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GREAT LAKES HARBORS STUDY

Summary report 30



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U.S. ARMY ENGINEER DIVISION,
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GREAT LAKES HARBORS STUDY

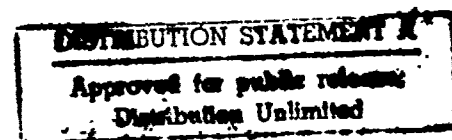
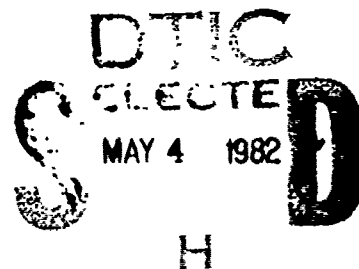
FINAL REPORT

APPENDICES

<u>Appendix</u>	<u>Title</u>	<u>Date of Report</u>
A	Iron Ore Traffic Analysis	April 1958
B	Stone Traffic Analysis	April 1958
C	Coal Traffic Analysis	July 1961
D	Grain Traffic Analysis	June 1965
E	General Cargo Traffic Analysis	November 1966

(To be published in Nov 1967)

These appendices were submitted in separate reports. They are available from the Division Engineer, North Central Division at the cost of reproduction.



GREAT LAKES HARBORS STUDY

SYLLABUS

It has been determined that improvements at 30 harbors, and construction of one additional harbor, are fully justified to take full advantage of the 27-foot depths provided in the Great Lakes Connecting Channels, the Welland Canal, and the St. Lawrence Seaway. Total estimated first costs to the United States for construction were \$154,400,000, with total annual charges of \$7,965,230. Estimated average annual benefits are \$25,237,100. Since benefits to current program of deepening the connecting channels will be realized only by improving harbors, a combined Great Lakes Connecting Channels-Harbors system analysis was required. The system analysis results in a benefit-cost ratio of 2.0 for the combined projects.



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FINAL REPORT ON GREAT LAKES HARBORS STUDY

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DEPARTMENT OF THE ARMY
NORTH CENTRAL DIVISION, CORPS OF ENGINEERS
536 South Clark Street
Chicago, Illinois 60605

NCDPD-PF

30 November 1966

SUBJECT: Great Lakes Harbors Study - Final Report

TO: Resident Member
Board of Engineers for Rivers and Harbors, Washington, D.C.

INTRODUCTION

1. AUTHORITY

a. This final report on the Great Lakes Harbors Study is submitted in response to resolutions by the Committee on Public Works, United States Senate, adopted 18 May 1956, and by the Committee on Public Works, House of Representatives, United States, adopted 27 June 1956, as follows:

"RESOLVED BY THE COMMITTEE ON PUBLIC WORKS OF THE UNITED STATES SENATE, That the Board of Engineers for Rivers and Harbors, created under Section 3 of the River and Harbor Act, approved June 13, 1902, be, and is hereby, requested to review the reports of the Chief of Engineers on the Great Lakes Connecting Channels, published as Senate Document Numbered 71, Eighty-fourth Congress, and other reports, with a view to determining the advisability of further improvements of the harbors on the Great Lakes in the interest of present and prospective deep-draft commerce, with due regard to the scheduled time of completion of the St. Lawrence Seaway and the connecting channels between the Great Lakes."

"RESOLVED, BY THE COMMITTEE ON PUBLIC WORKS OF THE HOUSE OF REPRESENTATIVES, UNITED STATES, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports of the Chief of Engineers on the Great Lakes Connecting Channels, published as S. Doc. 71, 84th Congress, and other reports, with a view to determining the advisability of further improvements of the harbors on the Great Lakes in the interest of present and prospective deep-draft commerce, with due regard to the scheduled time of completion of the St. Lawrence Seaway and the connecting channels between the Great Lakes."

b. The Chief of Engineers, by letter dated 10 December 1956, authorized the preparation of appropriate interim survey reports to the Great Lakes Harbors Study. Additional authority also was available to consider desired improvements, at a number of specific harbors, by separate Committee resolutions of Congress. The studies in response

to some of these resolutions were combined with the Great Lakes Harbors Study.

2. PURPOSE AND SCOPE

a. The need for increasing depths at Great Lakes Harbors was recognized in studies made in connection with the Great Lakes Connecting Channels report published in Senate Document No. 71, 84th Congress, 1st Session. That report, which recommended the deepening of the connecting channels to provide a controlling depth of 27 feet, was authorized by Congress on 21 March 1956. With the Great Lakes Connecting Channels authorized for deepening to a controlling depth of 27 feet and a controlling depth of 27 feet being provided in the St. Lawrence Seaway from Montreal to Lake Erie, it was necessary to determine the deepening and other improvements that would be economically justified at harbors on the Great Lakes to provide harbor depths commensurate with those in the Great Lakes Connecting Channels and the St. Lawrence Seaway. Deepening the connecting channels between Lakes Superior, Huron, Michigan and Erie, as authorized by Act approved 21 March 1956, was initiated in May 1957, and controlling depth of 27 feet was available in all of the channels in June 1962. The controlling depth of 27 feet in the St. Lawrence Seaway and Welland Canal has been available since 1959. Many deep-draft ships could not load to depths being provided in the connecting channels and St. Lawrence Seaway until the harbors were deepened.

b. Studies of Great Lakes commercial harbors have been completed under the authority for this report and interim reports have been submitted for all harbors for which further improvements are economically justified at this time. The detail studies made resulted in submitting 37 interim reports recommending improvements at 30 harbors. In addition the studies resulted in one interim report recommending a new harbor for authorization, making a total of 38 interim reports at 31 harbors. The first interim report was submitted to Congress in May 1959 and the final one in September 1965. The purpose of this final report is to summarize the results of the studies, presented in the interim reports. Information is also included in this report on commercial harbors for which separate reports were submitted during the past ten years when studies were under way on the Great Lakes Harbors Study.

c. Comprehensive over-all Great Lakes traffic analyses were made for iron ore, coal, stone and grain, and for overseas general cargo. Traffic analyses for other commodities were made as required for individual harbors. Engineering studies and estimates of cost of plans of improvement were made for each harbor where detailed studies were required to determine the economic feasibility of further improvements.

DESCRIPTION AND ECONOMIC DEVELOPMENT

3. GREAT LAKES - ST. LAWRENCE NAVIGATION SYSTEM

a. A general map of the Great Lakes and the St. Lawrence River from Lake Ontario to Montreal is shown on Plate 1.

b. The Great Lakes - St. Lawrence navigation system comprises the following major features:

(1) The five Great Lakes - Superior, Huron, Michigan, Erie and Ontario.

(2) The connecting channels between Lake Superior, Huron, Michigan and Erie, including the locks to overcome the 21-foot drop in the St. Marys River between Lakes Superior and Huron.

