CHAPTER 25

CASE HISTORY OF ST. JOHNS RIVER AND JACKSONVILLE HARBOR, FLORIDA

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INTRODUCTION

It seems particularly appropriate that this year should be chosen for the presentation of a case history of St. Johns River, since it is this year that marks the centennial of the first effort to secure a navigable channel across its bar for ocean-bourne vessels. That effort led to a congressional appropriation of $10,000, a sizable sum in those days, for planning and definite work toward that end. Work was completed only last year, which provided a 34-foot channel from Jacksonville to the ocean, complete with various protective works, and a cut-off channel which eliminates three hazardous bends and reduces the distance to be navigated. Thus, the accomplishments of a century of efforts can be seen. It is those efforts which comprise the substance of this paper. A map of the river is shown as figure 1.

PURPOSE

The purpose of this presentation is to give an insight to conditions which made improvement of St. Johns River desirable, some smattering of early history, and a brief account of how the present improvement was accomplished. Since the beginning of work at St. Johns River bar was one of the earliest attempts in this country to conquer the mouth of a major tidal river, the history of that conquest forms an excellent index to the advance of knowledge in the field of coastal engineering.

HISTORICAL

An early book on Jacksonville begins by paraphrasing a statement attributed to Herodatus, in which he stated in summarizing the economy of an empire: "Egypt is a gift of the Nile." The paraphrase continues: "In a somewhat similar sense, Jacksonville is a gift of the commeroe-bearing St. Johns." In a true sense it may be said that Jacksonville owes its existence, its early development, and much of its present commercial status to the river which passes through the city and provides its outlet to the Atlantic Ocean. The earliest Indian village to occupy the site of Jacksonville, and the small town which succeeded it--both chose that location because it was the narrowest point on the lower 80 miles of the river and thus was easier to cross. This geographical advantage placed the early settlement on the highroad of commerce where it has since remained. As the area developed, the village became the key port for the commerce of the region and grew in stride with that development. The river valley attracted the first

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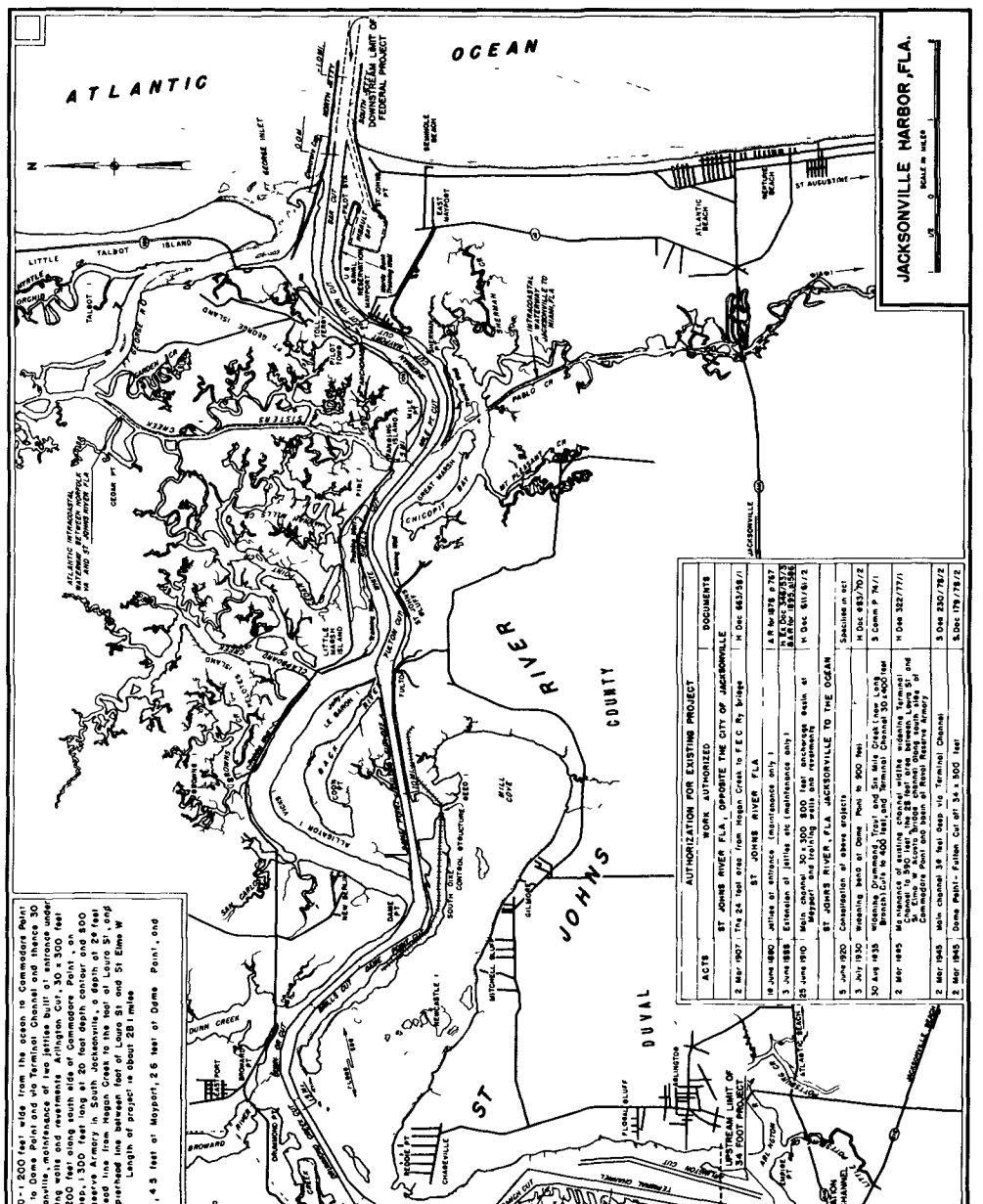

