FLORIDA
SEA GRANT COLLEGE

Fort George Inlet
Glossary of Inlets Report No. 10

by H. Kojima and S. D. Hunt

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FORT GEORGE INLET
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FOREWORD

The numerous inlets connecting Florida's inner waters to the Atlantic Ocean and the Gulf of Mexico are important from considerations of recreational and commercial vessel traffic and also because they provide small boats access to safe refuge during unexpected severe weather and waves. In addition, inlets act as flushing agents, providing renewal of bay waters by exchange with outer continental shelf waters. Unfortunately, inlets also contribute significantly to the serious beach erosion problem prevalent along most of Florida's shoreline. The complexities of the hydraulic and sediment transport mechanics in the vicinity of inlets present a formidable challenge to engineers and scientists. These factors, along with the interesting historical role that inlets have played in the early development of Florida, have resulted in considerable documentation pertaining to the major inlets of the State.

This report on Fort George Inlet is one of a "Glossary of Inlets" series to be prepared under the Florida Sea Grant College project, "Glossaries of Tidal Inlets in Florida." The purpose of this series is to provide for each inlet a summary of the more significant available information and to list known documentation. It is hoped that this series will yield an improved understanding of the overall effect of each inlet on the economics, recreation, water quality and shoreline stability of the surrounding area. The proper management, use and control of Florida's inlet will require an appreciation of the evolution and the past response of the inlets.

ACKNOWLEDGEMENT

Thanks are due to Mr. Charles Stevens of the Corps of Engineers, Jacksonville District, and to Mr. Joseph Halusky and Mr. Christopher Jones of Sea Grant for their review comments. Several results reported here have been derived from a study of Fort George Inlet reported by the first author elsewhere (see references), under a contract (No. 99900-1530) by the State of Florida Department of Transportation, to the Coastal and Oceanographic Engineering Laboratory. The guidance of Dr. A. J. Mehta, the principal investigator of this project, was greatly appreciated. Finally, the many hours and effort put forth by graduate assistant Earl Hayter in reviewing the manuscript, Rena Herb for the typing and Lillean Pieter for the drafting must be acknowledged.

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I. INTRODUCTION

Fort George Inlet (shown in Figs. 1.1, 1.2 and 1.3), located on the east coast of Florida in Duval County, is a natural inlet connecting Fort George River to the Atlantic Ocean. This inlet lies immediately north of the St. John's River Entrance and approximately 6 miles south of Nassau Sound. Its coordinates are as follows:

$30^o24'30''$ N $\qquad$ $81^o25'00''$ W

Fort George River, which connects with Simpson Creek about 1.6 miles upstream from its mouth, extends northward and joins with the Intracoastal Waterway approximately 3 miles upstream from the mouth (see Fig. 1.2).

Fort George Inlet is an unimproved tidal entrance bordered by the north jetty of the St. John's River to the south and Little Talbot Island to the north. The inlet, like many natural inlets, is characterized by significant morphological changes in the inlet vicinity, namely, shoaling and channel shifting. The presence of the inner-tidal shoals (shown in Fig. 1.4) and outer shoals prevent navigational use of the inlet except by small-craft. Southern migration of Fort George Inlet coupled with an extension of the south shore of Little Talbot Island began in the late 1800's, coincident with the construction of the St. John's River jetties starting in 1881. Between 1857 and 1934, the inlet was forced approximately 9,000 ft to the south by accretion and extension of Little Talbot Island. A reversal of the southward migration occurred around 1938 after the north jetty of the St. John's River was capped in 1934. Since then, the inlet has been shifting northward, with Wards Bank spit (see Fig. 1.4) expanding northward as well. This northward migration of the inlet has resulted in erosion of the southern end of Little Talbot Island, and in recent times has endangered State Road A1A on Little Talbot Island and the A1A bridge over the river as well as Little Talbot Island State Park which is located on the southern half of Little Talbot Island. Because of this potential damage to the structures, an investigation of the inlet and its vicinity was conducted by the Coastal and Oceanographic Engineering Laboratory (COEL), University of Florida, at the request of Florida Department of Transportation (DOT) in 1978 (Kojima and Mehta, 1979, Kojima, 1979).

Prior to the study by COEL there had been very little investigation of the morphological changes, hydraulics and sedimentary processes in the area, due to the relatively limited use of the inlet by private or commercial interests. The U.S. Army Corps of Engineers, however, did study this area in conjunction with "The Federal navigation project, St. John's River, Jacksonville to the Ocean" (Corps of Engineers, 1927). DOT also conducted hydrographic surveys along the A1A bridge to investigate local scour beneath the bridge in 1969, 1972 and 1977.

The deepest channel (maximum depth of 35 ft below mean sea level) was located in 1978 at the western end of the bridge where serious bed scour had taken place. A maximum spring current of 2.3 fps was experienced near the bridge and the spring tide range measured near the bridge in June of 1978 was 5.3 ft.

Recreational and historical facilities around the inlet include fishing, surfing and swimming, the Kingsley Plantation Historical Monument and Little Talbot Island State Park. The Kingsley Plantation house built by Zephaniah Kingsley on Fort George Island in 1813 still stands today. Because of its historical significance, the plantation was acquired by the Florida Board of Parks and Historic Memorials in 1960 and has since been restored. Little Talbot Island State Park has camping and picnic areas and access to the nearby beaches. This park is administered by the Florida Department of Natural Resources, Division of Recreation and Parks, Tallahassee, Florida.

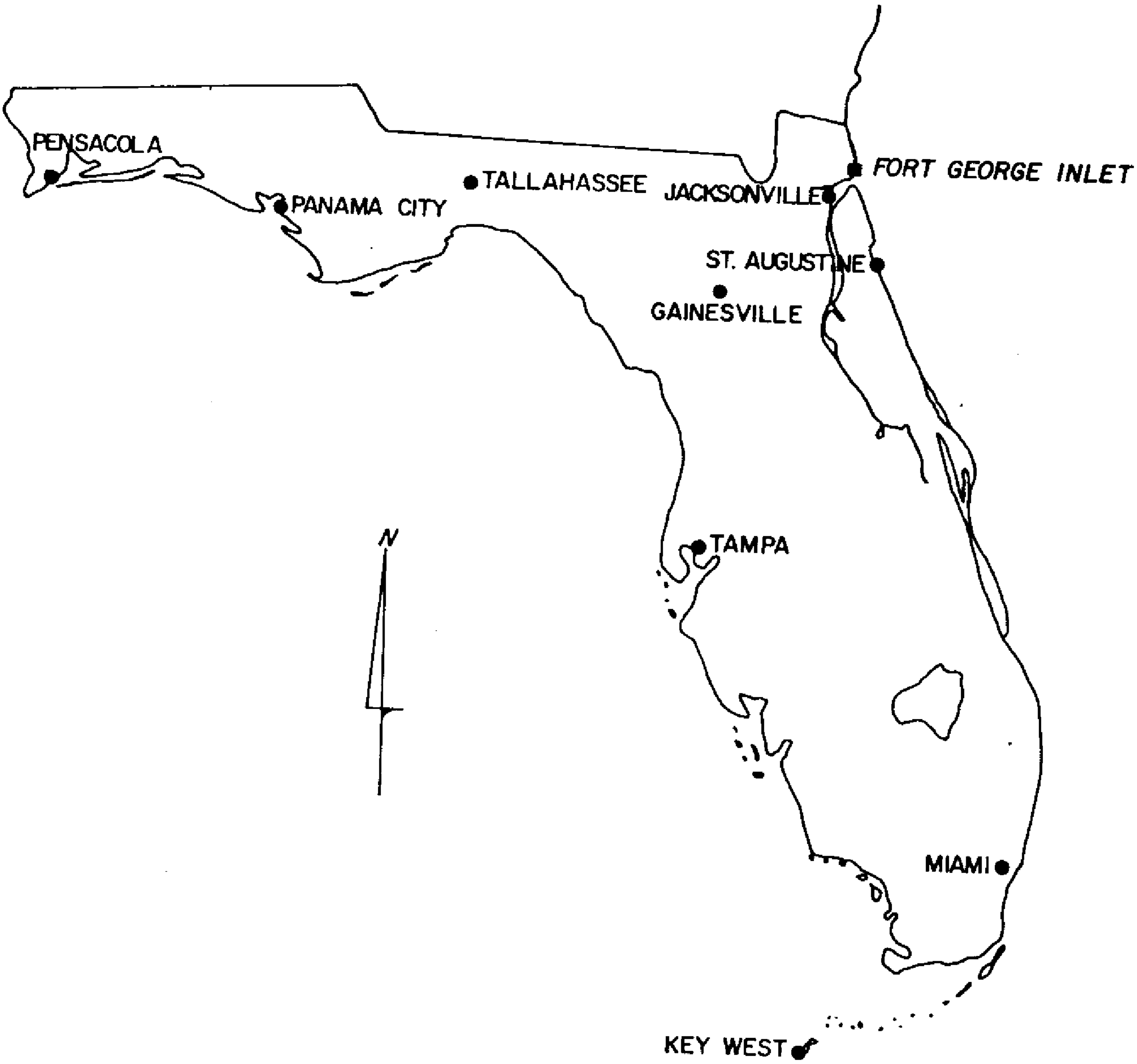


Fig. 1.1 Location Map.

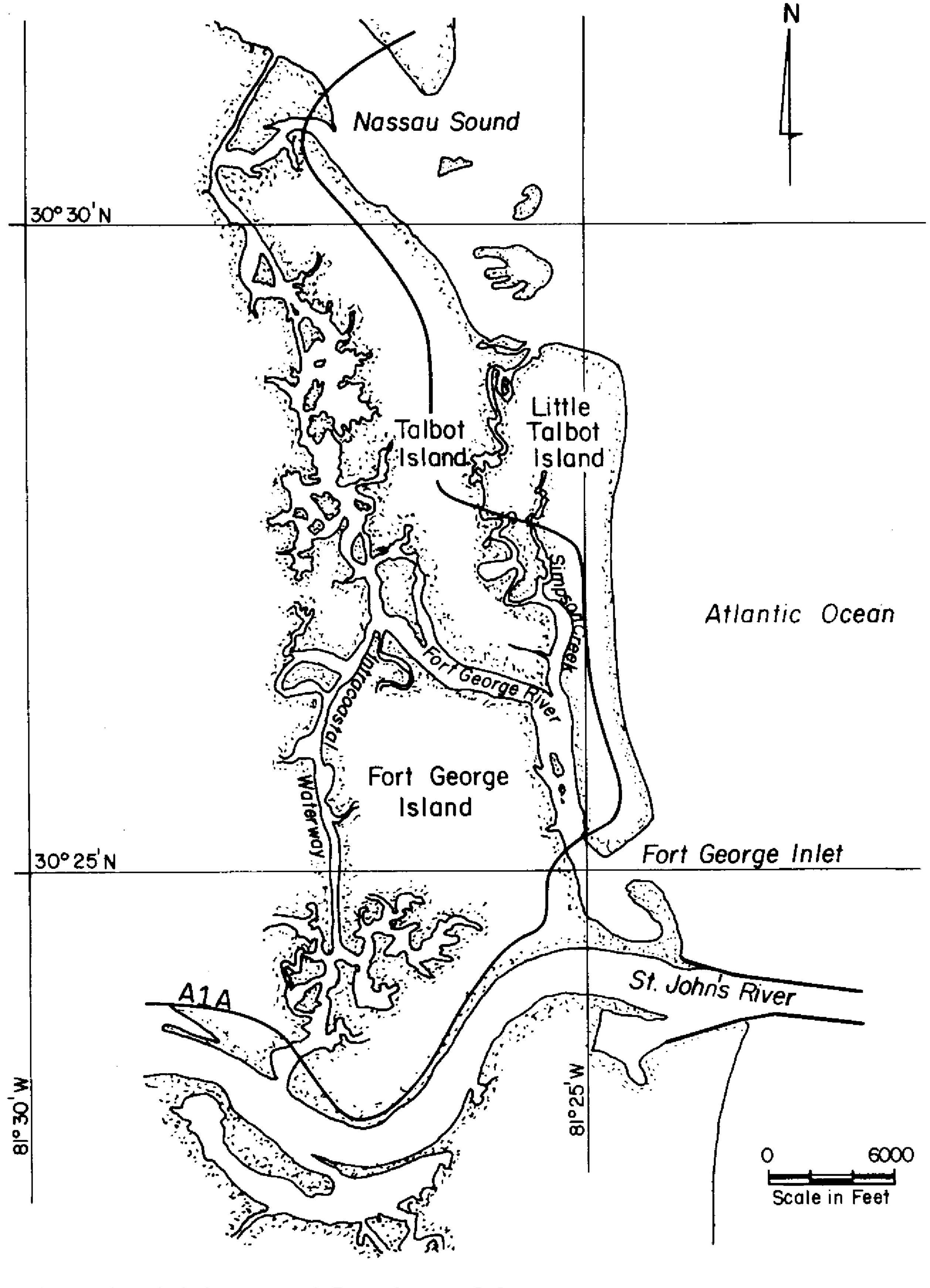


Fig. 1.2 Vicinity Map of Fort George Inlet

Fig. 1.3 Aerial View of Fort George Inlet showing the Inner-Tidal Shoals, May 1978. Scale 1" = 1250'

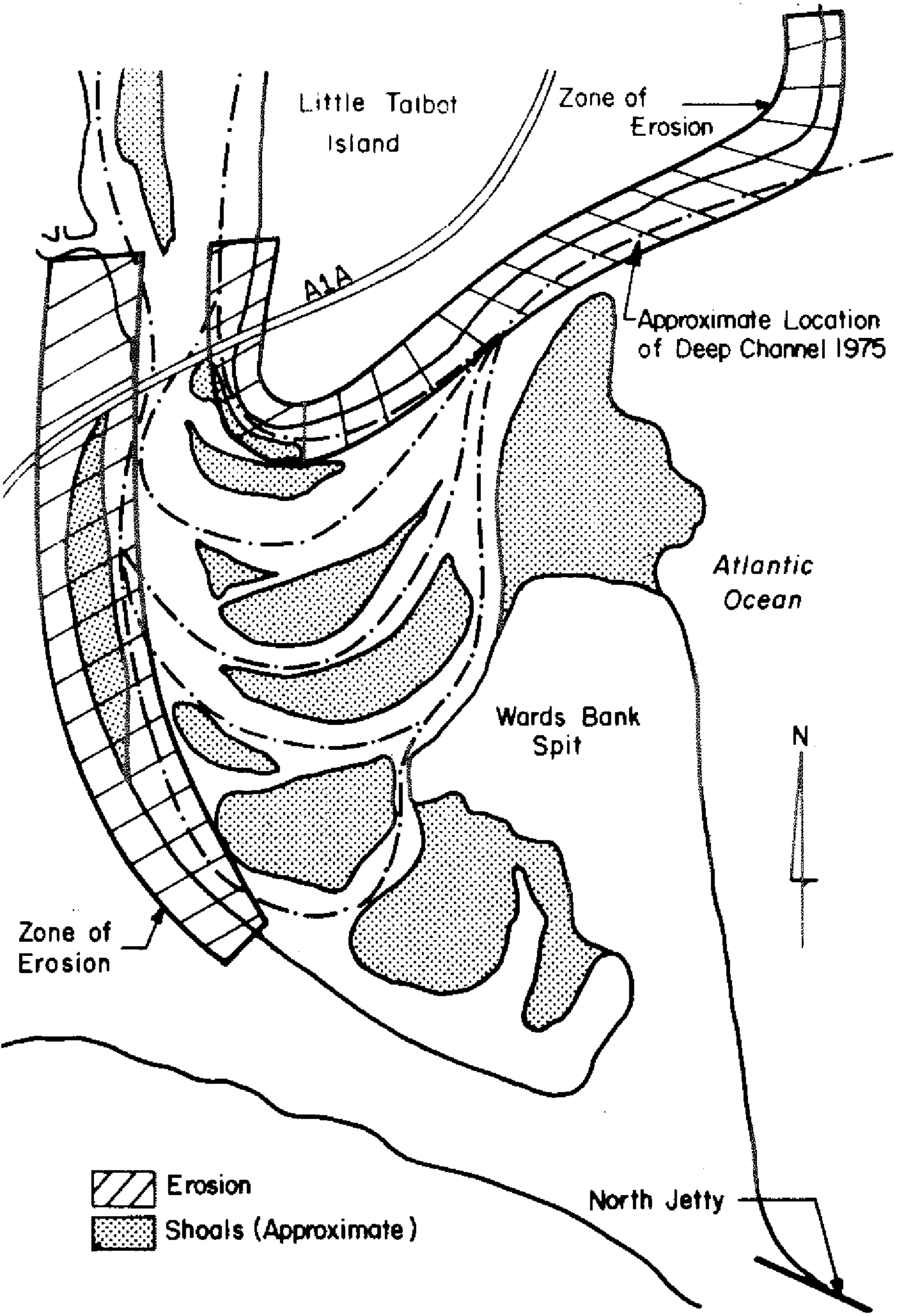


Fig. 1.4 Approximate Locations of Zones of Shoaling and Erosion.

II. GEOLOGIC SETTING

Geologic information for Duval County has been obtained by collecting rock cuttings from water wells drilled in the area and by examining these cuttings to determine the texture, mineral composition and fauna of the different formations. The rock samples that were collected in water wells throughout the county are shown in Table 2.1 (Leve, 1966).

The Oldsmar Limestone of the early Eocene age is the deepest and oldest formation in Duval county, which lies about 1,300 feet below mean sea level (msl). Lake City Limestone is the name applied to limestone of the early Eocene age that conformably overlies the Oldsmar Limestone and is approximately 580 feet below msl around Fort George Inlet. Deposits of the late middle Eocene age are named Avon Park Limestone and range in thickness from 50 feet throughout the western and central parts of the county to 250 feet in the coastal areas. All upper Eocene strata underlying Florida have been designated the Ocala Group by Puri (1953). The group includes three lithologically similar limestone formations: the Ingles, Williston, and Crystal River, listed in ascending order. A breakdown of sediments of the Miocene and Pliocene ages is found in Duval County, where the basal Miocene unit is identified as the Hawthorn Formation of Miocene age (Leve, 1961; Brown et al., 1962). The Hawthorn Formation is not exposed in the county but occurs at depths ranging from about 50 to 200 feet below land surface. This formation is found lying directly on the eroded surface of Eocene rocks and is in turn overlain by undifferentiated beds of upper Miocene and Pliocene age. The upper Miocene or Pliocene deposits consist of sand, shell, sandy clay and limestone, and their thicknesses range from as little as 10 feet to as much as 130 feet. Sediments forming the marine terraces and beach ridges, which now blanket all of Duval County, were deposited over the upper Miocene or Pliocene deposits during the Pleistocene and Holocene eras.

The topography in Duval County is mostly low, gentle to flat, and is composed of a series of ancient marine terraces which were formed at times in the Pleistocene when the sea was at various levels higher than the present level. The highest altitude is about 190 feet above msl in the extreme southwest corner of the county, along the eastern slope of a prominent topographic feature known as "Trail Ridge." Trail Ridge is a remnant of the highest ancient marine terrace in Duval County. The terraces tend to be parallel to the present Atlantic shoreline and become progressively higher from east to west. Other terraces are recognized in the county; in descending level they are the Sunderland, Wicomico, Penholoway, Talbot, Pamlico and Silver Bluff terraces.

Offshore sediment characteristics between Georgia and Cape Canaveral were investigated between August 1966 and February 1967 by the U.S. Army Corps of Engineers. Seismic reflection profiling and sediment cores were used to determine the availability of inner continental shelf sediments suitable for beach nourishment purposes. Though the general information from this investigation indicated no great abundance of sand along the nearshore in Duval County, some sand was found to be present about 4 to 6 miles offshore from the mouth of the St. John's River (Meisburger and Field, 1975).

Table 2.1
Stratigraphic Units in Duval County

Geologic Age		Stratigraphic Unit	Approximate thickness (feet)	Lithologic character
Recent and Pleistocene		Recent and Pleistocene deposits	0-150	Soil, muck, coarse to fine sand, shell, and some clayey sand
Pliocene		Pliocene or Upper Miocene deposits	20-110	Gray-green calcareous, silty clay and clayey sand
Miocene		Hawthorn Formation	260-490	Gray to blue-green calcareous phosphatic, sandy calys and clayey sands; contains fine to medium phosphatic sand lenses and limestone
Eocene	Ocala Group	Crystal River Formation	50-300	White to cream chalk, massive fossiliferous marine limestone
		Williston Formation	20-100	Tan to buff granular, marine limestone
		Inglis Formation	40-120	Tan to buff granular, calcitic, marine limestone
		Avon Park Limestone	50-250	Alternating beds of brown to tan hard, massive dolomite, brown finely crystalline dolomite, and granular calcitic limestone
		Lake City Limestone	425-500+	White to brown, purple-tinted lignitic, granular limestone and gray hard, massive dolomite
		Oldsmar Limestone	486	Cream to brown massive to chalky, granular limestone and tan to brown massive to finely crystalline dolomite

III. CLIMATE AND STORM HISTORY

3.1 Climate

The Fort George Inlet vicinity has a humid, semi-tropical climate characterized by long summers with much rainfall, and relatively mild and dry winters with occassional frost. According to records of the weather stations at Jacksonville (No. 4358) and Jacksonville Beach (No. 4366), the mean yearly temperature is 69°F (20.6°C) near the coast and about 1°F lower inland. The lowest mean monthly temperature at the Jacksonville station is 55.9°F (13.3°C) in January, and the highest mean monthly temperature is 82.6°F (28.1°C) in July.

