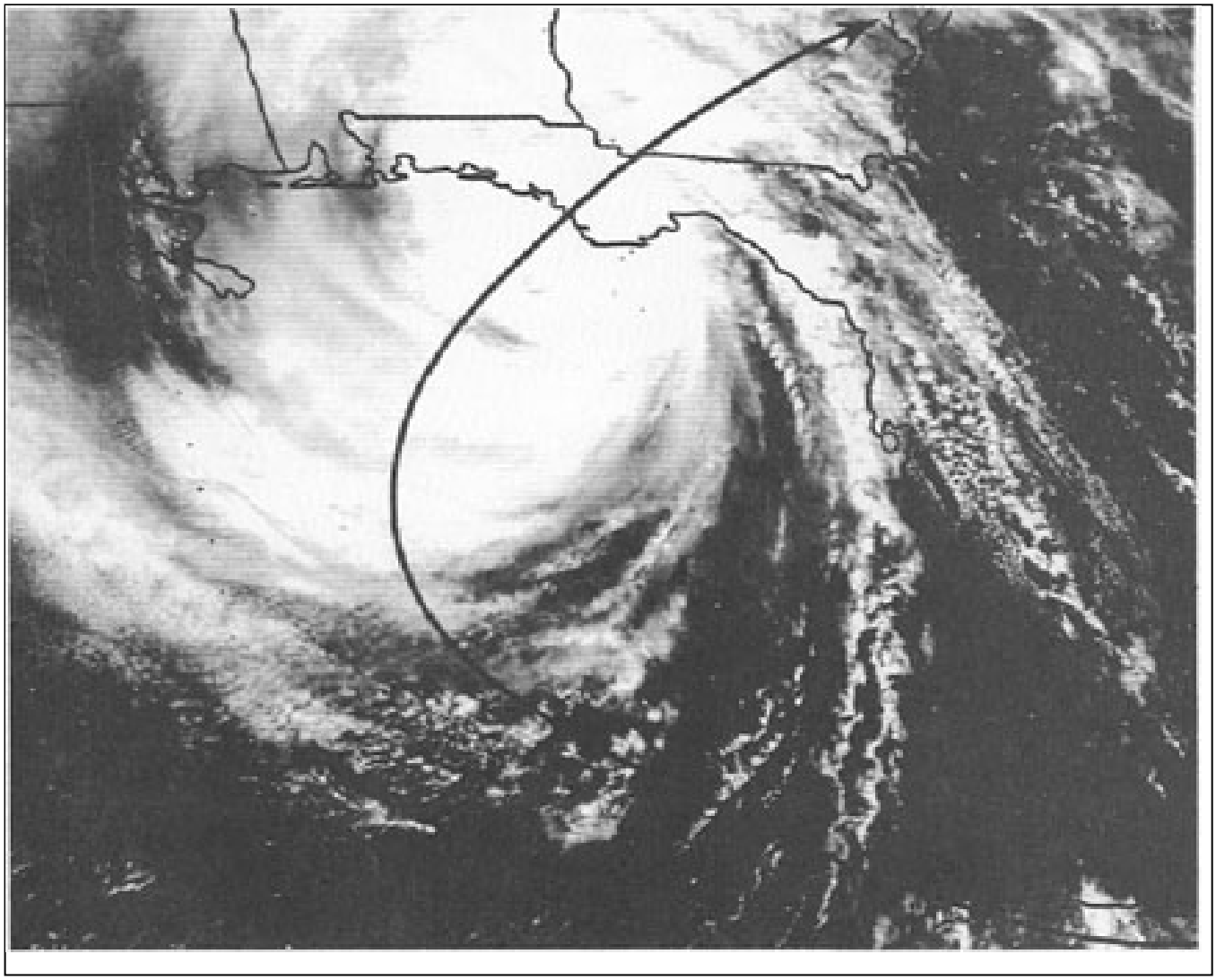
Hurricane Kate
November 15-23, 1985



Department of Natural Resources
Division of Beaches and Shores
Post Storm Report No. 86-1
September, 1986
By Ralph Clark

FOREWORD

This work describes the impact of hurricane Kate on the coast of Florida. The meteorological data was provided by the National Weather Service, the National Hurricane Center, and the Satellite Data Services of the National Oceanic and Atmospheric Administration. Tide data was provided by the National Ocean Survey, storm surge and high water mark data were provided by the Coastal and Oceanographic Engineering Department, University of Florida, and beach profile data was obtained and graphically presented by the Bureau of Coastal Data Acquisition, Division of Beaches and Shores. Post-storm photographs of Mexico Beach near the eye were taken by Brett D. Moore, P.E., and aerial photography of Cape San Blas and Sike's Cut before and after the storm were contributed by Kevin R. Bodge of the University of Florida. The manuscript was typed by Sarah C. Papin and the cover was created by Peggy M. Riedell.

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FIGURE 1. Track of Hurricane Kate, November 16-23, 1985.

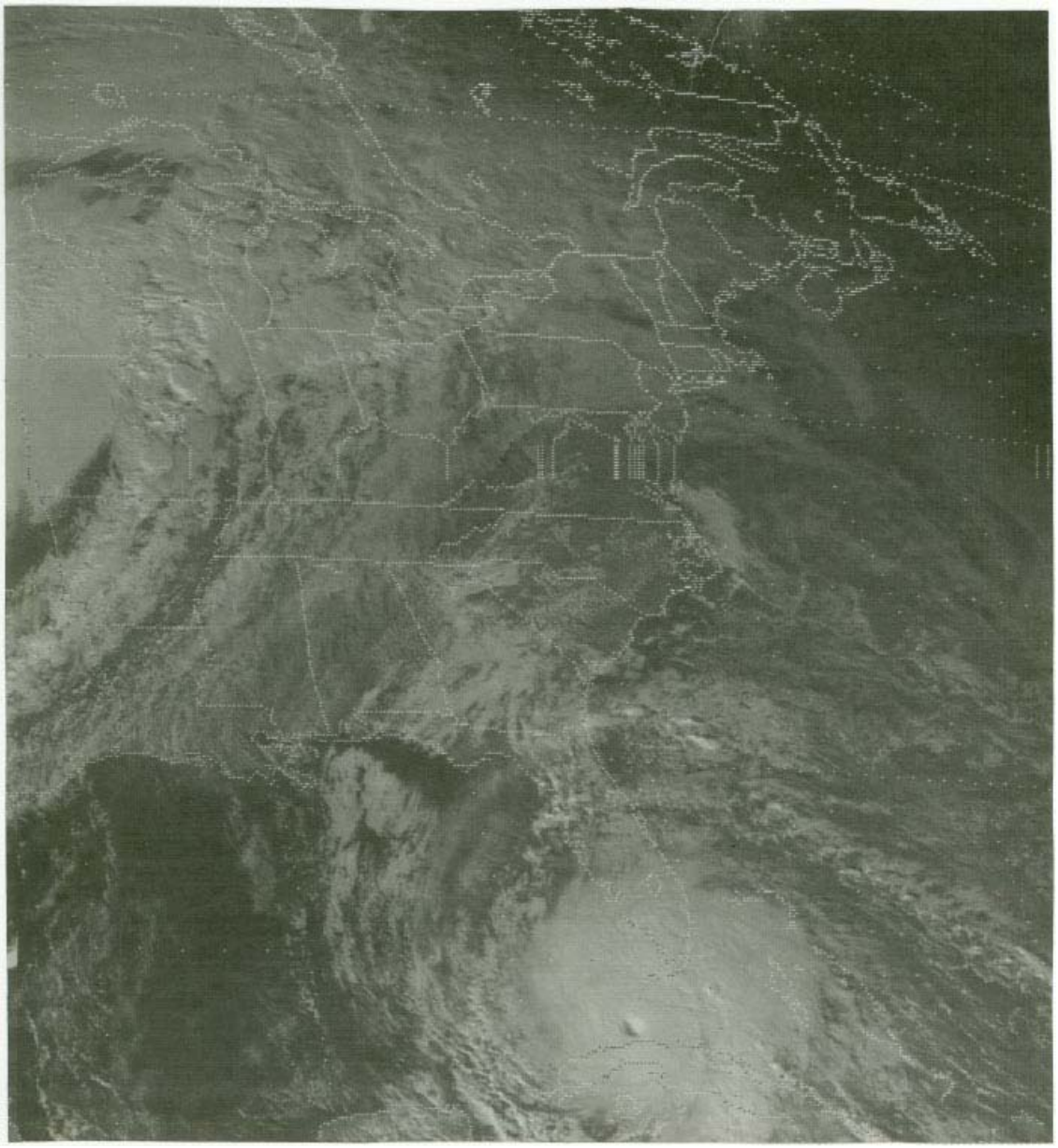

FIGURE 2. Hurricane Kate Impacting the Florida Keys at 2030 EST, November 19,1985 (Satellite Data Services, NOAA)

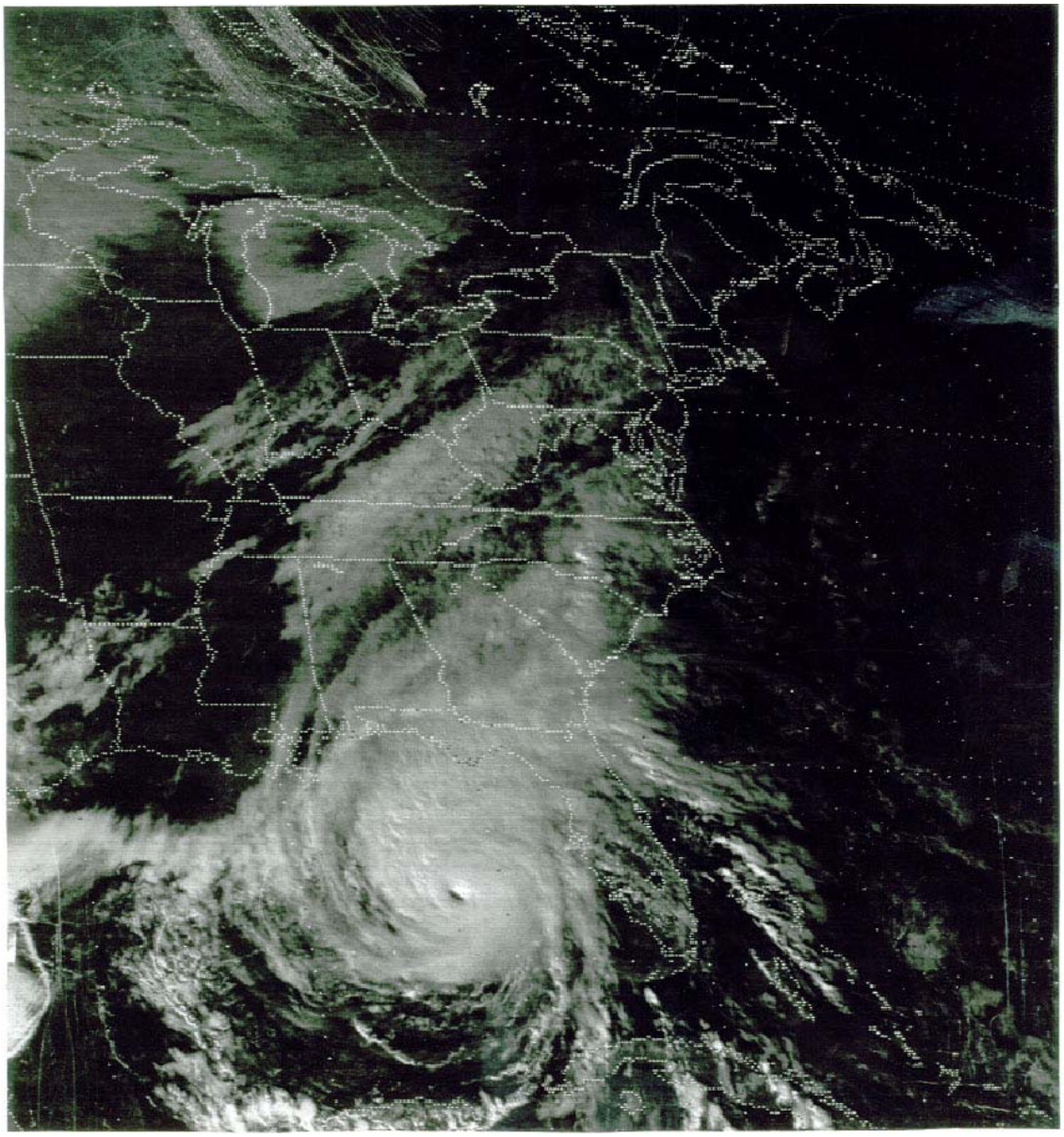

FIGURE 3. Kate at maximum intensity in the southeastern Gulf of Mexico at 2031 EST, November 20, 1985 (Satellite Data Services, NOAA)

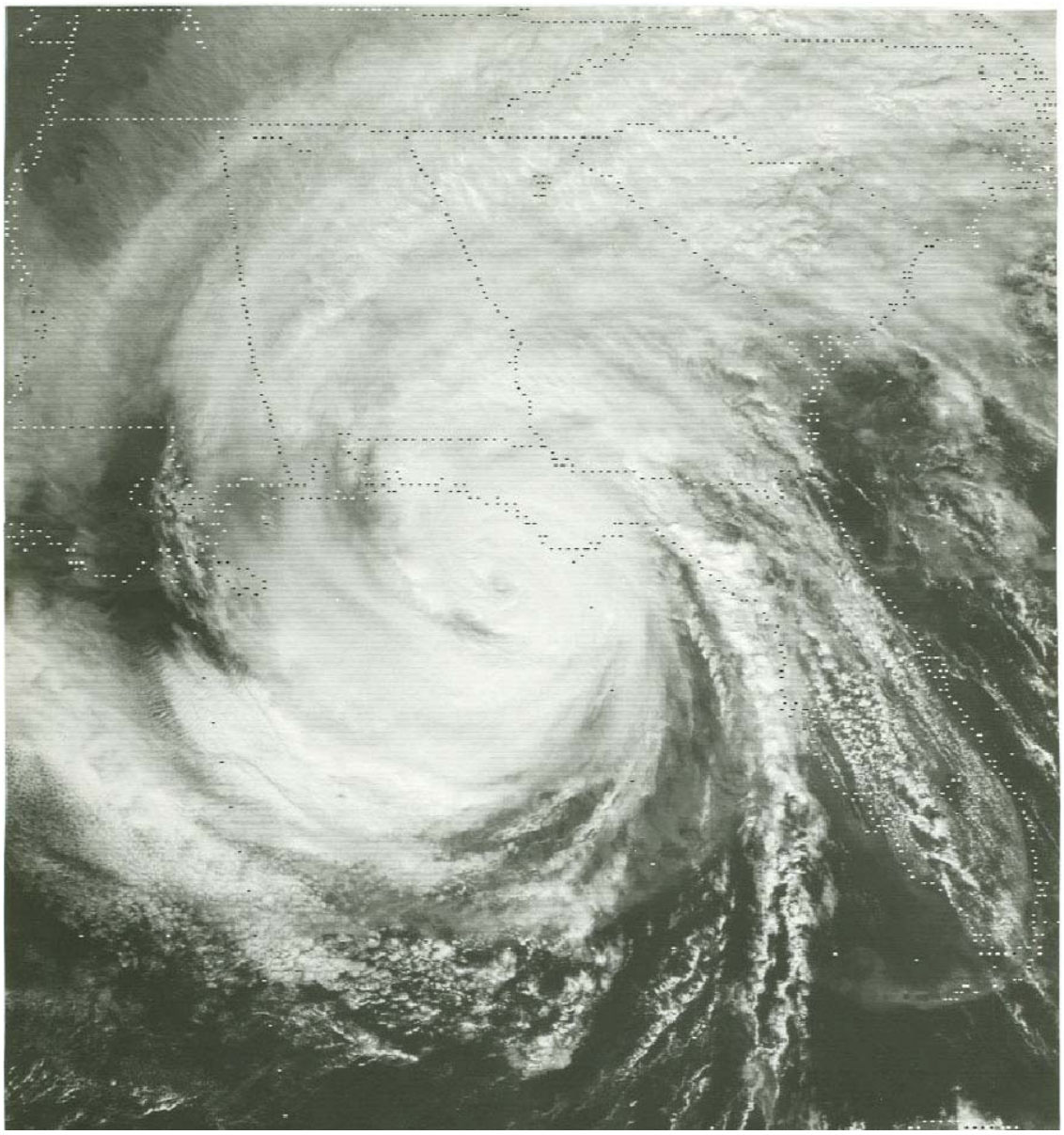

FIGURE 4. Kate at maximum intensity in the southeastern Gulf of Mexico at 2031 EST, November 20, 1985 (Satellite Data Services, NOAA)

INTRODUCTION

On November 21, 1985, the State of Florida experienced its first shore-incident hurricane in ten years. Not since hurricane Eloise crossed the coast near Panama City on September 23, 1975 had Florida experienced a shore-incident hurricane. The shore parallel brush of hurricane David and the fringe impact of hurricane Frederic, both in 1979, did not provide the magnitude of impact to Florida, which accompanies a shore-incident hurricane. The damage resulting in Florida from those storms was considerably less than was sustained by either hurricane Agnes in 1972 or Eloise in 1975, which were Florida's only two direct hits during the 1970's.

The 1985 tropical storm season produced eleven tropical storms in the North Atlantic Ocean, the Caribbean Sea, and the Gulf of Mexico. Seven of these storms reached hurricane strength. For an in-depth meteorological summary of these storms, readers are referred to the report of the National Hurricane Center, National Oceanic and Atmospheric Administration entitled "North Atlantic Tropical Cyclones, 1985" by Robert A. Case and Harold P. Gerrish

Kate, the eleventh and last tropical storm of the 1985 season, spawned a couple hundred miles northeast of Puerto Rico and the Virgin Islands before reaching tropical storm strength on November 15 (Figure 1). For three days Kate moved westerly passing nearly one hundred miles north of Hispaniola and across Great Inagua Island in the southern Bahamas. Kate attained hurricane strength during the late afternoon of Saturday, November 16. During the morning of Tuesday, November 19, hurricane Kate crossed the central north coast of Cuba. During the late morning of the 19th, Florida felt its first significant impact from Kate with the weather station in Miami Beach reporting a maximum sustained wind of 37 miles per hour, a peak wind gust of 78 miles per hour, and a minimum barometric pressure of 1014.6 millibars.

Although the eye of Kate remained over land for most of Tuesday while passing westward along the Cuban coast, it maintained a weakened hurricane strength. During the late afternoon, the weather station at Conch Key, Florida, reported a maximum sustained wind of 50 miles per hour and a peak wind gust of 78 miles per hour. When Kate emerged off the Cuba coast near Havana, the weather station at Key West reported a maximum sustained wind of 47 miles per hour, a peak wind gust of 69 miles per hour, and a minimum barometric pressure of 1006.8 millibars. Figure 2 is a satellite photograph showing the circulation of the hurricane while affecting the Florida Keys as the eye moved off Cuba and into the Gulf of Mexico on Tuesday evening, November 19.

Case and Gerrish (National Hurricane Center) reported, "After Kate emerged over the waters of the southeastern Gulf of Mexico

it strengthened at a rate of nearly 1 mb (millibar) per hour, reaching a minimum pressure of 953 mb by 2000 (Greenwich mean time) on November 20. Three hours earlier a NOAA data buoy in the east central Gulf reported averaged winds of 94 knots (108 mph) with a peak gust of 118 knots (135 mph) and sea heights of 10.7 meters (35 feet)." Figure 3 shows Kate near maximum intensity on Wednesday, November 20, while centered over the southeastern Gulf of Mexico.

Throughout Wednesday, Kate followed a northwesterly arc along approximately the same path across the southeastern Gulf of Mexico as hurricane Elena took on August 29. Although both the storms' tracks for those days were in remarkable alignment, little comfort was felt in predicting Kate's landfall point at that time given the eventual erratic track taken by Elena. In contrast to Elena's abrupt eastward turn and stall off Cedar Key, Kate gradually curved northerly on Thursday morning November 21. With hurricane warnings spread across the northeastern Gulf coast between Grand Isle, Louisiana and St. Marks, Florida, Kate slowed its forward speed and weakened in the early morning. Even though Kate had flexed its strength in the Gulf as a category 3 hurricane (classified by the National Weather Service using the Saffir-Simpson Hurricane Scale), it had weakened to a category 1 just prior to landfall (Figure 4).

Through the early afternoon on Thursday, November 21, Kate continued on a relatively straight north-northeast track towards the Florida Panhandle coast near Panama City. Fortunately for the Panama City area residents, many of whom remembered Eloise, Florida's last shore-incident hurricane in 1975, and most of whom remembered the recent scare of hurricane Elena's offshore pass only eleven weeks earlier, Kate's geometric center made landfall on Crooked Island east of Panama City near Mexico Beach. The weather station in Panama City reported a maximum sustained wind of 40 miles per hour, a peak wind gust of 78 miles per hour, and a minimum barometric pressure of 973.1 millibars. The weather station at Apalachicola which was located within the maximum wind field region of Kate reported a maximum sustained wind of 62 miles per hour, a peak gust of 85 miles per hour, and a minimum barometric pressure of 985.3 millibars.