(3) The Welland Canal and locks in Canada to overcome the 326-foot drop between Lakes Erie and Ontario.

(4) The St. Lawrence Seaway, including locks to overcome the fall of about 223 feet between Lake Ontario and Montreal.

(5) Federal harbors

(6) Private harbors

(7) Terminal and transfer facilities for commercial traffic.

c. The Great Lakes, with their connecting channels and the Welland Canal, form a deep-draft navigation chain with a controlling depth of 27 feet, extending from the west end of Lake Superior to the south end of Lake Michigan and to the east end of Lake Ontario at the head of the St. Lawrence River. A 27-foot navigation project is available on the St. Lawrence River from Lake Ontario to Montreal. There is a 35-foot navigation channel from Montreal to the sea. The length of steamer track from Duluth, Minnesota, at the west end of Lake Superior, to the head of the St. Lawrence River, at the east end of Lake Ontario, is about 1,150 miles, and from the head of the river to Montreal is about 185 miles. There is a 9-foot barge canal connection between the deep-draft Calumet Harbor and River project at the southerly end of Lake Michigan with the 9-foot Illinois Waterway, which connects with the Mississippi River inland waterway system. Thus, there are two modern water routes between the Great Lakes and the sea, the St. Lawrence River to the Atlantic Ocean, and the inland waterway system to the Gulf of Mexico.

d. In 1956, when this study was authorized, there were 61 commercial harbors on the Great Lakes, with controlling depths ranging from 16 to 26 feet, with only three harbors having depths of 26 feet.

4. NAVIGATION SEASON

Navigation on the Great Lakes - St. Lawrence system above Montreal is closed for about four months each winter due to ice. The season of navigation through the system averages about eight months, with navigation usually opening during the first half of April and closing about the middle of December. There is a small amount of intralake traffic during the winter on Lakes Michigan and Erie, and on the Detroit River.

This traffic is not pertinent to the studies in this report.

5. WATER LEVELS

a. The water levels of the Great Lakes vary from year to year, and from month to month during each year. The difference between the highest and lowest monthly average levels on the lakes since 1860, the period of record, has amounted to 3.9 feet on Lake Superior, 6.6 feet on Lakes Michigan, Huron and Ontario, and 5.3 feet on Lake Erie. During each year, the lake levels usually follow a seasonal pattern with the high for the year taking place in the summer months and the low taking place in the winter during the closed season of navigation. The seasonal variation between the summer high and the winter low usually ranges between one and two feet. Data pertaining to variations in lake levels during period of record since 1860 are summarized in Table 1.

Table 1 - Long-Term Variations in Great Lakes Levels, 1860-1964, IGLD 1955

Lake	Elev Low Water Datum, ft	Highest Monthly Mean Level		Lowest Monthly Mean Level		Range, Feet
		Date	Elev, ft	Date	Elev, ft	
Superior	600.0	Aug 1886	602.1	Apr 1926	598.2	3.9
Michigan	576.8	Jun 1886	581.9	Mar 1964	575.3	6.6
Huron	576.8	Jun 1886	581.9	Mar 1964	575.3	6.6
Erie	568.6	May 1952	572.8	Feb 1936	567.5	5.3
Ontario	242.8	Jun 1952	248.1	Nov 1934	241.5	6.6

b. At any point on the lakes there are daily and hourly level fluctuations which vary from a few inches to several feet according to the lake and place involved. They are caused by winds blowing over a lake's surface or by differences in the atmospheric pressure on different areas of the lake's surface. During such short-period disturbances of a lake surface, the level of one area of the lake is raised while the level of another area is lowered. For example, the effect of wind in causing such a disturbance may be to drive the surface water forward in greater volume than that carried by the lower return currents, thus raising the water level at the shore toward which the wind is blowing and lowering it at the opposite shore. Such effects are more pronounced in bays and at the extremities of the lakes where the impelled water is concentrated in a restricted space by the converging shores, especially if coupled with a gradually sloping inshore bottom which reduces the depth and checks the reverse flow. The maximum short-period rises which have been observed on the individual lakes, and their frequencies of occurrence, are presented in Table 2.

Table 2 - Observed Short Period Rises On The Great Lakes 1860-1964

Lake and Gage	Temporary Rise		
	Maximum Feet	Frequency Years	One Year Frequency, ft
<u>SUPERIOR</u> Marquette, Michigan	2.8	44	1.4
<u>MICHIGAN</u> Calumet Harbor, Illinois	2.8	30	1.8
<u>HURON</u> Fort Gratiot, Michigan (Near head of St. Clair R.)	2.5	10	1.7
<u>ERIE</u> Buffalo, New York	8.4	50	4.9
Toledo, Ohio	5.3	35	3.4
<u>ONTARIO</u> Tibbetts Pt., New York (Near head of St. Lawrence R.)	2.9	16	1.7

c. All project depths in the Great Lakes navigation system are in feet below low water datum, the plane on each lake to which Federal navigation depths are referred. Low water datum is referenced to IGLD (1955 International Great Lakes Datum) Elevations are in feet above mean water level at Fathers Point, Quebec, a point on the St. Lawrence River near the river transition to the Gulf of St. Lawrence. The present low water datum planes for each of the lakes were established in 1933 from a consideration of the recorded levels that had been experienced since 1860. The low water datum levels were selected so as to represent what might be termed the average low levels rather than the extreme low levels. With the low water datums as planes of reference, depths available during the navigation season are generally equal to or greater than project depths except during extreme low water years, such as those occurring during the mid-1920's and mid-1930's and during the early 1960's. For the

connecting rivers between Lakes Superior and Huron, between Lakes Huron and Erie, and for the upper reaches of the St. Lawrence River, low water datum is the sloping surface of the rivers when the lakes are at their low water datum elevations.

6. TRIBUTARY AREA

a. The tributary area of the Great Lakes, which generates the large amount of commerce on the Great Lakes, includes large parts of the eight states which border the Great Lakes. In addition to the bordering states, the tributary area, from the standpoint of commerce on the Great Lakes, includes several additional states, particularly in the coal-producing area bordering the easterly part of the basin, and the grain and livestock-producing areas in the north central United States bordering the westerly part of the basin. Also, in addition to the states bordering on the Great Lakes, all or part of 11 states adjoining the Great Lakes border states are tributary to the Great Lakes from the standpoint of overseas commerce through the St. Lawrence Seaway.

b. The major items of commerce on the Great Lakes are iron ore, limestone, coal, grain, petroleum products and overseas general cargo. The availability of low cost water transportation on the Great Lakes for the almost unlimited resources of iron ore, coal and limestone has resulted in making the Great Lakes region the heart of the nation for heavy industry, including the production of iron and steel, and related manufactures using large volumes of iron and steel. Statistics by the U. S. Bureau of Census show that the value added by manufacture in 1958, for areas within 99 miles of Great Lakes ports, was over 33-billion dollars, which was 24 percent of the total value added by manufacture in the entire United States.