The average annual precipitation at the Jacksonville station is about 54 inches, of which 60 to 70 percent falls between the months of June and October. At least 2 inches of rainfall per month can be expected on the average throughout the year. Heavier concentrations of rainfall, averaging 5 to 9 inches per month, are normal for the months of July through October.

The prevailing winds in the Fort George Inlet vicinity are from the east and southeast during the summer season and out of the northeast during the winter months. Offshore wind velocities and direction frequencies, taken from the results of 86,716 observations during the years 1956 through 1968, are shown in Table 3.1.The highest percentage of winds are from the northeast (16.8%) and east (14.3%). Winds with speeds between 7 and 16 knots are most frequent (54.4%). These data were collected in an area offshore centered at 29°32'N, 78°W, and were taken from the "Summary of Synoptic Meteorological Observations," volume 4 (U. S. Naval Weather Service Command, 1970).

Table 3.1
OFFSHORE WIND VELOCITY AND DIRECTION FREQUENCIES

Wind Direction	Speed (knots)					Percent Frequency	Mean Speed
	0-6	7-16	17-27	28-40	>41		
N	2.0	6.1	3.7	0.6	0.1	12.6	14.5
NE	2.4	8.8	4.8	0.7	*	16.8	14.4
E	2.6	8.8	2.6	0.3	*	14.3	12.3
SE	1.7	6.2	1.6	0.2	*	9.7	12.2
S	1.8	7.1	2.7	0.3	*	11.8	13.2
SW	1.5	6.7	2.7	0.3	*	11.2	13.7
W	1.4	5.7	3.2	0.8	*	11.1	15.2
NW	1.1	5.0	3.6	0.8	*	10.6	16.0
Calm	1.9						

* Indicate percent frequency less than 0.05. From the SSMO, Vol. 4, 1970.

3.2 Storms

Hurricanes (or tropical storms) and northeast storms are two major kinds of storms that cause beach erosion and related damage to the inlet vicinity and surrounding areas. Historical studies indicate that the inlet area has experienced, within a 150 mile radius, 45 storms of hurricane intensity between 1830 and 1972, which is an average of one hurricane every 3 years. Only 20 hurricanes, however, passed within a 50 mile radius in that period (one hurricane every 7 years). With the exception of Hurricane Dora (Sept. 1964), the effect of hurricanes on the area beaches has not been as severe as that of many northeast storms (commonly referred to as northeasters), which are caused by a stationary high pressure area northwest of a low pressure center located over the Atlantic near the east coast of the U. S. during the winter months. The severity of a northeaster is generally due to high winds which occur over a larger area and for a longer duration than in a hurricane, thus producing larger waves (Cry, 1965).

Figure 3.1 shows the tracks of hurricanes which passed within a 50 mile radius of Fort George Inlet from 1871 through 1972 (NOAA, 1973). Brief descriptions of some of the hurricanes and northeasters affecting the inlet and vicinity for the same time period are given below:

August 16-19, 1871	This hurricane which entered the East Coast near Cocoa Beach, Florida on August 17 moved inland in a north-northwestward direction. Its center passed near Jacksonville and moved into Georgia. This storm caused damage along the east coast of Florida, Georgia and South Carolina.
Sept. 18-30, 1894	After passing close to Key West, Florida, this hurricane moved inland near Ft. Myers on the west coast of Florida. The center of this hurricane moved over central Florida and struck south of Fort George Inlet on the 26th of September. Maximum winds at Jacksonville reached 46 mph and the barometer dropped to 29.34 in. The areas around St. John's River and other streams were under water from 1 to 3 feet in depth. The damage in the Jacksonville vicinity was estimated at $50,000. (Florida Times-Union, Sept. 27, 1894).
Sept. 29-Oct. 1, 1920	This hurricane originated in the Gulf of Mexico and approached Florida from the southwest, moving inland at Cedar Key. The storm crossed the State and entered the Atlantic Ocean near St. Augustine. Damage to seawalls, piers, and docks was reported (Corps of Engineers, 1964).
Nov. 28-Dec. 2, 1925	This northeast storm destroyed most of the timber bulkheads that had been constructed in Duval County during the Florida boom. Little information is available on this storm except that it was the most severe northeast storm experienced up to that time and the loss of life exceeded 50.

Nov. 25-29, 1932	This northeaster was one of the most severe to occur along the Florida coast. A damage survey made by the Corps of Engineers, Jacksonville District, in 1932 indicated that exceptionally heavy damage had occurred from north Florida to Palm Beach. In the inlet vicinity the storm was accompanied by unusually high tides (2 feet above normal) and large waves which reached the shore in advance of the high winds. Waves were reported to have reached a greater height than at any time during the preceding 60 years. Wind velocities reached a maximum of about 50 mph on the beaches. The beach dropped about 3 to 5 feet in elevation, and many of the timber seawalls that had been constructed since the 1925 storm were destroyed. The damage to property in Duval County alone was estimated at half a million dollars (Corps of Engineers, 1964).
Oct. 12-23, 1944	This hurricane entered the Atlantic Ocean southeast of Fort George Inlet and reentered the coast near Savannah. The hurricane was large with high winds which extended 200 miles to the east and 100 miles to the west. Extremely high tides occurred on the southwestern and northeastern coasts of Florida. Storm damages were estimated to be about $63 million in Florida. The shoreline of Duval County south of St. John's River was eroded landward approximately 150 feet and as much as 3 feet vertically. Highwater elevations up to 10 feet above normal were observed at Jacksonville Beach (NOAA, 1973).
Sept. 24-Oct. 7, 1947	This northeaster was accompanied by exceedingly high winds, tides and large waves. The storm was exceptional not only for its severity but also for its long duration. Damage during that 13 day storm was evaluated at $1.4 million on the 1947 price level. About 5,760 linear feet of concrete seawalls were destroyed, and 6,800 linear feet were damaged. The beach was lowered as much as 5 feet. Several dwellings were lost, others damaged, and six beach access ramps were destroyed or damaged.
Oct. 15-19, 1950	This was a small but violent hurricane. Total losses in the state were estimated at about $28 million. The hurricane caused some damage to Duval County beaches and seawalls. High tides and waves overtopped seawalls and rolled up the ramps leading from the street to the beach, flooding many low areas along the beachfront (Corps of Engineers, 1964).

Oct. 14-17, 1956	This northeast storm generated tides about 3 feet above normal and had sustained winds out of the northeast at 20 to 30 mph. Knee-deep flooding occurred at several beach front communities. No damage to seawalls was reported. Total damage in Duval County was estimated at $129,000. (Florida Times-Union, Oct. 16-17, 1956).
Oct. 30-Nov. 7, 1956	The damage during this storm was caused chiefly by wave action on top of high tides generated by winds from a storm center which later developed into Hurricane Greta. The winds blew generally from the northeast at sustained velocities of 20 to 30 mph for about 4 days. The winds generated tides as much as 4 ft above normal, with fairly heavy seas. Damage sustained was primarily to seawalls, ramps and foundations. (Corps of Engineers, 1964).
March 8-9, 1962	The winds from this northeast storm, known as the Great Middle Atlantic Coastal Storm, caused extensive damage along the entire east coast of the United States. This storm was exceptionally destructive due to the long fetch (1,200 miles) and the occurrence during a perigee spring tide. Damage estimates for the U.S. exceeded $200 million and over 350 people were killed by the flooding (Lundlum, 1963 and Stewart, 1962).
Nov. 26-Dec. 3, 1962	This northeaster was a severe coastal storm with winds of 60 to 70 mph within 100 miles of the center. The storm remained within 300 to 500 miles of the Duval County beaches for several days. 20 ft high waves with periods of about 11 seconds were generated by the northeast winds. Duval, St. John's and Flagler Counties were declared emergency disaster areas and temporary relief measures were provided with Federal funds. Total damage in Duval County was estimated at $2,580,000.
Aug. 26-28. 1964	Hurricane Cleo entered Florida at Miami and traveled generally northward over land for about 300 miles until it passed briefly over the ocean near Jacksonville Beach. Peak wind gusts at Jacksonville were measured at 44 mph. Total storm damage in Florida, including cleanup costs, was estimated at $125 million (U. S. Department of Commerce, 1964). Beach damage was relatively insignificant. The maximum reported shoreline recession was 10 ft adjacent to the inlet (Corps of Engineers, 1964).

Sept. 9-11, 1964	Hurricane Dora was the first hurricane of record to move inland from the Atlantic over extreme northeastern Florida. The "eye" passed over St. Augustine. Sustained winds of 64 knots were recorded at Jacksonville for the first time in the nearly 80 years on record. Extensive wind-induced river flooding occurred along St. John's River in Jacksonville. Along Jacksonville, Atlantic, Neptune and Mayport beaches, at least half of the seawalls suffered severe damage (NOAA, 1973; COEL, 1964).
Oct. 13-14, 1968	Hurricane Gladys entered the coast near Homosassa, Florida, and crossed the peninsula at 15 mph. Its center crossed the Atlantic Coast south of Ft. George Inlet on Oct. 19. Three lives were lost in the storm in Florida. Property damage in Florida was estimated at $6.7 million; damage along the east coast was minor (NOAA, 1973).

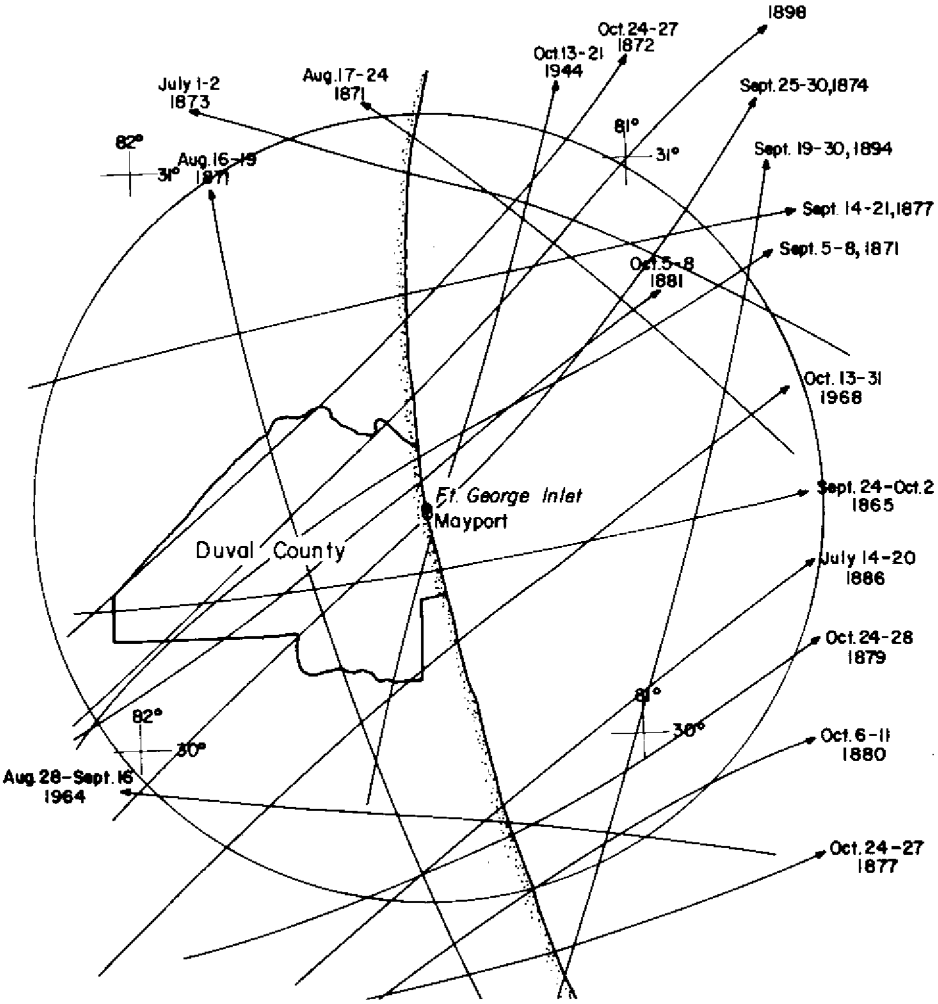


Fig. 3.1 Tracks of Hurricanes Passing Within a 50 Mile Radius of Fort George Inlet, 1871-1972 (NOAA, 1973)

IV. HISTORY

The early history of the area surrounding Fort George Inlet is characterized by populations of native Indians, the Spanish, the French and the English. The Timucuan Indians, peaceful farmers having dwelt throughout the area, left their primitive history interred in two burial mounds, which were explored by the Smithsonian Institution in the 1880's. Relics including chalk-like beads (still faintly red and blue) were found, as well as a midden of oyster shells, which was later used for road construction on Fort George Island.

The first white men to land in the area were a party of Huguenots under the leadership of the French explorer, Jean Ribault, on the first day of May, 1562. They anchored off the mouth of the St. John's River, which was originally given the name of the "Riviere de Mai" - The River May. The Spanish mission, San Juan del Puerto, which gave the existing name to the St. John's River, is believed to have been situated on Fort George Island from the late 16th century until 1702. Through scientific excavation and investigation conducted by the Jacksonville Historical Society in 1955 under the direction of Dr. John M. G. Goggin of the University of Florida, foundations, wooden boards, post holes, bits of a rosary, pieces of Indian pottery and Spanish majolica were found. These pertinent artifacts revealed much about the lifestyle at the mission.

Early in the 1730's British General James Oglethorpe, colonial leader of Georgia, scouted the land around Fort George Inlet. He named the island St. George and built the fortification, Fort St. George. It was near a hill (Mount Cornelia) on which cannons were placed which pointed towards fortifications on the southern shore of the St. John's River. Since the fort was deep in Spanish territory, Oglethorpe was forced to remove his cannons, destroy the fort, and withdraw in 1740.

The history of the inlet from this point in time through the present is summarized in the following chronology of events:

1813 - Zephaniah Kingsley turned many of the Fort George Island's 1,200 acres into a large plantation where sea island cotton, corn and citrus were grown. This plantation, which still stands today near Fort George Inlet, remained in the Kingsley family until 1868.

1848 - The claim of Juno Houston (an area lying within Talbot and Little Talbot Island) was surveyed by David H. Bunn under contract with the Surveyor General of Florida.

1857 - A hydrographic survey was made around the mouth of St. John's and Fort George Rivers under the command of Lt. Cmdr. S. D. Trenchard, U.S. Navy. His report described the bars of shoals existing north of the St. John's River entrance channel as being tidal and above mean low water (see Fig. 5.2).

1874 - Two converging jetties standing well above the high tide level were recommended to Congress for the St. John's River Entrance. Congress then appropriated $10,000 and dredging, which began in 1868, was resumed, but with no assurance that a permanent depth would be attained.

1879 - A survey and a report were made by Maj. Q. A. Gillmore recommending permanent improvement works consisting of two jetties projecting from the north and south banks of the St. John's River, converging to a width of 1600 to 1800 feet at the outer ends. Lengths of the proposed north and south jetties were 9400 ft and 6800 ft, respectively, with an attained depth of 15 ft at mean low water (mlw). They were to be of the drowned type; the outer 2000 ft at half tide level, with the inner portion at 3 ft below mlw consisting of stone riprap resting on a mattress of logs and brush. Thickness of the brush varied from 18 in. in shoal water to 38 in. in deep water. Side slopes were to be 1 to 4 or 5 for a distance of a half mile from sea ends, elsewhere 1 to 3/2 or 2. Total cost including dredging was estimated at $1,306,409 (Youngberg, 1938).

1880 - Congress appropriated $125,000 to begin the construction of the two jetties.

1881 - Construction of the St. John's River jetties started.

1886 - The permeable north jetty, which was ultimately to be based on Fort George Island, was projected across a so-called swash channel lying between the island and a nearby barrier shoal. Since the northerly swash channel began to deepen, it was decided to extend the jetty westward to connect it with higher ground on Fort George Island. In the same year, the Fort George Island Company was incorporated to develop the island into a tourist resort. Two hotels were built, one facing the ocean, the other facing the Fort George River. The hotels were a great success but were doomed to a short life, due to a yellow fever epidemic and a fire which destroyed the hotels in 1888.

1895 - The permeable submerged jetty had proven untenable, but for lack of funds and lack of legal authority, no effort was made to build up the jetties. At that time, due to reconstruction after storm damage, the north jetty was 11,000 ft. long, 10 ft. below mlw. It sloped upward for 2400 ft. from the end to the low water plane. The south jetty was 10,600 ft. long, the outer end was on the bottom at a depth of 20 ft. It sloped upward for 1200 ft. to mlw at 9400 ft. from shore end.

1896 - A report, dated Feb. 27, 1896, by the district engineer stated that the jetty works had not affected the river channel and had resulted in benefical changes at the mouth of the St. John's River. In the same year, a proposed 24 ft. project was adopted. This project provided for raising the crests of both jetties to normal high tide through their inner portions (600 ft. for north jetty, 800 ft. for south jetty). The north jetty was to be extended 1500 ft., the south jetty by 500 ft. Then 28 miles of the river channel were to be dredged a depth of 24 ft.

1905 - The Fort George Inlet vicinity and the St. John's River were surveyed by F. W. Bruce under the direction of Major Francis R. Shunk, U. S. Army Corps of Engineers.

1910 - The 24 ft project was practically completed but, in the meantime, a need had arisen for a channel of greater depth. On the basis of reports submitted by the U. S. Engineer Department, Congress approved a project for a 30 ft. deep channel from Jacksonville to the ocean, in St. John's River.

1924 - A hydrographic survey was made of the inlet vicinity by the U.S. Coast and Geodetic Survey (USCGS). This survey detailed the bathemetry of the offshore area as well as the inlet (see Fig. 5.3).

1927 - Survey was made of Fort George Inlet by the Corps of Engineers, Jacksonville District, in conjunction with seventeen proposed improvised groins to protect the completely exposed north jetty of St. John's River Entrance from serious erosion occurring on the north shore of the north jetty. 276,084 cu. yds. of dredged material were deposited on the north side of the north jetty on Wards Bank (Corps of Engineers, 1927, 1928).

1928 - The U. S. pipe line dredge Welatka completed a deposit of 695,921 cu. yds. of material on Wards Bank. (Corps of Engineers, 1929).

1929 - 515,168 cu. yds. were removed from the northside of Wards Bank Cut and deposited on the northside of the north jetty. (Corps of Engineers, 1928 and 1930).

1934 - A concrete monolithic cap was constructed for the north jetty to resist the movement of sand through the jetty. From the shoreline westward the cap is 2 ft. wide on top and 3 to 4 ft. deep. From the shoreline seaward, the cap is 6 ft. deep and 8 ft. wide to the full length of 3,550 ft. The voids in the jetty below the 4-foot elevation were plugged with stones.

1937 - The Annual Report of the Chief of Engineers dated June 30, 1937 summarized the improvements to the St. John's River as follows: two converging rubble stone jetties with crests 10 ft. above mlw, the north jetty is 14,300 ft. long, south jetty is 11,183 ft. long. The jetties are parallel and 1600 ft. apart for a distance of 4,022 ft. from the sea ends.

1949 - A bridge across the Fort George River was completed.

1954 - A hydrographic survey was made of the Fort George Inlet vicinity by US Coast and Geodetic Survey (USCGS).

1960 - An appeal from the Florida Board of Parks and Historic Memorials to enhance the beauty and appeal of the state park and refuge area on Fort George Island was voiced on the 15th of February.

1963 - The inlet vicinity was surveyed by the Corps of Engineers, Jacksonville District.

1969 - Scour underneath bents 4 through 10 of the A1A bridge caused DOT to add crutch bents, composed of two 20 inch square concrete piles at the end of each of the 7 bents (bent numbers refer to those in Fig. 5.5).

1971 - Hopkins (1971) mentioned in his "Bridge Scour at Selected Sites in North Florida" that the bridge was by far the most dramatic example of scour in this area known to him. The shift of the channel toward the west bank was evident as was the increase in scour depth throughout the entire section from bent number 1 to bent number 13.

1974 - Beach profiles and offshore soundings in the inlet vicinity were taken by the COEL in conjunction with the coastal construction setback line.

1977 - DOT surveyed the A1A bridge vicinity to investigate serious scour occurring underneath the bridge and along the Fort George River banks around the bridge.

1978 - The scour problem at the eastern part of the bridge span resulted in the placement of three additional piles on each side of the bridge cap every sixth bent between bents 13 through 32 (see Fig. 5.5). Stone riprap was constructed around the bridge abutment on Little Talbot Island. In this year, the COEL monitored the flow conditions of the inlet. Tide and current studies were made during the months of June and July. The bay and Wards Bank areas were surveyed by DOT in conjunction with the investigation of the stability of Fort George Inlet.

1979 - COEL made recommendations which would provide short-term solutions for the channel bank erosion problem (Kojima and Mehta, 1979, Kojima, 1979). Penland (1979) used fluorescent tracer dispersal in order to determine the present pattern of sediment dispersal in Fort George Inlet.

V. MORPHOLOGICAL CHANGES

5.1 Maps, Surveys and Photographs

Fort George Inlet appears on the following charts and maps: NOS Coast Chart No. 11492, NOS Nautical Chart Nos. 11489 and 11490, and USGS topographic map of the Mayport Quadrangle, photorevised in 1970.

Surveys of the inlet and adjacent areas have been made by USC & GS in 1853, 1857, 1923-4, 1951-4 and 1958-9 and by the Corps of Engineers between 1905 and 1927 for the St. John's River improvement project as well as in 1963 in conjunction with the beach erosion control study, Duval County. Figs. 5.1 through 5.3 show three of these surveys. In 1974 the COEL conducted a survey in relation to the coastal construction setback line for Duval County. Recent surveys of Little Talbot Island, the bay cross-section and Wards Bank were made by DOT in 1977-79, for an investigation of the stability of Fort George Inlet. Profiles are shown in the inset of Fig. 5.4. Locations of survey stations 40+00 through 68+00 along the A1A road are shown in Fig. 5.5.

