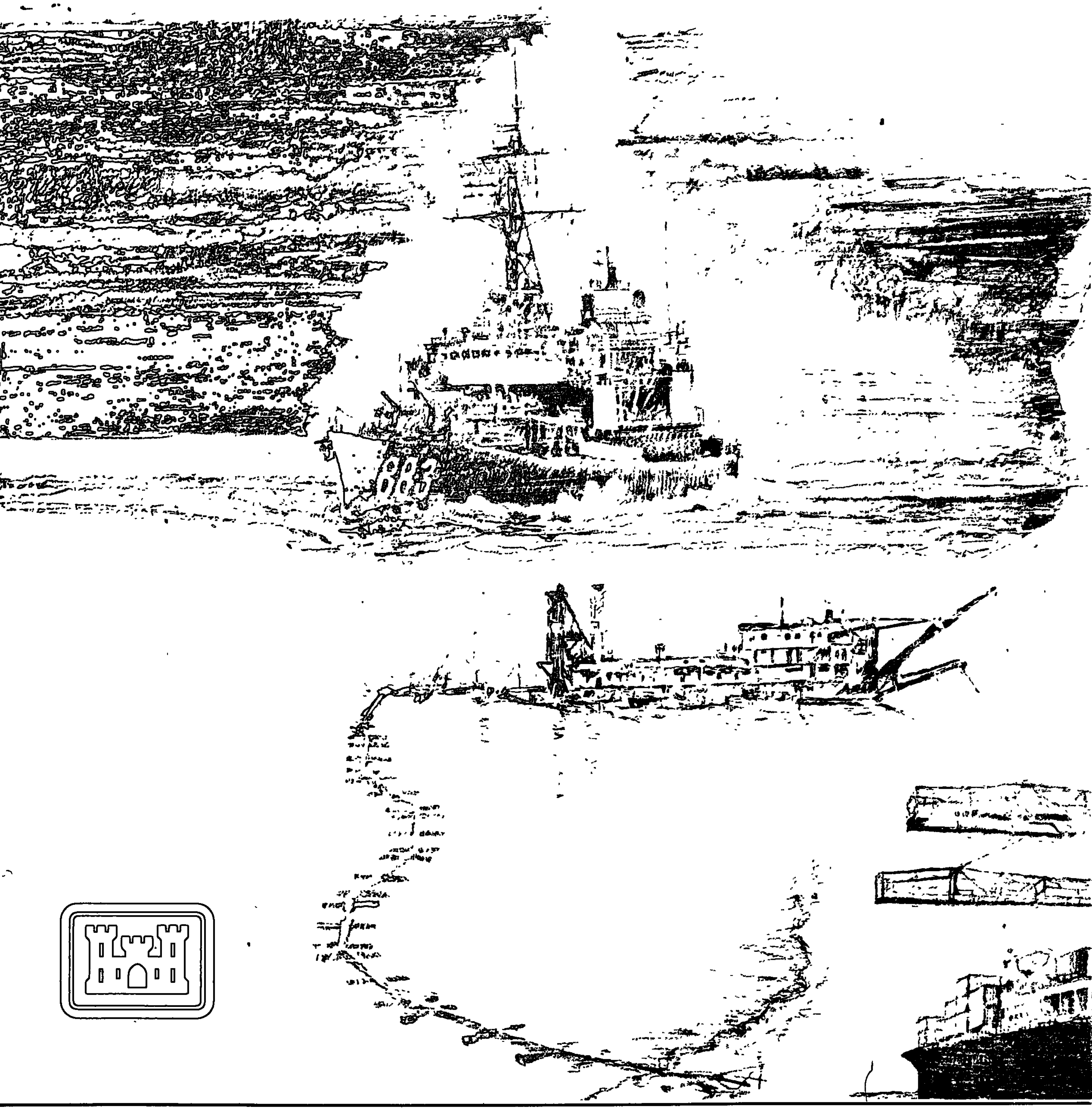
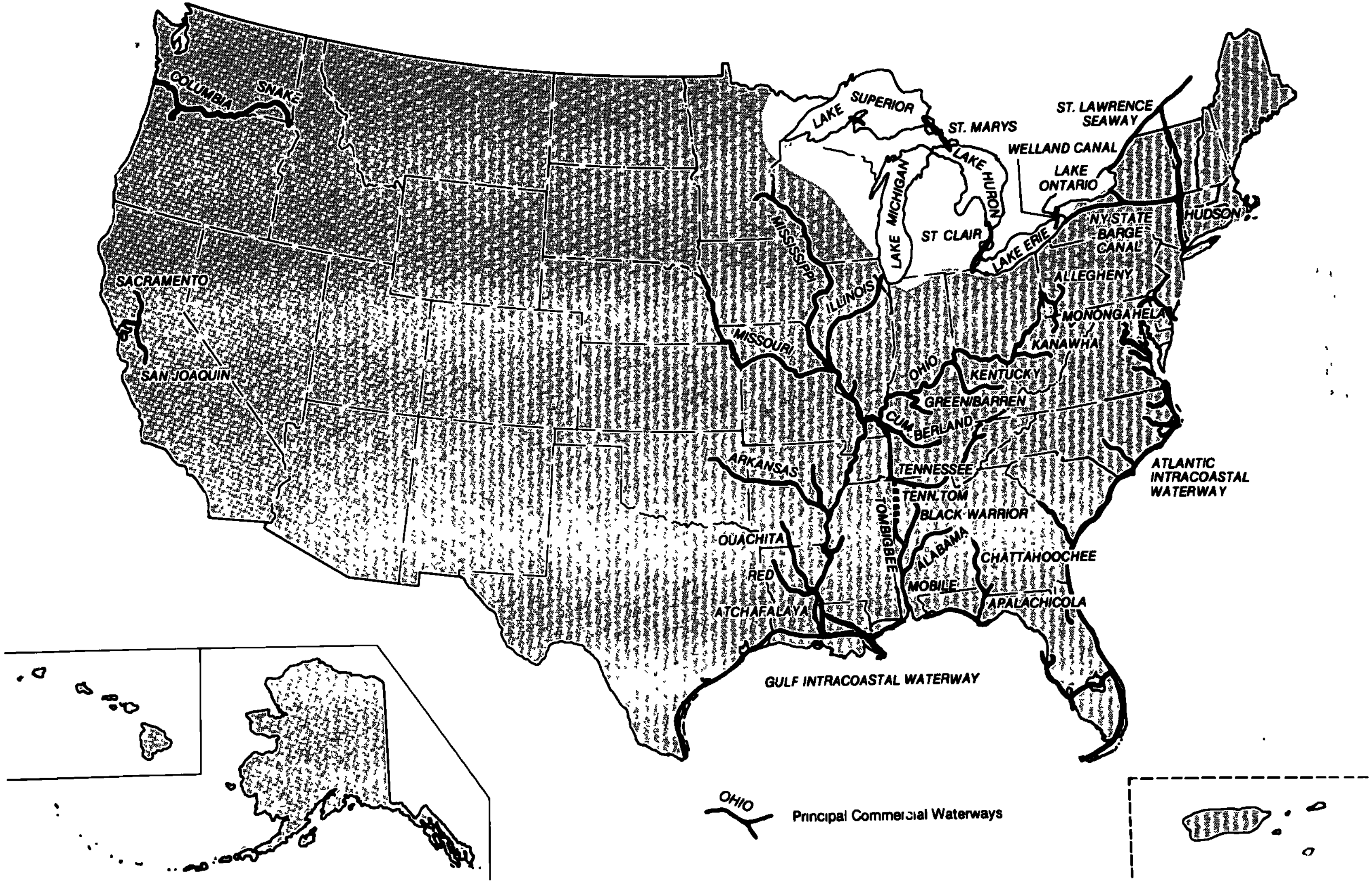
HISTORY OF GREAT LAKES NAVIGATION

National Waterways Study □ U. S. Army Engineer Water Resources Support Center □ Institute for Water Resources

January 1983
Navigation History NWS-83-4



THE NATIONAL WATERWAYS
GREAT LAKES SYSTEM



HISTORY OF GREAT LAKES NAVIGATION

John W. Larson

January 1983
Navigation History NWS-83-4

National Waterways Study □ U.S. Army Engineer Water Resources Support Center □ Institute for Water Resources

AUTHORITY FOR THE NATIONAL WATERWAYS STUDY

The Congress authorized the National Waterways Study (NWS) and provided the instructions for its conduct in Section 158 of the Water Resources Development Act of 1976 (Public Law 94-587):

> The Secretary of the Army, acting through the Chief of Engineers, is authorized and directed to make a comprehensive study and report on the system of waterway improvements under his jurisdiction. The study shall include a review of the existing system and its capability for meeting the national needs including emergency and defense requirements and an appraisal of additional improvements necessary to optimize the system and its intermodal characteristics. The Secretary of the Army, acting through the Chief of Engineers, shall submit a report to Congress on this study within three years after funds are first appropriated and made available for the study, together with his recommendations. The Secretary of the Army, acting through the Chief of Engineers, shall upon request, from time to time, make available to the National Transportation Policy Study Commission established by Section 154 of Public Law 94-280, the information and data developed as a result of the study.

PREFACE

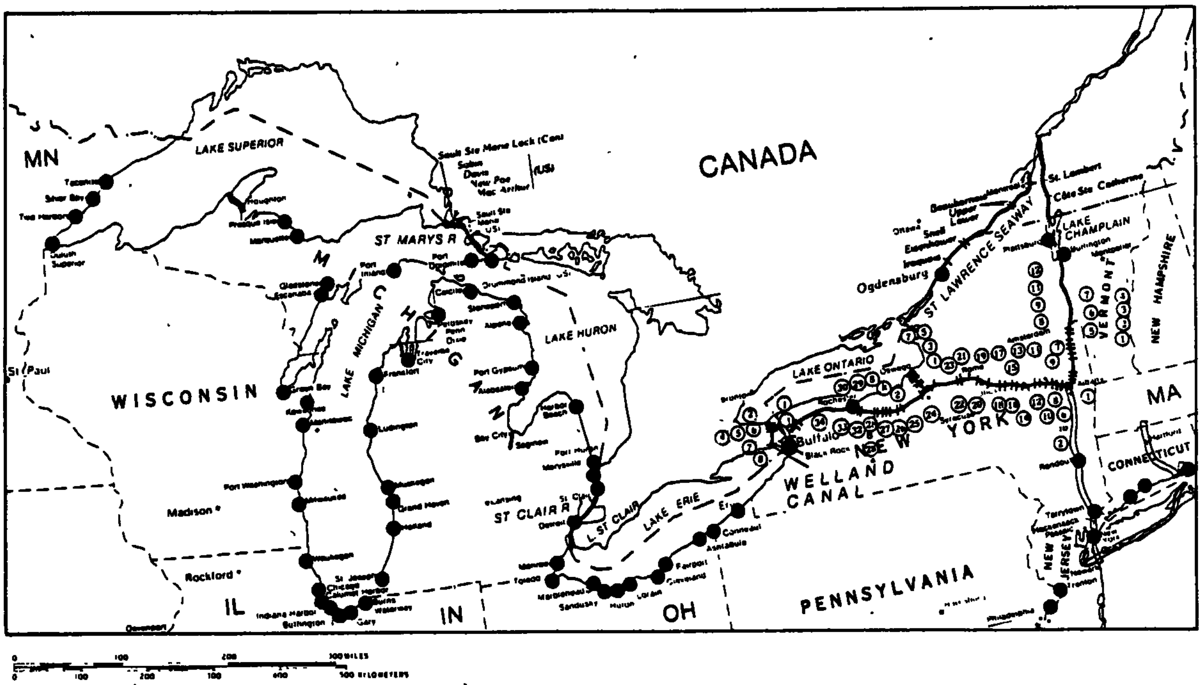
This pamphlet is one of a series on the history of navigation done as part of the National Waterways Study, authorized by Congress in Public Law 94-587. The National Waterways Study is an intensive review by the Corps of Engineers' Institute for Water Resources of past, present, and future needs and capabilities of the United States water transportation network. The Historical Division of the Office of the Chief of Engineers supervised the development of this pamphlet, which is designed to present a succinct overview of the subject area.

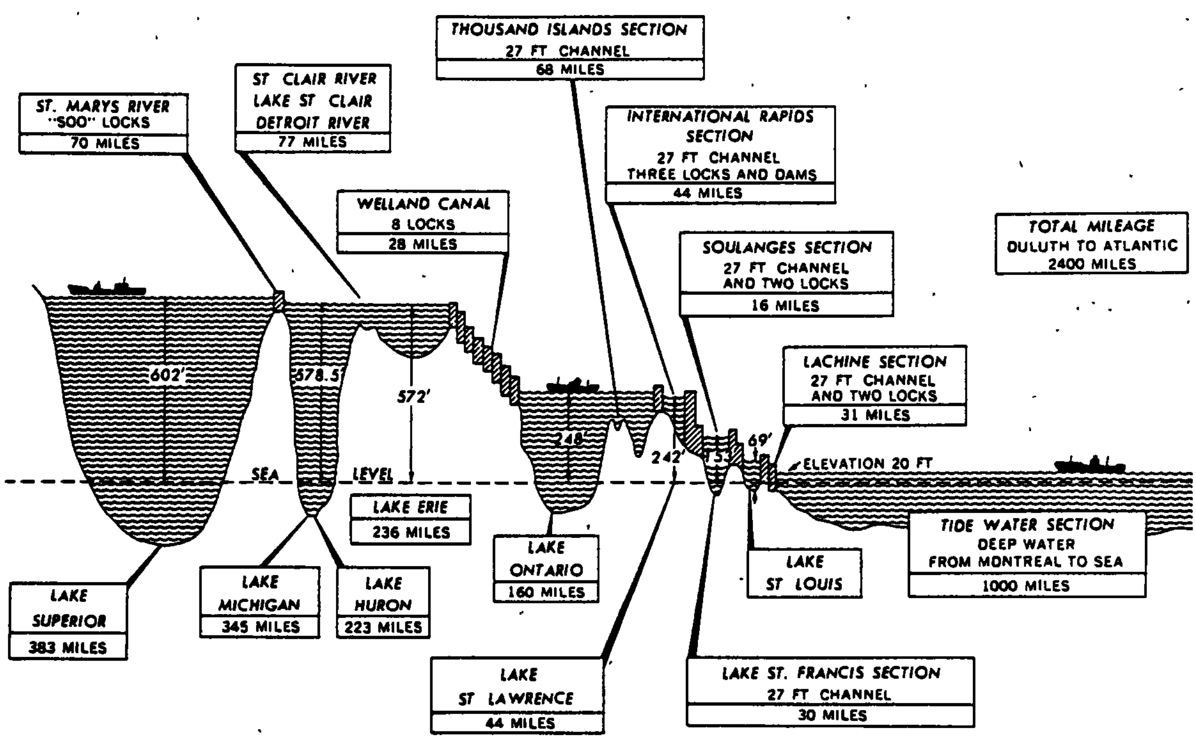
John T. Greenwood

JOHN T. GREENWOOD
Chief, Historical Division

TABLE OF CONTENTS

PROFILE OF THE GREAT LAKES AND ST. LAWRENCE SEAWAY





Source: Great Lakes Basin Framework Study; Great Lakes Basin Commission, 1975.

Chapter 1

BEGINNINGS OF LAKE COMMERCE

The French were the first Europeans to explore the uncharted waters of the five Great Lakes. Missionaries and fur traders traveling in canoes and small boats extended their activities from Montreal to the head of the lakes and beyond. They established small communities at Detroit, Sault Ste. Marie, Green Bay, and elsewhere.

The British gained a foothold on the lakes at Oswego on the southern shore of Lake Ontario in 1727. From Oswego, beginning in 1755, they launched several sloops and a schooner of 60 tons burden. When the British completed the conquest of Canada in 1753, they increased their Lake Ontario fleet by the addition of a number of French merchant and whale vessels.

Although the Americans achieved their independence in 1783 with Lake Ontario and the St. Lawrence River as their northern boundaries, owing to disputed claims, England continued to hold such strategic points as Oswego until 1796. Then, under terms of the Jay Treaty, the British garrisons received orders to withdraw. The establishment of an American fleet on Lake Ontario was delayed until after 1800.[1]

On Lake Erie the situation was similar. Although the Americans launched a schooner, the Washington, at Erie, Pennsylvania, in 1797, it was sold after its first season on Lake Erie to a Canadian, transported on wheels around the falls of the Niagara River to Lake Ontario, where in 1798 it sailed as a British vessel under the name "Lady Washington."[2]

After 1800, American vessels became more plentiful on both lakes. In the spring of 1817 the American steamer Ontario was launched at Sackets Harbor. The Ontario and the Canadian steamer Frontenac, launched but not put in use the previous September near Kingston, shared the reputation of being the first steamers on the Great Lakes. These vessels were followed in 1818 by Walk-in-the-Water. Launched at Black Rock on the Niagara River near Buffalo, New York, it was the first steam vessel on the lakes above Niagara Falls.[3]

About 1800, commerce began to increase on Lake Ontario and Lake Erie, but the movement of commodities was a slow and laborious process before roads were improved and canals and railroads built. Salt, for example, was an important item in the commerce of the time. Boats and teams carried salt from Salina to Oswego, New York, where it was loaded on lake vessels for shipment to Lewiston on the Niagara River. At that port it was unloaded from the ships, loaded on wagons, and transported to the head of the portage at Schlosser, New York where it was again unloaded, put on boats for the short journey to Black Rock, and transferred to lake vessels, its destination a number of communities on the shores of Lake Erie.[4]

Other goods carried westward across the State of New York by pack train or oxcart to Buffalo were loaded into lake vessels for shipment to points on Lake Erie. The expense of moving goods by land from New York City to Buffalo, as much as $100 per ton, greatly restricted the volume of this trade. Yet sufficient goods reached Buffalo and Black Rock in 1817 to keep 20 small merchant vessels operating on Lake Erie. Between 1817 and 1820, the number of these small vessels of 18- to 65-ton burden increased rapidly until each of the ports along Lake Erie's southern shore had one of its own.[5]

By 1820 the lake commerce had extended westward as far as Green Bay. Army installations and small civilian communities at Green Bay, Mackinac Island, Fort Gratiot at the foot of Lake Huron, and Detroit provided sufficient traffic to justify vessels calling at these points on a regular basis. They brought in troops and supplies and carried out beaver and other skins, maple sugar, and whitefish.[6]

To aid the growing lake commerce, Congress in 1817 appropriated $17,000 for two Lake Erie lighthouses. One was completed in 1818 at Erie, Pennsylvania, the other 2 years later at Buffalo. Other improvements for lake navigation were carried out either by local interests or, less frequently, by States.[7]

One of the first such improvements was begun in 1819 at the mouth of the Grand River, later the site of Fairport, Ohio. There a group of citizens formed a company, obtained a state charter, and raised $8,000 to construct a breakwater. Work on the project continued through 1821, but the company's funds ran out and storms destroyed much that had been accomplished. At Buffalo a group of citizens was more successful. In 1820 they obtained a $12,000 loan from the state of New York to begin an ambitious project to improve the mouth of Buffalo Creek. With the borrowed funds they constructed a 1,300-foot-long pier to protect the harbor entrance and enable the small vessels then plying the lakes to find safety in the lower reaches of the river.[8]

Buffalo citizens improved their harbor so that it and not its nearby rival, Black Rock, would become the western terminus of the Erie Canal. The "great canal" reaching from Albany on the Hudson River to Buffalo on Lake Erie had been under construction by the state of New York since 1817. When completed in 1825, the canal became the greatest single transportation factor in the early settlement and economic development of the lakes region. In the decades after the canal was opened, the cost of transporting a ton of freight from Buffalo to Albany was reduced from as much as $100 to under $8 a ton. The cheap transportation encouraged an increasing flow of immigrants to the lake country. Once in the West, settlers could at reasonable cost send the surplus products of their fields to eastern markets and import manufactured products from the East and abroad.[9]

PIONEER IMPROVEMENTS

Within a generation after the opening of the Erie Canal in 1825, the fertile open land around the American shores of Lake Ontario and Lake Erie was converted to farms, and many an isolated village became a bustling center of commerce and infant industry. Farther west around Lake Michigan in new immigrant settlements, agriculture and commerce, replacing the fur trade and Indian ways, produced a civilization similar to that on the eastern lakes.

The westward march of seaboard civilization was encouraged by local, state, and federal expenditures to improve transportation routes between the East and Middle West. Federal improvement of lake harbors began in 1824 under the administration of President James Monroe when Congress appropriated $20,000 for deepening the channel leading into the harbor of Presque Isle at Erie, Pennsylvania.[10] Throughout the pre-Civil War era, such appropriations were controversial. Strong supporters of states' rights opposed them, saying that these works were a local responsibility. Proponents of the appropriations insisted that, if the federal government could improve seaports, it could also spend money on lake ports. Harbor communities were chief among proponents of federal support of lake improvements but a federal role was also favored by most other western communities. Western states with little money and an urgent need for transportation lacked the strong tradition of state sovereignty peculiar to the original 13 states. With rare exception, members of Congress from western states voted for lake harbor and other internal improvement measures.[11]

Under President John Quincy Adams (1825-1829) an active executive policy favored internal improvements. In an act of 20 May 1826 the Nineteenth Congress provided specific appropriations for a number of harbors and rivers and for several surveys. Included in the appropriations were $15,000 for a new pier and repairing an old one at Buffalo Creek on Lake Erie and $3,000 for dredging Sackets Harbor on Lake Ontario. In addition to the two New York projects, the bill appropriated money for dredging four harbors in Ohio, at the mouths of the Grand River ($5,600), Ashtabula Creek ($12,000), Cunningham Creek

($2,000), and the Huron River ($5,000). Small sums ranging from $200 to $400 were provided for surveys to determine the cost and expediency of improvements at Oswego Bay on Lake Ontario and Sandusky Harbor and La Plaissance Bay on Lake Erie.

Legislation in the three years following 1826 provided sums to continue already authorized projects or to initiate new ones. An act of Congress on 2 March 1827 provided for 14 projects or surveys, among them a new pier halfway between Buffalo and Erie at Dunkirk Harbor on Lake Erie and another for improving Cleveland Harbor at the mouth of the Cuyahoga River. An act of 23 May 1828 provided funds for ten Great Lakes projects, two of which were new: removing a sand bar and building piers "or other works" at Black River (later Lorain, Ohio) on Lake Erie and making a survey of the mouth of the Genesee River on Lake Ontario, seven miles north of Rochester, New York. An act of 2 March 1829 appropriated funds for three new Great Lakes projects including improvements at Black Rock, New York, on the Niagara River; at Big Sodus Bay, New York, on Lake Ontario; and at Conneaut Harbor, Ohio, some 70 miles east of Cleveland on Lake Erie.

Although during his two terms as President, Andrew Jackson (1829-1837), unlike Adams, carried out no consistent internal improvement policy, his reputation as an opponent of internal improvements was undeserved. He vetoed six internal improvement bills, but approved 66; and during his administrations the federal government spent $11 million on internal improvements, a sum larger than that spent by all previous administrations together.

Between 1829 and 1837, Jackson approved expenditures to complete the Great Lakes harbor projects begun under Adams and to maintain and improve them by repairing storm damage, replacing decayed timber, deepening channels, building and extending piers, providing turning places, and in a few instances replacing wooden superstructures with stone masonry. A small but steady stream of federal funds were channeled into these Great Lakes projects during the 8 years of Jackson's two administrations.

Internal improvements continued to be supported by the federal government in the first two years of the administration of President Martin Van Buren (1837-1841) despite a major panic in 1837 and a depression which lasted six years. An act approved by Van Buren on 7 July 1838 provided for continued work on Great Lakes harbors but by 1840, when the political climate had changed, Congress appropriated only $1,000 for one internal improvement project. The almost annual river and harbor appropriations of the John Quincy Adams and Andrew Jackson administrations were not restored until after the Civil War.

ARMY ENGINEERS

Federal lake harbor improvements between 1824 and 1839 were carried out under the direction of officers of the U.S. Army Corps of Engineers. After 1828 and until 1863, the improvements were under the direction of the Corps of Topographical Engineers.[12] Army engineers were chosen to work on these civil projects because few qualified civilian engineers were available, employment on civil works provided the military engineers experience of benefit to the nation in time of war, and the harbor works were considered important to national defense. John C. Calhoun, Secretary of War in 1819, writing to Henry Clay, then Speaker of the House of Representatives, summarized the reasoning which underlay the use of military engineers on civil projects: "Whether we regard our country's internal improvements in relation to military, civil, or political purposes, very nearly the same system, in all its parts, is required."[13]

PIONEER HARBORS

Most early federally improved Great Lakes harbors were at the lower reaches of rivers or creeks. The harbors were improved by constructing nearly parallel piers from just upstream of the river's mouth into the deep water of the lake. The piers were constructed 200 feet apart or less, as close to one another as practical, so that river freshets would wash away any sand that tended to settle in the channel area between the piers. However, in rough weather it was difficult for lake vessels, most of which still navigated under sail, to proceed safely into a harbor entrance which was no more than 200 feet wide. To correct this problem one of the parallel piers, the one on the weather side, was sometimes extended beyond the other, thus acting as a breakwater behind which vessels could right themselves before proceeding into the harbor entrance. Later, after the Civil War, a modification of the basic plan included one or more breakwaters constructed offshore and at angles to the harbor entrances.

As lake vessels became larger, they required a greater harbor depth, and the parallel piers extended into still deeper water. The scouring effect of spring freshets was less effective in these deeper and longer entrance channels and eventually, toward the end of the pioneer period, regular maintenance dredging was required to keep the channels open. As vessels increased in size, they faced an additional problem. They could not turn around in the lower reaches of the rivers and, before 1840, wending places--what today would be called turning basins--were necessary in some harbors.

Wood was generally used in the construction of early lake harbor piers but, between 1835 and 1839, the wooden superstructure of the south pier at Buffalo Harbor was replaced with masonry. Masonry was a more expensive type of construction than wood and required specialized skills not everywhere available. Despite cost, by 1840 it was either being used or considered for superstructures at the larger lake harbors. A more unusual departure from the use of wood was carried out in 1839 at Oswego where concrete was successfully used instead of timbers as a foundation for a new masonry pier. But wood, either for its economy, the ease with which it was worked, or other reasons, continued to be used in Great Lakes harbor structures until near the end of the century. It was replaced by concrete only when timber was no longer readily and cheaply available in the Great Lakes area.

In the early years of Great Lakes harbor construction, piers were built of timber cribs made of logs flattened on two sides and about 20 or 30 feet long. The crib logs, notched together in much the same way as the walls of log cabins of the time, were fastened with wooden pegs or iron bolts and strengthened inside with cross beams. Constructed on or near shore, they were floated into position, filled with stones gathered from the shore or nearby fields, and sunk upon the natural bottom of the lake. Once a string of cribs was in place a superstructure, usually of sawed timber one foot thick, was built over them to a height of six to seven feet above the normal water level. The superstructure was then filled with small stones and planked over to form a deck. There were variations in pier construction and much local experimentation to offset recurring problems. Very early piers, built higher than they were wide, were not strong enough to withstand beating by waves, wind, and ice. In time, improvements were made on early construction methods, but so long as timber was used in building piers, frequent repairs were required on all above-water portions of the structures. Well-constructed underwater timber cribs lasted indefinitely.[14]

By 1837, 16 lake harbors had beacons or lighthouses for the safety and convenience of navigators. Army engineers were responsible only for construction. Great Lakes lighthouses, as those on the Atlantic coast, came under the jurisdiction of the Fifth Auditor of the U.S. Treasury. He designated collectors of revenue who also acted as superintendents of lighthouses within their districts.[15]

Federal harbor and lighthouse works were only part of a vast number of improvements in the period between 1820 and 1840 which contributed to a rapidly growing lake commerce. In 1825, one steamboat and 30 or 40 sailing craft with a combined tonnage of about 2,500 sailed on the lakes above Niagara Falls. By 1839 a total of 61 steamboats and 225 sailing vessels accounted for a combined tonnage of 35,125. During the same period, the state of New York completed the Erie and Oswega Canals, Canadian interests finished the Welland Canal around Niagara Falls, and the state of Ohio built the Ohio Canal. Some idea of the impact of these improvements may be gained by tracing the fortunes of a few harbors.[16]

When Federal improvement of Buffalo Harbor began in 1826, the number of vessels arriving and departing annually had more than doubled from the 120 that frequented the harbor 5 years earlier. Between 1825 and 1835 this traffic increased nearly tenfold to 3,280 vessels. Buffalo, in the words of Topographical Engineer Captain William G. Williams, was becoming "the grand depository of all the merchandise of the lakes destined for the harbor of New York and equally that of all that was destined to supply the extensive region situated upon the lake shores. . . ."[17]

Buffalo's chief rival for the western trade was Oswego on Lake Ontario. The busy traffic at Oswego harbor did not equal that of Buffalo on Lake Erie even when the Oswego Canal was completed by the state of New York in 1828 to connect Oswego harbor with the Erie Canal. One year later, however, vessels arriving and departing Oswego had access to the lakes above Niagara Falls through the Welland Canal which Canadian interests completed around Niagara Falls in 1829. The water route from the west to New York City by means of the Welland Canal, Lake Ontario, and Oswego Canal was less costly and quicker than the Erie Canal route east from Buffalo. Toll was paid by the mile in the early days and the Welland-Oswego route involved 168 miles less travel in canals and 20 percent less time.

As a result of Federal improvement at Oswego beginning in 1827 and its canal connections with the Erie Canal and the upper Great Lakes, the commerce of Oswego harbor grew rapidly. By 1840 it received three-quarter million bushels of wheat through the Welland Canal from the upper lakes, only one-quarter million less than Buffalo received that year from the West. By the early 1850's, Oswego was an even more substantial rival of the Lake Erie Port. In 1852, Oswego received 6,500,000 bushels of western wheat, a million more than Buffalo. Oswego's grain trade declined after 1852 when railroads at Buffalo began to capture much of the grain transport to New York.[18]

Of all western harbor commerce, Cleveland's was most impressive for the period. During 1825, when 54 sailing vessels and 21 steamboats visited that port, the combined value of its imports and exports was $182,871. Thirteen years later, in 1838, arrivals at Cleveland included 1,095 sail and 1,318 steam vessels and the combined value of the harbor's exports and imports exceeded $20 million. At the lake end of the Ohio Canal, Cleveland tapped a vast agricultural hinterland which accounted for the extraordinary expansion of its commerce.[19] Similar developments, though on a smaller scale, took place at other harbors on the lakes. Lake Erie led the way, followed by Lake Ontario and Lake Michigan. Only Lake Huron and Lake Superior, those lakes farthest north and west, remained outside of this general pattern. There were as yet no Federal improvements on Lake Huron or Lake Superior although the Government had already improved 7 harbors on Lake Ontario, 15 on Lake Erie, and three on Lake Michigan.