As night fell over north Florida, Kate veered northeast and the eye passed over northern Gulf County, Calhoun County, northwest Liberty County, and western Gadsden County. Residents of Quincy, Havana, Tallahassee, and their surrounding areas felt the maximum wind field to the right of Kate's eye. The weather station in Tallahassee reported maximum sustained winds of 46 miles per hour, a peak wind gust of 68 miles per hour, and a minimum barometric pressure of 992 millibars. However, a review of the

sporadic heavy wind damage throughout Gadsden and Leon Counties provided evidence of widespread microbursts or downbursts of

localized higher wind gusts which may have reached 100 miles per hour. Weakened to tropical storm status, Kate continued northeastward through South Georgia and coastal South Carolina before exiting the mainland. On Friday, November 22, the weather station in Albany, Georgia reported an early morning maximum sustained wind of 51 miles per hour and a peak wind gust of 67 miles per hour, and the weather station in Savannah reported near mid-day a maximum sustained wind of 40 miles per hour, a peak wind gust of 62 miles per hour, and a minimum barometric pressure of 1001.4 millibars. Once back in to the Atlantic Ocean, the remnants of Kate veered east and then southeast on Saturday, November 23, before dissipating.

Five deaths were attributed to Kate in the United States. In the Keys, a 28 year old man and a 62 year old woman drowned when their small boat capsized and another man was electrocuted by stepping on a downed power line. In north Florida, a 38 year old man was killed by a fallen tree on his truck, and near Thomasville, Georgia, a 22 year old man was killed when a tree fell on a wrecker truck. The total damage estimate for the United States was three hundred million dollars.

Kate brought rainfall totals averaging between 4 to 6 inches in the major impact areas of north Florida and southwest Georgia. Kate apparently spawned at least one small tornado on Live Oak Island, Florida, although numerous downbursts were apparent throughout Gadsden and Leon Counties in north Florida. The inland areas of north Florida and South Georgia sustained widespread wind damage to buildings and utilities and countless tree damage, many of which caused damage to adjacent structures when they fell (Figure 5).

It is not, however, within the scope of this document to discuss these inland storm damages. It is the intent of this discussion to qualitatively present the storm's impact on coastal construction based upon the author's observations of the damage. These observations were made during the immediate three week period after impact between November 22 and 25 in Wakulla County, November 25, 27, December 2, 4, 5, and 11 in Franklin County, December 5 and 12 in Gulf County, and December 12 in Bay County. A discussion with accompanying photography is presented by geographical coastal areas commencing in eastern Bay County near the landfall of Kate's eye and continuing eastward along the maximum wind field through Gulf, Franklin, and Wakulla Counties. Most of the discussion will be limited to the impact to major structures in these coastal areas. A preceding discussion will be made of Cuba and the Florida Keys.

FIGURE 5. Tree Damage on Lanier Road, Gadsden County

CUBA AND THE FLORIDA KEYS

On Tuesday, November 19, Kate passed westward along north central Cuba, forcing the evacuations of about 360,000 residents and causing 10 deaths and at least 50 serious injuries. Havana, the capital city of about 2 million residents, sustained widespread damage to telephone and electrical power lines. Cuban Radio Rebelde reported the collapse of numerous buildings in the city. Outside the city, sugar mills were damaged and much of the sugar cane crop was destroyed. A Radio Rebelde broadcast reported that Moron, a city in north-central Cuba, sustained substantial damage with numerous dwellings and buildings being destroyed.

While Kate passed over northern Cuba, the Florida Keys felt the fringe impact of less than hurricane force winds. Damage throughout the Keys was slight; however, numerous power lines were blown down and the lower Keys between Key West and Big Pine Key had lost its electrical power. Only minor flooding of low areas in the Keys occurred from wind generated tides, and the Keys shorelines fronting the Florida Straits sustained only minor erosion of intermittant beaches. Two mobile homes, one on Conch Key and another on Summerland Key, were destroyed by fire; the latter was touched off by a downed power line. Only one mobile home, located on Rockland Key, was actually destroyed by Kate's winds. And on Sugarloaf Key, the 300 foot tall radio tower which broadcasts the WKWF-AM and WAIL-FM radio stations collapsed during a high wind gust.

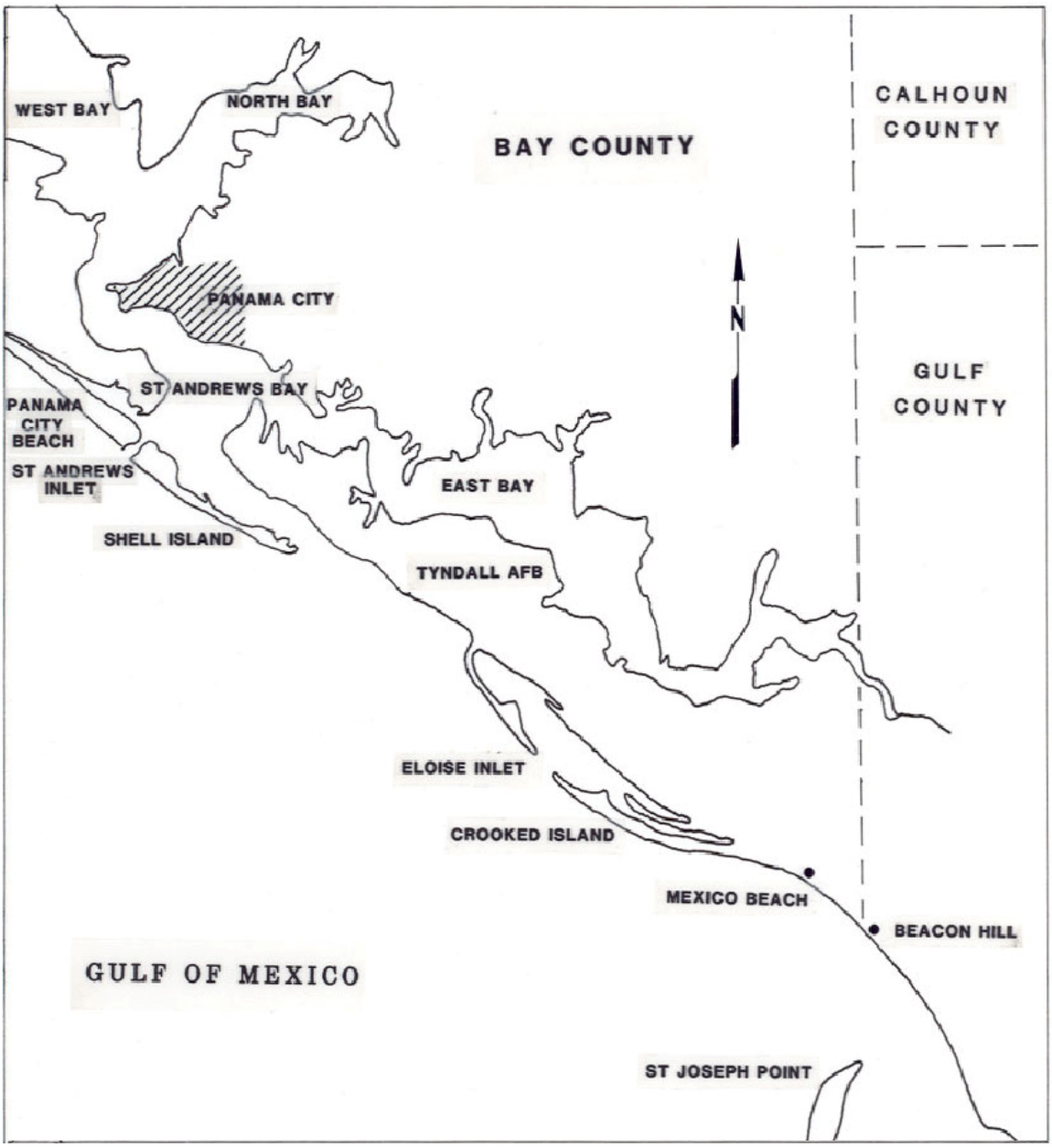

FIGURE 6. Bay County area Impacted by Kate

PANAMA CITY BEACH AND MEXICO BEACH, BAY COUNTY

In 1975, Eloise, the last shore-incident hurricane to hit Florida, crossed the coast at Phillips Inlet to the west of Panama City. Eloise caused severe beach and dune erosion and substantial damage to coastal construction along Panama City Beach. Fortunately for this area, Kate made its landfall to the east of Panama City and therefore Bay County escaped most of the storm's impact.

Generally, only light wind damage to signs, trees, and roofing was sustained in the Panama City area; however, the roof of the Federal Building sustained heavy damage. Panama City Beach had minor beach erosion in contrast to the heavy erosion sustained a decade earlier in Eloise. The worse damage from Kate was sustained along Spyglass Drive at the east end of Panama City Beach. The shoreline in this area has been receding at a rate in excess of five feet per year due in part to the longshore sediment transport deficit caused by the dredging of St. Andrews Inlet, located 1.7 miles to the east. All the inlet maintenance dredging material prior to the 1970's was hauled offshore and deposited in deep water.

At the Treasure Island Motel, the seaward projecting concrete bulkhead at the east end of the property had been destroyed during tropical storm Juan on Halloween. The storm wave activity from Kate caused substantial damage to the motel building by undermining the foundation and destroying four of the motel units (Figure 7). Reconstruction of at least 150 feet of concrete bulkhead wi11 be necessary to provide a reasonable level of protection to the remaining building. A landward relocation of the bulkhead will increase its chances of survival during future minor storms and will reduce the impact of the structure on the longshore transport of sediment.

Two single-family dwellings to the east of the Treasure Island Motel were also impacted by Kate. The dwelling nearest the motel sustained foundation and wall cracks from settlement and 130 feet of its concrete bulkhead and return wall sustained damage from wave impact loads and undermining. Heavy dune erosion between this dwelling and the motel has flanked the return wall and threatens to undermine this slab-on-grade dwelling which is now highly exposed to future storm damage (Figure 8). The adjacent dwelling had its 50 foot return wall destroyed. The southeast section of the large slab-on-grade dwelling was undermined and destroyed (Figure 9). Although the remainder of the house may be sealed off and made habitable, this structure will remain in danger of being destroyed in another major storm. The only other major damage in this area was sustained by the Panama City Beach fishing pier.

To the east of St. Andrews Inlet minor beach and dune erosion was sustained along both Shell Island and Crooked Island. The eye of hurricane Kate passed directly over Crooked Island; however, unlike the typical shore-incident hurricane which would have a peak surge and impact nearest the eye, Kate's surge and impact increased with distance to the east of the eye. Such an anomaly proved to be good fortune for the Town of Mexico Beach which found itself immediately adjacent and to the right of the eye. Such a location is often the critical site of severe storm impact.

Numerous dwellings in Mexico Beach sustained light wind damage, primarily to screen porches and roofing. Signs and power lines were down and minor flooding from the storm surge was experienced. Along the shoreline, minor to moderate beach and dune erosion was sustained resulting in numerous dwellings being threatened from continued erosion conditions (Figure 10). Approximately 50 feet of the end of 30th Street and 25 feet of the end of 27th Street were destroyed.

Adjacent 27th Street, 35 feet of concrete block wall was destroyed. Between 20th Street and 19th Street, 250 feet of concrete wall was undermined and destroyed (Figure 11). Another 75 feet of concrete block retaining wall and the front room of a slab-on-grade single-family dwelling was destroyed between 14th Street and 13th Street (Figure 12). To the west of 14th Street, a wood pile-supported dwelling was undermined and leaning from foundation settlement. At 13th Street, 35 feet of wooden bulkhead was damaged and 300 feet east of 12th Street, 75 feet of sloping concrete wall was substantially damaged. About 500 feet east of 12th Street, 60 feet of concrete block wall was destroyed at the Buena Vista Motel.

FIGURE 7. Treasure Island Motel Damage, Panama City Beach.

FIGURE 8. Heavy Dune Erosion adjacent Spyglass Drive has flanked a return wall and threatens a dwelling.

FIGURE 9. Slab-on-grade dwelling partly destroyed, Panama City Beach.

FIGURE 10. Mexico Beach Dwellings Threatened by dune erosion (Brett D. Moore)

FIGURE 11. Concrete wall destroyed, Mexico Beach (Brett D. Moore).

FIGURE 12. Seaward room destroyed on Mexico Beach dwelling.

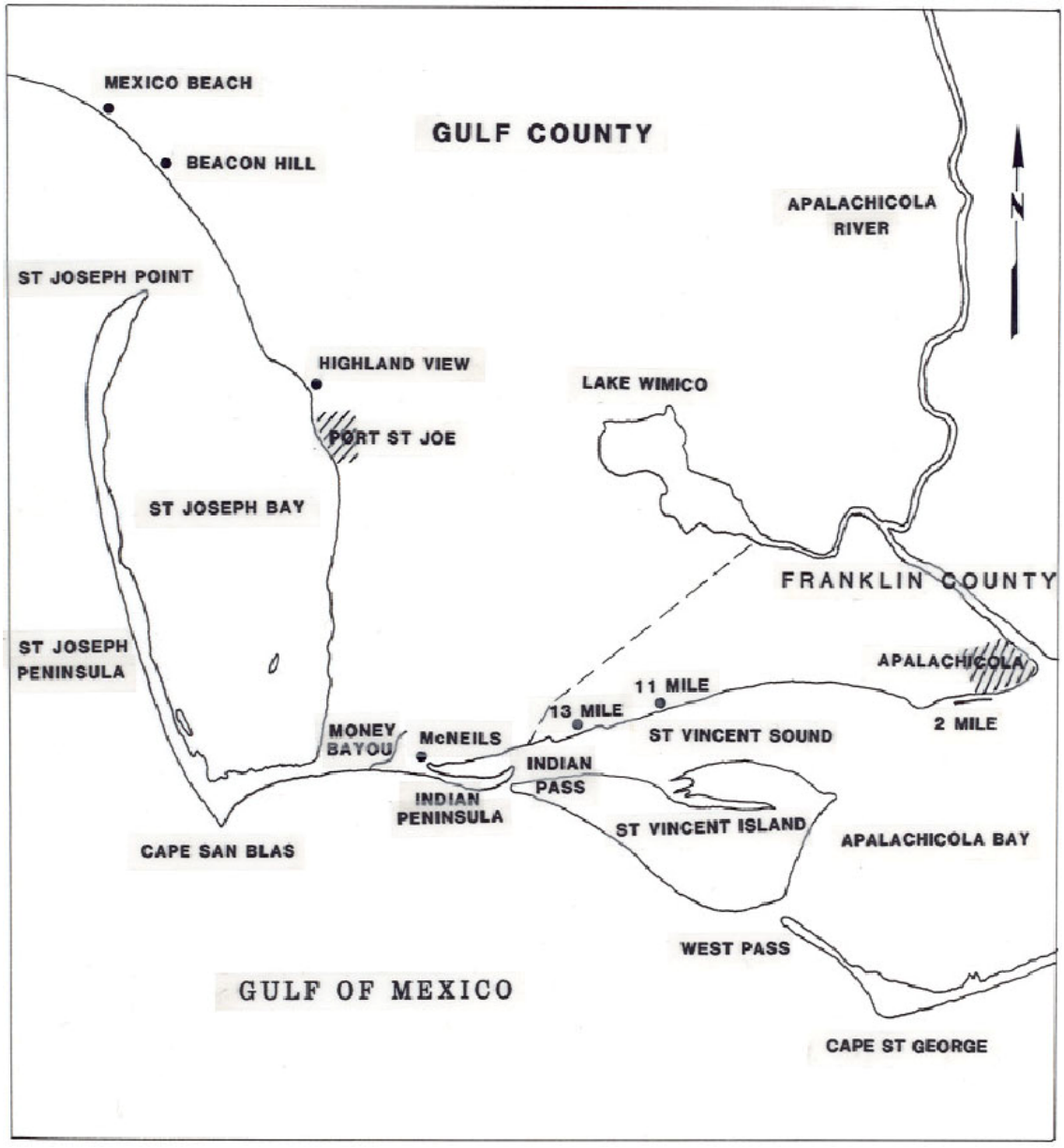

FIGURE 13. Gulf County and western Franklin County.

PORT ST. JOE, ST. JOSEPH PENINSULA, CAPE SAN BLAS, AND INDIAN PENINSULA, GULF COUNTY

Gulf County, located to the right of the eye's landfall, was substantially impacted by hurricane Kate. The severity of the impact appeared to increase to the east, that is with distance away from the point of landfall of the eye. Kate's impact to Gulf County was the most substantial since hurricane Agnes in June, 1972. Overall, 31 major structures (exclusive of roads) were destroyed or sustained major structural damage along coastal Gulf County by Kate. Only the damages of Franklin and Wakulla Counties exceeded that of Gulf County.

The Gulf of Mexico shoreline along U.S. Highway 98 in western Gulf County sustained only minor beach and dune erosion. There was no major damage in Beacon Hill, Yon Subdivision, or St. Joe Beach. In Highland View fronting St. Josephs Bay, approximately 100 feet of U.S. Highway 98 was damaged and 90 feet of the sloping concrete slab revetment was destroyed. A high water mark of +6.8 feet NGVD was measured by the Coastal and Oceanographic Engineering Department, University of Florida, near this site. A small restaurant structure was also destroyed. The City of Port St. Joe experienced widespread light wind damages with power lines down and roofing and sign damage heavy. At the industrial complex of the St. Joe Paper Company, six buildings had major wind damage. These structures typically had metal roofing and large surface areas and were highly exposed to winds off St. Josephs Bay. Although there was no apparent bulkhead damage to the 75 foot long steel sheet-pile bulkhead at the St. Joe Paper Company facility, a 65 foot section of steel bulkhead was damaged at the adjoining property's wharf. In Port St. Joe, a Gulf County school building for bus maintenance sustained major wind damage, and at the airport a hanger building was completely destroyed by wind with a single engine airplane inside. Along U.S. Highway 98 between Port St. Joe and Ward Ridge was minor waterfront damages and flooding of low areas west of the highway. Near St. Joseph Drive, about 200 feet of Constitution Drive was damaged and 1,275 feet of s loping concrete s lab revetment was destroyed and another 25 feet damaged.

Offshore from the mainland, St. Joseph Peninsula is a 16 mile long coastal barrier fronting St. Josephs Bay and aligns generally north and south between St. Josephs Point at its north tip and Cape San Blas to the south. Moderate to heavy beach and dune erosion was experienced along the entire length of St. Joseph Peninsula. At T. H. Stone Memorial State Park along the peninsula's north end the beach access walkways were destroyed and heavy dune erosion was experienced. Figures 14 and 15 are computer graphics of topographic survey data obtained by the Bureau of Coastal Data Acquisition, Division of Beaches and

Shores. two weeks after the impact of Kate. Figure 14 reflects a typical profile of the heavy dune erosion experienced in the park. This profile data reflects horizontal dune recession of nearly fifty feet in comparison to a July. 1984, profile. Figure 15 reflects profiles obtained a few days after hurricane Elena's offshore pass and a couple weeks after Kate in comparison with an earlier profile in November. 1983. The barrier dune which reached an elevation of nearly +22 feet NGVD was completely destroyed by Kate after it was substantially eroded by Elena. The University of Florida measured a storm surge elevation of +5.6 feet NGVD near the entrance to the park. Along the southern half of the peninsula between the park and Cape San Blas nearly all of the beach access walkways had their seaward ends destroyed. This area is currently only sparsely developed although a major boom in residential construction has recently been taking place primarily adjacent to the beach. Nearly all the dwellings and condominium buildings in this area sustained roofing damage.

Midway between Cape San Blas and the State Park two single-family dwellings were totally destroyed by erosion, flooding and wave loads(Figures 16 and 17). Approximately 2.000 feet to the south. an inappropriately sited swimming pool was also destroyed. As recently as November. 1983, aerial photography showed these dwellings to be located about 40 feet landward of the beach and the pool to be located about 70 feet from the beach. Profile data obtained by the Bureau of Coastal Data Acquisition adjacent to these dwellings before and after Kate reflected horizontal dune recession of approximately 35 feet due to Kate and a total of 80 feet since November. 1983. A nearby house aligned with the destroyed houses was relocated by house moving equipment inland about 150 feet the day before hurricane Kate struck. This area extending southward to Cape San Blas has been experiencing substantial historical erosion with a shoreline recession rate estimated between 10 to 20 feet per year. At the curve of Gulf County Road C30E where it approaches the Gulf shoreline near Cape San Bias, the storm surge completely overtopped the road and the washover deposit was carried into St. Josephs Bay. This area is known as Stump Hole due to the numerous remnant pine tree stumps in the surf zone left as monuments to the erosion of past storms. This area previously experienced overwash during hurricane Agnes in 1972, but perhaps the most erosion in recent years occurred during the siege of El Nino storms in the winter and spring of 1983.

The large coastal feature known as Cape San Blas was substantially destroyed by the impact of both hurricanes Elena and Kate in the fall of 1985. As reported in The Impact Of Hurricane Elena And Tropical Storm Juan On Coastal Construction in Florida (Beaches and Shores Post-Storm Report No. 85-3. March. 1986), approximately 1.500 feet of the exposed south tip of the

Cape disappeared after Elena passed by approximately 30 miles offshore on the evening of September 1. Another approximately 1,000 feet of the Cape was removed by hurricane Kate on November 21. Figure 18 shows Cape San Blas from the air in November, 1984 and Figure 19 taken on November 24, 1985, shows the remains of the Cape, three days after Kate 's impact and after nearly one half mile of the Cape was lost to the two hurricanes. The exposed southwest shore of Cape San Blas sustained heavy beach and dune erosion. About 200 feet of the end of the beach access road was destroyed (Figure 20). Profile data obtained by the Bureau of Coastal Data Acquisition adjacent to this beach access road revealed the barrier dune which had had a peak elevation of about +13.5 feet NGVD had been completely destroyed. An elevation of +3 feet NGVD remained at the site of this barrier dune after Kate. The entire barrier dune along the southern one mile of Gulf front beach south of the beach access road to the south tip of the Cape was totally destroyed. Most of the Cape is federally owned and extensive roofing damage was sustained by the several government buildings. In addition numerous equipment structures were damaged and a tall radio antennae was destroyed.