The 1963 survey gives the -6, -12, -18, and -30 ft. msl contours as well as a series of beach profile lines along the Duval County coastaline. In addition, a series of Department of Natural Resources (DNR) premanent reference monuments were set at approximately 1,000 ft. intervals along the coastline in conjunction with the coastal construction setback line study. These profile lines are shown in Fig. 5.4. Beach profiles at every third monument were taken to a depth of 20 to 30 ft. and at all other monuments the profiles were taken to wading depth. Since Florida law requires that the setback line be reviewed by DNR every 5 years, this project should provide valuable information concerning erosion and accretion along the coastline (Purpura and Sensabaugh, 1974; COEL, 1975).

Aerial photographs of the inlet have been taken by several governmental agencies in various years since 1943. Barwis (1975) has compiled a listing of the photographs and pertinent details for the years 1943-1974. Recent aerial photographs since 1975 have been taken in conjunction with the erosion on Little Talbot Island near the A1A bridge (S.R. 105). Figs. 5.6-5.9 show aerial views of Fort George Inlet in 1947, 1951, 1961 and 1975, respectively.

5.2 Outercoast Shoreline Changes

Significant shoreline changes in the inlet vicinity, as shown in Figs. 5.10 through 5.12, have been taking place since the first recorded map (Fig. 5.1) of the inlet was made. In the early 1900's the Corps of Engineers periodically made surveys of the area surrounding the inlet in conjunction with the St. John's River improvement project. These surveys detailed water depths of Fort George Inlet as well as the mean high water (mhw) shoreline over the area. Moreover, the Duval County Beach Erosion Board made a study of the comparative positions of the mhw shoreline over the period 1858 to 1963 using USCGS surveys as well as the Corps of Engineers survey of 1963. The report noted that, since 1853, the south end of Little Talbot Island, which was near the confluence of Fort George River and Simpson Creek in 1853, has extended about 9,000 ft. southward.

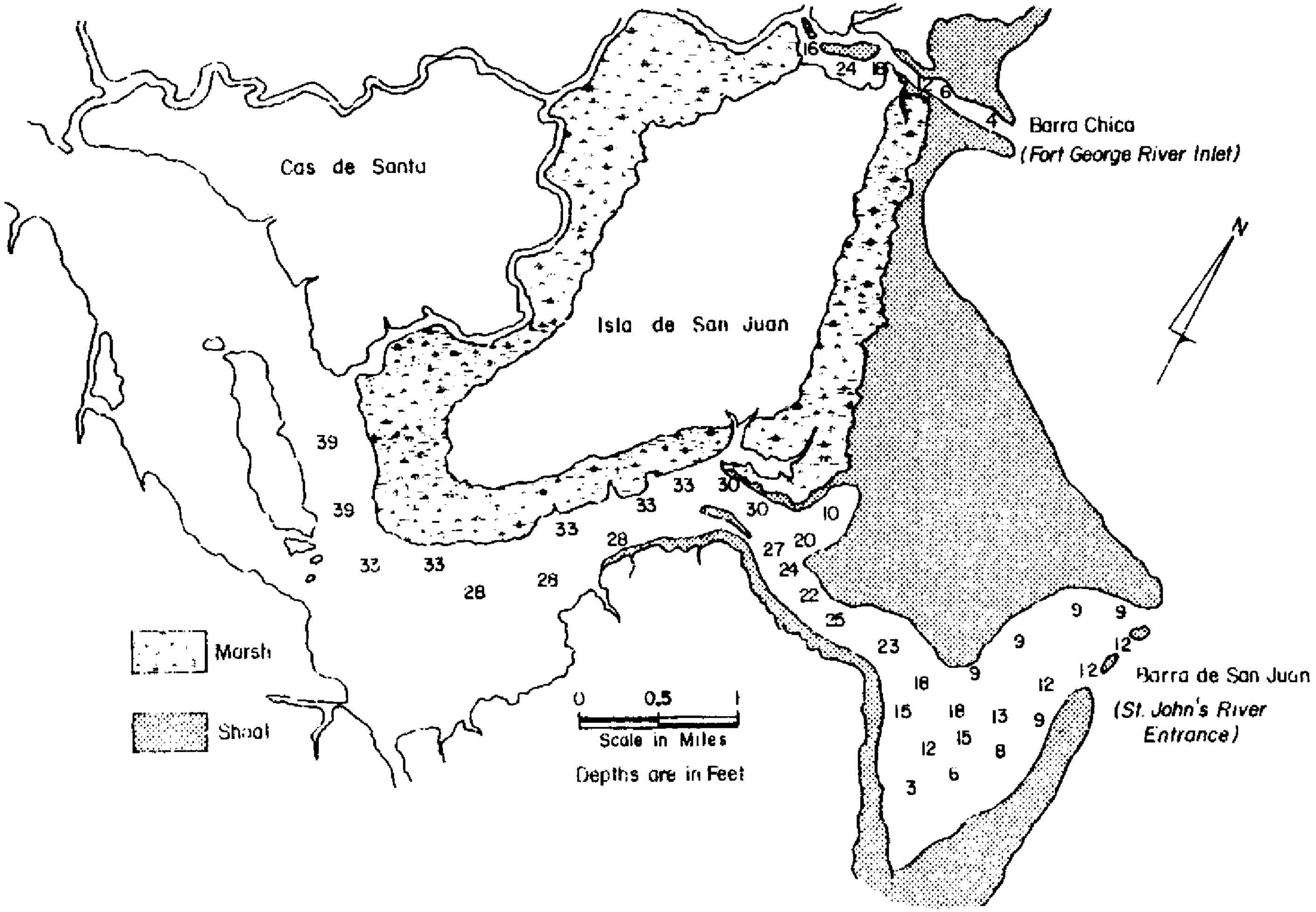


Fig. 5.1 Spanish Mariner's Chart, 1809

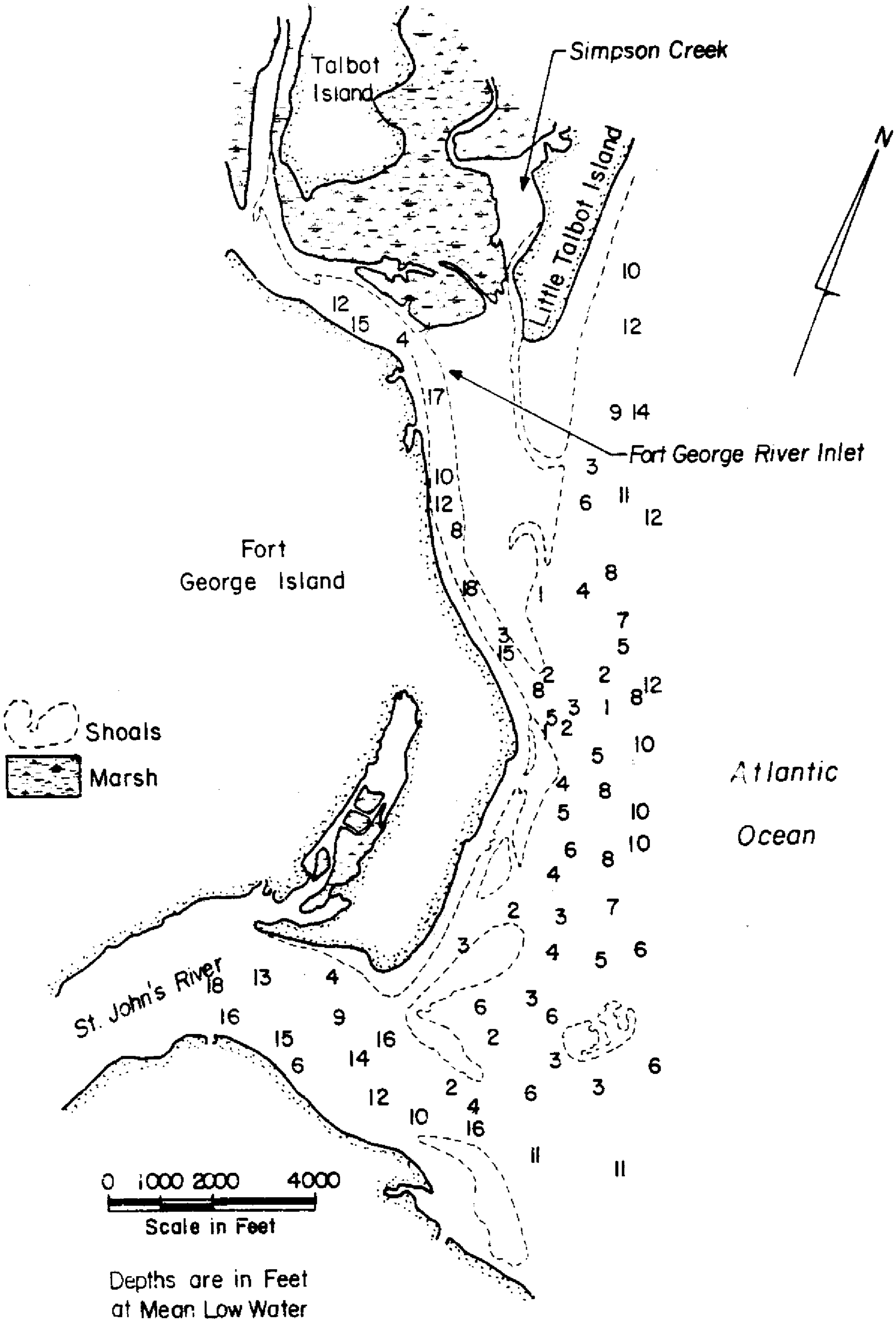


Fig. 5.2 Early Hydrographic Survey by the U.S. Navy, 1857

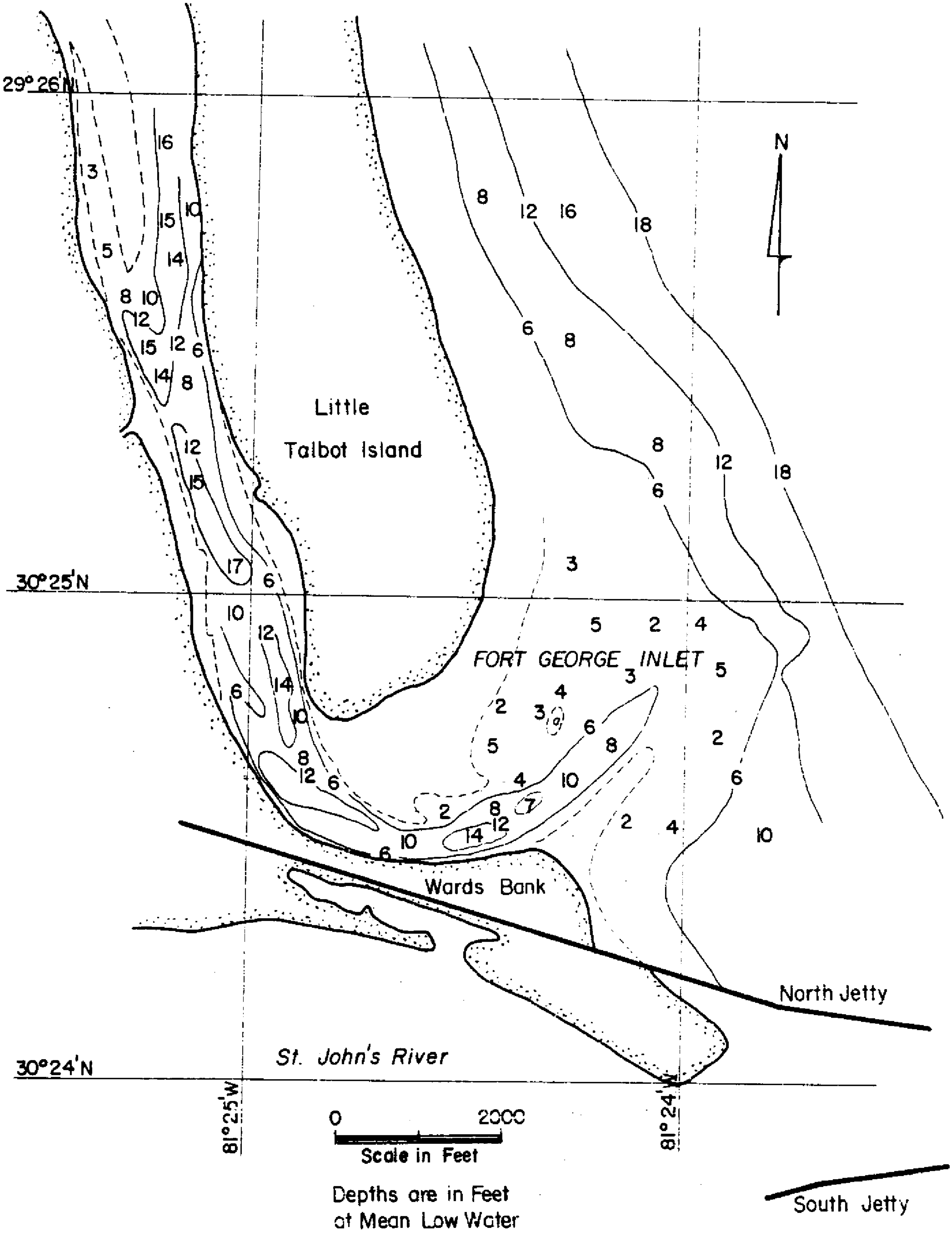


Fig. 5.3 USCGS Hydrographic Survey of Fort George Inlet, 1924

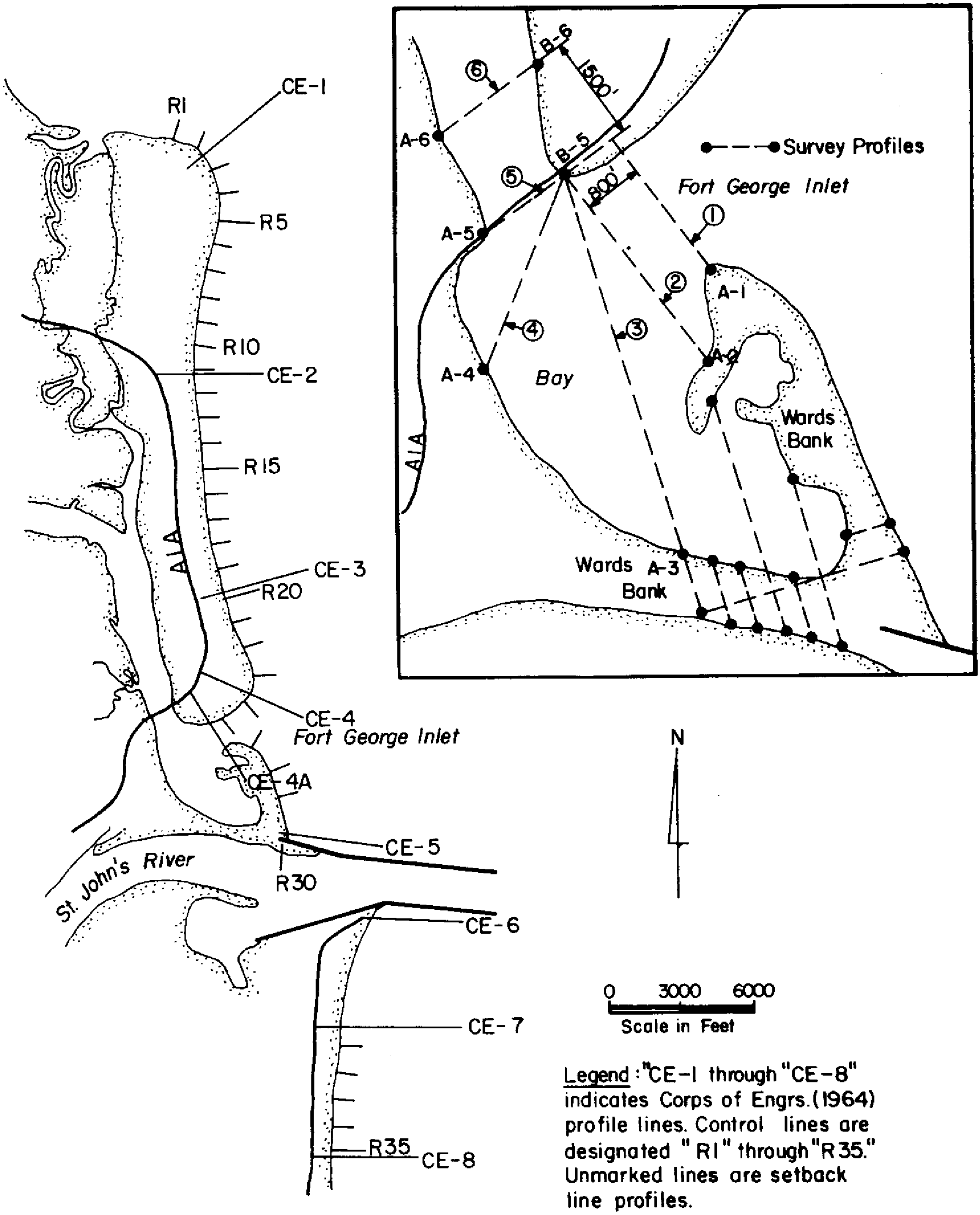


Fig. 5.4 Locations of DNR Survey Profile Lines, 1974. Inset shows DOT Survey Lines for Study of Inlet Stability.

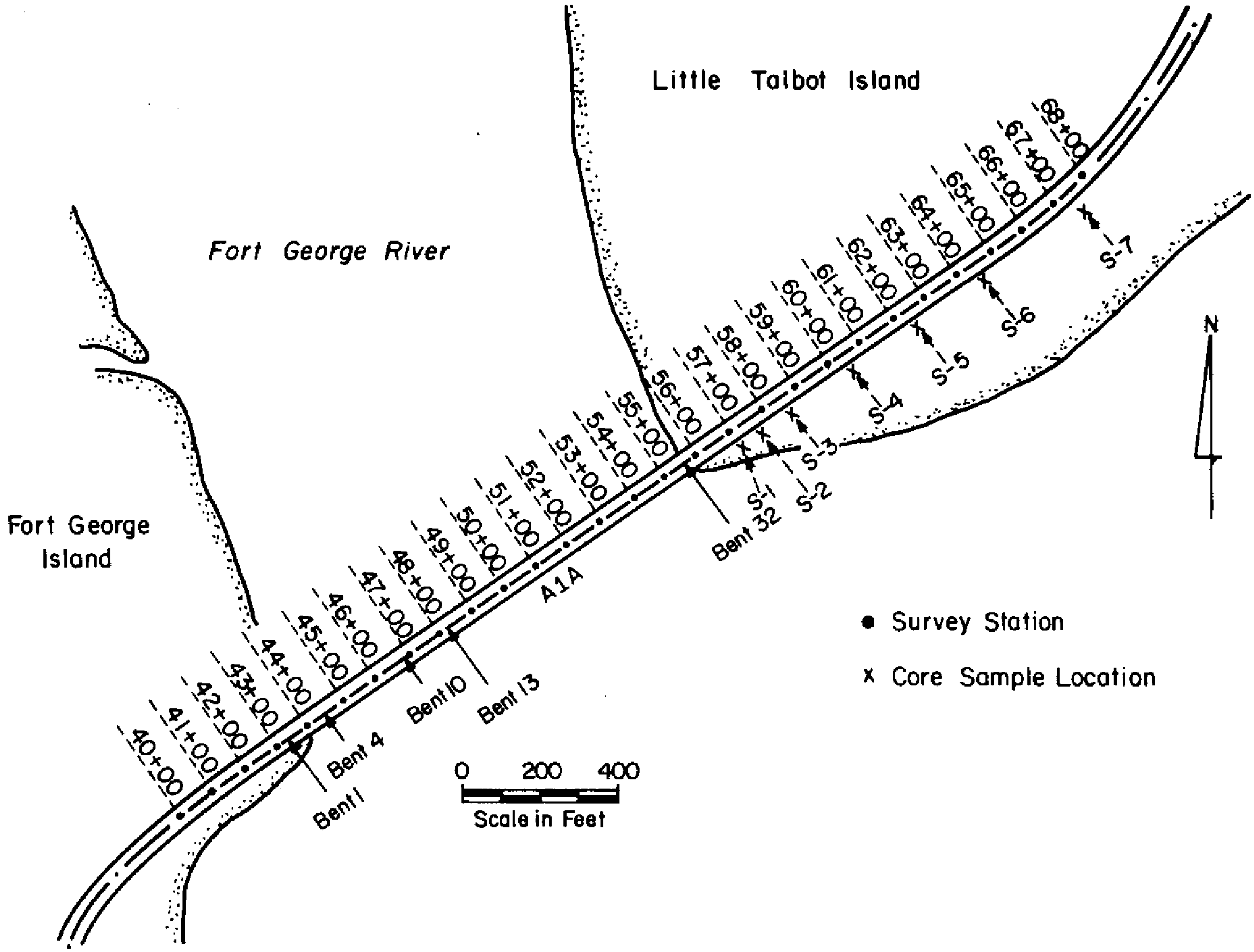


Fig. 5.5 Location of DOT Survey Stations and Core Samples, 1977-78

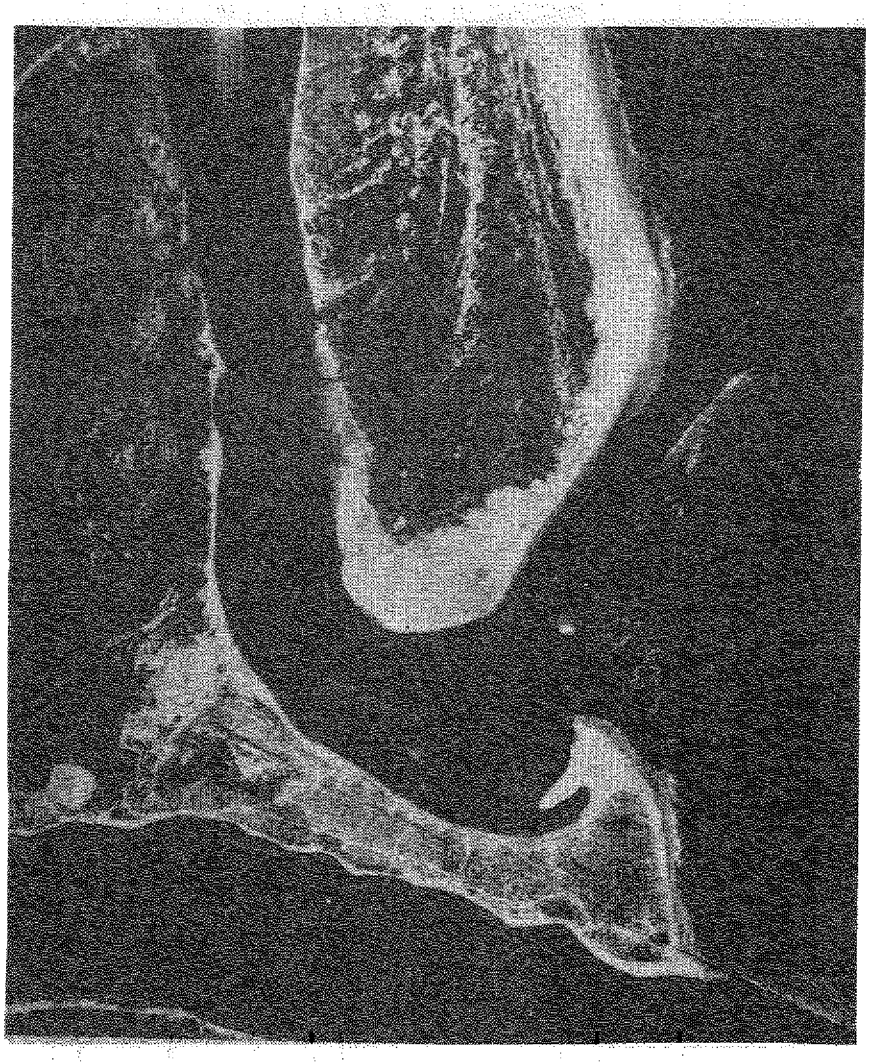


Fig. 5.6 Aerial View of Fort George Inlet, Feb. 26, 1947. Scale: 1" = 2000'

