# FLORIDA SEA GRANT PROGRAM

## ST. LUCIE INLET
## Glossary of Inlets Report #1

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Marine research · Education · Advisory Services
A Sea Grant Program for Florida

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## FOREWORD

The numerous inlets connecting Florida's inner waters to the Atlantic Ocean and Gulf of Mexico are important from considerations of recreational and commercial vessel traffic and also provide small boat 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 presents a formidable challenge to engineers and scientists.

The factors noted, 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 St. Lucie Inlet is the first in a "Glossary of Inlets" series to be prepared under the State University System Sea Grant Project "Nearshore Circulation, Littoral Drift, and the Sand Budget of Florida". The purpose of this series is for each inlet to provide 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 future management, use, and control of Florida inlets will require an appreciation of the evolution and past response of the inlet and considerable future study.

ACKNOWLEDGEMENTS

Appreciation is extended to the many people whose time and efforts contributed greatly to the historical information presented in this report. Special thanks go to Miss E. Alexander and Mrs. H. Tilden of the P. K. Yonge Library of Florida History, Gainesville, Florida; Mrs. Bearden and Mrs. Arana of the St. Augustine Historical Association, St. Augustine, Florida; Mrs. Barbara Parsons of U. S. Army Corps of Engineers, Jacksonville District; and to Mr. Jim Brock of Stafford and Brock Associates, Stuart, Florida.

Thanks are also extended to the many employees of the U. S. Army Corps of Engineers, Jacksonville District, Jacksonville, Florida.

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# INTRODUCTION

St. Lucie Inlet is an enlarged man-made opening from the Atlantic Ocean into the Indian and St. Lucie Rivers on the East Coast of Florida, East of the town of Stuart, Florida. The inlet is shown on National Ocean Survey (formerly U. S. Coast and Geodetic Survey) Chart, Nos. 845SC, 855SC, 1112, 1247, and U. S. Geological Survey Chart "St. Lucie Inlet 1948" - (70 PR). Detailed bathymetric surveys can be found on National Ocean Survey (U.S.C.G.S.) Hydrographic Survey Chart Nos. H-1571 (1883), H-5031 (1930), H-5023 (1930), and H-1523b (1882-83). A portion of National Ocean Survey Chart 1247 is shown in Figure 1 for reference to areas mentioned in this report.

## Geography and Geology

The area surrounding St. Lucie Inlet is primarly devoted to fruit and vegetable farming, cattle raising, recreational and commercial fishing; and catering to the winter tourist trade. The majority of waterfront land surrounding the inlet and its tidal shores has been absorbed by fishing, tourist, and development interests. Detailed characteristics of the economy of the St. Lucie area can be found in Reference 1.

To the North of St. Lucie Inlet lies Hutchinson Island, a 21 mile long barrier island extending to Fort Pierce Inlet, also a man-made inlet. Approximately 7 miles south of Fort Pierce Inlet, a dune line approximately 10 to 15 feet in height (above MSL) starts, and runs Southward paralleling the coast to within 1 1/2 miles of St. Lucie Inlet, the higher portions of the dune line lying nearer to St. Lucie Inlet. From this location South-

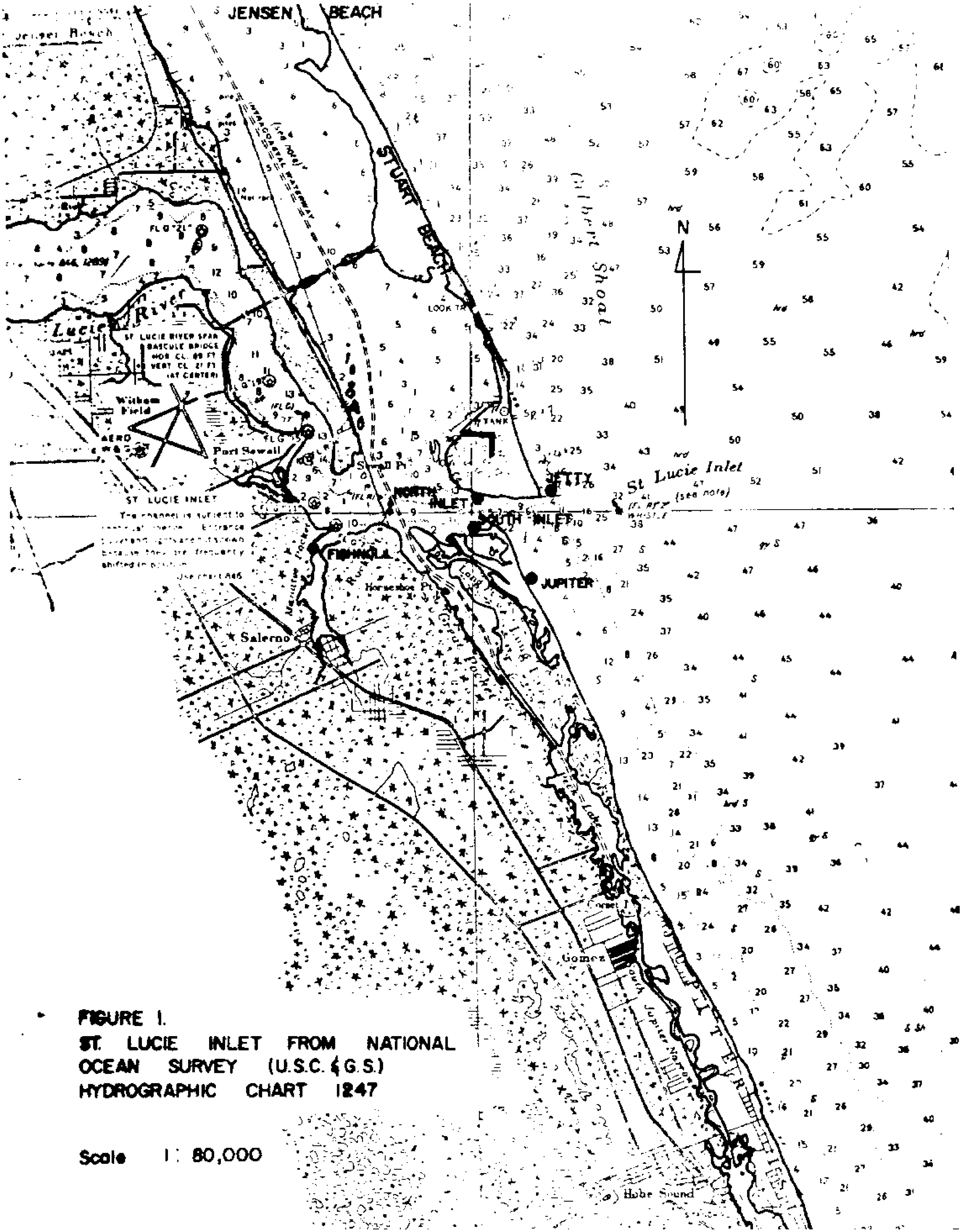



**FIGURE 1.**
**ST. LUCIE INLET FROM NATIONAL OCEAN SURVEY (U.S.C. & G.S.) HYDROGRAPHIC CHART 1247**

**Scale 1 : 80,000**

ward to St. Lucie Inlet no dune line exists, maximum elevations being 5-10 feet above MSL.

In the southernmost portion of Hutchinson Island, coquina, and worm rock reefs lie at the water line or in the shallow water offshore, protecting the coastline from rapid erosion. These features are especially prevalent near the entrance to St. Lucie Inlet. A reef lying off the entrance to the inlet is exposed at extremely low tides. Approximately 2 miles North of the inlet, extensive worm rock and coquina formations at the shoreline (in the vicinity of present House of Refuge Museum) have prevented the barrier island from breaking through into the Indian River.

On the mainland, approximately 3000 feet inland from Hutchinson Island, sandhills 25 to 35 feet in elevation run continuously from Fort Pierce to St. Lucie Inlet. These high sandhills of the coastal ridge are sand dunes built upon old beach ridges formed during the Pleistocene epoch. The sandhills and the almost ninty degree bend of the St. Lucie River suggest the possibility of an ancient shoreline with a predominant southward littoral drift and an ancient inlet in the vicinity of Sewall Point. This theory is in general agreement with at least one evolution theory for barrier islands on Florida's east coast. Geologists speculate that the barrier islands were formed following or concurrent with one of the last of four periods of emergence evident in Florida, at which time there was a tilting of the plateau about its longitudinal axis. The west coast was partially submerged, as indicated by the wide estuaries and offshore channels of its streams, while the east coast was correspondingly elevated. The barrier islands are thought to be part of an ancient offshore bar which was elevated above sea level and further built up by wave and wind action.

Jupiter Island lying to the South of St. Lucie Inlet, is also a narrow barrier island, with widths varying from 100 feet in the Lake Peck area to approximately 3600 feet at the Northernmost portion of the island. Elevations of the island vary from 0-5 feet for the 5 miles directly south of the inlet to 10-15 feet further south. A dune line starts in the vicinity of Hobe Sound approximately 10-15 feet in height, and continues southward to Jupiter Inlet. Profiles of Jupiter Island in this region are similar in nature to those of Hutchinson Island. Approximately a mile west of Jupiter Island, a continuation of the fossil dunes 20-25 feet in elevation is apparent.

The entire St. Lucie area is underlain by the Anastasia formation consisting of sandstone and coquina, and covered by a thin veneer of Pamlico sands.

Further details of this area can be found in References 1, 2, 3, 4, and 5.

# HISTORY OF INLET

Although many charts and maps in the early 1800's show an inlet in the St. Lucie River area, evidence to the contrary suggests that no inlet existed (at least in recorded history) on the east coast of Florida between the Indian River Inlet, north of Fort Pierce (now closed), and Jupiter Inlet 20 miles south of Stuart, Florida.

The inlet takes its name from the St. Lucie River, and from a former Spanish fort Rio de Santa Lucia, established in 1565 by Pedro Menendez de Aviles, the early Spanish explorer-colonist who founded St. Augustine. Older maps give the name Santa Lucia to the inlet.

St. Lucie Inlet was created in 1892 when local residents desiring a connecting channel between the Indian River and the Atlantic Ocean made a cut through the low sand ridge separating the river from the ocean using mules and a "fresno". The dimensions of the cut were 30 feet wide by 5 feet deep. Prior to the cut, a good portion of the St. Lucie River's water probably flowed south through Jupiter Inlet due to the southward directed momentum at the confluence of the Indian and St. Lucie Rivers. Indian River water most probably flowed through both Jupiter Inlet and Indian River Inlet, a natural inlet existing at that time just north of the present Fort Pierce Inlet, with the division of the tidal flow somewhere in the vicinity of the St. Lucie area. No jetty structures were constructed when the inlet was initially cut.

References 1 and 6 state that the inlet, once cut, continued to widen to 1700 feet and deepen to 7 feet by 1898, at which time it began to widen at a slower rate, until reaching a reported width of 2600 feet in 1922. The locations of these width measurements are not stated in the references cited, but it has been determined from the existing old surveys that these widths were the controlling widths (narrowest widths) of the inlet at those times. Between 1892 and 1926 surveys, the shoreline had moved approximately 2000 feet westward on both sides of the inlet.

The first Federal interest in St. Lucie Inlet is seen in House Document (HD) 1312, 60th Congress, 2nd Session, dated January 11, 1909. Recommendations were made at that time for Federal funds (with local participation) to be appropriated to establish an 18' channel from the ocean to an interior basin, and to construct a jetty on the north side of the inlet. federal opinion was that a jetty would also be needed on the south side of the inlet at a future time, but that funds could not be justified for ideal inlet protection works at that time.

The recommended improvements were intended to serve two purposes: (1) to create a harbor of refuge with a draft greater than 12 feet since only two existing (Jacksonville and Key West) and one proposed (Miami); deep draft harbors were on the east coast of Florida in the early 1900's; and,(2) to provide an access route for planters and growers (especially pineapple growers) to ship their goods by water.

In a survey report of public opion in the Stuart area prior to HD 1312, a Mr. E. B. Thomson of the Jacksonville Florida Army Corps of Engineers Office notes:

> "The community in the vicinity of Sewalls Point from Fort Pierce to Lake Worth seems thoroughly aroused to the necessity of some relief from the excessive freight charges

they are now compelled to pay. Public meetings have recently been held and as soon as my business became known, I was waited upon by a committee of representative (pineapple) growers and given every assistance to investigate the need for further and less expensive outlet for their crops."

The Port Sewall area was considered to be an ideal site for a regional shipping terminal in the early 1900's due to large produce exports from the St. Lucie River tributary area. Also, a private firm was planning to dredge a canal (the present St. Lucie canal) from Lake Okeechobee to the St. Lucie River, opening a route from the vast interior of Florida to the coast.

House Document 1312 mentions that the inlet was labeled as Prospect Inlet on old Coast and Geodetic Survey charts, but this is believed to be in error. Most likely, the location of the proposed inlet (before 1892) was labeled as "prospective" inlet on old charts, hence the word Prospect Inlet which this document mentions.

In the River and Harbor Act of March 4, 1913, (H. D. 675, 62nd Congress), a Federal project was adapted providing an appropriation of funds for experimental dredging of a channel 18 feet deep across the reef and ocean bar as a preliminary step toward securing of a channel of that depth from the ocean entrance to Sewall point. In 1916, dredging work was carried out seaward from the mouth of the inlet on an approximate east - southeast alignment. The dredged portion of the channel rapidly shoaled with sand, and abandonment of the project was recommended in 1917, and in 1933 although no legislative action was taken on either of those occasions.

In the early 1900's, the St. Lucie entrance was shallow and obstructed by shifting sand bars, through which a narrow, and unstable channel of 4 1/2 to 6 feet depth (MLW) was generally found. The reef which extends across the front of the inlet was reported to be 3 ½ to 10 feet below mean low water (MLW).

Bill McCoy, a famous rum runner during the Prohibition era, was the owner of considerable land in the vicinity of the St. Lucie Inlet and used the inlet as a point of entry for thousands of cases of bootlegged liquor obtained from the Bahama Islands. It was his illegal bottles of liquor smuggled through this inlet that coined the American phraseology, "The Real McCoy," thereby distinguishing his brand from imitations.

In 1928, the Martin - St. Lucie Counties Improvement District, predecessor to the St. Lucie Inlet District, entered into a contract for dredging a channel 18 feet deep and 200 feet wide from the ocean, through the offshore bar and reef system, about 4500 feet in length to the inlet entrance, and, from that point, 150 feet wide and 10,000 feet long to a terminal site at Port Sewall. The project also provided for dredging of a turning basin at Port Sewall. (See Figure 2 as modified from Reference 1). Under the contract, 1,091,202 cubic yards of mud, sand, shell, and rock, were dredged from the turning basin and the 150 foot wide by 10,000 l.f.f. channel. The project was completed to the west side of the inlet in 1929. The dredged material was deposited on the site of the terminal pier and on the South side of the inlet. By act of the Florida State Legislature, the development and operation of the port was organized as a special taxing district under the title St. Lucie Inlet District and Port Authority.

During the same 1926-1929 period, local interests constructed a jetty extending from the North inlet point to the rock reef, about 3,325 feet long. The jetty material was mainly coquina rock with a density of 113-125 lbs./ft.$^3$ (Specific gravity 1.8-2.0) and maximum dimensions of 6-7 feet (see Figure 3). The offshore portion of the jetty was partly covered with granite blocks.