BEGINNINGS OF LAKE SURVEY

Though Congress provided no funds for harbor projects in 1841, it did appropriate $15,000 to commence a survey of the northwestern lakes. Responsibility for the work fell to Captain William G. Williams, in charge of improvement of Buffalo Harbor. Captain Williams was well acquainted with such work. His survey at Buffalo and Black Rock Harbors in the winter of 1838-39 was a forerunner of the more ambitious survey of all of the Great Lakes. Taking advantage of frozen conditions on Lake Erie, Williams measured a line on the lake from the pierhead at Black Rock to a point on shore above the south channel at Buffalo. The distance was precisely 4 miles and 1,225 feet. Then, measuring the angles of imaginary lines extending from the two ends of this base line to a fixed point at a distance on the Canadian shore, he established a triangle with sides of known lengths. Using either of the two new lines as a new base line, he could extend the system indefinitely. Measuring the angles to determine such triangles was called triangulation, while a survey carried out in this way was called a trigonometrical survey.

Williams favored hydrographic surveys as well. He said that while trigonometrical surveys made it possible to determine the exact positions of permanent landmarks, hydrographic surveys should supplement them in determining depths of water in the lakes in relation to thse landmarks. Compiled on charts, the information from both types of surveys was important to the safety of lake navigation and useful for the systematic planning of improvements for navigation. When he reported on his 1838-39 survey in the area of Buffalo and Black Rock, Williams expressed the hope that such surveys would soon be commenced for all the lakes since they would serve "as a basis of a great system, which undoubtedly, these (lake) improvements are destined to become."

Congress was a long way from funding a system of lake improvements but Williams' hope for further lake survey work was rewarded. After 1841, Congress provided for surveys of the northwestern lakes with annual appropriations ranging from about $20,000 in the early 1840's to a prewar high of $85,000 in 1859.

The survey work which Williams began was not completed until 1882 but he would not have been surprised. While he saw the immediate value of the survey results in charts useful for the safety of lake navigation, he looked forward to future benefits from the careful scientific work involved in making them. A system of improvements of the lakes based on exact knowledge was not to be accomplished overnight, he said, but "was a work that should grow with the country." His vision and the beginning he made in systematically surveying the lakes helped to assure continued federal involvement in navigation improvements on the lakes.[20]

THE NEED FOR FURTHER IMPROVEMENTS

Those who engaged in lake commerce in the early 1840's made good use of the navigation charts based on federal lake survey work but they wanted a great deal more from the federal government. Demands for federal assistance became more insistent as the lake trade grew and involved an increasing number of vessels operating over a larger area. The value of lake trade increased from $4 million to over $60 million between 1835 and 1846.[21] In the earlier part of this period when Lake Erie trade was dominant, Ohio harbors contributed about 80 percent of the exports and receipts. While the Lake Erie trade remained dominant, Lake Michigan was rapidly becoming more important during the 1840's and early in the decade the most urgent requests for federal help in constructing harbors came from that quarter.

Those who favored federal improvements on the lakes made their desires known to Congress in various ways. James Doty, who in 1840 represented Wisconsin Territory in Congress, received many requests from his constituents for improvements on Lake Michigan. In May 1840, for example, Doty received a letter from E. Starr, a resident of Milwaukee, complaining about the lack of harbors on the western shore. "Three or four steamers have passed up the lake with many immigrants for our Territory," he wrote, "but the lake was so rough they could not land here . . . . There had been property enough lost within the last ten days on Lake Michigan to have built three good harbors. The steamboat, Champlain, the brig, <u>Queen Charlotte</u>, and four or five schooners are ashore, and some of them total wrecks, and what a pity it is that they were not all loaded with Senators and members of Congress."[22]

Those who desired resumption of federal improvements on the lakes found that topographical engineers assigned to lake harbor work were able to offer statistics supporting local requests for harbor improvements. On 1 March 1842, Captain Thomas Jefferson Cram, stationed at Racine, Wisconsin, reported that, between 1834 and 1841, annual receipts of Lake Michigan steam and sail vessels increased 113-fold (from $3,542 to $401,595).

He also noted that, while commerce was growing rapidly, navigation on the lake was very dangerous. In those seven years, 90 vessels, 118 lives, and over $1 million in property had been lost on Lake Michigan. Most of such lake disasters could be prevented, he advised, by improving a few natural harbor sites. Captain Williams wrote Colonel Abert in October 1842, "to submit to the bureau my impression of the extreme necessity of creating harbors along the coast of Lake Michigan."[23]

Conditions for navigation were not much better on Lake Erie. From Buffalo in December 1842, Williams wrote to Colonel Abert concerning "the late gales and numerous disasters that have been the result of want of proper protection to lake navigation. . . On the lakes there is at all times a dangerous proximity of coast, upon which vessels must be thrown in a long continued gale, whilst on the ocean there is generally room to drift until the storm is over." He then described the condition of more than 1,000 miles of lakeshore from Buffalo to Chicago, calling attention to the lack of harbors for shelter of vessels in times of storm. He did not advocate the improvement of every harbor "out of considerations of expediency and economy which the times demand," but he maintained ". . . there are some points on the lake which, it seems to me, the government is called upon emphatically to protect."[24]

Advocates of federal lake harbor work had reason for optimism in the early 1840's. In April 1841, Whig Vice President John Tyler became President following the death after less than one month in office of President William Henry Harrison. Tyler favored internal improvements for the West. He said they were "due every consideration of public policy" and that "the lakes and rivers of the West should receive all such attention at the hands of Congress as the Constitution will enable it to bestow." On 3 March 1843, he approved a bill for the protection of commerce on Lake Michigan which authorized the expenditure of $30,000 for the construction of a harbor at or near Milwaukee, $25,000 for continuing harbor work at Chicago, and a like sum for continuing work at St. Joseph Harbor.

CANADIAN IMPROVEMENTS

The continued attention of Army Engineers to their river and harbor responsibilities even when there were no funds for improvements helped assure survival of the federal program. Other factors were also decisive. One was Canadian activity in improving waterways and other transportation-related public works. Upper and lower Canada were united in 1841. In 1842 the Province of Canada, as it was called, received a substantial Imperial loan (1.5 million) for roads to unite the Province and for waterway projects to enlarge the Welland Canal and improve navigation on the St. Lawrence River. All projects were under the direction of a Board of

Works which provided a degree of centralization unknown in such matters in the United States. Indirectly, the Canadian project was an important factor in support of those favoring an enlarged Federal role in lake improvements.

The Canadian project caused a stir in the United States. A Senate Committee on Commerce was made aware of its implications for American trade by the report of a special committee of the legislative assembly of Canada. The report, dated February 1843, stated that while "colonies of the British Empire are maintained at . . . great expense for the sake of their trade, the securing and controlling (of the trade) of the (American) western states . . . making them in effect colonies . . . is an object of no little moment particularly when it can be obtained without expense or even negotiation." The Canadian policy, if successful, would have captured the American grain trade and taken business away from Buffalo, Oswego, and New York City while greatly benefiting Montreal, Canada's major port.[25]

Canada's waterway policy was an important reason for Americans to have a more aggressive policy of their own, or so it was believed by many influential voices around the lakes and in Congress. In February 1843, the Senate Committee on Commerce, speaking of the "young and vigorous" commerce of the lakes, rejected the idea of idly standing by while the western States were made, in effect, British colonies and recommended consideration of all the many improvements desired by the lake communities. The committee expressed the conviction that all such improvements should "bear relation each to the other, and be perfected with a view to a general system . . . "[26]

RESUMPTION OF FEDERAL PROJECTS

Federal help for lake harbors came again, after a half dozen years of neglect, during the first session of the 38th Congress in 1844. On 11 June, President Tyler approved a river and harbor bill which appropriated funds ranging from $40,000 to $5,000 for 20 Great Lakes harbors. Buffalo and Erie harbors were each awarded $40,000: Cleveland and Michigan City, $25,000; Oswego, River Raisin, St. Joseph, Chicago, and Milwaukee, $20,000; and the remaining harbors, lesser sums. A few days later, on 15 June, President Tyler approved separate bills appropriating $12,000 each for the harbors of Southport (Kenosha) and Racine on Lake Michigan. Though the 1844 appropriations were as generous as those of earlier similar legislation, they were far below estimates to repair and render permanent the various harbor structures. The 1844 sums were important for making repairs, completing unfinished work, or making relatively modest extensions of existing projections, but they did not in themselves allow more ambitious improvements necessary for permanent protection of lake commerce.

After 1844, eight years passed before funds were again available for lake harbor projects. Although the $2.25 million appropriation provided for rivers and harbors in 1852 during the presidency of the Whig Milliard Fillmore (1850-1853) was the largest of its kind in antebellum history, it was hardly more than a token. To be sure funds for several new lake harbors were provided, including five on Lake Michigan; Manitowac and Sheboygan, Wisconsin: Waukegan, Illinois: and New Buffalo and Black Lake Harbors, Michigan. In addition, Federal harbor projects were authorized on Lake St. Clair at the mouth of the Clinton River, and on Lake Ontario at Little Sodus Bay, New York. Unfortunately, the funds appropriated in 1852 were barely enough to commence these projects. The sums allotted to the older federal harbors permitted only the most urgent repairs and maintenance and allowed for modest project extensions at only a few sites.

Any hope that additional funds would be authorized in 1855 was firmly dashed by President Franklin Pierce (1853-1857), who on 4 August vetoed a comprehensive river and harbor appropriation designed to make possible continued rehabilitation of harbor structures. By 1855, funds of harbor improvement were again exhausted, and none would be appropriated until the Civil War.

EFFECT OF RAILROADS

The character of the lake trade began to change in the 1850's as a result of railroad competition. John L. Henderson, commercial editor of the Buffalo Democracy, wrote in 1855, "The south and east shores of the chain of lakes (are) lined with railroads which are fast drawing passenger travel from the lakes." He noted that, while passenger steamers were disappearing, a rapidly increasing number of large steam vessels were being built to haul grain and other bulky cargoes. Competition from railroads encouraged transporting bulk cargoes in vessels as large as the Great Lakes connecting channels would permit.[27]

Competition was only one aspect of the lake and rail transportation relationship. Railroads, like canals, contributed to the growth of lake transportation. They did so by opening up tributary areas from which agricultural surplus was shipped to lake ports and to which manufactured items were shipped in return. The situation at Chicago in 1855 was described by Topographical Engineer Lieutenant Colonel James D. Graham, who was in charge of Federal harbor improvements on Lake Michigan. "There are as many as ten principal railroads," Graham reported, "which concentrate at this port after having traversed and intersected an area of most fertile country of 163,000 square miles."[28]

During 1855, he noted, Chicago received over $88 million and forwarded nearly $98.5 million in merchandise by railroad. On the other hand, the port received $95,700,000 and shipped nearly $35 million in goods by lake. Most products of the hinterland came to Chicago by rail or through the Illinois-Michigan Canal, completed by the State of Illinois in 1848. Shippers sent wheat, over seven million bushels in 1855, to Chicago primarily by rail; 6,622,000 bushels was sent on, most of it by way of the lake, to eastern markets. Chicago imports from the East by lake were largely manufactured products.[29]

Despite continued expansion of Chicago's lake trade, by midsummer 1855 no vessel with a draft of more than 7 1/2 to 8 feet could pass over the bar into the harbor. The Chicago Board of Trade on 26 July requested a federal dredge for clearing out the north channel of the harbor, but the dredge was in use at another Lake Michigan harbor. By 1856, only a narrow channel 12 1/2 feet deep was available for ships near the north pierhead, and no federal dredging was done for lack of funds.

By the end of 1857 Graham at Chicago had no money and had sold "all the remnants of movable property belonging to the harbor, under the rules of the War Department, in order to raise a small fund to patch up the most decayed parts of the piers, where breaches had occurred." The repairs, he felt, were "inadequate to save the harbor from ruin, unless a speedy appropriation be made in aid of this very important work." Although no other funds were appropriated for harbor work during the next 5 years, Colonel Graham remained at Chicago and never lost an opportunity to remind his superiors of the importance of these neglected works.[30]

Because of their opposition to federally sponsored internal improvements, Presidents Franklin Pierce (1853-1857) and James Buchanan (1857-1861) vetoed all bills to approve lake navigation. Lake communities objected to this policy, particularly when it affected the St. Clair Flats, a troublesome area in the connecting channel between Lake Huron and Lake Erie.

For some time, the shallows at the mouth of the St. Clair River had added to the expense and uncertainty of shipping between the upper lakes and Lake Erie. As lake vessels became larger and Lake Michigan began to provide a growing proportion of the western trade, demands for a deep channel through the St. Clair Flats were repeatedly addressed to Congress. Captain Williams called attention to the problem as early as 1841. "This shoal," he said, "is the only obstruction to navigation above the falls of Niagara to the southern end of Lake Michigan." When lake levels were low, there were long delays at the flats. "Vessels are compelled frequently to have their cargoes taken out by lighters until they have crossed the shoal, and groups of them are frequently collected at this point and retarded in their voyage for several days." A single vessel, aground in the narrow, crooked, and shallow channel through the flats, could block all vessel traffic between Lake Huron and Lake Erie.[31]

When the federal government failed to take action, a steamboat association marked out the channel at the flats with buoys or stakes each spring in the early 1840's. When the association members undertook the more ambitious project of dredging a deeper channel there in 1846, they failed. Their funds or arrangements were insufficient, and the work was abandoned.[32]

In 1847 a River and Harbor Convention at Chicago considered navigation through the flats a matter of serious concern. In a memorial, convention delegates called the attention of Congress to "the immense commercial cargoes which descend from Lake Michigan to the ocean" which had to pass over the flats. A federal improvement there, they said, would be part of a system of lake improvements which Congress should provide. While the memorial brought no improvement of the St. Clair Flats during Polk's administration, on 30 August 1852, President Fillmore signed a bill which appropriated $2.25 million for about 100 civil works, including $20,000 to initiate a federal project at the flats. The sum proved barely sufficient in 1853 to construct a dredge to carry out the work. Expectations of further federal action died when, on 4 August 1854, President Pierce vetoed a comprehensive rivers and harbors bill which would have provided funds to put the dredge to work on the St. Clair Flats. After Pierce's 4 August veto, commercial men of the lakes led by the Buffalo Board of Trade contributed $18,000 for the project.[33] They obtained permission from Secretary of War Jefferson Davis to use the government dredge, and in late July 1856 began dredging a channel in the St. Clair Flats in accordance with the War Department plan. Dredging was frequently interrupted by an unusually stormy season so that the extent of the improvement was less than had been anticipated. Still a narrow channel 60 feet wide and nearly 10 feet deep was created from deep water in the lake to deep water in the river.

Meanwhile, in the winter of 1855-1856, Graham, apparently on his own initiative, had sent an assistant to the major lake ports to obtain statistical information on the commerce over the flats during the 230 days of the 1855 navigation season. It was an ideal year in which to demonstrate the importance of the St. Clair Flats. Crops were good and there was a heavy foreign demand for grain occasioned by the Crimean War. In addition, the extension of railroads opened new lands for growing grain and tapped new markets for merchandise brought to Chicago by water from the East. The result in 1855 was an unusual amount of trade on the lakes. Colonel Graham found that the total value of merchandise and agricultural produce known to have passed over the St. Clair Flats in the shipping season in 1855 was $251 million or an average of more than $1 million per day. In concluding his detailed report, he said, "something would seem then, under the perview of the Constitution, to be necessary to be done."[34]

In Washington, Senator Lewis Cass of Michigan shared Graham's views. Since early 1855 he had been active on behalf of an appropriation for the St. Clair Flats and for funds to deepen a channel some miles below Sault Ste. Marie where the St. Marys River passed through the shallow lower end of Lake George. The latter project was important in view of the opening in 1855 of a canal constructed by the state of Michigan at Sault Ste. Marie. The 5,400-foot-long canal had two locks in tandem, each 350 feet long and 70 feet wide; it made navigation possible between Lake Superior and the lower lakes. A bill providing funds for the two projects passed the Senate and then the House on 3 March 1855, the last day of the second session of the 33rd Congress; but Pierce killed it with a pocket veto.

In 1856, Senator Cass introduced and Congress passed new bills on behalf of the St. Clair Flats and the St. Marys River improvements. On 19 May, President Pierce vetoed the bill for improvement of the St. Clair Flats, saying that the project was "subject to those objections which apply to other works designed to facilitate commerce and contribute to the convenience and local prosperity of those more immediately concerned--an object not to be constitutionally and justly attained by the taxation of the people of the whole country."[35] Three days later, on 22 May, Pierce vetoed the second bill. Both eventually passed over Pierce's veto in July 1856.

On 8 October 1856, responsibility for overseeing work on the projects was assigned to Topographical Engineer Captain Amiel W. Whipple. Both projects were begun in July 1857. The Lake George project, completed in July 1859, resulted in a channel 14 to 18 feet deep and generally 150 feet wide through the shallow southern end of the lake. In October 1859, Captain Whipple reported of the channel, "It is already much used, and highly esteemed by navigators. When its width shall have been increased to three hundred feet, and the curve in the natural channel below rectified, I think it will be faultless."[36]

The St. Clair Flats project funds were exhausted and work stopped in August 1858 after the channel had been improved to a 230-foot average width and an average depth of 14 to 15.5 feet. The Canadian Government, which some years earlier had appropriated $20,000 as a contribution toward improving the flats whenever a channel of a certain size would be excavated there by the United States, undertook in the latter half of 1858 to further dredge the channel, giving it a width which Captain Whipple thought would be "sufficient for present navigation purposes."[37]

The depth of the channel was a greater concern to Captain Whipple because the lake varied in depth from year to year. A 13 1/2-foot deep channel in 1858, he pointed out, would be less than an 8 1/2-foot deep channel with lake levels experienced in 1849. In October 1858, he recommended that Congress be asked for $50,000 to dredge a 150-foot wide path through the middle of the improved channel to an 18-foot depth at extreme high water, equivalent to 12 feet during periods of extreme low water. Captain Whipple's recommendation set the stage for a confrontation between a new and growing Republican party in favor of federal river and harbor improvements and the incumbent President, James Buchanan, a States' rights Democrat firmly opposed to such works. In 1859, a year after Whipple made his recommendation, the Republican-dominated state legislature of Michigan adopted a resolution in support of an appropriation for further improvement of the St. Clair Flats. The resolution, copies of which were sent to the governors of all the northern States, asserted that such improvements were a federal responsibility. Agreeing with the sense of the resolution, a majority of members of the first session of the 35th Congress late in 1859 passed a bill for a special $35,000 appropriation to continue St. Clair Flats improvement.

After studying the background of this project, President Buchanan vetoed the appropriation on 2 February 1860, giving his reasons in a long message to Congress. Responsibility for these matters belonged with the states, he said. "Whenever the state of Michigan shall cease to depend on the Treasury of the United States I doubt not that she, in conjunction with upper Canada, will provide the necessary means for keeping this work in repair in the least expensive and most effective manner . . . ."[38]

Thus, clearly on the eve of the 1860 elections, a Democratic president vetoed a measure of interest to every harbor community on the lakes and restated in unequivocal terms the position the Democratic party had held on internal improvements since 1840. It was an issue of interest to the Republican party when it convened its second national convention on 16 May at Chicago. The party nominated Abraham Lincoln of Illinois for President and adopted a platform which promised free homesteads and easy naturalization laws, two issues of interest to the West. The party platform also supported high tariffs, appealing to the manufacturing interests of the East, and it spoke out in favor of federal appropriations for river and harbor improvements, appealing alike to western farmers and to commercial interests in both East and West. The Democratic party, split in 1860 between northern and southern factions, could offer no effective opposition to the election of the Republican.[39]

The constitutionality of federal improvements for navigation on the Great Lakes, though overshadowed by events of graver significance involving the very survival of the nation, was at issue in the Civil War which followed the 1860 Republican victory. Since the war the federal government's constitutional right to make improvements for navigation on the lakes has never been seriously questioned.

Chapter 2

GREAT LAKES CONNECTING CHANNELS

1866-1916

The Great Lakes provided ample width and depth to make them natural highways of commerce. Major obstacles to full navigational use of these inland seas were the narrow, often shallow, and sometimes rocky waterways connecting the lakes. The Great Lakes connecting channels included the St. Marys River, actually a strait, between Lake Superior and Lake Huron; the Straits of Mackinac between Lake Michigan and Lake Huron; and a channel consisting of the St. Clair River, Lake St. Clair, and the Detroit River between Lake Huron and Lake Erie. Vessels passing between Lake Erie and Lake Ontario used the Canadian-built Welland Canal.

Improving comparatively short stretches of waterway--about 65 miles between Lakes Superior and Huron and some 80 miles between Lakes Huron and Erie--made continuous deep channel navigation possible from Duluth, Minnesota, at the head of Lake Superior, to Buffalo, New York, at the foot of Lake Erie, a sailing distance of about 985 miles. Significant benefits accrued from relatively low investments in improving Great Lakes connecting channels. This was true although in the period of unprecedented and unanticipated growth between 1866 and 1916, both in the volume of lake commerce and the size of vessels employed, connecting channel projects frequently became outdated before they were completed.

THE ST. CLAIR FLATS

By 1865, improvement in the St. Clair Flats was the most important single need for the general benefit of Great Lakes commerce. As Corps of Engineers Colonel Thomas Jefferson Cram explained: "Very few channels of the world present such a constant stream of passing vessels. . . . The number of tugs, steamers, propellers, scows, barges, sloops, and schooners that passed the St. Clair Flats between the first of April and 15 December 1865 was 22,274 and the number of timber rafts 90." During those months an average of 86 vessels and 1 raft passed through the flats daily. The 2 1/2-mile long, 230-foot-wide channel, deepened to about 15 feet before the war, had by 1865 filled in unevenly from both sides and had become a shallow, tortuous channel through which vessels wormed their way always in danger of grounding. Costs from detentions, collisions, towage, pilotage, building a lighthouse, and maintaining beacon and range lights--all made necessary by the narrow, crooked channel--amounted to nearly half a million dollars annually.[1]

For the much needed work on the St. Clair Flats channel, Congress appropriated $80,000 on 23 June 1866 and an additional $150,000 on 2 March 1867. Colonel Cram started work on the new channel under contract in the late summer of 1867, but until 1870 lake vessels continued to use the old channel. The new channel was about a mile shorter and 300 feet wide. The banks at each side were vertical and reveted with dikes for the entire length of the cut.

Late in 1872, Major Orlando M. Poe, who had replaced Cram, reported that heavily loaded propellers and other vessels of deep draft were grounding in the canal. When grounded these propeller-driven vessels and tugs pulling sailing vessels often tended to swing around, stern to pier, and race their propellers in an effort to get loose. Such efforts caused the earth filling of the embankment to run out through cracks in the sheet piling. About the first of October 1872 the propeller ship Philadelphia grounded in the canal and "in endeavoring to force her way through worked her machinery violently, piling up the sand behind her. . . ."[2] As a result of this incident and others, depth in the canal was reduced to 11 feet 6 inches. To plug the leaks, marsh sod was placed inside the sheet pilings, and the holes in the embankment behind them were again filled with earth. In addition, before leaving Detroit at the end of April 1873, Major Poe recommended that the channel be dredged to a depth of 16 feet.

Major Godfrey Weitzel, succeeding Poe at the St. Clair Flats ship canal project on 1 May 1873, carried out Poe's recommendation for deepening the canal. Congress had appropriated $100,000 for the project, and on 30 May 1873 the contract was awarded to a Canadian firm. The project was completed in 1875.

In 1886, Colonel Poe, in charge again, submitted plans to improve the canal. He wanted to drive a second row of sheet piling along the face of the dikes, repair the decaying superstructure, and dredge the canal to 20 feet. Work on the sheet piling and superstructure repair started in 1887 and continued through 1889, but the dredging was delayed. As a result, in the fall of 1888, the canal became blocked with sand thrown up by grounded vessels. Vessel interests appealed to President Grover Cleveland, who telegraphed Colonel Poe to exhaust all legal means for clearing the channel. Poe was authorized to hire dredges, and some 50,000 yards of sand was removed in the fall of 1888.[3] In 1890, Congress appropriated an additional $80,000 for the work, and a contract was let for deepening the canal. By July 1892, after some 20,000 additional cubic yards of sand had been removed, a navigation depth of 18 feet was available across the St. Clair Flats.

Keeping the dikes in order was an endless task. Lieutenant Colonel Garret J. Lydecker, who took charge of the St. Clair Flats in 1896, recommended repairing them again. In 1899, after a tow barge, John Fritz, was grounded at the lower entrance to the canal, blocking passage of deep-draft vessels for 1 1/2 days, Lydecker recommended building a second channel at the flats.[4] Incidents such as this at congested areas of the connecting channels prompted the Corps of Engineers to recommend second channels wherever there was danger that a grounded or disabled vessel could halt lake traffic. In 1902, Congress authorized a second channel at the flats. Work began in July 1904, and the second channel opened on 3 September 1906 at a cost of less than $418,000. That year, 60 1/2 million tons of freight valued at over $629.5 million passed through the flats canals.[5]

THE ST. MARYS RIVER

The state of Michigan completed its canal at Sault Ste. Marie in 1855. Ten years later, the amount of iron ore shipped down from Lake Superior country to the lower lakes through the Sault locks increased nearly a hundredfold from not quite 1,500 tons in 1855 to over 147,000 tons. Some 3,000 tons of copper passed over the same route in 1855 while a decade later the total was three times that quantity. Lumber, grain, and flour from Lake Superior swelled the downward traffic, and coal was the major upbound item. By 1869 one-third of the Nation's iron and two-thirds of its copper came from Lake Superior mines. Most of it was brought out by vessel through the Michigan State locks at Sault Ste. Marie.[6]

The Sault locks were used to overcome the 9-foot difference in elevation above and below the rapids. In 1869 the 1 1/2-mile canal around the rapids had a depth of 13 feet, although only about 10 1/2 feet of water was available over the lock sills. The canal was 100 feet wide at the surface but, because of slanting walls, only 60 feet wide at the bottom.

Because of the restrictive dimensions of the canal and locks, traffic between the lower lakes and Lake Superior was confined to vessels of small or medium size or to larger vessels with less than full loads. When built, the locks were large enough to hold three vessels and a tug, but could hold only one vessel of the type commonly used in 1869. The larger vessels and the growing number of them engaged in the Lake Superior trade resulted in frequent delays at the locks. Enlargement of the locks at Sault Ste. Marie became a necessity.[7]

The canal and locks near the entrance of Lake Superior were only one link in the St. Marys River water route between the upper lake and Lake Huron. The St. Marys is actually a strait composed of a number of lakes of various shapes and sizes connected by narrower streams, many of which have rapids. The names of some of these many lakes and streams, rapids, and islands have changed but the geography, except for the man-made channels, is still the same. By numerous possible routes and combinations of routes, smaller craft passed between the falls of Sault Ste. Marie and the deep water of Mud Lake, now called Lake Munuscong, to the De Tour Passage which is the gate to Lake Huron. The Canadians used a channel which brought them to Lake Huron by way of Georgian Bay. On the American side, a channel passage about three miles below the falls first turned northeast, then north of Sugar Island, westward through Lake George, and then eastward of Neebish Island through the East Neebish Rapids to Mud Lake. Eventually it reached Lake Huron, in all a distance of about 75 miles.

The channel at the lower end of Lake George, a ten-mile-long, three-to four-mile-wide expansion of the St. Marys River, beginning about 12 miles below the falls, was improved by the Federal Government in the 1850's. As late as 1859 this improved channel was 150 feet wide and 14 feet deep. By 1866 the channel filled in and was no more than 50 feet wide in places and no more than 12 feet deep. In that year Congress appropriated $50,000 to further improve the channel, and supervision of the project was given to Colonel Cram. Although additional funds were provided in 1867 and 1868, the work did not progress satisfactorily because sand continued to sift into the channel. In 1870 the improvement of channels on the St. Marys River below the falls became part of a larger federal project which included a new lock at the Sault.

On 11 July 1870, shortly after Major Orlando Poe was assigned to the Detroit area, Congress appropriated $150,000 for a new lock on the St. Marys Canal and improvement of the St. Marys River. While the new Federal lock was being constructed, the old locks constructed by the state of Michigan continued to be owned and operated by the state. Since interlake traffic could not be stopped while these improvements were made, much of the work was done in winter when locking operations stopped.

The project required 12 summers and six winters to complete and cost just over $2 million. The new canal was widened from an original uniform width of 100 feet to as much as 270 feet and deepened to 16 feet. Steep cribwork revetment replaced the gentle side slopes which had scraped against larger vessels in the original canal. A single lock constructed alongside the old state locks was 515 feet long and 80 feet wide and had a depth of 17 feet over the miter sills. When work was completed in 1881, ownership of the old canal and the state locks passed from the state of Michigan to the federal Government. On 4 September

1881, the first vessel, the steamer City of Cleveland passed through the new lock.[8]

While the new lock, later called the Weitzel Lock, was under construction, traffic through the canal multiplied five times. Since the size and tonnage of vessels constantly increased, only a small percentage of the new vessels could make use of the old locks while fully loaded. In the face of this crisis, on 14 January 1882, Major Weitzel recommended the construction of a second new lock, this one to replace the old state locks.[9]

Weitzel's recommendation was included in a brief report to Brigadier General Horatio G. Wright, then Chief of Engineers. Made in response to a House of Representatives resolution which called for information on the works required for properly completing improvement of the St. Marys River and the St. Marys Falls Canal, this report proved to be an unusually perceptive document. The construction of a new lock to replace the old was a project which Colonel Poe (since 1882) was to take up again after 1886. Another project recommended by Weitzel, the completion of the channel through Lake George and the East Neebish Rapids to obtain a depth of 16 feet, was only a stop-gap improvement to allow time for the completion of a new channel on the St. Marys River below the falls. This new channel, the farthest west of all possible channels through this intricate waterway, passed through what was then called Hay Lake and is now Lake Nicollet. The route through Hay Lake, shorter and with fewer bends, could be navigated at night with a few inexpensive aids. The route through Lake George, which it would replace, was crooked and could not be used at night without numerous and expensive navigational aids.

The ability to pass at night from below the canal to Lake Huron had a significance apparent only to one familiar with the operations of the locks. While the old locks operated only in the daylight hours, the new lock, beginning in September 1881, was open for passage night and day. Yet little use was made of it between 8 p.m. and 4 a.m. because of the difficulty of navigating at night below the canal. As the decade progressed, traffic vastly increased and the new lock began to reach its maximum capacity. It became necessary to operate 24 hours a day to handle the traffic.