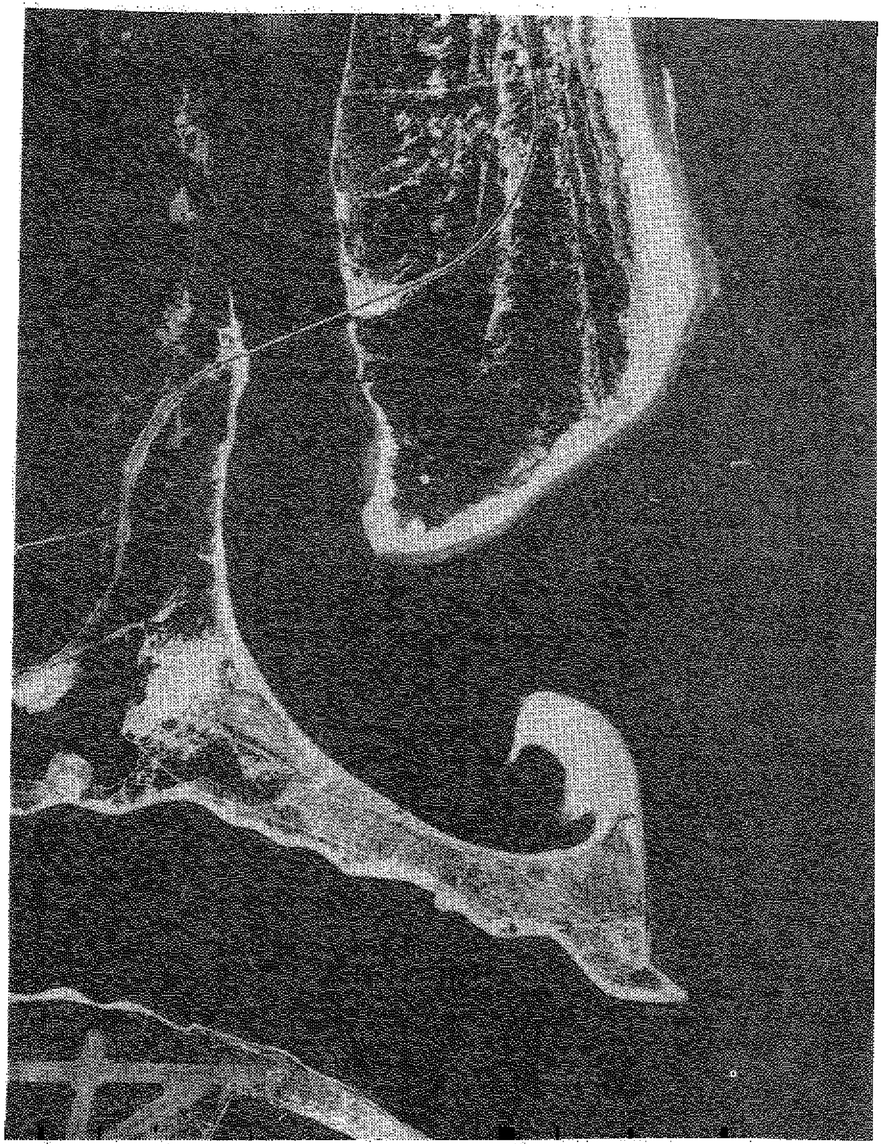


Fig. 5.7 Aerial View of Fort George Inlet, April 1, 1951. Scale: 1" = 2000'

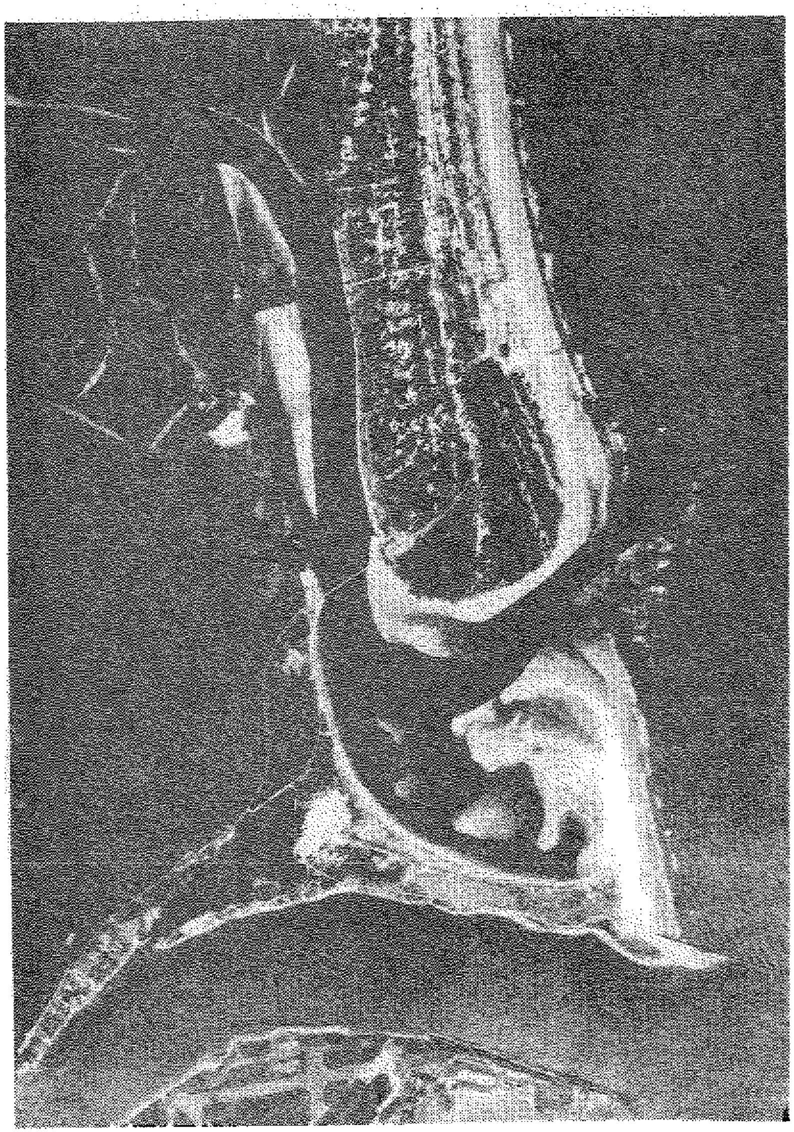


Fig. 5.8 Aerial View of Fort George Inlet, Oct. 20, 1961. Scale: 1" = 2500'

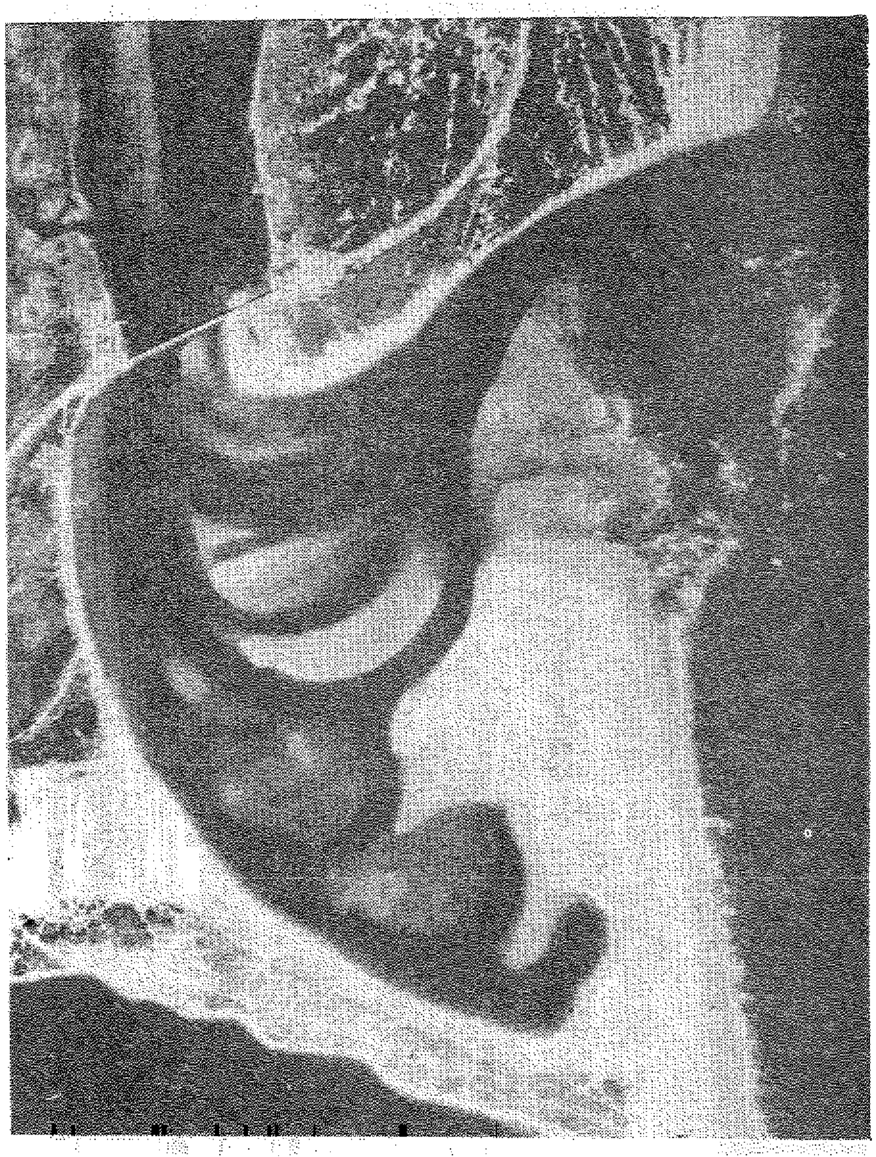


Fig. 5.9 Aerial View of Fort George Inlet, Jan. 14, 1975. Scale: 1" = 1300'

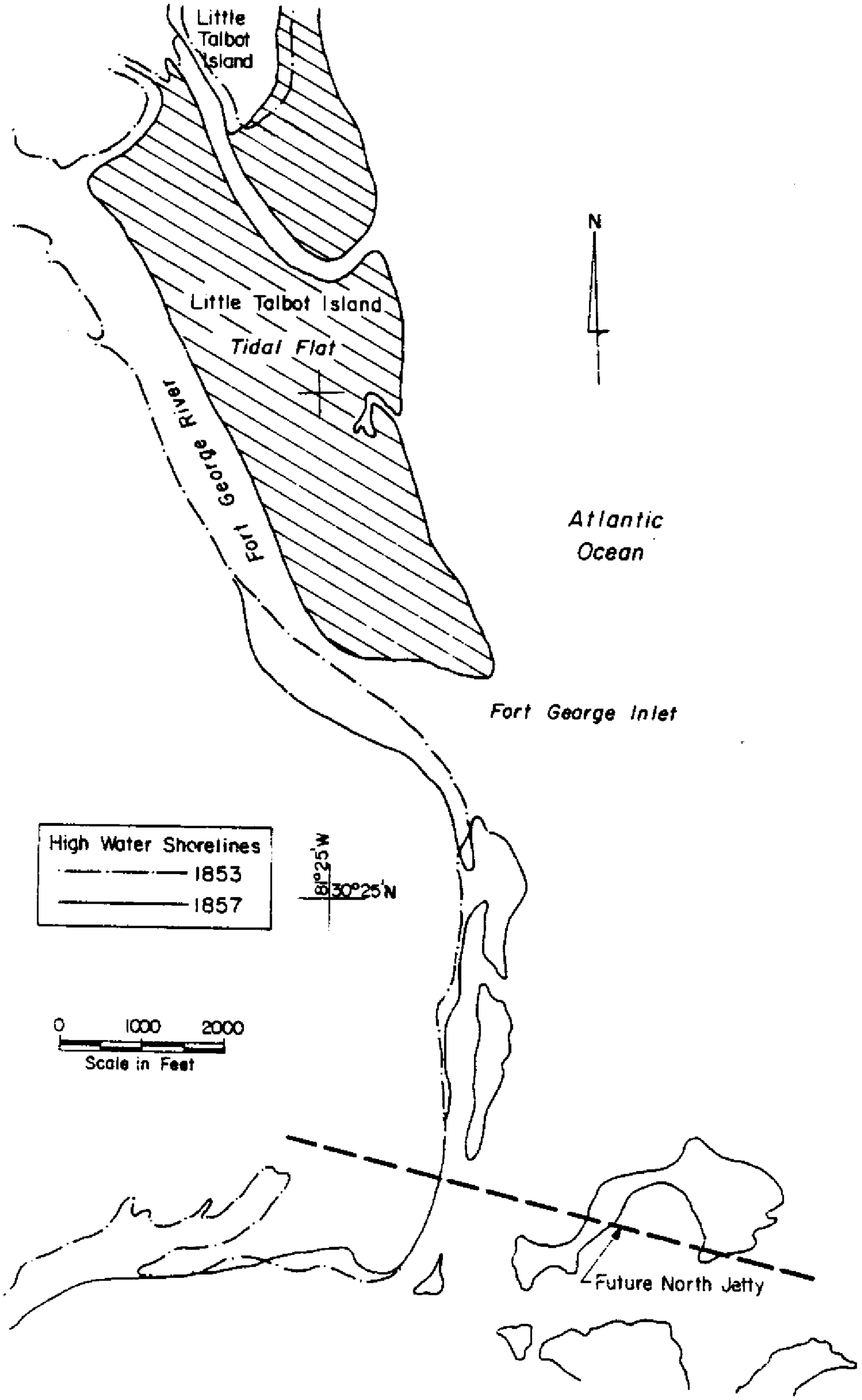


Fig. 5.10 Mean High Water Shoreline Changes - 1853-1857 for Fort George Inlet Vicinity

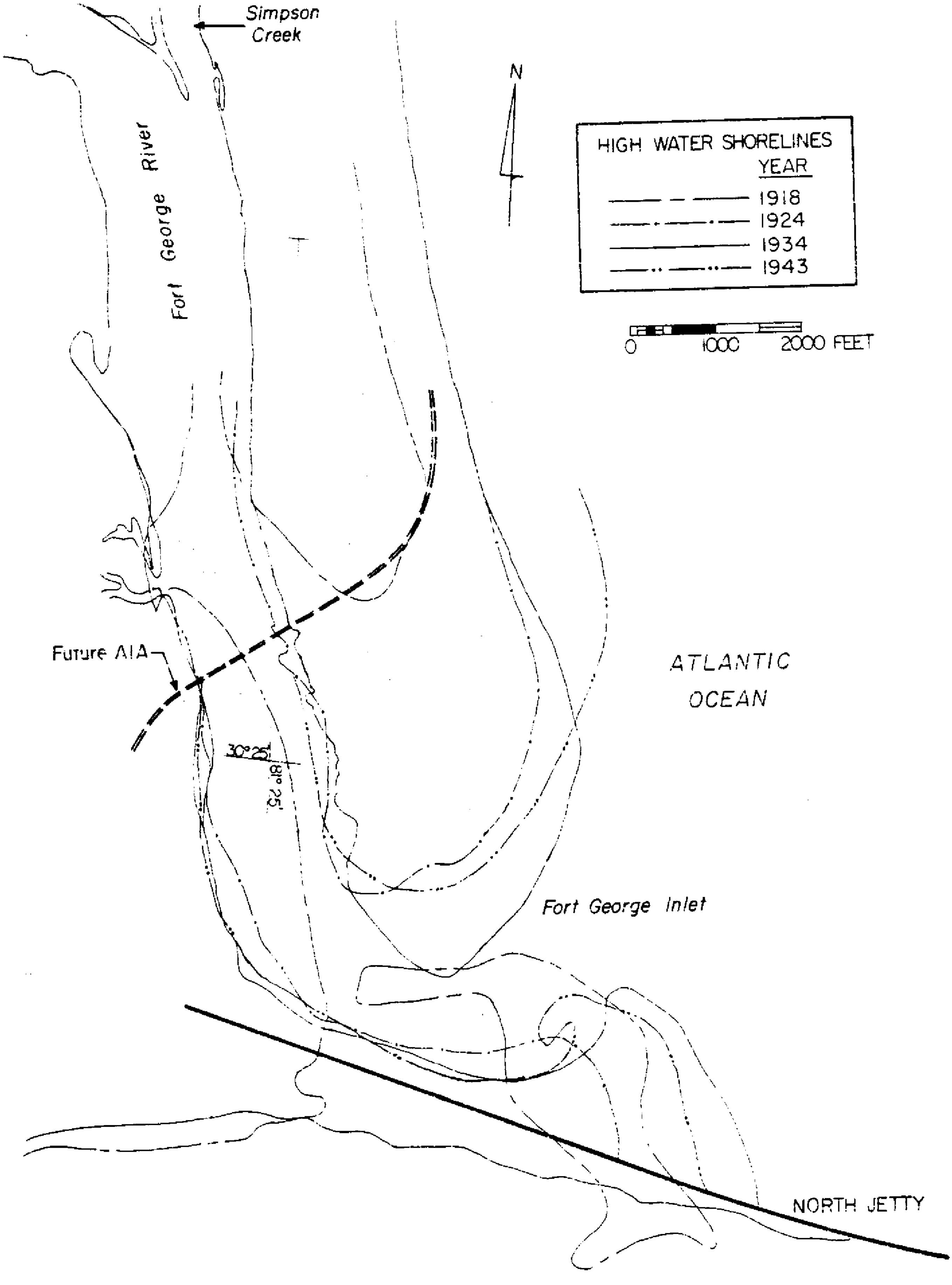


Fig. 5.11 Mean High Water Shoreline Changes - 1918-1943, for Fort George Inlet Vicinity

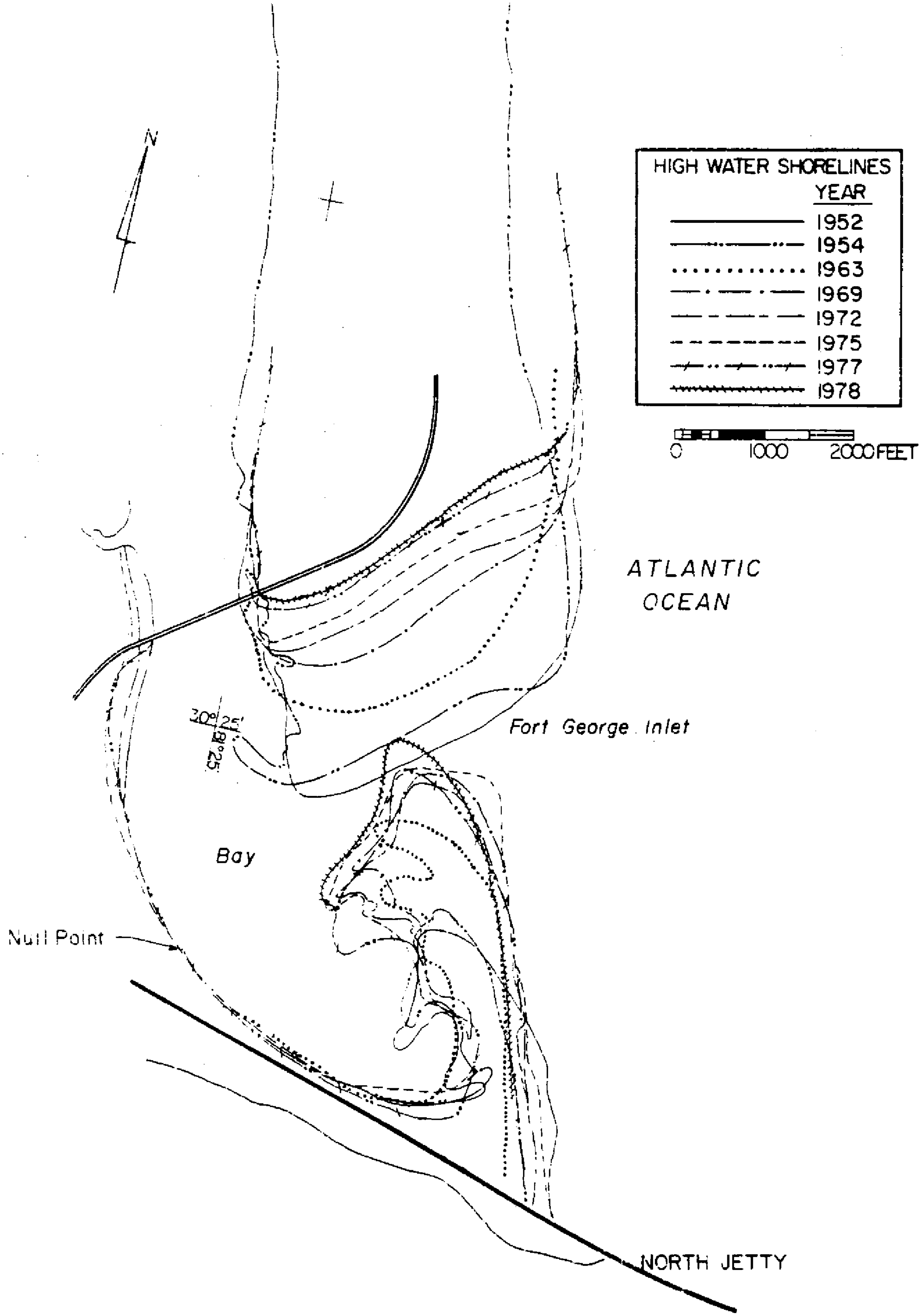


Fig. 5.12 Mean High Water Shoreline Changes - 1952-1978, for Fort George Inlet Vicinity

In the same study the movement of the mhw line between 1853 and 1963 was tabulated and the results are presented in Table 5.1. The report indicated that the ocean shore of Little Talbot Island (referring to profiles CE-1 to CE-3 in Fig. 5.4) advanced considerably seaward during the period of record. For the period 1923-24 to 1963, that shoreline advanced about 650 ft. or about 16 ft. annually. It is apparent that accretion has taken place south of the inlet and adjacent to the north jetty of St. John's River while the southern tip of Little Talbot Island has eroded over this period.