Fig. 1, St. Johns River, Jacksonville, Florida, to the ocean

important Florida tourist trade, saw the beginning of the Florida citrus industry, and poured forth a flood of lumber used in the construction of our rising nation. The river transported those tourists, oranges, and timbers--and Jacksonville bloomed in proportion as that economic life-blood flowed through its vital artery, the St. Johns River.

EARLY HISTORY

Recorded history credits Jean Ribault, the French Hugenot soldier and seaman, with the discovery of the St. Johns River. He anchored at the mouth on May 1, 1562, naming the stream the River of May. Ribault's account of that day is quoted as follows:

> The night now approaching, we returned to our ships, for we durst not hazard our ship because of the bar of sand that was at the mouth of the river, notwithstanding, at full tide there were at least two fathoms and a half of water, and it was but a leap over a surge to pass this bar, not exceeding two cables (1,200') in length, and then afterwards there are six or seven fathoms of water everywhere; *** a ship of four to six hundred tons may enter therein at all tides, yea, of a far greater burden if there were pilots.

On his second voyage to the mouth of the St. Johns, in 1565, however, Ribault found water depths at the bar too shallow to allow entrance of his four largest vessels. He was forced to anchor them outside. This fact very nearly brought him to grief almost immediately, since a Spanish fleet of five ships under Menendez attacked the anchored ships. Their skeleton crews were barely able to escape with the vessels as the Spanish gave futile chase. The fugitive ships later found their way back to join Ribault. In the main, this successful escape only delayed the evil day for Ribault's venture, but the examples cited show the very early need for improvement of navigation facilities at St. Johns Bar, and the shifting nature of its channel.

NEED FOR IMPROVED CHANNEL

Long before improvement of the river was a seriously considered possibility, the seeds for a profitable river-borne commerce were planted near Tallahassee. There, in the 1820's and '30's, a large cotton area was brought into production. Much of the crops were moved by oxcarts to the St. Johns River upstream from Jacksonville, and loaded on sailing vessels bound for Savannah and Charleston for transshipment. The increase in cotton shipments from plantations west of the lower river and the increasing needs for imported consumer goods in Jacksonville and other St. Johns River ports led to the establishment of a weekly steamer schedule from Savannah to the St. Johns River in 1835. As freight and passenger demands increased, better-type vessels were gradually substitued for the earlier crude carriers. After the close of the Seminole War in the early 1840's, commercial traffic began to

increase daily in volume and regularity. The variety of shipments grew to include lumber, cotton, oranges, and barreled fish. Those commodities were generally shipped to Savannah in the shallow-draft side-wheel steamers of that era. The railroads had not yet reached the region and the river was the only outlet for volume shipments, overland routes being poorly developed. Most of the shallow-draft steamers were comparatively small ships which chose the protected inland water route to Savannah, which is now a part of the Atlantic Intracoastal Waterway system. That waterway afforded depths up to 6 to 10 feet and threaded its way through the tidal estuaries along the coast, where the waters were protected from the ocean by a continuous string of islands. There was some risk connected with shipping across St. Johns bar to the ocean, since craft of shallow enough draft to cross the bar were too light to be entirely seaworthy, especially during the fall season of greatest incidence of tropical storms.