Along the connecting peninsula between Cape San Blas and the mainland, the Gulf fronting shoreline has generally been accreting in recent years. This area is relatively sheltered by the Cape and its outer shoals, and although substantially flooded by the storm surge of Kate, only very minor beach and dune erosion was sustained. In this area, one dwelling was totally destroyed by the winds of Kate (Figure 21). As was typical of any other dwellings destroyed by wind, this structure did not have adequate roof to wall and wall to floor connections.

Along the mainland shoreline west of Money Bayou, light to heavy wind damage was sustained and minor beach and dune erosion occurred. East of the junction of Gulf County Roads C30E and C30 two mobile homes were destroyed, one mobile home was substantially damaged and two concrete block dwellings sustained major damage. Most of the dwellings in this area west of Money Bayou sustained. light to extensive roofing damage and had screens blown out, antennas blown down, decks damaged and walkways destroyed. One dwelling had a one room addition destroyed. One dwelling under construction sustained major wind damage and another dwelling sustained major roof damage due to wind.

Money Bayou was opened to tidal flow by the storm surge of Kate. In th is area the Coastal and Oceanographic Engineer ing Department, University of Florida, measured a high water mark of +8.4 feet NGVD. East of Money Bayou, extensive flooding and wind damage was sustained (Figure 22). The first dwelling east of Money Bayou, a two-story structure, sustained major flood damage to the ground floor and major roof collapse due to wind loads (Figure 23). The adjacent dwelling to the east, a manufactured

home, was destroyed by winds, waves, and flooding (Figure 24) and the next dwelling to the east was floated completely off its short pile foundation and sustained wind and flooding damage (Figure 25). The fourth dwelling east of Money Bayou sustained major roof damage and two others sustained minor roofing damage. A quarter mile east of Money Bayou a mobile home was destroyed by wind and flooding (Figure 26) and three-quarters of a mile east of Money Bayou a dwelling sustained major structural damage to the lower floor due to wave impact loads (Figure 27). Profile data of the Bureau of Coastal Data Acquisition reflected about 5 feet of vertical scour to the foredunes in this area due to Kate.

In eastern Gulf County, Indian Peninsula extends two and one-half miles in length between Money Bayou and Indian Pass. Minor to moderate beach and dune erosion was sustained along this peninsula and widespread roofing and screen damage was sustained by the dwellings in this area. Most of the older dwellings in this area are set back a substantial distance from the Gulf beach and are actually closer to the Indian Lagoon shoreline. One dwelling landward of Gulf County Road C30B sustained major roof damage due to wind. The 500 foot long Indian Peninsula fishing pier was destroyed by the storm surge and waves. Along the Gulf County Road C30 fronting on Indian Lagoon, the Indian Pass Trading Post sustained roofing and water damage and a single - family dwelling sustained major damage due to waves and wind.

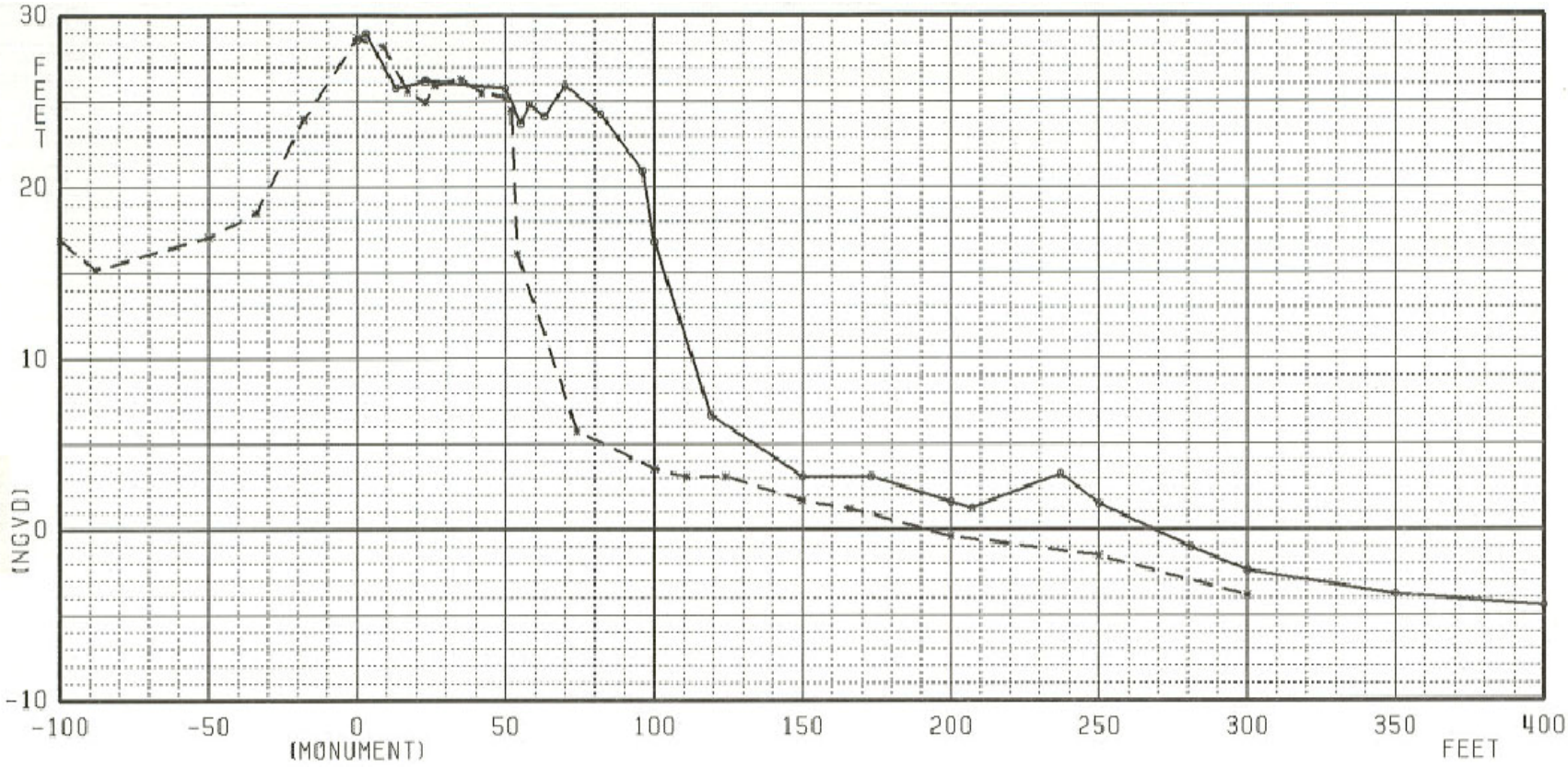

FIGURE 14. Heavy dune erosion on St. Joseph Peninsula

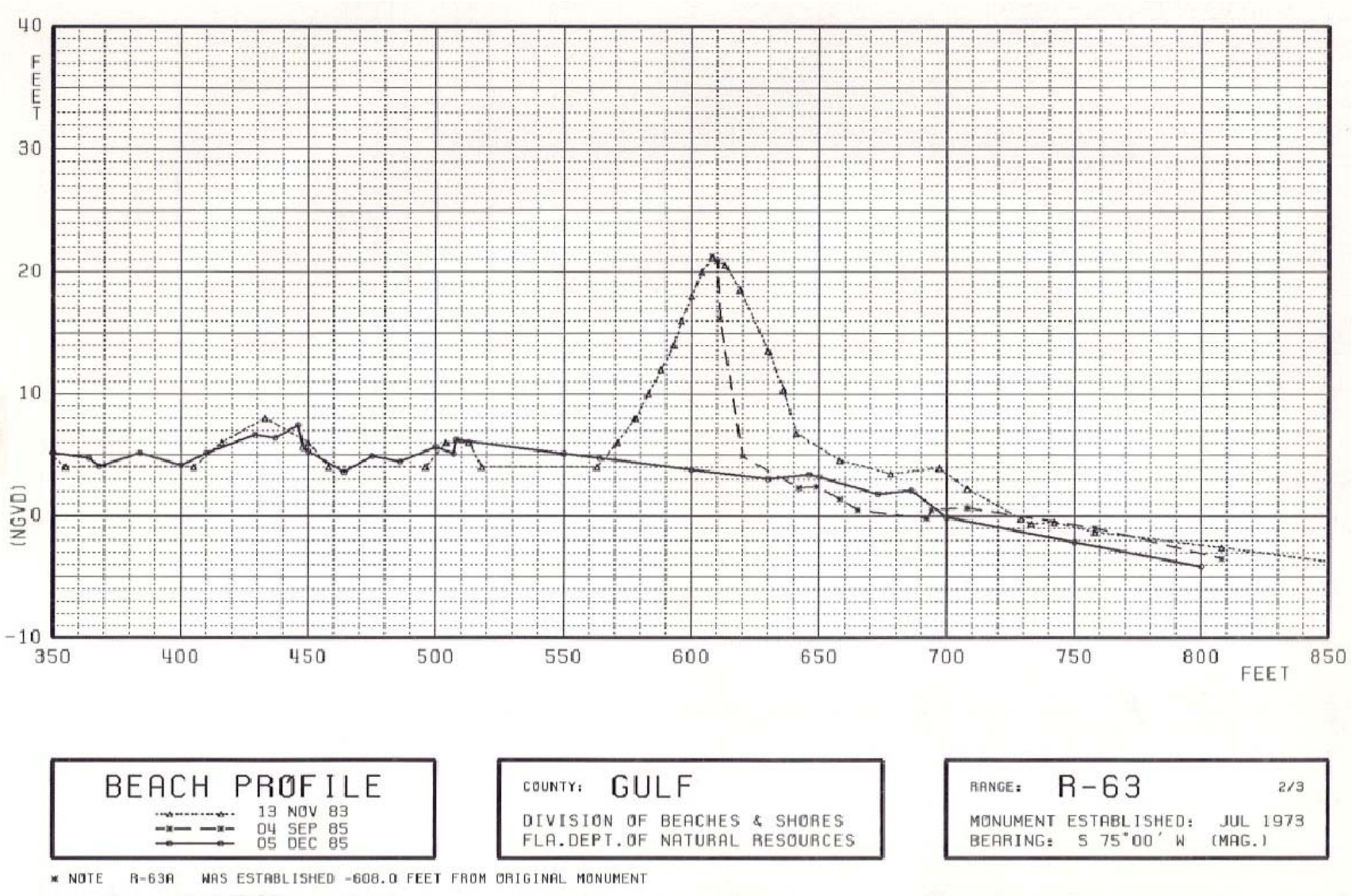

FIGURE 15. After hurricane Elena the seaward half of the barrier dune. Kate destroyed the remainder

FIGURE 16. Dwelling destroyed, St. Joseph Peninsula.

FIGURE 17. Dwelling destroyed, St. Joseph Peninsula.

FIGURE 18. Cape San Blas, November, 1984 (Photograph provided by Kevin R. Bodge, University of Florida)

FIGURE 19. Cape San Blas, November, 1984 (Photograph provided by Kevin R. Bodge, University of Florida)

FIGURE 20. Cape San Blas beach access road destroyed.

FIGURE 21. Dwelling by wind near Cape San Blas.

FIGURE 22. Flooded area east of Money Bayou.

FIGURE 23. Dwelling damaged by wind and flooding.

FIGURE 24. Manufactured dwelling destroyed by winds, waves, and flooding.

FIGURE 25. Damaged dwelling floated off its short pile foundation.

FIGURE 26. Mobile home destroyed by wind and flooding.

FIGURE 27. Dwelling damaged by wave impact loads.

APALACHICOLA AND WESTERN FRANKLIN COUNTY

During the late afternoon and early evening of Thursday, November 21, the City of Apalachicola huddled in the darkness as the maximum wind field of hurricane Kate impacted the area of western Franklin County. At the airport west of Apalachicola the National Weather Service reported a peak wind gust for north Florida of 78 miles per hour. While St. Vincent Island was sustaining heavy beach and dune erosion and flooding, the storm surge of Kate propagated through the constricted St. Vincent Sound and caused substantial flooding of the mainland shoreline area south of Franklin County Road 3022 and U.S. Highway 98. In Apalachicola and western Franklin County, 39 major structures, excluding roads, were destroyed or sustained major structural damage.

At an area known as 14 Mile, two mobile homes were destroyed by the flooding. These structures were the St. Vincent National Wildlife Refuge offices. Substantial tree damage made many of the refuge trails unpassable on St. Vincent Island. At an area known as 13 Mile, three structures were destroyed by the flooding. A concrete block slab-on-grade seafood processing plant located on the St. Vincent Sound shoreline was totally destroyed by storm waves propagating on the storm surge. About 2,000 feet inland from the sound a frame single-family dwelling and a mobile home were destroyed by the flood waters. Nearby a large steel hull boat strapped to a trailer was floated further inland about 100 feet by the flood. Just west of the junction with U.S. Highway 98, about 350 feet of Franklin County Road 3022 was substantially damaged due to erosion from St. Vincent Sound (Figure 28).

Extending along the Apalachicola Bay shoreline west of the City of Apalachicola is the Two Mile Breakwater constructed of dredge material by the U.S. Army Corps of Engineers. This breakwater provided substantial protection to the upland properties; however, flood damage was extensive at the gap in the breakwater where the navigation channel extends offshore. Behind the breakwater segment west of the navigation channel gap, seven major structures sustained major structural damage. Of these, four seafood processing houses and one metal warehouse building sustained major roof and siding damage due to wind. Behind the damaged warehouse a mobile home was damaged from the building's debris. Additionally, a carport attached to a single-family dwelling was destroyed and a mobile home was damaged from flooding near the shoreline.

At the gap in the breakwater for the navigation channel, evidence existed indicating how substantial the damage would have been without the breakwater (Figure 29). A large concrete block

former seafood house which was being used as a storage building was totally destroyed by wave impact loads (Figure 30). Nearby, but only partially sheltered by the breakwater, another concrete block commercial building was damaged by waves and gutted by flooding (Figure 31). Across the street one mobile home was destroyed and another damaged by wind (Figure 32).

East of the navigation channel gap in the breakwater four major structures were destroyed and ten others were substantially damaged. One small mobile home was destroyed by flooding and another was destroyed by wind. Two other mobile homes were damaged by flooding, waves, and foundation scour. Three single family dwellings were substantially damaged by flooding, waves, and wind damage, one of which had its roof blown of f and a detached bedroom damaged. Additionally, five seafood processing buildings sustained substantial wind and water damage. At the breakwater's east end the storm surge and storm waves broke over a bulkhead and destroyed a 50 foot segment of concrete block retaining wall and destroyed the eastern portion of the Hut Restaurant (Figure 33). Adjacent to the Hut Restaurant a mobile home was destroyed by waves and floating debris (Figure 34).

In downtown Apalachicola, the 100-year old water tower was toppled by Kate's winds (Figure 35). Widespread light wind damage was experienced throughout the city. One dwelling sustained major roof damage. Along the waterfront of the Apalachicola River, four seafood processing buildings and another metal commercial building sustained wind and water damage. Some dock damage and flooding was sustained along Water Street. At the mouth of the river a concrete block commercial building sustained heavy wave damage (Figure 36). Docks and boats alike were damaged at the marina at Battery Park (Figure 37). Nearby an old wood hotel structure sustained foundation damage due to wave activity.

East of the mouth of the river extends the John Gorrie Causeway which sustained substantial flooding from Apalachicola Bay. Approximately 1,350 feet of U.S. Highway 98 was damaged along the Gorrie Causeway.

FIGURE 28. Franklin County Road 3022 damage from St. Vincent Sound shoreline erosion.

FIGURE 29. Heavy damage at the gap in the two mile breakwater, Apalachicola.

FIGURE 30. Concrete block commercial building destroyed by waves.

FIGURE 31. Heavy wave damage to another commercial building.

FIGURE 32. Mobile home destroyed by wind.

FIGURE 33. Wave damage to the Hut Restaurant on Apalachicola Bay shoreline.

FIGURE 34. Apalachicola Bay shoreline dwelling destroyed.

FIGURE 35. One hundred year old Apalachicola water tower toppled by Kate’s winds.

FIGURE 36. Building damaged by waves at the mouth of the Apalachicola River.

FIGURE 37. Marina Damage at Battery Park, Apalachicola.

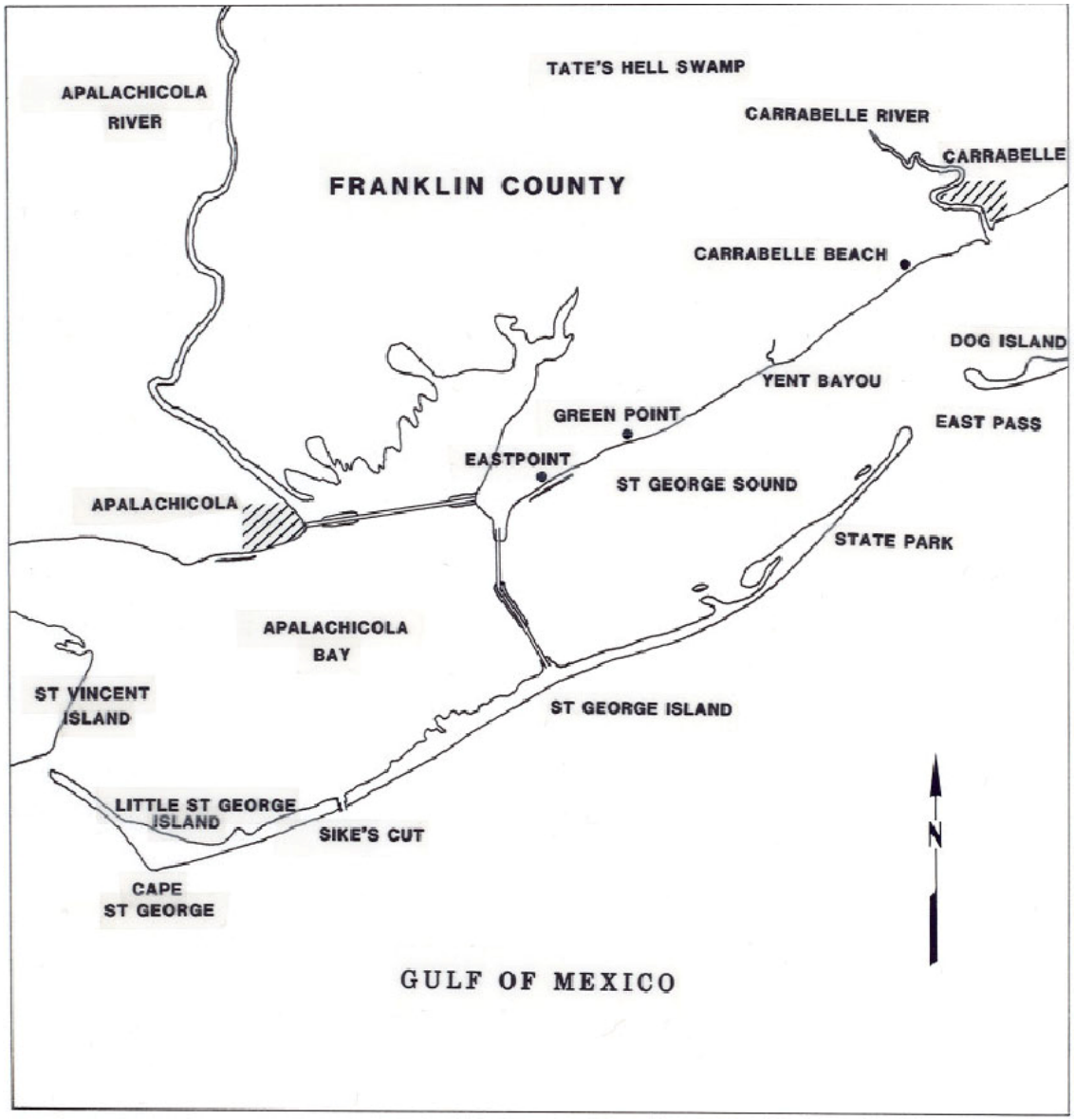

FIGURE 38. St. George Island and Apalachicola to Carrabelle, Franklin County.

ST. GEORGE ISLAND, FRANKLIN COUNTY

The prior chapter discussed the coastal damages along the mainland shoreline of Franklin County fronting on Apalachicola Bay. Of the 156 major structures exclusive of roads which were destroyed or sustained major structural damage on the coast of Franklin County, 110 were located along the mainland shoreline and only 46 were located on the outer barrier coast. Generally, improved siting and construct ion standards in practice on the barrier coast was a major factor in the reduced number of structures sustaining major damage. All of those structures on the barrier coast which sustained major damage did not meet the current coastal building standards of Franklin County or the State of Florida. On St. George Island, nineteen major structures exclusive of roads were destroyed or sustained major structural damage. Of these, three single-family dwellings and one mobile home were destroyed, and thirteen single-family dwellings and two mobile homes sustained major structural damage.