Table 5-1
Mean-High-Water Shoreline Changes in the Vicinity of Fort George Inlet (Corps of Engineers, 1964)

Profile	1853-1923/4 (ft)	1923/4-1951/54 (ft)	1951/54-1963 (ft)	1923/24-1963 (ft)
1	*	-150	+380	+230
2	*	+550	+350	+900
3	*	+700	+440	+1,140
4	*	+1,060	-750	+310
4A	*	-1,180	-480	-1,660
5	*	+130	+200	+330
6	*	+460	-60	+400
7	-400	=70	+55	-15
8	-200	-110	-10	-120

+ denotes accretion
- denotes erosion
* no data

(These profile numbers correspond to the Corps of Engineers profiles in Fig. 5.4)

Fig. 5.13 schematically shows the movement of the inlet together with Little Talbot Island, based on the mhw shoreline changes (Figs. 5.10-5.12) drawn by using USCGS and Corps of Engineers surveys and numerous aerial photographs. It is interesting to note that significant shoreline changes took place after construction of both the permeable (submerged) north jetty and the impermeable (capped) jetty at St. John's River. After 1886, when the submerged (permeable) north jetty was built, the shoreline of Little Talbot Island advanced remarkably southward. The total southward extension between 1853 and 1934 was approximately 12,000 ft. as shown in Figs. 5.10 and 5.11 and was accompanied by the southward migration of the inlet. This inlet migration might have been one of the reasons for the serious erosion of Wards Bank, which completely exposed the north jetty around 1927 (Corps of Engineers, 1927). Because of this, seventeen improvised groins were constructed along 1,500 ft of the shoreline south of Fort George Inlet. Between 1927 and 1929 about 2.5 million cubic yards of dredged material were deposited on Wards Bank, where the groins were located. After the north jetty was capped and became impermeable in 1934, the island started moving toward the north, with Wards Bank spit expanding northward as well. This movement has been forcing the inlet to migrate northward. The diagram on the lower right hand side of Fig. 5.13 shows

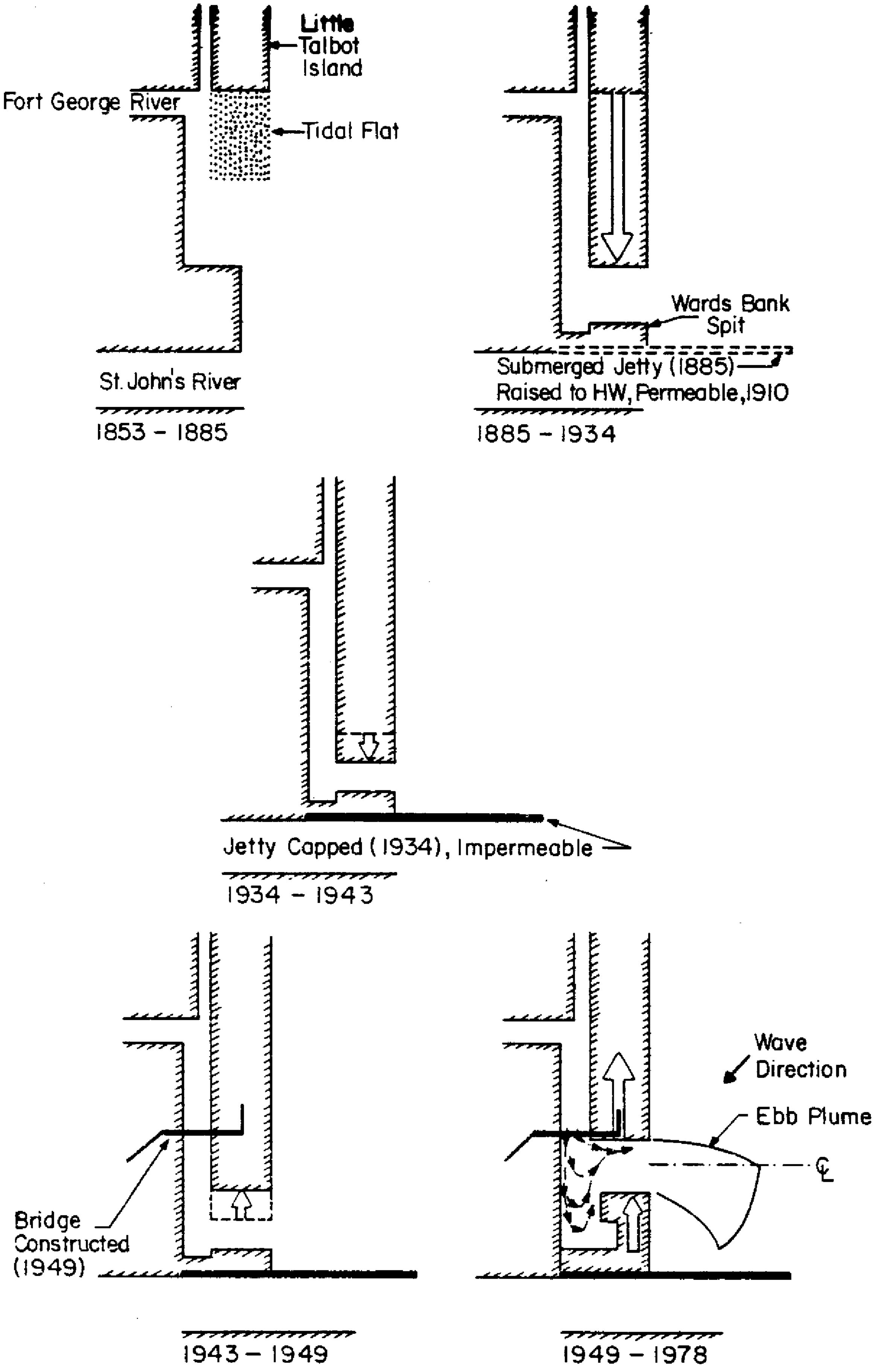


Fig. 5.13 Schematic Diagram of Movement of Fort George Inlet and Surrounding Area due to St. John's River North Jetty

that the ebb plume, i.e. the jet issuing from the inlet during ebb tide, is deflected toward the south due to the predominance of waves from the northeast. This ebb plume erodes the southern tip of Little Talbot Island because strong current flows near the shore of the island and transports eroded sediment south of the inlet centerline (Kojima and Mehta, 1979).

The north jetty of the St. John's River serves as a breakwater and limits the incident waves to those from the northeast and east. Thus, the waves and littoral currents transport the eroded sediment in a southerly direction toward Ward Bank spit. The north jetty serves to severly restrict littoral drift to the south and as a result accretion occurs on the spit. Thus, the inlet channel is forced to migrate northward to accomodate the accumulated sediment on Ward Bank spit (Kojima and Mehta, 1979).

5.3 Changes in the Inlet Cross-Section

Measurements of the inlet and bay cross-sections were made by DOT in 1969, 1977 and 1978. Both 1969 and 1977 surveys were taken exclusively in the vicinity of the bridge. Other measurements were carried out by the Corps of Engineers in 1963 and by COEL in 1974.

Fig. 5.14 shows the cross-sectional profiles taken at a distance of 60 ft. south of the centerline of the bridge. The deep channel on the west side of the bridge has shown a tendency to migrate westward accompanied by an increase in maximum depth. Bottom scour has been taking place on the east side of the section, together with the shore erosion on Little Talbot Island. Note that in the survey of Dec. 19, 1977 the depth of the west channel is somewhat shallow in comparison with the two other surveys of the same year. This is presumed to be due to survey error. Figure 5.15 shows cross-sectional profiles for all sections except for sections three and five (the section numbers correspond to those survey profiles in the inset of Fig. 5.4). Since section one has a minimum cross-sectional area, this section may be thought of as the inlet throat. Sections two and four clearly show one of the characteristics of Fort George Inlet, namely the shoals between which several narrow channels run.

Longitudinal profiles beneath the bridge are shown in Fig. 5.16 where distance zero indicates the centerline of the bridge, and station numbers correspond to those in Fig. 5.5. The profiles characteristically show local scour holes. An extensive discussion of this problem has been given elsewhere (Kojima, 1979). It suffices to note that the maximum scour depth is typically found to occur within a distance of 16 ft. from the bridge centerline.

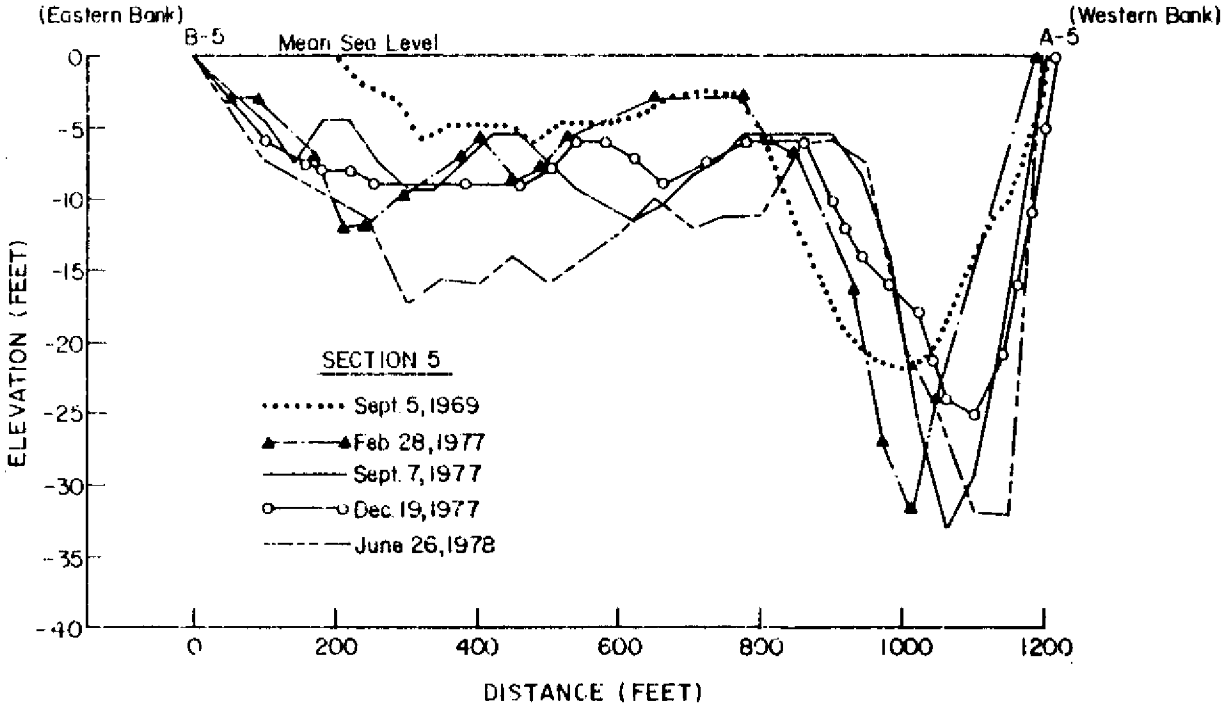


Fig. 5.14 Cross-sectional Profiles near the Bridge

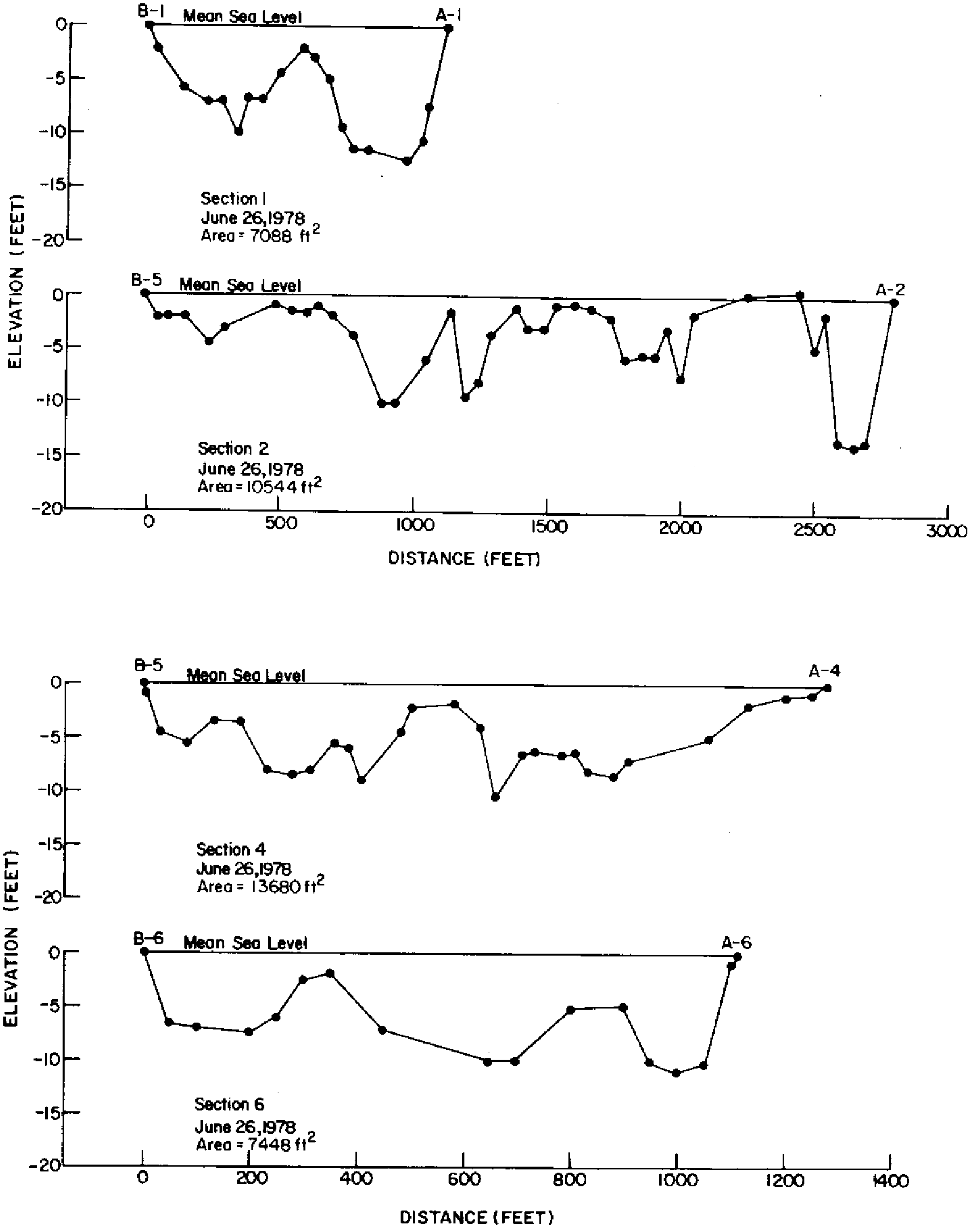


Fig. 5.15 Inlet Cross-Sections. See Fig. 5.4 for Locations of Transects.

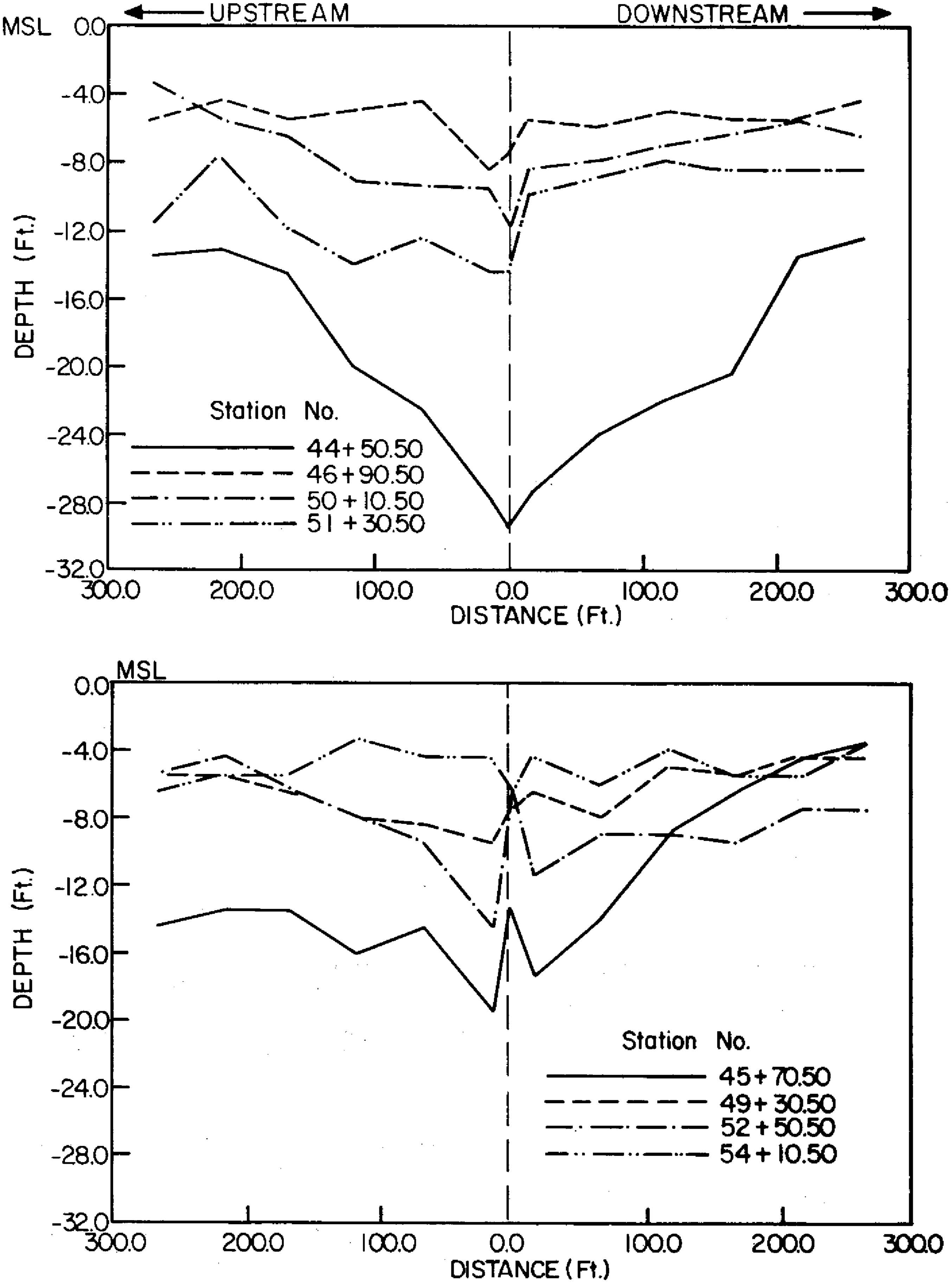


Fig. 5.16 Longitudinal Profiles Beneath the A1A Bridge

VI. HYDRAULICS

6.1

For the period of June 12, 1978 through June 19, 1978, the COEL operated a tide gage in the Fort George Inlet vicinity in conjunction with the study of the stability of the inlet (Kojima and Mehta, 1979). The gage was attached to a pier at the Camp Alamancani fish camp located immediately north of the A1A bridge (as shown in Fig. 6.2) and it measured the bay tide. The ocean tide characteristics were obtained by applying correction factors for the range and lag applicable for Fort George Inlet to the hourly data obtained from NOS for the Mayport tide gage. The Mayport Station is located just upstream of the ocean entrance of St. John's River. These bay and ocean tide data for spring and neap conditions are shown in Fig. 6.1. Based on these data, the following ranges were obtained:

Spring ocean tide range = 5.6 ft.
Spring bay tide range = 5.3 ft.
Neap ocean tide range = 4.5 ft.
Neap bay tide range = 4.1 ft.