c. There are 29 Standard Metropolitan Statistical Areas in the Great Lakes basin, with a total population of 21,587,000 in 1960. The five largest areas are as follows:

	<u>Population in 1960</u>
Milwaukee, Wisconsin	1,232,731
Chicago, Illinois	6,220,913
Detroit, Michigan	3,762,360
Cleveland, Ohio	1,909,483
Buffalo, New York	1,306,957

EXISTING PROJECTS

7. CONNECTING CHANNELS

a. Improvement of the connecting channels above Lake Erie was authorized on 21 March 1956. The improvement provided for

increasing controlling depths from 24.8 feet and 21 feet below low water datum in downbound and upbound channels respectively to a controlling depth of 27 feet below low water datum in both downbound and upbound channels. The channels were designed to provide a safe draft of 25.5 feet for Great Lakes freighters when the water level is at low water datum. In order to provide this safe draft, project depths varied from 27 to 30 feet to provide allowances for squat of vessel when under way, for exposure to wave action, and for an additional foot of clearance between safe draft and channel depth for hard bottom than for soft bottom where applicable. The project depths have been available through the connecting channels since June 1962.

b. The existing project provides for the construction and operation of four locks in the St. Marys River at Sault Ste. Marie, Michigan. The principal features of the locks are shown in Table 3. There is one lock at Sault Ste. Marie, Ontario. This lock is 59 feet wide and 900 feet long, with a depth of 16.8 feet over the sills.

Table 3 - Principal Features of Locks, St. Marys Falls Canal

Principal Features	Lock			
	MacArthur	Sabin	Davis	Poe-Under Const. ¹
Width, feet	80	80	80	110
Length between miter sills, feet	800	1350	1350	1200
Depth on upper miter sill, feet	31	24.3	24.3	32
Depth on lower miter sill, feet	31	23.1	23.1	32
Lift, feet	21.7	21.7	21.7	21.7

¹ - Scheduled for completion in fall of 1967.

c. Controlling depths of 27 feet have been available since 1959 in the Welland Canal between Lake Erie and Lake Ontario, and in the St. Lawrence River from Lake Ontario to Montreal, Quebec. There is a 35-foot ship channel in the St. Lawrence River from Montreal to the ocean. The controlling dimensions of Welland Canal locks are 80 feet wide, and 859 feet long between miter sills, with depth of 30 feet over sills. St. Lawrence River locks are the same size as Welland Canal locks, except they are 860 feet long. Prior to 1959 the controlling depth in the Welland Canal was 25 feet, and in the St. Lawrence River above Montreal was 14 feet. Controlling lock dimensions in the St. Lawrence River prior to 1959 were 252 feet long and 44 feet wide, with depth of 14 feet over the sills.

d. The limiting dimensions of ships for the MacArthur Lock at St. Marys Falls Canal, and for the Welland Canal and St. Lawrence River locks, are 730 feet long and 75-foot beam. These locks have depths in excess of channel depths leading to the locks. Consequently, the draft of ships is limited by channel depths, and not by the locks.

8. HARBORS

The project depths in 1956, prior to initiation of studies for this report, for 61 Federal commercial harbors are shown in Table 4. The depths shown are for the protected harbor areas which, in general, control maximum drafts. At many harbors, increased depths have been provided in lake approaches and in entrance channels to allow more clearance between channel depth and draft due to wave action in exposed areas, and also due to squat when ships are under way. Detailed information on existing harbor projects in 1956 can be found in the interim reports. These interim reports are discussed further in paragraph 12 below, under Plan of Improvement.

Table 4 - Project Depths in 1956 for Federal Commercial Harbors on Great Lakes

Location	Project Depth ¹ (feet)	Location	Project Depth ¹ (feet)
<u>LAKE SUPERIOR</u>		<u>LAKE HURON</u>	
Grand Marais, Minn.	16	Cheboygan, Mich.	15-18
Two Harbors, Minn.	26	Alpena, Mich.	18.5
Duluth-Superior, Minn. & Wis.	20-26	Saginaw River, Mich.	16.5-24
Ashland, Wis.	20-25	Harbor Beach, Mich.	21
Ontonagon, Mich.	15	Black River, Port Huron, Mich.	20
Presque Isle, Mich.	26		
Marquette, Mich.	25		
Grand Marais, Mich.	18		
<u>LAKE MICHIGAN</u>		<u>LAKE ST. CLAIR - LAKE ERIE</u>	
Manistique, Mich.	18	Detroit-Rouge River, Mich.	18-25
Gladstone, Mich.	19	Detroit-Trenton Channel, Mich	21
Menominee, Mich.	21	Monroe, Mich.	21
Green Bay, Wis.	22	Toledo, Ohio	25
Sturgeon Bay Canal, Wis.	22	Sandusky, Ohio	21-22
Kewaunee, Wis.	20	Huron, Ohio	25-26
Two Rivers, Wis.	18	Lorain, Ohio	24-25
Manitowoc, Wis.	21	Cleveland, Ohio	21-25
Sheboygan, Wis.	15-21	Fairport, Ohio	21-25
Port Washington, Wis.	18-21	Ashtabula, Ohio	24
Milwaukee, Wis.	21	Conneaut, Ohio	25-26
Racine, Wis.	19-21	Erie, Pa.	18-25
Kenosha, Wis.	21	Dunkirk, N. Y.	16-17
Waukegan, Ill.	18	Buffalo, N. Y.	22-25
Chicago, Ill.	21	Black Rock Channel, N. Y.	21
Calumet Harbor, Ill.	21-26		
Indiana Harbor, Ind.	22-26		
Michigan City, Ind.	18		
St. Joseph, Mich.	18-21		
South Haven, Mich.	19		
Holland, Mich.	21		
Grand Haven, Mich.	21		
Muskegon, Mich.	21		
White Lake, Mich.	16		
Ludington, Mich.	18		
Manistee, Mich.	21		
Portage Lake, Mich.	18		
Frankfort, Mich.	18		
Charlevoix, Mich.	18		
		<u>LAKE ONTARIO</u>	
		Rochester, N. Y.	20
		Great Sodus Bay, N. Y.	20
		Oswego, N. Y.	21-22
		Ogdensburg, N. Y.	19-21

¹ Depths shown are for protected harbor areas only. Increased depths for entrance channels, including lake approaches, are not shown.