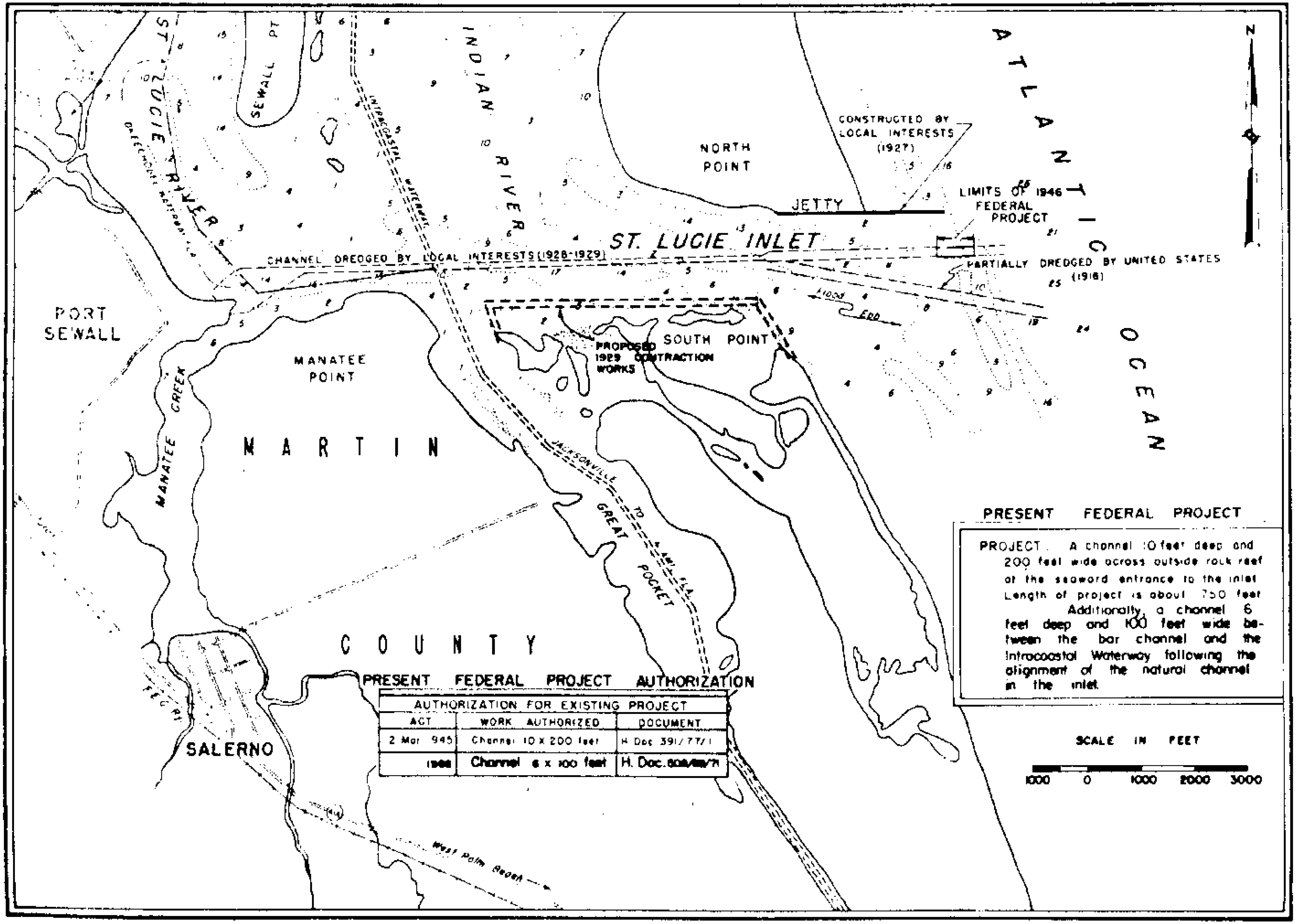



FIGURE 2. CORPS OF ENGINEERS PROJECT MAP OF ST. LUCIE INLET (REFERENCE 1), AS MODIFIED

FIGURE 3. PORTION OF NORTH JETTY AT ST. LUCIE INLET

The jetty originated from the 1926-1929 shoreline which is approximately 1800 feet west of the present shoreline on the north side of the Inlet. A sand and shell levee with stone revetment was planned on the south side of the inlet to act as a contraction work, but was never constructed. A portion of the dredged material from the channel was spoiled at this location as mentioned. The constriction caused by spoiling of dredged material in the vicinity of the planned contraction work, along with the confining action of the north jetty caused some scour in the inlet, allowing for a controlling depth through the inlet of approximately 5 to 6 feet mean low water (MLW).

In March 1941, a survey of the Corps of Engineers showed the controlling depths to be as follows: across the entrance bar, 4 feet; from the Inlet across Indian River to Port Sewall, 6 feet; and in the St. Lucie River from its mouth to the junction of the north and south Forks, 4 feet.

The 1945 River and Harbor Act (H. D. 391, 77th Congress) authorized modification of the project to provide a 10 by 200 foot channel about 750 feet across the seaward bar and reef. This improvement was completed in 1948 (see Figure 2). It seems that the dredging of this cut resulted in a stable positioning of the navigation channel in the shadow of the jetty (see Figure 4). In 1946, the controlling width of the inlet had decreased to 1800 feet, undoubtedly due in part to the spoiling of dredged material on the South side of the inlet in the vicinity of the proposed contraction works mentioned earlier.

In March 1962, a severe Atlantic storm caused a breakthrough in the barrier beach at Peck Lake, about 3.7 miles south of the St. Lucie Inlet. Before the breakthrough, the beach barrier was about 400 feet wide from the ocean to Peck Lake. The initial breach was about 400 feet wide and 5 feet

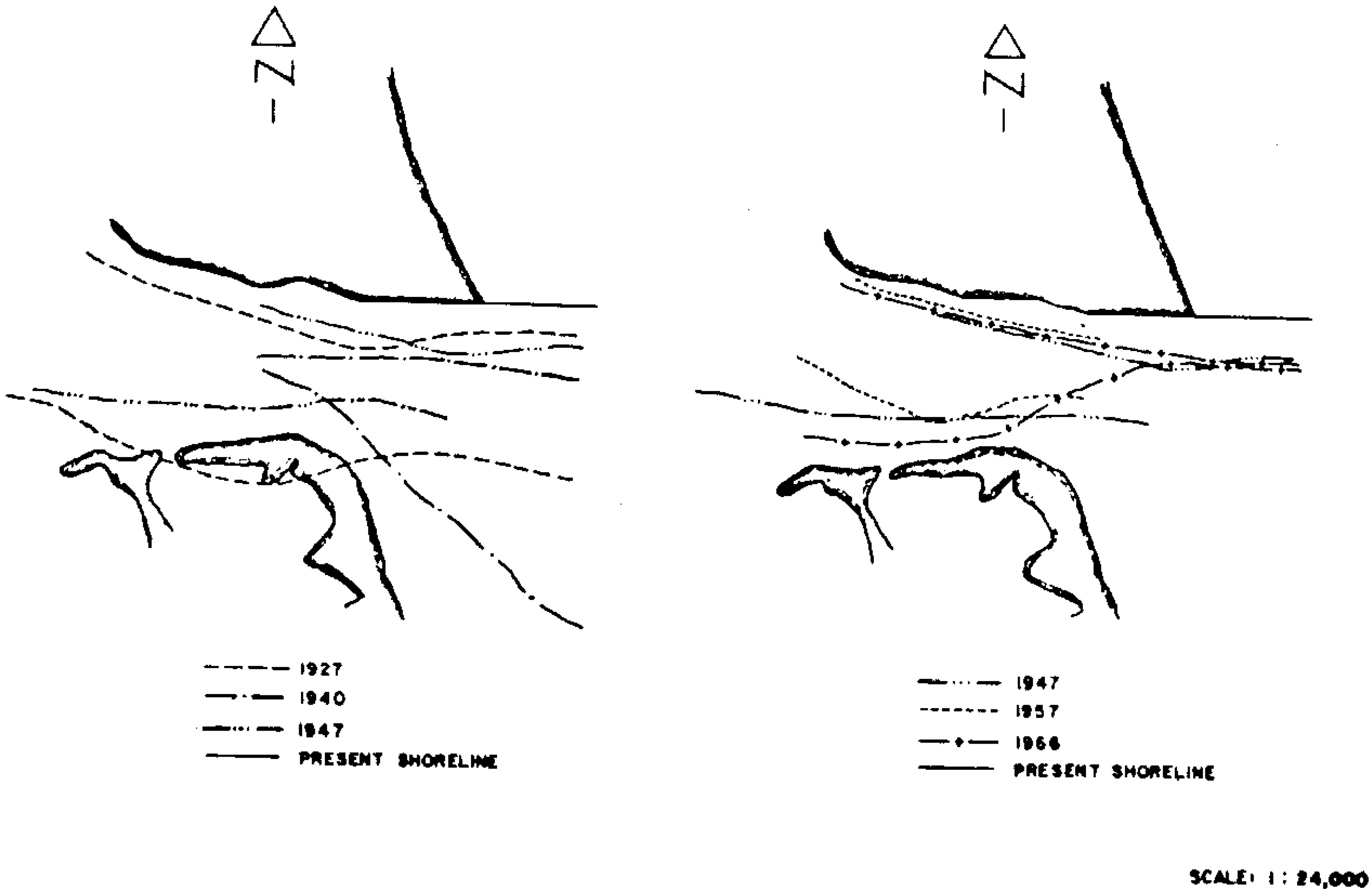



FIGURE 4. LOCATION OF ST. LUCIE INLET'S TIDAL CHANNELS (FROM REFERENCE 8)

deep. The inlet widened to about 700 feet and deepened to 12 feet within a year. The new inlet was accessible to boaters via the intracoastal Waterway, and was the preferred inlet, due to hazardous navigation conditions in St. Lucie Inlet on rough days, and to the protection offered the Peck Lake Inlet by an offshore reef.

The new inlet caused serious shoaling in Peck Lake and the adjacent Intracoastal Waterway and further degradation of beaches to the South. It was closed by the Corps of Engineers using a hydraulic dredge in August, 1963 as a means to alleviate this shoaling and erosion problem.

In January 1965, emergency dredging in the St. Lucie entrance in accordance with the River and Harbor Act of 1945 was undertaken to restore a depth of at least 6 feet between the Intracoastal Waterway and the Atlantic Ocean. This work included maintenance dredging in the authorized bar-cut channel.

Further legislation was passed on November 7, 1966, (H. D. 508, 89th Congress) modifying the St. Lucie Inlet project to include maintenance of a 6 by 100 foot channel along the best natural deep-water alignment between the Federal bar-cut channel and the Intracoastal Waterway.

The situation at that time was described in Reference 7:

> "The process of accretion and erosion North and South of the inlet still apprears to be continuing but at a lesser rate than immediately after the jetty construction in 1926....; the seaward portion of the navigation channel seems to be relatively stable at least in the horizontal plane (no shifting). During the winter, however, shoaling often occurs as a result of strong northeasterly wave action. Sand transported by these waves is carried through the jetty (see Figures 5a, 5b and 5c from Reference 7), of which, especially the nearshore 500 feet, is very porous. As a result, a bar is formed across the inlet, and a natural sand bypassing system, as is the case for unimproved inlets, is developed..... The bar was removed by a side casting dredge with a boom length of 90 feet. The dredged material was deposited South of the dredging operation. After a few weeks, the bar appeared again."

FIGURE 5a
ST. LUCIE INLET - JUNE 1966

FIGURE 5b
ST. LUCIE INLET - JANUARY 1967

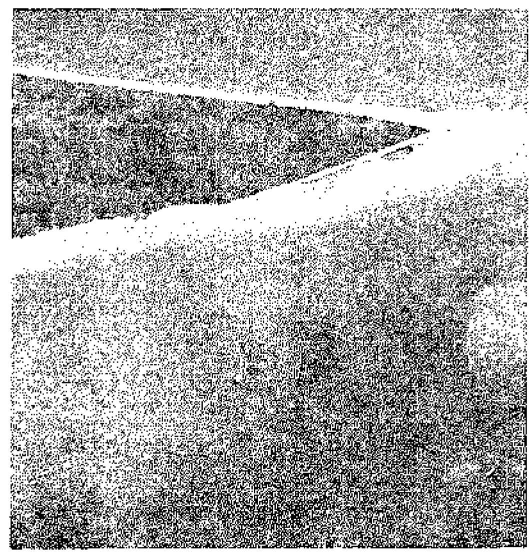


FIGURE 5c
ST. LUCIE INLET - APRIL 1967
(U.S. ARMY CORPS OF ENGINEERS SIDECAST DREDGE "MERRITT" WORKING IN INLET)

Table 1

Controlling Widths, Depths, and Cross Sectional Areas in

St. Lucie Inlet (from various surveys listed in Appendix)

| Year | Mean Depth (ft.)[1] | Controlling Depth (ft.)[2] | Controlling Width (ft.)[1] | Cross Sectional Area (ft.)[1] |
|---|---|---|---|---|
| 1892 | | 5 | 30 | 150 |
| 1898 | 7.2 | 5 | 1700 | 12,200 |
| 1908 | 10.4 | 4-5 | 2400 | 25,000 |
| 1927 | 6.9 | 5 | 2450 | 16,960 |
| 1930 | | 3 | 1830 | |
| 1934 | 10.8 | 4 | 1500 | 16,200 |
| 1941 | 11.7 | 4 | 1800 | 19,930 |
| 1947 | 9.4 | 5 | 1750 | 16,470 |
| 1957 | | 5 | 1750 | |
| 1960 | | 6 | 1750 | |
| 1963 | 8.9 | 5 | 1700 | 15,050 |
| 1966 | 9.9 | | 1446 | 14,313 |
| 1968 | 7.4 | | 1680 | 12,431 |
| 1970 | | 6 | 1500 | |

[1] At throat of inlet

[2] In the main channel(s)

The latest survey shows the controlling width of the inlet to be approximately 1500 feet, with a controlling depth of 6 feet. Reference 1 states:

> "The circuitous channel between the Federal bar cut and the Intracoastal Waterway changes periodically in depth and alignment. Severe storms and adverse weather conditions occasionally cause shoaling throughout the length of the channel between the ocean and the Intracoastal Waterway. However, strong tidal currents appear to restore adequate depths for small craft navigation in the seaward end of the connecting channel and in the Federal bar-cut channel. Review of available surveys for the period 1947-1963 shows a recurring shoal near the North point of Long Island."

Table 1 gives a history of controlling depths and widths in the Inlet, and Figure 6 shows the history of cross sectional areas in the Inlet. Figure 4, mentioned previously, provides a history of the channel-shifting within the inlet.

In the reference cited above, the Corps of Engineers has estimated that approximately 4000 cubic yards of material will have to be dredged every five years to maintain present project depths in the natural channel leading from the Federal Bar Cut to the Intracoastal Waterway.

Reference 1 also states:

> "From a review of available data, including annual reports of the Chief of Engineers, office records, and available surveys of bottom conditions in the inlet, it is indicated that a small percentage of littoral material enters the inlet and settles out to form shoals in the part of the waterway used for navigation. Maintenance dredging of the Intracoastal Waterway west of the inlet has averaged about 8,500 cubic yards annually since 1948. Comparison of bottom conditions between available surveys indicate an average shoaling rate approaching 10,000 cubic yards annually."

The Corps of Engineers concludes from the above and from the fact that no local dredging was done in the preceeding 15 years, that the existing inlet system shoaling rate is about 20,000 cubic yards annually. Table 2

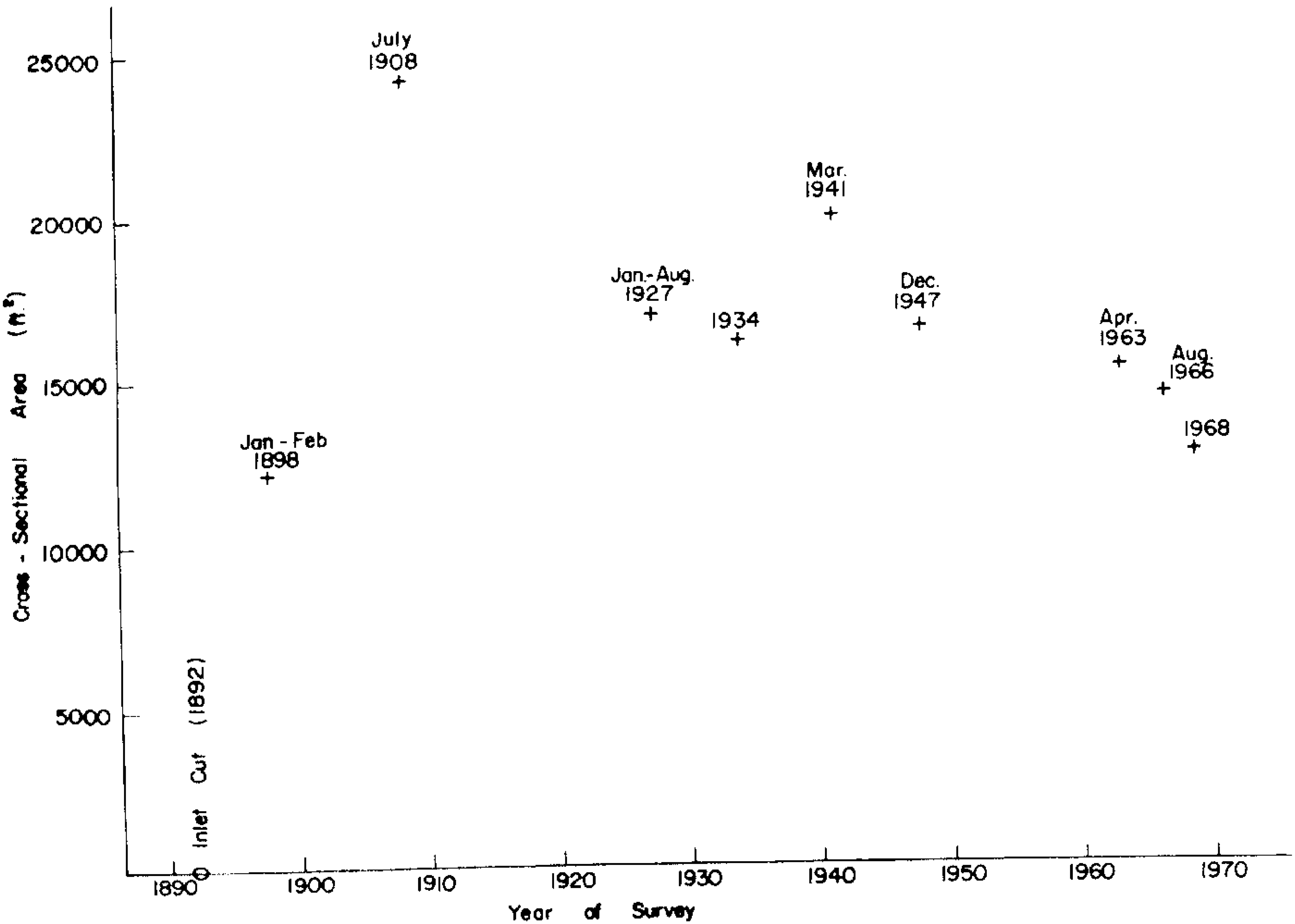



FIGURE 6. CROSS - SECTIONAL AREA OF ST. LUCIE INLET AT THROAT

gives a maintenance dredging history for the inlet since 1965.

