				8.70	8.90	8.42	7.94	8.34	8.42	7.32	7.70	23.89	23.17
2300	15	SEP	1990	8.64	8.84	8.35	7.86	8.28	8.35	7.24	7.62	23.81	23.08
2330				8.57	8.77	8.28	7.79	8.20	8.28	7.15	7.54	23.73	22.99
0000	16	SEP	1990	8.51	8.71	8.21	7.71	8.13	8.21	7.07	7.45	23.64	22.90
0030				8.44	8.64	8.14	7.63	8.06	8.13	6.98	7.37	23.55	22.79
0100	16	SEP	1990	8.36	8.57	8.06	7.54	7.98	8.05	6.89	7.28	23.47	22.70
0130				8.29	8.50	7.98	7.45	7.89	7.97	6.79	7.19	23.37	22.59
0200	16	SEP	1990	8.21	8.42	7.89	7.36	7.81	7.89	6.69	7.09	23.27	22.48
0230				8.13	8.34	7.81	7.27	7.72	7.80	6.59	6.99	23.17	22.36
0300	16	SEP	1990	8.05	8.26	7.72	7.17	7.63	7.71	6.48	6.89	23.07	22.25
0330				7.96	8.18	7.63	7.07	7.53	7.61	6.37	6.78	22.96	22.12
0400	16	SEP	1990	7.87	8.09	7.53	6.96	7.44	7.52	6.25	6.67	22.85	22.00
0430				7.77	7.99	7.43	6.85	7.33	7.41	6.13	6.55	22.73	21.87
0500	16	SEP	1990	7.68	7.90	7.32	6.74	7.23	7.31	6.01	6.43	22.61	21.73
0530				7.57	7.80	7.22	6.62	7.11	7.20	5.88	6.31	22.48	21.59
0600	16	SEP	1990	7.47	7.69	7.10	6.50	7.00	7.08	5.75	6.18	22.35	21.44
0630				7.36	7.59	6.99	6.37	6.88	6.96	5.61	6.05	22.21	21.29
0700	16	SEP	1990	7.24	7.47	6.86	6.24	6.75	6.84	5.46	5.91	22.07	21.13
0730				7.12	7.35	6.74	6.10	6.62	6.71	5.31	5.76	21.92	20.96
0800	16	SEP	1990	7.00	7.23	6.61	5.96	6.49	6.57	5.16	5.61	21.77	20.80
0830				6.87	7.10	6.47	5.81	6.35	6.43	5.00	5.45	21.60	20.61
0900	16	SEP	1990	6.73	6.97	6.32	5.65	6.20	6.28	4.83	5.29	21.44	20.43
0930				6.59	6.83	6.18	5.49	6.05	6.13	4.65	5.11	21.26	20.23
1000	16	SEP	1990	6.45	6.69	6.02	5.32	5.89	5.97	4.47	4.94	21.08	20.03
1030				6.29	6.54	5.86	5.14	5.72	5.80	4.28	4.75	20.89	19.82
1100	16	SEP	1990	6.13	6.38	5.69	4.96	5.54	5.63	4.08	4.55	20.69	19.60
1130				5.97	6.21	5.51	4.77	5.36	5.45	3.87	4.35	20.48	19.37
1200	16	SEP	1990	5.79	6.04	5.32	4.57	5.17	5.25	3.66	4.14	20.26	19.13
1230				5.61	5.86	5.13	4.36	4.97	5.05	3.43	3.92	20.03	18.87
1300	16	SEP	1990	5.42	5.67	4.93	4.14	4.76	4.85	3.20	3.68	19.80	18.61
1330				5.22	5.47	4.71	3.91	4.54	4.63	2.95	3.44	19.54	18.33
1400	16	SEP	1990	5.01	5.26	4.49	3.66	4.31	4.39	2.69	3.18	19.28	18.04
1430				4.79	5.04	4.26	3.41	4.07	4.15	2.42	2.92	19.00	17.73
1500	16		1990	4.56	4.80	4.01	3.15	3.82	3.90	2.14	2.63	18.72	17.42
1530				4.31	4.56	3.75	2.87	3.55	3.63	1.84	2.34	18.41	17.07
1600	16		1990	4.06	4.31	3.48	2.57	3.27	3.35	1.53	2.03	18.09	16.72
1630				3.79	4.04	3.19	2.27	2.98	3.05	1.20	1.70	17.75	16.35
1700	16		1990	3.51	3.75	2.89	1.94	2.67	2.74	0.86	1.36	17.39	15.96
1730				3.21	3.45	2.58	1.60	2.34	2.41	0.50	0.99	17.01	15.54
1800	16		1990	2.89	3.13	2.24	1.24	1.99	2.06	0.11	0.61	16.62	15.10
1830				2.56	2.80	1.89	0.86	1.63	1.69	359.71	0.20	16.19	14.63
1900	16		1990	2.21	2.44	1.52	0.46	1.24	1.30	359.29	359.78	15.75	14.14
1930				1.84	2.07	1.12	0.03	0.83	0.89	358.84	359.32	15.27	13.6[illegible]
2000	16		1990	1.45	1.67	0.70	359.58	0.40	0.45	358.36	358.84	14.76	13.07
2030				1.03	1.24	0.26	359.10	359.93	359.98	357.86	358.33	14.22	12.47
2100	16	SEP	1990	0.58	0.79	359.78	358.59	359.44	359.48	357.33	357.79	13.65	11.85
2130				0.11	0.31	359.28	358.05	358.92	358.95	356.76	357.21	13.03	11.17
2200	16	SEP	1990	359.61	359.79	358.74	357.48	358.36	358.38	356.16	356.59	12.38	10.46
2230				359.07	359.24	358.17	356.86	357.76	357.78	355.52	355.93	11.68	9.69