Between West Pass and East Pass, extends 28 miles of coastal barrier fronting Apalachicola Bay and St. George Sound. The western six to seven miles of this coastal barrier system is historically referred to as Little St. George Island and includes the large coastal feature known as Cape St. George. The former natural tidal pass separating Little St. George Island from St. George Island is now closed; however, the storm surge from Kate substantially inundated this old inlet and carried flood waters into Apalachicola Bay. Between this closed pass and the dredged St. George Island Channel (also referred to as Bob Sike's Cut) is about two and one-half miles of the historical west end of St. George Island. In Post-Storm Report 85-3, heavy dune erosion was reported due to the offshore pass of hurricane Elena along the entire length of Little St. George Island and St. George Island. Hurricane Kate inflicted additional heavy erosion throughout this area. Unfortunately, beach profile data was not obtained west of Sike's Cut, but personal observations of this area after both storms revealed heavy beach and dune erosion. The predominant longshore transport of sediment in this area is westerly toward Cape St. George and the shore line recession west of Sike's Cut reflects the deficit of sediment which typifies numerous other Florida coastal inlets which are dredged to maintain navigable depths.

As reported in Post-Storm Report 85-3, the inlet's rock jetties at Sike's Cut were breached by the substantial shoreline recession caused by Elena on September 1. Figure 39 is an aerial photograph of the inlet prior to Kate. The Mobile District Corps of Engineers conducted an emergency dredging operation in the channel after Elena, removing shoals and placing the material in the breach between the east jetty and the shoreline. Although some erosion did occur in this filled area immediately east of

the inlet by Kate (Figure 40), conditions were substantially better than After Elena. The storm waves of Kate must have been substantially out of the southwest because the black channel buoy normally located directly offshore from the inlet was located one mile east of Sike's Cut after the storm.

The beaches and dunes along the St. George Island Plantation east. Of Sike's Cut sustained heavy erosion from Kate. The exposed root systems of old sand pine stumps located the former barrier dunes which were destroyed by the combined erosion impact of hurricanes Elena and Kate (Figure 41). None of these former barrier dunes exists for 7,000 feet east of Sike's Cut. The remaining two and three-fourths of a mile of St. George Island Plantation shoreline to the east reflect heavy dune erosion with steep vertical escarpments fronting the beach. Although no storm surge data was obtained in this area from Kate, the surge appeared to range somewhere between approximately +7 feet NGVD and +8 feet NGVD (personal observation). Along the Plantation's beachfront no major structures sustained major structural damage however, most all the beach dwellings sustained light wind damage and all the beach access walkways were destroyed along their seaward extremities. The beach dwellings in the Plantation typically sustained damage to their roofing, screens, and antennas, and a few dwellings sustained wind damage to porches and chimneys. Throughout the Plantation numerous pines were blown down. Near the east end of the Plantation on the beach a 45 foot length of railroad tie retaining wall was destroyed.

Between the St. George Island Plantation and Franklin Boulevard at the St. George Island causeway, two dwellings were destroyed and seven others sustained major structural damage by Kate. The two dwellings which were destroyed, were both pile-supported and sustained only wind damage. One of these, a pile-supported manufactured home, was located about 700 feet inland from the beach at 11th Street West inland of Gulf Beach Drive which is the second paved road inland from the beach (Figure 42). Nearby, on the beach seaward of Gorrie Drive, a slab-on-grade concrete block dwelling sustained major roof damage due to wind (Figure 43). In the four block stretch between 12th Street West and 8th Street West on Gorrie Drive, 29 dwellings sustained roofing damage including nine which sustained extensive roofing damage. A number of dwellings in this stetch had screen damage, a few fences were destroyed, and a screen porch with roof was destroyed. In addition, a dwelling located north of Gorrie Drive between 9th Street West and 8th Street West sustained major structural roof damage due to wind (Figure 44).

Adjacent to the beach to the east of the end of 8th Street West, the older of two adjoining wood frame dwellings sustained major structural roof damage due to wind (Figure 45). The roof damage seen in Figures 44 and 45 reflect the need for stronger roof to wall connections particularly where large roof overhangs are

constructed. On the beach, immediately west of the end of 7th Street West, a pile-supported wood frame dwelling was destroyed by wind (Figure 46). The connection details of this structure did not even comply with the Standard Building Code at the time of construction, let alone the current coastal building codes in effect on St. George Island. Airborne debris from this dwelling was carried over 150 feet inland and a sect ion of the roof knocked out a seaward pile from the neighboring dwelling across Gorrie Drive. Between 8th Street West and Franklin Boulevard, another 28 structures sustained roofing damage including ten with extensive roofing damage and one with a damaged porch and collapsed roof. Several dwellings sustained screen damage, a few antennas were blown down, a fence was destroyed, and a few porches and decks were damaged. A number of beach access walkways also had their ends destroyed.

On the Apalachicola Bay shoreline area of St. George Island west of the causeway, two single-family dwellings and one mobile home sustained major structural damage due to the flooding from the bay. The storm surge and wave activity in Apalachicola Bay from Kate inflicted additional damage to the causeway to St. George Island beyond that damage previously sustained by hurricane Elena. As discussed in Post-Storm Report 85-3, the strong east to southeast winds associated with Elena's west-northwestward track on September 1 caused a significant setup of the storm tide along the causeway's east shoreline. Because of this storm tide and the storm wave activity which propagated westward along the axis of St. George Sound substantial causeway erosion and damage to three bridge abutments were sustained during Elena. Kate's predominant storm wave propagation appeared to be towards the northeast in this area and the northernmost of the four bridge abutments, which had not previously been damaged by Elena, was severely eroded by Kate. In addition, Kate inflicted heavy damage on the other three bridge approaches.

East of Franklin Boulevard along Gorrie Drive, two dwellings were destroyed and eight others sustained major structural damage. Along this eastern segment of Gorrie Drive 47 other dwellings sustained roofing damage including seventeen with extensive roofing damage. Additionally, several dwellings sustained screen and antennae damage and two porches were substantially damaged. To the north of Gorrie Drive about 500 feet west of 5th Street East, a wood frame barrel-shaped dwelling was ripped apart by Kate's winds (Figure 47). This type of construction is not appropriate for the open coast due to the inferior roof and wall connections. Nearby, another dwelling located 200 feet west of 5th Street East sustained major structural roof damage due to wind. On the beach immediately east of the end of 5th Street East, a slab-on-grade concrete block dwelling sustained major structural roof damage due to wind and had its concrete block porch destroyed by wave uprush (Figure 48). At another similar type dwelling located 600 feet east of 6th Street East, the porch

was destroyed and its roof collapsed causing major structural roof damage to the main portion of the structure (Figure 49). Immediately adjacent and to the east, a pile-supported wood frame dwelling sustained major foundation damage due to wind in combination with the scour of sediment around the piles (Figure 50). The structure's inadequate pile to beam connections were damaged and pile penetration was insufficient causing the structure to lean towards the north in danger of collapse from another strong onshore wind.

To the east about 400 feet is a mobile home on the south side of Gulf Beach Drive. This grade level mobile home sustained major damage from flooding which was extensive throughout this portion of the island. A couple thousand feet to the east was another site of heavy damage. Two slab-on-grade concrete block duplex units sustained major structural roof damage (Figure 51). The roof to wall connections of these structures could not withstand the uplift forces of the wind against the large roof overhangs. The slab-on-grade concrete block dwelling next door to the east also had its roof blown off as well as its seaward wall destroyed due to wave activity (Figure 52). A half-foot of sand was deposited on the slab of this grade level dwelling and the interior was gutted by the flooding. At the adjacent duplex to the east a 50-foot concrete block wall was destroyed and the understructure area was damaged by the wave uprush. Further east, about 1,200 feet west of the east end of Gorrie Drive another grade level dwelling was substantially damaged by wind and wave loads (Figure 53). The wind blew the entire roof off this wood frame dwelling and the flooding and wave uprush destroyed the front porch, battered the seaward wall and gutted the interior. The dwelling was subsequently removed after the repair cost to the structure's damage was assessed at over fifty percent of the dwelling's value.

In the two miles between the east end of Gorrie Drive and the State Park, heavy dune erosion was sustained and extensive flooding occurred through major dune breaches. Most of the dwellings in this area are recently constructed and are built to improved construction standards. In this area there was no major damage; however, twelve dwellings sustained roofing damage including one with extensive roofing damage. In addition, four condominium buildings near the park sustained roofing damage with one new building sustaining extensive roofing damage. Several beach access walkways were also destroyed in this area.

In addition to the dwelling damage along the private properties of St. George Island, the flooding caused major road damage at three locations. Adjacent to the beach at Franklin Boulevard, approximately 150 feet of road pavement edge was damaged on Gorrie Drive due to hydraulic scour. Between 5th Street East and 6th Street East, a 250-foot segment of Gulf Beach Drive was

substantially damaged and further east another 300 feet of Gulf Beach Drive was damaged.

Road damage was widespread along the St. George Island State Park which includes the eastern eight miles of St. George Island. Post-Storm Report 85-3, the park road damage due to Elena was which includes the eastern eight miles of St. George Island. In Post-Storm Report 85--3, the park road damage due to Elena was discussed. The close proximity of the park road to the beach berm and shoreline in contrast to the remainder of the island's roads was a major factor in the damage sustained by both Elena and Kate. In addition, the barrier dune elevations as well as the average ground elevations along the park road are lower than the rest of the island. These low elevations subject the east end of the island to inundation from storm tides. As reported in Post-Storm Report 85-3, Elena totally destroyed approximately 400 feet of the road at its eastern end. An additional 21,000 feet or nearly four miles of pavement sustained damage to its edge. This pavement edge damage probably left the narrow asphalt road unsuitable for safe driving conditions during normal public park usage. Whether the road safety was questionable is now academic because Kate destroyed much of what was previously only damaged along the east end. Kate totally destroyed approximately 5,120 feet or nearly one mile of road pavement (Figure 54). Another approximately 1,000 feet of road sustained pavement edge damage where it was previously undamaged by Elena. Nearly three miles of the road which had pavement edge damage from Elena sustained minor to moderate additional edge damage from Kate.

The University of Florida obtained two measurements of the storm surge of Kate in the park. The two storm surge gages measured +6.2 feet NGVD and +8.0 feet NGVD. Figures 55 through 57, are computer graphics of topographic survey data obtained by the Bureau of Coastal Data Acquisition, Division of Beaches and Shores, after both Elena and Kate. Figure 55 reflects the dune erosion and threat to the park road at atypical profile between the two high use beach access faci1ities. The park road is located 50 feet landward of the survey monument. Figure 56 is a profile located at the eastern high use beach access facility and Figure 57 reflects the dune erosion and low ground elevations at the east end of the park road.

The damaged condition of the park road following the impact of the two hurricanes necessitated the closure of the eastern two and one-half miles of road past the eastern high use beach access facility. This eastern segment of road is currently only useable by permitted four-wheel drive vehicular access. The remainder of the park road system which sustained some pavement edge damage has received emergency repairs sufficient to open the facilities for normal public usage. The one mile of road which was destroyed by Kate was made particularly vulnerable to storm damage when Elena destroyed all the protective dune system fronting that

stretch of road. The combined dune erosion of both Elena and Kate left a large proportion of the undamaged and repaired segment of road extremely vulnerable to future storm damage; however, the degree of vulnerability has since been mitigated by the dune restoration activities of the park staff.

A dune stabilization project with the planting of sea oats is needed at both high use beach access facilities in order to provide a sufficient level of protection to these facilities from future storm tides. In addition, where the newly constructed barrier dunes along the park road do not sufficiently revegetate naturally, a program of mulching, seeding, and transplanting, should be considered for enhancing the restoration process.

Whether along the park shoreline or along the private properties of St. George Island, dune restoration and revegetation is highly recommended to enhance the recovery and to ensure the future protection of the island. The beach and dune system along the island provided a major protective function to substantially minimize the damages from the storm surge and storm waves of Elena and Kate. In order to utilize the natural protection best provided by the beach and dune system of St. George Island, the dunes will need to recover from the erosion sustained by Elena and Kate. The strategic placement of sand fencing and the successful establishment of dune vegetation has never been in more critical need throughout St. George "Island.

FIGURE 39. Sike's cut (St. George Island Channel) in November, 1985 prior to Kate (photograph by Kevin R. Bodge).

FIGURE 40. Sike's cut after Kate, November 24, 1985 (Kevin R. Bodge).

FIGURE 41. Sand pine stump on the beach reveals severe erosion. St. George Island Plantation.

FIGURE 42. destroyed dwelling on Gulf Beach Drive.

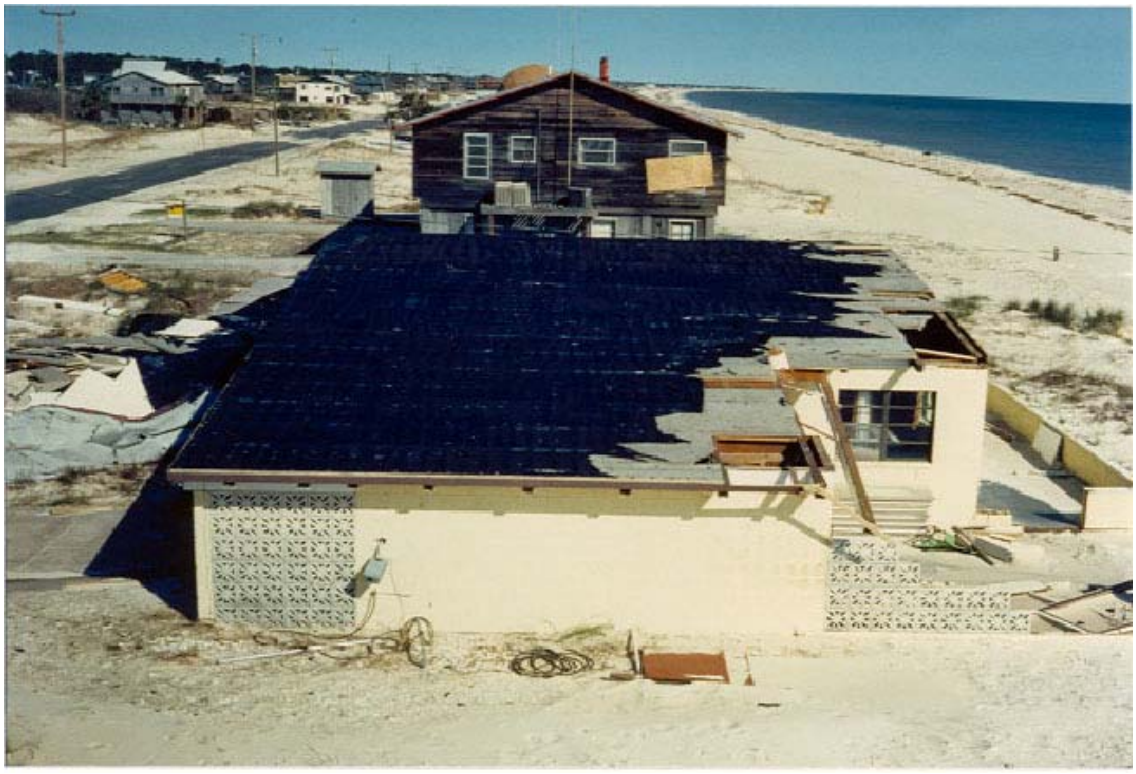

FIGURE 43. Major roof damage due to wind.

FIGURE 44. Gorrie Drive dwelling’s roof collapsed.

FIGURE 45. Severe Structural roof damage due to wind.

FIGURE 46. St. George Island beach Dwelling destroyed by wind.

FIGURE 47. Barrel-shaped house destroyed by wind.

FIGURE 48. Structural roof damage due to wind and conrete block porch destoyed by waves.

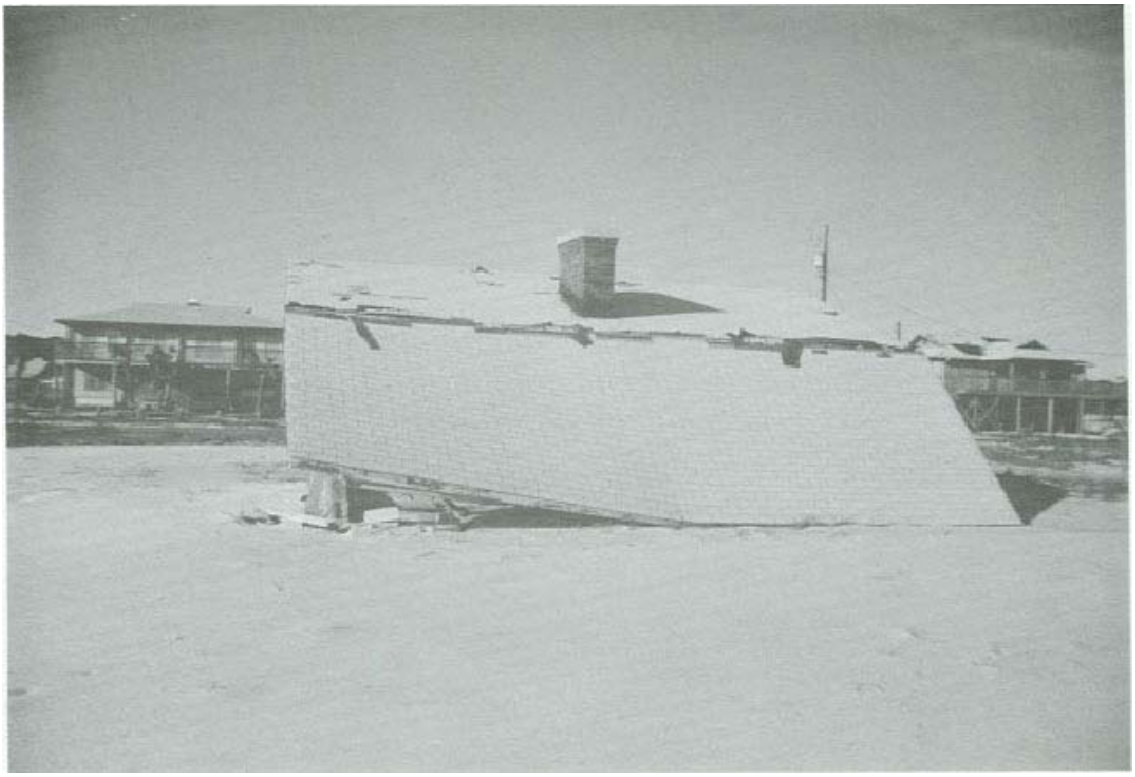

FIGURE 49. Porch destroyed and roof collapsed.

FIGURE 50. Pile-supported dwelling with inadequate pile to beam connections and insufficient pile penetration leans following wend loads and scour.

FIGURE 51. Duplex sustained major structural roof damage.

FIGURE 52. Dwelling with roof blown off and seaward wall destroyed by waves.

FIGURE 53. Frame dwelling damaged beyond repair by wind and wave loads.

FIGURE 54. St. George Island State park road destroyed.

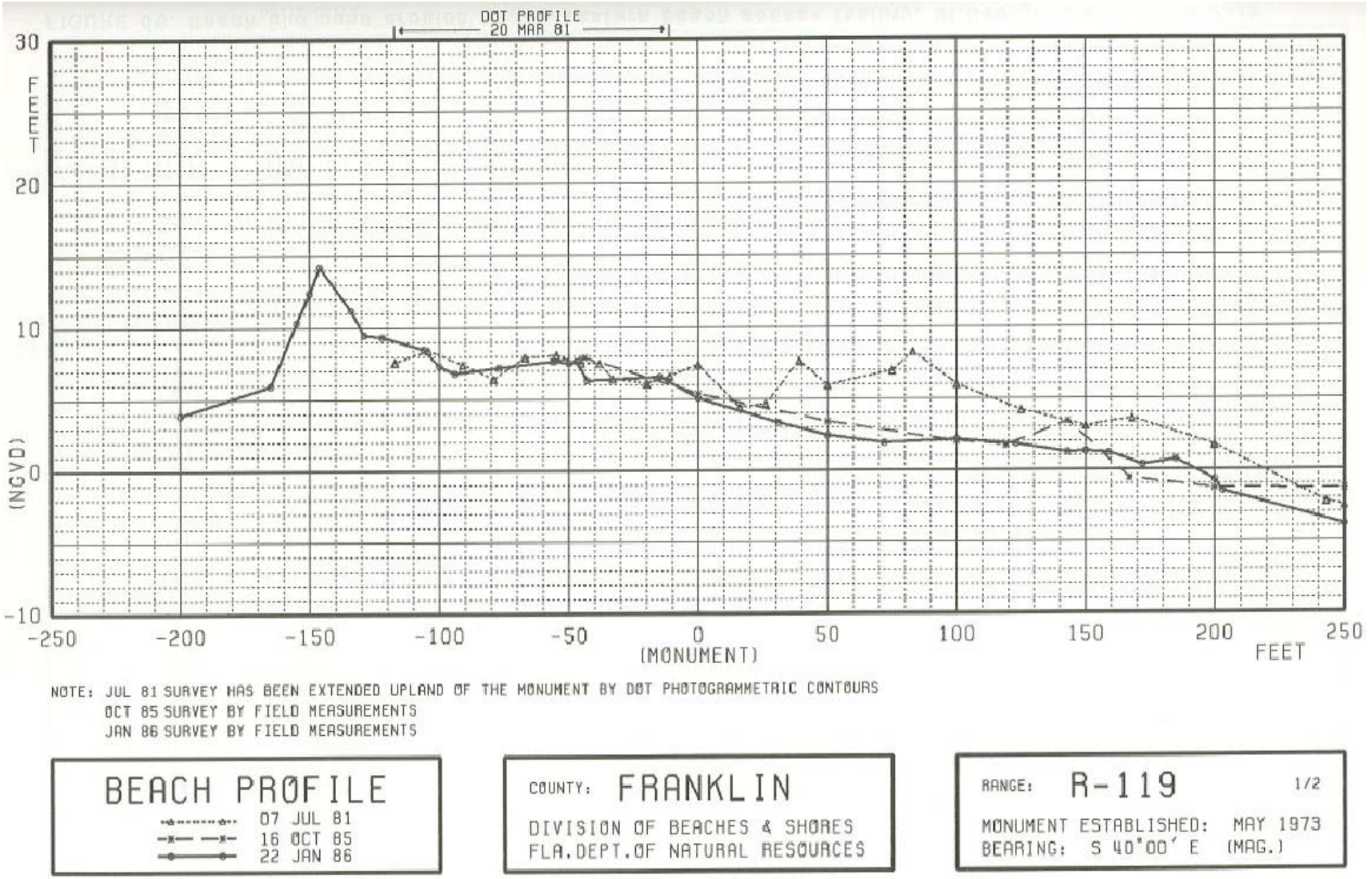

FIGURE 55. Dune erosion due to Elena and Kate leaves little protection for the St. George Island State Park road between the two beach access facilities.