Those larger steamers or deeper-draft schooners taking the open ocean route were often required to stand off the bar for days or even weeks, awaiting the capriciousness of the shifting channel at the bar. When those ships did enter the river they had no further difficulty in the main river where depths exceeded those at the bar. After loading with timber or other commodities at Jacksonville or other river ports, the real difficulty was encountered in getting the loaded vessel over the bar with its deeper draft. The delay and economic loss incurred by such limitations made Jacksonville a rather ill-favored port city as compared to Savannah, and the even closer port of Fernandina, 30 miles northward. The excellent natural harbor at Fernandina easily afforded berth for hundreds of trading vessels which could and did make use of its excellent facilities. It was those limitations on shipping to Jacksonville and the great competitive advantage of its neighboring coastal ports which led Jacksonville citizens to first dream of a deep-water channel over the bar and its continuation up to the town.

First attempts to secure improvement - In 1852, the first step in securing deep water at the bar was made, when Dr. Abel Seymour Baldwin, local physician and civic leader, was sent to Washington to secure an appropriation for planning and definite work toward obtaining deep water at the bar. Dr. Baldwin's trip to Washington came as a result of his very early interest in the river. The birth of the idea, in a practical form, is directly attributed to his foresight. As a physician, he was often forced to call on his patients by boat over many miles up and down the river. During such trips to Fort George Island and the mouth of the river, Dr. Baldwin became convinced that a small appropriation from Congress to close Fort George Inlet would tend to channelize the waters of the St. Johns River, giving them freer discharge to the ocean, thus forcing a deeper channel for the passage of ships over the bar. While not an engineer, Dr. Baldwin had a scientific turn of mind, which caused him to note and interpret natural phenomena. He observed the currents in the river, and kept the meteorological record for Jacksonville for many years.

First appropriation - While in Washington, he was successful in securing a congressional appropriation of $10,000 for St. Johns bar. That appropriation provided funds for a survey and for project planning by the Army Engineers, which had the responsibility, then as now, for the development of river and harbor projects. In 1853, Lt. H. G. Wright was sent to Jacksonville to make the survey and experimental dredging. Wright reported that one pier or jetty on the north side of the main channel at the bar would largely overcome the difficulties. Lt. Wright's recommendation, however, was not acted upon and did not result in further appropriation for actual construction work. Withholding of the appropriation was said to have been caused when powerful influence was exerted in Washington on behalf of those interested in Fernandina harbor. Those interests apparently did not want their investments in Fernandina jeopardized by permitting water-borne traffic to be weaned away by the upstart port which was developing at Jacksonville despite the natural restrictions at the bar. Thus, work was delayed until the War between the States broke upon the country, presenting further delays. Progress was definitely arrested from 1853 to 1877, a period of 24 years, with no improvement for St. Johns River.

CONDITIONS AT THE BAR

Before resuming the history of improvement, it might be well to digress and see just what conditions were like at the bar. The earliest known map showing the bar is that of de Brahm, dated 1769, which is in the British Museum. It shows the south bank of the river extending into the ocean a considerable distance beyond the north bank. The mouth was divided into two distinct channels by a large marshy island designated on the map as "Middle Ground." That region was also shown on charts of the United States Coast and Geodetic Survey as early as 1856, and it was again surveyed by the Army Engineers in 1868. Before improvement there were two channels in the bar, which provided varying depths of from 6 to 8 feet at mean low water. The middle ground between the channels was a shifting sandy shoal called Pelican Island or Pelican Shoals. In 1878, this middle ground was found to be 2,000 feet south southeast of its position in 1868. It was then understood that the channel performed a cycle of operations during a period of about 25 years. The channel would work its way southeast, such movement being caused by the littoral drift (southward in this area), until it had progressed to a point sufficiently southward to extend the channel oceanward by deposition of sand carried by the stream. At such point the natural slope of the channel became flattened and inefficient, and a new, more efficient channel would break out over the shorter distance to tidewater on the north. Then, the cycle would begin to repeat itself southward. Sometimes there was only one channel, but usually there were two, one being deeper than the other, but subject to rapid changes due to storms or excessively high tides. The sailing directions varied from year to year, and often from day to day. No shipper or pilot would dare take his ship over the bar without sounding the channel by small boat.