COMMERCE AND VESSEL TRAFFIC

9. EXISTING COMMERCE

a. The existing commerce discussed herein includes all United States commerce on the Great Lakes for the ten-year period 1955-1964, including domestic, Canadian and overseas commerce, but excluding internal, intraport and local traffic. During the ten-year period 1955-1964, the annual commerce averaged 190,035,000 tons and varied from a low of 158,084,000 tons in 1958 to a high of 217,538,000 tons in 1957. A summary of United States commerce on the Great Lakes for ten-year period 1955-1964 is shown in Table 5, and a summary of the same commerce by major commodities is shown in Table 6.

b. Commerce at 55 Federal harbors on the Great Lakes for the ten-year period 1955-1964 is shown in Table 7, and for 15 private harbors is shown in Table 8. Plates 2 through 10 are a set of flow charts which shown for 1964 the movements on the Great Lakes of major commodities, United States-Canadian traffic, United States-overseas traffic, and a summary of domestic traffic, excluding local and intraport traffic. The character of the movements in 1964 are, in general, representative of movement of Great Lakes traffic in recent years.

c. The largest item of commerce is iron ore, which is shipped from ports on Lake Superior, from Escanaba, Michigan, on Lake Michigan, and from Canada on the St. Lawrence River below Montreal. Iron ore is received at ports at southerly end of Lake Michigan, on the Detroit River, at ports along southerly shore of Lake Erie, and at Buffalo and Tonawanda, New York, at the eastern end of Lake Erie. The second largest item of commerce is coal, which is shipped from Calumet Harbor, Illinois, from Toledo, Ohio and other ports along the south shore of Lake Erie and from ports along the south shore of Lake Ontario. Coal is widely distributed throughout the Great Lakes, with a substantial percentage of the total movement exported to Canada. Practically all of the stone is shipped from private harbors on Lake Huron and on the northerly shore of Lake Michigan. The major portion of the stone is shipped to steel-producing areas at southerly end of Lake Michigan, on Detroit River, and along southerly shore of Lake Erie, including Buffalo Harbor. The remainder is given wide distribution through the Great Lakes, primarily for production of cement, for construction purposes and for chemical industries. Most of the grain shipments are from Duluth-Superior harbor at west end of Lake Superior, from Calumet Harbor, Illinois, and from Toledo, Ohio, with some shipments from several other ports. Most of the grain is destined for Buffalo, New York, and for export, through the St. Lawrence Seaway. Overseas general cargo commerce is widely distributed throughout the Great Lakes area. Petroleum products are given wide distribution throughout the Great Lakes. A large percentage of total shipments of petroleum products is from Indiana Harbor, Indiana with substantial shipments from Muskegon, Michigan; Saginaw River, Michigan, and Toledo, Ohio.

Table 5 - Summary of United States Commerce on the Great Lakes, Excluding Internal, Intraport and Local Traffic, 1955-1964

(In Thousands of Tons)

Year	Grand Total Tonnage	Imports		Exports		Domestic	
		Total	From Canada	Over- Seas	Total	To Canada	Over- Seas Lakewise
1955	216,178	8,681	8,434	247	22,688	22,400	288
1956	210,849	10,866	10,573	293	25,992	25,711	281
1957	217,538	10,116	9,886	230	25,272	24,984	288
1958	158,084	8,005	7,657	348	17,790	17,430	360
1959	166,630	14,877	13,794	1,083	20,533	17,700	2,833
1960	191,111	12,851	11,974	877	23,151	19,169	3,982
1961	172,032	11,986	11,007	979	23,205	18,802	4,403
1962	176,810	15,649	14,488	1,161	25,417	20,485	4,932
1963	188,249	18,006	16,495	1,511	28,502	24,455	4,047
1964	206,022	24,152	22,118	2,034	30,465	24,867	5,598

Table 6 - Summary of United States Commerce on the Great Lakes, by Major Commodities, Excluding Internal, Intraport and Local Traffic, 1955-1964 ¹

Commodity and Type of Traffic	T E A R									
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
(In Thousands of Tons)										
IRON ORE - TOTAL	98,708	88,501	96,581	60,297	58,222	81,548	66,962	70,065	74,447	86,563
Domestic, Lakewise	88,799	76,449	85,946	52,751	45,860	68,465	55,146	54,705	56,475	63,552
Canadian	9,909	12,052	10,635	7,543	12,362	13,059	11,816	15,287	17,972	23,011
Overseas	-	-	-	-	-	24	-	73	-	-
LIMESTONE - TOTAL	29,570	29,631	29,569	22,095	25,004	26,490	24,250	23,685	25,002	28,798
Domestic, Lakewise	28,606	28,535	28,436	21,327	23,972	25,633	23,590	23,064	24,761	27,882
Canadian	964	1,096	1,113	768	1,032	857	660	621	241	916
Overseas	-	-	-	-	-	-	-	-	-	-
COAL - TOTAL	54,001	58,330	57,746	45,597	47,254	47,064	44,415	46,627	51,851	52,266
Domestic, Lakewise	40,053	42,288	41,958	34,988	36,135	36,288	34,096	35,933	38,679	38,693
Canadian	13,948	16,042	15,788	10,609	11,119	10,776	10,319	10,692	13,172	13,573
Overseas	-	-	-	-	-	-	-	2	-	-
GRAIN - TOTAL	4,751	5,745	5,316	4,932	6,797	7,196	7,919	9,100	9,706	9,516
Domestic, Lakewise	3,685	4,223	3,574	3,412	2,839	2,775	3,082	2,865	3,013	2,300
Canadian	1,066	1,521	1,742	1,488	1,963	2,020	2,775	3,110	4,657	4,020
Overseas	-	1	-	32	1,995	2,401	2,062	3,125	2,036	3,196
ALL OTHER - TOTAL	22,148	28,642	28,326	25,163	29,353	28,813	28,486	27,333	27,243	28,879
Domestic, Lakewise	23,056	22,496	22,216	19,808	22,414	21,948	20,927	19,177	18,813	18,978
Canadian	4,947	5,573	5,591	4,679	5,018	4,431	4,239	5,263	4,908	5,465
Overseas	535	573	519	676	1,921	2,434	3,320	2,893	3,522	4,436
GRAND TOTAL	216,178 ²	210,849 ²	217,538 ²	158,084 ²	166,630 ²	191,111	172,032	176,810	188,249	206,022
Domestic, Lakewise	184,809	173,991	182,150	132,289	131,220	155,109	136,841	135,744	141,741	151,405
Canadian	30,834	36,284	34,869	25,087	31,494	31,143	29,809	34,973	40,950	46,985
Overseas	535	574	519	708	3,916	4,859	5,382	6,093	5,558	7,632

- ¹ Source: Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 5, Tables 2 and 2B. Excludes less than 500 tons.
- ² Excludes Dept. of Defense controlled cargo and Special Category commodities for which breakdown by Canadian and Overseas is not available prior to 1960, as follows: 1955 - 53,574 tons; 1956 - 35,043 tons; 1957 - 26,123 tons; 1958 - 21,457 tons; 1959 - 21,584 tons.