Colonel Weitzel's arguments for the new channel were convincing, and on 2 August 1882 when his successor, Major Francis U. Farquhar, was in charge, Congress appropriated $200,000 to start improving Hay Lake. In all, between 1882 and 1894, Congress appropriated $2,165,000 for the project. Before the improvement, the practical maximum available draft by a very irregular course at the Sugar Island Rapids at the head of Hay Lake and at the Middle Neebish Rapids below was about six feet. By 1894 a channel 300 feet wide and 17 feet deep was available over the

Hay Lake route. More than five million cubic yards of material was removed to produce the improved channel. On 7 June 1894 the new Hay Lake Channel, though not entirely finished, opened to navigation. The following year almost all of the commerce on the St. Marys River used the new channel.[10]

Meanwhile, the amount of waterborne commerce between Lake Superior and Lake Huron increased at an unprecedented rate. In 1883 some 4,000 vessels carrying 1.8 million tons of freight passed through the Sault Canal. Ten years later 12,000 vessels passed through, carrying well over 10 million tons. The cargoes included coal, copper, flour, grain, iron ore, pig and manufactured iron, lumber, and salt. In 1893 there were vast increases in every type of cargo except lumber. The most impressive freight growth was in flour, which increased during the decade from 427,000 to 5.6 million barrels, and iron ore which increased from 804,000 to 4.6 million tons.[11]

The growth in canal traffic was particularly impressive since in 1883 both the old state locks and the Weitzel Lock were in operation, whereas by 1893 the entire Lake Superior trade used the Weitzel Lock. Although the second Federal lock was commenced on the site of the old State locks in 1887, it was not completed until 1896. In June 1887, when an average of 56 vessels went through the Weitzel Lock daily, Colonel Poe estimated that its ultimate capacity was one vessel locked through every 15 minutes, or 96 vessels per day.[12] On one day--17 July 1895--the "ultimate capacity" of the Weitzel Lock was exceeded when 119 vessels were locked through. The average delay to a vessel waiting for lockage that year was nearly 5 hours, making an estimated total of 83,000 hours lost at the Weitzel Lock.[13]

On 9 September 1895, locking conditions at the Sault were improved by the opening of a Canadian canal and lock which had been under construction since 1888. The Canadian canal was 1 1/8 miles long, 150 feet wide, and 22 feet deep. It had a lock 900 feet long and 60 feet wide with 22 feet of water over the miter sills. By comparison the second American lock, to be completed the following year, would be 800-feet long and 100 feet wide with 21 feet of water over its miter sills.

In constructing the new lock later named for him, Colonel Poe rendered the old state locks inoperable when he erected a 1,500-foot cofferdam. The removal from operation of the old locks was accompanied by some sentimental regret. "They were a magnificent construction in their day," Colonel Poe commented, "and would still be useful if the commerce had not entirely outgrown them."[14]

The Weitzel Lock had functioned so well that many of its features were retained in the Poe Lock, but the gates, unlike those of the Weitzel

Lock, were to be constructed of steel. As the Poe Lock neared completion it became a source of national pride. Nearly 2 1/2 million pounds of steel went into the construction of its five sets of gates, and they were compared proudly with the gates of other great locks of the world. The lock opened to commerce on 3 August 1896 and the first boats to lock through were the U.S. steamer Hancock, the revenue cutter Andrew Jackson, and the U.S. tug Antelope.[15]

TWENTY-FOOT DEPTH

In January 1891, looking ahead to the completion of the Poe Lock with its 20-foot navigable depth, Poe submitted a plan for a minimum navigation depth of 20 feet and a minimum width of 300 feet in all the channels connecting the upper lakes. Until this time such areas had been improved on a piece-meal basis, so depths varied from point to point. The water route between Chicago and Buffalo or Duluth and Cleveland was actually only as deep as its shallowest channel. The size of vessel which could be employed and the weight of its cargo were determined by the shallowest portion.

The River and Harbor Act of 13 July 1892 appropriated $375,000 to begin and authorized a total of $3 1/2 million to complete a connecting channel 300 feet wide with a uniform 20-foot navigable depth in nine sections of the connecting channels. One of these project areas, as we have already noted, was the St. Clair Flats. Other areas were at St. Marys River including Round Island, Little Mud Lake, a reef near Sailors Encampment Island, and a shoal in Mud Lake 1 1/2 miles below Sailors Encampment. Other shallow sections to be deepened were at the foot of Lake Huron in Lake St. Clair and at the mouth of the Detroit River. Improving these nine sections of the connecting channels began under Colonel Poe's supervision, and contracts for the work were entered into in December 1892. Responsibility for the projects passed to Colonel Garret J. Lydecker in May 1896. The following year, after some 5 1/2 million cubic yards of material had been removed, the project as then conceived was complete.[16]

The connecting channel improvements authorized in 1892 were intended to provide navigation depths of 20 feet. When the project was completed in 1897, the actual depths available to navigation ranged between 17 and 19 feet because of the low lake levels which prevailed after 1892. To establish depths for the 1892 project, the mean level of Lake Erie in 1877 was used as a reference plane. However, after 1892 the lakes were almost continuously below the 1877 level. By an act of 13 June 1902, Congress provided for a 20-foot navigable depth 300 feet wide on one-way and 600-feet wide on two-way channel stretches from below the falls to Lake Huron. Similar improvements were also authorized on the lower reaches of the Detroit River. To obtain a 20-foot navigable depth, channels were to be deepened to 21 feet at a Lake Erie stage of 570.8 feet above mean tide in the New York Harbor.

Changes in reference planes for different sections of the connecting channel projects were authorized at various times while Major William H. Bixby was in charge, between 1902 and 1904. As new reference planes were applied to more and more projects in the connecting waters, additional dredging and rock removal were necessary. As a result, before one project had been completed, a new project--or an old project based on a new reference plan--was begun. Some of the more difficult stretches of channel were under almost constant improvement for many years.

Larger lake vessels required dependable navigation depth of at least 20 feet. After the turn of the century the trend toward larger vessels became more pronounced and can be simply illustrated. In 1903 there was a five-percent increase over 1902 in the tons of freight moving through the locks at the Sault, but the number of vessel passages decreased by six percent, and the number of lockages by three percent. The 45 large steam freighters put into commission for the Lake Superior trade that year ranged from 225 to 436 feet in length with drafts of 19 to 21 feet. As yet there were no vessels in the 500- and 600-foot class, but one was under construction and would be commissioned the following year.[17]

At Detroit in 1909, Colonel Charles E.L.B. Davis, who as a lieutenant colonel in 1904 replaced Bixby, strongly recommended that a new and second channel of 22-foot depth be dredged on the lower reaches of the Detroit River. Dredging operations had been going on in that area for more than 30 years during which time the channel was partly blocked most of the time by dredges and drilling plants. During that time, given the volume of commerce and the increasing size of vessels, the danger of a blockade of the first channel as the result of a collision was very great. A second channel, which could be excavated without interruption from passing vessels, could be completed in 4 to 5 years. The new channel could then be used for downbound vessels, while the original channel could be used for upbound craft. The danger of collision would be greatly reduced with one-way traffic and, in the event of a blockade in one channel, the other could be used temporarily for vessels going in both directions.

On 2 March 1907, Congress authorized up to $4,670,950 to carry out the project for a 12-mile long second channel, later called the Livingston Channel, with a minimum width of 300 feet, a maximum width of 800 feet, and a 22-foot depth at a Lake Erie state of 570.8 feet above mean tide at New York Harbor.

By 1915 the Corps of Engineers had all but completed projects authorized at the Livingston and two other channels at Fighting Island and Amherstburg in the Detroit River. A draft of 22 to 23 feet was available throughout the Detroit River portion of the Lake Erie-Lake Huron connecting channel.[18]

DECISIONS AT SAULT STE. MARIE

While the Detroit River project was being completed, decisions concerning the locks at Sault Ste. Marie were being made which would influence lake shipping for decades to come. Answering questions such as how long, how wide, and how deep the locks should be was made difficult by a rapid and continuous increase not only in the amount of traffic at the Sault but in the size of vessels used. The problem was expressed as early as 1891 by Colonel Poe when he wrote, "For thirty-five years I have watched the increase of Great Lakes commerce but neither I nor anyone has been able to expand in ideas at the same rate. The wildest expectations of one year seem absurdly tame by the side of the actual facts of the next."[19] Among the developments not anticipated in planning a new lock in the Sault was the potential of the Mesabi Iron Range in northern Minnesota. Discovered in 1890, the Mesabi Range, by 1905, provided 58 percent of the iron ore shipped from Lake Superior.[20]

When the Poe Lock was planned, it was anticipated that it would accommodate as many as four vessels at once. By the time it was placed in operation, the size of vessels had grown so that it would accommodate only two. By 1905, it would accommodate but one. During 1905, 33 steamers were launched. Three of these were 569 feet long and 56 feet wide. Before the end of the year, orders for 40 more steamers had been received by the shipbuilding yards at such points as Cleveland, Lorain, and Toledo, Ohio; Wyandotte, Ecorse, and St. Clair, Michigan; Chicago, Illinois; and West Bay City, Ontario. The time had come for additional lockage facilities at the Sault. Responsibility for developing the plans fell to Lieutenant Colonel Davis.

In view of the rapidity with which commerce and the size of lake vessels had been increasing, Davis' recommendations concerning the size of the proposed lock were of the greatest importance. If the dimensions proved too small, the lock would soon be outdated; if too large, money would be spent unnecessarily. His idea of an adequate lock was one that was 1,350 feet long between gates, 80 feet wide, and 24.5 feet deep below extreme low water at the miter sills.

By 1906 there were boats of 600-foot length in operation while ones of 650 feet were already being considered. Davis believed, "that the number of boats longer than 650 feet will be very small and (that) provision need not be made for placing two of them in one lockage."[21] The lock was designed, therefore, to take two boats 650 feet in length. The beam of boats passing through the canal had not increased as rapidly as the length, but by 1906 the largest boats had reached a width of 60 feet. Colonel Davis anticipated that vessel width would soon reach 70 feet. The lock, therefore, should provide a 10-foot clearance for vessels of 70-foot beam.

Vessel interests opposed placing the new lock at the Weitzel site, saying that taking the lock out of operation during construction would seriously limit available lockage capability. After examining the lockage data, Colonel Davis agreed with them. There were two other possibilities. One plan would place the new lock parallel and north of the Poe Lock and, to accommodate the new lock, the existing canal above the Poe and Weitzel Locks would be doubled in width. The third plan, the one eventually adopted, also placed the new lock north of the Poe Lock but instead of using the existing canal, proposed an entirely separate canal. The new canal would also provide an entrance to a fourth lock should one ever be needed.

Recommendations for this $6,200,000 project were submitted by Colonel Davis to the Chief of Engineers on 3 December 1906. The River and Harbor Act of 2 March 1907 adopted the project and appropriated $1,200,000 to commence construction.

Most of the actual construction of the new lock was carried out under the supervision of Lieutenant Colonel Curtis Townsend who replaced Davis on 2 March 1908. He was aided by Assistant Engineer Louis Sabin who had been made general superintendent of the canal in 1906. Sabin, a University of Michigan graduate, did much of the design work on the third lock, later called the Davis Lock, and on the fourth lock which eventually bore his name.

Discussion of the possible need for a fourth lock began in 1908, just as construction was getting under way on the Davis Lock. Undecided as to future needs at the St. Marys Ship Canal, the House Committee on Rivers and Harbors went directly to Sabin for the answers. Since 1889 the quantity of freight passing through the canal had doubled every six years, the committee noted. The flow of traffic was down in 1908 because of a depression, but what could be expected in the future? In response Sabin told the House Committee that one could not assume commerce at the Sault would continue to increase at the same pace as in the past. "At this rate," he said, "the traffic in 1932, or only 24 years hence, would reach a billion tons, a result so absurd as to show this method to be valueless."[22] Instead, he estimated possible growth in terms of the potentials of specific commodities. The maximum traffic in iron ore, for example, would not exceed 100 million tons, and the total traffic would not exceed 153 million tons in any year before 1950. He believed the time would come when a fourth lock would be required but, in his view, the need was not immediate.

Vessel traffic picked up in 1909 and, toward the end of the season, vessel owners began to complain that their boats had encountered difficulties passing through both the American and Canadian locks. In December, 1909, William Livingston, president of the Lake Carriers' Association, wrote the Chief of Engineers that the Association planned to approach Congress about the necessity of a fourth lock at the Sault. The panic of 1907 and the depression which followed were only a temporary check, Mr. Livingston said, and the country was again ready "to take great strides in growth and prosperity." The third lock, when completed, would not handle all the large vessels which would want to use it. Because of the many years involved in constructing a lock, a project for a fourth lock, Livingston said, should start as soon as possible.[23]

Congress, in the River and Harbor Act of 25 July 1912, authorized construction of the fourth, or Sabin, lock. Construction of both the Davis and Sabin Locks was carried out under General Superintendent Louis Sabin. Work on the Sabin Lock began in 1913 just as the Davis Lock was nearing completion. The Sabin Lock was finished in 1919.

The Davis and Sabin Locks were very similar. In construction and operation they were much advanced over earlier locks and both were greatly influenced by new technical innovations. They were to be the longest locks in the world. Power for both was supplied by a small hydraulic plant near the middle of the falls which was acquired by the United States when it purchased all lands to the north between the ship canal and the international border. The power plant was improved and eventually leased back to its original owner, the Edison Sault Electric Company. The company then provided power for lighting and operating the locks and sold the surplus for commercial use.

In conjunction with these developments, controlling works were constructed in the river to regulate the flow of water from Lake Superior. The Canadians constructed similar controlling works on their side of the river. A Boundary Waters Treaty of 11 January 1909, which established an International Joint Commission, made provisions for cooperation between Canada and the United States in regulating the flow of water at the Sault.

By 1916, total traffic through the canal at the Sault was nearly 92 million tons, 82 percent of which passed through the American locks. More and more vessels were of the 600-foot class. Whereas there had been no vessels of this size in 1904, there were 34 in 1916. In the next decades vessels approximately 606 by 60 feet became the standard, and by the 1930's, 300 or more of them would be plying the lakes.[24]

Until the mid-1930's there was no necessity to consider further expansion of the capacity of the locks at Sault Ste. Marie. Since the sills of the Davis and Sabin Locks were deeper than the shallowest stretches in the connecting channels, any vessels that could reach the Sault could be locked through. Work would continue in the coming decades, however, on deepening, widening, and otherwise improving difficult stretches of the connecting channels.

Certainly a major accomplishment of the half century 1866-1916 was the improvement of the ship canal and other channels connecting the waters of the upper Great Lakes, one of the most important waterways of the world. This achievement and the federal construction of Great Lakes harbors to be discussed in the following chapter were powerful factors in the growth of the commercial and industrial strength of the United States on the eve of its participation in World War I.

Chapter 3

GREAT LAKES HARBORS

1866-1916

LAKE SUPERIOR

After the completion of the ship canal and locks at Sault Ste. Marie by the state of Michigan in 1855, Lake Superior became easily accessible from the lower lakes. Only 2 steamboats and 5 sailing vessels visited Superior City, Wisconsin, in 1854; but by 1856 the number grew to 40 steamboats and 16 sailing vessels. They carried supplies for lumbering and sawmill operations as well as passengers.[1]

In 1856, Superior City grew from 600 to 1,500 inhabitants, but a financial panic in 1857 and the depression that followed stopped for a time development of the area at the head of the lake. People left, and Superior City and its neighbor, the embryo community of Duluth on the north side of the harbor, became nearly deserted townsites until after the Civil War.[2]

Lake Superior harbors farther east near the copper and iron mines of Michigan's northern peninsula fared better in the years just prior to the Civil War. Marquette, Michigan, was a major harbor for the shipping of iron ore and pig iron. Copper was shipped from Ontonagon, Michigan; Portage Entry, a small settlement on the west short of Keweenaw Bay; Copper Harbor on the north shore of Keweenaw Point; and Eagle Harbor, a good steamboat landing 16 miles west of Copper Harbor. Local interests constructed an extensive pier and a breakwater at Ontonagon by 1857.[3]

Beginning of Federal Improvements

Between 1847 and 1865, 15 lighthouses were constructed under the direction of the Treasury Department on the American shores of Lake Superior.[4] Otherwise no Federal improvements for navigation were made on Lake Superior until Congress, on 2 March 1867, appropriated funds for improving Ontonagon, Marquette, Eagle, and Superior City harbors.

Responsibility for overseeing the improvements was assigned to Major Junius B. Wheeler. From his Milwaukee office Wheeler served as superintending engineer at various harbor projects on Lake Superior and Lake Michigan between 1866 and 1870. Wheeler assigned direct supervision of projects at Superior City, Eagle Harbor, and Ontonagon to a civilian employee, Henry Bacon, and supervision of the Marquette project to Lieutenant James B. Quinn of the Corps of Engineers.[5]

Bacon visited Superior City and Ontonagon in July and August 1867. At Superior City he found one of the finest natural harbors in the world. A basin some 4,000 acres in extent was separated from the open lake by a long, narrow sand spit. The spit was broken near its southern end by an opening through which the waters of the St. Louis River discharged into Lake Superior. The longer, north section of this sand spit was called Minnesota Point; the southern part, Wisconsin Point.

The natural entrance from the lake to the basin was winding and varied considerably in depth. Although the opening was normally not less than nine feet deep, during bad northeast storms it decreased to three or four feet. The plan for improving the natural harbor entrance included construction of two piers made of cribs extending into the lake.

In 1867, Superior City had only a small commerce. Among its exports were several bales of furs, 700 barrels of fish, and forest products including 1.8 million board feet of lumber and quantities of shingles and laths. Flour, pork, corn, oats, salt, and 419 tons of merchandise were brought in by ship--not a spectacular amount of commerce for what was to become one of the world's most important harbors.[6]

No less important a harbor than Superior City in 1867 was Ontonagon, which in that year exported 1,500 tons of copper and imported 526 tons of flour and 133 tons of powder, probably for mining operations.[7] Unimproved, the entrance channel would not permit vessels drawing more than 7 feet of water to proceed to the mouth of the river. Improved, the harbor was to be made more accessible by the construction of parallel crib piers from the mouth of the river across a bar and into deep water in the lake. Ontonagon, in addition to its direct commercial value, provided a harbor of refuge for lake commerce generally. Its own commerce declined to minor importance by 1916.[8]

Duties at other harbors kept Bacon from beginning improvement of Eagle Harbor until 1868. The harbor was a natural bay in the bold, rocky, and dangerous coast on Keweenaw Point. Vessels drawing more than 9 feet were not able to pass a submerged ledge of rock across the opening of the bay. The plan of improvement called for a breakwater and an 80-foot-wide excavation of a rocky bar at the bay's entrance to provide a 14-foot depth. The project was completed in 1879, but Eagle Harbor's commerce remained small despite this Federal effort.[9]

Federal improvement at Marquette harbor began in the spring of 1867. As at Eagle Harbor, the Marquette harbor was formed by a natural indentation in the shoreline. While the bay at Marquette had a depth of 18 feet or more, it provided no shelter from winds coming from the east to northeast. The original Federal improvement consisted of a 2,000-foot-long breakwater extending from the north shore of the harbor. The breakwater was completed in 1875. By that time it was not unusual to see as many as 50 vessels riding at anchor behind the breakwater or moored at the ore docks and merchants' piers. In 1889, work was begun to lengthen the breakwater to 3,000 feet, and soon thereafter the breakwater was provided a concrete superstructure.[10]

Grand Marais, Minnesota, the only harbor of refuge for vessels on Lake Superior's north shore between Agate Bay (Two Harbors) and Portage Bay, also received federal attention in the 1870's. It was for a harbor of refuge rather than of commerce that Congress on 3 March 1879 appropriated $10,000 for two piers to protect the bay's entrance. The project was finally completed in 1901.[11]

Improvements in the 1880's

The name "Grand Marais" was also given to a bay located on the Michigan shore of Lake Superior some 313 miles east of Duluth and 90 miles west of Sault Ste. Marie. In the 1880's, the federal government first improved this border, as well as Agate Bay, Minnesota, 27 miles northeast of Duluth on the north shore of Lake Superior; and Ashland, Wisconsin, about 95 miles east of Duluth.

The harbor at Grand Marais, Michigan, was a natural bay, 240 acres in extent, with depths of 30 to 50 feet but its 3,000-foot-wide entrance was obstructed by a bar less than seven feet below the surface of the water. Only a few fishermen lived on the shore in 1871, and the area had little commerce. The only object in improving the entrance was a harbor of refuge on a rocky nine-mile coast subject to shipwrecks. To that end, Congress in 1880 appropriated $10,000 to construct parallel piers projecting into the lake. A pile dike was added in 1894 to protect the harbor from storms and encroaching sand. Harbor traffic later attained commercial importance in the export of pine timber and peaked in 1907. Thereafter, the pine timber in the area was exhausted and the harbor declined.[12]

Ashland Harbor was another shipping point for lumber, and about 1885 it also became important for the shipping of iron ore brought by rail from the Gogebic range on the Michigan-Wisconsin border. The harbor, at the head of a large bay, was generally deep enough for navigation but shallow for a considerable stretch along its wharves. In 1886, Congress appropriated $22,500 to begin a breakwater and dredging of the shallow wharf front area. In time a second breakwater was added. Between 1887, when the improvement was begun, and 1916, commerce at the harbor increased from 1.4 million tons of imports, mostly coal sand, and gravel, but the bulk of the tonnage was exports, largely iron and pig iron.[13]

While shipments of iron ore mined in Michigan's Upper Peninsula increased toward the end of the century, the Marquette and Ashland harbors were eventually surpassed as ore shipping centers by other harbors. The first of these was Two Harbors on the Minnesota north shore. In 1884, Agate Bay, which with Burlington Bay was one of twin ports later known as Two Harbors, became the first port to ship Minnesota iron ores. In that year a railroad was completed from Tower, Minnesota on the Vermilion iron range to Agate Bay where an ore dock had recently been completed. Congress was quick to respond to these developments and in July authorized a survey of the bay. Completed the following year by Major Charles J. Allen, the survey recommended a federal project.[14]

Agate Bay had adequate depth for vessels of the time but offered no shelter from storms. The Federal project consisted of two breakwater piers approaching each other on a line from the eastern and western points of the bay. When the project was completed in 1901 a 50-foot depth was available at the entrance between the breakwaters. The depth inside the bay permitted ore carriers with 20-foot draught to reach the docks. In 1916, freight traffic at Two Harbors, almost entirely iron ore, was valued at over $33 million.[15]

At the small harbor of Presque Isle, Michigan, the existence of a railroad terminal with ore and coal docks was the primary reason for commencing Federal improvement in 1896. In that year Congress authorized a 1,000-foot breakwater. The project, completed by 1900, was modified in 1902 to include an extension which would connect the breakwater with the shore. When the federal project was commenced in 1897, commerce at Presque Isle exceeded one million tons. By 1916, exports were more than three million tons of iron ore, valued at nearly $10 million.

<u>Duluth-Superior Harbor</u>

At Duluth-Superior harbor, railroad construction encouraged optimism concerning harbor prospects by bringing workers, industry and settlers to the area and by connecting the part with the hinterland to the west. The Mississippi-Lake Superior Railroad between Duluth and St. Paul began construction at the Duluth end in 1869. To unload vessels carrying needed materials for its road, the company built a harbor, wharf, and breakwater on Lake Superior just outside Minnesota Point. In 1871 the first grain elevator at the head of the lakes was built behind the protecting arm of the railroad's breakwater and that year, too, the federal government extended the breakwater. A planned federal outer harbor project was soon abandoned, however, under pressure from local interests who cut a canal through the point.

The Northern Pacific Railroad and the council of the city of Duluth initiated the controversial canal project in the fall of 1870 by setting a steam dredge to work digging a ditch across Minnesota Point. Operations were stopped in winter only to resume the next April while Superior residents, backed by the State of Wisconsin, sought a court injunction to halt the project.

By June 1871, when an injunction finally arrived from Washington, the canal was already 50 feet wide and eight feed deep. Duluth authorities quieted Superior's objections for a time by agreeing to construct a bulkhead to seal off the northern portion of the bay and prevent the waters of the St. Louis River from disgorging through the new cut. The bulkhead was constructed in 1871-72 but it was an obstacle to Superior's use of the entire bay and to Duluth-based shipping facilities. It was eventually removed.

The city of Duluth, having used all of its available funds without completing the canal, turned the project over to the Northern Pacific Railroad. The railroad wanted the canal to provide easy access to the Duluth side of the bay because it planned a dock of its own inside Minnesota Point where it would receive the expected shipments of grain from the prairie country. Northern Pacific completed the Duluth canal project in 1872. The following year the nation suffered through another depression. Duluth and Superior languished, and within the next few years more than half of the area's population moved on, many to settle on railroad and government lands in the West. In 1873 and 1874, federal funds were used to rebuild revetments on each side of the Duluth canal, and since then it has been considered a federal project.

Around 1878 a flow of agricultural products came from the western grain fields bringing a new vitality to the twin ports. Wheat and other products of the West were brought to the harbor by railroad and then, to take advantage of the cheaper transportation provided by the lakes, were transferred to ships bound for eastern lake ports. After 1878, Duluth and Superior experienced periods of rapid development. Elevators and flour mills were built and, to handle the increasing flow of ore from Minnesota's iron mines, ore docks, then coal docks, warehouses, and other facilities were constructed including a shipyard which after 1888 built "whaleback" freighters and barges.

Federal harbor improvement to keep pace with developments in lake shipping was central to the growing prosperity of the two ports. Whereas the River and Harbor Act of 1873 had specified that a 13-foot depth would be made available in all important harbor channels, an act of 1881 authorized the Corps of Engineers to dredge the harbor to an overall depth of 16 feet to accommodate larger vessels. After the opening of the Weitzel Lock at Sault Ste. Marie in September 1881 and the completion of the harbor deepening project in 1882, vessels with a draft of nearly 16 feet moved from Duluth and Superior all the way to the lower lakes.

The 16-foot draft was soon obsolescent. In 1895 the Canadians completed a lock at Sault Ste. Marie which accommodated ships with a 20-foot draft, as would a new American lock, the Poe, scheduled for completion in 1896. An act of 3 June 1896 authorized widening and deepening already existing channels to a 20-foot navigation depth. The project also provided for dredging new channels and extensive turning and anchorage basins in what for the first time was officially designated as a single "Duluth-Superior" Harbor.

When the dredging was completed in 1902, 17 miles of harbor channels were excavated to a standard 20-foot depth. Additional funds for the harbor were authorized until by 1914 a total of over $7.4 million in Federal money was invested there. While the investment was large in that period, commerce of the harbor was proportionately larger. The 52 million tons handled at Duluth-Superior Harbor in 1916 was 1,731 percent greater than the commerce in 1890 before the harbor was deepened to 20 feet. In 1916, Duluth-Superior Harbor with its ample depth and turning basins, its miles of improved channels, and its up-to-date loading and unloading facilities was the modern lake harbor par excellence.[17]

LAKE MICHIGAN

The Federal government improved some 28 harbors on Lake Michigan during the 1800's. Many of these harbors exported lumber and, once timber in the surrounding area was exhausted, they had nothing suitable to ship. Unless well-situated to be harbors of refuge or to handle the ferryboat traffic which crossed Lake Michigan, such harbors went into a rapid decline and by 1916 the Federal government maintained them at best on a very modest scale. Lake Michigan harbors which flourished into the 20th century were at or near industrial centers where coal was consumed in quantity and iron ore was manufactured into finished to semi-finished products.

By 1916 most of Lake Michigan shipping took place at the southwestern end of the lake with Chicago at its center. Chicago emerged from the Civil War as the rail center of the United States but also as the giant of lake shipping. Three-quarters of all the waterborne exports from Lake Michigan were carried in lake vessels loaded at one of the busy docks crowded along the Chicago River. While other lake cities generally doubled in population between 1860 and 1870, Chicago outstripped them all, growing from 112,000 to 299,000 in the decade.[18]

Until the 1890's local government and private interests improved the city's inner harbor on the Chicago River. The Federal effort was confined to the harbor entrance piers and breakwaters. When Major Junius B. Wheeler took charge of the federal project at Chicago in 1869, he was convinced that the Chicago River was "entirely inadequate to meet the wants of commerce rapidly growing."[19] Wheeler proposed relieving the congestion of the inner harbor by creating a protected area on the lake of about 455 acres. The outer harbor would be created by the construction of a breakwater 4,000 feet long southward and at a right angle to the south pier. In September 1870 Congress appropriated $100,000 to commence the project. Work was continued with annual appropriations until 1875. A north breakwater project, completed between 1882 and 1890, and the dredging in 1882 of 136,000 cubic yards of material from the outer harbor provided the 16-foot depth required by the larger vessels of the time and made up the major Federal harbor improvements at Chicago in the 1880's.

Meanwhile, commerce at Chicago continued to grow until it reached a peak of nearly 11 million tons in 1889. Its steady decline thereafter was largely due to congestion at the harbor and along the river. As office buildings, hotels, theaters, and department stores of Chicago's business center encroached on industrial sites along the river, land became more valuable and industries relocated, many of them to the south along the Calumet River.

In 1890 at the beginning of this transition Captain William L. Marshall, a grand newphew of Chief Justice John Marshall, took charge of Federal improvements at Chicago. At the time no dredging was being done in the outher harbor, and Marshall recommended that dredging be postponed indefinitely. Litigation was in progress concerning ownership of submerged land along the lakefront. The city did not plan to allow vessels to dock in the area. Rather, it considered filling part of the basin and using it for a park.

When, in 1895, litigation concerning submerged lands in the outer basin was decided in favor of the state of Illinois and the city of Chicago, Captain Marshall expressed no disappointment. He did object, however, to spending federal funds on the inner harbor. A very direct man, Marshall reported that, "No improvement in [the] Chicago River should be made by the general government; nor any public funds expended thereon so long as the city of Chicago uses it as a dumping ground for its filth and refuse of all kinds." "The city," he added, "should be required to remove all deposits made therein that tend to diminish its present navigable capacity or to cease depositing its sewage therein."[20]

The River and Harbor Act of 1890 had given the Secretary of War broad authority to prohibit dumping of refuse which tended to impede or obstruct navigation, but the law had many weaknesses and was difficult to enforce.

Finally, in the River and Harbor Act of 3 March 1899 it was made unlawful to throw, discharge, or deposit refuse of any description into navigable waters without a permit from the Secretary of War. The law provided a firm legal basis for proceeding against those who dumped refuse in navigable waters but, as interpreted by the Corps of Engineers and the courts alike until the 1960's, the act pertained only to abuses which affected navigation.[21]

Despite Marshall's objections, Congress, in the River and Harbor Act of 1894, authorized funds to begin Federal improvement of the lower sections of the Chicago River to permit 16-foot navigation, a project which was completed in 1899 at the cost of $650,000. Before the work was finished Marshall warned that since the city of Chicago deposited, on the average, more than 1,000 cubic yards of solid waste in the river each day, benefits from improving its depth to 16 feet would soon disappear unless as much as $50,000 a year was spent on maintenance dredging.[22] Congress did not at first provide for this maintenance, expecting that it would be the responsibility of the city of Chicago.