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DEVELOPMENT IN THE TRIBUTARY AREA

By the 1870's the citrus industry was becoming one of Florida's largest commercial activities. The banks of the St. Johns River were especially favored sites for orange groves because the soil gave a fine flavor to the fruit, and the broad river ameliorated freezing winter temperatures to a marked degree. Then, too, the St. Johns provided virtually the only means of volume transportation of the fruit to the northern markets. Thus, the real beginning of the commercial citrus industry in Florida occurred along the banks of the St. Johns River. The larger groves had their own packing houses with long wharfs extending into the stream for direct loading to river steamers. Smaller groves were served by a "floating packing house." An old steamer was renovated for such use; it would pick up bulk fruit all along the river and pack it en route to Jacksonville where it was transshipped to the northern markets. By the early 1880's, orange raising on the St. Johns was a $10,000,000 investment with an annual yield of 75,000,000 oranges selling at $15 per 1,000, representing an annual gross of one and one-quarter million dollars.

In the importance of the freight steamers, passengers were not neglected. During winter months the tourist industry began to vie with citrus as the leading cash crop of the St. Johns valley. In the 1880's, Jacksonville had less than 15,000 population, but its 40 hotels and even more boarding houses played host to some 75,000 tourists annually. Those tourists were influential people, controlling much of the wealth of the nation. Many remained in the area, and others invested in the industry of the region. Such visitors contributed greatly to Florida's progress.

Long before the tourist era, New England shipbuilders discovered that the St. Johns River was a unique region, in that the two main timbers used in their craft grew together down to the banks of the stream. Live oak and long leaf yellow pine grew in such profusion that logging crews were sent to fell and collect the timbers during the late fall and winter months. In summer, the shipbuilders sent schooners which loaded up logs and loggers all along the river and returned them to New England.

An enormous lumber industry also began in the St. Johns valley in the early 1850's, and has continued to the present day. The early rapid growth of Jacksonville began as this industry rose and flourished. Palatka became a supply point for millions of board feet of cypress annually. Cross ties, shingles, and construction lumber of oak, pine, cypress, and other woods found their way out to the markets of the nation through the St. Johns River.

The above indications of the industrial and financial development of the area are mentioned merely to show that in spite of serious restrictions on navigation at the mouth of the river, a high economic structure was rising in the St. Johns valley, and particularly in

Jacksonville. That the restriction was severe is indicated by the fact that, according to the secretary of the Board of Trade in 1895, the average tonnage of vessels entering Jacksonville in 1870, before any improvement was made on the river, was 338 tons including steamers. Sailing vessels averaged below 200 tons, and it was a rare schooner that reached as high as 250 tons. By 1894, channel improvement had increased the average tonnage of visiting vessels to 1,060 tons, with sailing vessels up to 450 tons being quite common. Even with those limitations, however, Jacksonville was described in 1895 as "the most important orange market in the world and the greatest winter resort in America." When Henry M. Flagler and Henry B. Plant pushed the tourist and citrus industries farther south by the advent of their railroads, other industries rose to take their places, and the need continued for ever-increasing improvement of the river to facilitate the growing water transportation of the area.

EARLIER PROJECTS

About 1877, Dr. Baldwin, who had never lost his dream of river improvement, was able to put his plans into action again. Early in 1878 he went to New Orleans to confer with Capt. James B. Eads, who had been one of the engineering minds behind the design and construction of the Mississippi River jetties. Capt. Eads agreed to come as a consultant for local interests and make a survey and report on the St. Johns Bar for $1,000. Eads was not a member of the Corps of Engineers, but was a well-known engineer of that era. Dr. Baldwin returned and raised the money by popular subscription. Eads arrived in March 1878 and reported that there was no doubt of the success of a jetty system. He recommended two converging jetties from the mainland across the bar to deep water. He recommended a high-level jetty rising above the water surface. He envisioned the resulting possibility of a 20-foot channel and estimated the cost at about $1,700,000. His report was approved by the local citizens' committee, which prepared a brief requesting a Federal appropriation of $1,700,000 for the work. The brief stated that from 1866 to 1878 the loss of vessels and cargoes from Cape Canaveral to Brunswick was $1,500,000, and that in 1872 alone such loss was $570,000, much of which might have been saved by a deep-water entrance at the mouth of the St. Johns.