Navigation through St. Lucie Inlet has been a hazardous undertaking throughout the inlet's history. Navigation hazards are especially apparent when northeasterly seas and swells break in or near the Federal Bar channel, due to the wave - current interaction on an ebb tide (see Figure 7). Incidents where recreational and charter boats have broached and capsized in or near the bar channel are numerous. At least four lives have been lost in boating accidents in this inlet. Known damage to boats has totaled well over $100,000. A detailed account of recorded boating damages in St. Lucie Inlet can be found in Reference 1.

Table 2

Recorded Maintenance Dredging* History of St. Lucie Inlet Since 1965

(Sources of information are the various reports listed in References section and also the Navigation Section of the U. S. Army Corps of Engineers Jacksonville District Office)

| Dredger | Period | Dredge | Total Quantity Removed (Cubic Yards) | Total Unit Cost |
|---|---|---|---|---|
| J. B. Fraser & Sons | Dec 64<br>29 Jan 65 | 12" pipeline Dredge TWO BROTHERS | 8,255 | $7.72/cubic yard |
| Government | 3 Dec 66<br>20 Dec 66 | Dredge-sidecast MERRITT | 37,960 | 0.61/cubic yard |
| Government | 24 Mar 67<br>16 Apr 67 | Dredge-sidecast MERRITT | 26,750 | 0.77/cubic yard |
| Layne Dredging | 1 Mar 68<br>8 Mar 68 | 20" pipeline Dredge R. M. CASON | 100,102 | 1.33/cubic yard |
| Prosperity Dredging Co. | 18 Nov 68<br>8 Dec 68 | 16" pipeline Dredge CAPTAIN | 42,420** | 3.02/cubic yard |
| Government | 1-20 Dec 68 | Dredge-sidecast MERRITT | 8,773 | 3.29/cubic yard |
| Government | 5-29 Nov 69 | Dredge-sidecast MERRITT | 18,456 | 1.41/cubic yard |
| Government | 10 Nov -<br>12 Dec 71 | Dredge-sidecast MERRITT | 18,829 | 1.99/cubic yard |
| Government | 5 Nov -<br>12 Dec 72 | Dredge - ? | ≅ 30,864 | Not known at this time |

*This work includes all Federally contracted dredging in inlet channel and bar cut. Figures for bar cut alone are not known. No dredging in Intracoastal Waterway is included in this table.

**A portion of this material was placed on the south beach, but all other material listed was spoiled in open water except for sidecast dredging which was placed in close proximity to dredged areas.

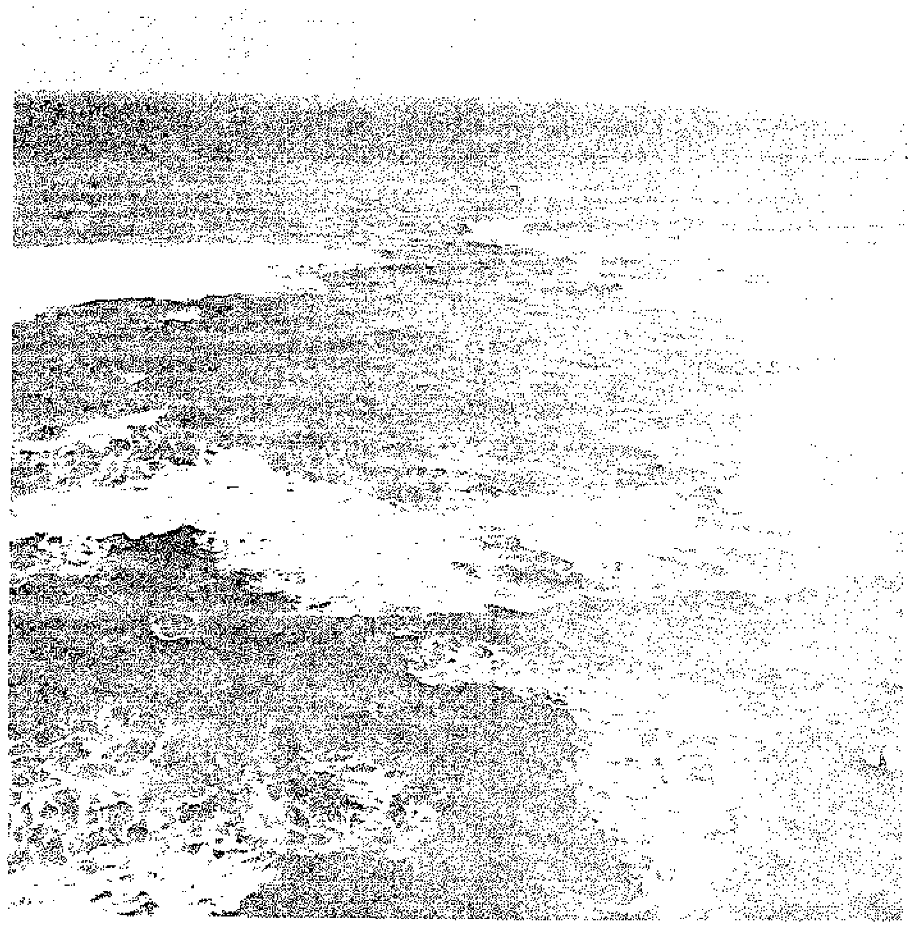


FIGURE 7. WAVE – CURRENT INTERACTION AT ST. LUCIE INLET NEAR OCEAN BAR AT EBB TIDE

## HISTORY OF SHORELINE CHANGES

The St. Lucie Inlet area has had a history of shoreline erosion and accretion North of the Inlet, and of continual erosion South of the inlet. When the inlet was cut in 1892, the shoreline experienced a phenomonal initial erosion on both sides of the inlet. Historic surveys show that between 1882 and 1928 the shoreline for about 1.5 miles north of the inlet receeded considerably, with a maximum recession of about 2000 feet directly North of the inlet. The south side of the inlet experienced an even greater erosion problem as can be seen from Figure 8 (Modified from Plate II of reference 8). There are at least two reasons for the predominance of South side erosion in these years: (1) The southward directed momentum of the St. Lucie and Indian Rivers, causing large southward nearshore velocities on ebb tides, and (2) The inlet functioning as a barrier to net littoral transport, (recorded as being from north to south) trapping littoral drift material in a middle ground shoal, in a bar across the mouth of the inlet,and impounding material north of the jetty.

When the North jetty was constructed in 1929, the north shore of St. Lucie was stabilized,and accretion on the north side of the jetty took place. Between 1928 and 1946, accretion had moved the shoreline seaward to a position in 1946 that approximately coincides with the 1882 position. In this same period, shoreline erosion continued on the south side of the inlet. For the period 1832-1946, an average annual erosion for the first 5 miles directly South of the inlet has been estimated at 250,000 cubic yards per year.

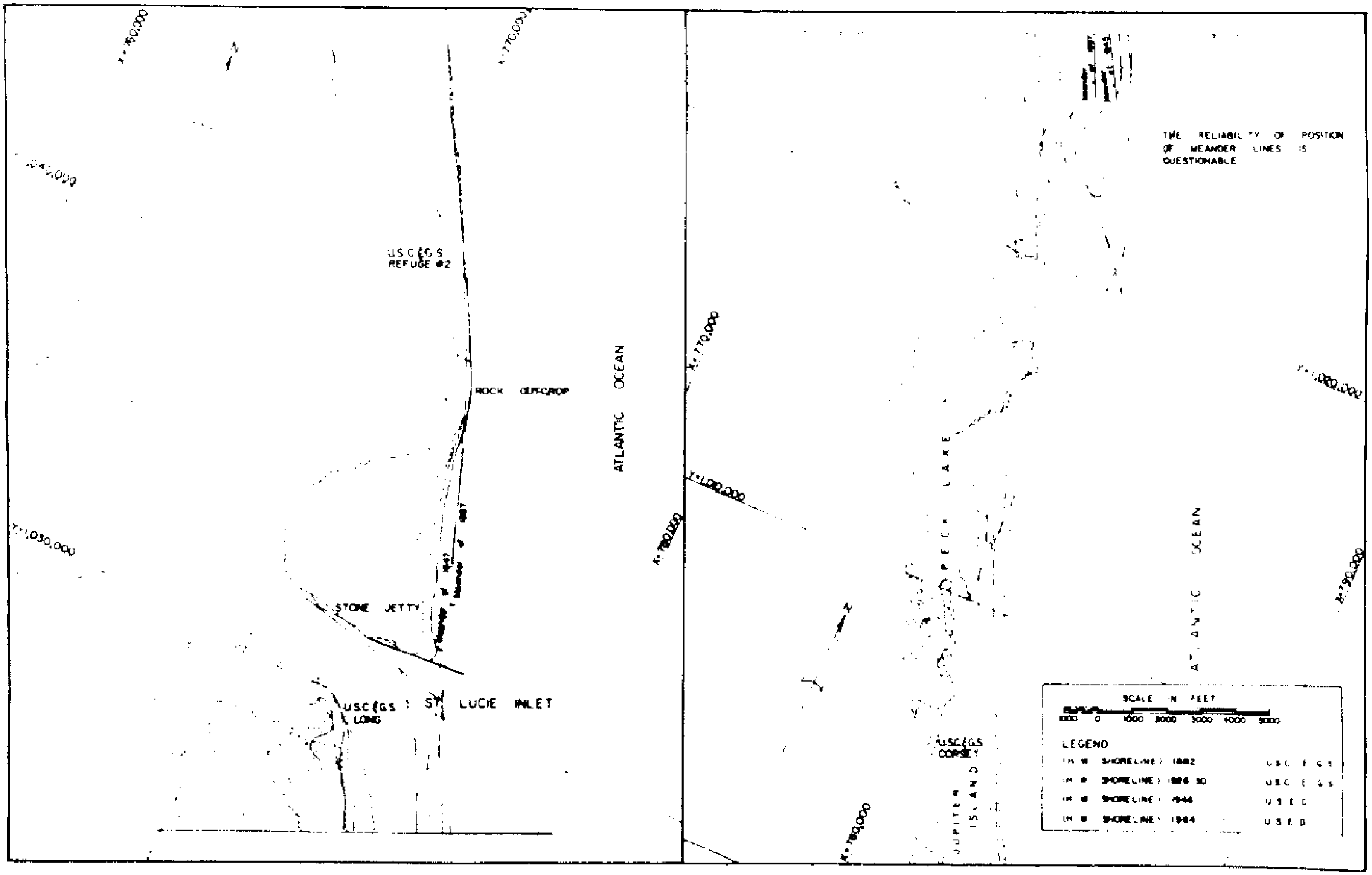



FIGURE 8. SHORELINE CHANGES IN THE VICINITY OF ST. LUCIE INLET (FROM REFERENCE 8)

Between 1946 and 1962, the mean high water shoreline directly north of the inlet had advanced 500 feet further, with an estimated annual accretion rate of 130,000 cubic yards in the 2 ¼ mile reach north of the jetty. The south shore continued to erode further during this 16-year period, with a maximum recession equal to 720 feet occurring at a point about 1 ¼ miles south of the inlet. About this time, the shoreline at the south point of the inlet reached an equilibrium position, and continued erosion occurred further to the south. The reach of shore between St. Lucie Inlet and the former Peck Lake Inlet eroded at an annual rate of 450,000 cubic yards in this period. Mean high water shoreline changes for the 1946-1962 period are presented in Table 3 (from Table C-1 of Reference 1). As mentioned previously, during the storm of 1962, Jupiter Island broke through Peck Lake, where a new inlet was formed.

Since 1962, the shoreline North of St. Lucie has continued to accrete while the shoreline south of the inlet has continued to erode. The continual erosion on the south side is indicated by the dead Australian pine trees which prevail along the beach for a 3 mile stretch south of the inlet (see Figure 9). This portion of shoreline has continually been the most critical erosion problem along the entire shoreline of Florida.

Local interests have long insisted that the erosion problems experienced on Jupiter Island have been intersified by the construction of the north jetty. The beach erosion problem along Jupiter Island consists of recession of the shoreline and dunes, and also a general lowering of the beach profile. The erosion and damage to the beach, seawalls, and ocean front property are accelerated and greatly magnified during storms of tropical and extra-tropical origin. As a result of several northeast storms, the beach level is lowered, structures are damaged or destroyed, and valuable

Table 3

Mean High Water Shoreline Changes in Vicinity of St. Lucie Inlet

1946 to 1962 (from Reference 8)

| Location (miles from centerline St. Lucie Inlet) | Changes (feet) Total during period | Average annual |
|---|---|---|
| North 2-1/2 | No change | No change |
| 2-1/4 | +40 | +3 |
| 2 | -10 | -1 |
| 1-3/4 | -30 | -2 |
| 1-1/2 | -60 | -4 |
| 1-1/4 | +20 | +1 |
| 1 | +100 | +6 |
| 3/4 | +190 | +12 |
| 1/2 | +350 | +22 |
| 1/4 (existing north jetty) | +500 | +31 |
| South 1/4 | No change | No change |
| 1/2 | -190 | -12 |
| 3/4 | -400 | -25 |
| 1 | -420 | -26 |
| 1-1/4 | -720 | -45 |
| 1-1/2 | -650 | -40 |
| 1-3/4 | -540 | -34 |
| 2 | -550 | -34 |
| 2-1/4 | -660 | -41 |
| 2-1/2 | -630 | -39 |
| 2-3/4 | -590 | -37 |
| 3 | -530 | -33 |
| 3-1/4 | -490 | -31 |
| 3-1/2 | -470 | -29 |
| 3-3/4 (Peck Lake Inlet) | -480 | -30 |

FIGURE 9. EROSION DIRECTLY SOUTH OF ST. LUCIE INLET

ocean front property is eroded. Natural buildup of the beach during summer months alleviates the situation to a degree, but complete recovery never occurs due to the barrier and the sand-trapping effect of St. Lucie on the southward moving sand in northeast storms or hurricanes.

Corrective action by the residents of Jupiter Island to protect against damage caused by climatological stress on the inlet barrier island system has been extensive. Seawalls, sloping revetments, groins, and artificial nourishment have been provided by local interests. Vertical seawalls, generally along an established bulkhead line as recommended by the 1947 Beach Erosion Board report, were built along much of the developed part of Jupiter Island. Groin construction began in the early 1950's. In 1956, the town of Jupiter Island began a program of artificial nourishment of the beaches. Beach fill material was dredged from inland sources and pipelined to sections of the beach. Borrow areas were generally in Hobe Sound and the Intracoastal Waterway. From 1956 to 1963, a total of about 700,000 cubic yards of material was deposited on the beach. The summer of 1960 brought the first precast concrete block revetment to Jupiter Island. Since that time, many sections of sloping concrete block revetment have been constructed on the island.

In 1963, an engineering firm in Stuart, Florida, began nourishing the beach with a specially designed drag scraper (see References 9 and 10) which hauled sand to the beach from 500 to 800 feet offshore. No definite estimates are available on the total quantity placed as a result of the scraper operations.

Most of the beach nourishment and protective structures on Jupiter Island have been placed on the developed section of the beach approximately 5 to 11 miles south of the inlet. The combination of St. Lucie Inlet at the north end of the island and Jupiter Inlet at the south end makes it impossible to determine exactly what the singular effect of St. Lucie Inlet has been on erosion problems of Jupiter Island's developed central portion. St. Lucie's destructive effect on the Northern portion of Jupiter Island has always been evident.

Hurricanes and northeast storms have also caused considerable damage to the North on Hutchinson Island. Jensen Beach and Stuart Beach, shown in Figure 1, have experienced a considerable loss of sand during major storms of record. Storms of October 1963 and August 1965 (hurricanes), and March 1962, December 1963, and January 1964 (northeasters) damaged or destroyed seawalls, retaining walls, and upland buildings and facilities, and eroded recreational beaches completely, lowering the profile as much as 6 feet. The beaches and recreational area were partially replenished by the use of bulldozers, draglines, and trucks in distributing sand gained during favorable weather. Hurricane Betsy in September 1965, completely eroded both Jensen Beach and Stuart Beach. However, natural partial recovery improved conditions considerably after the storm.