FIGURE A-6

V. SC SLOSH MODELING PROCESS

The South Carolina Hurricane Evacuation Study incorporated use of two SLOSH basins and a series of SPLASH computer runs. SLOSH basins were Savannah-Hilton Head, including the lower South Carolina coast; and Charleston, including the coast from the Georgia state line to Myrtle Beach. The portion of Horry County from Myrtle Beach to the North Carolina state line was covered with a series of SPLASH runs tied into and coordinated with output from the Charleston basin SLOSH run.

The modeled storms were those with the highest meteoroligical probability of paralleling, closely approaching, or making landfall on the South Carolina coast. Tracks, intensities, forward speeds, directions of motion, radii of maximum winds, and lowest barometric pressures of historical hurricanes were used for the simulations.

The resulting simulations represented the five intensity categories of the Saffir/Simpson Scale; four directions of motion: Northerly, Northwesterly, Westerly and Northeasterly; and landfalling or closest approach locations spaced 10-20 miles apart, to the left or right of Charleston harbor, the "0-mile point," along the South Carolina coast. Specified radii of maximum winds for the simulated hurricanes were 25 miles for categories 1-4, and 15 miles for category 5. Radii were varied based on the assumption that the more intense category 5 hurricanes will, as did hurricane Camille (Gulf Coast, 1969), have a generally smaller radius of maximum winds.

It should be stressed that the category intensities for each of the parallel storm tracks were for the most meteorologically probable storms, after factoring in expected effects of land mass on intensity.

Among historical hurricanes whose intensities are recorded there has been no category 5 hurricane along South Carolina's coast. Were one to occur its most likely track would be a west, northwest, or north heading. It is also unlikely that a category 4 or 5 hurricane would develop on, or move along a northeast heading on or immediately near the coastline. For these reasons only category 1, 2 and 3 hurricanes on northeast headings were modeled for the South Carolina study (Appendix Three, Parts One-Five).

The initial sea surface height set in the SLOSH models for the study was +1.0 ft. msl. This height, a tidal anomaly, represents that of the water surface above mean sea level which occurred several days prior to the arrivals of historical hurricanes.

Based on the central barometric pressures assigned to each intensity category of the Saffir/Simpson Hurricane Scale, it is possible for the central barometric pressure to decrease upwards of twenty millibars and despite a real increase in storm intensity it remains, within the same intensity category. It has also been noted that storm surge heights are responsive to small decreases in central barometric pressure. In the deeper offshore waters such increases are minimal; in shallow nearshore waters the increase becomes more pronounced.

For this reason, a scale expressing differences between central barometric pressure and ambient baromatric pressure as Delta-p (Δ p) for each hurricane

category was devised for the South Carolina study. When this variable was factored into simulations for specific basins a potential for 0.5 to 2.0 foot increases in surge heights for each 5 mb difference in Delta pressure (Δ p), depending on local variables, was found. Tables 2-1 and 2-2 (Hazards Analysis) lists categories of hurricanes, central barometric pressures, and millibar differences in pressure, expressed as Δ p, for the simulated storms modeled in the South Carolina Study.