After Marshall left in 1899, Congress continued to appropriate funds for improving navigation on the Chicago River. By 1903 nearly 107,000 cubic yards of old dock and landfill had been removed from along the edges of the channel. In 1902, Congress authorized construction of two turning basins on the river. Congress also declared three tunnels under the Chicago River to be unreasonable obstructions to navigation and authorized the Secretary of War to give notice to their owners to alter them. By 1906 and 1907, projects to lower the tunnels to provide at least 22 feet of water over them were completed and on 2 March 1906, Congress appropriated $500,000 for dredging the river to 21 feet. The work was carried out between 1909 and 1912, but as early as 1910 it was necessary to start redredging to maintain the 21-foot depth.

Meanwhile, a harbor commission appointed by the city council in 1909 recommended the development of an outer harbor just north of the entrance to the Chicago River. The new harbor would handle freight and passengers and replace wharves no longer in use on the Chicago River. Two years later the city decided to establish a harbor on the lakefront and asked for federal cooperation to the extent of constructing a protecting breakwater for the new facility.[23] The River and Harbor Act of 25 July 1912 appropriated $350,000 toward the improvement.

The city of Chicago began construction of the municipal pier in 1915 and completed it in 2 years at a cost of $5 million. Work on the federal project to extend the existing north breakwater began in 1916. Despite these efforts, by 1916 waterborne commerce at Chicago had dropped to less than 2.5 million tons. Chicago Harbor, once a giant on Lake Michigan, had lost its position to a newcomer at Calumet.

Calumet Harbor

Calumet, Illinois, was in its infancy in 1870. Corps officers did not believe that the needs of Calumet for the next 10 years warranted any federal expenditures to improve the harbor. Nevertheless, Congress in July 1879 appropriated $50,000 to begin work there on a harbor of refuge. The project involved widening and deepening the river, cutting through a sand spit above the river's mouth to provide more direct access to the lake, and constructing two parallel piers out into the lake to a depth of 12 feet.

Over the years the north and south piers were extended until, by 1896, the original project was completed. A channel 16 feet deep was maintained from the lake to the Calumet River. Meanwhile the federal government had also extended the 16-foot channel on the 3 1/2-mile stretch of river up to Lake Calumet. A year later much of this channel was already filling in largely from garbage, sewage, and industrial waste deposited in the river. "The United States," Captain Marshall maintained, "are simply the scavengers for this vicinity."[24]

Yet improvement of the Calumet River stimulated industry and commerce. Steel manufacturing began in South Chicago in 1880 with the construction of a rolling mill. About the same time a railroad branch line was extended to South Chicago and a large grain elevator was built. Thereafter the community grew steadily. In 1895 one company was completing elevators to store over 4 million bushels of grain. In the same year a Chicago shipbuilding company on the Calumet River completed three steel vessels for freight service while three more were in the stocks and soon ready to be launched. In contrast to the Chicago River, there was ample room for expansion. As much as two-thirds of the frontage along the Calumet River was still vacant. Major Marshall, despite his misgivings about the waste deposited there, recommended that the Calumet River be dredged to a depth of 20 feet for the first two miles southward of the lake. Congress authorized the project in 1896 and by 1899 the 20 foot channel was completed and Marshall could report, "The capacious channel (of the Calumet River) continued to attract industries dependent on cheap transportation of crude and bulky articles . . . "[25]

Congress authorized a breakwater for Calumet harbor in 1896, and by 1915 the projected outer harbor work was complete. Consisting of two parallel entrance piers and a breakwater, the works provided a safe 300-foot-wide entrance to the Calumet River and an exterior harbor of refuge about one-half square mile in area.[26]

Harbors on the Southwest Shore of Lake Michigan

Four additional harbor projects around the south shore of Lake Michigan were the result of late 19th century changes both in lake navigation and industry. One of the harbors, that at Gary, Indiana, 13 miles northeast of Calumet, was not constructed until after the turn of the century and then as a private undertaking of the Indiana Steel Company.[27]

Private interests at Indiana Harbor constructed piers into the lake, dredged the area between them to a 21-foot depth, and began to construct a canal to connect the harbor with the Little Calumet River. In 1910 the federal government took over the improvement, constructed two rubble-mound breakwaters to protect the harbor entrance, and maintained the outer harbor to a 22-foot depth. Sharing the growth of the Chicago area generally, Indiana Harbor received such bulk commodities as oil, iron, coal, and lumber.

Father northeast at Michigan City, Indiana, the old harbor was first improved by the Federal Government before the Civil War. By the 1890's, continued Federal effort there included the construction of exterior breakwaters and dredging of Trail Creek, but by 1916 it was clear that the commerce did not justify maintenance of a channel of more than 15-foot depth. Michigan City did not develop industries which would benefit from the new kind of lake commerce. Most of the community's transportation needs were well supplied by local railroads.[27]

Waukegan, about 35 miles north of Chicago, was unique on Lake Michigan in that it had no natural harbor. In the early days lake vessels loaded and unloaded at unprotected docks on the lakefront. After 1855, when the city was first provided with railroad connections, its lake shipping went into a decline. Nevertheless citizens of Waukegan continued to press for a harbor and in 1879 Lieutenant David Houston formulated a plan for an artificial harbor consisting of an interior basin dug into the low ground between the lakeshore and a bluff and two piers extending into the lake.

When the United States began the improvement at Waukegan in 1880, the harbor's only lake trade was in tanning bark from Michigan and lumber for local use. In 1889, however, Waukegan became the terminal of the Elgin, Joliet, and Western Railroad which was connected with more than 30 railroads running to all parts of the country. The Elgin, Joliet, and Western Railroad soon constructed slips in the harbor, and the city of Waukegan dredged the channel between the piers. In 1900 the city constructed a 412-foot timber dock. A coal company equipped with modern coal handling appliances obtained privileges at one of the slips. In addition, a company with large grain elevators in South Chicago obtained dock privileges at a slip still to be constructed.

Waukegan, like South Chicago, became an alternate harbor serving commercing interests which wanted to avoid the congestion of the Chicago harbor. The River and Harbor Act of 30 June 1902 provided for a 20-foot depth at the harbor, extension of the piers, and construction of a breakwater. These projects were completed in 1904. By 1916 the value of Waukegan harbor's commerce exceeded $5 million.[28]

Other Harbors on the Western Shore of Lake Michigan

The history of waterborne commerce and harbor improvement north of Waukegan on the western shore of Lake Michigan from 1866 to 1916 is a composite story shaped by the shifting fortunes of a dozen communities. Early activity at these lake harbors from Kenosha northward to Menominee, Michigan, varied. Kenosha, 33 miles south of Milwaukee, was in prairie country, excellent for agriculture, but with no timber. Menominee, at the mouth of the Menominee River on the western shore of Green Bay, had a hinterland rich in timber and iron ore but had little land suitable for growing crops.

Each harbor was originally important for the export of a single item in great quantities--from Kenosha, wheat; from Menominee, lumber--and both imported a great variety of manufactured items or other products not found locally. A major import in the south was lumber, so long as it was available from Wisconsin and Michigan harbors to the north. Soon after the Civil War, exports from the southern harbors became more diversified and included a variety of agricultural as well as manufactured products, and imports included raw materials for manufacturing. Northern harbors such as Menominee continued primarily to export iron ore and lumber as long as timber was available. Since Menominee had little to manufacture but lumber, there were no imports of raw materials. As the turn of the century approached, Menominee began to decline as a port but survived because of the establishment of a railroad-car ferry service between it and harbors on the eastern shore of Lake Michigan. Farther south, exports became less diversified after about 1900 and tended, as lake commerce generally, to consist of such products as grain which was easily moved by water in large bulk-carrying lake freighters. Imports, to an even greater extent, became less diversified and included such bulk products as coal and cement.[29]

A typical Lake Michigan harbor was at the mouth of a river. Improvements were generally made by constructing two parallel piers out into the lake and dredging between them. At first a depth of 12 feet was provided, then 16 feet, and as time went on piers were extended and channels deepened until by 1916 all important harbors provided depths of 20 feet or more. Revetments were usually required in addition to piers for stabilizing the channel between the landward ends of the piers and the inner harbor formed by the lower stretches of a river. Green Bay, where piers were not required, was an exception as was the harbor of refuge at the eastern end of the Sturgeon Bay Ship Canal. There piers were built far apart at the shore and converged at their outer extremities to create a triangular protected area.

During the 1880's in Milwaukee Bay a harbor of refuge was created by constructing a breakwater, and in the 1890's breakwaters were provided for other harbors. A new type of harbor, the "arrowhead," was introduced after 1905. Such a harbor consisted of two breakwaters with their outer ends forming a 90-degree angle to one another while their inner ends connected to the shore. Also about this time timber was replaced by cheaper and more permanent concrete in the construction and repair of harbor works.

Harbors on the Eastern Shore of Lake Michigan

Of the 16 harbors improved in the 19th century on the eastern shore of Lake Michigan, only St. Joseph had any significant Federal help before the Civil War. Each of these harbors had a full and individual history but there were common features which set them apart from lake harbors elsewhere.

Many of these harbor settlements originated in the 1830's or 1840's. From the first, all were more or less involved in lumbering and were improved in the late 1850's or early 1860's by lumber interests. Nine of them were located off Lake Michigan on smaller lakes, usually the expanded lower reaches of a river connected to Lake Michigan by a natural winding channel which was abandoned and replaced with a straight artificial cut. After the Civil War the federal government improved all of these harbors, with the exception of Petoskey, by constructing two parallel piers into the lake to a depth at least as great as was desired in the enclosed channel and by dredging in the channels to establish and maintain that depth.

Commerce at most of the harbors on Lake Michigan's eastern shore reached a peak in the lumber trade in the 1880's or early 1890's. After that time, the timber was gone and lumber quickly ceased to be a significant item of commerce at these harbors. Various events of the 1890's determined their future. Three harbors, Frankfort, Ludington, and Grand Haven, became the eastern terminals of railroad-car ferry service with harbors on the western shores of Lake Michigan. At Holland and Muskegon, the manufacturing of lumber was replaced by the manufacture of a variety of other products for which raw materials could be brought in by water. For a time, Ludington and Manistee exported great quantities of salt.

At all harbors except Petoskey on Lake Michigan's eastern shore, sandy soil made harbor depths difficult to maintain. To avoid annual dredging the government piers were extended father and farther into the lake. Around 1905 the most important harbors began to be improved with exterior breakwaters, frequently of the arrowhead type.

LAKE HURON

All of the vessels moving between Lakes Erie, Michigan, and Superior passed close to the northern and eastern half of Michigan's Lower Peninsula but, until after the Civil War, no Federal harbor improvements were undertaken there. The Lower Peninsula had only one pre-Civil War harbor of significance, Detroit, where because of the natural depth of the Detroit River, no improvements were necessary. After the war new harbor communities developed, many of them for shipping lumber. Between 1866 and 1916 the federal government improved some 13 harbors along this coastline reaching from Mackinaw Island southwest to the Rouge River.

On this coast Harbor Beach, Cheboygan, Alpena, and the Saginaw and Rouge Rivers have survived to this day as commercial harbors. But only two, the Rouge and Saginaw Rivers, can accommodate the large modern vessels plying the lakes. The others are chiefly harbors for recreational boating.

The histories of these harbors repeat in essentials the development of Lake Michigan harbors. Beginning in the late 1880's, the shift to large vessels carrying bulk commodities left some harbors with declining lake commerce while others expanded greatly. The Rouge River, one of the harbors that flourished, became for Detroit what the Calumet River was to Chicago.

Rouge River

When the Rouge River was examined in 1886 by Lieutenant Colonel Orlando M. Poe, it emptied into the Detroit River about 1 mile west of what were then the city limits of Detroit. The river was 50 miles long but was remarkable in the natural depth of water at its lower reaches. Its channel was 11 feet deep at its mouth and from 13 to 18 feet for a distance of 1 1/2 miles upstream. In the early days light-draft vessels ascended the river to Dearborn, a distance of 15 miles.

In 1866 the Detroit waterfront along the Detroit River was fully occupied to the easterly city limits by manufacturing establishments. A movement was already under way to seek locations southward near the mouth of the Rouge River and upstream along its banks. Colonel Poe, who made the preliminary examination of the Rouge River in 1886, recommended that it be surveyed at as early a date as practical. Congress authorized a survey which resulted in a proposal for improving the river from its junction with the Detroit River upstream for a distance of 15,000 feet.[31] The River and Harbor Act of 1888 appropriated funds to begin the project. By 1902 the entire stretch of the Rouge River from its mouth 15,000 feet upstream to the Wabash Railway bridge was dredged to a uniform depth of 16 feet and a varying width from 240 feet to 70 feet.[32]

The River and Harbor Act of 3 June 1896 authorized a survey with the objective of extending the Federal project on the Rouge River an additional 1 3/4 miles upstream. Dredging to a depth of 13 feet on this stretch of the river was authorized by Congress by joint resolution approved 11 April 1898.

Commerce on the Rouge River may have totaled as much a 194,000 tons in 1888 but generally it remained around 100,000 tons until 1903.[33] That year, after the large plant of the Detroit Iron and Steel Corporation was established near the mouth of the Rouge River, Army engineers recommended that the depth of the first 1,400 feet of the lower reach of the project be increased to 21 feet. The River and Harbor Act of 2 March 1907 provided for this modification, and the project was completed before 1912.

Meanwhile, commerce on the river increased considerably. In 1903 it was about 135,000 tons. By 1916 commerce reached 1,415,000 tons valued in excess of $5 million. Of these totals, exports were negligible, but receipts of such bulk items as gravel and sand, iron ore, petroleum products, and stone justified the $106,000 which had been expended on the project since 1888.[34]

Saginaw River

The Saginaw River, only 22 miles long, flowed northward into the south end of Saginaw Bay. Like the Rouge River, the Saginaw River in its natural state was more navigable, particularly for the smaller vessels of the pre-Civil War period, than most streams of its length. Trapping for furs, the first industry on the Saginaw River, was followed by lumbering. By 1860, towns along the river included Saginaw, East Saginaw at the head of the river about 22 miles south of where it entered Saginaw Bay, Milwaukee, and Bay City, 5 miles from the river's mouth.

Improvements became necessary as commerce and the size of vessels grew. Vessels entering the Saginaw River in 1865 had a draft of eight feet or less. Citizens of the Saginaw Valley spent $100,000 in dredging bars for the improvement of the river that year. Because such community efforts were carried out only intermittently and the improved channels were not protected by piling, the results were temporary.

In the River and Harbor Acts of 23 June 1866 and 2 March 1867, Congress appropriated a total of $95,500 for dredging a 12-foot channel across an extensive bar which blocked the entrance to the river one mile from shore in Saginaw Bay. After the improvement, export trade from the Saginaw Valley grew and by 1872 exceeded $14 million.

With the help of improved gang and circular saws, production of lumber was increasing rapidly. Commerce grew accordingly, and a project for improving the river above Bay City was authorized in 1874. It provided for dredging a ten-foot channel across several bars and for constructing a pile revetment along a portion of the improved channel. In 1876 and 1879 similar project modifications were made in other shallow areas along the river. Work on these projects continued until 1881. A Board of Engineers in 1882 reviewed the situation on the Saginaw River and recommended that the channel be made 200 feet wide and 14 feet deep from Saginaw Bay to Bay City and 12 feet deep from Bay City to the head of the river.[35] These recommendations became the basis for all subsequent work on the river until 1910.

Commerce on the Saginaw River grew enormously. At the height of the lumber industry in 1882, 552 steam vessels and 1,702 sailing vessels with a total tonnage of over 784,000 arrived at Saginaw River ports. Four years later most of the logs brought to mills on the Saginaw River arrived by water, but by 1893 the railroad took over. Wood that was left in the depleted forests of the Saginaw Valley was being manufactured locally into boxes, sashes, doors, and flooring and set to market by rail.

With the decline of lumbering, cities like Saginaw and Bay City developed into manufacturing centers which depended on water transportation for imports of raw material needed in their factories. By 1899 coal became the major export item while imports included over 728,500 tons of grain, gravel, lumber and logs, brick, fish and fruit.[36]

In July 1909, Lieutenant Colonel Curtis Townsend recommended a channel 18 feet deep in the bay and 16 feet deep in the river. "A depth of 12 feet," he said, "is not sufficient to meet the requirements of existing lake navigation."[37] The River and Harbor Act of 25 June 1910 authorized a deepening project for the entire river and 4 1/2 miles into the bay. Despite the improvement, which was completed in fiscal year 1915, waterborne commerce on the Saginaw River declined steadily and by 1916 fell to less than 139,000 tons.[38] Communities in the Saginaw Valley had already begun a transition to a more diversified economy which would assure an increased navigational importance for the Saginaw River.

LAKE ERIE

For nearly a quarter of a century after the opening of the Erie Canal in 1825, Lake Erie led all of the other lakes in the volume of its trade. Buffalo was the middle point where grain, mostly from other Lake Erie ports, was gathered for shipment by canal to the Atlantic seaboard and from where manufactured items from the seaboard and abroad went westward. By the mid-1850's more and more manufactured items moved by rail, and the major sources for western grain had shifted to Lake Michigan. Buffalo remained the fulcrum of the East-West trade, but other Lake Erie ports also prospered because they, like Buffalo, were located at the meeting of lake and rail routes between Lake Superior iron and copper mines and the coal fields of Pennsylvania, West Virginia, Ohio, Kentucky, and Tennessee. The iron ore received at some Lake Erie harbors was transferred to railcars and sent to manufacturing centers elsewhere, and the coal received by rail was transferred to lake vessels for shipment mostly north and westward. A number of Lake Erie harbors became manufacturing centers where large quantities of coal and iron ore were consumed.

In 1916 the commerce of Lake Erie exceeded 100 million tons, more by a large margin than the 80 million tons handled that year on Lake Superior and greatly surpassing the year's total of 43 1/2 million tons on Lake Michigan. Commerce on Lake Huron and Lake Ontario that same year amounted to only 5 1/2 and 2 1/4 million tons, respectively. Six of the 10 busiest Great Lakes harbors that year were on Lake Erie.[39]

Among all lake harbors, Buffalo remained the major point of transshipment for freight moving between the Midwest and the Atlantic Seaboard. More than one-third of Buffalo's harbor business was in grain in 1916. Because grain had a higher value per unit of weight than iron ore or coal, the 18 1/2 million tons of water freight handled in 1916 at Buffalo was worth $482 million, nearly $100 million more than the 52 million tons, largely iron ore and coal, handled that year at the giant of all lake harbors, Duluth-Superior. Iron ore from Lake Superior and Lake Michigan made up an additional 33 percent of Buffalo's waterborne commerce. As at a number of other Lake Erie ports, a large part of the ore as well as grain received at Buffalo was manufactured near the harbor area into semifinished and finished products. The city became a major milling center for grain, and nearly all of the iron ore received was consumed at large-scale plants on the outer harbor and bordering the Niagara and Buffalo Rivers.

Between 1866 and 1916, railroads, industry, local government, and the federal government all played a role in radically changing the outlines and dimensions of most Lake Erie harbors. The federal effort was generally confined to improvements lakeward of the shoreline. Prior to the Civil War, the federal government improved most Lake Erie ports by constructing two parallel piers into the lake as entrances to natural harbors, usually on the lower reaches of a river. Between 1866 and 1916, emphasis was on breakwaters which created large artificial outer harbors to accommodate lake vessels of increased size.

For these larger vessels greater depths were necessary in the entrance channels. Since river currents were not strong enough to maintain the depths, dredging became a regular feature at most harbors. Larger vessels also needed wider channels. The original harbor piers, built to confine the current at the mouth of a river, were sometimes over 120, and seldom more than 250 feet wide. Vessels seeking refuge from a gale or even a strong wind had difficulty entering the narrow channel between the piers, and many shipwrecks resulted. After the Civil War, Army engineers advocated the construction of breakwaters in the lake to provide shelter on the most exposed side of lake harbor entrances.

Breakwaters were often connected to the land with a shore arm so as to form an L-shaped structure. Although they sheltered vessels from winds coming from one direction, early breakwaters were sometimes dangerous structures to anchor behind when the wind came from the opposite direction. Frequently, this problems was met by building a similar breakwater structure on the other side of the harbor entrance. Although the primary function of breakwaters was "to provide a still water harbor (or haven) even in the roughest weather," Army engineers saw the breakwater-enclosed outer harbors as having an additional purpose which was "to cover (protect) a long shoreline for docks." The expectation that outer harbors would relieve congestion in the narrow and unsatisfactory harbors along the bank of the rivers was only partially realized in the 19th century. Yet breakwaters did provide necessary havens for lake vessels and contributed to the development on the Great Lakes of an inland waterborne commerce of unprecedented volume and value.

Buffalo Harbor

After intermittent efforts beginning in 1866, federal improvement and maintenance of Buffalo and other Great Lakes harbors was continuous. The first post-Civil War project at Buffalo harbor was extension of a seawall begun in the 1830's and built along the sandy shore southward of the harbor entrance. Work on a seawall was abandoned after 1866 in favor of an outer harbor project first recommended by Captain William G. Williams in 1839. In 1866, Congress authorized construction of the outer harbor project, a 4,000-foot breakwater in Lake Erie south of the harbor entrance about one-half mile from and parallel with the shore.

Construction, begun in 1869, was not completed until 1894. Each year, beginning in 1869, several hundred feet of stone-filled wooden cribs were put in place. But during a violent storm in October 1871, several cribs sank through lake bottom clay into a soft stratum below. After similar sinking which took place in 1873, a board of engineers met in August 1874 with Colonel Charles E. Blunt, then in charge at Buffalo. The board concluded that artificial foundations would be required and recommended dredging a 50-foot-wide cut to bedrock, if necessary, in the bottom of the lake along the line of breakwater construction, the cut to be fitted with gravel and rubblestone. The 1874 board also recommended that "to obtain the full benefit of the work in giving a large still-water harbor even in the roughest weather, as well as to cover a long shoreline for docks," the Buffalo breakwater should be prolonged southward until it was 7,600 feet long.[40] The recommendations were approved, funds were appropriated, and until 1886 construction continued according to 1874 plans. On 14 October 1886, when 6,369 feet of the breakwater was complete, one of the worst gales in Buffalo history destroyed much of the breakwater's wood superstructure. Captain Frederick A. Mahan, in charge between 1886 and 1890, recommended rebuilding the superstructure in masonry.[41]

In 1887 a board of engineers adopted Mahan's plan for reconstruction. By 1894 the "old breakwater," as it was soon officially called, was virtually complete. A southern shore arm, partly built but destroyed by storms, would have marked the southern limits of the outer harbor. It was soon apparent, however, that Buffalo's outer harbor, as conceived in 1874, was too small. In 1874, 9,860 vessels arrived and departed the harbor and cargoes totalling 4.6 million tons were handled there. By 1894, 22,900 vessels arrived and departed and over ten million tons of freight passed over the harbor docks. Buffalo needed an outer harbor at least twice as large as the one authorized in 1874.

In 1895, Major Ernest X. Ruffner, in charge at Buffalo between 1892 and 1895, recommended that the old breakwater south shore arm be abandoned and a 9,700-foot extension be built south of the old breakwater to Stony Point. Congress authorized the new project in 1896. As modified, the project provided for a 9,700-foot south breakwater of which the northern 5,000-foot portion was of rubble-mound construction. The remaining 4,700 feet were to be of timber mounted on an artificial foundation extending down to solid rock. Each type of construction had advantages lacking in the other. While timber cribs required an expensive artificial foundation, vessels could be tied up alongside them. The rubble-mound portion was impractical for mooring vessels but could be built up on the natural lake bottom.

A narrow fair weather harbor entrance separated the old from the new south breakwater. At Stony Point another section of timber crib breakwater 2,800 feet long, extending out from the shore toward the end of the southbreakwater, left a 600-foot-wide entrance between the two structures. The Stony Point breakwater was completed in one year, but destructive storms and foundation problems delayed completion of the new south breakwater until 1904.

Meanwhile, in 1897, the Corps recommended a north breakwater primarialy to protect the entrances to Black Rock harbor and the Erie Basin, a lakeside terminal for the Erie Canal. Federal construction of the new 2,203-foot north breakwater was commenced in 1900 and completed in 1901. Built of stone-filled cribs with concrete superstructure, it extended northwesterly from Buffalo harbor's north entrance channel.

Replacing timber structures with concrete, stabilizing structures by placing deposits of rock dredgings alongside them, riprapping, and construction of a 1,000-foot extension to the Stony Point breakwater continued until 1915. By then the system was essentially complete and consisted of 23,600 feet of breakwater.

The breakwater system changed the Buffalo harbor picture, but the Federal Government was not alone in making contributions to the harbor. The Erie Basin, created after 1850 by the State of New York, opened into the Buffalo River about 8,000 feet upstream from its mouth. Private industry also made many harbor improvements. The Bethlehem Steel Company, for example, between 1902 and 1903 constructed a canal 4,000 feet long, 2,000 feet wide, and 21 feet deep from its plant to the southern extremity of the outer harbor. Between 1904 and 1905 the Hanna Furnace Company, Great Lake Portland Cement Company, Bethlehem Steel Company, and Pennsylvania Railroad worked together in constructing a Union Canal, a 2,000-foot-long slip, 200 feet wide and 21 feet deep, also entering the outer harbor at its southerly limit.

Local governments, too, were active in harbor improvements. The city of Buffalo, beginning in 1848, constructed a two-mile canal. First known as the Blackwell Canal and later as the City Ship Canal, it opened into the Buffalo River a short distance above its mouth. Much harbor business was carried out there. Between 1872 and 1900, the Buffalo harbor entrance channel was dredged by the city. Dredging there was resumed by the United States in 1901. Thereafter, the city continued dredging the Buffalo River 20 to 21 feet deep from the inner limit of the federal project to a distance 29,000 feet upstream.

Not only Buffalo but all major harbors on Lake Erie were eventually deepened and maintained to depths which corresponded to those in the Great Lakes connecting channels. Generally, depths were maintained from 12 to

15 feet in the 1860's and 1870's, 16 to 17 feet in the 1880's, 18 to 20 feet in the 1890's, and, after the turn of the century, 21 feet or more. By 1916 all major Lake Erie harbors--Buffalo, Cleveland, Ashtabula, Conneaut, and Lorain--with the exception of Toledo, were provided breakwater systems.[42]

Toledo

Toledo, on the banks of the Maumee River about five miles above where that river empties into Maumee Bay, was a natural harbor of refuge at the western end of Lake Erie and had no need for Federal harbor improvement assistance prior to the Civil War. The small lake vessels of the pre-Civil War era could follow the shallow winding channel through Maumee Bay to deeper waters in the lower reaches of the Maumee River and to the Toledo docks upstream. As lake vessels increased in size after the Civil War, the 9- to 12-foot-deep entrance through the bay to Toledo Harbor was too shallow and too uncertain.

In response to postwar appeals of Toledo citizens for Federal assistance, Congress on 23 June 1866 appropriated $20,000 to begin the improvement. The 1866 funds were applied to deepening the existing, rather crooked, channel through Maumee Bay to a consistent 12-foot depth. By 1872 a committee of the Toledo Chamber of Commerce explained to Congress that the 12-foot channel was not deep enough for the largest vessels, propellers in the 1,000- to 2,000-ton class, to stop at Toledo.[43] The following year Congress appropriated $100,000 to begin deepening the natural channel of 15 feet. Anticipating a 16-foot depth over the St. Clair Flats, in 1880 Toledo citizens asked that Congress authorize the deepening of the Maumee Bay Channel to an equivalent depth.[44] As so often in years of rapid change in lake navigation, hardly had the authorized 16-foot project begun when, in the early 1890's, a 17-foot project was initiated.

By 1895, when the 17-foot project was nearly complete, over two million tons of freight moved through the harbor. Wheat exports, long a major commodity, dropped between 1893 and 1895 from 491,500 to 73,000 tons. Coal, on the other hand, some 751,000 tons in 1895, was replacing wheat as the major export while the major import was 236,000 of iron ore.[45] Toledo lake commerce remained at the 1895 level for the remainder of the decade. Already by 1899 the largest vessels normally drawing 19 feet of water were forced to leave Toledo with less than maximum loads, but legislation in that year provided for a 21-foot-deep and 400-foot-wide channel through Maumee Bay and for a 1,000-foot dike to protect the new channel. By October 1915 the 21-foot channel was completed from the lake through the bay and up the Maumee River to the Toledo docks, a distance of 15 miles. The next year, vessels drawing as much as 21 feet frequented the harbor. Lake traffic at Toledo exceeded ten million tons in 1916; it was five times the tonnage recorded in 1895, and was valued at nearly $40 million. In tonnage handled, Toledo was the seventh largest harbor on the lakes. Of the total commerce of the port, 94 percent was coal and iron ore.

Cleveland Harbor

Cleveland harbor lacked the natural advantages of Toledo. In 1827, federal construction began there of piers into the lake from the lower reaches of the Cuyahoga River. Between 1866 and 1875 the Corps of Engineers repaired and extended the harbor piers. In 1871 it began work to deepen the entrance channel to 16 feet.

A breakwater in the lake west of the harbor entrance was recommended by a board of engineers in 1875. After authorization and funding by Congress, construction began and the entire stone-filled wooden crib (west) breakwater structure, 7,360 feet long, was completed in 1884. Between 1876 and 1884, while the breakwater was being built, Cleveland's waterborne commerce consisting primarily of iron ore, lumber, and grain remained around 2.4 million tons annually.

Construction of an east breakwater commenced in 1885. Thirty years later, after numerous modifications to the project, Cleveland's breakwater system was completed. Some 28,000 feet, partly rubble-mound, partly timber crib, and with concrete superstructure, provided a protected outer harbor five miles long and 2,000 to 4,000 feet wide. The main harbor entrance, 700 feet wide, was protected by converging arms extending lakeward from the inner ends of the east and west breakwaters. Between 1905 and 1909 the outer harbor was dredged to depths ranging from 21 to 23 feet. The harbor piers, meanwhile, had been reconstructed with concrete superstructure. The channel between them was widened to 325 feet and deepened to 23 feet.

The port's waterborne commerce increased between 1885 and 1889 from about 2.5 million to over five million tons. Shipments of grain dwindled while coal and coke became major exports and iron ore the major import. By 1916, shipments and receipts reached 16 1/2 million tons, mostly iron ore and coal. In tonnage, Cleveland ranked fourth among Great Lakes harbors.[47]

Making the most of Cleveland's location at a point of transfer between rail and vessel, numerous enterprises in the steel industry and allied lines developed there. Among them was shipbuilding, and many of the vessels engaged in lake commerce were constructed here.[48]

Ashtabula, Conneaut, and Lorain

While Cleveland's success appeared to follow naturally from its early commercial importance, the development of three other Ohio communities--Ashtabula, Conneaut, and Lorain--into major lake port status was more surprising. Ashtabula, surpassing Cleveland in 1916 with 18 1/2-million tons of iron ore and coal passing over its docks, was the third busiest harbor on the lakes. Conneaut was fifth with 18 million tons of waterborne commerce, largely iron and coal. Lorain ranked tenth with a total of nearly 9 million tons, also mainly iron and coal.