The beaches on the south portion of Hutchinson Island are probably not influenced by St. Lucie Inlet to nearly the same extent as are the beaches on Jupiter Island, due to the protective effect, of the north jetty at St. Lucie. The erosional problems on south Hutchinson Island are probably primarly due to a net flux of sand being transported offshore during the natural onshore/offshore seasonal motion of sand, and to a eustatic rise in sea level (Reference 11).

For a more complete description of beach erosion problems in the area surrounding St. Lucie Inlet, the reader is referred to References 2, 8, and 12.

# CLIMATOLOGY OF THE ST. LUCIE AREA

## Astronomical Tides and Currents

The mean range of the semidiurnal tide in the Atlantic Ocean is 2.6 feet in the vicinity of St. Lucie Inlet. The spring range of tide is 3.0 feet. The mean range of tide inside the inlet is approximately 1.0 feet. Figure 10, from Reference 7 gives a 3 day recording of tides in the St. Lucie area. Locations for the tidal measurements are shown in Figure 1. From the tidal curves, it can be seen that the landside tide opposite the ocean entrance lags the ocean tide by approximately 2 hours.

In the same study, currents were measured by drogues and cupmeters, and were found to vary considerably across the inlet, with a maximum surface current in the constricted portion of the inlet of 5.5 - 6 feet per second (North Channel) on flood, and 5 - 5.5 feet per second (South Channel) on ebb. During the main portion of the tidal cycle, depth-averaged velocities in both channels were found to be approximately 2 - 3 feet per second. Surface current measurements made in the channel during the period July 18 and 19, 1966, (average tidal range) on flood and ebb conditions are shown repectively in Figures 11 and 12. From these figures, it is apparent that on flood tide, most of the water enters the inlet via the North Channel, while on ebb tide, the water leaves in the South Channel. The strong southward flow on ebb which is partially responsible for extensive erosion directly south of the inlet is shown in Figure 13.

The pattern of water movement noted above has also been deduced from salinity measurements (Reference 16) which show higher salinities in the North Channel (due to ocean flow predominance) and lower salinities in the South Channel (due to St. Lucie River flow predominance). Salinities in the

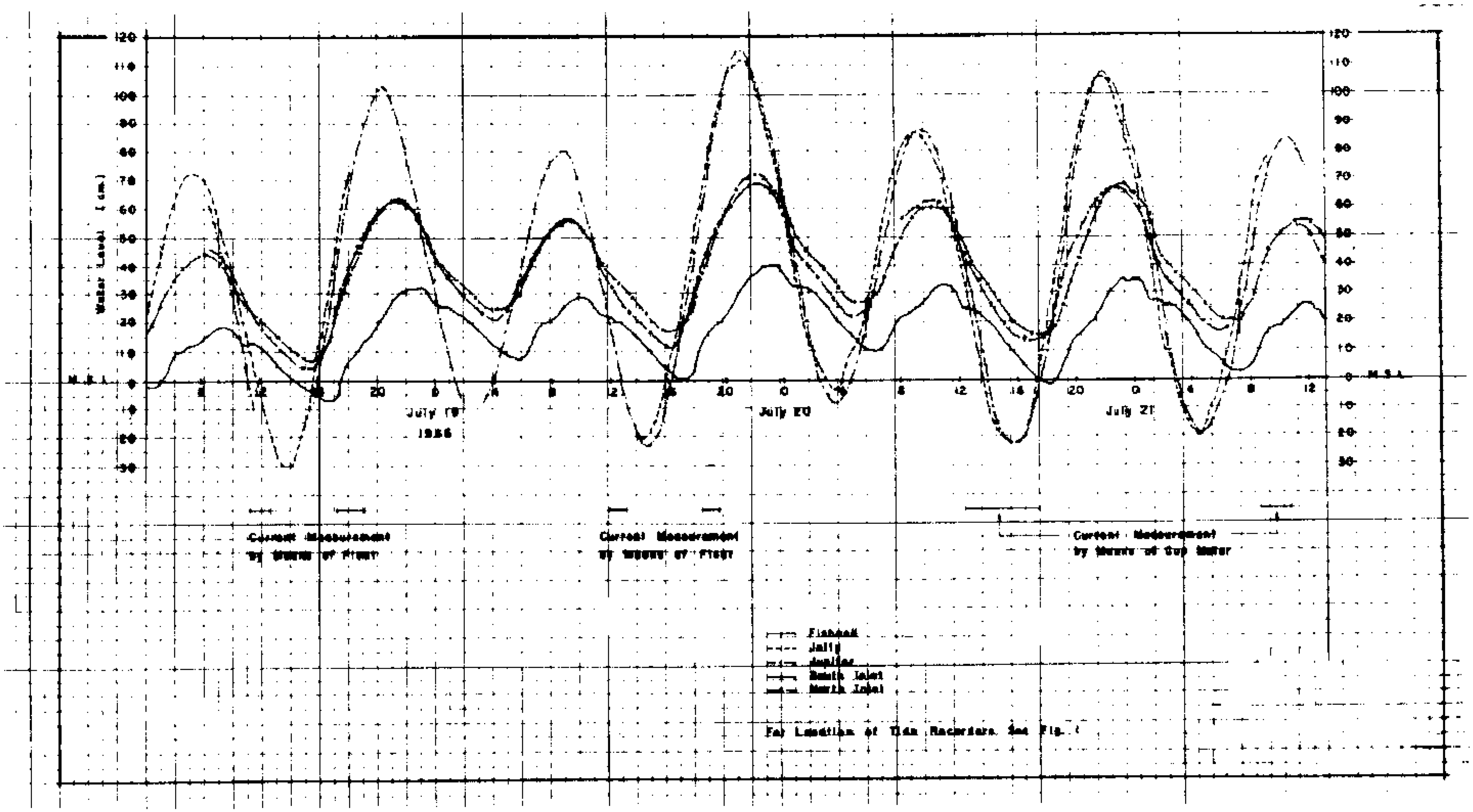



FIGURE 10. TIDAL RECORDINGS AT ST. LUCIE INLET (FROM REFERENCE 7)

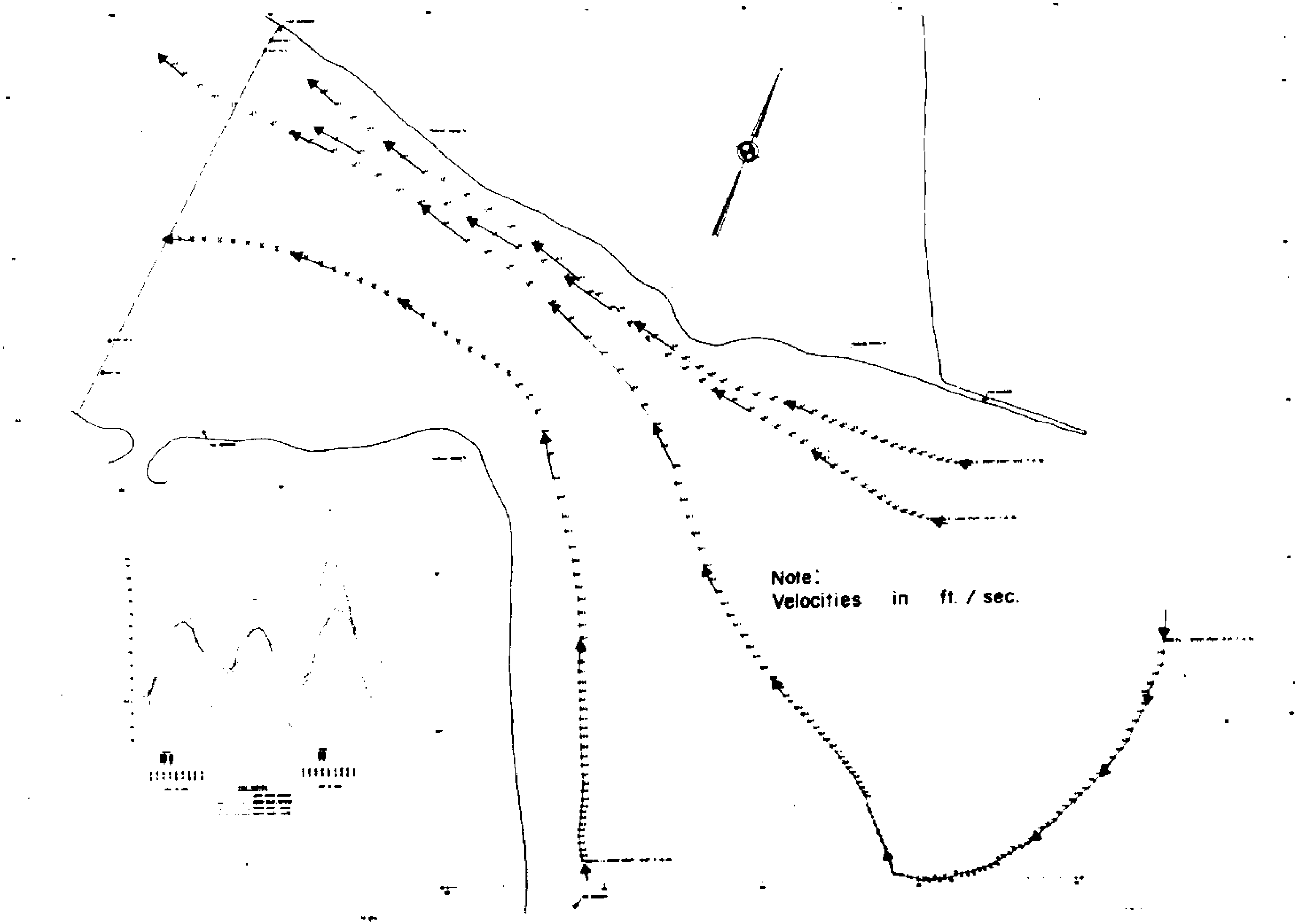



FIGURE II. TIDAL CURRENTS ON FLOOD TIDE IN ST. LUCIE INLET (FROM REFERENCE 7)

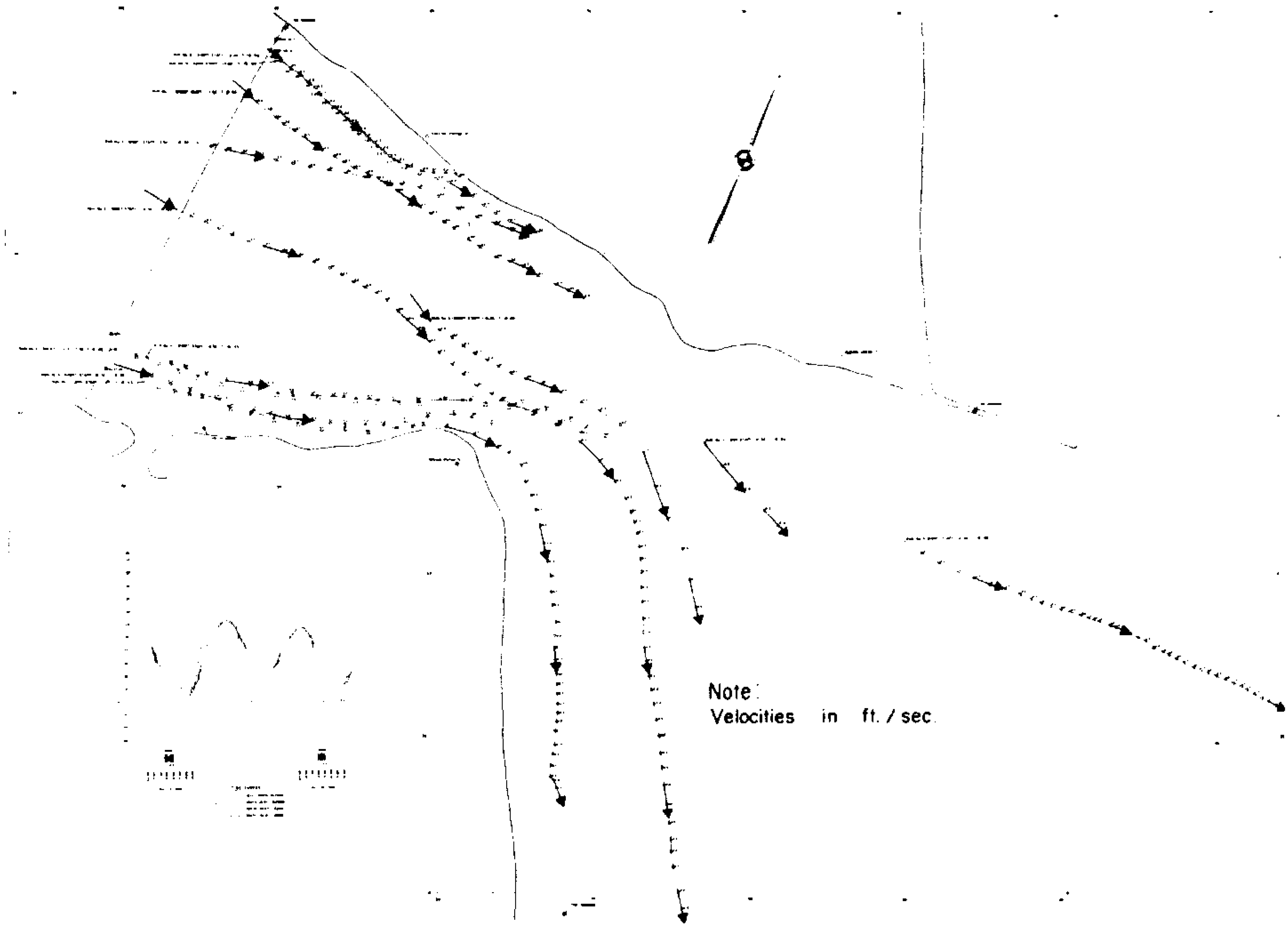



FIGURE 12. TIDAL CURRENTS ON EBB TIDE IN ST. LUCIE INLET (FROM REFERENCE 7)

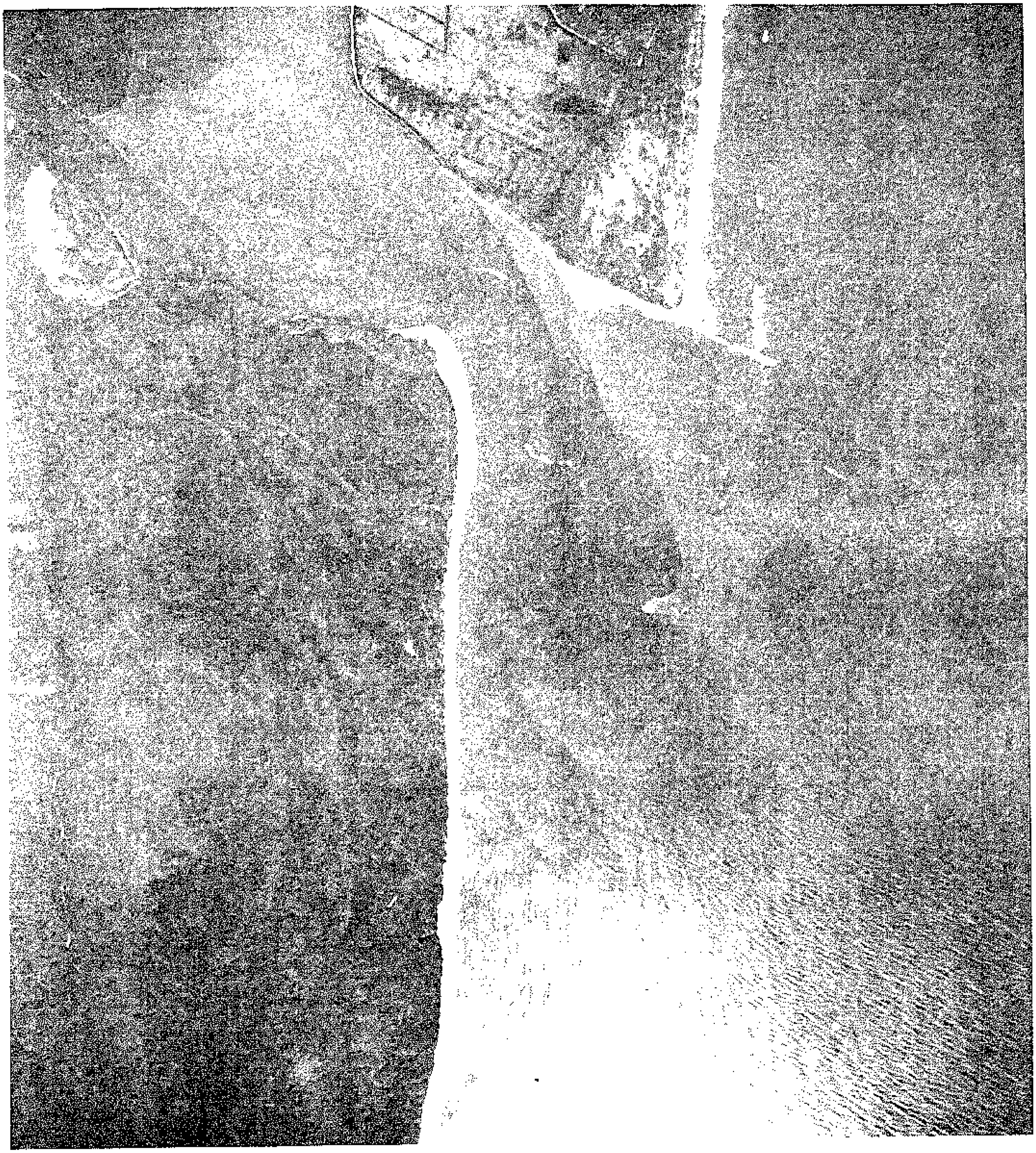


FIGURE 13. SOUTHWARD DIRECTED EBB FLOW AT ST. LUCIE INLET.
N.O.S. AERIAL PHOTO NO. 70E-5658, 2-10-70

water columns are well mixed in the St. Lucie area except on slack tides where a slight salinity difference over depth occurs. Maximum discharge through the inlet is estimated at 40,000 cfs, (Reference 7).