The brief was effective, because in 1878 Capt. George Daubigny was sent to make an exhaustive survey of the river. Capt. Daubigny worked under the direction of Lt. Col. Q. A. Gillmore, in charge of the office of the Corps of Engineers in New York. On Capt. Daubigny's report, Col. Gillmore recommended a jetty system such as Capt. Eads had done, but he favored a low or submerged jetty. Gillmore's plan was submitted to Congress on June 30, 1879 and adopted.

ORIGINAL PROJECT

It is interesting to note the theory behind the Gillmore recommendation. The north jetty was to be 9,400 feet long and the south jetty

6,800 feet. A channel 15 feet deep at mean low water was envisioned. The outer 2,000 feet of each jetty was to be built up to half-tide level, but the inner portions were to be submerged to permit the waters of the ebb flow to escape at periods of high velocity on the theory that a reduction in such velocity was desirable to prevent undue channel erosion. It was assumed that the jetties would result in a channel with central depth of 15 feet, gradually sloping to each inner side of the jetties. The jetties were to consist of rip-rap stones resting on a mattress of logs and brush to prevent settlement. The mattress would be 18 to 38 inches thick. The jetty stones were to be placed with a slope of 1 foot vertical to 4 or 5 feet horizontal, making a rather wide structure at the base. Congress appropriated $125,000 in 1880 to begin work on the jetties. Meanwhile, a Government dredge boat, the "Henry Burden" was engaged in experimental dredging at the bar, together with other contract dredges, from 1870 to 1873, expending a congressional appropriation of $50,000. The dredging was not expected to produce permanent results, but it did show that maintenance of a channel deeper than 6 to 8 feet was an expensive job of hide-and-seek in the shifting channels, and that excavated areas quickly refilled. Thus, jetties became a necessity.

Early construction work - Under the jetty appropriation, contracts were awarded in 1880 to Lara, Ross and Company of Staunton, Virginia, for a solid raft of logs covered with brush compressed to a thickness of about 20 inches and topped with stone to make a total height of about 3 feet. This was to be the foundation for the south jetty, and 2,785 linear feet was laid in 1880. Mr. R. G. Ross, of the above-mentioned company, has related that logs used in that foundation work cost 2-1/2 to 5 cents each. The logs were cut on the banks of the river. Only the longest and straighest timbers were used, some without a limb up to 70 feet. By the middle of 1881 the entire foundation seaward of the low-water shore line had become covered by sand, which was considered a good thing, since it was thus protected from the toredo, or marine borer. The immediate result of the work was to arrest the southerly progress of the north channel and hold it more stationary. A secondary result was that the snoal to the north of the north channel (Ward's Bank Shoal) began to have its southern tip scoured off. Vessels continued to use the south channel, passing right over the jetty foundation.

In March 1881, Congress appropriated $100,000 more, and a contract was awarded to J. H. Durkee of Jacksonville for work similar to that already described. Work continued under both contracts as additional layers were placed on the south jetty, and foundations were placed for the north jetty. As the height of the south jetties rose, a gap 300 feet wide was left to permit passage of vessels at that point, since the scouring action had not been sufficient to open up the north channel as expected. Perversely, the water rushed along the south jetty and caused minor undermining until several spur jetties were constructed north of, and perpendicular to, the main south jetty. Serious

erosion also occurred along the south line of the south jetty, resulting from water falling over the low jetty when the river was higher than the ocean level during ebb tide flow. It was found necessary to raise the jetty above mean low water to prevent this. As rock was piled higher, appreciable settlement began.

Difficulties encountered - In August 1882, Congress again appropriated $150,000. A new contractor was added to the force, but an epidemic and an unusually severe winter in 1882-83 resulted in little progress. Channel erosion at once became so severe along the south jetty that the safety of the entire project was jeopardized. At places the jetty sank 15 feet. In a single night one portion sank 6 feet. By the middle of 1883, there was 2 feet less water over the bar than during the preceding year. The District Engineer, in reporting to the Chief of Engineers, expressed great doubt that Congress would appropriate money fast enough to permit continuation of contracts to raise the jetties and save them from certain destruction.

Work was accelerated, however, and sunken places were filled with more layers of mattress and stone. At length, the structures were found to be too narrow to place additional material, and work was begun in widening the base and building up to the level already reached. Unequal settlement of the foundation, the uneven bottom, and the shifting sands caused engineers and contractors unending hardships.