Table 7 - Commerce at 55 Federal Harbors for 10-Year Period 1955-1964, Excluding Internal, Intraport and Local Traffic

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
(In Thousands of Tons)										
LAKE SUPERIOR										
Grand Marais, Minn.	54	64	70	78	54	48	47	56	37	30
Two Harbors	19,103	16,038	19,173	11,661	9,080	15,266	11,418	13,016	0	0
Duluth-Superior	68,298	59,433	60,693	34,473	31,462	42,668	31,373	30,295	41,521	42,965
Ashland	4,977	4,348	4,287	2,863	1,853	1,574	1,460	1,502	1,088	632
Ontonagon	-	-	-	-	1	11	9	16	13	16
Presque Isle	5,702	4,817	4,720	3,177	2,793	4,340	3,753	3,981	5,657	6,934
Marquette	767	805	671	771	978	925	867	1,063	1,246	1,390
LAKE MICHIGAN										
Manistique	341	306	297	221	202	216	147	136	119	134
Gladstone	163	189	215	217	262	246	232	284	271	279
Menominee	826	867	771	682	702	746	573	578	556	454
Green Bay	3,180	3,451	3,491	3,397	3,582	3,400	3,005	2,492	2,366	2,517
Kewaunee	1,189	1,154	1,111	1,102	1,143	1,045	1,004	1,024	1,079	1,153
Two Rivers	149	161	168	163	188	185	179	163	53	80
Manitowoc	2,413	2,393	2,243	2,083	2,238	2,163	2,102	1,940	1,880	2,127
Sheboygan	501	493	494	513	502	455	384	498	507	464
Port Washington	911	860	768	838	942	630	705	496	712	733
Milwaukee	8,711	8,600	8,395	7,655	8,799	8,506	8,367	6,720	6,625	6,381
Racine	103	130	118	123	119	134	119	131	119	115
Kenosha	26	22	33	49	74	39	65	80	54	59
Waukegan	82	84	82	82	306	240	267	317	416	470
Chicago	294	238	265	309	329	404	421	463	561	530
Calumet Harbor	21,530	22,996	22,940	16,612	19,490	18,606	16,842	17,683	18,806	23,884
Indiana Harbor	20,079	19,141	19,724	17,620	15,241	19,176	19,378	17,543	18,477	17,968
Michigan City	1	0	194	36	244	151	151	120	142	109
St. Joseph	324	383	255	249	410	460	463	383	352	435
South Haven	67	62	77	78	114	74	64	192	94	81

Table 7 - Commerce at 55 Federal Harbors for 10-Year Period 1955-1964, Excluding Internal, Intraport and Local Traffic (Continued)

	(In Thousands of Tons)									
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
LAKE MICHIGAN (Continued)										
Holland	242	233	236	202	255	261	247	239	298	193
Grand Haven	2,820	1,388	1,594	1,368	1,677	1,527	1,319	1,444	1,265	2,598
Muskegon	3,793	4,314	4,383	3,474	4,216	3,573	3,212	3,348	3,068	3,350
White Lake	21	29	17	17	12	10	33	32	25	25
Ludington	3,603	3,860	3,541	3,504	3,838	3,892	3,589	3,686	3,843	3,904
Manistee	906	878	521	431	572	590	509	503	603	634
Frankfort	1,788	1,768	1,636	1,497	1,509	1,416	1,296	1,175	1,219	1,423
Charlevoix	47	44	68	77	78	83	83	103	93	97
LAKE HURON										
Alpena	79	69	100	117	133	148	125	142	135	143
Saginaw River	4,296	4,354	4,811	4,158	5,054	5,404	5,526	4,722	5,000	5,498
Harbor Beach	57	55	50	46	49	51	38	41	45	32
Cheboygan	57	71	86	74	95	105	99	107	84	93
LAKE ERIE										
Detroit-Rouge River	10,979	11,521	11,628	9,217	11,780	11,440	10,443	10,928	11,408	13,476
Detroit-Trenton Channel	1,153	2,182	1,915	2,443	2,126	3,316	2,525	3,385	3,819	3,338
Monroe	20	21	40	16	72	33	29	23	31	29
Toledo	35,208	35,440	34,031	28,274	33,415	33,664	33,676	36,082	40,054	41,065
Sandusky	7,962	8,280	8,389	6,232	6,442	5,654	4,613	4,100	3,958	2,768
Huron	2,784	3,262	2,871	1,745	2,052	2,204	1,423	1,545	1,632	1,547
Lorain	7,821	7,515	8,180	4,475	4,428	6,695	5,760	5,508	4,733	6,407
Cleveland	20,089	16,964	19,056	11,535	12,302	17,612	17,035	16,667	16,748	20,111
Fairport	2,750	2,473	3,121	2,457	2,794	2,749	2,920	2,982	2,862	3,402

Table 7 - Commerce at 55 Federal Harbors for 10-Year Period 1955-1964, Excluding Internal, Intraport and Local Traffic (Continued)

		(In Thousands of Tons)									
		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
LAKE ERIE (Continued)											
Ashtabula		13,041	13,141	12,409	8,348	9,394	10,223	7,532	8,988	10,814	11,600
Conneaut		15,133	11,049	15,790	6,620	5,156	7,158	1,913	3,063	3,269	5,933
Erie		6,593	6,168	5,902	4,398	3,446	2,296	2,313	2,411	2,342	1,720
Buffalo		21,744	20,928	22,256	11,685	11,231	14,277	12,228	12,404	13,704	15,244
LAKE ONTARIO											
Rochester		328	324	494	273	317	389	351	320	753	429
Great Sodus Bay		1,603	2,365	2,258	1,276	1,008	1,218	1,081	1,531	2,268	1,381
Oswego		2,341	2,594	2,322	1,546	750	893	59	1,001	519	216
Ogdensburg		396	445	382	345	280	275	251	250	274	280

Table 8 - Commerce at 15 Private Harbors for 10-Year Period 1955-1964

(In Thousands of Tons)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
LAKE SUPERIOR										
Façonite 1	11	27	437	3,245	4,238	6,525	8,726	8,918	9,460	9,126
Silver Bay 1	245	4,382	6,094	5,802	4,129	5,676	6,644	6,323	8,744	11,683
LAKE MICHIGAN										
Port Dolomite 2	1,936	1,838	2,482	1,537	2,131	2,775	2,330	2,502	3,207	3,446
Port Inland 2	4,610	4,094	4,569	3,564	2,406	4,174	3,591	3,866	4,311	4,894
Escanaba 1	6,892	6,098	6,896	3,921	3,793	7,669	6,119	5,821	6,129	7,708
Oak Creek 3	755	959	1,149	1,228	1,415	1,769	1,847	2,160	2,310	2,449
Buffington 4	1,291	1,492	1,626	1,638	1,616	1,544	1,753	1,386	1,295	1,687
Gary 5	10,555	8,766	10,613	9,353	6,712	11,677	9,289	9,045	10,398	9,114
LAKE HURON										
Calcite 2	15,776	15,946	14,911	11,986	14,572	13,004	12,635	12,203	11,309	13,682
Stoneport 2	5,190	4,961	4,836	3,196	3,561	4,000	3,552	3,741	3,960	4,910
Port Gypsum 2	-	-	-	-	289	264	274	195	284	277
Alabaster 2	793	781	678	691	623	624	510	513	454	507
Drummond Island 2	2,328	2,187	2,086	1,767	2,244	2,043	2,050	1,427	1,734	2,152
Bayshore (Alpena) 2	2,918	3,154	3,431	2,088	2,400	2,287	2,002	2,219	2,611	2,573
LAKE ERIE										
Marblehead 2	1,432	509	410	336	621	776	832	669	1,138	753

NOTES: 1 Primary use, shipment of iron ore.
2 Primary use, shipment of stone.
3 Primary use, receipt of coal.
4 Primary use, receipt of stone and coal for cement.
5 Primary use, receipt of iron ore, coal and stone.