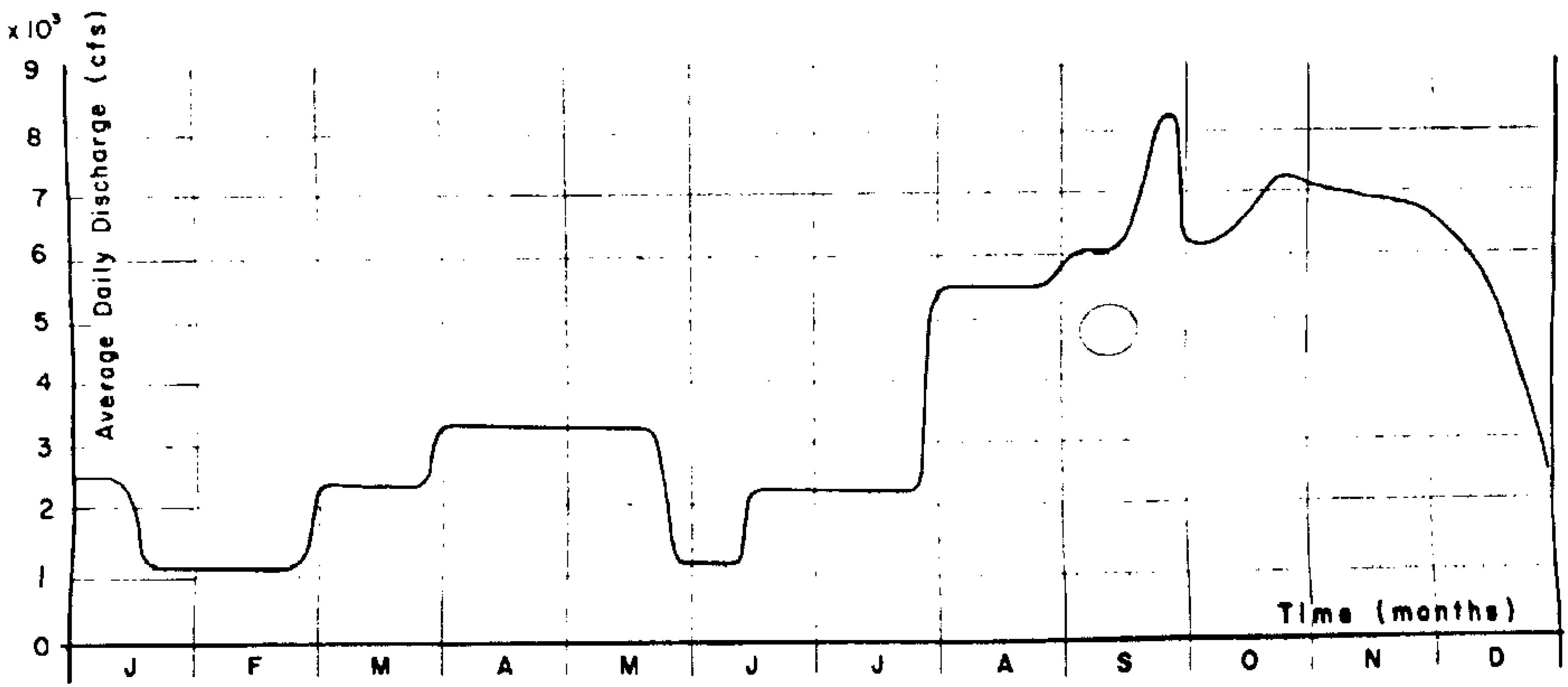
St. Lucie River flow has a large effect on the volume of water flowing through the inlet, and the mixing of the water column. The north and south forks of the St. Lucie River drain the major portion of Martin County. This drainage flow along with the flow in the St. Lucie Canal makes up the St. Lucie River flow.

Flow in the St. Lucie Canal is controlled by a lock and dam structure 1 ½ miles upstream from the confluence of the canal and the South fork of the St. Lucie River. The discharge from St. Lucie locks for the year 1960 is presented in Figure 14. The yearly average discharge of the St. Lucie River is approximately 10% of the maximum discharge of the inlet.

Storm Tides

Deviations from the normal tidal level in the ocean occur due to wind stress on the water surface. Strong northeasterly winds in the study area are reported to raise the water levels by an additional 0.8 feet above the normal astronomical level while southerly and westerly winds lower the water level by the same amount. Extreme water level fluctuations from the astronomical tide levels occur with hurricanes and major extratropical storms. Information on extreme tides is sparse, but during the October 1953 hurricane an ocean tide level of 6.3 feet was recorded by the U. S. Geological Survey at Eau Gallie. Reference 8 states that the lowest tide to be expected is 2 feet below mean low water.

The University of Florida and the National Oceanic and Atmospheric Administration have both derived storm tide level vs. frequency of occurrence




From: U.S.G.S. " Surface Water Supply of the U.S. "
Part II b

FIGURE 14. DISCHARGE FROM ST. LUCIE LOCKS, 1960

curves for this area (Reference 13). These curves are presented in Figure 15 (Figure 4 in Reference 13). The NOAA curve shows a 7 foot tide to be a 1 in 200 year occurrence while the University of Florida curve predicts the same storm tide level for a 1 in 25 year occurrence. While the frequency of occurrence is probably somewhere between these values, it should be noted that Reference 8 states that "Tropical storms in this vicinity occasionally increase the tide range to 7 feet," suggesting that the University of Florida curve may be closer to the true situation. This area has experienced 52 storms of hurricane intensity between 1830 and 1965 within a 150 mile radius of St. Lucie Inlet. Only 15 hurricanes passed within a 50 mile radius in the same period though, giving a frequency of one hurricane within a 50 mile radius per 9 years. Unfortunately the effect of the hurricanes on the St. Lucie Inlet channel and surrounding shoreline has not been documented. It is believed that these hurricanes have a tendency to drive a great deal of sediment into the inlet where it is trapped into shoals, in addition to causing tremendous erosion problems due to strong longshore currents, and steep waves.

The worst storm to hit the St. Lucie area was the storm of August 24-29, 1944. Wind gusts of up to 153 mph were recorded in the Stuart-Jupiter area. Stuart suffered the worst damage in its history, having over 500 people left homeless in its surrounding area. A high water mark of 8.5 feet was observed in the St. Lucie River on the railroad bridge near Stuart. Sections of waterfront streets were swept by high seas and were badly eroded.

Winds

Wind records have been summarized by the United States Weather Bureau for the period 1938-1946 in the proximity of West Palm Beach and are available in House Document 772, 80th Congress, 2nd Session. Figure 16 is repro-

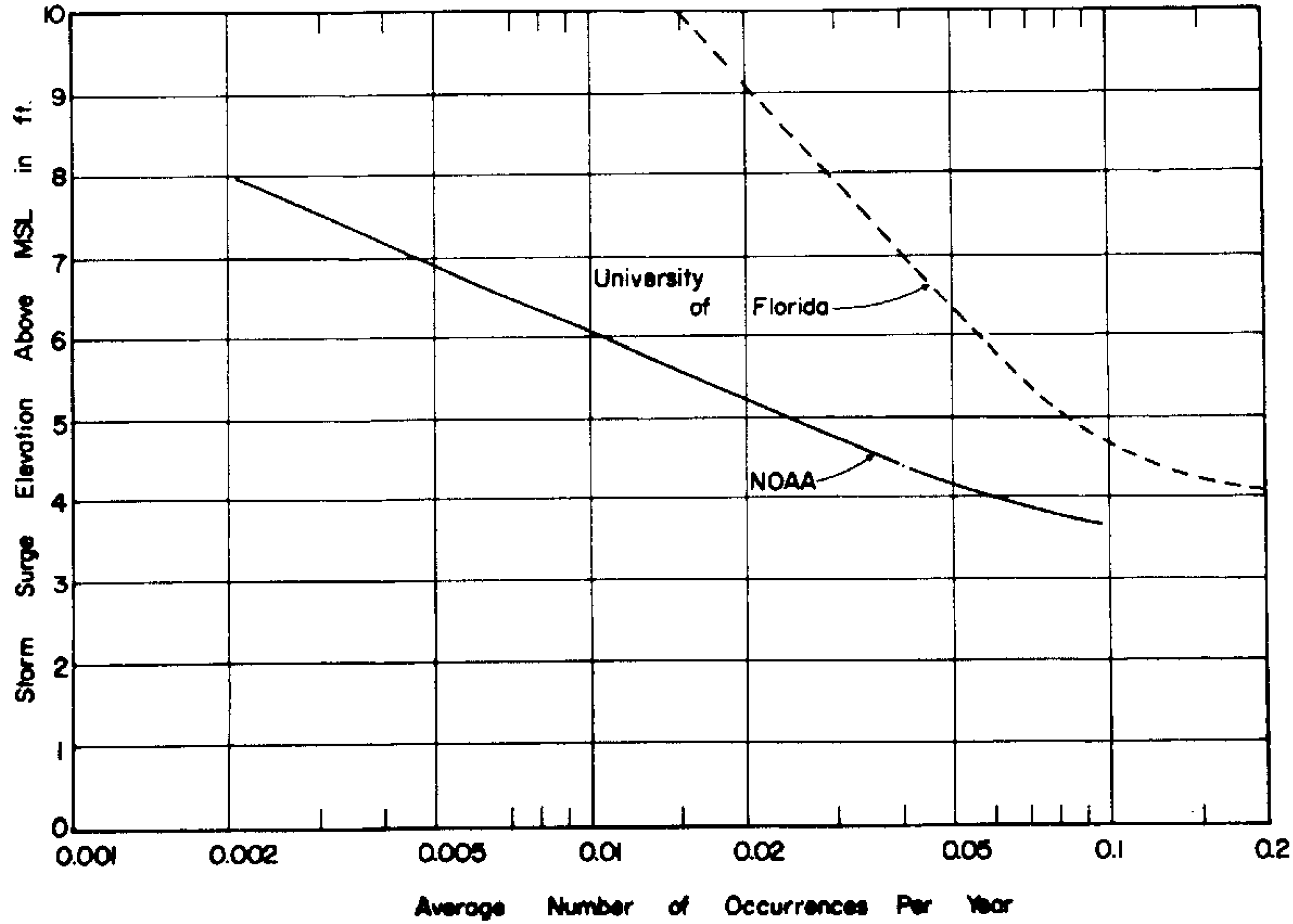



FIGURE 15. STORM SURGE FREQUENCIES FOR MARTIN COUNTY, FLORIDA

duced from this document. The West Palm Beach wind rose shows that wind velocities were greater from the northeast sector than from the southeast sector, but that duration of wind and wind movement were greater from the southeast sector. It is felt that these onshore winds are also representative for the St. Lucie area.

Yearly cumulative average wind data compiled from ship observations in the 5 degree offshore square shown in Figure 16 is summarized in Table 4. It should be noted that this data is of more importance than local wind data since offshore winds are primarily responsible for waves acting on the coastline. The offshore wind rose presented in Figure 16 and data in Table 4 indicate that the strongest winds are from the northern sector and that predominant winds in the general area are from the northern and eastern sectors, but that on the average, the percentage of time that winds blow from the northeast and the southeast are approximately equal.

Waves

Figure 16 also shows an ocean swell rose, for the same 5° square of ocean area. A total of 40,601 observations were made during the 1932-1942 period, more or less equally distributed over each month of the year. The swells are classified according to the height of waves and are indicated on the diagram by the width of lines weighed in proportion to the square of the swell heights. The swell rose indicates a predominance of swell from the northeast. Reference 8 states that during the months September through February, the prevailing and predominant swells are from the south and southeast, and during March, April, and May the resultant directions of swell are uncertain. Walton, in Reference 14, found similar results for Hutchinson Island using both sea and swell observations.

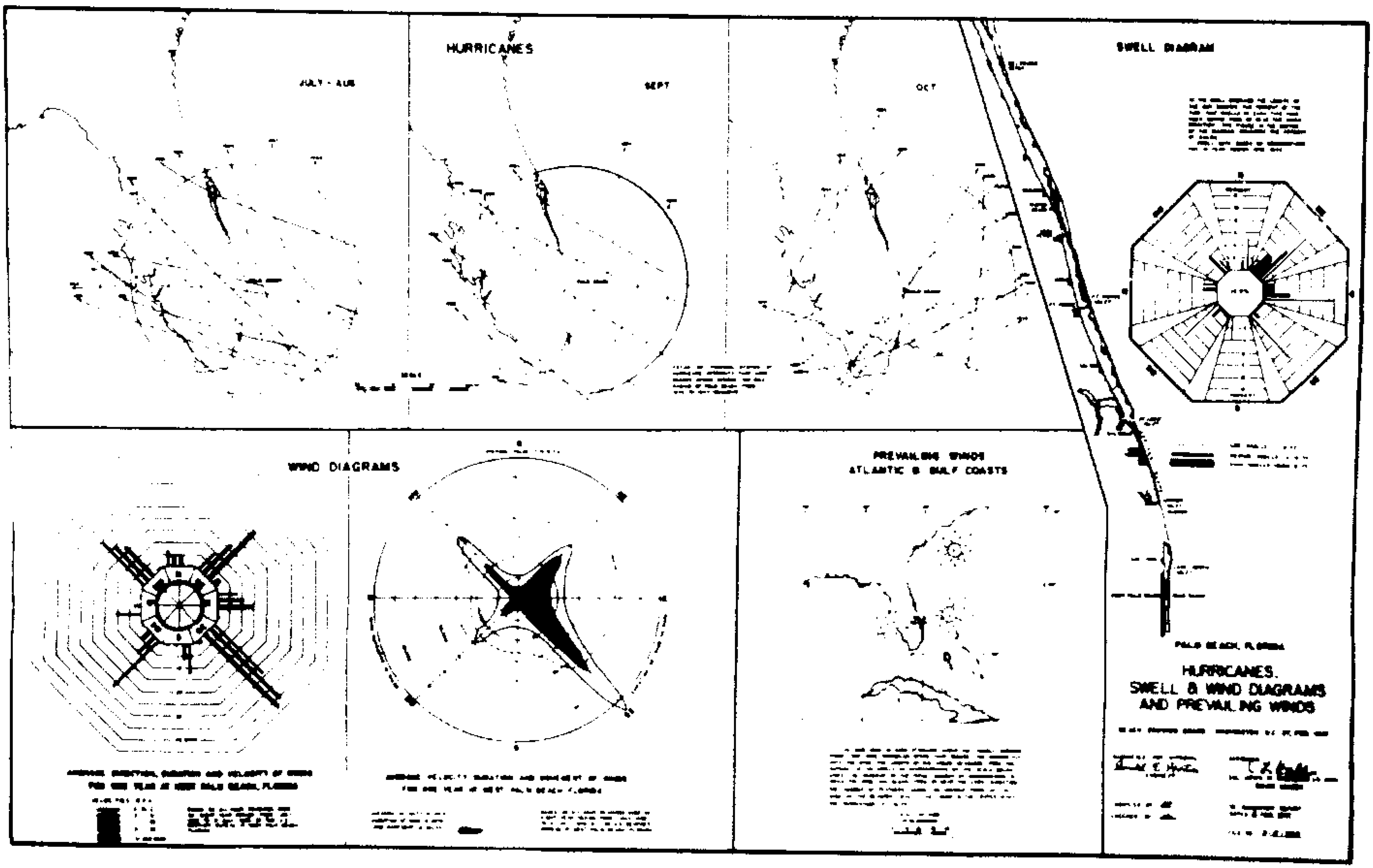



**FIGURE 16. HURRICANES, SWELL AND WIND DIAGRAMS, AND PREVAILING WINDS AT PALM BEACH FLORIDA**

Table 4

Yearly Average Offshore Winds - (Reference 8)

(from observations 1879 to 1933)

| Direction | Percent of time | Direction | Percent of time |
|---|---|---|---|
| North | 10 | Southwest | 6 |
| Northeast | 16 | West | 5 |
| East | 22 | Northwest | 8 |
| Southeast | 20 | Calms | 3 |
| South | 10 | | |

A wave height vs. frequency diagram for the West Palm - Lake Worth area has been presented in Figure 17. The data for this curve were taken by a shore based wave gage operated by the Coastal Engineering Research Center. No direction can be ascertained from this gage.