It was later discovered that the log mattress was not flexible enough to conform to the bottom surface sufficiently to prevent undermining scour action. One of the contractors, devised a facine mattress of bound brush instead of logs, which was cheaper and gave superior results. It was found also that two dikes of stones could be laid along the edges of the foundation and filled with an oyster shell core, giving excellent results, and speeding construction. The shells were later capped with stone. Appropriations continued, but often at such wide intervals as to require large expenditure of the new appropriation in repairing damages to the work accomplished in the earlier contracts.

Much of the earlier rock dumped on the jetties was gneiss and granite from New York, which was hauled in by seagoing barges in tow. Often the barges would arrive in rough weather, and the greatest efforts were expended in dumping their cargoes in place to prevent excessive demurrage. The New York product was expensive as compared to Florida limerock. While not as dense as the granite, the limerock had a natural affinity for marine growth such as oysters and other shell fish, which quickly cemented the jetty into a solid mass. Later, the New York product was entirely abandoned in favor of Florida limerock.

About 1890, the work was showing favorable results in that the north channel was beginning to scour out. In the report of the Chief of Engineers for that year, the original estimate of $1,306,000 was

increased to $1,471,000, with the recommendation that the north jetties be extended 2,260 feet to a point 11,250 feet from shore, and raised to full height for the shoreward 6,700 feet; and that the south jetty be extended nearly 2,000 feet, to a point 8,500 feet from shore with full height for the shoreward 4,400 feet.

Other appropriations were made, usually from $100,000 to $200,000 at a time; other contractors were brought in for new work. Concrete blocks weighing 6 to 10 tons were used in place of natural rock. In 1887, however, it was found that some of those 10-ton blocks were removed by gales on north jetty at a point about a mile out to sea. While that was unusual, it showed that no small stones could be used above mean low water, even as a support for larger stones. In a contract in 1891, it was specified that stone for topping must be at least 1 ton in weight and at least 50 percent over 4 tons each.

Beneficial results begin - By June 1892, definite results were noted from the work. About 4,500,000 cubic yards of soft material had been scoured out of the channel, which, if divided by the cost of the jetties, amounted to only 21 cents a cubic yard for removal--less than half the unit cost of the original dredging operations. The jetties were even then an unqualified success, and quite an engineering feat.

Original project completed - On July 13, 1892, and March 3, 1893, Congress appropriated $397,000 with which to complete the original project. The south jetty was completed to project dimensions during 1894-1895. During 1894 the bar channel deepened itself to 15 feet, where there had been only 10.7 feet the year before. At the completion of the project in 1895 there was 15 feet of navigable water over the bar, and 18 feet in the channel up to Jacksonville. This 18-foot channel throughout the river was due largely to a bond issue floated by Duval County. This bond issue made $300,000 available to the government as a local contribution. It was used in removing shoals and improving the channel near Dames Point, where existed the minimum channel dimensions between Jacksonville and the ocean. The money was expended under the direction of the Corps of Engineers in dredging in the river, and in the construction of training walls along the river to retain the flow down the permanent navigation channel, so that sufficient velocities would be maintained to keep the channel scoured out and free of sand. At the completion of the original work $1,785,000 had been spent, including the $300,000 contributed by the county.

Erosion along the river - As the jetties gradually became effective, changes took place farther up the river. Water began to flow past St. Johns Bluff at dangerously eroding velocities. The same thing happened at Dames Point. Banks began to cave in, and hundreds of thousands of yards of sand fell into the channel, which had to be dredged out later at great expense. It was not until retaining walls were built and exposed banks were rip-rapped with stone that the condition was corrected.

The jetties then stood completed to project dimensions, the foundations permanently settled and welded together by oysters and other sea growth. The south jetty was about 2-1/2 miles long, the north jetty was 3 miles long, and the two were about 1,600 feet apart at the outer ends. The final cap was made of huge pieces of South Carolina granite, which is about all that is visible today. It is impressive to note that only about 10 to 15 percent of the jetties can be seen, the remaining portions being below the low water level. From time to time the jetty topping has been replaced or added to as needed.