10. PROSPECTIVE COMMERCE

a. During the 10-year period 1955-1964, traffic in four major commodities, iron ore, coal, stone and grain, comprised about 85 percent of total United States commerce on the Great Lakes. These four commodities and overseas general cargo comprise the major items of commerce considered in developing plans for a system of harbors to take full advantage of the recent improvements in the connecting channels above Lake Erie, in the Welland Canal, and in the St. Lawrence Seaway. Comprehensive over-all Great Lakes traffic analyses were made for iron ore, coal, stone, grain and overseas general cargo to develop estimates of prospective traffic as a basis for determining harbor improvements which could be justified. For other commodities, traffic analyses were made as indicated at individual harbors. The five traffic analyses accompany this report in the following appendices:

Appendix A - Iron Ore Traffic Analysis

Appendix B - Coal Traffic Analysis

Appendix C - Stone Traffic Analysis

Appendix D - Grain Traffic Analysis

Appendix E - Great Lakes-Overseas General Cargo Traffic Analysis

b. The iron ore traffic analysis developed estimates of prospective shipments and receipts of iron ore at United States Great Lakes harbors for the 50-year period 1958-2007. Total annual average receipts at United States harbors for the 50-year period are estimated at about 138-million tons. It is estimated that about 70 percent of this total will be shipped from Great Lakes ports, about 29 percent from eastern Canada through the St. Lawrence Seaway, with the balance of about 1 percent from overseas. Table 9 shows estimated average annual shipments from all Great Lakes harbors, shipments through the St. Lawrence Seaway to United States harbors, and receipts at all United States Great Lakes harbors for the 50-year period 1958-2007.

c. The coal traffic analysis developed estimates of average annual prospective shipments of coal for 50-year period 1965-2015 from all United States Great Lakes harbors, and the distribution of total shipments to both United States and Canadian harbors. Estimated average annual shipments amounted to 120-million tons, with about 73 percent shipped to United States harbors, and the balance of about

27 percent shipped to Canada. Table 10, Page 21, presents estimates of average annual shipments from United States harbors and distribution of this commerce to United States and Canadian receiving ports.

d. The stone traffic analysis developed estimates of prospective shipments and receipts of stone at Great Lakes harbors for the 50-year period 1958-2007. Practically all of the stone is shipped from private harbors. Estimated average annual shipments are 50,540,000 tons. Table 11, Page 23, presents estimates of average annual shipments and receipts.

e. The grain traffic analysis developed estimates of prospective traffic in grain for the years 1965, 1980, and 2015. There are three general types of grain movements on the Great Lakes, as follows:

Shipments between United States harbors designated as lakewise movements.

Exports from United States harbors to Canada and overseas.

Imports from Great Lakes harbors in Canada.

Lakewise receipts and shipments of grain averaged 3,430,000 tons during the 1948-1957 period, and declined to an average of 2,556,000 tons during the 1959-1963 period. There was a large increase in exports of grain following the opening of the St. Lawrence Seaway in 1959. Exports averaged 641,000 tons during the 1948-1957 period, increased to 880,000 tons in 1958, and to 3,470,000 tons in 1959, the year the deep-draft St. Lawrence Seaway was opened, with a further increase to 6,413,000 tons in 1963. Total lakewise shipments and exports were 9,136,000 tons in 1963. The estimated prospective shipments of grain for the years 1965, 1980 and 2015 are 10,750,000, 14,000,000, and 19,600,000 tons, respectively. Table 12, Page 24, shows total shipments broken down between exports and lakewise shipments for the years 1948 through 1963, and projected shipments for the years 1965, 1980, and 2015. Imports of grain from Canadian Great Lakes harbors declined from an annual average of 1,378,000 tons during the 1948-1957 period to an annual average of 320,000 tons during the 1959-1963 period, the first five years of operation of the deep-draft St. Lawrence Seaway. Future imports are expected to remain at a relatively low level and will comprise only a small segment of the Great Lakes grain movement. No estimate of prospective traffic has been made for this movement.

f. The Great Lakes overseas general cargo traffic analysis developed estimates of total prospective traffic in overseas general cargo to all United States Great Lakes harbors for the years 1965, 1975, 1985, 1995, 2005 and 2015. Estimates of prospective traffic at individual harbors were then developed as required for interim reports. There was a large increase in United States overseas general cargo traffic on the Great Lakes in 1959, the year the St. Lawrence Seaway

was opened to deep-draft traffic. The average annual overseas general cargo during the 7-year period 1952-1958 was 493,000 tons. In 1958, it was 78,000 tons, while in 1959, the first year deep-draft ships could enter the Great Lakes through the St. Lawrence Seaway, it increased to 1,875,000 tons. In 1964, the total traffic was 4,165,000 tons. Table 13, Page 25, presents estimates of overseas liner type general cargo as developed in the Great Lakes-Overseas General Cargo Traffic analysis.