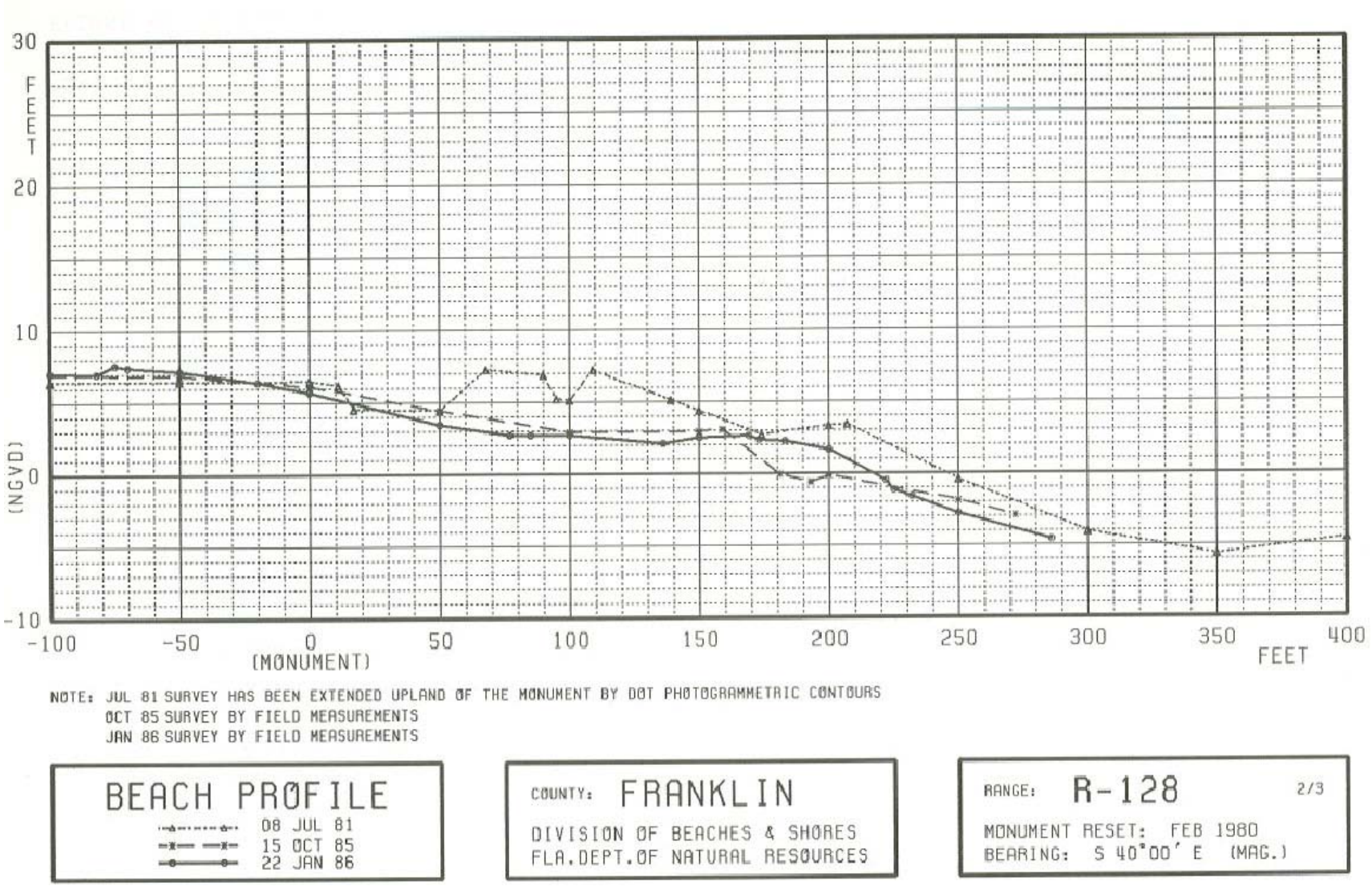

FIGURE 56. Beach and dune erosion at the eastern beach access facility, St. George Island State Park.

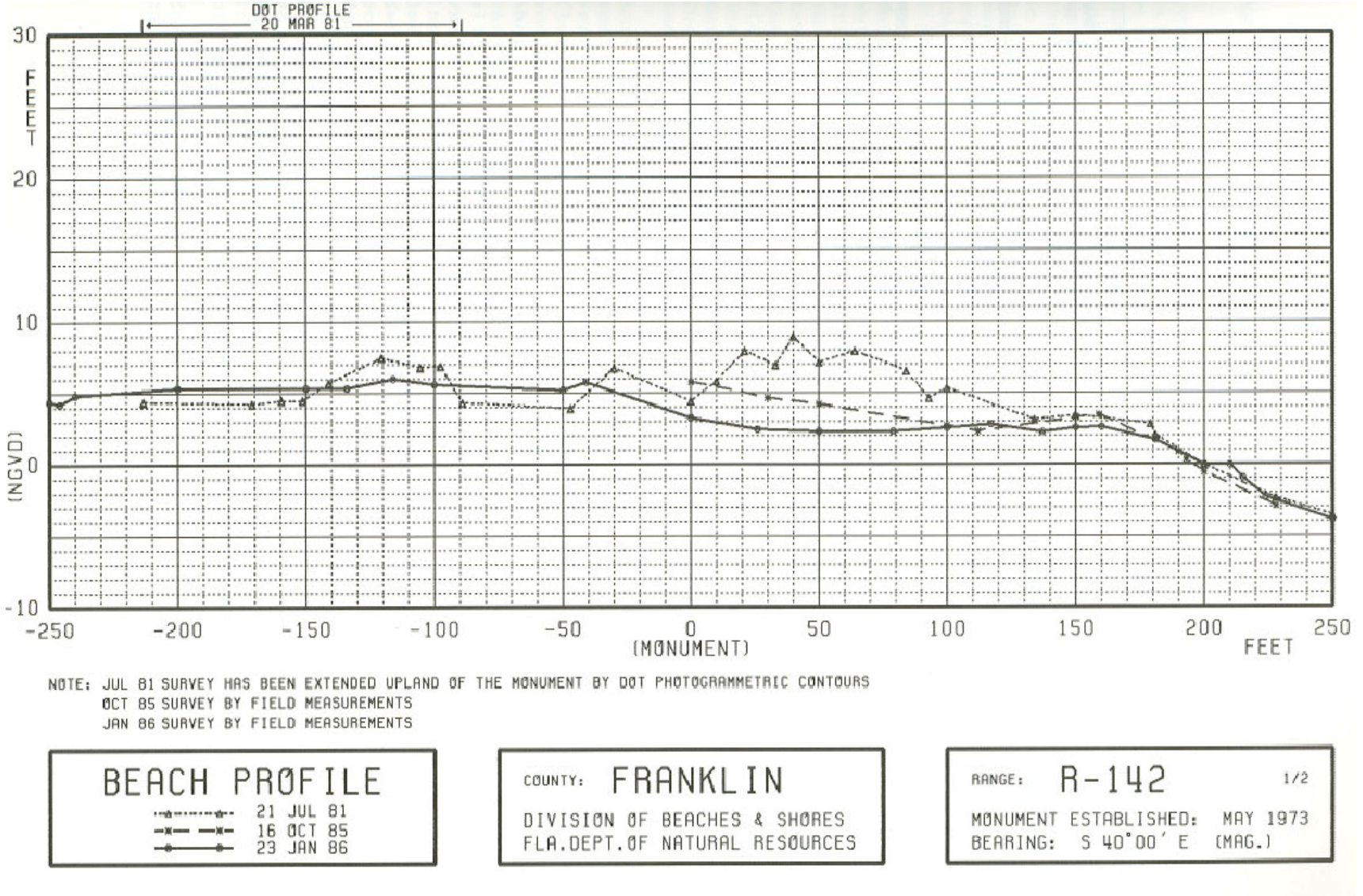

FIGURE 57. Dune erosion and low ground elevations at the east end of the park road

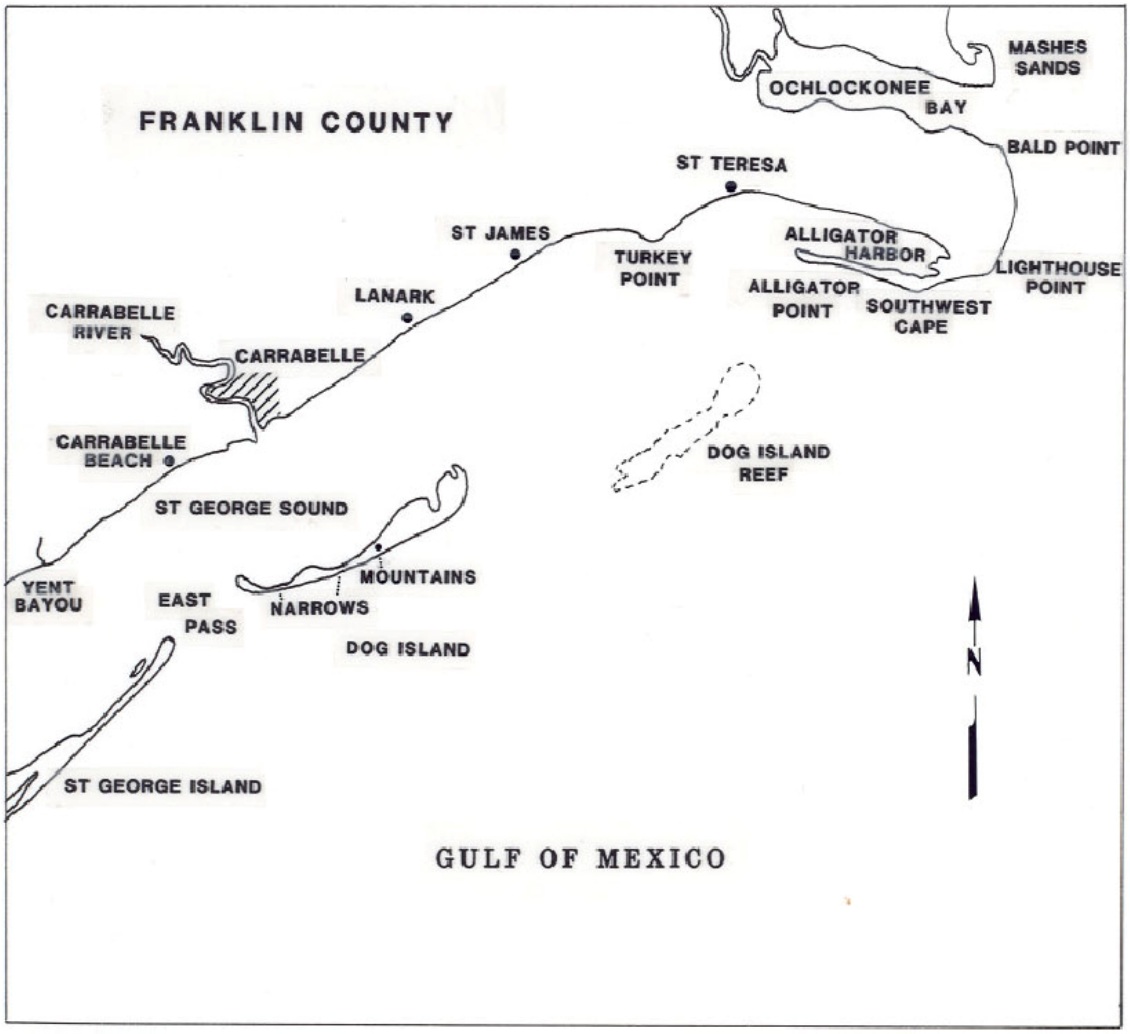

FIGURE 58. Dog Island and eastern Franklin County.

DOG ISLAND, FRANKLIN COUNTY

Lying four miles offshore from Carrabelle and the mainland, Dog Island is a six and one-half mile long coastal barrier island with approximately eight miles of shoreline fronting on or subject to Gulf of Mexico wave activity. Access to the island is limited to only boats and light aircraft as there is no connecting causeway to the mainland for vehicular access. Given the isolated nature of the island a few residents were not able to evacuate for Kate prior to conditions becoming too deteriorated for safe navigation to the mainland. Although hurricane conditions on Dog Island should not be considered safe, sufficiently high elevations do exist in an isolated region of the island, called the Mountains, to afford refuge from the highest of storm tides.

Unfortunately, no storm surge data or beach profile data was obtained after Kate on Dog Island due primarily to the degree of difficulty in access for the data acquisition operations of the University of Florida and the Florida Department of Natural Resources. Areas more access i b 1 e were given higher priority in the immediate post-storm data acquisition effort. Given the storm surge data obtained by the University of Florida in the nearby areas of eastern 8t. George Island and Carrabelle, a storm surge of approximately +8 feet NGVD would have been expected. The storm surge of Kate appeared to range between +7 feet NGVD and +8 feet NGVD on Dog Island (personal observation).

Across the two mile wide East Pass from 81. George Island, the western one mile of Dog Island sustained heavy beach and dune erosion. This west end of the island is subject to large fluctuations in the shoreline but has generally been accumulating sediment transported westerly from the eroding areas to the east. About a mile from the west end of the island and extending eastward for over a half mile is a narrow segment of the island with only a width of a few hundred feet. This narrow area is extremely vulnerable to storm conditions and was substantially inundated by the storm surge from Kate. One single-family dwelling had been located in this narrow area and was totally destroyed by the storm surge, the storm waves, and the scour conditions of Kate. Foundation piles and other debris from this dwelling were found deposited five and one-half miles to the northeast on the mainland east of Carrabelle. The battering loads of at least one derelict piling destroyed a mobile home east of the Ell' s Court on U. 8. Highway 98 (Figure 80). The western Narrows, as this area is called, remained tidally inundated for several months after Kate. At present, the highest of astronomical tides still flood this area.

East of the western Narrows is a one mile length of Dog Island, called Cannonball Acres, which is up to one-half mile wide.

Heavy beach and dune erosion was observed along Cannonball Acres after Kate. This Area is also very low and subject to storm surge flooding. Flooding was extensive throughout this area after Kate as few ground elevations exceeded Kate's floodwaters. One relatively new pile-supported beach dwelling was observed in Cannonball Acres with no major damage. It had originally been constructed substantially inland in the woods; however, given the high erosion rate in this area it is now located at the beach with no dune system. Septic tanks are unsuitable in this low area and at this site the septic tank located seaward of the dwelling floated above grade during Kate's flooding and was transported inland a couple hundred feet and deposited in the woods (Figure 59).

To the east is another Narrows area of about a half mile length and as narrow as 250 feet. Like the western Narrows this area was inundated and leveled of any dunes during the storm surge of Kate. Because of the continued tidal breaching of both Narrows for weeks after the storm, Dog Island was reported to be separated into three islands. Although the eastern Narrows soon closed, the area was still inundated by the astronomical high tide a month after the storm (Figure 60). The one dwelling, which was recently constructed in the eastern Narrows, has a substantial pile foundation and high elevation and sustained no major structural damage. The few feet of vertical scour across this area has rendered the septic system of this dwelling nonfunctional.

Most of the development of Dog Island extends for three and three-quarters of a mile between the eastern Narrows and near the east end of the island, and with the exception of the Pelican Inn consists solely of single-family dwellings. Most of the beach dwellings constructed on Dog Island have been prudently sited. However, in the past, a few dwellings have been threatened by erosion and relocated inland. One dwelling near the eastern Narrows was threatened by erosion and relocated inland over 200 feet in 1982. During one of the more severe EI Nino storms in the spring of 1983, either a small tornado or a downburst blew the roof off this dwelling. To continue its problems, Kate's winds inflicted major structural roof damage to the dwelling.

The three-quarter mile stretch of beach between the eastern Narrows and the mountains has experienced a severe erosion rate Figure 61). Based upon observations of the erosion after Kate in comparison with January, 1981, aerial photography, this segment of the island has experienced over 100 feet of dune recession at a rate of over twenty feet per year. Whether or not this high rate of erosion continues will depend upon the frequency of storm tide conditions and the degree of recovery between the storms. It is highly recommended that the property owners in this area initiate a program of sand fencing to assist in the natural redevelopment of dunes. Fertilization of the recovering beach and

dune vegetation during the rainy periods would further enhance the dune reestablishment and stabilization.

Kate inflicted heavy dune erosion along the Mountains; however, the dwellings in this area are situated sufficiently inland and at high elevations and were not threatened by the erosion. Heavy beach and dune erosion was also incurred along the entire eastern half of Dog Island but no structures besides the dwelling at the western Narrows sustained major structural damage due to the storm surge, waves, or erosion. Eight dwellings did sustain major structural damage due to the winds of Kate. In addition, another 50 beachfront dwellings sustained roofing and other wind damage including fourteen which sustained extensive roofing damage. Screen damage was widespread and a number of beach access walkways were destroyed. A gazebo on the beach and a viewing deck in the dunes were also destroyed.

Figure 62 shows one dwelling, located just east of the Mountains, which sustained additional major structural roof damage due to Kate's winds after tropical storm Juan caused the initial damage. At another dwelling nearby, a seaward section of roof with the roof trusses was blown over the house and inland nearly 100 feet. At the slab-on-grade dwelling next door, the wind undermined the slab, sandblasted the paint off the trim, and filled the screen windows with sand (Figure 63). Figure 64 shows one of two Dog Island dwellings which not only had structural roof damage but also had the seaward wall blown inward by Kate's winds. Near the east end of Dog Island one slab-on-grade concrete block dwelling is threatened by dune erosion which reached to within a foot of the foundation. This structure will probably not survive another major erosion event.

As recommended for St. George Island, the placement of sand fencing and the seeding, planting, and fertilization of dune vegetation, will enhance the recovery of Dog Island's beaches and dunes. Very little care has been given the beach and dune system by the property owners to date; however, as the erosion continues to encroach upon the beachfront structures with each coastal storm, dune restoration activities will have to be given a much higher priority.

FIGURE 59. Dog Island septic tank carried inland by the flood.

FIGURE 60. Eastern Narrow inundated at high tide three weeks after Kate.

FIGURE 61. Severe erosion threatens dwelling, Dog Island.

FIGURE 62. Dwelling sustained major structural roof damage due to wind.

FIGURE 63. Wind undermined the slab, sandblasted the paint off the trim, and filled the screen windows with sand.

FIGURE 64. Island dwelling with heavy wind damage.

ST. GEORGE SOUND SHORELINE AND COMMUNITIES OF EASTPOINT, CARRABELLE BEACH, CARRABELLE, LANARK, ST. JAMES, AND ST. TERESA, FRANKLIN COUNTY

The mainland coast of Franklin County between Eastpoint and St. Teresa extends for thirty miles. The coastal area south of U.S. Highway 98 was extensively damaged by the winds, the flooding, the wave impact, and the erosion of hurricane Kate. Along this stretch of coast 71 major structures were destroyed or sustained major structural damage and 3.6 miles of U.S. Highway 98 were destroyed or substantially damaged.

Across the John Gorrie Causeway from Apalachicola lies the fishing and seafood processing community of Eastpoint. On the Apalachicola Bay shore line west of the causeway to St. George Island a single-family dwelling and a mobile home sustained substantial flooding and wind damage. On U.S. Highway 98 in western Eastpoint, the Ace Hardware store, a concrete block structure, was substantially damaged by wind as the west walls caved in revealing the absence of adequate reinforcing steel (Figure 65).

The recently constructed Eastpoint breakwater provided substantial protection to this seafood community of numerous waterfront oyster shucking houses. At the west end of the breakwater a mobile home was destroyed by flooding and a 150-foot length of rubber tire coastal protection structure was destroyed. Along the waterfront behind the breakwater one seafood processing building was destroyed by waves and flooding, and fifteen others sustained major structural damage from flooding, waves, and wind. Figure 66 shows one Eastpoint oyster house which sustained major structural damage to its bayward end from flooding and waves. Had it not been for the protective breakwater most of the Eastpoint waterfront structures would have been totally destroyed. A storm surge of +7.2 feet NGVD was measured in this area by the University of Florida. A mobile home at the east end of the breakwater north of the highway was al so destroyed by wind.