Littoral Drift

Littoral drift is strongly dependent on wave height and wave direction. When waves are from the north or northeast, littoral drift is southward, while for waves from the south and southeast, the direction is reversed. From the wave data presented previously, it is apparent that the net littoral drift in the St. Lucie area is southward. The Corps of Engineers (References 1 and 8 has estimated a net value of littoral drift in the study area to be 230,000 cubic yards per year from dredging records and volumetric surveys of accretion North of the North jetty, and erosion on the South shore of the inlet. No total north or south drift values are given in either of the references. Walton, by using ship wave observations, (Reference 14), has estimated total littoral drift as 397,000 cubic yards per year south and 303,000 cubic yards per year north; thus, a net drift of 94,000 cubic yards to the South. Also, in the same reference, a seasonal littoral drift versus month of year diagram is presented for Hutchinson Island and has been included as Figure 18. This diagram shows the predominance of southward littoral drift from September through March, and northward littoral drift predominance from April through August.

Shoaling and bypassing patterns in the vicinity of the inlet have been described in Reference 1. This reference concludes that:

The net southerly drift rate passing the north jetty under existing conditions is estimated to be 100,000 cubic yards annually. The estimated volume entering the inlet annually is estimated to be 50,000 cubic yards, of which 20,000 cubic yards are believed to remain permanently in the general

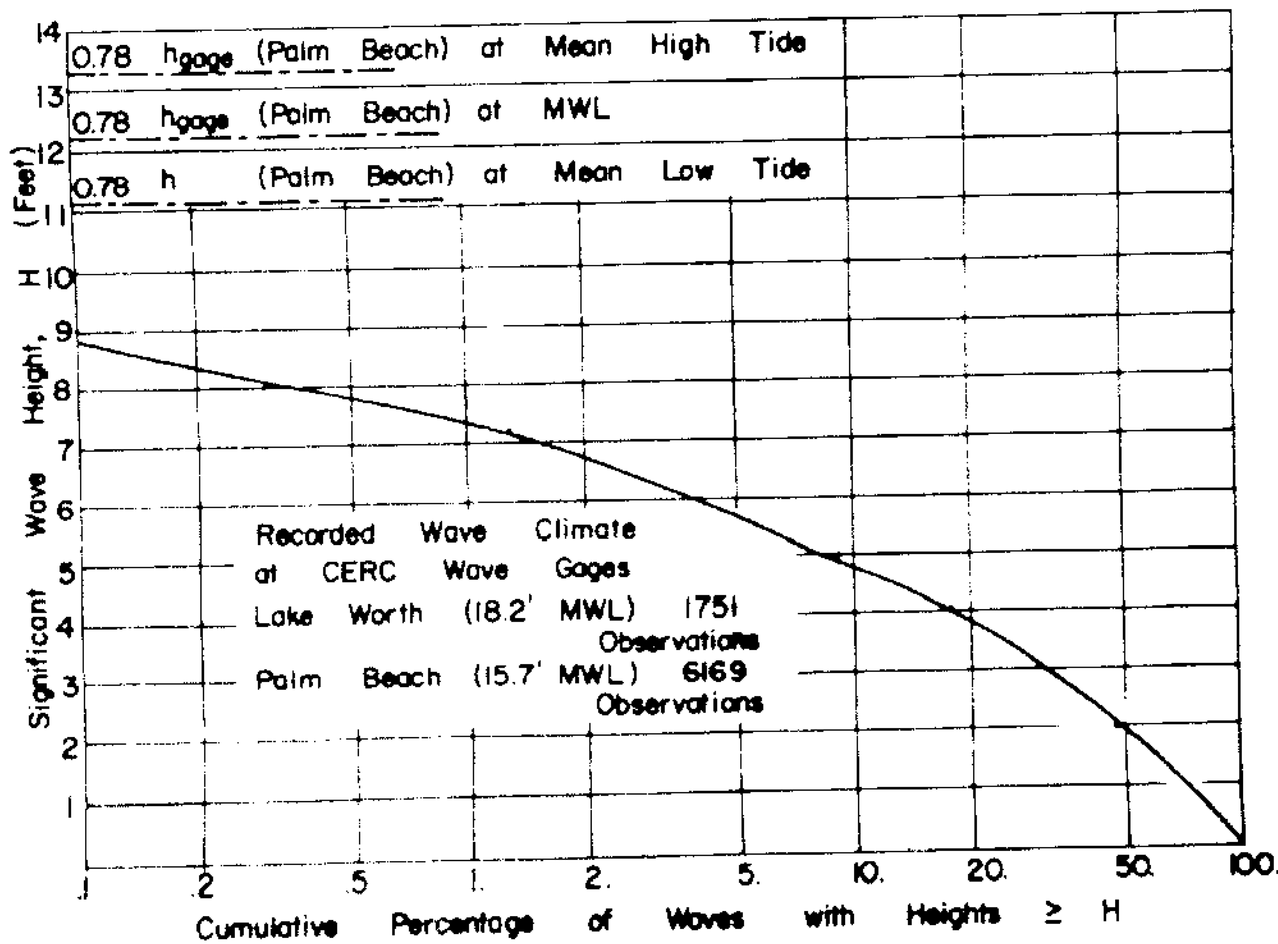



FIGURE 17. OBSERVED WAVE HEIGHTS AT LAKE WORTH - PALM BEACH, FLORIDA

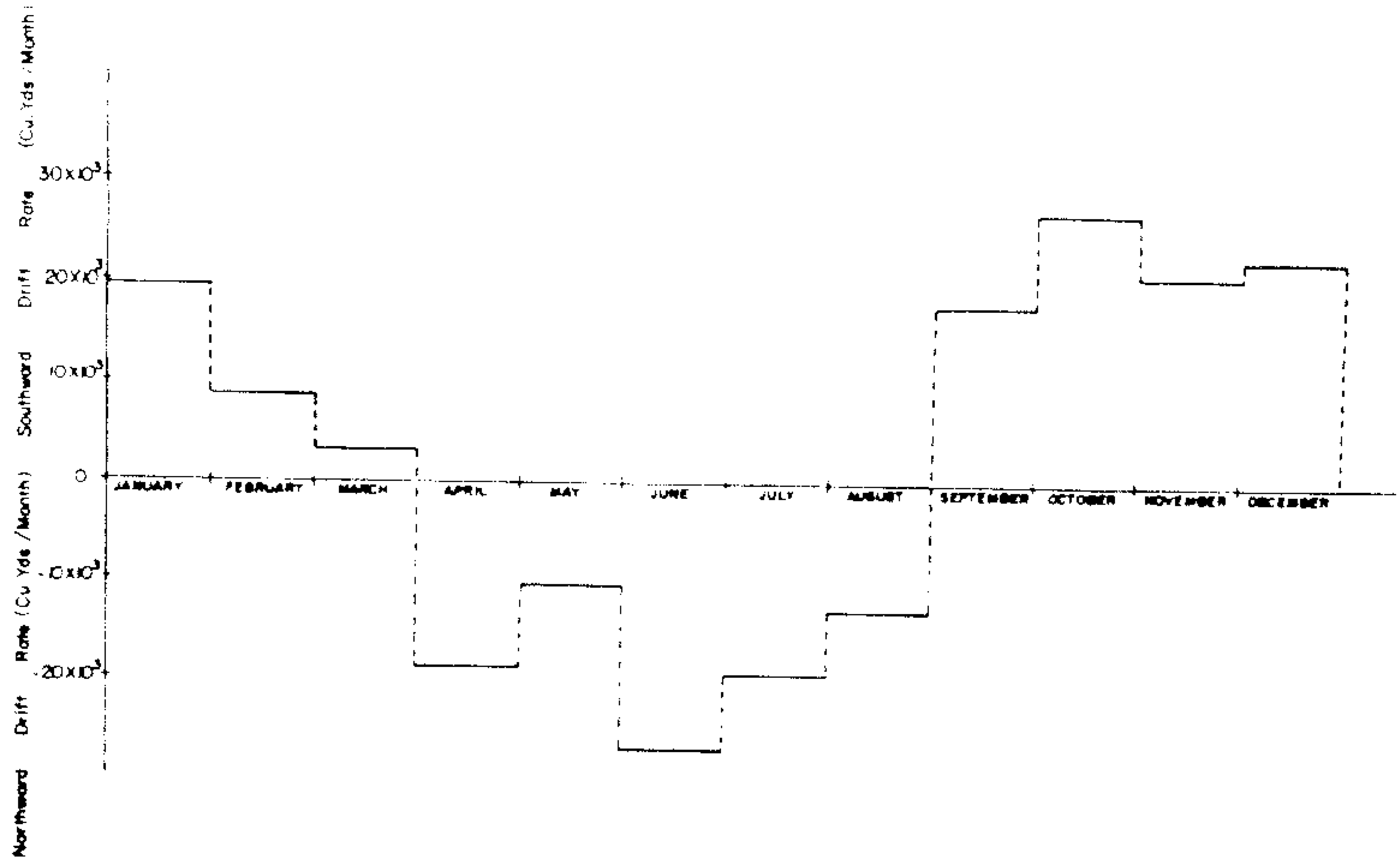



FIGURE 18. VARIATION OF NET LITTORAL DRIFT WITH SEASONAL WAVE CLIMATE BETWEEN FORT PIERCE INLET AND ST. LUCIE INLET

area and 30,000 cubic yards are believed to be transported out on ebb tides. Of the volume not being permanently retained in the inlet, 20,000 cubic yards are estimated to move offshore into relatively deep water, as evidenced by the constant drain of material from the shoreline south of the inlet, and 10,000 cubic yards are estimated to be transported southerly along the shore. Of the 50,000 cubic yards not entering the inlet, it is estimated that 30,000 cubic yards are transported into deep water, and 20,000 yards are estimated to cross the inlet zone and continue downcoast. Thus, the total volume of material crossing the inlet, directly or indirectly, and moving alongshore to the south, is estimated to be 30,000 cubic yards per year.

Recent work by the University of Florida (Reference 15) on the interior shoals of St. Lucie Inlet is summarized in Figure 19 which shows the amount of deposition occuring during St. Lucie's history. The U.S.C.G.S. chart of Indian River dated 1883, before the inlet was cut, was used as a base map for these calculations. It is noted in the figure that the 1908 survey gives a total deposition lower than that of 1898. This inconsistancy is partly due to the 1898 survey encompassing a larger area of the Indian River but may also be due to either the lack of good data in the 1898 survey or the possible flushing of sediment further into the bay, during this period, out of the area covered by the surveys.

A recent trend line based on the smaller area covered by the surveys has been drawn using the results of the 1908, 1930, and 1934 surveys (which could be extended to include the 1894 survey data point also). This trend line (dashed) gives an annual shoaling rate of 30,000 cubic yards in recent years, or a total of 2.2 million cubic yards between 1892 and 1934. Using the best survey (1930) and the 1883 base survey, both covering a much larger area of the Indian River, an annual shoaling rate of 214,000 cubic yards was com-

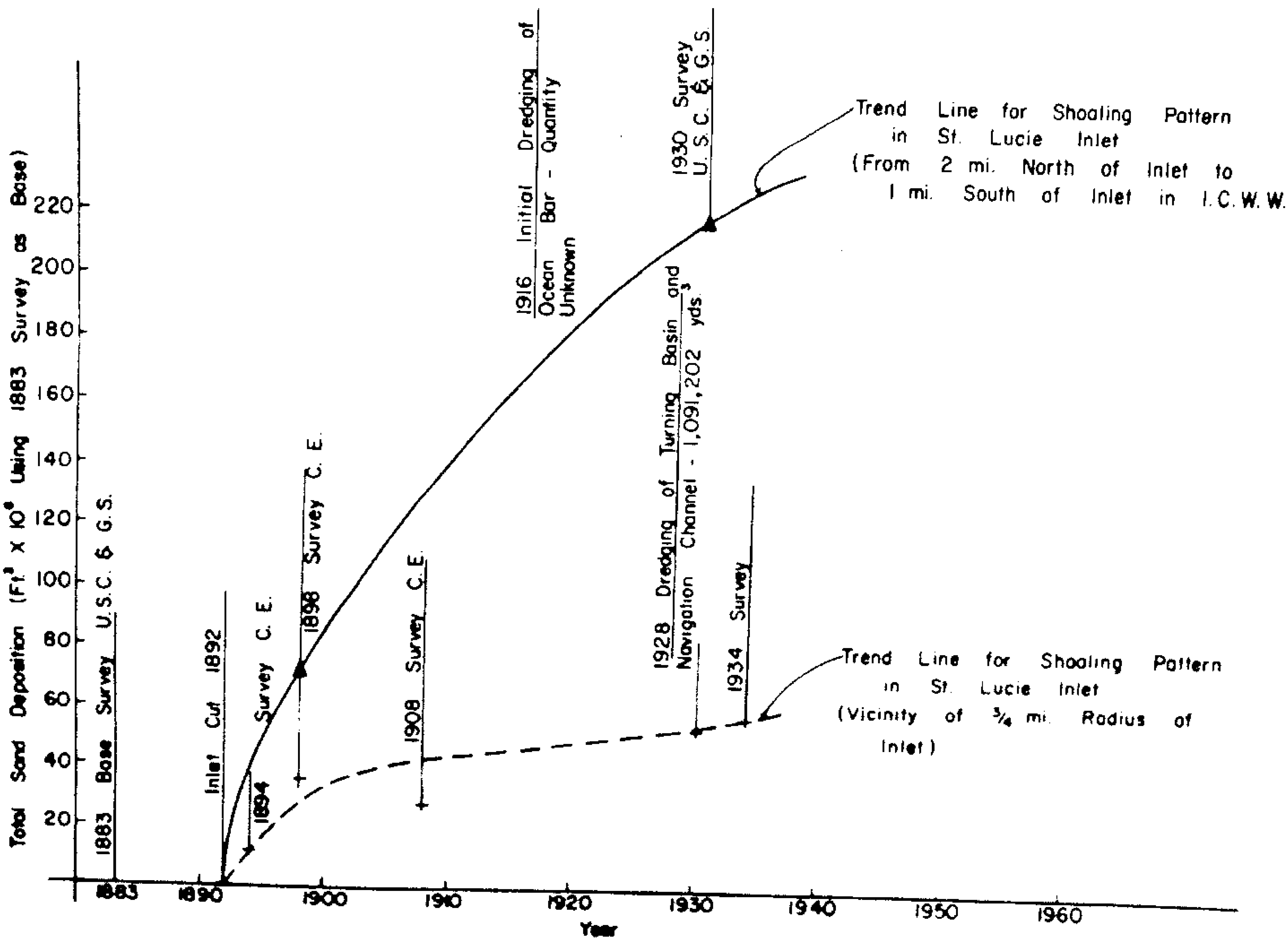



FIGURE 18. DEPOSITION OF SAND IN THE INTERIOR OF ST. LUCIE INLET

puted. Through 1930, the total volume of sediment accumulated within the inlet based on these same two surveys was estimated as 8.1 million cubic yards.