Though among the earliest Federally improved harbors on the lake, all three remained rather small ports until the 1980's. Once centers for the shipping of agricultural products and the receipt of manufactured wares, by the Civil War or soon thereafter they lost much of their harbor business to the railroads. In the years immediately following the Civil War, the lake trade dropped of at Ashtabula until by 1872 only 25 vessels visited the harbor. In that year the Cleveland Tuscarawas Railroad was extended to Lorain. The following year no more than 50 to 60 vessels called at the port. Conneaut, too, though once a shipbuilding center, had so declined by the 1880's that the harbor was used only by small sailing and fishing craft. All three harbors made comebacks before the end of the century. Paradoxically, the railroads which contributed to the decline of these harbors also supplied the stimulus which revived them before the end of the 19th century. Federal assistance to these harbors slackened when shipping declined, but, with the establishment of railroad terminals and facilities for handling bulk commodities of iron and coal, the federal government realized the potential of these ports and provided the protective structures and harbor depths required for their commerce.[49]

Other Lake Erie Harbors

In the importance of their railroad lines and federal improvements and in the nature of their waterborne commerce, Fairport, Huron and Sandusky, Ohio, and Erie, Pennsylvania, resembled most other Lake Erie harbors. Fairport, at the mouth of the Grand River 34 miles east, and Huron Harbor, 48 miles west of Cleveland, had harbors originally improved by the Federal government with piers which were lengthened from time to time over the years. Both Fairport in 1896, and Huron, in 1905, were authorized Federal breakwater projects. By 1916 Fairport had an outer harbor of some 40 acres protected by 1,320 feet of breakwaters. Its outer harbor and entrance channel were maintained to an 18-foot depth. Huron had a Federally constructed outer harbor somewhat triangular in shape, 14 acres in area, which was maintained at a 19-foot depth. Railroad companies had improved, primarily by dredging, both inner harbors located in the lower reaches of the Grand and Huron Rivers. In 1916, Fairport handled 3.8 million tons and Huron 2.8 million tons of water freight.

The harbors of Erie, Pennsylvania, and Sandusky, Ohio, remained important ports in the industrial era of the late 19th and early 20th centuries. Although Federal harbor improvements were carried out at both places, Erie and Sandusky were located on natural bays and required no artificial outer harbors.[50]

Niagara River

Starting near Buffalo at the foot of Lake Erie, the Niagara River descends some 326 feet in its 34-mile course to Lake Ontario. The river is navigable from its source to the upper rapids, a distance of about 20 miles. It can also be navigated 7 miles from Lewiston below the falls to its mouth at Lake Ontario.

Many surveys and estimates, both public and private, were made for an American canal around the upper rapids and the falls. In 1835 Captain William G. Williams of the Corps of Topographical Engineers surveyed five possible routes for such a canal. Congress favorably considered the project he recommended for building it, but no funds were appropriated because of the financial crisis beginning in 1837. Additional surveys and estimates were made in 1864, 1868, 1889, 1897, and 1900. The 1900 surveys by the United States Board of Engineers on Deep Waterways, superseded all previous examinations, and recommended a Niagara Ship Canal with locks 21 feet deep and 600 feet long by 60 feet wide, but the recommendation was never carried out.[51] Midwestern interests championed a route to the Atlantic which would use the Great Lakes, the proposed Niagara Ship Canal, and the St. Lawrence River; New York State interests favored an all New York route to New York City and the sea. That route, through the Erie Canal, or after 1918, its successor, the New York State Barge Canal, served the water transportation needs of the United States between the lakes and the Atlantic seaboard until the completion of the St. Lawrence Seaway project in 1959.[52]

Although the United States never constructed a canal around Niagara Falls, improvements for navigation were made on the upper 20 miles of the Niagara River. An appropriation for the improvement of Tonawanda Harbor on the Niagara River about 18 miles below Black Rock was made in 1881, and in 1891 work was commenced on improving the river from Tonawanda to the port of Niagara Falls. Between 1889 and 1900, because of the increasing commerce and a trend toward larger vessels, the Niagara River channel from its source to and including Tonawanda Harbor was widened to 400 feet and deepened, where necessary, to 18 feet.

In 1902, Major Thomas W. Symons, Buffalo District Engineer, proposed a ship canal including a lock around the rocky shallows near Black Rock at the head of the river to enable the largest ships to reach the naturally deeper water downstream. The proposal was viewed by canal supporters as the first step toward an American canal around the falls. It was favored, too, by those New York State interests who wanted to enlarge the Erie Canal.

By 1880, traffic on the Erie Canal had reached a maximum of about 4.8 million tons. After 1880 the canal rapidly lost traffic to competing railroads. The abolition of tolls in 1883 did not stop the decline, and by 1900, canal traffic had dropped to 2.1 million tons, less than one-half the 1880 figure. Concern for loss of traffic on the canal led the people of New York in 1903 to pass a $101 million bond issue to construct a new or "barge" canal which could handle larger and deeper draft boats than the Erie Canal. The new canal would terminate at Tonawanda from which point canal vessels could proceed to Buffalo on the Federally improved Niagara River.

Major Symons's ship canal proposal was authorized and funded by Congress in 1905. A deepwater channel in the Niagara River between Buffalo and Tonawanda was accomplished over a period of years. Much of the dredging had been completed by the time the 650-foot-long, 60-foot-wide, and 22-foot-deep lock in the Black Rock Canal was opened to navigation in 1914.

In 1916 nearly 2 million tons of waterborne freight passed through the Black Rock Canal and lock. The principal downbound items of freight were iron ore, lumber, and pulpwood. Upbound cargoes were chiefly sand, gravel, and limestone.[53]

LAKE ONTARIO

Toward the end of the 19th centry, at a time when lake transportation was characterized by long distance hauling of bulk commodities in large vessels, Lake Ontario was cut off from developments elsewhere by the restrictive dimensions of Canada's Welland Canal. The original Welland Canal, completed in 1829, first made possible the shipment of western grain and lumber to Lake Ontario ports. Oswego was best situated to take advantage of this commerce. In 1829 a canal was completed from Oswego to join the Erie Canal at present-day Syracuse, New York. The route to New York City by Oswego and Erie Canals and the Hudson River was shorter and cost less in canal tolls than the Erie Canal route east from Buffalo. Oswego, for a time, competed with Buffalo as a major point for the transshipment of western grain.

Oswego Harbor

Oswego's future as a harbor depended on the Welland Canal. In 1850, to meet the demands of lake shipping, the government of Upper Canada completed and deepened the canal from eight to nine feet. In 1853 this second Welland Canal was rebuilt to accommodate vessels of ten-foot draft. A ten-foot depth, generous for the canal in 1853, was by 1870 becoming inadequate. Connecting channels of the western lakes were deeper. Depending on the stage of water, the Michigan locks at Sault Ste. Marie could accommodate vessels drawing nearly 12 feet of water. Other connecting channels and major harbors had already been dredged to 13 feet.

By 1870 Oswego had had 30 years of vigorous growth. Between 1840 and 1870 its population rose from 4,423 to nearly 21,000. Milling was an important industry in 1870. Oswego had 11 grain elevators and 16 flour mills, and one-third of the cornstarch used in the country was manufactured there, as much as 25 million pounds in a single year. Oswego's flour milling and cornstarch production depended on western wheat and corn brought to Oswego through the Welland Canal. In 1870, Oswego imported over seven million bushels of wheat and 1.7 million bushels of corn from the west. In addition, some 500,000 bushels of wheat, 3.2 million bushels of barley, and over 300 million board feet of lumber arrived at Oswego that year from Canadian ports. Oswego's exports in 1870 were all sent to Canadian ports and included salt, cement, and about 52,000 tons of coal. With such a volume of commerce, it is not surprising that Oswego recorded over 10,000 vessel entries and clearances in 1870.

In that year a board of engineers, considering Oswego Harbor inadequate to accommodate its commerce safety, recommended construction there of an outer harbor similar to those to be built at a number of major lake harbors elsewhere. The outer harbor project, authorized by the River and Harbor Act of 11 July 1870 and completed in 1882, consisted of an outer breakwater 5,800 feet long nearly parallel to and 1,100 feet lakeward from the old west breakwater.

The Canadians, meanwhile, had been constructing a new Welland Canal and it, too, was completed in 1882. This third Welland Canal had sufficient depth to accommodate vessels of 12-foot draft, and five years later the depth was increased to 14 feet. These improvements, however, were not sufficient to meet the needs of more and more larger vessels put in service on the upper lakes. Because the larger vessels could not pass through the Welland Canal, smaller vessels carried western cargoes of grain to Oswego while the larger vessels charging lower rates brought their cargoes to Buffalo.

Other developments also damanged Oswego's harbor business. To compete with railroad freight rates, the state of New York began to reduce canal tolls in the 1870's and on 1 January 1883 abolished them altogether. Since the Canadians continued to levy tolls for use of the Welland Canal, the Oswego Canal route was now more expensive than the Erie route east from Buffalo. In 1892 Captain Dan C. Kingman of the Corps of Engineers reported from Oswego that no considerable growth in commerce should be anticipated between Lake Erie ports and those of the upper lakes. "The Welland Canal tolls," he said, "combined with the removal of tolls from the New York State canals, has had the effect of building up Lake Erie ports at the expense of those on Lake Ontario."

Ample evidence supported this assertion. By 1982 Oswego's imports dropped to 285,000 tons. Since 1870 there had been decreases in every commodity handled except coal. Oswego exported 52,000 tons of coal in 1870; in 1892 seven to eight times that amount left the harbor.

United States ports on Lake Ontario lost grain trade because shipment was too costly in the smaller vessels able to pass through the Welland Canal. However, since it was equally unprofitable to ship coal through the Welland Canal, American ports on Lake Ontario had an advantage in the coal trade with eastern Canada. A number of Lake Ontario harbors were kept busy transshipping coal which arrived by rail from Pennsylvania to vessels operating on Lake Ontario. Yet, while local economies were stimulated whenever imported grain was manufactured into flour before being reshipped, transshipment of coal did not contribute significantly to the growth of Lake Ontario harbor communities.

No large cities developed on the shore of Lake Ontario as they had on Lake Erie, and the commerce of the busiest Lake Ontario harbors was exceedingly modest compared to that of most harbors on the upper lakes. Federal harbor projects on Lake Ontario were also less ambitious. In 1881 when construction of the west breakwater for Oswego's outer harbor was completed, Congress authorized an enlargement of the project to include an east breakwater 2,700 feet long. Seven cribs, 248 feet in all, were sunk in place but no further work was ever carried out. The federally constructed west breakwater provided an outer harbor ample for Oswego's needs. In 1916 an outer harbor area 30 acres in extent was dredged and maintained to a 16-foot depth while the inner harbor was provided a depth of 15 1/2 feet. In 1916, Oswego commerce was less than half that of Charlotte harbor, 59 miles to the west at the mouth of the Genessee River.[54]

Charlotte Harbor

Federal improvement of Charlotte harbor near Rochester, originally authorized in 1829, consisted of the usual piers constructed into the lake from the mouth of the river. The piers were extended from time to time and the channel between them was increased by dredging. The lake trade at Charlotte fluctuated irregularly and reached a $1.5 million peak in value of imports in 1855. Thereafter, the transportation needs of nearby Rochester were met largely by railroads and the Erie Canal. By the 1870's the harbor had declined in importance and the federal effort there was confined to maintaining the structures and occasional dredging.

A Canadian market for coal provided Charlotte an opportunity to revive its harbor business. In the mid-1870's a dock for loading coal barges was built in the harbor, but the shipping of coal did not become a major enterprise there until after 1883. In that year the Buffalo, Rochester, and Pittsburgh Railroad was completed to Charlotte and a trestle from which B.R. and P. coal cars could be unloaded by gravity into barges was built three miles up the Genessee River.

Anticipating these developments, Congress, which throughout the 1870's had provided only small sums for Charlotte harbor, appropriated $35,000 in 1882 to begin work on a 15-foot channel. The needs of Charlotte harbor expanded and the 1882 project was modified repeatedly until 25 June 1910 when a new project authorized a 20-foot channel depth for the harbor. This project was completed in 1913. It was the only harbor on Lake Ontario to be provided the 20-foot depth considered essential for all major harbors on the upper lakes.

Meanwhile, Charlotte was replacing Oswego as the busiest Lake Ontario harbor and was becoming that lake's principal coal shipping point. In 1889, Charlotte shipped 350,000 tons of coal as compared to Oswego's 282,000 tons. Charlotte's coal tonnage exceed one million in 1916 while that of Oswego was less than 600,000. Shipments of coal and coke constituted about 90 percent of the total tonnage moving through Charlotte and 94 percent of that at Oswego.[55]

<u>Great and Little Sodus Bays</u>

In addition to Oswego and Charlotte, the only commercially active harbors on Lake Ontario in 1916 were Great and Little Sodus Bays. The commerce of Great Sodus Bay was never large and in the early days consisted of receipts of general merchandise and lumber for local use. In 1872, however, a branch line of the Pennsylvania Railroad extended to Sodus Point and in time a substantial export commerce in the shipment of coal developed. In 1916, coal exports made up 98.8 percent of 190,000 tons of lake commerce at Great Sodus Bay. There were practically no imports. At Little Sodus Bay the situation was similar. In 1916, coal shipments from the harbor amounted to 129,563 tons. Other exports totaled only seven tons, and there is no record of receipts.

A number of other Lake Ontario harbors had little or no commerce in 1916. Among them were Olcott, Pultneyville, Cape Vincent, and Sackets Harbor. Commerce disappeared so completely at Sackets Harbor that in 1898 the Chief of Engineers decided that no further work there was warranted.[56]

LAKE COMMERCE IN 1916

By 1916 the fleet of cargo vessels plying the Great Lakes had become remarkable for its efficiency. The proportions of this accomplishment are made clear when compared with conditions in 1889, the first year for which a systematic effort was made to obtain information on the volume of the lake trade.

In 1889 some 2,737 lake vessels transported 25,266,974 tons of freight cargo. In 1916 a fleet of 2,856 vessels transported 125,384,042 million tons. Although the 1916 fleet included only 4.3 percent more vessels, it transported 396.2 percent more cargo than its 1889 counterpart.

Naturally the 1916 fleet consisted of larger vessels. The 2,737 vessels of the 1889 fleet had a total gross tonnage of 920,294 tons. The gross tonnage of the 1916 fleet was 2,737,491. The average tonnage of a steam vessel was 406 tons in 1886; in 1916, 1,312 tons. The average tonnage of a sailing ship grew from 192 tons in 1889 to 898 tons in 1916.

Increase in vessel size is only one explanation for the vastly increased shipping capacity of the 1916 fleet. Based on gross tonnage figures, the 1916 fleet was only 197.5 percent heavier and larger than the 1889 fleet; yet it transported 396 percent more freight. Steam vessels, because of their speed and other advantages, were capable of moving more cargo in a given season than a sailing vessel. Between 1889 and 1916, the number of steam vessels increased from 1,467 to 1,837, while the number of sailing vessels dropped from 962 to 162.

In size, numbers, and speed, steam vessels contributed to the efficiency of the 1916 fleet. Improvements which increased the number of trips a vessel could make in a single shipping season were crucial. Increased efficiency in loading, unloading, and fueling vessels was an important factor but also of particular importance was the ease and certainty with which the water routes, particularly in the connecting channels, could be navigated.

The Federal Government provided for ease and certainty of navigation on the lakes. It did so partly by assuring adequate width and depth in the Great Lakes connecting channels and at the locks at Sault Ste. Marie and by constructing safe and commodious harbors, tasks assigned to the U.S. Army Corps of Engineers.[57]

The Federal Government contributed to lake navigation in other ways. The Revenue Cutter Service, operated under the direction of the Secretary of the Treasury to enforce customs laws, provided logistical support as well to Lifesaving Service stations and assistance to distressed mariners. The Treasury Department also operated the Lighthouse Service until 1903 when the agency was transferred to the newly established Department of Commerce and Labor. The Lighthouse Service also operated lightships and such aids to navigation as beacons, buoys, and fog signals. Beginning in 1876, a government-operated Lifesaving Service was organized which soon had nearly 30 stations on the lakes. The Lifesaving Service, which became a separate entity of the Treasury Department, had 60 stations on the lakes by 1900. Safety of passengers and crews was the special concern of a Federal Steamboat Inspection Service established in 1852. In 1903 this service was transferred from the Treasury Department to the Department of Commerce and Labor. Progress toward elimination of the overlapping responsibilities of these agencies took place in 1915 when functions of the Revenue Cutter and Lifesaving Services were merged into the newly established United States Coast Guard. During times of national emergency, the Coast Guard, at the direction of the President, was to operate under the direction of the Navy; otherwise, it remained a part of the Treasury Department.[58] In 1966, the Coast Guard became an operating unit of the Department of Transportation.

In 1916 the Great Lakes fleet, which represented 22.3 percent of the total vessel tonnage in the United States, handled 48.6 percent of the nation's waterborne freight shipments, a greater annual tonnage of freight shipments than the vessels of the entire Atlantic, Gulf, and Pacific seaboards. Federal improvements on the Great Lakes helped to make this achievement possible, but the shipping achievements of the Great Lakes fleet were also the result of the combined efforts of the private and public sectors. Beyond this, the achievement was both cause and effect of such other developments as the expanding resources and industrial production of the Great Lakes region.

Chapter 4

A THIRTY YEAR VIEW

1916-1945

COMMERCE AND IMPROVEMENTS DURING WORLD WAR I

The United States joined England and France in the war with Germany and its allies on 6 April 1917. By the end of the year the nation's transportation facilities were on the verge of collapse. Rapid mobilization including the moving of men, equipment, food, arms, and clothing as well as the iron, steel, coal, and grain needed by America's allies taxed these facilities to their utmost. In December 1917 the government took over control of transportation, including the nation's railways and the inland waterway fleets.[1]

Lake traffic, particularly at Sault Ste. Marie, was heavy throughout the war. Even in 1916, before the United States entered the conflict, war-stimulated needs for iron, coal, and grain resulted in a record movement of over 117 million tons of bulk freight on the lakes and 91 million tons through the locks. Beginning early in 1917, barbed wire barriers and armed guards assured that no enemy sabotage would interrupt locking operations. Eighty-nine million tons of freight was locked through in 1917, and lock crews were kept busy locking record numbers of vessels. On a single day, 5 July 1917, 161 vessels were handled. In 1918, 85 million tons of freight passed through the locks. To meet the extraordinary need in 1918, the Weitzel Lock, completed in 1881 but closed to traffic since the Davis Lock was opened in 1914, was opened again and passed 2,000 vessels around the falls before it was finally closed for the last time in October.[2]

Because of their indispensable role in moving cargoes between Lakes Superior and Huron, the canals and locks at Sault Ste. Marie were not affected by wartime cutbacks on civil works projects. Some channel deepening was carried out just west of the ship canal in 1917 and 1918 and work on the fourth lock continued throughout the war.

After the war, freight tonnage moving through the canals at the Sault fluctuated sharply in 1921 to 46 million tons, increasing in 1923 to 91 million, and leveling out in 1925 at 81 million tons. The most significant year-to-year fluctuations were in the quantities of iron ore shipped from Lake Superior. Only 22 1/2 million tons of iron ore came down through the Sault in 1921, a year marked by postwar industrial stagnation. As industry adjusted to a peacetime economy the ore traffic picked up, reaching 59 million tons in 1923 and leveling out in 1925 at 54 million tons.[3]

IMPROVING THE LIVINGSTON CHANNEL

The war delayed improvement of the busy 12-mile Livingston Channel, which had been completed in 1912 for down-bound vessels passing through the Detroit River. The current was strong and vessels steamed through at full speed, 8 to 10 miles an hour, to avoid drifting and possibly striking submerged rock banks on each side of the excavated cut. Despite federal regulations which limited the flow of vessels in this channel to one in five minutes, collisions did occur. When a lead vessel grounded, those following behind had difficulty slowing down because the rock bottom of the channel would not hold an anchor. Between 1912 and 1916 there had been 35 serious accidents in the channel, 12 of which resulted in halting downbound traffic and rerouting it through the congested upbound Amherstburg Channel. In 1917, Colonel Harry Burgess, who was in charge of the Corps of Engineers Detroit District from July 1916 to May 1917, recommended a $2 1/2 million project for widening the Livingston Channel.[4]

After the war, in an act of 2 March 1919, Congress provided for widening rock sections of the channel from generally 300 feet to an overall 450 feet. While the work was carried out between 1920 and 1925, the Livingston Channel was used by shallow draft upbound boats; i.e., those carrying lighter cargoes of coal. The heavier draft downbound vessels, usually carrying iron ore or grain, were routed through the Amherstburg Channel. When the Livingston Channel widening was completed in 1925 it again became the one-way downbound channel for lake vessels using the Detroit River.

LOW LAKE LEVELS, 1920-1924

Shipping on the Great Lakes was subject to influences other than the economic cycle. Before 1916, in the years when the 20-foot navigation project was being carried out, the mean flow of the St. Marys River was about 80,000 cubic feet per second. Beginning about 1918, a deficiency of rain over Lake Superior caused a gradual drop in the level of the lake and a resultant reduction in the discharge of water through the St. Marys River. Between 1922 and 1925 the discharge, as controlled by the International Joint Commission, was somewhere between 41,000 and 56,000 cubic feet pet second. This reduced flow, combined with evaporation in the lower lakes caused by high and persistent winds and exceedingly hot summers of 1920-1924, resulted in reduced levels in the lower lakes and in the channels connecting them.[5]

In the early 1920's the connecting channels no longer offered dependable and continuous safe passage for vessels of 20-foot draft. In 1921 the channels were sufficiently deep for 20-foot draft for only 40 percent of the navigation season. By 1924 it was not possible to navigate through the connecting channels with a vessel of 20-foot draft any time during the navigation season. From year to year as more channel depth was lost due to receding lake levels, shipping efficiency was impaired and transportation charges increased for bulk commodities.

Congress, on 3 March 1925, authorized the Corps of Engineers to consider deepening by one foot the ship channels between Duluth and Buffalo. Colonel Edward M. Markham, assigned the examination work by the Chief of Engineers, recommended against the project ". . . because of the length of time requisite to accomplishment and the inevitable costs thereof."[6]

Nothing more was done toward an overall deepening of the connecting channels until 1927 when Congress authorized an examination of the Great Lakes ". . . with a view to providing ship channels with sufficient depth and width to accommodate the present and prospective commerce at low water datum." This time the Chief of Engineers put a preliminary examination and eventually a survey in the hands of a special board of four Corps officers. On 14 February 1928 this board recommended deepening all downbound navigation channels to 24 feet.[7]

No immediate action was taken by Congress on this recommendation. The Republican-controlled Congresses and President Calvin Coolidge (1923-1929) were inclined to agree that government expenditures and taxes should remain low. Nevertheless, more modest projects were authorized and carried out during the period including one to widen the Middle Neebish Channel used by upbound vessels navigating the lower St. Marys River. Even this project was consistent with the views of an economy-minded Congress since it was conceived as an alternative to the more expensive widening of a 13-mile, 300-foot-wide stretch of the West Neebish downbound channel on the St. Marys River just above Mud Lake. Conditions here were similar to those on the Livingston Channel before it had been widened. Although there had been only one blockade of the West Neebish Channel since its completion in 1908, on 21 May 1910 the John B. Ketchum II grounded near the head of the cut and obstructed the channel to passage of all but small vessels for 17 days. As a result of the 1910 experience, traffic was regulated, but the possibility was always present that a vessel might strike the bank because of pilot error or fog and blockade the channel. At such a time, downbound vessels would be rerouted through the upbound Middle Neebish Channel which, in the words of Colonel Markham, was "utterly unsafe to permit simultaneous two-way navigation" because it was only 300 feet wide.[8] In 1926, Lieutenant Colonel Elliott J. Dent, then in charge at Detroit, recommended widening the West Neebish Channel to 650 feet at the cost of $10 1/4 million. Lakes Division Engineer Colonel Spencer Crosby, finding Dent's recommendation extravagant, proposed a less expensive alternative of widening the Middle Neebish Channel so that, in an emergency, it could more easily handle two-way traffic.[9] Adopting this recommendation, the River and Harbor Act of 21 January authorized widening the Middle Neebish Channel to 500 feet. Most of the work was carried out under contract by the end of 1928.

HARBOR IMPROVEMENT AND MAINTENANCE

Between 1916 and 1929, Federal work on Great Lakes harbors was confined for the most part to completing earlier projects, replacing wooden superstructures with concrete, repair and maintenance generally, and dredging to maintain harbor depths. There were a few new projects, such as the one authorized in 1917 for eliminating bends in the Rouge River so as to allow passage of vessels 400 or more feet long. After this project was completed in 1923, the new Rouge River channel was dredged annually to maintain a 21-foot depth. In 1929 alone 500,000 cubic yards of material was removed from the river.

Dredging to maintain channel depth was required at all major harbors. At Toledo, for example, some 400,000 cubic yards of silt washed in by waves or brought down by the Maumee River settled in the harbor channels annually. In 1929 a contract was let for dredging 1.4 million cubic yards of material from the harbor and from Maumee Bay. At Duluth-Superior, Buffalo, Cleveland, and elsewhere, the federal harbor effort on the lakes from 1916 to 1929 was similar. The emphasis was on repair and maintenance of harbor improvements which had been conceived and largely carried out prior to the first world war.

LAKE COMMERCE IN THE 1920's

Lake commerce continued to keep pace with the generally prosperous trend of the decade. Freight tonnage through the locks at the Sault increased yearly and in 1929 reached a record 92.6 million tons. Total bulk freight commerce on the lakes in 1929 included 138.5 million tons of iron ore, coal, grain, and stone and for the first time exceeded the 1916 record of 118 million tons.

Throughout the 1920's the flow pattern of lake commerce continued to resemble that of 1916. Duluth-Superior, mainly due to shipment of iron ore, led all lake ports in tonnage handled. As in 1916 the next port of importance was Buffalo. As an indication of the growing importance of harbors at the southern end of Lake Michigan, Chicago including Calumet had by 1929 replaced Ashtabula as the third port of importance. Other important lake ports in the order of their average tonnage for the decade were Ashtabula; Toledo; Cleveland; Conneaut; Calcite, Michigan, a private harbor on Lake Huron; Ashland; Milwaukee: Agate Bay (Two Harbors); Lorain; Escanaba, Michigan, a private harbor on Lake Michigan; Detroit, including the Rouge River; Sandusky; Gary, Indiana, a private harbor on Lake Michigan; Indiana Harbor; Fairport; Erie; and Ludington.

Lake Erie continued to lead all lakes in tonnage handled. About 40 percent of the entire lake tonnage was received and shipped at Lake Erie ports in 1928. That year Lake Superior followed with 32 percent, Lake Michigan had 22 percent, Lake Huron 5 percent, and Lake Ontario 1 percent. Grain and iron ore was shipped from West to East and coal primarily from East to West. These commodities traveled largely on the same routes and to the same destinations as in 1916.[10]

DEPRESSION-RELATED IMPROVEMENTS

In October 1929 a stock market crash introduced the worst depression the country had known. Lake traffic dwindled until in 1932 bulk freight amounted to only 41.6 million tons, and only 20.4 million tons of freight passed through the locks at Sault Ste. Marie. To provide employment and stimulate the economy during hard times rather than in response to the immediate needs of lake commerce, the federal government initiated extensive improvements in the connecting channels. On 4 July 1930, President Herbert Hoover signed a $145 million river and harbor act which authorized implementation of the 1928 recommendation to deepen downbound sections of the connecting channels to 24 feet. The project, begun by Detroit District Engineer Major David McCoach in 1931, was completed in 1936. Additional depression-stimulated legislation followed on 16 June 1933 when a new President, Franklin D. Roosevelt, signed the National Industrial Recovery Act. Among other items the act established a Public Works Administration (PWA) to provide employment through public works construction; it eventually spent over $4 billion on 34,000 public works projects. During the economic emergency, Congress allowed the details of this legislation to be filled out by the Executive Department of the Government. Two years later, Congress, in the River and Harbor Act of 30 August 1935, affirmed its leading role in civil works by belatedly giving these projects specific authorization.

As the result of legislation during the presidencies of Hoover and Roosevelt in the darkest years of the Great Depression, conditions for navigation on the lakes were substantially improved. By 1936 most of the crisis-inspired connecting channel projects had been completed. A channel 1,000 feet wide and 26 feet deep was available from Lake Superior to the head of the canal above the locks at Sault Ste. Marie. Between the St. Marys River below the locks and Lake Huron wherever downbound and upbound traffic used the same channel there was now a depth of 23.7 feet and a width of 600 feet. The same depth with a 300-foot width was available in channels used only by downbound vessels. Channels used solely by less heavily laden upbound vessels were also 300 feet wide but provided only for 20-foot navigation depth.[11]

The project for deepening the channels in the St. Clair River to 25 and 26 feet, as provided by the River and Harbor Act of 4 July 1930, also neared completion in 1936. The removal of the center dike, originally the west dike in the canal at the St. Clair Flats was completed in 1934 and this, with dredging, provided an 800-foot-wide channel about 25 feet deep across the once troublesome area.

Projects on the Detroit River were either complete or very nearly so by 1936. Adjacent to Fighting Island, a 26,000-foot-long stretch of channel 26 feet deep and 800 feet wide was provided by 1933. In the same year the Wyandotte Channel across Grassy Island was completed to a 21-foot depth and 300-foot width. In 1934 the shoals at the head of the Detroit River were crossed by a channel 24.7 feet deep and 800 feet wide, and a 13,000-foot stretch of the Livingston Channel was widened to 800 feet and provided 24-foot depth. In November 1935, a 5,000-foot stretch of the Ballards Reef Channel was completed to 28-foot depth and 600-foot width. By 1936 all that remained to be accomplished on the Detroit River was some work on the 34,000-foot stretch of channel which passed west of the Detroit River Lighthouse to Lake Erie.

Harbors as well as Great Lakes connecting channels benefited from depression-inspired Government spending in the early 1930's. While regularly appropriated funds were used to maintain Cleveland harbor, for example, Federal public works emergency funds were used between 1934 and 1936 on new work to deepen the entrance channel and portions of the outer harbor to 25 feet. Similar deepening to provide major harbors with depths comparable to those being achieved in the connecting channels was carried out at Toledo, Huron, Lorain, Fairport, Ashtabula, Conneaut, and Erie on Lake Erie; at Two Harbors and Duluth-Superior on Lake Superior; and at Calumet and Indiana Harbor on Lake Michigan.