NOS operated a tide gage about 1.5 miles upstream of the A1A bridge in Fort George River. The ranges recorded are shown in Table 6.1. NOS also gives tidal predictions in their tide tables for Fernandina Beach (18 miles north) and Jacksonville Beach (9 miles south) for the open ocean tides. These ranges are given in Table 6.1.

Table 6.1
Tide Range for NOS Tide Stations

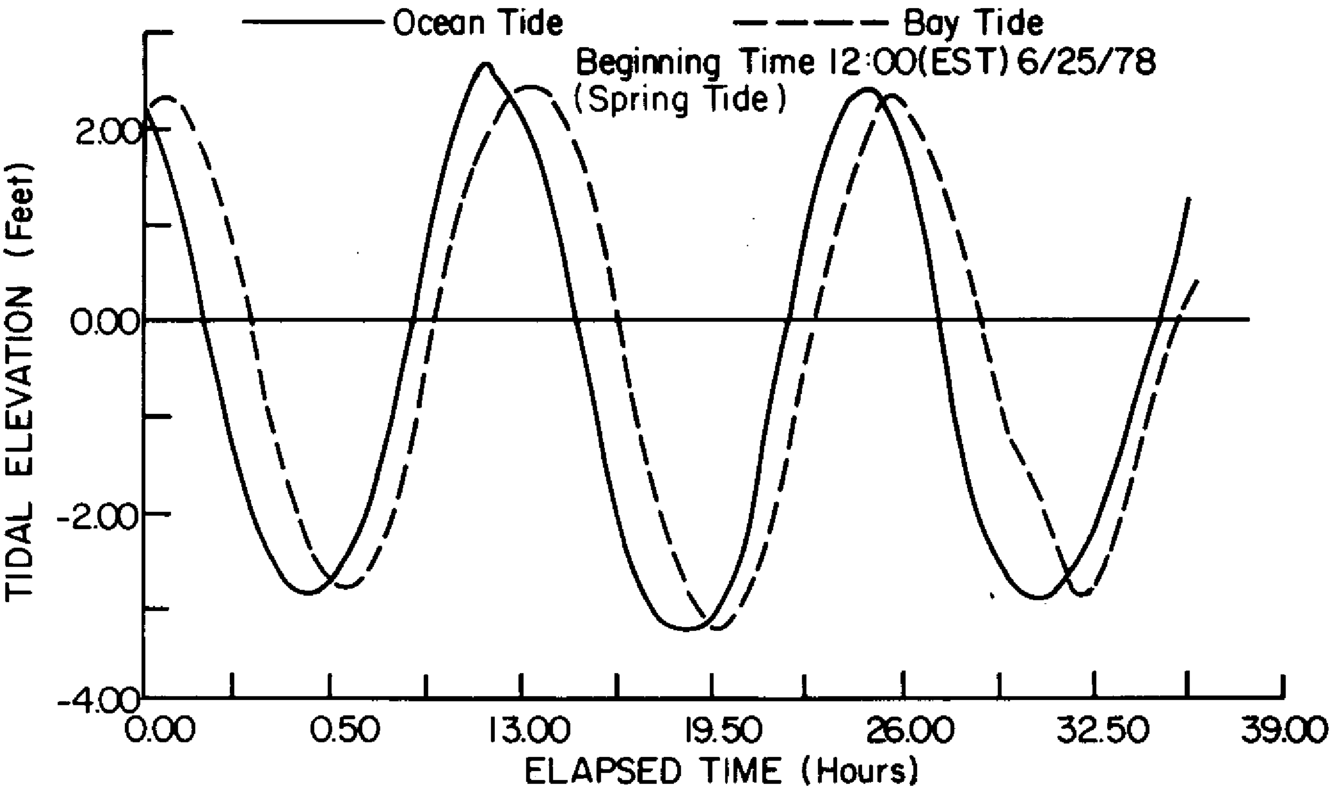
Station	Mean Range (ft)	Spring Range (ft)
Fort George Island	4.8	5.6
Fernandina Beach	5.7	6.7
Jacksonville Beach	5.0	5.6

The line of mean tide level (mtl) along the open coast in the vicinity of Fort George Inlet is estimated to be 0.28 ft. above the 1929 mean sea level datum (N.G.V.D., which is the reference datum for many USCGS and DOT bench marks in the area (Corps of Engineers, 1968)). The line of mean low water (mlw) is estimated to be approximately 2.1 ft. below the 1929 datum.

6.2 Currents

Currents were measured at Fort George Inlet by COEL in 1978, in conjunction with an investigation of the stability of Fort George Inlet. These measurements fall in two categories:

1. Instantaneous vertical and transverse profiles at six cross-sections using an Ott current meter. Locations of the six cross-sections are shown in Fig. 6.2.



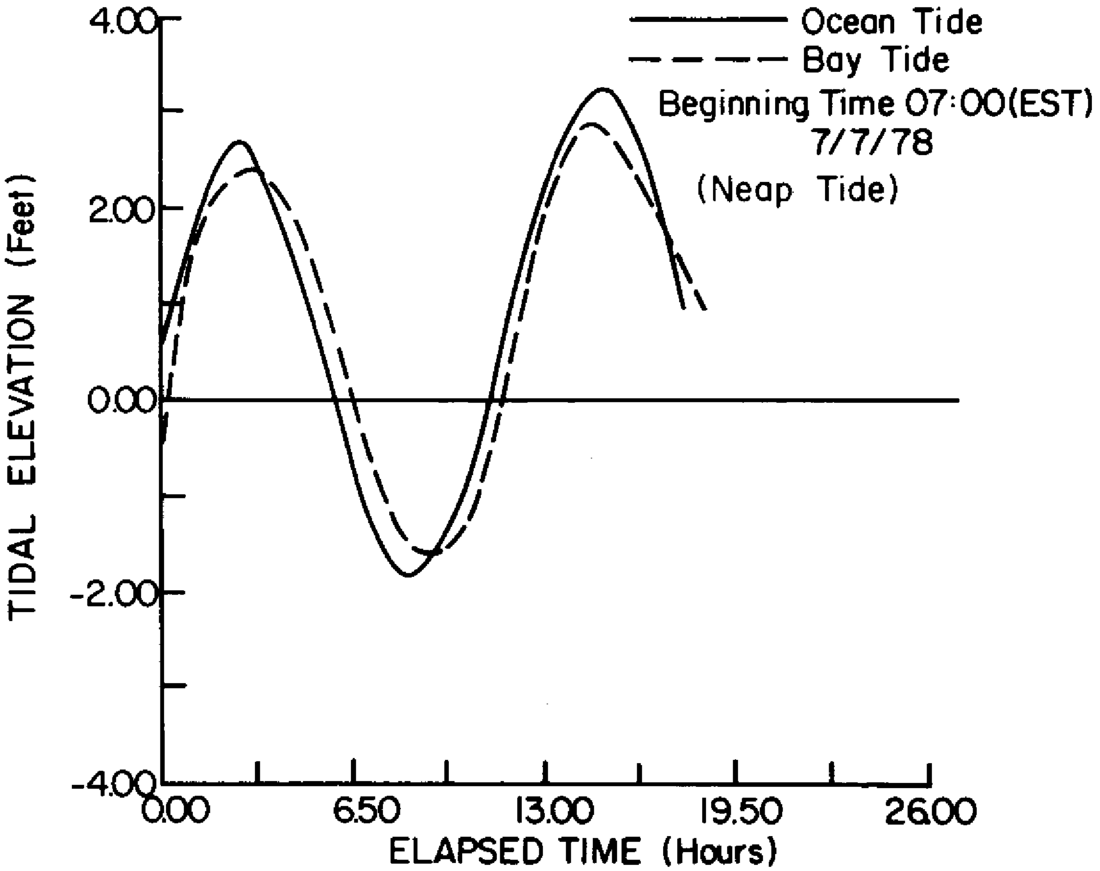


Fig. 6.1 Tidal Records for Ocean Tide and Bay Tide

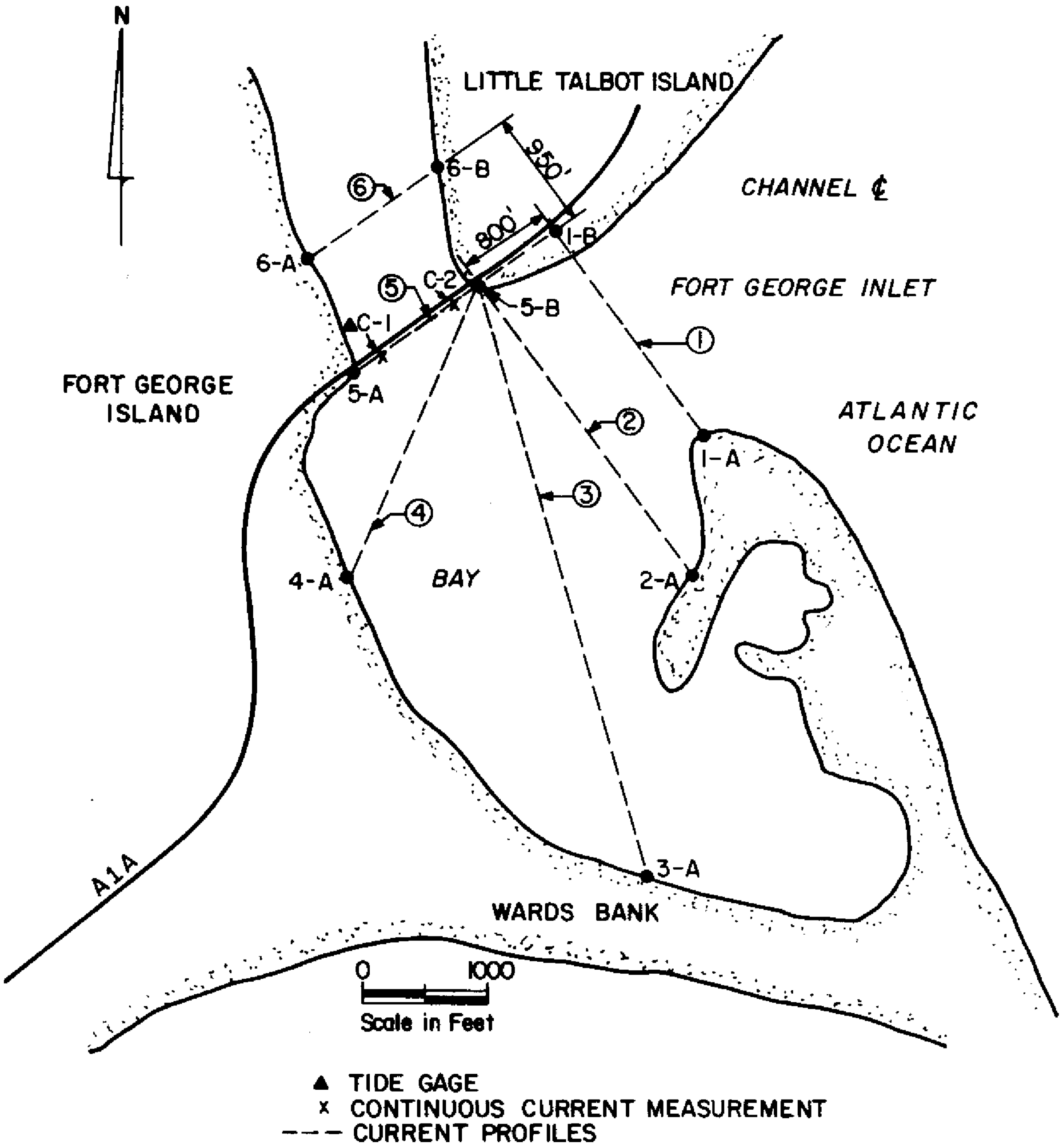


Fig. 6.2 Locations of Tide Gage, Continuous Current Measurements and Instantaneous Current Profiles

2. Continuous velocity data at two stations immediately south of the bridge. These data were measured 2 feet above the bottom at each station for one tidal cycle. One station (C-1) was located at a distance of 160 ft. from the west bank of Fort George River, the other (C-2) at a distance of 400 ft. from the east bank, as shown in Fig. 6.2.

Depth-averaged transverse velocity profiles at the inlet throat section and near the bridge were plotted in a dimensionless form as shown by examples in Fig. 6.3. This facilitates comparison of each profile. It is interesting to note that the flow near the east bank during both flood and ebb is channelized through a newly developing channel, whereas the flow near the west bank is somewhat uniformly distributed in spite of the presence of the deep channel.

Figure 6.4 shows the continuous velocity records measured near the bridge on June 26 and July 7, 1978. The strongest current occurred during flood at C-2 where bed scour and erosion of the channel bank are significant. On the other hand, the current at C-1 was relatively weak during flood, whereas during ebb it had almost the same magnitude as the current at C-2. Note that the time-velocity record on 6/26/78 was taken during spring tide and the record on 7/7/78 during neap tide.

6.3 Hydraulic Parameters

a. Tidal Prism

The tidal prism was estimated by integrating the discharge curve (shown in Fig. 6.5) between two successive slack waters. Note that the tidal range for the flood prism was from low water to high water, whereas the range for the ebb prism was in reverse order. The time-discharge relationship (shown in Fig. 6.5) was calculated based on the measured continuous velocity by the method developed by Mehta et al. (1977). The tidal prisms estimated near the bridge for 6/26/78 (for spring condition) and for 7/7/78 (for neap condition) were as follows:

Flood Prism = 2.97 x 10^8 ft^3 6/26/78
Ebb Prism = 3.01 x 10^8 ft^3 6/26/78
Ebb Prism = 2.81 x 10^8 ft^3 7/7/78

Since the area influenced by the tides is relatively small (See Sec. 6.3d) and no significant loss or gain of water is experienced due to freshwater inflow or effects of the inlets connected via the Intracoastal Waterway to the north and south (see Fig. 1.2), the tidal prisms for flood and ebb are almost equal.

b. Maximum Currents

The maximum velocities were determined from the cross-sectional average velocity curve which was computed from the time-discharge curve (Fig. 6.5) mentioned in Section 6.3a. The time-discharge curve was divided by the corresponding flow cross-sectional area, determined from the cross-section geometry and tidal elevation, and thus gave the cross-sectional average velocity curve, shown in Fig. 6.6. This particular curve is for the spring tide condition. It is observed that the maximum

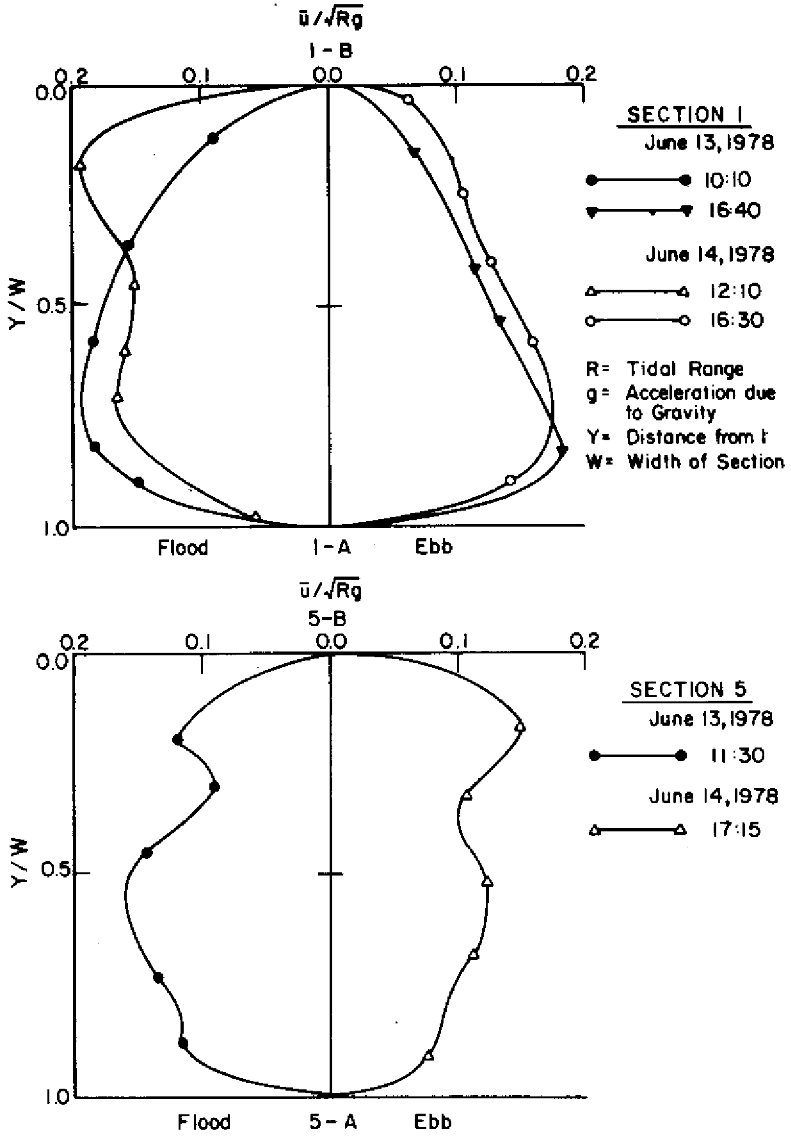


Fig. 6.3 Dimensionless Transverse Velocity Profiles for Sections 1 and 5.

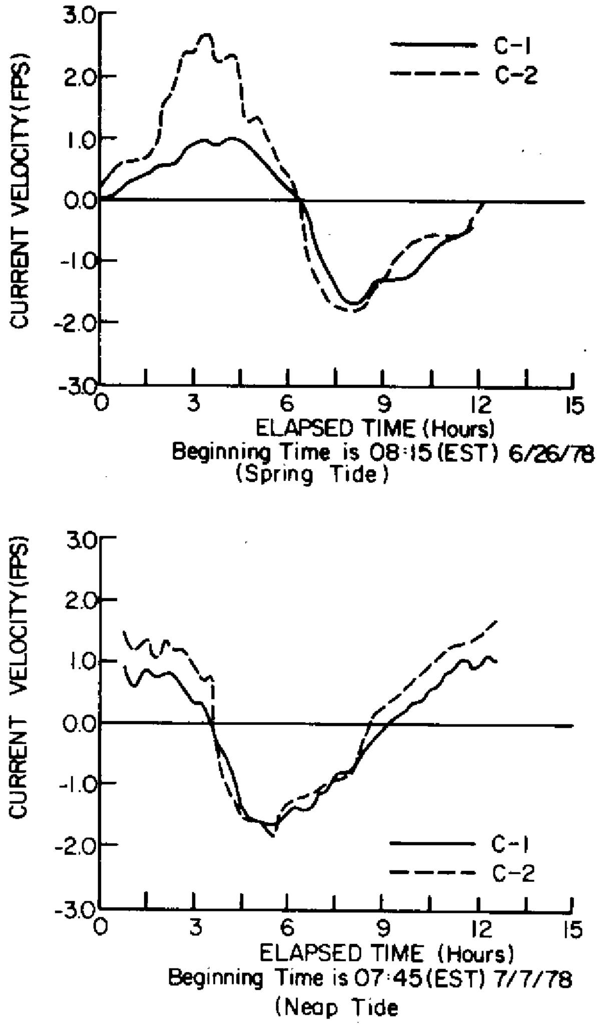


Fig 6.4 Measured Continuous Velocity Record at the Bridge.