Table 9 - Prospective Average Annual Iron Ore Commerce for 50-Year
Period 1958-2007

SHIPMENTS		RECEIPTS - U. S. HARBORS	
Harbor	Millions of Net Tons	Harbor	Millions of Net Tons
Michipicoten, Ontario	1.88	Calumet Hbr & Riv, Ill & Ind	19.01
Port Arthur, Ontario	6.45	Indiana Harbor, Indiana	14.01
Taconite, Minnesota	10.77	Gary, Indiana	14.02
Silver Bay, Minnesota	9.80	Detroit, Michigan	1.72
Two Harbors, Minnesota	14.45	River Rouge, Michigan	5.45
Duluth-Superior, Minn-Wis	43.90	Trenton Channel, Michigan	4.87
Ashland, Wisconsin	2.76	Toledo, Ohio	7.50
Presque Isle, Michigan	6.14	Huron, Ohio	2.65
Marquette, Michigan	0.63	Lorain, Ohio	7.42
Escanaba, Michigan	3.51	Cleveland, Ohio	20.88
Picton, Ontario	<u>0.98</u>	Ashtabula, Ohio	10.54
Total frm Great Lakes Hbrs	101.27 ¹	Conneaut, Ohio	15.05
		Erie, Pennsylvania	4.16
Eastern Canada via St. Lawrence Seaway	39.75 ²	Tonawanda, New York	0.46
		Niagara River, New York	0.73
Foreign sources overseas via St. Lawrence Seaway	1.50 ²	Buffalo, New York	<u>9.48</u>
		Total U. S. Harbors	137.95
		Canadian Harbors ¹	<u>4.57</u>
Total	142.52	Total	142.52

¹ Includes estimate of about 4.57-million tons shipped to Canadian Great
Lakes Harbors from Lake Superior Region

² For U. S. Harbors

Table 10 - Prospective Average Annual Coal Commerce for 50-Year
Period 1965-2015

SHIPMENTS		RECEIPTS	
Harbor	Thousands of Net Tons	Harbor	Thousands of Net Tons
Toledo, Ohio	47,250	Two Harbors, Minnesota	160
Sandusky, Ohio	17,000	Duluth-Superior, Minn-Wis	4,750
Huron, Ohio	1,200	Washburn, Wisconsin	90
Lorain, Ohio	3,200	Ashland, Wisconsin	450
Cleveland, Ohio	700	Ontonagon, Michigan	350
Fairport, Ohio	1,900	Hancock, Michigan	30
Ashtabula, Ohio	6,000	Houghton, Michigan	30
Conneaut, Ohio	2,600	Dollar Bay (Keweenaw Waterway), Michigan	160
Erie, Pennsylvania	3,000	Torch Lake, Michigan	170
Buffalo, New York	700	Marquette, Michigan	150
Total Lake Erie Harbors	(83,550)	Munising, Michigan	60
Calumet, Ill., and Burns Waterway, Indiana	24,350	Sault Ste. Marie, Michigan	130
Total Lake Michigan Hbrs	(24,350)	Lime Island, Michigan	120
		Detour, Michigan	700
Rochester, New York	2,100	Manistique, Michigan	20
Great Sodus Bay, New York	7,700	Escanaba, Michigan	230
Oswego, New York	2,300	Menominee, Michigan	350
Total Lake Ontario Hbrs	(12,100)	Green Bay, Wisconsin	2,560
GRAND TOTAL	120,000	Two Rivers, Wisconsin	40

Table 10 - Prospective Average Annual Coal Commerce for 50-Year
Period 1965-2015 (Continued)

RECEIPTS		RECEIPTS	
Harbor	Thousands of Net Tons	Harbor	Thousands of Net Tons
Manitowoc, Wisconsin	310	Harbor Beach, Michigan	1,180
Sheboygan, Wisconsin	540	Port Huron, Michigan	500
Port Washington, Wisconsin	1,600	St. Clair River, Michigan	2,460
Milwaukee, Wisconsin	2,200	Detroit, Michigan	5,500
Racine, Wisconsin	80	Rouge River, Michigan	7,000
Waukegan, Illinois	80	Ecorse, Michigan	50
Calumet Harbor, Ill-Ind	3,450	Trenton Channel, Michigan	2,130
Indiana Harbor, Indiana	3,350	Monroe, Michigan	5,460
Burns Waterway, Indiana	3,000	Toledo, Ohio	1,800
St. Joseph, Michigan	20	Islands, West End Lake Erie	20
Holland, Michigan	60	Erie, Pennsylvania	190
Grand Haven, Michigan	50	Buffalo, New York	1,530
Muskegon, Michigan	2,000	Niagara River, New York	6,500
Ludington, Michigan	200	Oswego, New York	3,200
Manistee, Michigan	300	Ogdensburg, New York	110
Traverse City, Michigan	50	Private Harbors	15,890
Cheboygan, Michigan	30	Total U. S. Harbors	(88,000)
Alpena, Michigan	2,120	Total Canadian Harbors from United States Great Lakes Harbors	<u>32,000</u>
Saginaw River, Michigan	3,600	GRAND TOTAL	120,000

Table 11 - Prospective Average Annual Stone Commerce for 50-Year
Period 1958-2007

SHIPMENTS		RECEIPTS	
Harbor	Thousands of Net Tons	Harbor	Thousands of Net Tons
Drummond Island, Michigan	2,941	Duluth-Superior, Minn-Wis	1,626
Port Dolomite, Michigan	2,703	Manitowoc, Wisconsin	484
Port Inland, Michigan	7,888	Milwaukee, Wisconsin	588
Calcite, Michigan	28,000	Calumet Harbor, Ill & Ind	4,215
Stoneport, Michigan	5,207	Indiana Harbor, Indiana	3,618
Alpena, Michigan	1,650	Buffington, Indiana	2,856
Alabaster, Michigan	1,500	Gary, Indiana	3,028
Marblehead, Ohio	<u>651</u>	Dudington, Michigan	468
Total	50,540	Saginaw River, Michigan	2,028
		Port Huron, Michigan	928
		Detroit, Michigan	3,623
		River Rouge, Michigan	2,950
		Trenton Channel, Michigan	1,023
		Wyandotte, Michigan	2,164
		Lorain, Ohio	2,414
		Cleveland, Ohio	4,342
		Fairport, Ohio	2,417
		Ashtabula, Ohio	1,182
		Conneaut, Ohio	815
		Erie, Pennsylvania	413
		Buffalo, New York	5,473
		Miscellaneous	<u>3,885</u>
		Total	50,540

Table 12 - Great Lakes Total Grain Exports and Lakewise Deep-Draft Shipments, By Lake Area,
Actual 1948-1963 and Projected 1965-2015

Area	(In Thousand Tons)									
	Actual Traffic					Projected				
	Avg Ann 1948-57	1958	1959	1960	1961	1962	1963	1965	1980	2015
<u>TOTAL SHIPMENTS</u>	<u>4,071</u>	<u>3,863</u>	<u>5,757</u>	<u>6,403</u>	<u>7,178</u>	<u>8,690</u>	<u>9,136</u>	<u>10,750</u>	<u>14,000</u>	<u>19,600</u>
Lake Superior	3,215	2,732	3,816	4,355	4,387	4,405	4,663	5,160	6,210	8,100
Lake Michigan	650	851	1,383	1,294	1,399	2,423	2,579	3,310	4,865	7,265
Lake Huron-Erie	206	280	558	754	1,392	1,862	1,894	2,280	2,925	4,235
<u>TOTAL EXPORTS</u> <u>(Ovs. & Can.)</u>	<u>641</u>	<u>880</u>	<u>3,470</u>	<u>4,026</u>	<u>4,415</u>	<u>6,060</u>	<u>6,413</u>	<u>8,000</u>	<u>11,000</u>	<u>16,000</u>
Lake Superior	228	262	1,983	2,329	2,167	2,569	2,414	2,960	3,810	5,200
Lake Michigan	317	436	1,013	994	1,027	1,787	2,198	2,890	4,410	6,755
Lake Huron-Erie	96	182	474	703	1,221	1,704	1,801	2,150	2,780	4,045
<u>TOTAL LAKEWISE</u> <u>SHIPMENTS</u>	<u>3,430</u>	<u>2,983</u>	<u>2,287</u>	<u>2,377</u>	<u>2,763</u>	<u>2,630</u>	<u>2,723</u>	<u>2,750</u>	<u>3,000</u>	<u>3,600</u>
Lake Superior	2,987	2,470	1,833	2,026	2,220	1,836	2,249	2,200	2,400	2,900
Lake Michigan	333	415	370	300	372	636	381	420	455	510
Lake Huron-Erie	110	98	84	51	171	158	93	130	145	190