In 1935 the carefully kept records of traffic at Sault Ste. Marie, which had come to be regarded as a barometer of general business conditions, gave some indication that the worst years of economic stagnation had passed. In 1935, vessels locking through at Sault Ste. Marie carried 48 million tons of freight, more than twice the amount moved through the locks in 1932. Total bulk freight traffic on the lakes in 1935, some 82.8 million tons, was also double that of 1932 but only 60 percent of the record set in 1929.[12]

The Lake Carriers Association's annual report for 1935 expressed "tempered optimism" for the immediate future of lake commerce and business generally.[13] President Roosevelt appeared to believe that the worst of the economic crisis was over. On 6 September 1935 he announced "substantial completion" of the experimental stage of his administration and promised that this would lead to a "breathing spell."[14] After half a dozen years of uninterrupted work on improving connecting channels and several years of harbor improvement, Army Corps of Engineers officers who planned and carried out the work could look forward to more routine maintenance and repair operations.

The general flow pattern of lake commerce remained essentially unchanged between 1929 and 1935 apart from what at the time was considered an "astounding development" in the traffic annals of the lakes. The unusual development occurred in 1934 when, because of poor harvests, the United States imported wheat, barley, oats, Latvian and Polish rye, and Argentine flaxweed. Almost 20 million bushels of the imported grain was brought westward up the St. Lawrence River and through the Great Lakes, some of it to ports such as Duluth-Superior which normally exported great quantities of grain.[15]

More significant for the future than grain imports was the opening in 1932 of the fourth Welland Ship Canal which could accommodate vessels 600 feet long with a maximum draft of 22 feet. By 1935, upper lake freighters were regularly using the Welland Canal to bring iron ore, coal, and grain to Lake Ontario. In that year 8.9 million tons of freight moved through the canal as compared to 2.5 million in 1916.[16]

Welland Canal traffic had potential for changing the relative importance of Lake Ontario in lake commerce. In the decade 1925-1935 Lake Ontario ports averaged less than one percent of the tonnage of United States lake ports while Lake Erie ports continued to lead with 40 percent followed by Lake Superior ports with 25.5, Lake Michigan ports with 22.4, and Lake Huron ports with five percent. Nearly 50 percent of the gross tonnage of United States ports for the decade was handled by six ports. Duluth-Superior was still dominant but Buffalo, before 1932 the eastern terminus of upper Great Lakes shipping, lost ground in the decade to Toledo which between 1926 and 1935 averaged a somewhat higher annual tonnage. The other three ports in order of tonnage handled were Chicago including Chicago Harbor, Calumet, and the Chicago River; Cleveland; and Ashtabula.[17]

NEW SAULT LOCK NEEDED

In the years between the opening of the fourth or Sabin Lock in 1919 and 1936 when the project for deepening downbound channels connecting Lakes Superior, Huron, and Erie to 24 feet was completed, there was no need to consider expanding the capacity of the locks at Sault Ste. Marie. Since the sills of the Davis and fourth locks were deeper than the shallowest stretches in the connecting channels, any vessel that could reach the Sault could be locked through. The situation changed after 1936.

In 1937, freight tonnage through the locks at Sault Ste. Marie climbed to 87.6 million tons, a figure surpassed in only 3 years of the generally prosperous 1920's. Though traffic dropped again in 1938 to 40 million tons, the slump was temporary. In 1939, the year in which World War II began in Europe, traffic at Sault Ste. Marie climbed to 69.8 million tons; in 1940 there were 89.8 million, only three percent less than the 1929 record. Total bulk freight commerce on the lakes reached a record 145.2 million tons of iron ore, coal, grain, and stone in 1940 when procurement for national defense had only begun.[18]

As the reviving economy called for more and more iron ore from Lake Superior country, ore carriers were increasingly loaded to take full advantage of the deepened downbound channels. In 1936 no ore vessels passing through the locks had a draft of 23 feet. By 1940 there were 213 such vessels and the heavily laden downbound ore boats lost time during the height of the shipping season due to congestion in the north canal leading to the Davis and fourth locks. Newer and still larger vessels, if fully loaded, could not pass through the locks at all.[19]

The benefits to shipping expected from constructing a new and deeper lock on the south canal to replace the Weitzel Lock, while significant by 1941, probably would not have evoked immediate action had not national defense added a note of urgency. A new lock at the Weitzel site would be removed as far as possible from the Davis and Sabin Locks. Its location would minimize the possibility of all major locks being put out of commission by a single large caliber bomb. Furthermore, in constructing a new lock, better provisions could be made to guard against possible damage to machinery, gates, and other vital parts from sabotage or attack.

On 11 February 1941, Congress requested a report on the need for a new lock. The Chief of Engineers assigned the task to the Detroit District Engineer who recommended a new lock 800 feet long, 80 feet wide, and 30 feet deep on the site of the old Weitzel Lock. "It is estimated", he added, "that the work will require 16 months for completion, if prosecuted as an emergency measure and work carried on through the winter."[20] Anticipating that the lock could be constructed in 16 months required extraordinary confidence. It had taken 8 years each to build the Weitzel and Poe locks and 6 years to build Davis. The Sabin lock had had also taken 6 years.

During the shipping season of 1941, while Congress weighed the importance of a new lock against other defense priorities, 110.7 million tons of freight moved through the Sault, breaking all previous records. Before the season ended on 8 December, the day following the Japanese attack on the U.S. Naval Base at Pearl Harbor, Hawaii, Congress declared a state of war to exist between Japan and the United States. Declarations of war with Germany and Italy followed on 11 December. Fearing that an enemy ship might bring planes into Hudson Bay and that from there aircraft might slip down undetected for an attack on the locks and the approaching canals at the Sault, the government made the canal one of the most guarded sites in the United States. Ground troops patrolled the area with machine guns while barrage balloons swayed overhead and fighter aircraft at designated airfields remained alert for a possible air attack on the vital waterway.

THE MACARTHUR LOCK

On 7 March 1942, Congress authorized the new lock project. Plans and specifications had already been prepared by the Upper Mississippi Valley Division of the Corps of Engineers. Even before official notice to proceed was received, on 14 May, bids were opened for removing the old Weitzel Lock, constructing the necessary cofferdams on the upper and lower approaches, and excavating the lock site. The contract for constructing the lock proper contained the stipulation that the lock would be completed not later than 4 July 1943. The project was placed on a 7-day-around-the-clock schedule.

Subzero temperatures during the winter of 1942-43 did not stop construction on the new lock. Over 200,000 cubic yards of concrete had to be heated when mixed, sheltered after placement, and protected during curing. Obtaining enough competent labor, critical machinery, and materials added other difficulties, but the lock officially opened on 11 July 1943, only 1 week behind schedule. Earlier, on 15 June, by an act of Congress, the lock was named the MacArthur Lock.[21]

Fortunately for the United States and its allies, no attack or sabotage occurred at the Sault. Throughout the war, day and night without interruption except for winter months, record quantities of iron ore were transported through the locks eastward to Lake Erie or south to Lake Michigan where smelters and factories manufactured war-related products for shipment to battlefronts in Europe and the Pacific.

Chapter 5

IMPROVEMENTS IN LAKE TRANSPORTATION

1945-1969

Even before the war ended, on 2 March 1945 President Franklin Roosevelt, who had just returned from his meeting at Yalta with Prime Minister Winston Churchill and Premier Joseph Stalin, signed the first general rivers and harbors authorization since 1938. Congress saw the new river and harbor act as part of its postwar planning. Many projects included were not essential for the war effort and would be eligible for funding only after peace had been restored and when their construction would afford at least partial relief from an anticipated acute unemployment situation.[1]

Several provisions of the 1945 act related to the ongoing project for improvement of the connecting channels between the Great Lakes. One authorized replacing the Poe Lock with a new lock of the same 800-foot length as the MacArthur Lock but 100 instead of 80 feet wide and 32 instead of 30 feet deep. Although Congress rescinded provisions of the 1945 law prohibiting construction of all but war-related projects in the River and Harbor Act of 24 July 1946, no work had been undertaken on these projects when, 10 years later, new legislation initiated modifications on a grander scale. The reasons lay in a number of postwar developments which could not be clearly anticipated 10 years earlier.

INCREASED COMMERCE AND LARGER VESSELS

One unanticipated postwar development was a continuing high level of lake commerce. After a moderate dip in 1946, lake commerce increased in the years following the war. In 1948 more tonnage moved on the lakes than ever before. The cargoes were essentially those of the previous half century. Iron ore, coal, limestone, and grain composed 80 percent of the 1948 lake commerce. Also, the flow of lake commerce was much the same as it had been for half a century. Most of the iron ore, 91.7 million tons, was mined in the Lake Superior region and moved through the locks at Sault Ste. Marie to the southern end of Lake Michigan and ports on Lake Erie. The flow of coal was to a large extent the reverse of the movement of iron ore. Some 66.9 million tons was shipped on the lakes in 1948, mostly from Lake Erie ports to destinations on Lake Michigan and Lake Superior. Limestone, some 22.3 million tons, made up the third major item of 1948 bulk commerce on the lakes.

Limestone was shipped principally from Lake Huron and upper Lake Michigan ports for use largely at iron, steel, and cement manufacturing centers on lower Lake Michigan, on Lake Erie, and, to a lesser extent, on Lake Superior.[2]

The sustained heavy commerce of the war and postwar periods resulted in the construction of new and larger vessels for the lakes fleet. Thinking and planning of connecting channel modifications during World War II had been attuned to Great Lakes navigation as it had existed for nearly 40 years and aimed primarily at accommodating lake freighters with 600-foot length, 60-foot breadth, and drafts of around 19 feet. However, vessels built after World War II were larger than anything that had ever sailed the lakes. One of these freighters, the Wilfred Sykes, launched at Lorain, Ohio, on 28 June 1949, was 678 feet long and 70 feet across.

When launched the Sykes was the the largest ship in the lakes and the first lake ship to burn oil. At full draft the Sykes could haul a cargo of 21,700 tons, nearly twice the 11,000 tons of the average freighter. With a loaded speed of 16.5 miles per hour, the Sykes was able to make 44 round trips during the navigation season as compared with 34 trips for the average ship in the ore fleet.[3]

After 1949 nearly every shipping line on the Great Lakes launched a vessel which could be favorably compared with the Sykes. Before long there were giant carriers of over 700 feet in length. Motivation to build larger vessels was strong, when navigation conditions permitted, since doubling the cargo capacity had been known to multiply net earnings fourfold.[4]

PLANNING THE SAINT LAWRENCE SEAWAY

Another postwar development was progress toward congressional authorization of United States participation in the construction of the St. Lawrence Seaway. The idea of opening the Great Lakes to ocean navigation was an old one, and on 3 October 1945, President Harry S. Truman urged Congress to enact legislation ". . . so that work may start on this great undertaking at the earliest possible time."[5] He reminded Congress that, "During the war we were forced to suspend many of the projects to harness the waters of our great rivers for the promotion of commerce and industry and for the production of cheap electric power . . . . For over 50 years the United States and Canada under both Republican and Democratic administrations, under liberal and conservative governments, have envisioned the development of the project together as a joint enterprise."[6]

In 1940, President Franklin D. Roosevelt had authorized the Corps of Engineers to survey the St. Lawrence River. The following year Ottawa and Washington signed an agreement to provide deepwater navigation from Montreal to the head of lakes. After World War II, the Great Lakes Division of the Corps of Engineers furnished Congress with estimates of costs for deepening the Great Lakes connecting channels. Despite this activity on the part of the Corps and the enthusiasm of Presidents Roosevelt and Truman, Congress was reluctant to proceed. Only in 1949 did Congress finally ratify the 1941 agreement. Actual construction activities began after 13 May 1954, when President Dwight D. Eisenhower signed the St. Lawrence Seaway Act which provided $105 million in revenue bonds to fund the United States' share of seaway construction.

THE SEAWAY COMPLETED

The St. Lawrence Seaway opened in 1959. It provided a 27-foot-deep waterway in the St. Lawrence River to permit deep-draft vessels to navigate between Lake Ontario and the Atlantic Ocean and improvements to the Welland Canal making it capable of handling deep-draft vessels passing between Lake Ontario and Lake Erie. Of the seven locks required for deep-draft navigation between Montreal, Quebec, and Lake Ontario, only two, the Dwight D. Eisenhower and the Bertrand H. Snell Locks, were within the limits of the United States. Construction of these locks, removal of shoals in the Thousand Island section of the St. Lawrence River, excavation of the 10-mile long Wiley-Dondero Ship Canal in the International Rapids section, and many other features including construction of a high level suspension bridge, dikes, buildings, and roads were carried out by the U.S. Army Corps of Engineers. Engineers worked as agents of the St. Lawrence Seaway Corporation, which had been created by Congress for constructing, operating, and maintaining features of the project within the limits of the United States.[8]

CONNECTING CHANNELS ABOVE NIAGARA

The St. Lawrence project included no provisions for improving the connecting channels above Niagara to permit deep-draft ships to reach such harbors as Detroit, Duluth, Chicago, or Milwaukee. By resolutions of the Public Works Committees of the Senate and the House of Representatives on 25 March and 24 June 1953, respectively, the Corps of Engineers was asked to look into the advisability and costs of providing depths in the connecting channels of at least 27 feet, a depth commensurate with that which was to be authorized for the St. Lawrence Seaway. Corps of Engineers' studies showed that annual savings of nearly $10 million in water transportation costs for iron ore, stone, and grain alone could be expected if the connected channels were made 27 to 30 feet deep for the safe passage of vessels drawing 25.5 feet of water. Deepening of the connecting channels could be justified on its own, Corps studies showed, without reference to seaway potentials. The Corps estimated the project would cost about $135.9 million and would require $200,000 worth of annual maintenance. Governors of States bordering the lakes responded enthusiastically to the proposal, and most urged speedy authorization.[9] Congress voted for the project, and President Eisenhower approved it on 21 March 1956.

The project involved deepening and widening the entire navigation channel connecting Lake Superior and Lake Huron and that connecting Lake Huron and Lake Erie, 167 miles in all, to depths ranging from 27 to 30 feet and widths of 300 to 1,200 feet. To assure safe passage between Lake Huron and Lake Michigan of vessels with drafts of 25.5 feet, a shoal would be removed between Mackinac Island and Round Island to a 30-foot depth over a 4,000- by 1,250-foot area. The entire project involved the removal of an estimated 44 million cubic yards of earth and enough rock, it was said at the time, to fill 2 1/2-cubic yard capacity dump trucks which, if placed bumper to bumper, would more than encircle the earth.

In addition to engineering problems involved in drilling, blasting, and excavating rock, sand, and clay for deep channels, the Corps of Engineers had the additional problem of scheduling the work so as to complete the project in six years and interfere as little as possible with commerce, particularly with the bulk shipment of iron ore upon which the economy of the nation was critically dependent. Another problem, perhaps the most critical of all, was the limited availability of the highly specialized equipment needed to perform the work. In one way or another, obstacles were overcome and the work was carried out. In June 1962 project depths of 27 to 30 feet were available through all the connecting channels.[10]

HARBOR DEEPENING

Meanwhile, economic and engineering studies carried out by the Corps of Engineers determined that it was worthwhile to deepen 30 Great Lakes harbors and to construct one new harbor, Burns Waterway, Indiana, to accommodate the ships loaded to depths being provided in the connecting channels, the Welland Canal and the seaway. So that vessels could take full advantage of connecting channel and seaway improvements, Congress, between 1960 and 1965, authorized the projects recommended in the Corps studies.

Plans for deepening the harbors and constructing the Burns Waterway were based on the current and prospective commerce of the harbors involved. On Lake Superior Two Harbors, Duluth-Superior, Presque Isle, and Marquette harbors were deepened to 27 or 28 feet for large bulk cargo vessels carrying iron ore and coal. It was anticipated that Duluth-Superior harbor would also be a general cargo port for oceangoing vessels. Harbors on Lake Michigan at Milwaukee, Chicago, Calumet, Indiana Harbor, and Muskegon were deepened to 27 or 28 feet, while the new Burns Waterway, also dredged to a depth of 27 to 28 feet, required breakwaters. Harbors at Green Bay, Manitowoc, and Kenosha were provided depths from 22 to 25 feet. It was expected that overseas vessels carrying general cargo would use Lake Michigan deep-draft harbors, but that bulk cargo vessels carrying iron ore, coal, limestone, or grain would make up the larger part of Lake Michigan commerce. Federal harbors on Lake Huron at Alpena and Saginaw were deepened: Alpena to 23 feet in anticipation of large coal shipments; Saginaw to 25 feet to accommodate lake vessels carrying coal, limestone, and petroleum products and general cargo from or for ocean vessels. On the Detroit River stretch of the connecting channels, lower portions of the Rouge River were authorized for dredging to 25 feet to accommodate overseas vessels with general cargo and lakers carrying iron and steel, scrap iron, and petroleum products. The Trenton Channel was to be deepened to 25.5 feet to accommodate vessels carrying iron ore and limestone. On Lake Erie, harbors at Toledo, Huron, Lorain, Cleveland, Fairport, Ashtabula, Conneaut, Erie, and Buffalo were deepened to 27 or 28 feet. Overseas general cargo was anticipated at Toledo, Cleveland, Ashtabula, Erie, and Buffalo but the bulk of Lake Erie commerce was expected to remain largely coal, iron, limestone, and grain. On Lake Ontario the harbors at Rochester (Charlotte) and Great Sodus Bay were provided depths ranging from 22 to 24 feet primarily for shipments of coal at Rochester and for overseas general cargo and aluminum at Oswego.[11]

By 1966, 16 projects were completed, 6 were substantially done, while work had not yet commenced on 10. Virtually all of the harbor improvements for deep-draft vessels authorized between 1960 and 1965 were later carried out. These 31 major commercial harbors, 28 lesser federally improved commercial harbors, and 15 private deep-draft harbors make up today's United States commercial lake harbor system.

THE NEW POE LOCK

Meanwhile, in the 1950's, developments on the lakes suggested renewed consideration of the lock authorized in 1946 to replace the aging Poe Lock at St. Marys Falls. After the war, except for 1949, freight tonnage on the lakes remained above 100 million tons annually. In 1953 it broke all records by exceeding 200 million tons. As the 1950's progressed, more and more lake cargo was being carried in the larger deep-draft vessels but only the MacArthur Lock was capable of accommodating these vessels when loaded to the maximum permissible in the connecting channels. Since the Canadian lock at the Sault was narrow and shallow, it could handle only relatively narrow vessels with light draft. The bulk of the traffic was at the American locks. In 1954, 51 percent of the total freight was sent through the MacArthur Lock. The Poe Lock, too shallow for economical use, was inactive. The Davis and Sabin Locks accommodated the remainder of the fleet and, because of their great lengths, were frequently used for double lockages.

In 1957, it became necessary to clarify the absolute maximum dimensions of vessels which would be locked through the MacArthur Lock. The maximum overall vessel length which could be accommodated in the lock with its safety boom lowered was 660 feet. When in 1957 a number of vessels exceeded this length, special procedures were evolved for handling them. While the safety boom was in place, the entering vessel was permitted to proceed under her own power to a point halfway into the lock chamber where the vessel was brought to a complete stop with four lines out, two leading forward and two astern. The vessel was then hauled forward on her mooring lines and the safety boom was raised to allow the bow of the vessel to pass. Although time was lost in these careful maneuvers, dammage to vessels and destruction of the lower lock gates were prevented. With this system it was possible in 1957 to set the maximum length of vessels locking though the MacArthur Lock at 730 feet; the maximum width was established at 75 feet. By 1965, 52 lake vessels exceeded 660 feet in length and required special handling at the MacArthur Lock.[12]

Congress had anticipated the need for an additional deep-draft lock and authorized its construction in 1946. By the time funds were available for detailed planning in 1958, it was evident that the 800-foot lock originally planned would be inadequate. Studies carried out by the Corps of Engineers showed that a lock 1,000 feet long, 100 feet wide, and 32 feet deep would better serve lake commerce. A lock of these dimensions was planned, and in December 1960 the Detroit District awarded the first contract for the project. It included construction of cofferdams, excavation of the old Poe Lock to make room for the new and larger lock, and reconstruction of 400 feet of the west center pier. Early in 1961, work had barely begun on the cofferdams and demolition of the old Poe Lock when shipowners, finding that vessel size in the 1,000-foot-long, 100-foot-wide lock would be limited to 840 by 90 feet, expressed serious dissatisfaction. They were considering the construction of vessels up to 950 by 95 feet in size. As a result of their concern, lock requirements were restudied and in August 1962 the dimensions of the proposed lock were increased to a length of 1,200 feet and a width of 110 feet.[13]

In July 1964 a contract on a bid of $21,472,000 for construction of the new Poe Lock was awarded to a Canadian firm and work commenced the following month. The new Poe Lock was perhaps the first lock ever built between two existing locks. Traffic continued at the MacArthur and Davis Locks on either side of the construction site. Construction sequences were developed so that some of the work could be carried out in winter when the MacArthur and Davis Locks were shut off with cofferdams and pumped dry. Such considerations caused several modifications to the project and increased the time and cost required for construction. Nevertheless, the first test ship, the steamer Philip R. Clarke with a cargo of 18,000 tons of taconite pellets, passed through the new Poe Lock in October 1968 and the lock was officially dedicated in June 1969.

Chapter 6

CHANGING ASPECTS OF LAKE AND SEAWAY NAVIGATION

The generally high level of bulk freight carried on the Great Lakes and through the St. Lawrence Seaway in the 1970's and the continued predominance of the traditional cargoes--iron ore, coal, limestone, and grain--suggest few changes in commerce since the 1950's. Actually, lake and seaway shipping was vastly different in the 1970's--in vessel technology, in flow patterns for shipping bulk commodities, in ways of maintaining channels and harbors, and in planning future improvements.

CHANGES IN VESSEL SIZE

The size of vessels on the lakes and seaway in the 1950's was limited by the capacity of the MacArthur Lock, the 15 locks of the Welland Canal, and the St. Lawrence Seaway to approximately 730 feet by 75 feet with a maximum draft of about 26 feet. The completion in 1969 of the new Poe Lock at Sault Ste. Marie which could handle vessels up to 1,100 feet long, made it possible to navigate the lakes above Niagara with larger vessels. Incentive to build larger bulk carriers for use above Niagara was provided as shipments of iron ore were replaced by shipments of pelletized iron ore called taconite. Open pit ore which could be mined and shipped without further processing declined in the late 1950's and was replaced by low grade ore reduced to pellets at processing plants near the mines. The pellets, uniform and more easily handled by automatic means than ore, have about twice the iron content of raw ore. But unlike ore they contain no moisture, do not freeze, and can be transported in winter months whenever navigation remains open. The first shipment of taconite pellets came down the lakes in 1956.

The trend toward larger vessels to transport taconite began in the late 1950's. The largest of the decade and the lake queen of its day was the Edmund Fitzgerald launched in the summer of 1958, a year before the St. Lawrence Seaway was opened for deep draft ships. The Fitzgerald, which has become the stuff of song and legend, was 729 feet long and 75 feet wide. The Detroit News said it was "the biggest object ever dropped into fresh water in recorded history, (the) longest and largest ship ever on the Great Lakes . . . perhaps the largest which ever will be built." Visitors to the MacArthur Lock on 28 July 1968 saw the Fitzgerald lock downward with 30,260 tons of taconite pellets, the largest cargo ever carried through the lakes.[2]

Ships vastly larger than the Fitzgerald and expressly designed to use the increased capacity of the new Poe Lock were soon on the planning boards. In early 1969, officials of Bethlehem Steel Corporation of Erie, Pennsylvania, announced that Litton Industries was building them a vessel 1,000 feet long and 105 feet wide which would be able to carry 55,000 gross tons of cargo at a draft of 26 feet 9 inches.

The bow and the stern sections of the great vessel were built at Litton's shipyard at Pascagoula, Mississippi. When joined together they made a ship 182 feet long and 72 feet wide. This miniship sailed up the Atlantic coast and through the St. Lawrence Seaway to a graving dock at Erie, Pennsylvania, where it was cut in two and expanded to 1,000 feet by welding in 18 50-foot sections or modules which had been fabricated in a nearby factory.

On 3 May 1972 this vessel, the Stewart J. Cort, entered the Poe Lock for the first time. It carried a record 51,000 tons of taconite pellets from Lake Superior en route to Bethlehem Steel's Burns Harbor, Indiana, on Lake Michigan.[3] Four years later, three 1,000-foot vessels were on the lakes; in 1981 there were 13.

Already in 1976 the Corps of Engineers considered the possibility that vessels 100 feet longer than the Cort would be built for the Great Lakes. The new 1,000-foot vessels were capable of maneuverability unknown in the older, smaller bulk freighters. Such improvements as twin screws, twin rudders, and bow and stern thrusters permitted them to turn on an axis around a point located within the vessel. Vessels of 1,100 feet with such capabilities could move through the connecting channels and the new Poe Lock by adopting procedures similar to those used with 767-foot vessels in the MacArthur Lock. The Corps concluded that the use of 1,100-foot vessels through the Great Lakes system was feasible, and they would not have a significant impact on the natural environment.[4] In January 1977 the Secretary of the Army approved the use of 1,100-foot vessels on the lakes. While there are as yet no ships that size with the newest lake freighter construction methods, a 1,000-foot vessel could be extended 100 feet by cutting it and adding two 50-foot modules.

CHANGES IN THE FLOW OF LAKE COMMERCE

Iron Ore

Beyond the introduction of 1,000-foot vessels, the 1970's experienced the culmination of a number of changes in the traditional flow patterns of bulk cargoes of iron ore and coal. On a small scale in 1954, Canadians began loading iron ore from the Quebec-Labrador area at ports on the lower St. Lawrence River for shipment west through the Welland Canal to ports on Lake Erie and Lake Michigan.[5] After the completion of the St. Lawrence Seaway in 1959, this traffic increased until about 15 percent or 12.9 million tons of the iron ore transported on the lakes came from eastern Canada.[6] At the end of the decade, in 1979, shipments of iron ore from lower St. Lawrence River ports leveled out at 13.3 million tons or 14.5 percent of the 92 million tons of that year's lake commerce in iron ore.

In that year, 92 million tons of iron ore were transported on the lakes, more than any other year except 1953 when the record total was 95.8 million tons. Although the ore from eastern Canada was important to the trade, the bulk of ore was still in 1979 shipped from Lake Superior ports. With the introduction of taconite, however, older shipping patterns were altered and Duluth-Superior and Two Harbors were no longer as dominant as in the 1950's. Two new ore ports built by mining companies at Silver Bay and Taconite Harbor began to ship taconite from the North Shore. Declining ore shipments at Duluth-Superior Harbor totaled 30 million tons annually by 1965 and in 1979 were down to 28 million. Two Harbors closed down ore shipping completely between 1963 and 1966 and shipped about 5 million tons of ore in 1970, but in 1979 its total had grown to 11 million tons. In the same year 8 million tons of taconite was shipped from Silver Bay and 9 million from Taconite Harbor.[7]

Coal

A change in the flow pattern of coal also began in the 1950's. As late as 1948 most of the bituminous coal shipped on the lakes was loaded at Lake Erie ports for destinations on Lake Michigan (12.4 million tons) or Lake Superior (13.2 million tons). A 1948 exception to this pattern was the shipment of 6.9 million tons of soft coal by rail to a dock at South Chicago from where it was sent by water to other ports on Lake Michigan. Another 1948 exception to the traditional east-west flow pattern for lake-transported coal was the shipment of 4.9 million tons from Lake Erie ports eastward through the Welland Canal, most of it to Canadian ports on Lake Ontario and the St. Lawrence River.[8]

By 1965, Lake Erie coal shipments westward to Lake Superior and Lake Michigan dropped to 4.9 and 5 million tons respectively, while coal shipments eastward through the Welland Canal grew to 7.2 million tons. By 1970 the trend was clearly established when only 3.1 and 3.5 million tons of coal were sent from Lake Erie ports to ports on Lake Superior and Lake Michigan, respectively, and 10.6 million tons went eastward through the Welland Canal. During that period Canada expanded its industrial and utility use of coal while in the United States fossil fuel was being replaced by petroleum. Since the replacement of coal by petroleum was less extensive in the Great Lakes area than in other parts of the country, the continued decline of lake shipments of coal to ports on Lake Superior and Lake Michigan was due less to a decline in demand than to competition from railroads, more specifically to the introduction of "unit trains" which were committed by long-range agreements between consumer, railroad, and producer to load at one place of origin and unload at one destination. In the early 1970's, unit trains began moving coal from Appalachian mines to lake destinations such as Detroit, bypassing traditional Lake Erie transshipment ports such as Toledo. Once the major coal shipping port on Lake Erie, Toledo shipped 18.6 million tons of soft coal to United States ports in 1965, 17.7 million tons in 1970, and only 10.7 million tons in 1979.[9]

The results of the shift of the Great Lakes coal shipping pattern were also particularly striking for Duluth-Superior harbor. During World War II and through 1948 an average of nine million tons of coal was received at the harbor annually. A decline began in the 1950's. By 1970, Duluth-Superior received only 893,938 tons of coal. However, the low record of the century for Duluth-Superior coal receipts was made in 1972 when only 447,048 tons arrived at the harbor.[10]

The following year Duluth-Superior harbor was the scene of an event even more illustrative of change from the traditional pattern of east-west coal shipments. In 1973 some 127,000 tons of western low sulphur coal was transshipped there for the St. Clair, Michigan, area. After 1973, increasing quantities of Wyoming, Montana, and North Dakota low-sulphur coal came directly to the Superior, Wisconsin, docks by unit trains and were transshipped down the lakes. In 1979, Lake Superior down-lake shipments of coal increased to 6.3 million tons; 58 percent of it was loaded on lake vessels at Superior, the remainder at Thunder Bay, Ontario.[11]

Limestone

Until the 1970's the all-time high for lake commerce in limestone was 30.7 million tons in 1964. During the 1970's between 36 and 43 million tons of limestone was shipped annually from such private harbors as Calcite, Stoneport, and Drummond Island, Michigan, on the western shore of Lake Huron; Port Dolomite and Port Inland, Michigan, on the northern shore of Lake Michigan; and Marblehead, Ohio, on western Lake Erie. The major receiving ports for limestone corresponded with major ore receiving ports where it was used in blast furnaces to remove impurities from iron ore, and in the manufacture of cement. The movement of limestone through the lakes complemented lake shipment of coal to the extent that many vessels engaged in carrying coal from Lake Erie to Lake Superior ports loaded limestone on their return voyages. Like coal, cement, and pulpwood, limestone was for many years transported in bulk freight vessels equipped with self-unloading conveyors.[12]

Grain

Although grain continued to move from west to east on the Great Lakes, there were significant changes in the grain trade after the 1950's. Annual tonnage during the 1950's, ranging from 336 to 571 million bushels, was below the record of 674 million bushels in 1945. Annual grain shipments in the 1960's ranged between 520 and 892 million bushels. In the worst year of the 1970's, 699 million bushels of grain was shipped while in 1978, grain shipments exceeded the billion bushel mark. In 1980, lake shipments of grain totaled 1.15 million bushels.[13]

From the early years of the century, most Great Lakes grain shipments originated on Lake Superior. Shipments from the Canadian ports of Fort William and Port Arthur, now Thunder Bay, greatly exceeded those of Duluth-Superior Harbor, the major United States grain shipping port on Lake Superior. Duluth-Superior by the 1970's improved on earlier records and shipped between 151 and 305 million bushels annually. Duluth-Superior shipped an all-time record 364 million bushels of grain in 1980, Thunder Bay over 500 million.[14]

While Lake Superior ports continued to handle the bulk of Great Lakes grain shipments, there were marked changes in the destination of Lake Superior grain. In the beginning of the lake grain trade, Buffalo was the major recipient. It was through the late 1920's. Buffalo received 110 million bushels of grain in 1920 and in 1928 a record 276.6 million bushels. No more than 15 million bushels of grain were carried down through the Welland Canal to ports along the St. Lawrence River in 1920. However, 8 years later, in 1928, this trade grew to some 182 million bushels.[15]

The grain trade declined during the depression and years of poor crops in the 1930's. Yet in those years the shift toward the Welland route continued, particularly after 1932 when the new Welland ship canal opened to the largest lake vessels. In 1933, grain arriving at Buffalo for unloading totaled 108 million bushels, the lowest of any year since 1918 while 115 million bushels moved through the Welland Canal.[16] Buffalo's position in the grain trade remained important during the 1940's and 1950's but, with the completion of the St. Lawrence Seaway and the enlargement of the Welland Canal in 1959, the grain flow turned more decisively against Buffalo. Throughout the 1960's, Buffalo's annual grain receipts ranged between 62 and 94 million bushels while annual shipments to the St. Lawrence area ranged from 148 to 469 million bushels. By the 1970's, Buffalo's grain receipts were reduced to between 41 and 71 million bushels annually while annual shipments to the St. Lawrence area grew to between 499 and 611 million bushels. Most of the grain shipped down the St. Lawrence route was either transshipped at downriver ports or proceeded directly overseas.[17]

Although the total volume of grain shipped from lake ports increased over the past 20 years, the lake ports declined in percentage terms compared to Atlantic, Gulf, and Pacific ports. In 1969, of a total 1.4 billion bushels of United States grain exported, 18 percent was shipped from ports on the Great Lakes. In 1979, 4.5 billion bushels of United States grain were exported, of which 510 million bushels, only 11 percent, were shipped from lake ports. More than half of the exported grain, 2.7 billion bushels, was handled at Gulf ports and total shipments from either the Atlantic (585 million) or Pacific coasts (689 million) exceeded lake port shipments.[18]

Miscellaneous Bulk Cargo

Iron ore, coal, limestone, and grain accounted for most of the freight tonnage on the Great Lakes. Among other bulk cargoes in 1978, 4.8 million tons of sand, gravel, and crushed rock was transported on the lakes, in local traffic most often from one point to another within the same harbor. Of the 1.3 million tons of salt moved on the lakes in 1978, most was imported by Canada. Gypsum, 1.3 million tons, was chiefly a cargo shipped from one United States lake port to another. Distillate fuel oil, 1.9 million tons, also moved between United States lake ports. Somewhat more than one-third of the 4.5 million tons of residual fuel oil shipped on the lakes in 1978 was imported by Canada. The remainder moved between United States ports or merely locally.[19]

GENERAL CARGO

General cargo has been defined as cargo which consists of "miscellaneous goods packed in boxes, bags, bales, crates, drums, unboxed or uncrated, accepted and delivered by mark or count."[20] General cargo shipping persisted on the lakes until World War II but was overshadowed by bulk cargoes of raw products of mines, forests, and fields surrounding the lakes. A revival of general cargo shipping was anticipated once the St. Lawrence Seaway made it possible for vessels to move between lake and overseas ports. For some years after the seaway opened, this prediction seemed justified. In 1959 only two million tons of general cargo moved through the Montreal to Lake Ontario portion of the seaway while six years later, in 1965, this freight increased to 3.8 million tons and reached a high of 7.1 million tons in 1971. Since that date general carge tonnage declined on the seaway to a mere four million tons in 1980.[21] The loss is partly attributed to increased competition from coastal ports.