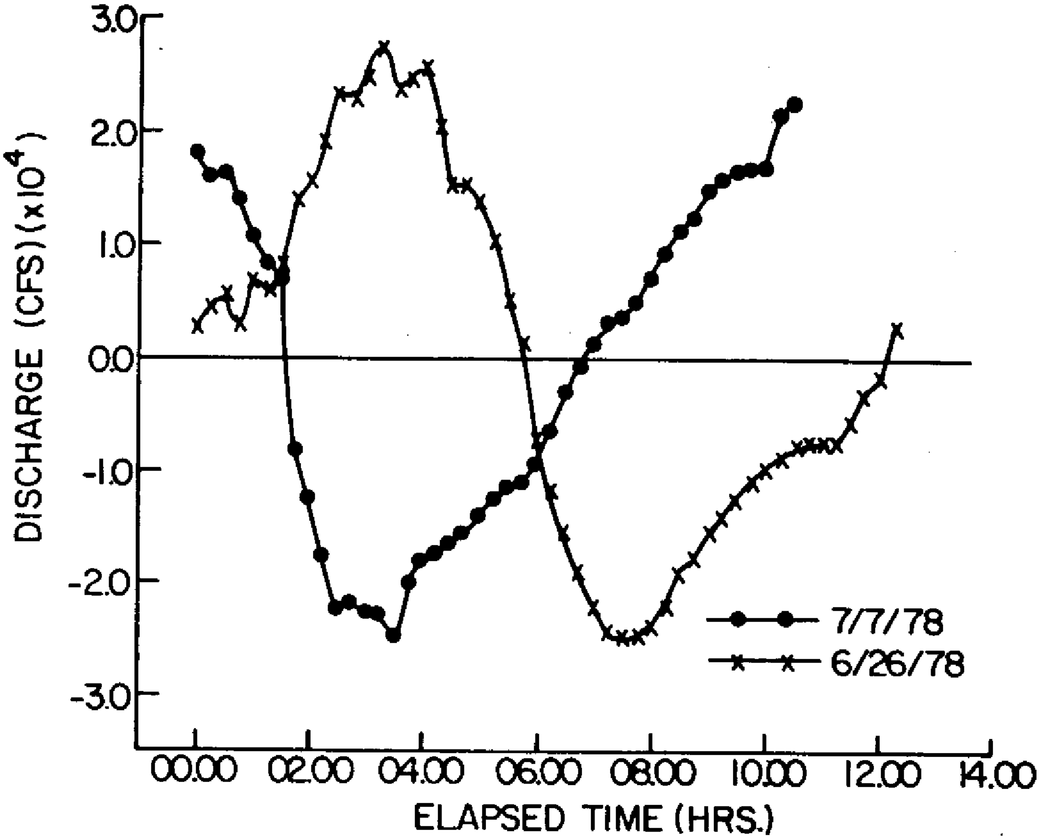


Fig. 6.5 Time-Discharge Record Near Bridge. Starting Times: 08:15 for 6/26/78; 07:45 for 7/7/78

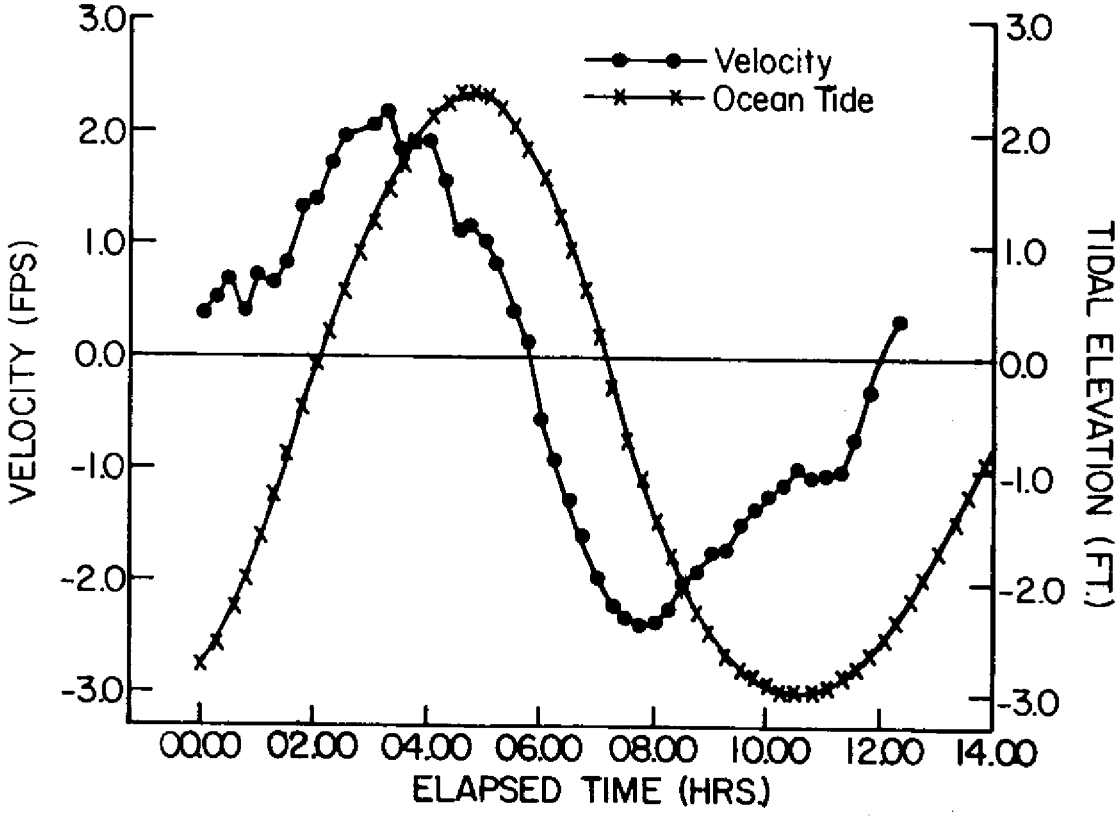


Fig. 6.6 Cross-sectional Average Velocity Near the A1A Bridge and Associated Ocean Tide. Starting Time is 08:15 on 6/26/78

cross-sectional average flood velocity was 2.20 fps and the corresponding ebb velocity was 2.38 fps. Note that the ocean tide range for these velocities was 5.6 ft.

c. Bay Range

Since the bay area is comparatively small (see Section 6.3d), the bay tide is assumed to be the same as that recorded by the tide gage near the bridge. Thus the bay tide range obtained on June 26, 1978 was 5.30 ft.

d. Bay Area

Since the Fort George Inlet system is not a closed system (exits to the ocean exist through Fort George River and the Intracoastal Waterway to both the north and south as seen in Fig. 1.2), an effective bay area must be determined. This is found by dividing the spring tidal prism by the tide range, i.e.

$$2.99 \times 10^8 \text{ ft}^3/5.30 \text{ ft} = 5.64 \times 10^7 \text{ ft}^2$$

This area is much less than the bay area of many other typical tidal entrances (see, for instance, O'Brien and Clark, 1973), and is thus considered small.

The following hydraulic parameters have been obtained:

Spring ocean tide range = 5.61 ft.
Spring bay tide range = 5.30 ft.
Spring max. cross-sectional average velocity (flood) = 2.20 fps
Spring max. cross-sectional average velocity (ebb) = 2.38 fps
Spring max. cross-sectional average velocity = 2.29 fps
Spring tidal prism = 2.99×10^8 (ft^3)
Bay area = 5.64×10^7 ft^2
Inlet throat cross-sectional area (below msl) = 7,088 ft^2
Inlet throat surface width = 1,040 ft.
Inlet throat hydraulic radius (mean depth) = 6.82 ft.

6.4 .Waves and Storm Surge

There are currently no wave data available that are specific to the outer coast area of Fort George Inlet. The wave data available at the present time are the offshore data from the "Summary of Synoptic Meterological Observations," (U. S. Naval Weather Service Command, 1970).

Walton (1973) derived wave height and period distributions (shown in Figs. 6.7 and 6.8) from the SSMO data. As observed from these figures, higher percentages of waves are from the northeast (16.9%) and east (14.0%). Waves with heights between 3 and 4 ft. are most frequent (30.3%). The prevailing wave periods are less than 5.5 sec (53.3%). Wave period of 5.5 to 7.5 sec and 7.5 to 9.5 sec have percentage frequencies of 26.7% and 10.4%, respectively.

In addition to the astronomical tides,storm surge and wave setup are important factors in creating extreme high water levels, especially on shallow coastal areas. Very few reliable records are available of water levels on the open coast during major hurricanes which have occurred in the past few decades. The COEL, however, has analyzed available normal and storm surge data along the coast of Florida before 1959 and has expressed the results

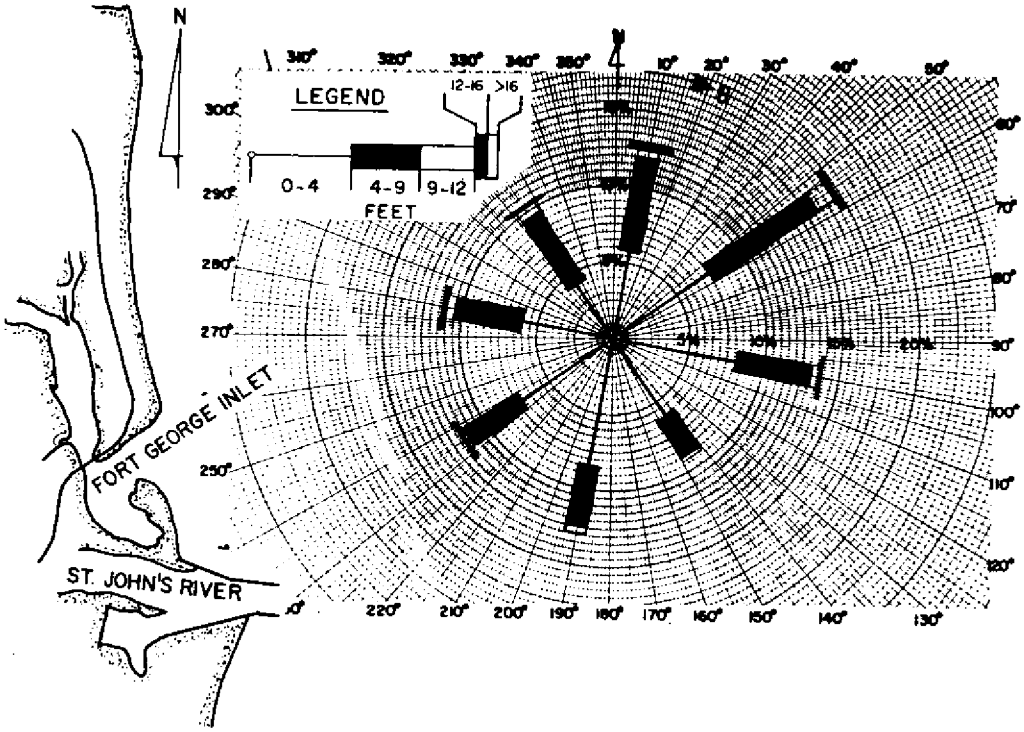


Fig. 6.7 Wave Height Rose for Offshore Wave Climate, SSMO Data Square No. 11- Annual (Walton, 1973)

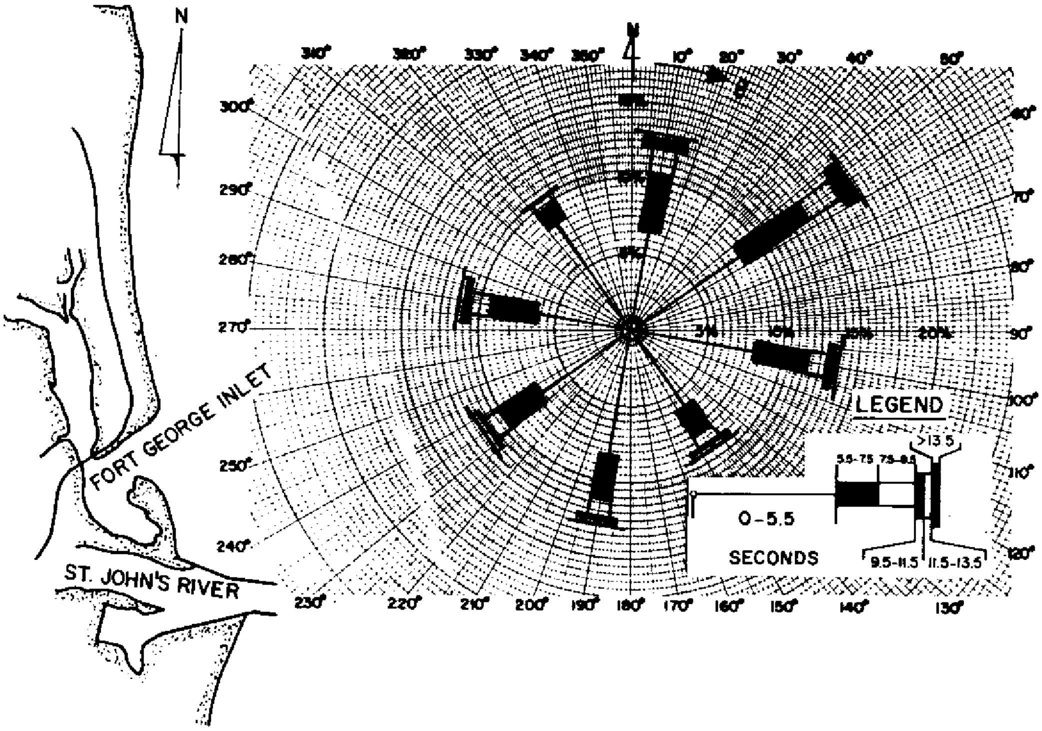


Fig. 6.8 Wave Period Rose for Offshore Wave Climate, SSMO Data Square No. 11- Annual (Walton, 1973)

in terms of frequency of occurrence for a certain water level to be equaled or exceeded. Fig. 6.9 (COEL, 1975) shows storm surge elevation frequencies computed by the COEL and by NOAA. The storm surge elevation used to establish the coastal construction setback line for Duval County was 10.9 ft. (100 year return frequency according to COEL) which was superimposed upon a wave setup of 1.5 ft., resulting in a 12.4 ft. water level elevation above normal (COEL, 1975).

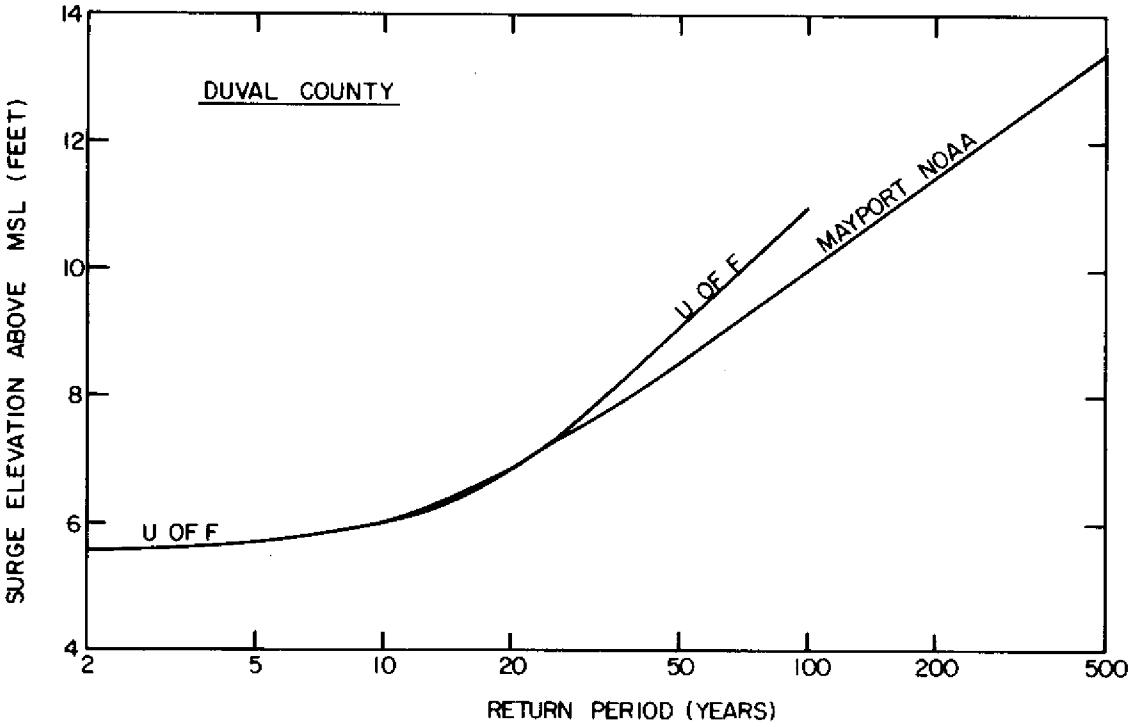


Fig. 6.9 Storm Surge Elevation Versus Storm Return Period for Duval County (COEL, 1975)

VII. SEDIMENTARY PROCESSES

7.1 Volumetric Changes

a. Outer Coast

The beach erosion studies by the Corps of Engineers, as mentioned in Chapter 5, were made on the movement of offshore contours and the general volumetric changes in offshore sediment during the period of 1923/24 to 1963. These results have been given in Tables 7.1 and 7.2 (Corps of Engineers, 1964). Since the -30 ft. contour line was not measured between profile numbers 1 and 4A, (profile numbers refer to those in Fig. 5.4) the volumetric calculations are presented landward of the -18 ft. contour for these profiles. It is apparent that the -6, -12 and -18 ft contours at profile numbers 4 and 4A on the southern tip of Little Talbot Island receded (i.e. moved landward) significantly. This recession resulted in volumetric erosion of 6.2×10^4 cu. yds. per year for the period of 1923/24 to 1963. This is mainly due to the inlet channel shifting and realignment. However, the net average annual volumetric change for all of Little Talbot Island during the same period was 1.4×10^5 cu. yds. of accretion, mainly stored between profile numbers 2 and 3. It is interesting to note that in comparing the change of -6, -12, -18 and -30 ft. contours over the same period, all except the -6 ft. contour receded, whereas the mean high water shoreline advanced. This fact indicates a steepening of the offshore profile.

b. Inner Coast

Volumetric changes for the regions surrounding Fort George Inlet (see inset of Fig. 7.2) were calculated based on the shoreline changes shown in Figs. 5.11 and 5.12 (Kojima and Mehta, 1979). Fig. 7.1 shows the volumetric changes of Little Talbot Island south of SR A1A. The region of interest as indicated in the inset is the shaded area south of the dashed line, which is a linear, eastward extension of the A1A bridge centerline. This region for the years shown in Figs. 5.11 and 5.12 was planimetered to obtain the surface area. This area was multiplied by a mean elevation of 5 ft. (assumed from consideration of typical land elevation above mhw in this region) to determine the volume of material. Between 1918 and 1934, approximately 2 million cu. yds. of sediment deposited in this region. Erosion of this area is estimated to have begun around 1938, and since then the south end of the island has been losing sediment at almost a constant volumetric rate. However, recent (1980) aerials show new zones of accretion.

Fig. 7.2 gives estimates of the rate of change of the sedimentary volume V (above mhw) in regions 1, 2 and 3, whose landward boundaries were chosen arbitrarily (see dashed lines in the inset). The line separating areas 2 and 3 was selected from consideration of the eroding shoreline and the accreting shoreline, which were divided by the indicated "null point" where the shoreline showed no significant changes, based on the mhw shoreline changes shown in Figs. 5.11 and 5.12. The volume of the three regions was obtained from the corresponding surface area by multiplying by 5 ft. The rates were determined by dividing the change of volume, ΔV, of each region during two successive study years by the duration, Δt, and then plotted at the middle of the corresponding time period. In the same manner, the rate of net volumetric change in the three region system,

Table 7-1. OFFSHORE DEPTH CHANGES 1923/24 TO 1963

Profile	6 ft Contour	12 ft Contour	18 ft Contour	30 ft Contour
1	-100	-20	+3,900	*
2	+540	+780	-60	*
3	+810	+1,070	+280	*
4	-2,530	-3,500	-500	*
4A	-3,250	-2,800	*	*
5	180	-1,700	-880	-870

* No data

\+ Indicates advance, distance measured in feet

\- Indicates recession, distance measured in feet

From the Corps of Engineers 1964

Table 7-2. VOLUMETRIC ACCRETION AND EROSION 1923/24 TO 1963

Profile	Landward of 18 ft. MLW			Seaward of 18 ft. MLW			Total	Average Annual
	Accretion	Erosion	Net Change	Accretion	Erosion	Net Change	Net Change	Net Change
1	5,615	7,004	-1,389	*	*	*	*	*
2	8,930	3,446	+5,484	*	*	*	*	*
3	6,223	372	+5,851	*	*	*	*	*
4	1,672	3,858	-2,186	*	*	*	*	*
4A	439	720	-281	*	*	*	*	*
5	101	463	-362	0	465	-465	-827	-129