East of the breakwater along the east end of Eastpoint, 3,650 feet of the highway was damaged. To the east of the Florida Highway Patrol station another 2,900 feet of U.S. Highway 98 was destroyed (Figure 67). Further east, the roof blew off another mobile home north of the highway. Between the junction of State Road 65 at Green Point and Yent Bayou, nine damaged segments of U.S. Highway 98 totaled approximately 9,700 feet (Figure 68).

Most of the dwellings south of the highway along the St. George Sound shoreline between Yent Bayou and Carrabelle Beach were damaged either by flooding, waves, wind, or erosion. Erosion caused the unusual collapse of one of these structures (Figures

69 and 70). This wood frame dwelling was undermined due to erosion beneath most of the structure; however, only a front row of foundation piles existed on the bay side of the dwelling. The erosion progressed beneath the dwelling enough to leave the landward side perched on grade after falling off its concrete block footings. The end result was for the dwelling to literally break in two with a collapse in the middle of the house.

Nearby, a mobile home had major foundation damage and settlement due to erosion and another dwelling sustained major foundation damage and had 150 feet of wood bulkhead destroyed. Several other dwellings sustained roofing damage from wind and one wood frame dwelling is in imminent danger of collapse due to erosion (Figure 71). Further east a concrete block dwelling sustained major damage to its front wall due to wave loads and another dwelling with foundation damage caught two toppled pine trees on its roof (Figure 72). Several other dwellings to the east sustained various minor wind damages and one concrete block dwelling sustained major wave damage.

On this mainland shoreline of St. George Sound, adjacent to East Pass, the wide inlet between St. George Island and Dog Island, is an area of very high sand dunes. These dunes are as high as any in Franklin County and are relics to a high-energy period of geologic time. The bay shore erosion of one very large dune is as spectacular as any site on the northern coast of the Gulf of Mexico. To dramatize this significant dune erosion a slab-ongrade concrete block dwelling is on the verge of collapsing onto the beach (Figure 73). The southeast corner of this dwelling was undermined and collapsed during Kate. To the west, on the same eroding dune formation, a manufactured dwelling was destroyed by wind (Figure 74). Heavy debris from this dwelling including the roof and large mattresses were found blown across the highway.

East of this large dune formation in a low area, 800 feet of U.S. Highway 98 was damaged. To the east, a mobile home was rolled over by the wind and flooded while lying on its roof (Figure 75). Nearby, a large concrete block dwelling sustained major roof damage by wind as well as wave and flooding damage to its walls and foundation. One pile-supported dwelling located on the beach was on the verge of collapse after being damaged by hurricane Elena; however, in the couple months after Elena, the owner repaired the foundation and the structure withstood the forces of Kate with only minor damages. To its east, another 800 feet of U.S. Highway 98 was damaged.

The area immediately west of Carrabelle Beach was hit hard by Elena on September 1. As discussed in The Impact of Hurricane Elena and Tropical Storm Juan on Coastal Construction in Florida Beaches and Shores Post-Storm Report No. 85-3), this area is directly exposed to the storm tide and wave activity through East Pass which is nearly two miles wide. In addition, there are

nearly four miles of open water across St. George Sound north of East Pass for storm waves to propagate. This mainland shoreline sustained heavy erosion from Elena and seven single-family dwellings were destroyed and two others sustained major damage on September 1 (See Figures 18 through 21 of Beaches and Shores Post-Storm Report No. 85-3). Kate inflicted additional heavy erosion to this area. At the site of several dwellings destroyed by Elena, Kate damaged another 765 feet of highway and scattered much of the earlier debris (Figure 76). A pile-supported mobile home which survived Elena was destroyed by Kate (Figure 77). Kate destroyed another pile-supported, wood frame single-family dwelling nearby while causing six feet of vertical scour (Figure 78). The roof and walls of this dwelling were blown off and the foundation piles were knocked out by wave forces.

To the west of the Carrabelle Beach Roadside Park another 800 feet of highway was damaged as heavy dune erosion was sustained. A double-wide mobile home next to the roadside park had its roof blown off as did another mobile home further east.

The City of Carrabelle is substantially protected from storm wave activity given its location inside the mouth of the Carrabelle River. Substantial flooding and dock damage did occur along this fishing community' s waterfront. Additionally, widespread light to moderate wind damage was experienced throughout the city. Around the Carrabelle waterfront major roof damage was incurred by four commercial buildings and major flooding damage was sustained by another. Behind the IGA Food Store a downburst rolled a large mobile home (Figure 79).

On the east side of Carrabelle along the St. George Sound shoreline, two dwellings sustained major foundation damage from waves and scour, and five segments of road were damaged totaling 870 feet. In this area, the Coastal and Oceanographic Engineering Department, University of Florida, measured a storm surge of +7.9 feet NGVD and a high water mark of +8.7 feet NGVD. Immediately east of Carrabelle a single-family dwelling by the Ell's Court sustained wave damage to its foundation and siding. East of Ell's Court a mobile home was destroyed by the battering loads of waterborne debris from a house destroyed offshore on Dog Island (Figure 80).

A few miles east of Carrabelle along U.S. Highway 98 is the community of Lanark Village. Most of the older homes in Lanark Village are located inland of the highway and generally only light wind damage was sustained in the inland areas. Most of the newer waterfront dwellings were pile-supported and sustained only light wind damages. However, five mobile homes and four single family dwellings were substantially damaged south of the highway. One mobile home was destroyed at the Gulf Breeze Campground by wind, water, and a fallen tree. Nearby, another mobile home

sustained major flood damage and a double-wide mobile home sustained major wind damage to its roof.

As reported in Post-Storm Report 85-3, the storm waves of hurricane Elena destroyed a wood frame single-family dwelling which was not sufficiently elevated. The flooding of Kate, equally as significant as Elena, induced additional damage to the remnants of this structure. To the east, the roof blew off another mobile home which was elevated on wood piles. A slab-on-grade concrete block dwelling sustained major damage to its walls and foundation by the storm waves and scour. Another dwelling had its porch damaged and its roof collapsed.

West of the Lanark Marina, a mobile home sustained substantial flooding and wave damage and a single-family dwelling sustained major wind and water damage and was hit by a fallen tree. At the Lanark Marina, the storm tide and wave activity from Kate carried some of the floating docks across the crown of U.S. Highway 98 and placed them in the ditch along the north right-of-way. As reported in Post-Storm Report 85-3, the crown elevation of the road is approximately +7.5 feet NGVD. To the east of the Lanark Marina adjacent a runout channel carrying upland drainage, the wind destroyed a dwelling's porch and collapsed its roof.

East of Lanark Village, extending along U. S. Highway 98 is the small shoreline community of St. James. Waterfront damage along St. James was extensive as five single-family dwelling structures were destroyed and eight others plus a motel end unit sustained major structural damage. St. James is exposed to the open waters of the Gulf of Mexico with only Dog Island Shoal, located northeast of Dog Island and five miles offshore from St. James, providing any barrier to storm waves propagating from the Gulf. St. James is also heavily wooded and the high wind gusts toppled many pine trees which caused additional damage to structures (Figure 81).

Near the west end of St. James two cottages were damaged beyond repair, sustaining major structural damage to the roofs and walls. One of the structures was moved from its foundation by the flood which gutted both structures and deposited substantial debris inland by the road. Another cottage in St. James was totally destroyed by predominantly wave loads acting simultaneously with wind loads (Figure 82). Wave loads and scour destroyed 60 feet of aluminum bulkhead, 35 feet of concrete block retaining wall, and 235 feet of grouted bag revetment at three properties to the east. Wave loads also substantially damaged the seaward end unit of a motel (Figure 83) and substantially destroyed the seaward portion of a single-family dwelling. Immediately adjacent to and west of Martha Anns Motel at the east end of St. James, another single-family dwelling was destroyed by the storm surge and wave loads (Figure 84). Although this structure was not sufficiently elevated, had it been located

somewhat further landward from the point of wave breaking as was the undamaged adjacent dwelling, the damage may have been minimal. Nearby, a sufficiently elevated dwelling sustained no structural damage but had 65 feet of wood bulkhead destroyed (Figure 85)

Of the other eight dwellings in St. James with major structural damage only two with roof and siding damage were subject to major wind damage. The other six dwellings all sustained their major damage from the storm surge and wave loads. Four of these dwellings sustained major foundation damage due to wave impact loads and one dwelling sustained foundation damage as well as porch and roof damage due to wave loads. Another dwelling's roof collapsed when wave loads destroyed the supporting columns. Flooding problems were additionally seen at the Anneewakee Motel which suffered drainfield damage and at Martha Anns where a large container trailer was moved by the storm surge.

Further east, at the St. Joe Paper Company office, a single family dwelling sustained extensive roofing damage. And at the Florida State University Marine Laboratory at Turkey Point, 100 feet of paved road was damaged. A National Ocean Survey tide gage operating at Turkey Point measured a peak tide near 7:06 p.m. (1906 Eastern Standard Time) on November 21 at +7.75 feet NGVD.

In contrast to the extensive flooding damage along St. James. the community of St. Teresa to the east sustained very little flood damage but widespread light wind damage. Numerous screen porches were damaged by wind in St. Teresa but most dwellings are sufficiently siting landward of the shoreline and at a high ground elevation due to the prominent ancient dune system in this community. Major wind damage was sustained by three single family dwellings in St. Teresa. A wood frame dwelling, east of an out let channel connecting a fresh water wet land to the Gulf, sustained major damage when wind uplift pressures ripped the roof and porch off the dwelling. An adjoining dwelling structure immediately landward of this dwelling sustained major damage from the impact of the airborne roof (Figure 86). Another single family dwelling near the Wilsons Cottages also sustained major roof damage due to wind. Further east, the Bay North Development at Camp Weed sustained heavy dune erosion which threatens the imprudently sited seaward structures of this relatively new development. A large deck was damaged on the seaward side of one dwelling and another had its stairs damaged. A new wood bulkhead is under construction at this site as the armoring syndrome is usually justified by property owners for imprudently sited coastal structures which were not subject to adequate shoreline setback restrictions.

FIGURE 65. Ace Hardware store damage by wind, Eastpoint.

FIGURE 66. Oyster house damaged by flooding and waves, Eastpoint.

FIGURE 67. U.S. Highway 98 destroyed near Green Point.

FIGURE 68. U.S. Highway 98 destroyed between Green Point and Yent Bayou.

FIGURE 69. Dwelling with one front row of piles collapsed when undermined by erosion.

FIGURE 70. Landward side of same dwelling still supported by original grade showing the collapse in the middle.

FIGURE 71. Dwelling threatened by erosion, St. George Sound shoreline.

FIGURE 72. Dwelling damaged by two toppled pines.

FIGURE 73. Partially undermined and damaged dwelling in imminent danger from severe dune erosion.

FIGURE 74. Manufactured dwelling destroyed by wind, with the roof blown across U.S. Highway 98.

FIGURE 75. Mobile home rolled over by the wind and flooded.

FIGURE 76. Severe damage west of Carrabelle Beach.

FIGURE 77. Pile-supported mobile home which survived Elena was destroyed by Kate..

FIGURE 78. Pile-supported dwelling destroyed by wind, waves, and erosion of Kate.

FIGURE 79. Mobile home rolled by downburst behind the Carrabelle IGA Food Store.

FIGURE 80. Mobile home east of Carrabelle destroyed by battering loads of waterborne debris from house destroyed on Dog Island.

FIGURE 81. One of many fallen pines in St. James.

FIGURE 82. Wind and wave loads destroyed a St. James structure.

FIGURE 83. Wave loads damaged seaward unit of motel St. James.

FIGURE 84. Dwelling destroyed by waves west of Martha Anns Motel.

FIGURE 85. Sufficiently elevated dwelling with no damage although wood bulkhead was destroyed.

FIGURE 86. St. Teresa dwelling damaged by the impact of an airborne roof off another dwelling.

ALLIGATOR POINT TO OCHLOCKONEE BAY, FRANKLIN COUNTY

The easternmost coastal barrier shoreline in Franklin County includes the four mile long peninsula of Alligator Point between its northwest tip and the Southwest Cape, the two mile eroding beach between the Southwest Cape and Lighthouse Point, and the three mile long low energy beach between Lighthouse Point and Bald Point at the entrance to the Ochlockonee Bay. With the inclusion of the Alligator Harbor shoreline of Alligator Point, this stretch of sandy shoreline includes all possible shoreline alignments for exposure during all storm conditions. For those areas fronting on the Gulf of Mexico, there are three areas of significant shoreline erosion stress: the Phipps Preserve on the northwest tip of Alligator Point, the one mile stretch of shoreline east of the Southwest Cape, and the one mile stretch around Lighthouse Point.

In 1972, hurricane Agnes destroyed a few single-family dwellings near the Southwest Cape and several others sustained major damage. At the northwest tip of Alligator Point nearly all the single-family dwellings were destroyed or sustained major damage. Extratropical storms in January, 1978, March-May, 1983, and March, 1985 caused substantial continued erosion stress to the areas of critical erosion. By the end of the 1985 tropical storm season, the Alligator Point area had experienced the equivalent of three hurricanes in a twelve week span. On that first pass, Elena inflicted major structural damage to three single- fami1y dwe11ings and destroyed sixty feet of revetment, approximately 400 feet of concrete bulkheads, and 3,000 feet of paved road. Two days later, on September 1, Elena passed by offshore for the second time and with a greater intensity. On the second pass, with Elena traversing the northeastern Gulf of Mexico on a northwesterly track, the Alligator Point area found itself located closer to the region of maximum winds and in a more vulnerable condition following the heavy beach and dune erosion associated with the first pass. The consecutive impacts of hurricane Elena on Alligator Point resulted in three single family dwellings being destroyed and seven others sustaining major structural damage. Elena also destroyed a 100 foot long rock groin, 310 feet of rock revetment, 270 feet of wood bulkheads, 1,500 feet of concrete bulkheads, and 4,750 feet (0.9 mile) of paved road. Elena's storm tide in this area ranged from the author's estimate of +8.0 feet NGVD at the northwest tip to the measured elevation of +9.0 feet NGVD by the University of Florida at Ochlockonee Bay. A detailed discussion of the impact of Elena on this area is given in Post-Storm Report No. 85-3.

Elena was the first impact of a hurricane experienced by Franklin County in thirteen years but it only took less than three months County in thirteen years but it only took less than three months for the next hurricane when Kate impacted the area on November 21. In comparison to the ten dwellings structurally damaged by

Elena in the Alligator Point area, Kate's major damage was double as four dwellings were destroyed and sixteen others sustained major structural damage. In addition, in contrast to the scattered light wind damage to only a handful of dwellings inflicted by Elena, Kate's winds inflicted widespread light wind damage to a large percentage of the Alligator Point area dwellings. Of the 221 dwellings which fronted on the beach between the northwest tip of Alligator Point and Bald Point at the entrance to Ochlockonee Bay, 125 dwellings (approximately 56 percent) sustained roofing damage. Of these, eleven dwellings had extensive roofing damage.

Kate inflicted additional moderate to heavy beach and dune erosion to the areas of erosion stress. As observed following Elena, the storm tide which inundated the 4,000 feet of the Phipps Preserve along the northwest tip of Alligator Point appeared to be approximately +8.0 feet NGVD (personal observation). The Phipps Preserve shoreline area immediately west of the groin field was substantially eroded by Elena but approximately 1,000 feet of shoreline west of the groin field accreted approximately 50 feet of additional beach width by the storm wave activity from Kate. This accretion was due to predominantly northwestward longshore sediment transport which bypassed through the groin field.

Along the groin field the shoreline was substantially protected from erosion. A number of the tall pines in this area were blown down but only light wind damages were sustained by the dwellings. A rain gage on one of the dwellings measured one inch of rainfall from Kate.

The stretch of beachfront dwellings to the east adjacent to the Alligator Point Marina were heavily damaged by hurricane Agnes in 1972, but only one sustained major structural damage during hurricane Kate. In contrast to all the grade level dwellings destroyed by Agnes, most of the existing dwellings on western Alligator Point are now elevated on pile foundations. In the western one mile of beach dwellings on Alligator Point, ten are constructed at grade level and all of these were flooded by the storm tide of Kate. The one which sustained structural damage had its slab undermined and front wall damaged. Another slab-ongrade dwelling had its front porch destroyed which left the roof overhang sagging. Nearby, another dwelling perched on the westernmost high dune on Alligator Point had a section of its roof blown off causing structural damage to the roof trusses and walls.

Along the Alligator Harbor shoreline, Elena had damaged two dwellings by its storm tide and wave activity. Kate further damaged one of these and destroyed the other. A dwelling located a half mile east of the marina sustained additional wave damage to its concrete walls and had its concrete slab undermined and

cracked. The flooding gutted the interior and left a layer of mud deposited throughout the dwelling. The other dwelling, damaged by Elena's first pass and further damaged by Elena's second pass, was destroyed by Kate (Figure 87). A few other dwellings along the Alligator Harbor shoreline had their septic systems damaged or destroyed and received water damage and light wind damage.

Along the peninsular portion of Alligator Point, approximately 75 percent of the dwellings sustained wind damage to their roofs. Most of the damage was light roofing damage but approximately fifteen percent of the dwellings sustained extensive roofing or structural roof damage. Besides the previously mentioned dwelling with major structural roof damage, two other dwellings sustained structural roof damage along the peninsula. One slabon-grade concrete block dwelling located about a mile west of the Southwest Cape had its flat roof completely blown off along with the upper row of concrete blocks (Figure 88). Another flat roof dwelling located about a half mile west of the Southwest Cape had its porch destroyed and sustained major structural roof damage. Another dwelling inland on a canal also sustained structural roof damage.

Along Chip Morrison Drive at the Southwest Cape, Elena had destroyed one pile-supported dwelling, 220 feet of rock revetment and 100 feet of concrete bulkhead. During Kate, three dwellings sustained major structural damage. The dwelling shown in Figure 26 on page 29 of Post-Storm Report No. 85-3 was threatened by Elena's erosion. Based upon Department of Transportation aerial photography since 1969, this site had eroded approximately 150 feet in fifteen years. Kate eroded another five to ten horizontal feet of the dune line and undermined the southeast corner of this dwelling resulting in a concrete footing collapsing on the beach (Figure 89). In another storm induced erosion event, the dwelling could be destroyed; however, the dwelling is to be relocated 100 feet further landward on the property and placed on a pile foundation.

On Chip Morrison Drive adjacent to and east of a 300 foot long rock revetment was the pile-supported dwelling that was destroyed by Elena. A barrel-shaped wood dwelling next door had its pile foundation damaged by the erosion and wave activity during Kate. This dwelling is in critical need of additional piles to support it in another storm. The dwelling next door to the east had been undermined by Elena but its short wood piles and thick concrete grade beams appeared in good condition at that time. An inspection after Kate revealed the foundation had settled and sustained damage.

Immediately east of the Southwest Cape, Franklin County Road C370 is highly vulnerable to erosion and storm wave activity. As discussed in Post-Storm Report No. 85-3. Elena's first pass on August 30-31 damaged approximately 1.000 feet of the seaward lane

of asphalt pavement across from the KOA Campgrounds. On September 1, Elena completely destroyed 1.700 feet of the road at this location. In September and October the County replaced the roadbed with fill, but on November 21. Kate eroded the new roadbed. additionally damaged 250 feet of road pavement previously damaged, and damaged an additional 150 feet of pavement further east.

The stretch of beach dwellings east of the KOA Campgrounds was an area of heavy damage after Elena. Elena totally destroyed two dwellings and substantially damaged three others. Kate totally destroyed one of the damaged dwellings and destroyed one other. Two of the dwellings damaged by Elena were wood frame structures on soil bearing foundations. Both dwellings were undermined on September 1. settled and sustained storm wave and flooding damage. Kate caused additional wave. flooding. and wind damage to these dwellings (Figure 90). Immediately to the east of the damaged wood dwellings was a concrete block slab-on-grade dwelling behind a rock revetment which was under construction prior to Elena and was not complete when first put to test. Elena's wave activity damaged the eighty foot revetment and the dwelling sustained heavy structural damage (Figure 91). Arguments between the property owners and insurance adjusters as to whether the damage exceeded forty percent were resolved by the heavy southwest wave activity of hurricane Kate. The dwelling was totally destroyed (Figure 92).

The next four dwellings to the east were not damaged by the wave activity of Kate. The first two dwellings were adequately protected by a rock revetment and the second two were on adequate pile foundations. One of the pile-supported dwellings sustained structural roof damage when a high wind gust uplifted the porch deck roof overhang and blew it back over the dwe11ing' s roof. The adjacent pile-supported dwelling had sections of what appeared to be grade beams collapse but they were apparently non load bearing subfloor concrete enclosures. The next dwelling to the east was a concrete block slab-on-grade dwelling. The erosion of Elena left it in imminent danger of collapse from another storm erosion event. Kate eroded another ten to fifteen horizontal feet of dune in this area and destroyed this dwelling (Figure 93).