World-wide since the mid-1960's, more and more general cargo was shipped in standardized containers. Some coastal ports, because of their special facilities, the large quantities of containers handled, and their easy access by large container vessels, were preferred to lake ports for this traffic. Use of the containers reduced loading and unloading time at ports but required expensive handling equipment, sophisticated terminals, and considerable space in the harbor for sorting and storing. Although Chicago, Cleveland, Green Bay, Milwaukee, Toledo, and Duluth-Superior harbors handled container traffic in the 1970's, only Duluth constructed a container terminal. Because container-carrying cargo vessels have been built larger than the general cargo vessels in use when the St. Lawrence Seaway was constructed, the newer vessels cannot transit Seaway or Welland Canal Locks.[22] In the 1970's, lake ports lost general cargo which had been containerized and was handled instead at coastal ports better equipped to load and unload containers and better able to accommodate the new and larger vessels.

HARBOR MAINTENANCE

Operations to maintain navigation depth in Great Lakes channels and harbors were affected beginning around 1965 by a heightened and popular concern for the natural environment. Generally, material dredged from channels and harbors was deposited in designated deep areas of the lake. The practice was economical and assured that dredged materials would not interfere with navigation. However, over the course of the century or more during which lake disposal was practiced, major lake harbors became heavily populated urban-industrial areas. Harbors, almost invariably on the lower reaches of rivers, were sometimes used to dispose of waste from industry and from the surrounding urban centers. As a result the streams and harbors became badly polluted.

In the mid-1960's disposal of material dredged from these polluted areas became an important environmental issue. Studies were initiated by the Corps of Engineers in 1965 to determine the feasibility of alternate disposal practices. Beginning in 1966, the Corps, in cooperation with the Federal Water Pollution Control Administration, initiated more intensive studies under the title "Pilot Program for Determining Alternate Methods of Disposal of Polluted Dredgings" or simply "Pilot Program."[23]

By 1968 the Pilot Program had isolated 30 polluted harbors on the Great Lakes and provided the background information to enable Congress to enact Public Law 91-611, Section 123, signed by President Richard M. Nixon on 31 December 1970, which authorized the Corps of Engineers to construct, operate, and maintain contained dredged material facilities. Several provisions of the law delayed immediate construction of the diked disposal areas. One required a decision of the Environmental Protection Agency as to which sites were most urgently needed. Another required that land needed for the sites be provided by the States or subdivisions thereof. A third required a local sponsor who would agree to contribute 25 percent of the construction costs. The last requirement could be waived provided the administrator of the Enviornmental Protection Agency certified the area involved, and the industrial concerns located there were participating in an approved plan for treatment of wastewater.

These provisions, but in particular that concerning a possible waiver under certain conditions of 25 percent of the construction costs, delayed decisions while a dredging backlog in polluted harbors reached 12 million cubic yards by 1974. Only high water in the lakes kept the situation from becoming serious.

By 1975 the Environmental Protection Agency had looked again at the Great Lakes harbors and found a number of them not polluted after all. For these harbors the agency said that open lake dumping could be resumed. By the spring of 1978 the agency determined that dredged material which was only moderately polluted might be disposed of in the open lake provided each cubic yard of the polluted material was covered with two cubic yards of clean material.

As quickly as questions regarding local cooperation were solved and other requirements met, the Corps undertook construction of the needed disposal sites. As of 1 January 1980 the Corps had completed 20 of 39 proposed sites scheduled to serve 56 Great Lakes navigation projects.

MAINTENANCE DREDGING OF THE CONNECTING CHANNELS

There were no requirements for local funding in connection with disposal of material dredged from the connecting channels, and on these projects the Corps could sometimes move more quickly. Of all the sites on the lakes which had been classified as polluted, the St. Marys River and the Straits of Mackinac were the first to be restudied and reclassified as unpolluted, thus removing the requirement for diked disposal of dredging. In these areas some 39,000 cubic yards of material are removed annually by hopper dredges and derrickboats, either disposed of on land, or deposited in open water disposal areas. Although diked disposal areas were not considered necessary after the National Environmental Policy Act of 1 January 1970, an environmental impact statement was required on all Federal actions affecting the environment. A draft environmental impact statement was forwarded to the Council on Environmental Quality in August 1975, a final statement on 24 March 1976. Maintenance dredging of the St. Marys River and Straits of Mackinac was allowed to continue without substantial change or interruption.

Diked areas were required for disposal of dredged material from the St. Clair and Detroit Rivers. A site selected by the Corps for St. Clair River disposal at Dickenson Island was opposed on environmental grounds because it was feared the installation would upset the ecological balance of the island. However, findings of the Corps' environmental impact statement were sufficiently positive to enable a Federal judge to deny a request for an injunction to hold up the work.[24] The project was completed in 1975.

A site at Pointe Mouille on Lake Erie immediately south of the mouth of the Huron River was selected by the Corps for construction of a diked disposal area for material dredged from the Rouge and Detroit Rivers. This project was designed to protect a natural marsh area and was generally well received by those most concerned with the environment. Construction of this disposal area was carried out in 1976.

NAVIGATION SEASON EXTENSION

Traditionally, navigation on the Great Lakes has been suspended each winter between mid-December and early April. Congress, in the River and Harbor Act of 1965, authorized a preliminary study to determine whether an extension of the navigation season was feasible. After a review of world-wide experience in ice navigation and ice modification techniques, the Corps of Engineers concluded that with present technology winter navigation on the Great Lakes-St. Lawrence Seaway system was physically feasible; whether economically feasible or otherwise desirable could not be determined on the basis of such a limited study.

In 1970, Congress authorized a study of the economic justification for an extension of the season and a three-year, $6.5 million demonstration program. The program was carried out under the guidance of a Winter Navigation Board comprised of the Corps' North Central Division Engineer as Chairman; the Commander, 9th Coast Guard District as Vice-Chairman; and Senior Representatives of the St. Lawrence Seaway Development Corporation, Maritime Administration, National Oceanic and Atmospheric Administration, Environmental Protection Agency, Department of the Interior, Great Lakes Commission, and Great Lakes Basin Commission; technical advisors from the National Aeronautics and Space Administration and the Atomic Energy Commission; and two representatives of an advisory group which included shipping and industrial interests, labor, port authorities, and others. The Corps' Detroit District Engineer was made chairman of a working committee consisting of seven boards. Each board, made up of representatives of participating agencies, was to deal with a separate aspect of the demonstration program.

Since ice is the major obstacle to winter navigation, particularly on the upper lakes and the connecting channels, during the first winter of the program, 1971-72, aerial surveillance and photography of ice-restricted channels were undertaken, ground surveys of ice characteristics made, ice at critical areas measured, and water levels monitored at key locations. Merchant vessel construction, improvements to allow vessels to move safely in ice-covered waters as well as methods of icebreaking, and all-weather aids to navigation were other matters considered by the boards.

An Ice Control Work Group under the guidance of the St. Lawrence Seaway Development Corporation studied alternate methods of preventing and reducing formation of ice as well as ice control in critical areas of the international section of the St. Lawrence River. An Ice Management Work Group under the direction of the Corps of Engineers was responsible for similar studies on the Great Lakes. Among its projects was the installation of a bubbler system at Lime Island Turn in the lower section of the St. Marys River. The bubbler system was tried at the Lime Island Turn because it is representative of several turns in the St. Marys River where vessels experience particular difficulty when the channel is covered with ice. It consisted of piping laid on the river bottom through which compressed air was released to circulate warm water upwards. Results were satisfactory and vessels masters reported they were able to negotiate Lime Island Turn without difficulty.

Also studied were transportation problems resulting from winter navigation on the St. Marys River by residents of Sugar Island, located about 1.5 miles downstream from the locks at Sault Ste. Marie. During the first winter of the program, ferry service between Sugar Island and the mainland was interrupted by drifting ice caused by icebreaking operations and passing vessels. A bubbler system was installed at the mainland ferry dock and a barge with an engine-driven propeller was moored upstream of the ferry slip to circulate water into the slip to flush out ice and prevent drift ice from entering. When, despite these efforts, ferry traffic was occasionally interrupted, a Coast Guard tug broke up the ice and its vessels transported island residents to and from the mainland.

The Environmental Protection Agency was the lead agency in the work group which studied environmental and ecological effects of the demonstration program. A major concern of the environmental work group was the impact of the program on the Sugar Island residents. It concluded that breaking ice with an icebreaking vessel had little impact on the environment and the bubbler systems were also found to have no adverse effect. In fact, the addition of oxygen was expected to improve water quality.

The first year's results were generally encouraging. A United States ore carrier made a final lockage of the season at the Sault locks on 1 February 1972, and, during the extended season, nearly 2 million tons of cargo was shipped through the St. Marys River. The following navigation season was extended to 8 February and, during the winters of 1974-75 and 1975-76, year-round navigation on the upper lakes became a reality. By 1976 it appeared that winter navigation was feasible ten months, if not on a 12-month basis, and that extended navigation would be widely accepted provided problems dealing with the environment, the St. Marys River Island residents, and the safety and welfare of seamen could be solved.

Congress in October 1976 extended the demonstration program through June 1979 and set aside $6,468,000 in additional funding. After 1976 the program expanded to consider the more technical problems and human questions involved in winter navigation throughout the entire Great Lakes-St. Lawrence Seaway system.[25]

CONNECTING CHANNELS AND HARBORS STUDY

The navigation extension program has not been implemented, but longer shipping seasons are being considered as an alternative to larger locks and deeper channels for increased shipping. A study to determine the advisability of replacing one or more locks at Sault Ste. Marie with a new lock gave additional importance to the season extension plan. The lock study, carried out by the Corps' Detroit District, considered the need for replacing the old Sabin Lock with a larger one to insure capacity for larger vessels when the Poe Lock might close for repairs during periods of heavy traffic. Among the alternatives considered was a new giant lock capable of accommodating vessels up to 1,300 feet long and 130 feet wide and drawing up to 32 feet of water. The study recognized that construction of a new lock capable of accommodating vessels of larger size and draft could stimulate interest in increasing vessel sizes and deepening of the entire Great Lakes navigation system and that large-scale environmental effects would be inevitable.

Although Vice Admiral Paul E. Trimble, President of the Lake Carriers' Association, and others recommended a lock size to accommodate a ship from 1,300 to 1,500 feet long and 130 to 150 feet wide and the dredging of channels to 32 feet, environmental interests generally emphasized the tremendous impacts from dredging of channels and harbors which would result from the introduction of larger vessels on the lakes. On 12 February 1976, the Detroit District deferred the lock replacement study indefinitely, in part because of discontent over further deepening of channels and the use of larger vessels, and partly because a maximum vessel size study by the Corps' North Central Division had not yet been completed.

By early 1978, preliminary findings of the maximum vessel size study suggested that the maximum cargo vessel capacity of the Great Lakes system may be reached by 1990 but that, if modifications were made to permit extension of the navigation season, the capacity date would not be reached until about 2010. Some experts thought that the adverse environmental and social ramifications from extended season navigation on a permanent basis would be substantially less than those resulting from larger ships which require deeper channels and wider bends. Both the lock replacement and season extension studies have since become part of a comprehensive long-range study by the Detroit District on the Great Lakes Connecting Channels and Harbors and scheduled for completion in 1984.[26]

ST. LAWRENCE SEAWAY STUDY

While consideration is being given to possible modification to meet future requirements on connecting channels and harbors of the Great Lakes, a feasibility study is being carried out by the Corps' Buffalo District on additional locks and other navigation improvements on the international section of the St. Lawrence Seaway. Vessels entering or exiting the Great Lakes are limited to a length of 730 feet, a beam of 76 feet, and a draft of 26 feet. Since the locks were completed in 1959, the number of ocean-going bulk carriers has increased in the 700- to 1,000-foot range and container ships are expected to increase in size to 1,000 feet. However, the beam limitation of 76 feet is even more critical to the oceangoing fleet since both bulk cargo and container ships are being built with broader beams. The 25-foot draft restriction is the most severe of all. Already in 1976, 66 percent of oceangoing vessels using the seaway were unable to load to full capacity because of the draft restriction. In addition, lock capacity based on 4-hour waiting time and other factors has already been reached at the Welland Canal. Those on the St. Lawrence River are estimated to reach their capacity in the year 2000.[27]

Final results of the St. Lawrence Seaway and the Great Lakes Connecting Channels and Harbors studies are not yet known but they have already delineated major concerns of lakes and seaway navigation in the 1980's.

A CHRONOLOGY OF LAKE NAVIGATION

1763-1796 - British dominate the lake trade after defeating French in Canada until 1796, when they begin the withdrawal of their troops from American shores of Lake Ontario.

1797 - Americans launch their first lake schooner, the Washington, on Lake Erie near Presque Isle.

1800-1817 - Lake trade expands until by 1817 there are some 20 merchant vessels on Lake Erie.

1816-1817 - First two lake steamers, Frontenac and Ontario, are launched on Lake Ontario.

1818 - American launch their first steamer, Walk-in-the-Water, on Lake Erie. First American lighthouse on the lakes completed at Erie, Pennsylvania.

1818 - Local citizens begin one of the first harbor improvements on the lakes at the mouth of the Grand River, later Fairport, Ohio.

1820 - Citizens of Buffalo, New York, commence improvement of their harbor at the mouth of Buffalo Creek.

1821 - Arrivals and departures of vessels at Buffalo Harbor total 120.

1824 - First federal harbor improvement on the lakes begins at Erie, Pennsylvania. Federal appropriations continue almost every year until 1839.

1825 - Erie Canal completed by the State of New York providing waterway between Buffalo on Lake Erie and Albany on the Hudson River, the greatest single transportation factor in early settlement of the lake region and growth of lake navigation.

1825-1829 - President John Quincy Adams pursues active policy favoring federal internal improvements. As a result numerous harbors on Lake Erie and Lake Ontario are improved.

1826 - Arrivals and departures of vessels at Buffalo Harbor total 240.

1828 - Oswego Canal completed by the State of New York provides water connection between Oswego Harbor on Lake Ontario and the Erie Canal.

1829 - Welland Canal completed by Canadian interests provides navigable route between Lake Erie and Lake Ontario.

1829-1837 - During administrations of President Andrew Jackson, federal work on lake harbors continues and is expanded to sites on Lake Michigan.

1832 - State of Ohio completes Ohio Canal connecting Cleveland Harbor on Lake Erie with Portsmouth on the Ohio River thereby opening up a vast agricultural hinterland and stimulating an extraordinary expansion of lake commerce.

1835 - Arrivals and departures of vessels at Buffalo Harbor total 3,280.

1837 - Sixteen lake harbors are now equipped with federally constructed beacons or lighthouses.

1838 - Combined value of Cleveland's imports and exports is $20 million. Arrivals at Cleveland Harbor include 1,095 sail and 1,318 steam vessels.

1839 - After 2 years of the administration of President Martin Van Buren (1837-1839) regular annual appropriations for lake harbors cease until after the Civil War because of opposition of the Democratic party to internal improvements. Thus far, federal efforts have improved seven harbors on Lake Ontario, 15 on Lake Erie, and three on Lake Michigan.

1841 - Congress provides first funds to begin survey of the northwestern lakes. First screw-propeller steamer on the lakes, the Vandalia, built at Oswego.

1843 - Whig President John Tyler (1841-1845) approves bill for improving harbors at Milwaukee, Chicago, and St. Joseph on Lake Michigan.

1844 - President Tyler approves bill appropriating sums ranging from $40,000 to $5,000 for federal work on 20 Great Lakes harbors, the first general rivers and harbors bill in 6 years, and the last until 1852. Michigan and Surveyor, first iron-hulled steamers on lakes.

1846 - When the federal government fails to take action, a steamboat association unsuccessfully attempts to deepen the channel at the St. Clair Flats, a troublesome shallow area on the connecting channel between Lake Huron and Lake Erie.

1847 - A River and Harbor convention at Chicago calls for federal improvement at the St. Clair Flats.

1848 - The Illinois River-Lake Michigan Canal completed by the State of Michigan provides water route between Chicago Harbor on the lake and the Mississippi River.

1850 - Second Welland Canal completed by the government of Upper Canada has 9 feet of water on lock sills but soon thereafter is deepened to 10 feet.

1852 - Whig President Millard Fillmore signs largest river and harbor bill in antebellum history appropriating $2.25 million for some 100 works including a number of new harbors and $20,000 to initiate a project at the St. Clair Flats. The latter sum barely covers the cost of a dredge to begin the work. First iron ore from Lake Superior arrives at Cleveland Harbor on Lake Erie.

1854 - President Franklin Pierce (1853-1857), a Democrat, vetoes a comprehensive Rivers and Harbors Bill which includes funds for work on the St. Clair Flats. Chicago has first railroad connection with Mississippi River, at Galena, Illinois.

1855 - The State of Michigan completes a canal at Sault Ste. Marie, thereby opening traffic to lake vessels moving between Lake Huron and Lake Superior. The improvement includes two tandem locks each 350 feet long, 70 feet wide, and with about 11 1/2 feet of water over their sills. Railroad extensions completed westward to the Mississippi River, expanding the hinterland tributary to such Lake Michigan harbors at Chicago and Milwaukee increase the eastward shipment of grain and westward shipment of manufactured items.

1856 - In May, President Pierce vetoes bills for federal work at the Flats and for improvement of Lake George in the St. Marys River; in July, both bills are passed over the presidential veto. As a result the first federal work on the Great Lakes' connecting channels begins in October.

1857 - All federal funds for lake harbor work are exhausted and remnants of movable federal property at harbor sites are sold to make needed repairs.

1858 - Federal project at St. Clair Flats stops when funds are exhausted.

1859 - Federal project is completed at Lake George, a shallow area in the lower St. Marys River. Republican dominated State legislature of Michigan adopts a resolution in favor of further federal work at St. Clair Flats. Later in the year Congress passes a bill appropriating additional funds for the improvement.

1860 - In February, President James Buchanan (1857-1861), a Democrat, vetoes the Flats appropriation saying such improvements are State, not federal responsibilities. In May the Republican Party at its second national convention adopts a platform which speaks out in favor of federal river and harbor improvements.

1860-1865 - The 1860 Republican platform promises federal river and harbor improvement but the Civil War delays implementation. Lake commerce flourishes throughout the war and many new harbors, particularly for shipping lumber are improved on private initiative.

1866 - Federal improvement of Great Lakes connecting channels and harbors is resumed on a regular basis.

1867 - First appropriations for federal harbor improvement on Lake Superior.

1870 - Completion of federal project providing a 15-foot-deep, 300-foot-wide channel over the St. Clair Flats. Construction begins on a federal lock beside the now overtaxed State lock at Sault Ste. Marie and improvement of channels in the St. Marys River. Over 2,000 sailing ships in use on the upper lakes.

1875 - Federal project is completed for deepening the St. Clair Flats to 16 feet.

1881 - Federal lock, the Weitzel, opened at Sault Ste. Marie is 515 feet long, 80 feet wide, and has 17 feet of water over its sills. Ownership of the old State lock passes to the federal government.

1882 - The Welland Canal is deepened to 12 feet.

1883 - Some 4,000 vessels carrying 1.8 million tons of freight pass through the canal at Sault Ste. Marie.

1886 - First steel vessel, the Spokane, is put to use on lakes.

1887 - The Welland Canal is deepened to 14 feet.

1889 - First whaleback ships appear on the lakes.

1892 - Federal project is completed for deepening the St. Clair Flats to 20 feet. Work begins in December to deepen eight additional sections of the connecting channels between Lake Superior and Lake Huron and between Lake Huron and Lake Erie to 20 feet. First lake shipments of Mesabi iron ore.

1893 - 12,000 vessels pass through the locks at Sault Ste. Marie carrying over 10 million tons of coal, copper, flour, grain, lumber, and salt; nearly half of the freight, 4.6 million tons, is iron ore.

1894 - Hay Lake channel 300 feet wide and 17 feet deep is completed on the St. Marys River below the falls.

1895 - At Sault Ste. Marie, Weitzel Lock is overtaxed by the increased trade. Vessels wait an average of 5 hours to lock through; in all, 83,000 hours lost to vessels. Conditions improve in September when Canadians complete a canal with a lock 900 feet long, 60 feet wide, and with 22 feet of water over its sills. The Victory, first 400-foot bulk carrier, appears on lakes.

1896 - Second federal lock, the Poe, is completed at Sault Ste. Marie. The Poe Lock is 800 feet long, 100 feet wide, and has 21 feet of water over its sills.

1897 - Federal projects to deepen connecting channels to 20 feet based on depths at mean level of Lake Erie in 1877 are completed; because of low lake levels, actual depths range between 17 and 19 feet.

1900 - First 500-foot vessels on the lakes are launched.

1902-1904 - Work continues in connecting channels to achieve actual minimum navigational depths of 20 feet.

1906 - Second federal channel is completed at the St. Clair Flats and the first 600-foot lake vessels appear.

1907 - Congress authorizes a 12-mile-long second channel 300 feet wide and 22 feet deep, later called the Livingston Channel, on the lower reaches of the Detroit River; also authorizes construction of a third lock, later called the Davis Lock, at Sault Ste. Marie.

1912 - Congress authorizes funds for the fourth or Sabin Lock at Sault Ste. Marie, as the Davis Lock is being completed. Both locks are 1,350 feet long, 80 feet wide, and are 24.5 feet deep at the miter sills.

1915 - Federal work completed to provide a depth of 22 to 23 feet throughout the Detroit River portion of the Lake Erie-Lake Huron connecting channels.

1916 - 92 million tons of freight traffic pass through the locks at Sault Ste. Marie; 34 vessels are of the 600-foot class. Duluth-Superior Harbor is first in lake tonnage handled, with iron ore, coal, and grain making up 97 percent of 52 million tons shipped and received. Buffalo is the second busiest harbor on the lakes, Ashtabula third, Cleveland fourth. There are 1,837 steam and 162 sailing vessels operating on the lakes.

1919 - Sabin Lock is completed.

1920-1924 - Years of low lake levels.

1920-1929 - Relatively few new federal projects authorized; emphasis is on maintenance and upgrading existing projects.

1929 - Lake commerce reaches a record 92.6 million tons; largely iron ore, coal, grain, and limestone. Lake Erie leads the lakes in tonnage handled.

1930 - Depression-inspired legislation authorizes deepening downbound sections of connecting channels to 24 feet.

1932 - Under depressed economic conditions bulk lake freight falls to 41.6 million tons. Canadians open fourth Welland Canal which can accommodate vessels 600 feet long with 22-foot drafts.

1933 - Legislation establishing Public Works Administration also provides funds for further connecting channel improvement and deepening of major lake harbors.

1936 - Most depression-inspired federal lake improvements completed.

1940 - Bulk freight lake traffic sets new record of 145.2 million tons of iron ore, coal, grain, and limestone; 213 lake vessels now have full load drafts of 23 feet or more; some of them fully loaded cannot pass the locks at Sault Ste. Marie.

1942 - Congress authorizes new lock, the MacArthur, to replace the Weitzel Lock at Sault Ste. Marie.

1943 - MacArthur Lock, 800 feet long, 80 feet wide, 30 feet deep, is opened to traffic.

1946 - Another new federal lock authorized at Sault Ste. Marie but construction is delayed.

1948 - Freight tonnage moved on the lakes reaches record 217 million tons, 86 percent of which is iron ore, coal, limestone, and grain.

1949 - Bulk freighter Wilfred Sykes is launched at Lorain, Ohio; it is 678 feet long, and the first lake ship to burn oil.

1952 - First oil-fired turbine lake vessels are built.

1953 - Record lake shipments of iron ore reach 95.8 million tons.

1954 - President Eisenhower signs St. Lawrence Seaway Act allowing United States to participate with Canada in seaway construction; the first 710-foot-long freighter appears; first shipments of iron ore mined in Quebec-Labrador are sent westward through Welland Canal to Lake Erie and Lake Michigan points.

1956 - United States legislation provides authorization and funds to improve connecting channels and harbors above Niagara Falls to allow for vessels of 27-foot draft. First shipment of taconite pellets comes down the lakes.

1957 - Vessels are beginning to exceed maximum dimensions of MacArthur Lock. Special locking procedures are developed so that vessels up to 730 feet long can be locked through.

1958 - Edmund Fitzgerald is launched, first lake freighter 729 feet long.

1959 - St. Lawrence Seaway is put into operation.

1962	- Work is completed on Great Lakes connecting channels above Niagara.
1965	- So far, 15 Great Lakes harbors deepened to handle larger vessels now plying lakes due to St. Lawrence Seaway and connecting channel improvements.
1968	- New Poe Lock, 1,200 feet long, 100 feet wide, and 32 feet deep, is opened to traffic at Sault Ste. Marie.
1972	- First 1,000-foot lake vessel, the Stewart J. Cort, passes through Poe Lock carrying a record load of 51,000 tons of taconite. Duluth-Superior Harbor receives record low of coal for the century, only 447,000 tons.
1973	- First lake shipments eastward of low sulphur western coal begin at Duluth-Superior Harbor.
1979	- 92 million tons of iron ore shipped on the lakes this year exceeds all previous years except 1953.
1980	- Great Lakes shipments of grain reach a record 1 billion, 149 million bushels.
1981	- Thirteen 1,000-foot bulk cargo vessels are now operating on the lakes.

FOOTNOTES

CHAPTER ONE

1. U.S. Army Corps of Engineers, Buffalo District, "History of Oswego Harbor, New York," undated (typewritten) Historical File, North Central Division, Chicago, Illinois.

2. James Croil, Steam Navigation and its Relation to the Commerce of Canada and the United States (Toronto, William Briggs, 1891), p. 246.

3. Ibid., p. 251.

4. U.S. Army Corps of Engineers, Buffalo District, "History of Erie Harbor, Pa., " undated (typewritten) Historical File, Corps of Engineers North Central Division, Chicago, Illinois.

5. U.S. Congress, House, Communication from the Secretary of the Treasury Transmitting the Report of Israel D. Andrews on Trade and Commerce, etc., H. Ex. Doc. 136, 32nd Cong., 2d Sess. (Washington, Robert Armstrong Printer, 1853), "The Trade of the Lakes," 2:45-274.

6. James Sloan, "A Pioneer Trader," Publications, Buffalo Historical Society, 5 (Buffalo, 1902): 215-237.

7. T. Michael O'Brien, Guardians of the Eighth Sea, A History of the U.S. Coast Guard on the Great Lakes (U.S. Government Printing Office, 1976), p. 13.

8. Augustus Walker, "Early Days on the Lakes," Publications, Buffalo Historical Society, 5 (Buffalo, 1902): 287-318.

9. Report of Israel D. Andrews, pp. 277-279.

10. U.S. Congress, Senate, Laws of the United States Relating to Improvement of Rivers and Harbors, From August 11, 1790 to March 3, 1887, S. Misc. Doc. No. 91, 49th Cong., 2d Sess., 1887, p. 17.

11. Victor L. Albjerg, "Internal Improvements Without a Policy, 1789-1861," Indiana Magazine of History, 28 (March 1932): 168-179.