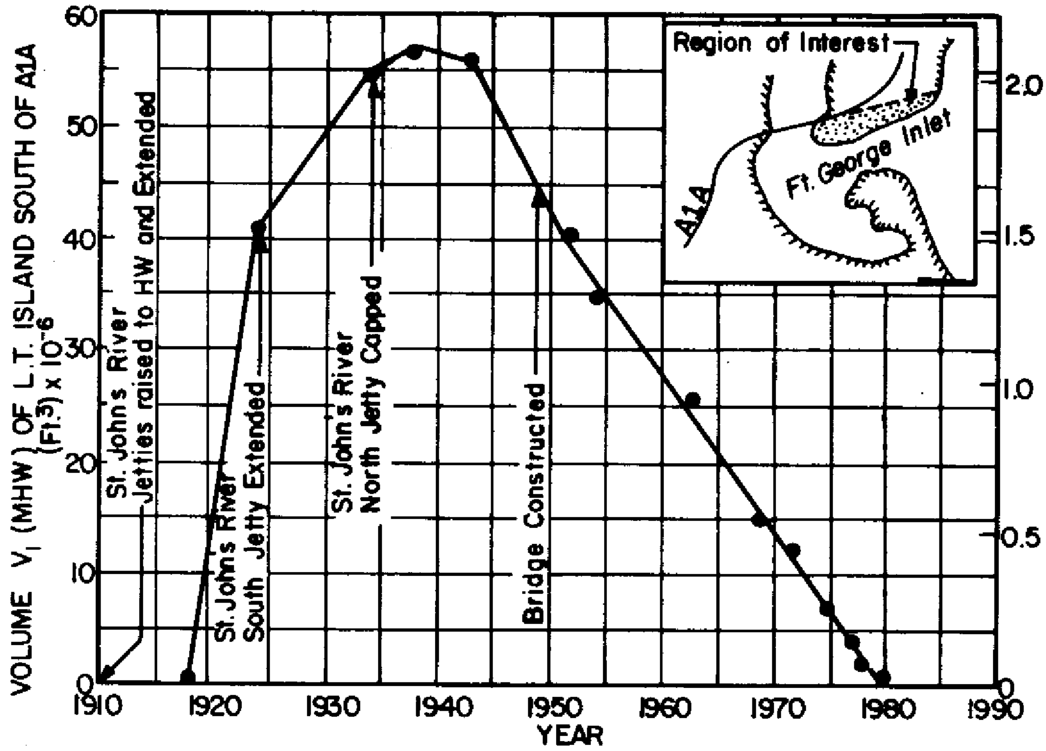


Fig. 7.1 Volumetric Change of Little Talbot Island South of A1A Versus Time

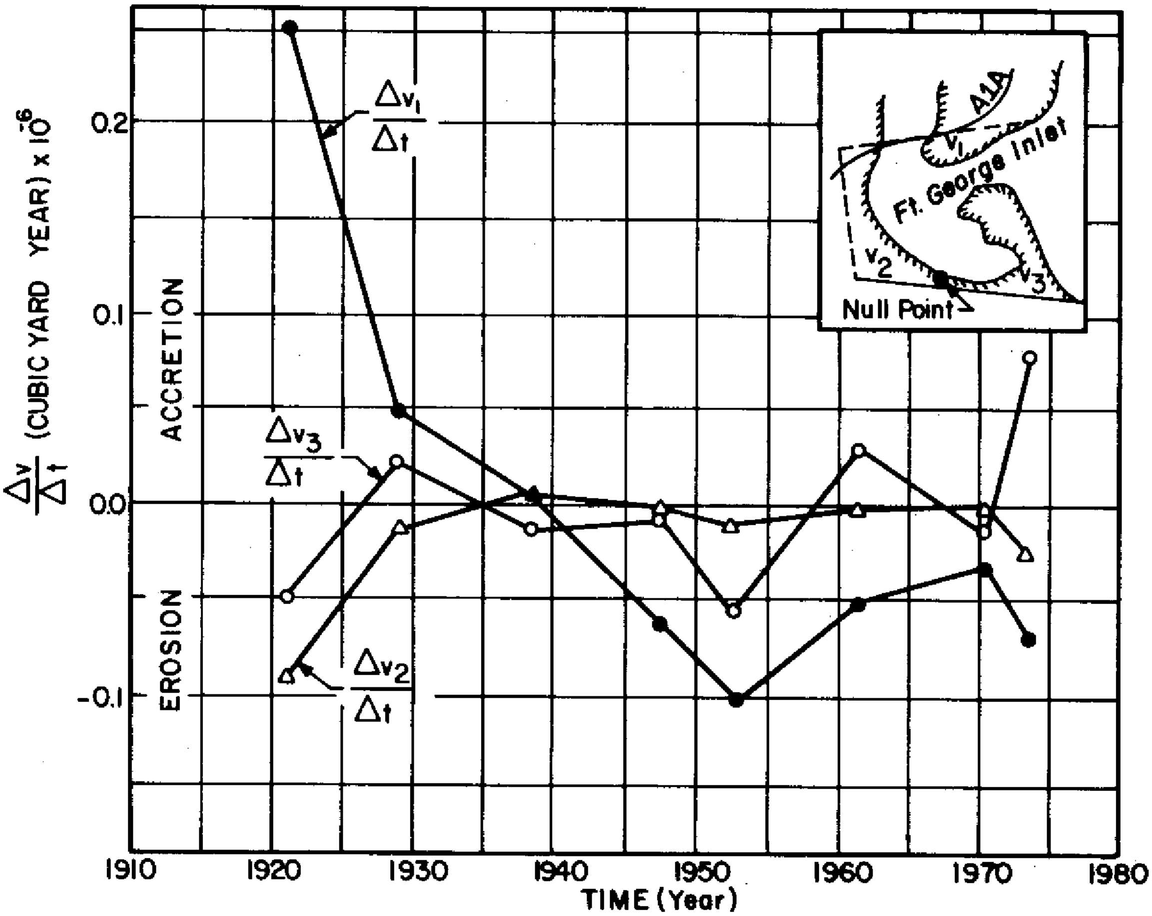


Fig. 7.2 Rate of Change of Sedimentary Volume at the Three Regions Vs. Time

$\Delta V/\Delta t$, where $\Delta V = \Delta V_1 + \Delta V_2 + \Delta V_3$, is presented in Fig. 7.3. A positive rate indicates net accretion and conversely, a negative rate indicates net erosion of the sediment in the system. Fig. 7.3 also shows that no net erosion or accretion occurred around 1938. This corresponds to the end of the southward extension of Little Talbot Island as indicated in Fig. 7.1. It is interesting to note that after 1953 the net erosion rate has generally been decreasing and approaching the $\Delta V/\Delta t = 0$ line; therefore the region of interest is possibly approaching a new sedimentary equilibrium.

c. Bar Volume

The outer bar volume at Fort George Inlet was computed by the method developed by Dean and Walton (1973). NOS navigation chart #11489 (1977 edition) was used for calculation of the offshore bar volume in the region shown in Fig. 7.4. Because of irregularity in the actual mean low water shoreline, the calculation was made from the 6 ft. contour line outward. The estimated volume of sand lying in the outer shoals was 5.6×10^6 cu. yds.

Walton and Adams (1976) developed a relationship between the spring tidal prism and the outer bar sand storage volume for inlets of three coastal energy level groupings, namely, highly exposed, moderately exposed and mildly exposed coasts. Fort George Inlet falls into the category of moderately exposed coasts for which the relationship is

$$\forall = 10.5 \times 10^{-5} \, p_s^{1.23}$$

where $\forall$ = outer bar volume in cubic yards and p_s = spring tidal prism in cubic feet. Taking $p_s = 3.0 \times 10^8$ cu. ft. (see section 6.3), the relationship gives $\forall = 2.8 \times 10^6$ cu. yds., which is one-half of the estimated value. This disagreement seems to be due to the estimated outer bar volume including some of the sand trapped due to the presence of the St. John's River north jetty.

7.2 Littoral Drift

In order to determine the rate of littoral drift in the Fort George Inlet vicinity the following considerations were made: using mhw shoreline changes between 1918 and 1934, it was assumed that the rate of southerly littoral drift was equal to the rate of accretion on Little Talbot Island over the same period. Since the northerly littoral drift is intercepted by the St. John's River jetties, only the southerly drift was considered. The volume of accretion south of A1A on Little Talbot Island is indicated in Fig. 7.1; therefore, the rate of accretion was determined by dividing the volume of accretion by the duration of 16 years. Thus the southerly drift rate is estimated to be 1.48×10^5 cu. yds./year. In order to verify this estimated rate, it was compared with the estimated annual southerly littoral drift rates computed by both the Corps of Engineers and Walton (Walton, 1973). The annual average southerly littoral drift rate calculated by the Corps of Engineers (1964) is 5.0×10^5 cu. yds./year, and Walton estimated the southerly rate to be 4.8×10^5 cu. yds./year. These values are more than twice the estimate based on the accretion of Little Talbot Island. This discrepancy can be explained when it is recognized that 1) the estimates of the Corps of Engineers and of Walton are applicable to a comparatively large stretch of the shoreline (from St. Marys Entrance to St. John's River) and 2) the estimate of 1.48×10^5 cu. yds./year is more site specific, and applicable only to Fort George Inlet, which is within the range of influence of the north jetty of St. John's River.

7.3 Sedimentary Characteristics

DOT obtained core samples along SR A1A on Little Talbot Island from May 11 through 15, 1978, in conjunction with the investigation of the stability of Fort George Inlet. At each location (shown in Fig. 5.5) core sub-samples of 1.5 ft. thickness were collected every 3 ft. for depths of 3 to 30 ft. below the ground level. The materal description of the sediment sample is shown in Fig. 7.5 where two successive samples have been averaged. The material above mean low water on the island is relatively new and loose, and contains a trace of shells. This is easily understood from the fact that the southward migration of Little Talbot Island began around 1885. Moreover, the presence of dense material below the mean low water level suggests that this area used to be a part of the tidal flat (see Fig. 5.11) which existed prior to the build-up of sand.

In the same study, the sand grain size at a depth of 3 to 4.5 ft. below the ground level (considered to be representative of surficial sediment) for each core sample was analyzed (Kojima and Mehta, 1979) and the results are presented in Table 7.3. The mean grain size (D_{50}) for the sample is 0.17 mm which falls into the category of fine sand. The sorting coefficient ($S_0 = \sqrt{D_{75}/D_{25}}$)is also shown in Table 7.3. All sediment samples except the sample at location S-2 are moderately well sorted. The average sorting coefficient of the sediment samples is 1.22.

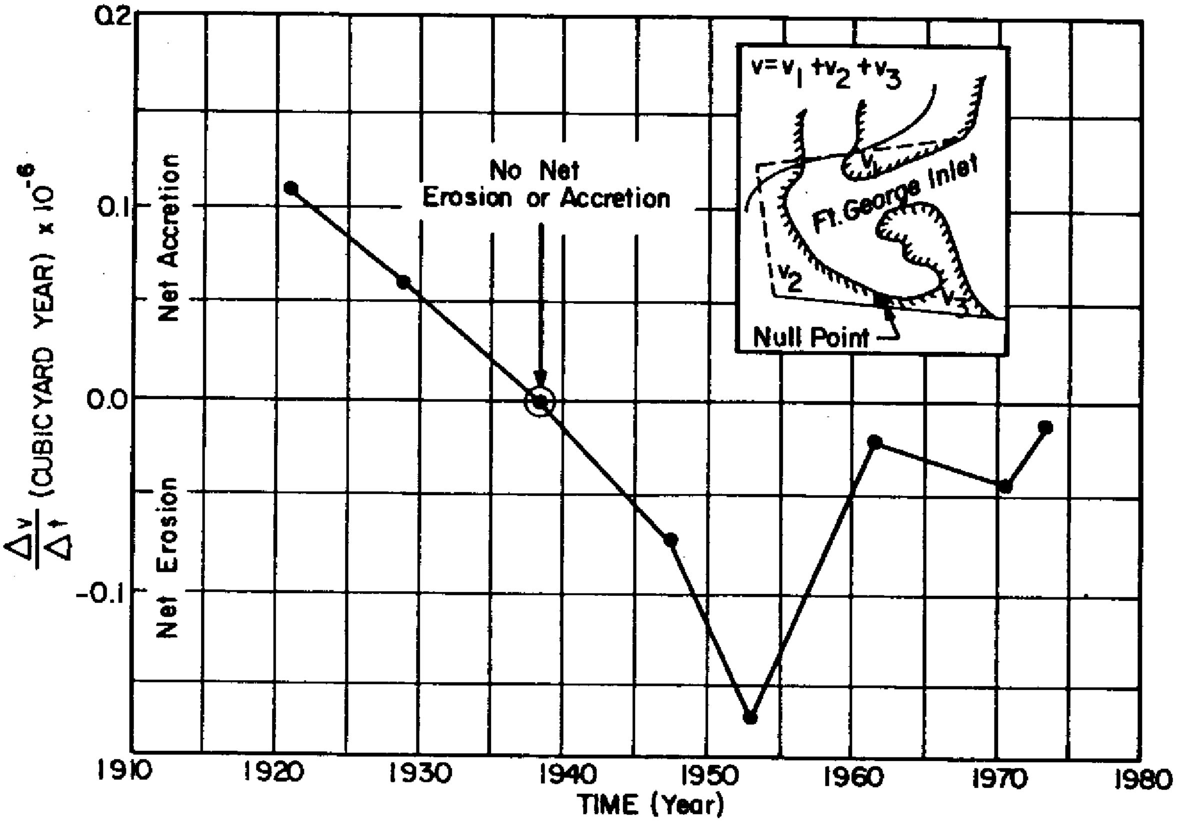


Fig. 7.3 Rate of Net Volumetric Change in the Three Region System Versus Time

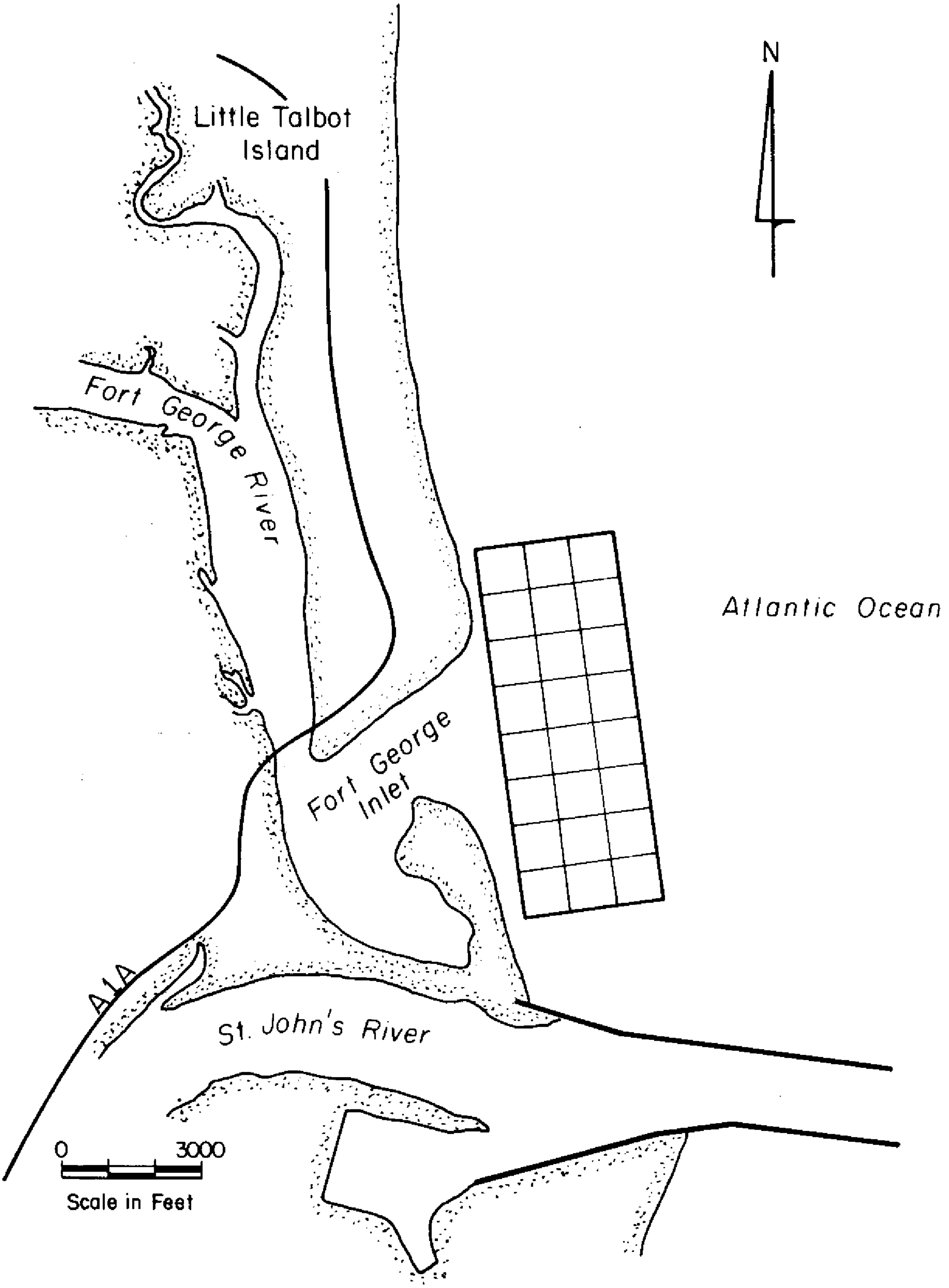


Fig. 7.4 Region of Outer Bar Volume Calculations

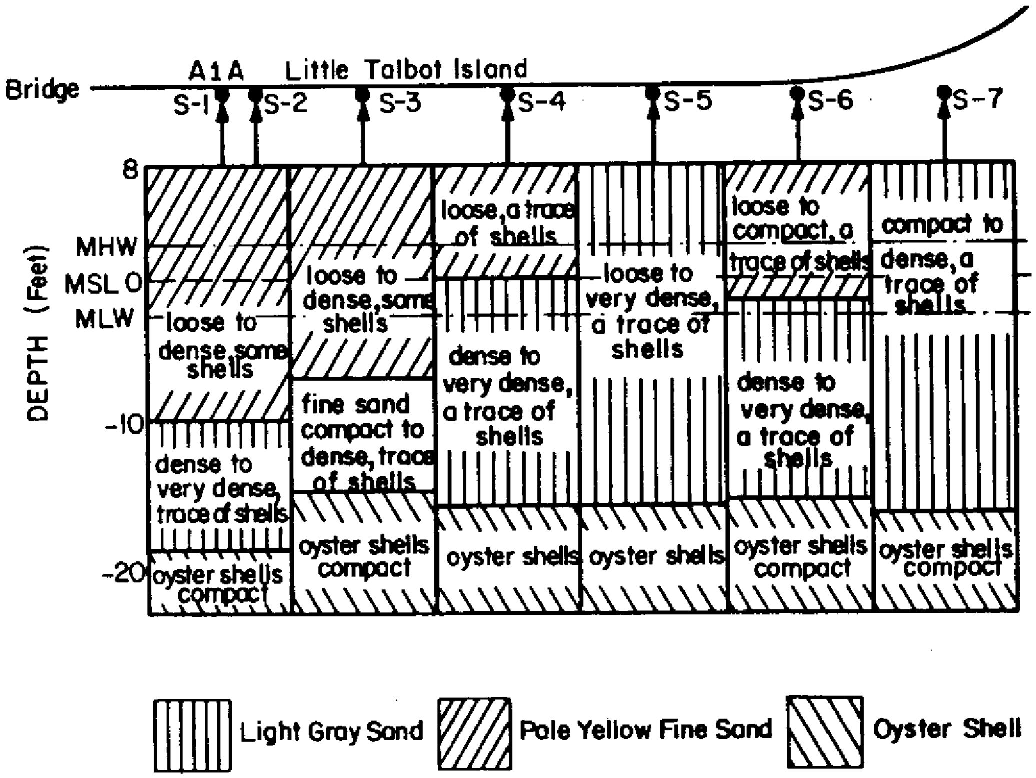


Fig. 7.5 Material Description of Sediment Samples on Little Talbot Island

Table 7.3
Sediment Grain Characteristics on Little Talbot Island

Sample Location No.	Mean Grain Size D_{50}	D_{75}	D_{25}	Sorting Coefficient S_0
S-1	0.180	0.21	0.15	1.18
S-2	0.20	0.51	0.16	1.80
S-3	0.16	0.18	0.15	1.10
S-4	0.16	0.18	0.13	1.18
S-5	0.15	0.17	0.13	1.14
S-6	0.16	0.17	0.15	1.07
S-7	0.16	0.18	0.14	1.14

VIII. SUMMARY

Information on Fort George Inlet compiled in this report is summarized below:

1) Fort George Inlet is a natural inlet located immediately north of the St. John's River entrance, and is characterized by significant channel shifting as well as inner-tidal shoaling.

2) Sediments forming the marine terraces and beach ridges, which now blanket the coast of Duval County, were deposited over the upper Miocene of Pliocene deposits during the Pleistocene and Holocene.

3) The mean yearly temperature in the inlet vicinity is 60°F (20.6°C) and the average annual precipitation is approximately 54 inches. The prevailing winds are from the east and southeast during summer and out of the northeast during the winter months.

4) As indicated by historical storm records, 20 hurricanes have passed within a 50-miles radius of the inlet (an average of one hurricane every 7 years) during the period 1830-1972. With the exception of Hurricane Dora (Sept. 1964), hurricanes have not damaged the beach as severely as many of the northeast storms. One of the most severe northeast storms occurred in 1962, causing total damage of $2.5 million in Duval County.

5) The construction of the St. John's River jetties, considered to have influenced the significant geomorphological changes in the inlet, began in 1881. The impermeable (capped) north jetty of 14,300 ft. in length was completed in 1934.

6) In 1949, a 1,239 ft. long bridge with 32 bents was constructed across Fort George River. The bridge has not affected the flow characteristics of the river to any great extent.

7) Southward migration of the inlet began around 1885 when the permeable (submerged) north jetty was built, and the southern end of Little Talbot Island extended approximately 9,000 ft. between 1857 and 1934. Reverse (i.e. northward) migration began after the north jetty was capped and became impermeable in 1934.

8) Since 1969, the river bed and bank on the eastern part of the Fort George River near the bridge have eroded considerably. On the western side of the river, the deep channel has shown a westward migration and is encroaching on the west bank.

9) Local bed scour around the bridge piles occurs between station nos. 44 and 46 near the west end and between station nos. 51 and 53 in the eastern half of the bridge (see Figs. 5.5 and 5.7).

10) Measurement of tidal fluctuation and hydraulic parameters in 1978 indicates the following:

Spring ocean tide range = 5.61 ft.
Spring bay tide range = 5.30 ft.
Average spring max. cross-sectional velocity = 2.29 fps
Bay Area = 5.64×10^7 sq. ft.

11) The offshore wave climate (based on the SSMO data) is composed of waves most frequently 3 to 4 ft. in height and coming from the northeast to east.

12) Between 1918 and 1934, approximately 2 million cu. yds. of sediment deposited south of SR A1A on Little Talbot Island. The southern end of the island lost sediment during the period 1938 - 1979.

13) The outer bar sediment volume is estimated to be 5.6×10^6 cu. yds. which is high compared to the estimated bar volume from the tidal prism relationship. This is presumed to be due to inclusion of sediment trapped by the St. John's River north jetty.

14) The mean sediment grain diameter on the southern end of Little Talbot Island is 0.17 mm, and the average sorting coefficient for the same samples is 1.22.

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