To the east. the one mile stretch of shoreline to the Lighthouse Point area sustained minor to moderate beach and dune erosion from Kate. Although there was no major structural damage along this stretch. approximately two-thirds of the fifty beach dwellings sustained roofing damage from Kate's winds. The beach

sand dune vegetation along this stretch as well as elsewhere along Alligator Point was substantially denuded up to and including the contour of +10 feet NGVD. It is expected, however, that the beach and dune plants will substantially recover during

the 1986 growing season. The storm tide along peninsula Alligator Point, around the Southwest Cape, and around Lighthouse Point appeared to be between +8.0 and +9.0 feet NGVD (personal observation). Debris lines representing the high water marks of wave uprush appeared to range from +9.0 to +10.0 feet NGVD (personal observation)

At Lighthouse Point, one dwelling sustained major structural damage during Elena, but Kate destroyed one dwelling and structurally damaged three others. A two story concrete block slab-on-grade dwelling which was undamaged by Elena was totally destroyed by storm wave loads during Kate (Figure 94). To its east a pile-supported dwelling, on twenty-four foot long, eight inch by eight inch square wood piles, sustained foundation damage from wave loads and scour (Figure 95). A few of the seaward deck piles were kicked out by the southwest wave activity and the dwelling was left in critical need of relocating inland. To its immediate east is a small dwelling which was threatened by the erosion of Elena and should have been relocated inland on the property (see Figure 41, page 36, Post-Storm Report No. 85-3). Kate eroded another five to ten horizontal feet of dune in this area and substantially damaged this dwelling's foundation leaving it hanging a t a dangerous angle over the eroded bluff (Figure 96). Needless to say, this dwelling is in imminent danger of collapse and should be relocated landward or it will be the next destroyed dwelling in this area. To its east is the wood frame dwelling on short wood piles and concrete footings which was undermined and sustained major damage to the foundation and floor slab during Elena (see Figure 42, page 37, Post-Storm Report No. 85-3). Kate's additional erosion caused further undermining and an additional section of this dwelling's floor slab collapsed.

To the immediate east of Lighthouse Point was a highly vulnerable segment of Franklin County Road C370. On Elena's first offshore pass in August, approximately 2,000 feet of the road had been damaged, with the seaward lane and road shoulder being destroyed. On Elena's second offshore pass, approximately 2,250 feet of the road was totally destroyed along with 1,400 feet of concrete bulkhead. Most of this vulnerable stretch of destroyed road has since been abandoned by the County as it did not qua Ii fy for federal disaster financial assistance due primarily to the availability of alternative access to the properties in this area. However, the northernmost 800 feet of this damaged road did qualify for disaster assistance and the County replaced the roadbed with fill to provide emergency access to the private properties to the north towards Bald Point. Although Kate did not damage additional pavement in this area, the emergency

roadbed was destroyed. This segment remains highly vulnerable to the erosion of any future storms and a landward relocation is critically needed to assure vehicular access to the properties between Lighthouse Point and Bald Point.

The one-mile stretch of undeveloped shoreline north of Lighthouse Point sustained heavy beach and dune erosion from Kate. Ancient high dunes in this area which are covered by dune scrub oak and sand pine are critically eroded and are not expected to recover from the impact of Kate (Figure 97). In a subdivision, one and a half miles south of Bald Point, a concrete block slab-on-grade dwelling sustained major damage due to direct wave attack on the seawardmost projecting wall during Elena (See Figure 43, page 37, Post-Storm Report 85-3). With the continued wave attack from hurricane Kate the remainder of the seaward wall was destroyed, including the load bearing corners, and the roof collapsed on the destroyed seaward room of the dwelling (Figure 98). Along this subdivision the combined effect of the storm tides and waves of both Elena and Kate caused the vegetation line to retreat approximately 100 feet. It is expected that over half of this width will recover during the 1986 growing season provided additional storms do not rescour the area.

FIGURE 87. Alligator Harbor shoreline dwelling destroyed.

FIGURE 88. Flat roof blown off Alligator Point dwelling.

FIGURE 89. Southwest Cape dwelling partially undermined by Kate.

FIGURE 90. Dwellings damage by Elena were additionally damaged by Kate.

FIGURE 91. Concrete block dwelling damaged by Elena.

FIGURE 92. Same dwelling destroyed by Kate.

FIGURE 93. Slab-on-grade dwelling undermined and destroyed.

FIGURE 94. Concrete block dwelling destroyed by wave loads.

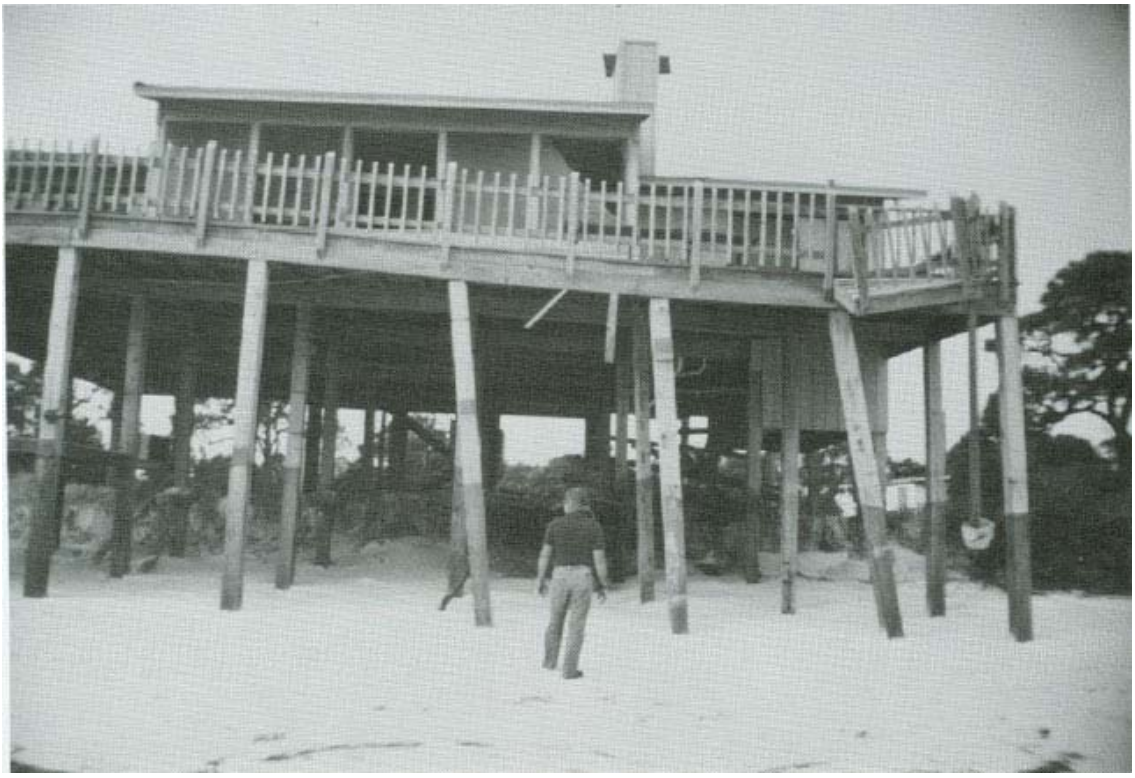

FIGURE 95. Pile-supported dwelling with insufficient pile penetration was damaged by scour.

FIGURE 96. Lighthouse Point dwelling damaged by Kate’s erosion.

FIGURE 97. Heavy dune erosion between Lighthouse Point and Bald Point.

FIGURE 98. Wave damage to dwelling near Bald Point.

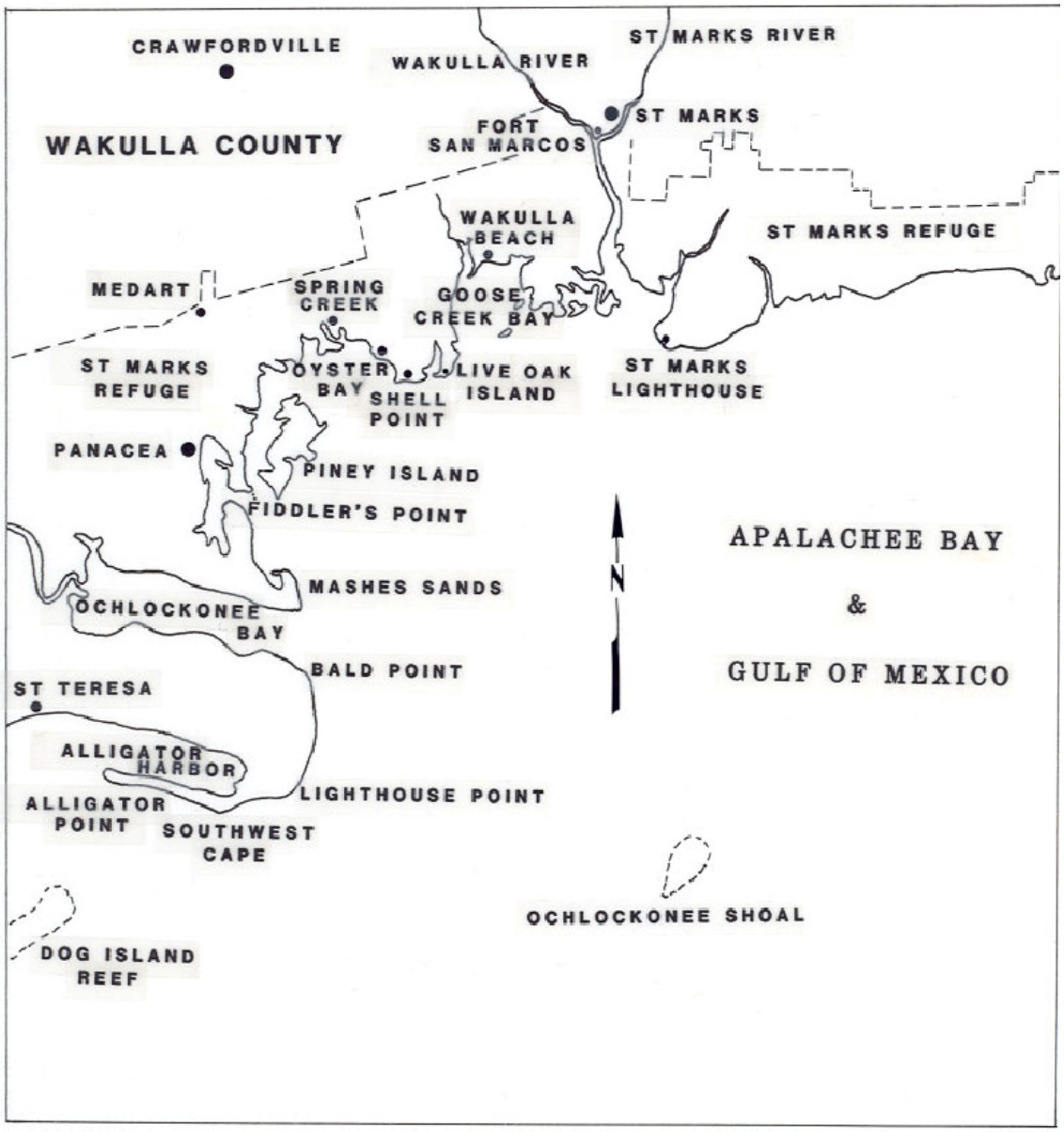

FIGURE 99. The coastal area of Wakulla County.

MASHES SANDS, PANACEA, SPRING CREEK, OYSTER BAY, WAKULLA SHELL POINT, BEACH, AND ST. MARKS, WAKULLA COUNTY

In the easternmost coastal county with severe impact from hurricane Kate, the Wakulla County coast line defines the northern rim of Apalachee Bay. Several fishing and leisure communities dot the Wakulla County coast surrounded by the vast and fertile St. Marks National Wildlife Refuge which extends for roughly thirty-five miles and covers 65,500 acres. Unlike the barrier beach coast to the west, the Wakulla County coast is characterized by tidal estuaries and embayments and only a few narrow sandy beaches. The ground elevations where coastal development exists range from +3.0 to +8.0 feet NGVD and therefore the entire coast is subject to inundation for substantial distances inland. The nearshore bathemetry is very shallow, which is a condition conducive to amplifying storm tides. Even the normal astronomical tide is amplified to the point that the St. Marks tide station of the National Ocean Survey reflects the largest tide range in the Gulf of Mexico.

During hurricane Kate, Wakulla County sustained its worse storm impact since hurricane Agnes in 1972. A number of structures which had previously survived Agnes were destroyed by Kate. Although the number of structures damaged in Wakulla County was only about a third of that number damaged in Franklin County, the density of the damage was as high as anywhere along the coast. Along the Wakulla County coast forty-six major structures excluding roads were destroyed or sustained major structural damage. This data does not correlate well with the figures provided by either the Federal Emergency Management Agency or the American Red Cross. The Federal Emergency Management Agency assessed 120 dwellings that were damaged with 112 dwellings being uninhabitable. The American Red Cross assessed 153 dwellings with major damage. The Red Cross and FEMA assessments included dwellings which were not damaged structurally but were gutted in their interiors by the flood waters. Many of these structures were made uninhabitable until they could be cleaned of debris and mud and until their utilities and septic systems could be repaired.

At the southwest end of the Wakulla County coastline is the estuarine system of Ochlockonee Bay. The Coastal and Oceanographic Engineering Department of the University of Florida measured a storm surge of +7.0 feet NGVD on the north shoreline of Ochlockonee Bay near U.S. Highway 98. During Elena, the Trade Winds Pier and an attached pier house building sustained heavy damage as did all the small docks on the bay. The docks that were repaired after Elena were redamaged by Kate. Kate also destroyed 125 feet of the Trade Winds Pier. A waterfront restaurant next to the U.S. Highway 98 bridge over the bay sustained damage to its deck over the Water. Further east

towards the Gulf, heavy damage was sustained by concrete bulkheads fronting on the bay. At the end of Blue Heron Way, 400 feet of concrete bulkhead was destroyed or sustained major damage, 100 feet of concrete bulkhead sustained minor damage, and 100 feet of wood bulkhead sustained minor damage. Heavy property erosion was also sustained landward of the destroyed bulkheads on Blue Heron Way (Figure 100). To the east near the entrance to Ochlockonee Bay heavy shoreline damage was sustained at the end of Sunrise Lane (Figure 101). At Sunrise Lane, 230 feet of concrete bulkhead was destroyed or sustained major damage, 790 feet of concrete bulkhead sustained cap damage, and 50 feet of wood bulkhead was destroyed. At Mashes Sands, recently acquired by the State of Florida, minor beach and dune erosion was sustained as the entire area was inundated by the storm tide. The half mile of beach at Mashes Sands fronting on the Gulf of Mexico represents the easternmost true barrier beach in the Florida Panhandle.

To the north of Ochlockonee Bay, the area surrounding Dickerson Bay including the seafood community of Panacea sustained widespread flooding and light wind damage. The Federal Emergency Management Agency assessed thirty-nine residences as being damaged by flooding in Panacea. Wakulla County Road C372A sustained storm tide and wave damage to 150 feet of pavement at Fiddler's Point.

The natural shoreline areas around Dickerson Bay and Oyster Bay reflected only minor or superficial erosion as the heavy shoreline vegetation and vast wetland acreage appeared to adequately absorb the storm tide and wave energy. At the head of Spring Creek severe flooding was experienced. Three seafood processing plants sustained major damage (Figure 102). In additional, one mobile home was destroyed and three others sustained major structural damage which may have been beyond any repair (Figure 103). The Red Cross assessed damages to twenty nine residences in Spring Creek. There are numerous wood frame grade-level dwellings and concrete block slab-on-grade structures including the Spring Creek Restaurant which were damaged by the flood waters. From the outside. these structures had no structural damage, but their interiors were gutted by the storm tide. Along with the extensive flood damage. there were light wind damages throughout Spring Creek.

On the eastern shore of Oyster Bay is the small leisure community of Oyster Bay. Located midway between Spring Creek and Shell Point, the community of Oyster Bay sustained the same severe flooding as Spring Creek but with a greater degree of exposure to wave activity as Shell Point. The storm tide and wave activity of Kate totally destroyed three major structures and inflicted major structural damage on four others in Oyster Bay. One mobile home was destroyed while two mobile homes and a single-family dwelling sustained major structural damage from the storm tide and waves.

Another wood frame dwelling had its seaward wall battered in by wave forces before the storm tide lifted the house off its foundation and floated it over onto the road (Figure 104). Another grade level manufactured home was totally destroyed by wave activity yet its screened porch was still standing after the storm (Figure 105). But the most surprising incident in Oyster Bay was the dwelling which was floated inland across a canal. This dwelling would have journeyed further if it had not met with another dwelling on the lot across the canal. As the flood waters receded this dwelling slid back onto the canal bank where it became grounded and appeared relatively unscathed for such a dramatic voyage (Figure 106).

On Shell Point, most of the large floating objects found on higher ground were boats that had been moored in the Shell Point Marina. The boat and dock damage was extensive. Along with Mashes Sands and Live Oak Island, Shell Point is one of three beach areas in Wakulla County which front on the Gulf of Mexico. Not counting the minor wind and water damages to mobile homes in the Shell Point Village subdivision, twelve major structures sustained major structural damage including two dwellings which were destroyed. Another twelve dwellings were assessed with heavy flood damage and minor wind damage but without major structural damage. This correlates well with the Red Cross assessment of twenty-five residences damaged. However, at least fifteen mobile homes in Shell Point Village sustained significant wind damage and a large number sustained water damage from the storm tide as well as from rain.

Along the Shell Point beach west of the end of Wakulla County Road C367 are twenty single-family dwellings directly exposed to the storm tide and wave activity from the Gulf of Mexico. Eight of these dwellings sustained major structural damage including one concrete block dwelling which lost its seaward wall to wave impact loads (Figure 107). Eight other dwellings sustained substantial water damage from the storm tide and minor wind damage, but were without major structural damage. Only five dwellings along this shoreline were on piling and they sustained no flood damage to their habitable areas. Most of the slab-on-grade dwellings had at least two feet of standing water in their interiors. A high water mark from the enclosed interior of the first beach dwelling west of Wakulla County Road C367 was measured to be +8.87 feet NGVD. This data appears to be the most representative high water data for the Shell Point and Live Oak Island area and reflects the significance of Kate's storm surge on the outer coast of Wakulla County. A National Ocean Survey tide gage located in the marina inside Shell Point measured a peak tide at 8:24 p.m. (2024 Eastern Standard Time) on November 21 at +8.44 feet NGVD. This tide data correlates well with the measured high water mark data.

The shoreline properties along the western stretch of beach at Shell Point are mostly bulkheaded. A 300 foot length of aluminum

bulkhead was totally destroyed by the wave loads accompanying Kate and much of the bulkhead debris was transported over a hundred feet inland (Figure 108). It is now apparent that this particular design wall should only be considered an expendable breakaway retaining wall when placed on the open coast subject to storm wave activity. Also destroyed in this area was a sixty five foot long concrete block retaining wall. In addition. the fifteen foot return wall to a substantial concrete bulkhead was also damaged.

Minor beach erosion was sustained all along the Shell Point Beach and a substantial quantity of sea grass uprooted from offshore beds littered the shoreface. To the east of Wakulla County Road C367. the Shell Point Motel and Restaurant sustained water damage from the storm tide. Approximately 5.000 square feet of the paved parking area next to the popular recreation beach was damaged. To the east. the Coast Guard Auxiliary building. a wood frame grade-level structure. situated on an ancient Indian shell mound sustained wind and wave damage. Further east. a new eight unit pile-supported wood frame condominium building sustained no structural damage.

Along the easternmost stretch of Shell Point Beach are nine single-family dwellings. Of these. the westernmost dwelling. A concrete block slab-on-grade structure. was destroyed by the storm tide and wave impact loads. Also destroyed at the property was fifty feet of wood bulkhead. Next door. A woodpile supported dwelling sustained foundation damage and had its porch collapse. The next two lots are substantially protected by a low profile rock mound structure which was constructed during the late summer prior to the impact of hurricane Elena. This rock mound has been impacted by four significant storm events through hurricane Kate and has shown no adverse impact on the beach system or adjoining properties while providing substantial erosion protection to the upland properties. One of the dwellings landward of the rock mound did sustain some damage to its concrete block understructure area. Three other dwellings in this area of Shell Point also received minor damages.

Across the entrance to Walker Creek. to the east of Shell Point is Live Oak Island. Given the nature and extreme degree of storm damage witnessed in this area a separate discussion has been set aside for Live Oak Island. East of Live Oak Island is Goose Creek Bay. Along the west shoreline of Goose Creek Bay is a popular gathering spot for mullet fishermen called West Goose Creek Seineyard. There is no major development in this area; however, and roughly twenty-two square miles of the Wakulla Unit of the St. Marks National Wildlife Refuge spans between the Shell Point Road and the St. Marks and Wakulla Rivers.

At the north shore of Goose Creek Bay lies Wakulla Beach, another landing for local fishermen. The half mile of shoreline to the

west of the end of the Wakulla Beach Road sustained no apparent shoreline erosion, but damage to the dune scrub and cedars was heavy. Five single-family dwellings exist along the end of Wakulla Beach Road and the seaward two dwellings sustained major structural damage. One of these dwellings, a pile-supported wood frame structure which overlooks West Goose Creek to the west, had a foundation pile knocked out by a large floating steel cylindrical tank. The other dwelling, a wood frame structure, sustained heavy flooding and wave damage (Figure 109). The Waku 11 a Beach Road appeared to have flooded as much as a mile inland from the Goose Creek Bay shoreline. Deep woods inspections from the Gander Creek swamp to the Abe Trull Field and eastward to the St. Marks River swamp revealed the Wakulla Unit of the St. Marks National Wildlife Refuge was substantially flooded.