12. For a history of the nonmilitary activities and organization of the United States Army Engineers see Stull W. Holt, The Office of the Chief of Engineers of the Army, Johns Hopkins Press (Baltimore,

1923), and Henry P. Beers, "A History of the U.S. Topographical Engineers, 1813-1963," The Military Engineer (June and July 1942). See also David Garry Ryan, War Department Topographical Bureau, 1831-1863, An Administrative History, University Microfilm, Inc. Ann Arbor, Michigan, 1969.

13. U.S. Congress, House, Roads and Canals, H. Doc. 462, 15th Congress, 2d Sess., 1819.

14. U.S. Congress, House, Harbors on the Great Lakes and Elsewhere, H. Doc. 1067, 61st Cong., 3d Sess., 1910.

15. U.S. Congress, Senate, Report, S. Doc. 428, 25th Congress, 2d Sess. 1838.

16. U.S. Congress, Senate, Message from the President of the United States, S. Doc. 58, 26th Cong., 1st Sess., 1840, pp. 146-154.

17. U.S. Congress, Senate, Report from the Topographical Bureau, S. Doc. 2, 27th Cong., 2d Sess. 1841, p. 146.

18. John G. Clark, The Grain Trade in the Old Northwest, (Urbana, University of Illinois Press, 1966), pp. 102-123.

19. Senate Doc. 58, Message from the President of the United States, 1840, pp. 58, 59.

20. Ibid., pp. 108-109.

21. James L. Barton, Lake Commerce, Letter to the Hon. Robert M'Clelland, (Buffalo, Press of Jewett, Thomas and Co., 1846) and U.S. Congress, House, Commerce of the Lakes and Western Rivers, H. Ex. Doc. 19, 30th Cong., 1st Sess., 1848.

22. U.S. Congress, House, Harbors of Lake Michigan, H. Doc. 236, 26th Cong. 1st Sess., 1840, p. 6.

23. U.S. Congress, Senate, Message From the President of the United States, S. Doc. 1, 27th Cong., 2d Sess., 1942, pp. 289-290.

24. Ibid.

25. U.S. Congress, Senate, Report of the Committee of Commerce, S. Doc. 234, 27th Cong., 3d Sess., 1843.

26. Ibid., p. 9.

27. John J. Henderson, Annual Statement of the Trade and Commerce of Buffalo, For the Year 1854 (Buffalo, Democracy Print, 1855), p. 41.

28. U.S. Congress, House, Rivers and Harbors, H. Ex. Doc. 27, 33d Cong., 2d Sess., 1855, p. 40.

29. Ibid., pp. 110-123.

30. U.S. Congress, Senate, Report of the Secretary of War Communicating the Report of Lieutenant Colonel J. D. Graham, S. Ex. Doc. 42, 35th Cong., 1st Sess., 1858, p. 10.

31. U.S. Congress, Senate, Annual Report of the Bureau of Topographic Engineers, S. Doc. 58, 26th Cong., 1st Sess., 1840.

32. U.S. Congress, House, Commerce of the Lakes and Western Rivers, H. Ex. Doc. 19, 30th Cong., 1st Sess., 1849, p. 42.

33. Lloyd Graham and Frank H. Severence, The First Hundred Years of the Buffalo Chamber of Commerce (Buffalo, Foster and Stewart, 1945), pp. 44-46.

34. U.S. Congress, Senate, Report of Secretary of War Communicating . . . A copy of the Report of Lieutenant Colonel Graham, Etc., S. Ex. Doc. 73, 34th Cong., 1st Sess., 1856, p. 7.

35. U.S. Congress, Senate, Message of the President of the United States, S. Ex. Doc. 78, 34th Cong., 1st Sess., 1856, p. 1.

36. U.S. Congress, Senate, Message of the President of the United States, Etc., S. Ex. Doc. 2, 36th Cong., 1st Sess., 1860, p. 810.

37. Ibid., p. 1264.

38. U.S. Congress, Senate, Message of the President of the United States, S. Ex. Doc. 2, 36th Cong., 1st Sess., 1860, p. 7.

39. Thomas D. Odle, "Commercial Interests of the Great Lakes and the Campaign Issues of 1860," Michigan History, 40 (1956):1-23.

CHAPTER TWO

1. U.S. Congress, House, River and Harbor Improvements, H. Ex. Doc. 56, 39th Cong., 2d Sess., 1867, pp. 7-67.

2. U.S. Congress, House, Annual Report of the Chief of Engineers, 1872, H. Ex. Doc. 1, 42d Cong., 3d Sess., 1872.

3. U.S. Congress, House, Annual Report of the Chief of Engineers, 1889, H. Ex. Doc. 1, pt. 2, Vol. II, 51st Cong., 1st Sess., 1889, pp. 2260-2267.

4. U.S. Congress, House, Annual Report of the Chief of Engineers, 1899, H. Doc. 1. 56th Cong., 1st Sess., 1899, p. 2998.

5. U.S. Congress, House, Annual Report of the Chief of Engineers, 1907, H. Doc. 1, 60th Cong., 1st Sess., 1907.

6. U.S. Congress, House, St. Marys Falls Ship Canal, H. Misc. Doc. 78, 41st Cong., 2d Sess., 1870, pp. 1-5.

7. Ibid., See also U.S. Congress, House, St. Marys Falls Ship Canal, H. Ex. Doc. 198, 41st Cong., 2d Sess., 1870, pp. 1-3.

8. U.S. Congress, House, Annual Report of the Chief of Engineers, 1886, H. Ex. Doc. 1, 49th Cong., 2d Sess., 1886. "Historical Sketch of the Improvement of Saint Marys River and Saint Marys Falls Canal, Michigan," pp. 1792-1807.

9. U.S. Congress, House, Annual Report of the Chief of Engineers, 1882, H. Ex. Doc. 1, 47th Cong., 2d Sess., 1882, p. 296.

10. U.S. Congress, House, Annual Report of the Chief of Engineers, 1896, H. Ex. Doc. 1, 54th Cong., 2d Sess., 1896, p. 2879.

11. U.S. Congress, House, Annual Report of the Chief of Engineers, 1883, H. Ex. Doc. 1, pt. 2, Vol. II, 48th Cong., 1st Sess., 1883 and U.S. Congress, House, Annual Report of the Chief of Engineers, 1893, H. Ex. Doc., 1, pt. 2, Vol. II, 53d Cong., 2d Sess., 1893, p. 2997.

12. U.S. Congress, House, Annual Report of the Chief of Engineers, 1887, H. Ex. Doc. 1, pt. 2, Vol. II, 50th Cong., 1st Sess., 1887, p. 2214.

13. Chief of Engineers, Annual Report, 1896, pp. 2762-2769.

14. Chief of Engineers, Annual Report, 1887, p. 2227.

15. Ibid., p. 2969.

16. Ibid., pp. 2955-2959.

17. Chief of Engineers, *Annual Report*, 1903, p. 2015.

18. Chief of Engineers, *Annual Report*, 1915, pp. 1314-1316.

19. Charles Moore, Ed., *The St. Marys Falls Ship Canal* (Detroit Semi-Centennial Commission, 1907), pp. 190-192.

20. Ibid., p. 196.

21. U.S. Congress, House, *Plan and Estimate for New Lock at St. Marys Falls Ship Canal*, H. Doc. 333, 59th Cong., 2d Sess., 1907, p. 5.

22. U.S. Congress, House, *Examination and Survey of St. Marys River, Mich.*, H. Doc. 64, 62d Cong., 1st Sess., 1911, pp. 1-16.

23. Ibid.

24. U.S. Department of Commerce, Bureau of the Census, *Transportation by Water, 1916* (Washington, Government Printing Office, 1920), p. 152.

CHAPTER THREE

1. U.S. Congress, House, *Report on the Internal Commerce of the United States for the Year 1891*, "The Commerce of the Great Lakes, the Mississippi River and Its Tributaries, " H. Ex. Doc. 6, 52d Cong., 1st Sess. (1892), 2:17-21.

2. U.S. Army Corps of Engineers, Duluth District, "History of Duluth-Superior Harbor, Minnesota and Wisconsin," 1940 (typewritten) Historical Files, North Central Division, Chicago, pp. 2-34.

3. J. Disturnell, *A Trip Through the Lakes of North America* (New York, J. Disturnell, 1857), pp. 57-82.

4. T. Michael O'Brien, *Guardians of the Eighth Sea, A History of the U.S. Coast Guard on the Great Lakes* (U.S. Government Printing Office, 1976), p. 18.

5. U.S. Congress, House, *Message of the President of the United States*, H. Ex. Doc. 1, 40th Cong., 2d Sess., 1867, p. 20.

6. Ibid., Appendix A1.

7. Ibid., Appendix A2.

8. U.S. War Department, Report of the Chief of Engineers, U.S.Army, 1917, (Washington, Government Printing Office, 1917), 1:1331-1333.

9. U.S. Congress, House, Annual Report of the Chief of Engineers, 1880, H. Ex. Doc. 1, 40th Cong., 3d Sess., 1880, p. 1900.

10. U.S. War Department, Report of the Chief of Engineers, U.S. Army. 1915 (Washington, Government Printing Office, 1915), 2:1932-1933.

11. U.S. War Department, Report of the Chief of Engineers, U.S. Army, 1912 (Washington, Government Printing Office, 1912), p. 945.

12. U.S. War Department, Report of the Chief of Engineers, U.S. Army, 1910 (Washington, Government Printing Office, 1912), p. 945.

13. U.S. War Department, Report of the Chief Engineer, 1917, p. 1327-1331.

14. U.S. Congress, House, Annual Report of the Chief of Engineers. . . for the Year 1885, H. Ex. Doc. 1, 49th Cong., 1st Sess., pt. 2, Vol. II, pp. 1955-1958.

15. U.S. War Department, Report of the Chief Engineer, 1917, pp. 1817-1819.

16. Ibid., pp. 1338-1340.

17. U.S. Army Corps of Engineers, Duluth District, "History of Duluth-Superior Harbor," 1940 pp. 44-49, and St. Paul District, Duluth-Superior Cultural Resources Study, August 1976, pp. 31-50.

18. U.S. Secretary of the Interior, Ninth Census, the Statistics of the United States (Washington, Government Printing Office, 1972), 1:10.

19. U.S. Congress, House, Improvement of the Chicago Harbor, H. Ex. Doc. 114, 41st Cong., 2d Sess., 1970, p. 3.

20. U.S. Congress, House, Annual Report of the Chief of Engineers, 1895, H. Doc. 2, 54th Cong., 1st Sess., 1895, 2:2694-2697.

21. Albert E. Cowdrey, "Pioneering Environmental Law: The Army Corps of Engineers and the Refuse Act," Pacific Historical Review, 46 (August 1975): 331-449.

22. U.S. War Department, Report of the Chief of Engineers (Washington, Government Printing Office, 1899), 4:2827.

23. Chicago, Illinois, Committee on Harbors, Wharves and Bridges, Report of the Sub-Committee on Harbor Development (Chicago, John I. Higgins, Printer, 1911), pp. 20-23.

24. U.S. Congress, House, Annual Report of the Chief of Engineers for the Year 1893, H. Ex. Doc. 1, 53d Cong., 2d Sess., 1893, 2:2816.

25. U.S. War Department, Report of the Chief of Engineers, 1899, 4:2839.

26. U.S. Engineer Office, Chicago, Illinois, "History of Calumet Harbor and River, Illinois and Indiana," May 20, 1936 (typewritten) Historical Files, Chicago District, Chicago, Illinois, pp. 1-6.

27. U.S. Engineer Office, Chicago, Illinois, History of Michigan City Harbor, Indiana," October 1, 1936 (typewritten) Historical Files, Chicago District, U.S. Army Corps of Engineers, Chicago, Illinois, pp. 1-3.

28. U.S. Engineer Office, Chicago, Illinois, "History of Waukegan Harbor, Illinois," March 18, 1936 (typewritten), Historical Files, Chicago District, Chicago, Illinois, 7:1-8.

29. U.S. Army Corps of Engineers, Milwaukee District, histories covering improvements, growth of communities and commerce for harbors on the western shore of Lake Michigan from their beginnings to the late 1930's are on file at the Chicago District, Chicago, Illinois.

30. U.S. Army Corps of Engineers, Milwaukee District, histories covering improvements, growth of community and commerce for harbors on the eastern shore of Lake Michigan are on file at the Detroit District, Detroit, Michigan.

31. U.S. Congress, House, Annual Report of the Chief of Engineers, 1887, H. Ex. Doc. 1, 50th Cong., 1st Sess., 1887, Vol. 2: 2275-2278.

32. U.S. War Department, Report of the Chief of Engineers (Washington Government Printing Office, 1903), 3:1993-1994.

33. Ibid.

34. U.S. War Department, Report of the Chief of Engineers, U.S. Army 1917, pp. 3202-3303.

35. U.S. Congress, House, Annual Report of the Chief of Engineers, 1888, H. Ex. Doc. 1, 50th Cong., 2d Sess., 1888, 2:1963-1968.

36. U.S. War Department, Report of the Chief of Engineers (Washington, Government Printing Office, 1899), 4:2985-2987.

37. U.S. Congress, House, Examination and Survey of Saginaw River, Mich., H. Doc. 740, 61st Cong., 2d Sess., 1910.

38. Report of the Chief of Engineers, 1917, pp. 1506-1508.

39. Ibid., pp. 1315, 1593.

40. U.S. Congress, House, Report of the Secretary of War, H. Ex. Doc. 1, 43d Cong., 1st Sess., 1873, 2:353.

41. U.S. Congress, House, Annual Report of the Chief of Engineers, 1888, Ex. Doc. 1, 50th Cong., 2d Sess., 2:2023-2056.

42. U.S. Army Corps of Engineers, Buffalo District, "History of Buffalo Harbor, New York," undated (typewritten), Historical Files, North Central Division, Chicago, Illinois.

43. U.S. Congress, House, Harbor at Toledo, H. Ex. Doc. 92, 42d Cong., 3d Sess., 1873, pp. 11-12.

44. U.S. Congress, House, Annual Report of the Chief of Engineers, 1880, H. Ex. Doc. 1, 40th Cong., 3d Sess., 1880, 2:2092-2099.

45. U.S. Congress, House, Annual Report of the Chief of Engineers, H. Doc. 2, 54th Cong., 2d Sess., 1896, 5:2917-2925.

46. U.S. War Department, Report of the Chief of Engineers, 1917, pp. 1523-1525.

47. Ibid., pp. 1540-1545.

48. U.S. Army Corps of Engineers, Buffalo District, "History of Cleveland Harbor," undated (typewritten), Historical Files, North Central Division, Chicago, Illinois, pp. 1-2.

49. U.S. War Department, Report of the Chief of Engineers, 1917, pp. 1537-1539, 1548-1557, and U.S. Army Corps of Engineers, Buffalo District, "History of Ashtabula Harbor, Ohio," and "History of Lorain Harbor, Ohio," undated (typewritten), Historical Files, North Central Division, Chicago, Illinois.

50. U.S. Army Corps of Engineers, Buffalo District, "History of Erie Harbor, Pennsylvania," undated (typewritten), Historical Files, North Central Division, Chicago, Illinois, and U.S. War Department, Report of the Chief of Engineers, 1917, pp. 1527-1534, 1545-1548, 1557-1560.

51. U.S. Congress, House, Report of Board of Engineers on Deep Waterways Between Great Lakes and Atlantic, H. Doc. 149, 56th Cong., 2d Sess., 1901.

52. Marvin A. Rapp, "The Niagara Seaway-All American Canal," Inland Seas 21 (Spring 1965) 1:49-58.

53. U.S. Army Corps of Engineers, Buffalo District, "History of Black Rock Channel and Tonawanda Harbor, New York," undated (typewritten), Historical Files, North Central Division, Chicago, Illinois, pp. 50-62.

54. U.S. Army Corps of Engineers, Buffalo District, "History of Oswego Harbor, New York," undated (typewritten), Historical Files, North Central Division, Chicago, Illinois, and U.S. War Department, Report of the Chief of Engineers, 1917, pp. 1589-1591.

55. U.S. War Department, Report of the Chief of Engineers, U.S. Army, 1915 (Washington, Government Printing Office, 1915), pp. 1971-1972 and Report of the Chief of Engineers, 1917, pp. 3246-3249.

56. U.S. Army Corps of Engineers, Buffalo District, "History of Little Sodus Bay Harbor, New York," and "History of Great Sodus Bay Harbor, New York," undated (typewritten) Historical Files, North Central Division, Chicago, Illinois.

57. Department of Commerce, Transportation by Water, 1916 (Washington, Government Printing Office, 1920), pp. 135-157.

58. Michael O'Brien, Guardians of the Eighth Sea, A History of the U.S. Coast Guard on the Great Lakes, pp. 61-62.

CHAPTER FOUR

1. Lake Carriers' Association, Annual Report (Detroit, P.M. Bland Printing Co., 1917), p. 65.

2. U.S. Army, Office of the Chief of Engineers, Annual Report (Washington, 1919), pp. 1606-1613, 3282-3307.

3. U.S. Army Corps of Engineers and United States Shipping Board, Bureau of Operations, Transportation on the Great Lakes (Washington, Government Printing Office, Revised edition, 1930), pp. 60-61.

4. U.S. Congress, House, Examination and Survey of Livingstone Channel, Detroit River, Michigan, H. Doc. 322, 65th Cong., 1st Sess. 1917.

5. U.S. Congress, House, Great Lakes Ship Channel - Duluth, Minn. to Buffalo, New York, H. Doc. 270, 69th Cong., 1st Sess., 1926, pp. 20-22.

6. Ibid., p. 31.

7. U.S. Congress, House, Great Lakes - Connecting Waters, Principal Harbors, and River Channels, H. Doc. 253, 70th Cong., 1st Sess., 1928, pp. 18-19.

8. Ship Channel, H. Doc. 270, 69th Cong., 1st Sess., 1926, p. 28.

9. Ibid., p. 1.

10. U.S. Army, Corps of Engineers, and United States Shipping Board, Bureau of Operations, Transportation on the Great Lakes (Revised 1930), pp. 73-347.

11. U.S. Congress, House Committee on Rivers and Harbors, Great Lakes - Connecting Waters, Principal Harbors, and River Channels, H. Doc. 53, 74th Cong., 1st Sess., 1935, pp. 10-11.

12. U.S. Army Corps of Engineers, Transportation on the Great Lakes, Transportation Series No. 1 (Washington, U.S. Government Printing Office, Revised 1937), pp. 84-85 and Lake Carriers' Association, Annual Report. (Cleveland, S. P. Mount Printing Co., 1935), p. 44.

13. Lake Carriers' Association, Annual Report, 1935, p. 9.

14. Tim Taylor, The Book of Presidents (New York, Arno Press, 1972), p. 403.

15. Lake Carriers' Association, Annual Report (Detroit, P.N. Bland Printing Co., 1934), p. 91.

16. Lake Carriers' Association, Annual Report, 1935, p. 107.

17. U.S. Army, Corps of Engineers, Transportation on the Great Lakes, (1937), pp. 437-441.

18. M. C. Tyler, "Great Lakes Transportation," Transactions of the American Society of Civil Engineers 105 (New York, 1940): 167-195.

19. Ibid.

20. U.S. Congress, House, St. Marys River, Michigan, H. Doc. 218, 77th Cong., 1st Sess., 1941.

21. U.S. Army Corps of Engineers, Great Lakes Division, GLD in World War II, pp. 125-132.

CHAPTER FIVE

1. U.S. Congress, House, River and Harbor Omnibus Bill, H. Report 63, 79th Cong., 1st Sess., 1945.

2. John R. Hardin, "Waterway Traffic on the Great Lakes," Transactions of the American Society of Civil Engineers 117 (New York, 1952): 351-360.

3. Ibid.

4. Fay, Spofford and Thorndike, Great Lakes Commerce and the Port of Oswego, New York (Boston, 1925), pp. E-69-E-70.

5. U.S. Congress, House, Development of the Great Lakes - St. Lawrence Basin, H. Doc. 302, 79th Cong., 1st Sess., 1945, p. 4.

6. Ibid., p. 2.

7. U.S. Congress, House, Text of an Agreement Between the Governments of the United States and Canada Pertaining to the St. Lawrence River, H. Doc., 77th Cong., 1st Sess., 1941.

8. U.S. Army Corps of Engineers, Buffalo District, New York, St. Lawrence Seaway, New York (Buffalo, 1979), pp. 3-1 - 3-17.

9. U.S. Congress, House, Great Lakes Harbors Study - Final Report, H. Doc. 178, 84th Cong., 1st Sess., 1955, pp. 8-14.

10. Peter C. Hyzer and Howard E. Hill, "Engineering the Deepening of the Great Lakes Connecting Channels," and Haviland F. Reeves, "New Cargo Capacity by the Inch," undated (typewritten), U.S. Army Corps of Engineers, Detroit District files.

11. U.S. Congress, House, Great Lakes Harbors Study - Final Report, H. Doc. 178, 90th Cong., 1st Sess., 1967.

12. U.S. Army Corps of Engineers, Destroit District, "Field Visit, Chief of Engineers, St. Marys Falls Canal, 10 November 1961" (typewritten), in Detroit District files.

13. Anne C. Garrison, "The Longer Ships," Michigan State Economic Record 10 (July, August 1968): 1.

CHAPTER SIX

1. Garrison, "The Longer Ships," p. 6.

2. Bernard E. Ericson, "The Evolution of Great Lakes Ships," Inland Seas 25 (Fall 1969):199-212 and Lake Carriers' Association, Annual Report, 1968 p. 105.

3. M. J. Perrini, "Threading the Needle," News Release, Detroit District, Corps of Engineers, 1 May 1972 (typewritten), in Detroit District files.

4. U.S. Army Corps of Engineers, Detroit District, "Transit of a 105' by 1100' Lake Freighter Through the Great Lakes System" (typewritten), 1976, in Detroit District files.

5. Donald A. Gandre, "Recent Changes in the Flow Pattern of Iron Ore on the Great Lakes," Inland Seas 27 (Winter 1971): 247-253.

6. Eric Schenker, Harold M. Mayer and Harry C. Brockel, The Great Lakes Transportation System (Madison, University of Wisconsin Sea Grant College Program, 1976), pp. 180-195.

7. Lake Carriers' Association , Annual Report (1979), pp. 34 and 37.

8. John R. Hardin, "Waterway Traffic on the Great Lakes," p. 354.

9. Schenker, Mayer and Brockel, The Great Lakes Transporation System, pp. 188-195.

10. U.S. Army Corps of Engineers, St. Paul District, Duluth-Superior Harbor Cultural Resources Study (St. Paul, 1976), pp. 89-95.

11. Ibid.

12. Schenker, Mayer and Brockel, The Great Lakes Transportation System, pp. 195-201.

13. Lake Carriers' Association, Annual Report, 1950-1980.

14. Ibid.

15. U.S. Army Corps of Engineers, Buffalo District, "History of Buffalo Harbor, New York," 1940 (typewritten), Historical Files, Corps of Engineers, North Central Division, Chicago, Illinois, pp. 33-38.

16. Ibid.

17. Lake Carriers' Association, Annual Report, 1940-1980.

18. Lowell D. Hill, "The Pattern of Grain Movements on the Inland Waterways," talk presented at National Waterways Roundtable, 23 April 1980.

19. Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Calendar Year 1978 (Fort Belvoir, Virginia, Water Resources Support Center, 1978), pp. 12-13.

20. Schenker, Mayer and Brockel, The Great Lakes Transportation System, p. 213.

21. Gaetane Hamsley, The St. Lawrence Seaway Authority (Ottawa, Seaway Transport Canada, 1980), pp. 1 and 2.

22. U.S. Army Corps of Engineers, Buffalo District, St. Lawrence Seaway, (Buffalo 1979), 3:7-11.

23. U.S. Army Corps of Engineers, Buffalo District, Dredging and Water Quality Problems in the Great Lakes, Summary Report, Buffalo, Buffalo District, 1969.

24. Port Huron (Michigan) Times Herald, 13 September 1974.

25. U.S. Army Corps of Engineers, Detroit District, Final Survey Study for Great Lakes and St. Lawrence Seaway Navigation Season Extension, Main Report and Final Environmental Impact Statement (Detroit, 1979).

26. U.S. Army Corps of Engineers, Detroit District, Revised Plan of Study for Great Lakes Connecting Channels and Harbors Study, (Detroit, 1979).

27. U.S. Army Corps of Engineers, Buffalo District, St. Lawrence Seaway, New York (Buffalo, 1979).

SELECTED BIBLIOGRAPHY

FEDERAL DOCUMENTS TREATING OF LAKE COMMERCE IN GENERAL

U.S. Congress, House, Commerce of the Lakes and Western Rivers, H. Ex. Doc. 19, 30th Cong., 1st Sess., 1849.

U.S. Congress, House, Communication From the Secretary of the Treasury Transmitting the Report of Israel D. Andrews on Trade and Commerce, Etc., H. Ex. Doc. 136, 32d Cong., 2d Sess., 1853.

U.S. Congress, Senate, Report of the Select Committee on Transportation-Routes to the Seaboard, S. Rept. 307, 43d Cong., 1st Sess., 1874.

U.S. Congress, House, First Annual Report on the Internal Commerce of the United States, H. Ex. Doc. 46, 44th Cong., 2d Sess., 1876.

U.S. Congress, House, Report on the Internal Commerce of the United States, H. Ex. Doc. 32, 45th Cong., 3d Sess., 1879.

U.S. Congress, House, Report on the Internal Commerce of the United States for the Year 1891, H. Ex. Doc. 6, 52d Cong., 1st Sess., 1892.

U.S. Department of Commerce, Bureau of the Census, Transportation by Water, 1916, Washington, Government Printing Office, 1920.

U.S. War Department, Army Corps of Engineers and United States Shipping Board, Transportation on the Great Lakes, Washington, Government Printing Office, 1926.

U.S. War Department, Army Corps of Engineers, Transporation on the Great Lakes, Revised 1937, Washington, Government Printing Office, 1937.

U.S. Department of the Army, Annual Reports of the Topographical Bureau, 1831-1851.

U.S. Department of the Army, Annual Reports of the Chief of Engineers.

CONGRESSIONAL DOCUMENTS CONCERNING ASPECTS OF GREAT LAKES NAVIGATION

U.S. Congress, House, Harbors of Lake Michigan, H. Doc. 236, 26th Cong., 1st Sess., 1840.

U.S. Congress, Senate, Report of the Committee of Commerce, S. Doc. 234, 27th Cong., 3d Sess., 1843.

U.S. Congress, House, *River and Harbor Improvements*, H. Ex. Doc. 56, 39th Cong., 2d Sess., 1867.

U.S. Congress, House, *St. Marys Falls Ship Canal*, H. Misc. Doc. 78, 41st Cong. 2d Sess., 1870.

U.S. Congress, House, *St. Marys Falls Ship Canal*, H. Ex. Doc. 198, 41st Cong. 2d Sess., 1870.

U.S. Congress, House, *Improvement of Chicago Harbor*, H. Ex. Doc. 114, 41st Cong., 2d Sess., 1870.

U.S. Congress, House, *Plan and Estimate for New Lock at St. Marys Falls Ship Canal*, H. Doc. 333, 59th Cong., 2d Sess., 1907.

U.S. Congress, House, *Examination and Survey of Saginaw River, Mich.*, H. Doc. 740, 61st Cong., 2d Sess., 1911.

U.S. Congress, House, *Examination and Survey of St. Marys River, Mich.*, H. Doc. 64, 62d Cong., 1st Sess., 1911.

U.S. Congress, House, *Examination and Survey of Livingstone Channel, Detroit River, Michigan*, H. Doc. 322, 65th Cong., 1st Sess., 1917.

U.S. Congress, House, *Great Lakes Ship Channel - Duluth, Minn., to to Buffalo, New York*, H. Doc. 270, 69th Cong., 1st Sess., 1926.

U.S. Congress, *Great Lakes - Connecting Waters, Principal Harbors and River Channels*, H. Doc. 253, 70th Cong., 1st Sess., 1928.

U.S. Congress, House, *Great Lakes Connecting Channels*, Senate Doc. 71, 84th Cong., 1st Sess., 1955.

MANUSCRIPTS

U.S. Army Corps of Engineers, Great Lakes Division, "Great Lakes Harbor Histories," typewritten histories of Great Lakes harbors prepared between 1935 and 1940 in response to Great Lakes Division, Cleveland, Ohio directives. Histories of Lake Erie and Lake Ontario harbors are in the North Central Division, Chicago Historical File; histories of harbors on Lake Huron and the eastern shore of Lake Michigan in the Detroit District office; histories for harbors on the western and southern shore of Lake Michigan are filed at the Chicago District office; and histories of harbors on Lake Superior are on file at the St. Paul District.

BOOKS

Clark, John G., The Grain Trade in the Old Northwest, Urbana, University of Illinois Press, 1966.

Croil, James, Steam Navigation and Its Relation to the Commerce of Canada and the United States, Toronto, Wm. Briggs, 1898.

Disturnell, J., A Trip Through the Great Lakes of North America, New York, 1857.

Fay, Spofford and Thorndike, Great Lakes Commerce and the Port of Oswego, New York, Boston, 1925.

Graham, Lloyd and Severence, Frank, The First Hundred Years of the Buffalo Chamber of Commerce, Buffalo, Foster and Stewart, 1945.

Moore, Charles, Ed., The St. Marys Falls Ship Canal, Detroit Semi-Centennial Commission, 1907.

Schenker, Eric, Mayer, Harold M. and Brockel, Harry C., The Great Lakes Transportation System, Madison, University of Wisconsin, 1976.

ARTICLES

Albjerg, Victor L., "Internal Improvements Without a Policy," Indiana Magazine of History (28 March 1932); pp. 168-179.

Cowdrey, Albert E., "Pioneering Environmental Law: The Army Corps of Engineers and the Refuse Act," Pacific Historical Review, 46 (August 1975): 331-449.

Ericson, Bernard E., "The Evolution of Great Lakes Ships," Inland Seas, 25 (Fall, 1969): 199-212.

Garrison, Anne G., "The Longer Ships," Michigan State Economic Board, 10 (July-August 1968): 1.

Hardin, John R., "Waterway Traffic on the Great Lakes," Transactions of the American Society of Civil Engineers, 117 (1952): 351-360.

Odle, Thomas D., "Commercial Interests of the Great Lakes and the Campaign Issues of 1860," Michigan History, 40 (1956): 1-23.

Rapp, Marvin A., "The Niagara Seaway-All American Canal," Inland Seas 21 (Spring 1965): 49-58.

Sloan, James, "A Pioneer Trader," Publications, Buffalo Historical Society, 5 (Buffalo, 1902): 215-237.

Tyler, M. C., "Great Lakes Transportation," Transactions of the American Society of Civil Engineers, 105 (1940): 167-185.

Walker, Augustus, "Early Days on the Lakes," Publications, Buffalo Historical Society, 5 (Buffalo, 1902): 287-318.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983-399-070