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APPENDIX

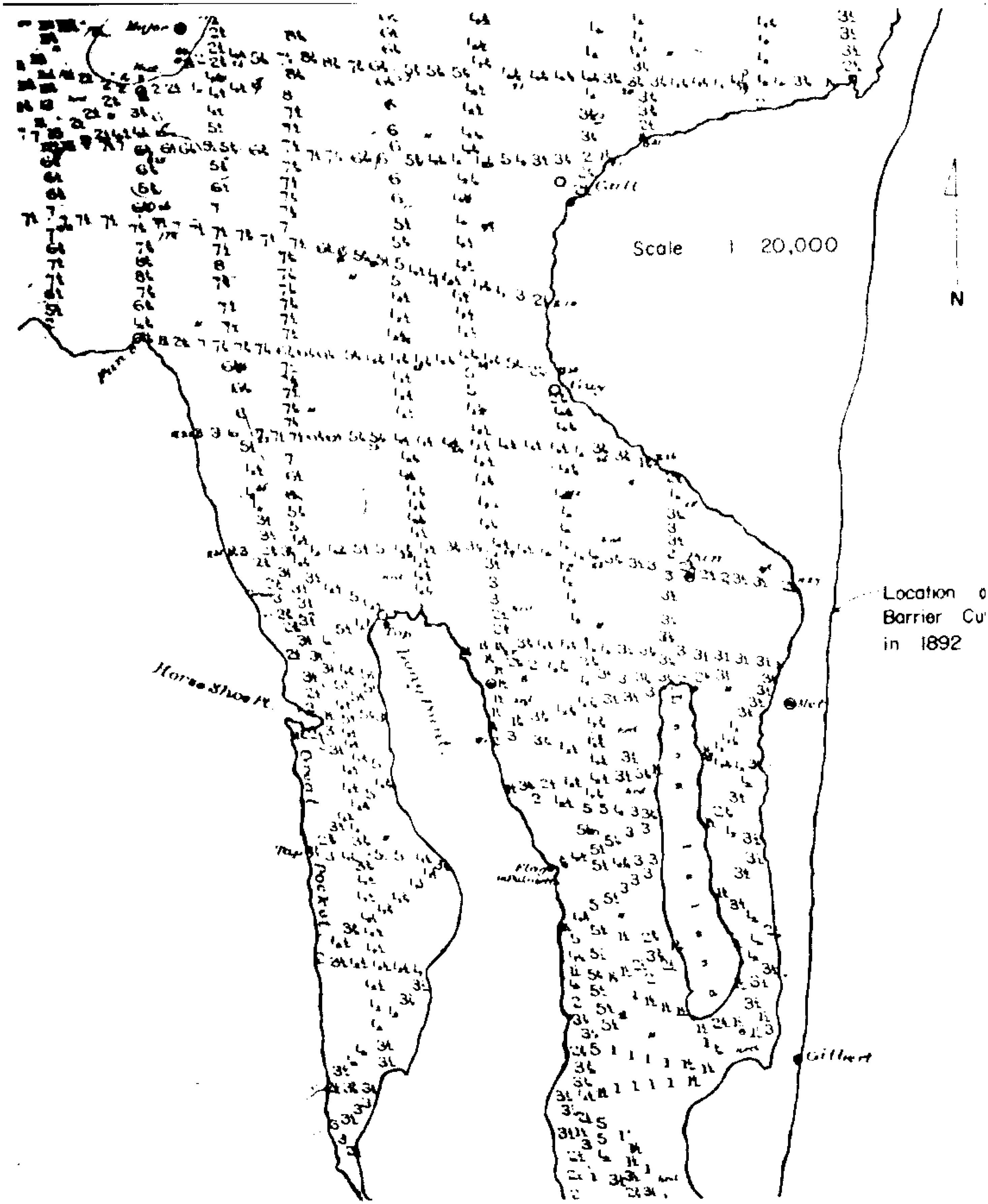


FIGURE A1. PORTION OF U.S.C. & G.S. (N.O.S.) HYDROGRAPHIC CHART NO. H-1571. DATE OF SURVEY 1883

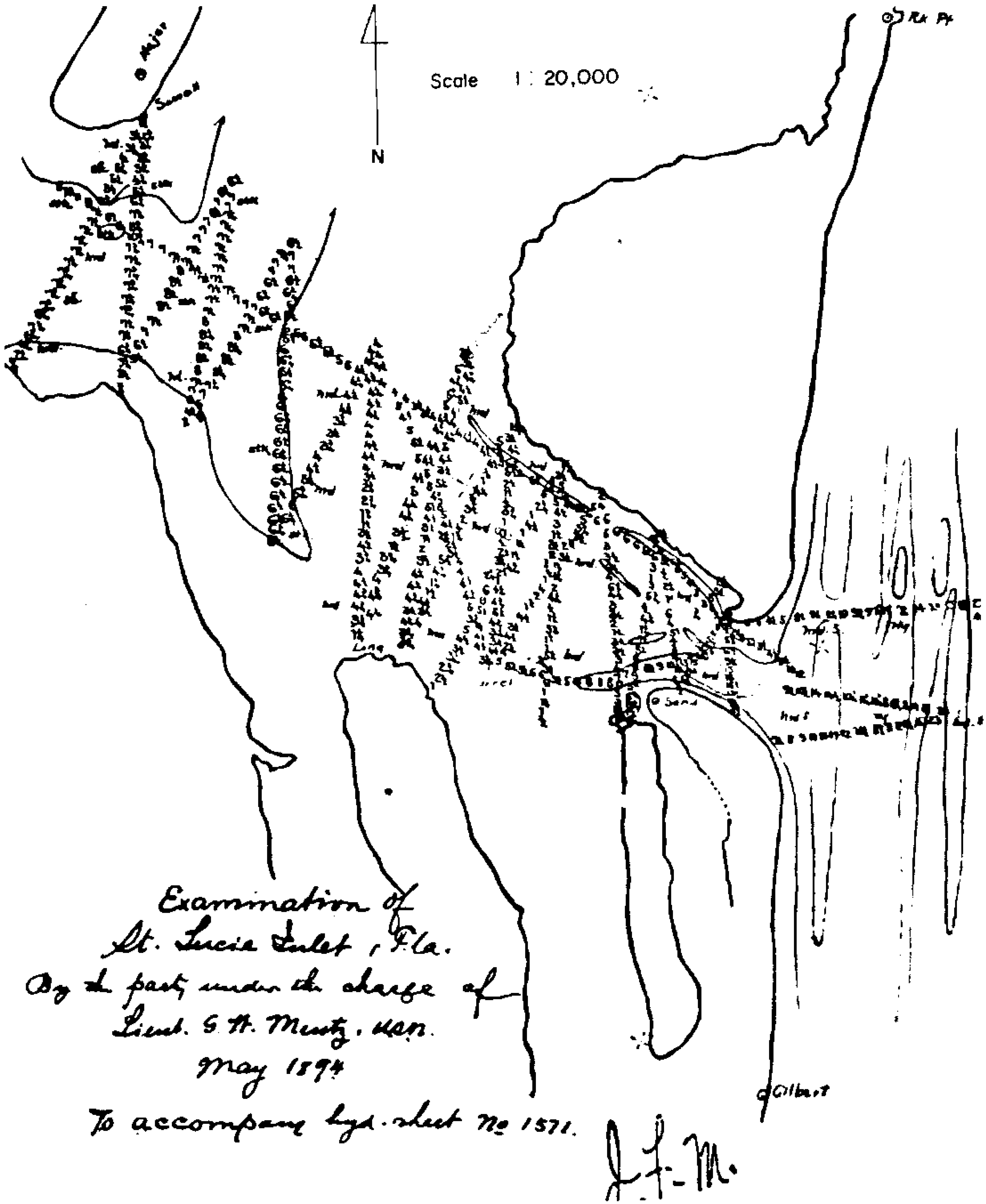


FIGURE A2. ST. LUCIE INLET; U.S.C. & G.S. (N.O.S) HYDROGRAPHIC CHART NO. H 1571, DATE OF SURVEY 1894

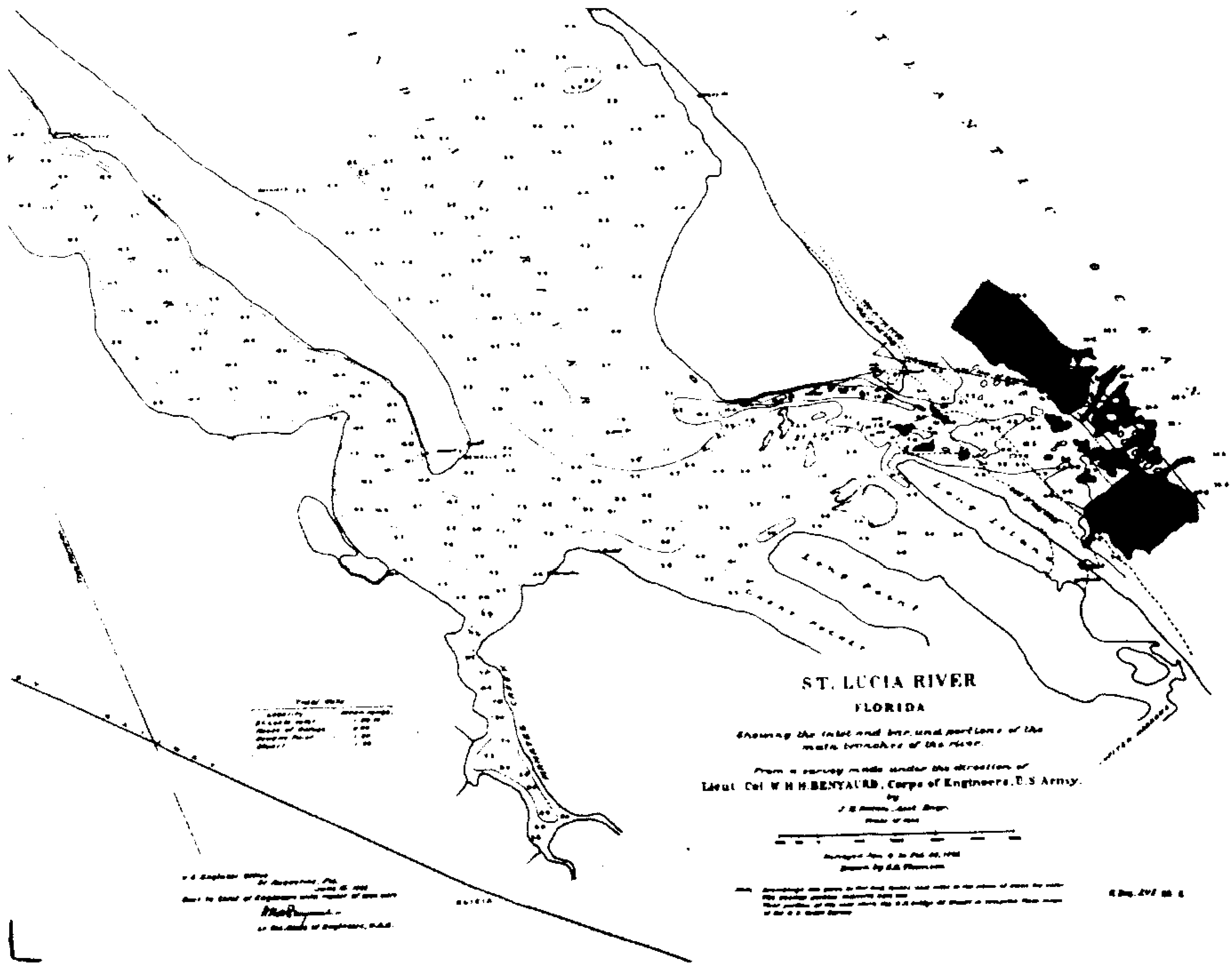


FIGURE A3. ST. LUCIE INLET U.S. ARMY CORPS OF ENGINEERS SURVEY 1898

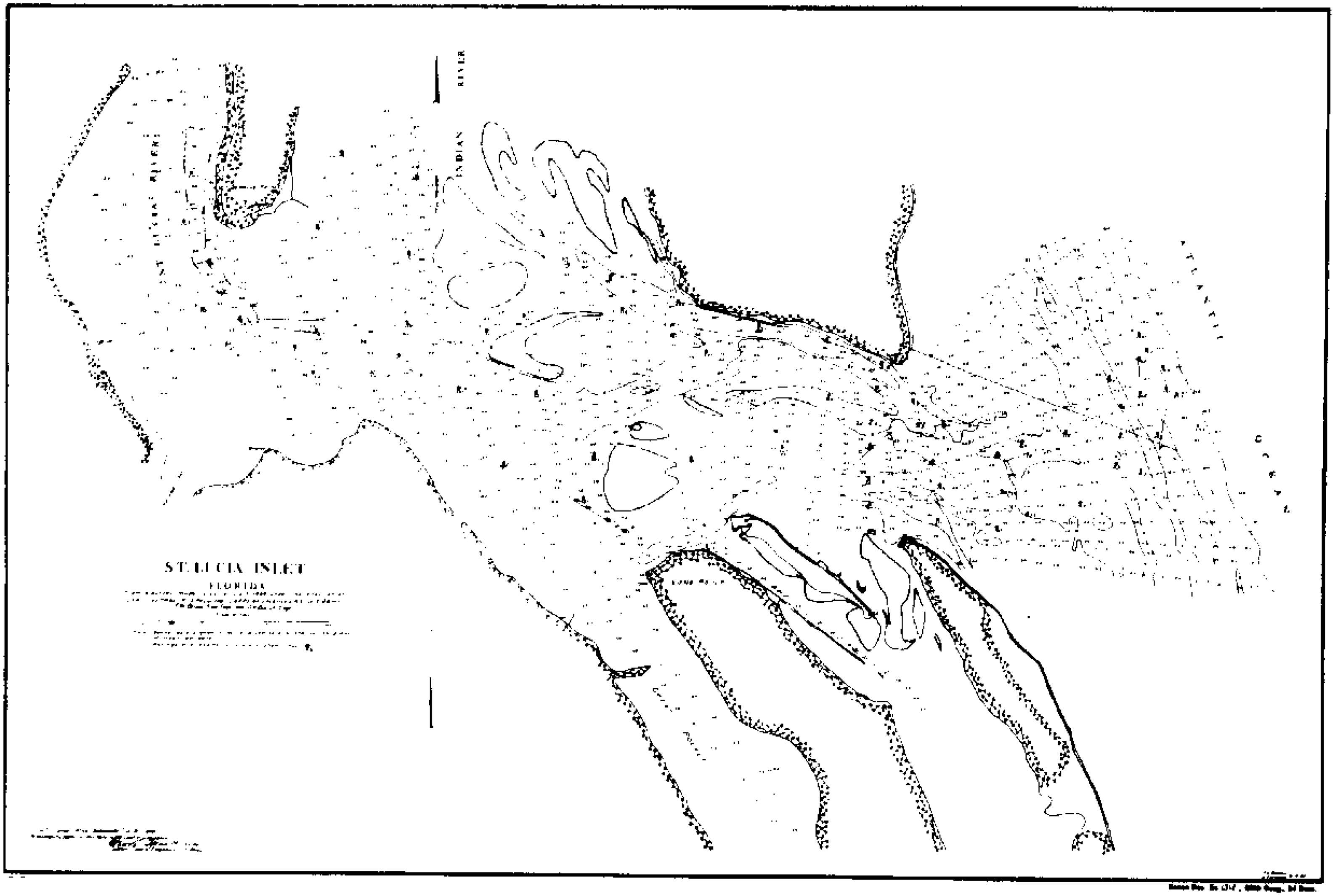


FIGURE A4. ST. LUCIE INLET U.S. ARMY CORPS OF ENGINEERS SURVEY 1908

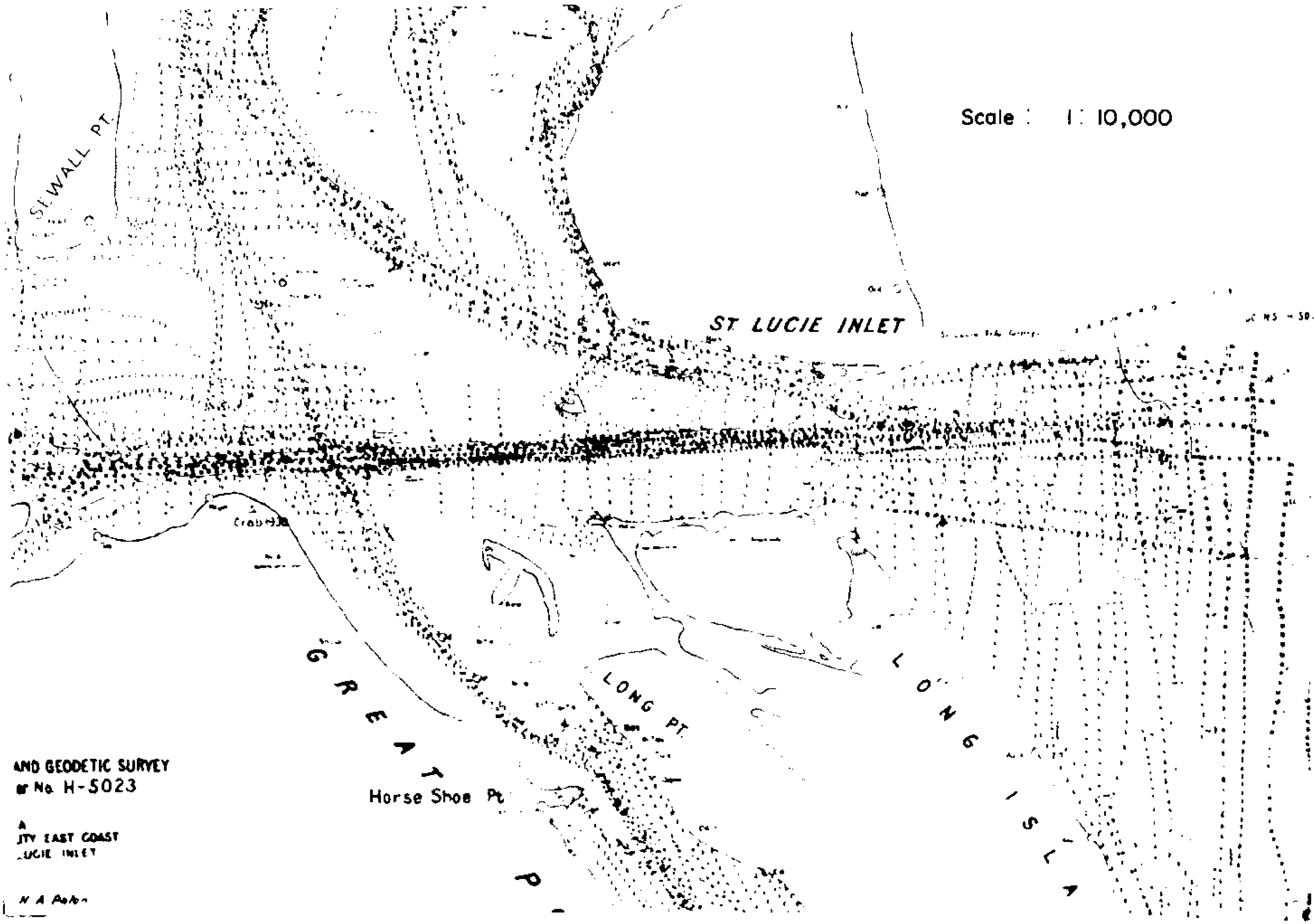


FIGURE A5 ST. LUCIE INLET N.O.S. HYDROGRAPHIC CHART NO. H-5023 DATE OF SURVEY 1930

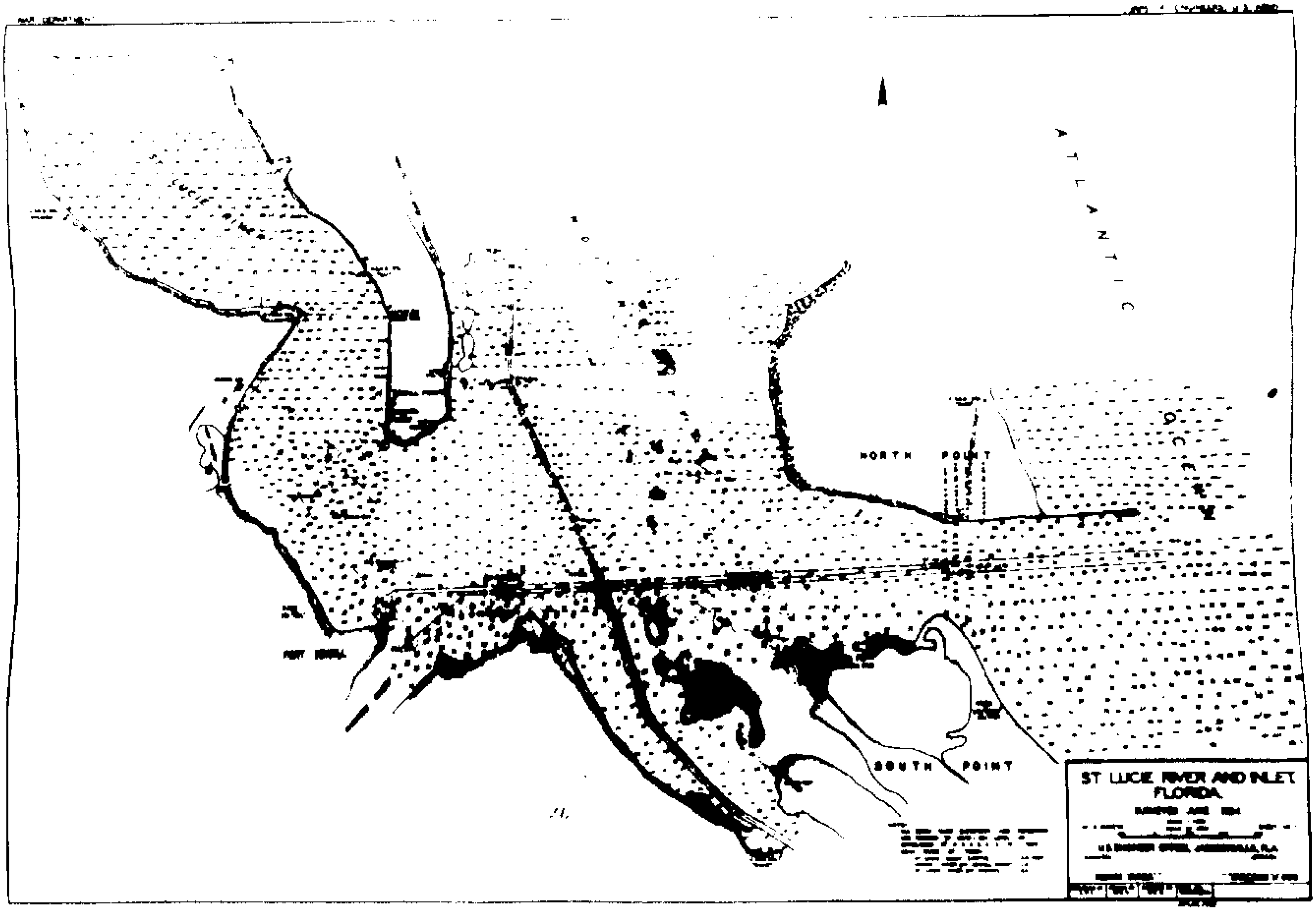


FIGURE A6. ST. LUCIE INLET U. S. ARMY CORPS OF ENGINEERS SURVEY 1934

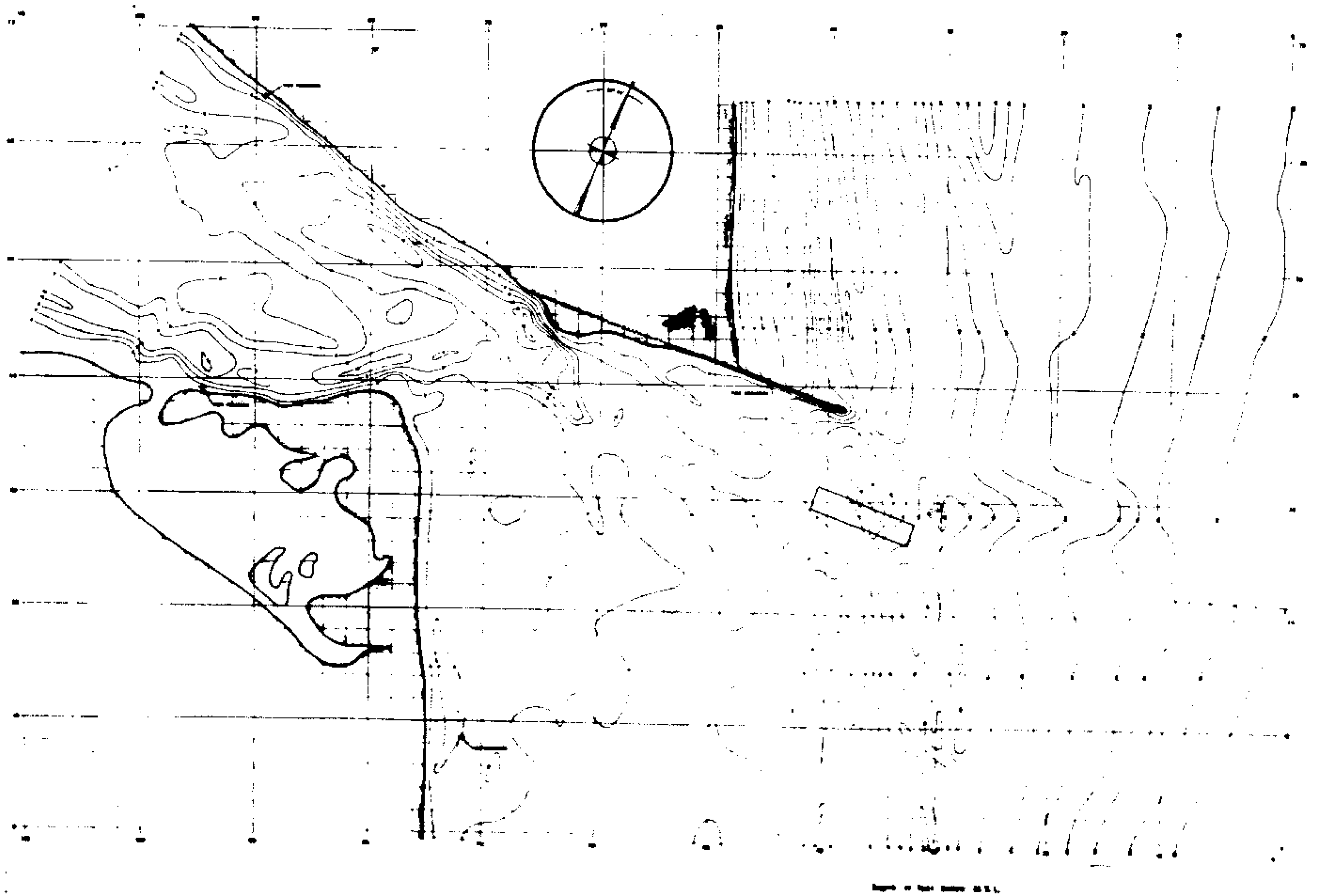

FIGURE A7. ST. LUCIE INLET U. F. COASTAL ENGR. LAB SURVEY 1968

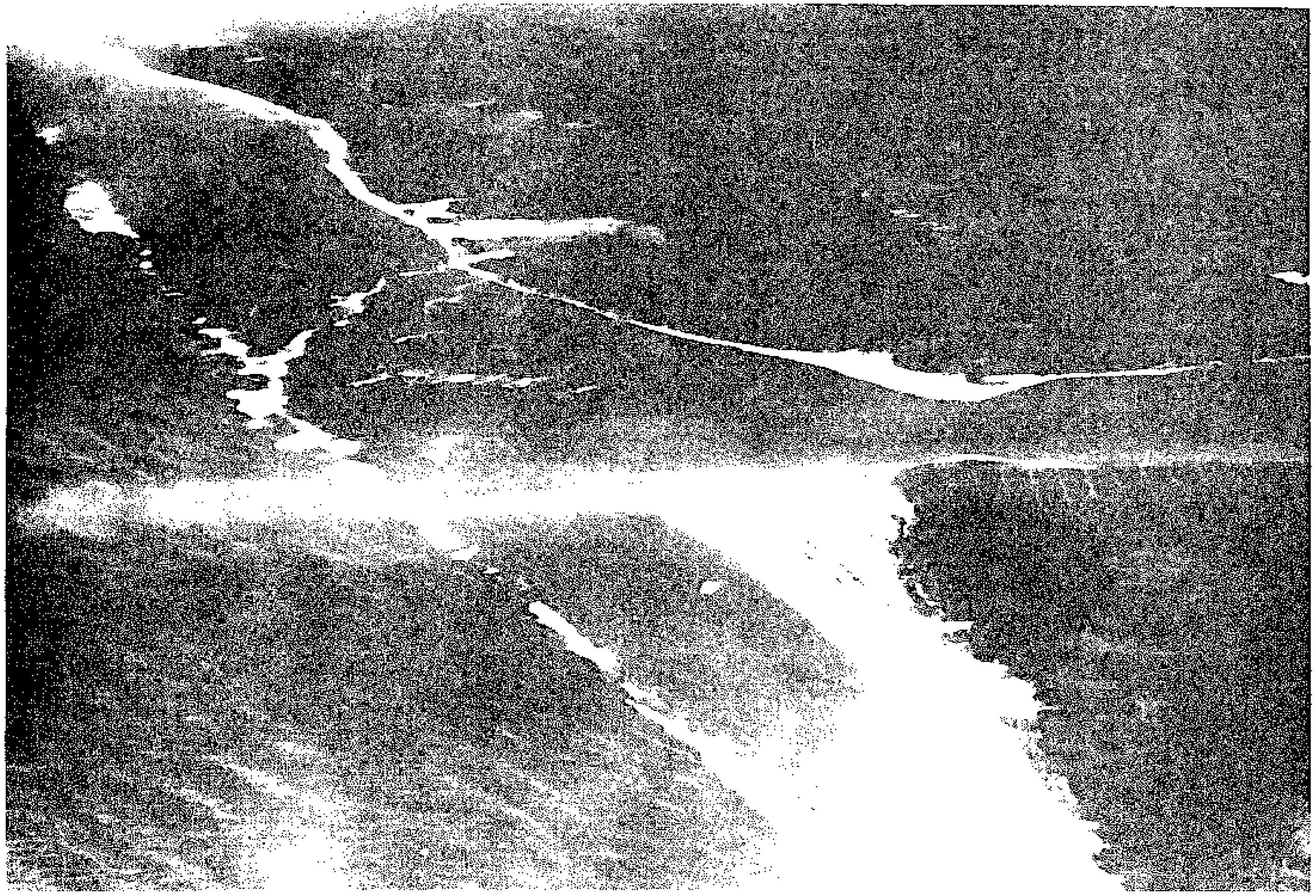

FIGURE A8. OBLIQUE AERIAL PHOTO OF ST LUCIE INLET 3-18-36

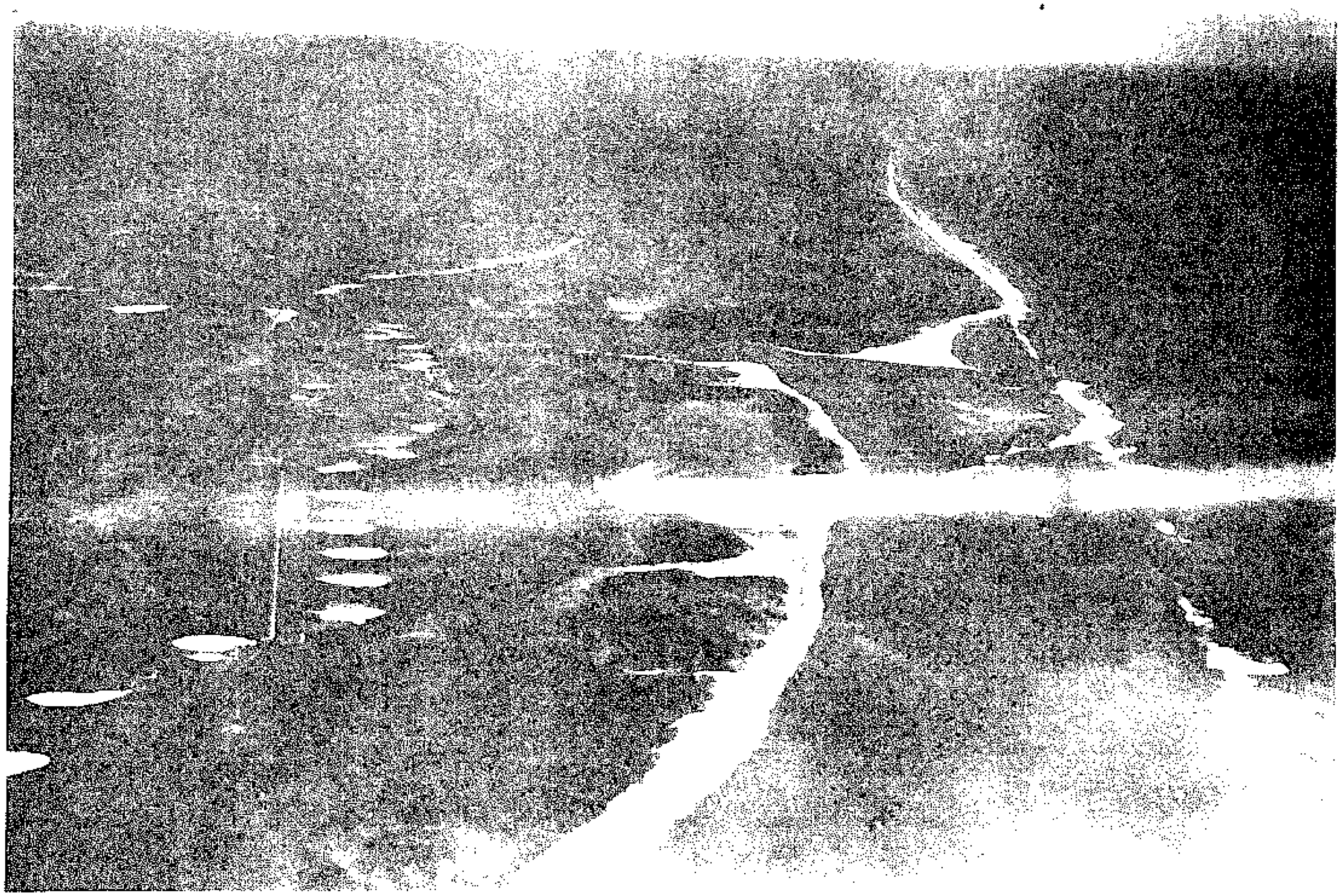

FIGURE A9. OBLIQUE AERIAL PHOTO OF ST. LUCIE INLET 3-18-36

The Florida Sea Grant Program is supported by award of the Office of Sea Grant, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, contract number 04-3-158-43, under provisions of the National Sea Grant College and Programs Act of 1966. The Florida Sea Grant Program was initiated in 1972 with three major components: applied marine research, education, and advisory services.

This public document was promulgated at a cost of $ 281.39 , or 70 cents per copy, to provide current information to persons interested in the management, use, and control of Florida's coastal inlets.

This is the second Report published by the State University System of Florida Sea Grant Program. These are semi-technical to technical publications and are numbered consecutively beginning with Report Number 1. The publication, "Research and Information Needs of the Florida Spiny Lobster Fishery," published in April 1974 and numbered SUSF-SG-74-201 is renumbered Sea Grant Report Number 1 and becomes the first in this series.