The St. Marks Unit of the Refuge to the east of the St. Marks River also incurred extensive flooding. The paved road to the St. Marks lighthouse sustained approximately 4,000 feet of shoulder damage, and approximately 220 feet of the paved parking lot was damaged. The levee system around the brackish water pools was breached requiring over 2,000 cubic yards of fill for repairs (communication with Mr. Joe White, Manager of the St. Marks National Wildlife Refuge). In a similar occurrence about seven teen miles to the east between the Econfina River and the Fenholloway River in Taylor County, the seaward levee of the two mile long Hickory Mound Impoundment was breached by the storm tide and completely drained.

Flooding was also extensive up the St. Marks River. Even the Confederate earthworks were breached by the flood at the famous fortress, San Marcos de Apalachee, at the confluence of the Wakulla River and the St. Marks River (Figure 110). Some of the old cedar trees at the State museum were toppled by the high wind gusts off the river. At the Shell Island Marina on the Wakulla River the flood scattered small craft throughout the area on higher ground (Figure 111). One mobile home had a tree on its roof and a sportfishing boat in its side and another mobile home sustained major structural damage from the flooding.

The Town of St. Marks on the St. Marks River has experienced great floods during hurricanes in the 1800' s and early 1900' s. Hurricane Kate was but another episode in the history of this community. The American Red Cross assessed sixty residences in St. Marks as being damaged by Kate's flooding. The marina and businesses along the St. Marks River were also flooded but generally no other structural damage to major structures was incurred.

FIGURE 100. Ochlockonee Bay shoreline bulkheads destroyed at Blue Heron Way.

FIGURE 101. Bulkheads destroyed at Sunrise Lane on Ochlockonee Bay.

FIGURE 102. Damage to Spring Creek seafood processing plants.

FIGURE 103. Mobile home damaged by flooding, Spring Creek.

FIGURE 104. Oyster Bay dwelling damaged by waves, floated inland by flood waters, and deposited on road.

FIGURE 105. Oyster Bay dwelling was destroyed yet screened porch was still standing.

FIGURE 106. Oyster Bay dwelling was carried across the canal by flood waters and deposited on the opposite bank.

FIGURE 107. Shell Point beach dwelling damaged by waves and flooding.

FIGURE 108. Aluminum bulkhead debris transported inland on Shell Point.

FIGURE 109. Beach dwelling damaged by waves and flooding.

FIGURE 110. Confederate earthworks at Fort San Marcos de Apalachee on the St. Marks River were breached by flooding.

FIGURE 111. Shell Island Marina on the Wakulla River was damaged by flooding.

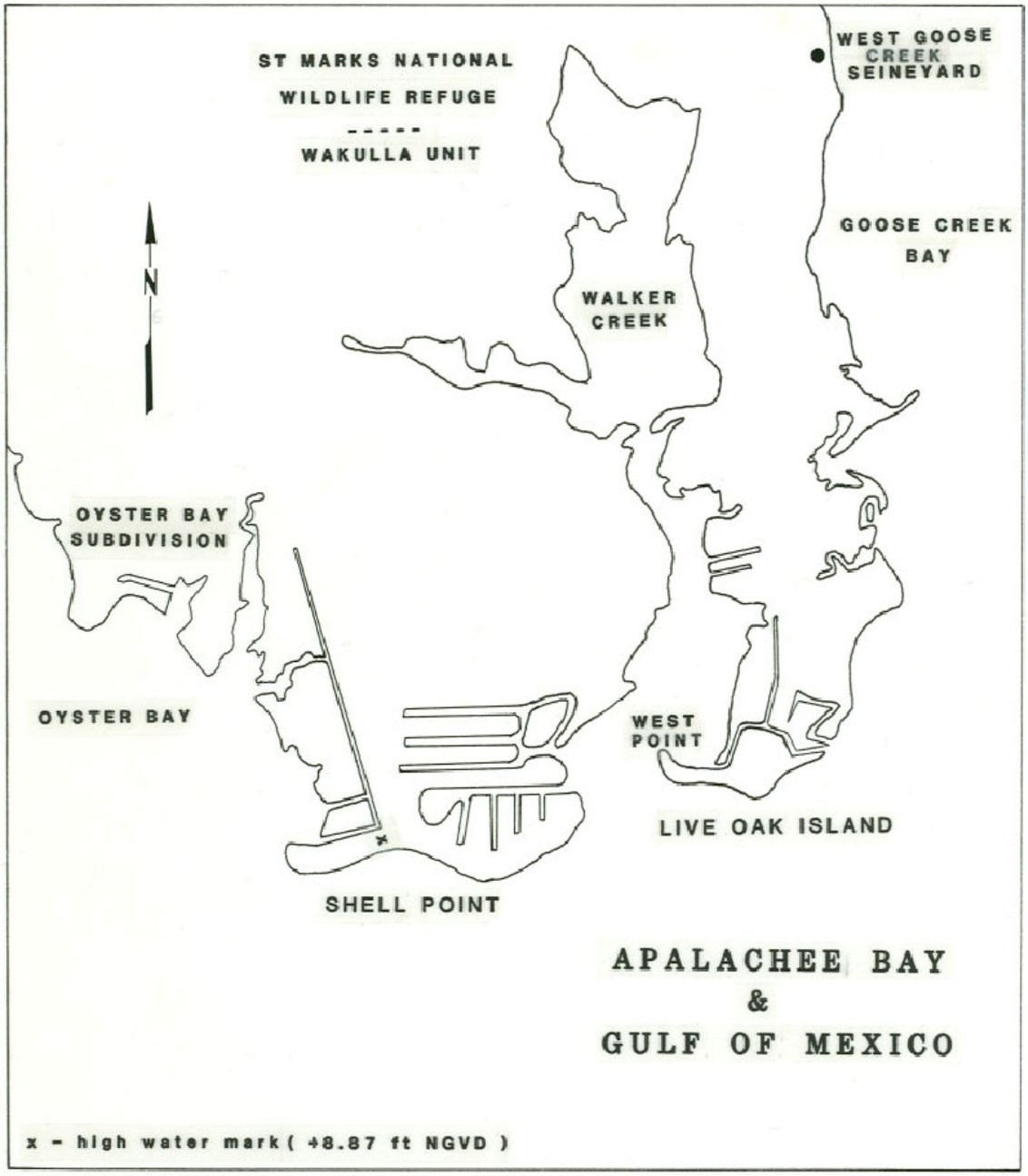

FIGURE 112. Oyster Bay, Shell Point, and Live Oak Island, Wakulla County.

LIVE OAK ISLAND, WAKULLA COUNTY

Perhaps it is fitting to terminate the discussions of Kate's coastal impact with a description of a microcosm of extreme damage as witnessed on a small coastal island in Wakulla County. Neither a commercial seafood community nor a recreational beach community, Live Oak Island is for most a forgotten and quiet residential community surrounded by the waters of Walker Creek, Goose Creek Bay, and Appalachee Bay. The ephemera 1 ca 1m sea conditions which prevail around this island make a storm surge event the paradox by which time and history is measured. Without a doubt, Kate will be the event to which all structures on Live Oak Island are referenced. No other coastal location in north Florida saw the density of severe damage as sustained on this island and few areas even saw an equivalent extremity of the storm's damage.

In the West Point Subdivision in a stretch of twenty dwellings, eight were destroyed, four others sustained major structural damage, and two others were gutted by flooding. The other six dwellings sustained minor wind and water damage. In addition, the unpaved road existed only by virtue of its platted location after the storm. Given the proximity to the Shell Point measured high water mark of +8.87 feet NVGD, it is assumed that an equivalent high water condition existed at Live Oak Island. High water elevations of between +9 and +10 feet NGVD including wave activity have been estimated from structures on Live Oak Island which has an average grade elevation of only +5 feet NGVD.

The two concrete block slab-on-grade dwellings at the west end of the West Point Subdivision were both destroyed by the storm tide and wave impact loads of Kate. One of the several Live Oak Island mysteries is the nature of the damage to the westernmost dwelling which had its leeward wall destroyed outward (Figure 113). Had it been damaged by flanking northwest wave activity the wall surely would have been knocked into the dwelling not away from it. The slab, however, was noticeably undermined on the leeside of the dwelling from apparent hydraulic forces and the wall could have fallen outward as a result of differential settlement of the foundation. The second dwelling from the west end, which also fronts on Walker Creek, had its walls knocked out by wave impact loads (Figure 114). It is of interest that the exposed waterward half of the dwelling had exterior walls on all three sides knocked out by wave loads and the landward half of the dwelling remained standing. In addition, the dwelling had severe differential settlement and slab breakage of the concrete slab foundation. The shoreline of both properties was covered with riprap placed on a gradual slope and little erosion was apparent.

The third dwelling from the west end, a wood frame structure *on* piles elevated about five feet above grade, sustained only minor flood damage as it undoubtedly caught the upper crests *of* the

wave activity. The next three dwellings are wood frame structures *on* concrete block footings elevated about three feet above grade. The first two dwellings sustained heavy wave damage to their siding and footings and the third dwelling was substantially destroyed by wave impact loads to the walls, floor, and footings (Figure 115). Next door to the east, the seventh dwelling from the west end was a concrete block s lab- on-grade structure which was destroyed by the storm tide and wave impact loads and was left standing as a frame skeleton with the roof miraculously hanging suspended (Figure 116).

Five *out of* eight dwellings in this stretch *of* shoreline exposed to the open Gulf waters were destroyed and each was not sufficiently elevated above the storm tide and wave activity. The other three dwellings were elevated *on* piles above the storm wave activity and sustained only minor damage. The eighth dwelling from the west end was elevated *on* wood piles about six feet above grade and escaped any major wave damage, but the ninth dwelling was a grade level wood frame structure which was battered by the wave activity and was scraped off its concrete s lab and deposited in a crushed s tat e partially *onto* the road (Figure 117). Also destroyed by the wave activity was 120 feet *of* concrete block retaining wall located at the shoreline.

The tenth dwelling from the west end is a pile-supported wood frame structure elevated about eight feet above grade which sustained no major structural damage other than minor roofing damage due to Kate's winds. The satellite dish and concrete parking slab beneath the dwelling were destroyed and a pile which supported the elevated deck was kicked *out* with the broken slab. Next door to the east another concrete block slab-on-grade dwelling was destroyed (Figure 118). Although the retaining wall and sodded lawn at this lot were not significantly damaged, the dwelling structure was pulverized into a level pile *of* frangible debris. To the east another pi le- supported dwelling elevated about eight feet above grade sustained only minor roofing damage and had its concrete parking slab damaged (Figure 119).

The major mystery *on* Live Oak Island was the disappearance *of* the thirteenth dwelling from the west end. This dwelling was a wood frame structure *on* short wood piles elevated about four feet above grade. Obviously destroyed, the dwelling was not to be found after the storm as only the foundation piles remained to mark its former location (Figure 119). Like the Oyster Bay dwelling which floated a substantial distance without sinking, this Live Oak Island dwelling could have floated some distance up Walker Creek before being destroyed by wave activity. However, no remains *of* the structure were ever found.

The two pile supported dwellings to the east were elevated eight to ten feet above grade and sustained little more than minor roofing damage, but four low structures further to the east were

substantially impacted by the flood. A large wood frame dwelling on concrete block footings sustained major damage and a one room frame structure was destroyed. The other two dwellings, both concrete block slab-on-grade structures, were gutted by flooding, but given their substantial setbacks of 100 and 150 feet from the shoreline they sustained no wave damage. On the opposite side of the canal at the east end of the West Point Subdivision, a wood frame slab-on-grade dwelling was substantially damaged by waves which propagated across the island and canal (Figure 120). Although the storm waves probably crested and broke over the island, the canal width and depth probably allowed for retransformation of the waves before additional breaking against the structure.

With grade elevations between +4 and +5 feet NGVD and a storm surge from Kate between +8 and +9 feet NGVD, breaking wave crests as high as +10 or +12 feet NGVD would be expected just inland of the shoreline. For dwellings located along the West Point Subdivision in close proximity to the shoreline, a minimum elevation of eight feet above grade or +13 feet NGVD would provide adequate protection from most storm tides and wave conditions. However, for a more extreme storm event, a maximum elevation of at least twelve feet above grade or +17 feet NGVD would be necessary for protection from a storm surge of twelve feet plus breaking wave crests. The current building elevation requirements for this area are substantially higher at +22 feet NGVD or seventeen feet above grade.

East of Wakulla County Road C367A and the West Point Subdivision, seventeen dwellings front on the shoreline exposed to storm wave activity from the Gulf of Mexico. All of these dwellings are sufficiently elevated on pile foundations and most have been constructed in the past ten years. No major damage was sustained to these dwellings although seven understructure enclosures were damaged as well as a couple decks, stairs, parking slabs and thirty feet of concrete bulkhead. An old water storage tank located 500 feet from the shoreline and next to the island road was floated off its foundation by the storm tide and two mobile homes on grade located across the canal from the eastern point of Live Oak Island were destroyed by the storm tide and wave activity. Another mobile home and a concrete block dwelling were also flooded without major structural damage.

Dwellings throughout Live Oak Island sustained minor wind damages particularly to roofing and screens. Two large old cedars were also toppled by the wind on the shoreline at the south point of the island. But the most significant wind damage on the island was sustained by a pile-supported dwelling which appeared to be

hit by a small tornado spawned by the hurricane. This dwelling was located on the north side of the canal adjacent to the east point of Live Oak Island, and the debris and wreckage from the

dwelling was deposited about 700 feet inland in a wetland marsh. The dwelling's roof was deposited 1,000 feet inland virtually in one piece on an access road to the east shoreline (Figure 121). In contrast to the dwelling in the West Point Subdivision which disappeared without a trace leaving upright foundation piles, this dwelling's foundation, utility pole, and shrubbery were all pushed over or completely removed (Figure 122). The dwelling to the east sustained only minor roofing damage and the pile supported mobile home with a large roofed screen porch to the west sustained no apparent damage. This lack of adjacent damage suggests the localized impact was the result of a tornado in lieu of a downburst

In summary, in the small community of Live Oak Island, twelve major structures were destroyed, four others sustained major structural damage, and several others were gutted by the flooding without major structural damage. When new construction meeting the current coastal building standards replaces the structural victims of Kate, Live Oak Island will have taken on a completely new appearance. It wi11 then take a hurricane of much greater intensity to cause an equivalent level of destruction as witnessed after Kate

FIGURE 113. Dwelling destroyed at west point of Live Oak Island.

FIGURE 114. Dwelling destroyed at Walker Creek entrance.

FIGURE 115. Frame dwelling on footings destroyed by wave loads.

FIGURE 116. Slab-on-grade dwelling gutted by the waves and flooding.

FIGURE 117. Grade level frame dwelling destroyed by waves.

FIGURE 118. Concrete block dwelling pulverized by wave activity.

FIGURE 119. Foundation piles are sole remains of dwelling which “disappeared” during Kate.

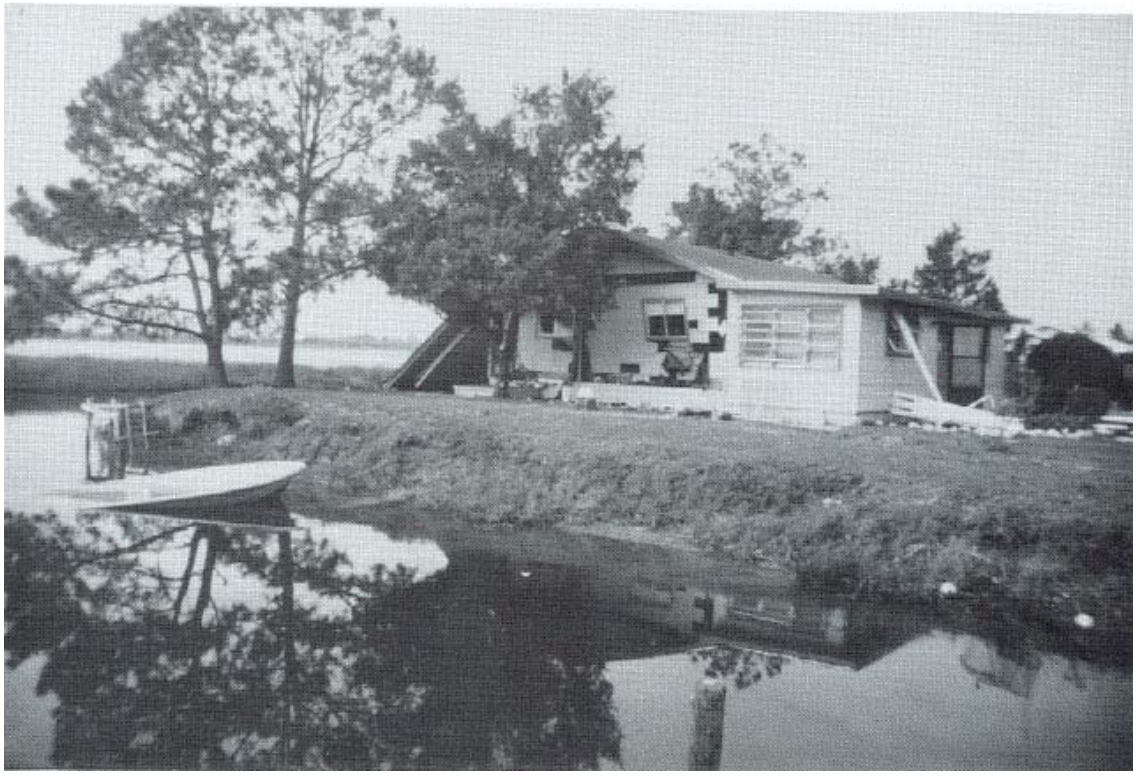

FIGURE 120. Dwelling damaged by waves which propagated across the island and the canal.

FIGURE 121. The roof was blown 1,000 feet inland and deposited in one piece on an access road.

FIGURE 122. Site of the dwelling which was probably hit by a tornado.

SUMMARY OF STRUCTURAL DAMAGES

MONOROE COUNTY

1	Mobile home destroyed
1	Radio tower destroyed
2	Major structures destroyed

BAY COUNTY

590 ft.	Bulkheads destroyed or damaged
170 ft.	Retaining walls destroyed
75 ft.	Paved road damaged
1	Single-family
3	Single-family dwellings sustained major structural damage
1	Motel building had 4 units destroyed
1	Fishing Pier damaged
6	Major structures destroyed or sustained major structural damage

GULF COUNTY

290 ft.	Sloping concrete slab revetment destroyed or damaged
65 ft.	Steel bulkhead damaged
500 ft.	Paved road damaged
4	Single-family dwellings destroyed
12	Single-family dwellings sustained major structural damage
3	Mobile homes destroyed
1	Mobile home sustained major structural damage
2	Commercial buildings destroyed
6	Industrial buildings sustained major structural damage
1	Public building sustained major structural damage
1	Fishing pier destroyed
1	Swimming pool destroyed
31	Major structures (excluding roads) destroyed or sustained major structural damage.

FRANKLIN COUNTY

275 ft.	Bulkheads destroyed
235 ft.	Revetments destroyed
330 ft.	Retaining walls destroyed
28,590 ft.	(5.41 miles) paved road damaged
17	Single-family dwellings destroyed
66	Single-family dwellings sustained major structural damage
14	Mobile homes destroyed
17	Mobile homes sustained major structural damage
2	Seafood processing buildings destroyed
31	Seafood processing buildings sustained major structural damage
2	Commercial buildings destroyed
9	Commercial buildings sustained major structural damage
1	Water tank destroyed
159	Major structures (excluding roads) destroyed or sustained major structural damage

WAKULLA COUNTY

1,025 ft.	Bulkheads destroyed or sustained major damage
270 ft.	Bulkheads sustained minor damage
185 ft.	Retaining walls destroyed
150 ft.	Paved Road damage
5,220 ft^2.	Parking lot damage
12	Single-family dwellings destroyed
17	Single-family dwellings sustained major structural damage
5	Mobile homes destroyed
6	Mobile homes sustained major structural damage
3	Seafood processing buildings sustained major structural damage
1	US Coast Guard Auxiliary building sustained major structural damage
1	Fishing Pier destroyed
1	Water tank destroyed
46	Major structures (excluding roads and parking areas) destroyed or sustained major structural damage

TOTAL MAJOR STRUCTURUAL DAMAGES

1,955 ft.	Bulkheads
525 ft.	Revetments
685 ft.	Retaining Walls
29,315 ft.	(5.55 mi) Paved Roads
132	Single-Family Dwellings
47	Mobile Homes
36	Seafood Processing Buildings
14	Commercial Buildings
6	Industrial Buildings
1	Public Building
1	US Coast Guard Auxiliary Building
3	Fishing Piers
2	Water Tanks
1	Radio Tower
1	Swimming Pool
244	Major Structures (Excluding Roads)

REFERENCES

Case, Robert A. and Harold P. Gerrish, 1986, North Atlantic Tropical Cyclones, 1985 (National Hurricane Center, NOAA, Miami, Florida).

Clark, Ralph, March, 1986, The Impact of Hurricane Elena and Tropical Storm Juan on Coastal Construction in Florida, Beaches and Shores Post-Storm Report No. 85-3.