VI. MAXIMUM ENVELOPE OF HIGH WATER

The occurrence of the maximum storm surge depends on a number of factors: where the eye of the hurricane crosses the coastline, hurricane intensity, bathymetry of the individual basin involved, coastline configuration, direction and forward speed of the hurricane, and the radius of maximum winds. In most instances, the maximum storm surge occurs in the right front quadrant of the storm path - and within a few miles of the radius of maximum winds - where the storm's highest winds come ashore.

Since we are not capable of predicting precise landfall location, forward speed, direction of movement, and other hurricane characteristics, the output from computer models is used to analyze many types of hurricane hazards.

The Maximum Envelope of Water (MEOW) is such an output. SLOSH-generated storm surge elevations were analyzed in terms of basin-specific factors - elevation, barriers, cuts and channels, and other pertinent information - each of which was transferred to its respective rectangular grid point on one of ten sectional hurricane evacuation maps for the South Carolina coast.

Next, Maximum Envelopes Of High Water for all storms of the same intensity and direction were plotted on overlays of each sectional map. Eighteen different sets of MEOW data were generated for each of the ten basin maps prepared for the South Carolina Hurricane Evacuation Study.

The resulting MEOW maps show the highest-possible water height at any given grid point, caused by any hurricane of a specific intensity and approaching from specific direction (Appendix One, Part One). Maximum Envelopes Of Water displayed on the maps are those produced by the hurricane only, and do not incorporate astronomical tide data since planners, for evacuation purposes, must assume that a hurricane will make landfall during a normal high tide. And, because MEOWs give the height of storm surge in feet above mean sea level, the depth of water at any particular location can be estimated by subtracting land elevation from the water height shown on the storm surge map.

For planning purposes it became necessary to reduce the number of MEOW maps. Using Saffir/Simpson intensity categories as the basis, the condensed maps (MOMS) include the Maximum Envelopes of High Water for all storms from all directions of approach for the category being considered (Appendix One, Part Two).

VII. TIME HISTORY DATA

Time and hourly histories, using critical flooding and wind information for each storm category and direction of approach were prepared for each of 109 key

grid points along the South Carolina coast, then summarized in a tabular format. Appendix Three, Parts One-Five list time and hourly history information for selected key points along the South Carolina coast. These data are presented in the following format:

NAME: name of the key grid point;

GRID POINT: mid-grid coordinates of the grid in which the key point is located.

INITIAL ELEVATION: the average elevation of the key point;

INITIAL FLOOD ELEVATION: it is assumed there will always be a one foot buildup before the storm surge arrives. If the storm surge never goes over one foot above initial elevation, it is indicated "******;"

INITIAL FLOOD TIME: when flooding can be expected to begin at the key point; expressed in negative numbers indicating pre-landfall;

HIGH WATER ELEVATION: the highest water level attained at the key point during hurricane passage;

HIGH WATER TIME: in hours and minutes of highest water level at the key point;

LOWEST WATER ELEVATION: of importance during more intense hurricanes; in some instances water may not return to its original level;

LOWEST WATER TIME: actual time of low water; if water level does not return to initial level, shown as "9999;"

TIME 40 MPH EXCEEDED: hours and minutes when winds exceed this speed; significant to preparedness planning and evacuation; negative value indicates pre-landfall;

TIME 75 MPH EXCEEDED: the first time winds exceed this speed; negative value indicates pre-landfall, "9999" indicates winds do not reach 75 mph;

TIME BELOW 75 MPH: the first time, hours and minutes, winds fall below this speed; positive value indicates post-landfall; "99999" indicates winds do not reach 75 mph;

TIME BELOW 40 MPH: the first time wind speeds fall below 40 mph; positive value indicates post-landfall;

MAXIMUM WIND SPEED: Maximum wind speed attained; TIME OF MAXIMUM WIND SPEED: in hours and minutes;

DIRECTION OF MAXIMUM WIND: shown in degrees (90.0 being due east).

Time and hourly history data is useful for other decision making, determining when evacuees can safely begin returning to their homes, for instance; or, where low water may present problems, when to expect a return to normal water levels.

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