24 AND 30-FOOT PROJECTS

The original project was hardly completed when the need for deeper water became apparent. After several reports by the Corps of Engineers, and considerable backing by the Jacksonville Board of Trade, Congress made an additional appropriation of $350,000 in 1902 to start a 24-foot channel, 300 feet wide, from Jacksonville to the ocean. Two powerful dredges were built for the work, the "St. Johns" and the "Jacksonville." Within 4 years the 24-foot channel became a reality. By 1916, another project addition resulted in a 30-foot channel from Jacksonville to the ocean. The latter channel improvements were quite expensive, requiring the removal of tens of millions of cubic yards of material. The total cost of the project to June 30, 1946, was $19,540,000, including maintenance costs.

PRESENT PROJECT

Work was completed in 1951, providing a 34-foot channel from Jacksonville to the ocean. Minimum width is 400 feet, with greater widths up to 1,200 feet at critical banks. Existing protective works along the river include 7 miles of training walls, and revetments at five localities totaling some 3.5 miles of bank protection. Upstream from the 34-foot reach, project depths are 30 feet for about 2.5 miles past other piers and wharfs bordering the principal business area. The upstream limit of the project is 26.1 miles from the outer end of the jetties. above that project, but of lesser interest in this discussion, another project begins on St. Johns River and extends upstream 161 miles to Lake Harney. Dimensions of the latter waterway range from 13 feet deep by 200 feet wide at Jacksonville, to 5 feet deep by 100 feet wide in the upper reaches.

Costs of the Jacksonville to the ocean project from its inception to date have totaled $14,970,300 for new work and $11,222,600 for maintenance, a total of $26,192,900.

THE CUT-OFF CHANNEL

An interesting feature of the new work is the cut-off channel from Fulton to Dames Point, which removes three critical bends, and shortens the navigation distance by 1.9 miles. That work also entails training

dikes and additional revetments to channelize the flow, prevent erosion, and to reduce maintenance costs. As a part of the cut-off channel, an extensive dike was provided parallel and south thereof to prevent shoaling in the channel. An access-way was provided in the dike for the passage of small craft, and to assist in reducing any tendenoy toward stagnation in Mill Cove, the large water expanse south of the cut-off.

Model study.--Design of the features of the 34-foot project, inoluding the cut-off channel and various training walls, was based on an extensive model study conducted by the Waterways Experiment Station in Vicksburg, Miss. A scale model was constructed of the lower 110 miles of the river. Scales employed were 1:1,000 horizontally and 1:100 vertically. Tides and flows were mechanically reproduced in the model and interpreted in an exhaustive study. Since completion of construction, velocities, tidal effects, and other hydraulic phenomena have been measured on the prototype and oompared to model results with surprising accuracy. It becomes quite obvious that if present model techniques had been available at the inception of work on St. Johns River, many expensive trial and error methods could have been eliminated.

JACKSONVILLE HARBOR

The port of Jacksonville has 81 wharves and piers, affording more than 8 miles of berthing space for vessels. It is served by four major railroads. Adequate warehouse and cold-storage facilities are available in connection with the port. Repair facilities are adequate for marine needs and include floating dry-dook installations.

The port is an important distributing center for petroleum and fertilizer products, oyster shell, paper, creosote, automobiles and machinery, coffee, sugar, and other items from both foreign and domestic sources. It also ranks high as a naval-stores port, and enjoys a large commerce in lumber, fruits, and vegetables. Port facilities are adequate for existing oommerce, with ample space for expansion to accommodate future needs. For Jacksonville Harbor in 1951, foreign waterbourne oommerce totaled 755,432 tons imported and 214,072 tons exported. Domestic coastwise receipts totaled 2,480,225 tons, with shipments totaling 59,562 tons. Internal receipts totaled 268,433 tons and shipments amounted to 489,464 tons. Local commerce accounted for 144,514 tons, or a grand total of 4,411,702 tons for the year.

CONCLUSION

Throughout this case history, the latest principles of coastal and hydraulic engineering have been adopted as they become known. From the earliest beginnings of dragging heavy chains across the bar for deepening the channel, to the present efficient excavation performed by modern pipe-line and hopper dredges, the best in scientific knowledge

has been employed. From the earliest "cut and try" procedures to the latest techniques in model studies, the St. Johns River has received the best that our field of engineering has had to offer. The records show that for every increase in depth of the river there has been a corresponding increase in population and commercial growth in Jacksonville. In a hundred years, and at a cost of $26,000,000, the bar of a tidal river has been conquered, and a great deep-water port has developed at a distance of some 25 miles from the sea. Surely the expenditure of Federal funds for the betterment of St. Johns River and its ocean bar have resulted in great and wide-spread national benefits.

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