Table 13 - Prospective Overseas General Cargo

(In Thousand Tons)

Harbor	1965	1975	1985	1995	2005	2015
Green Bay, Wis.	105	152	185	198	207	215
Manitowoc, Wis.	4	5	6	7	7	8
Milwaukee, Wis.	390	615	715	805	885	960
Kenosha, Wis.	50	61	68	73	77	80
Chicago, Ill.	260	450	520	520	520	520
Calumet Harbor, Ill-Ind	1,160	1,630	1,810	2,000	2,190	2,380
Burns Waterway, Ind.	-	165	240	285	330	370
Muskegon, Mich.	68	86	99	111	122	133
Saginaw River, Mich.	65	95	115	130	145	160
Rouge River, Mich.	275	310	345	380	410	440
Cleveland, Ohio	380	565	720	825	930	1,035
Ashtabula, Ohio	85	100	120	125	130	130
Erie, Pa.	74	130	160	183	204	224
Buffalo, New York	170	305	355	395	435	475
Rochester, New York	20	35	50	60	65	70
Oswego, New York	45	65	80	95	108	120
Other Harbors	599	831	1,112	1,408	1,685	1,880
Total	3,750	5,600	6,700	7,600	8,450	9,200

NOTE: The harbors listed are those for which estimates of prospective overseas general cargo traffic were shown in interim reports. Estimates of prospective overseas general cargo traffic were not developed for Duluth-Superior and Toledo for which interim reports were made prior to the completion of the general cargo traffic analysis.

11. EXISTING AND PROSPECTIVE VESSEL TRAFFIC

a. In 1953, in connection with studies being made for deepening the connecting channels to provide a controlling depth of 27 feet, the Lake Carriers' Association and other vessel interests were consulted with regard to the composition of the prospective Great Lakes bulk cargo fleet that would be developed to take advantage of the 27-foot channels. It was assumed at that time that harbor channels would be deepened in order that full advantage would be taken of the 27-foot depths in the connecting channels and in the St. Lawrence Seaway. There was then developed the composition of the prospective bulk cargo fleet as of 1985. It was considered that the predictions of a 1985 fleet were still valid for use in the Great Lakes Harbors Study, with only some changes in characteristics of the vessels. Table 14 shows the classification and characteristics of the Great Lakes bulk cargo fleet as used in this study. Table 15 shows the composition of the Great Lakes bulk cargo fleet in 1953, 1957, 1965, and as predicted for 1985.

Table 14 - Classification and Characteristics of United States Great Lakes Bulk Cargo Fleet

Class	Over-all length (feet)	Bulk Carriers		Self-Unloaders	
		Draft (feet)	Capacity (tons)	Draft (feet)	Capacity (tons)
1	Under 400	-	-	-	-
2	400-499	21.0	10,000	-	-
3	500-549	21.3	12,900	22.2	11,800
4	550-599	21.9	15,500	21.7	14,000
5	600-649	25.0	22,100	25.6	20,200
6	650-699	25.7	23,300	25.8	22,400
7	Over 700	26.5	28,000	26.2	24,900

NOTE: Draft and Capacity pertain to summer season.

b. Studies of prospective overseas general cargo traffic concluded that the type of ship used for that traffic would be the Maritime Administration's C-2 type ship or foreign ships of equal size and capacity. The C-2 type ship has an over-all length of about 450 to 500 feet and beam of about 60 or 65 feet, with cargo deadweight capacity of 8,500 tons at a draft of 25 feet 6 inches in fresh water.

Table 15 - United States Great Lakes Bulk Cargo Fleet In
1953, 1957, 1965 and Predicted for 1985

Class	Number of Ships			
	1953 Fleet	1957 Fleet	1965 Fleet	Estimated for 1985
<u>Bulk Carriers</u>				
1	18	1	0	0
2	69	35	4	2
3	77	53	16	5
4	74	45	15	28
5	29	107	96	55
6	2	3	8	58
7	<u>2</u>	<u>4</u>	<u>12</u>	<u>26</u>
Total	271	248	151	174
<u>Self-Unloaders</u>				
1	3	6	0	0
2	6	10	3	0
3	16	10	9	3
4	4	13	13	6
5	2	8	11	3
6	1	1	4	7
7	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>
Total	32	48	40	21

NOTE: The bulk cargo fleets listed above comprise the ships carrying
iron ore, coal, limestone and grain.

PLAN OF IMPROVEMENT

12. IMPROVEMENTS DESIRED

a. Twenty-six public hearings were held between 16 October 1956 and 28 February 1957. The hearings covered the entire Great Lakes area from the westerly end of Lake Superior to Ogdensburg, New York, on the St. Lawrence River. The first hearing held in Detroit, Michigan, on 16 October 1956, covered the over-all Great Lakes Harbors Study as well as the Port of Detroit. Each of the other hearings covered from one to several harbors to assure that local interests at every commercial harbor had the opportunity to be heard at a public hearing. Transcripts of the public hearings are on file in the District Offices.

b. In general, improvements were requested for deepening harbors or parts of harbors to take full advantage of the 27-foot channels being provided in the Great Lakes Connecting Channels and in the St. Lawrence Seaway. It was emphasized that the increased depths requested would result in major savings in cost of transportation for the present and prospective fleets. In a few cases, improvements to harbor entrances and protective structures were requested to accommodate the larger Great Lakes bulk carriers in the prospective fleet.

13. PLAN OF IMPROVEMENT

a. It was determined that interim reports should be submitted at the earliest practicable date on individual harbors or portions of harbors for which all necessary information could be developed at an early date. This procedure was adopted since considerable time would be required to determine the improvements which were economically justified for each commercial harbor. This permitted early submission of interim reports on improvements at individual harbors which were economically justified generally for bulk commodity commerce which would take advantage of the 27-foot controlling depth being provided in the Great Lakes Connecting Channels, in the Welland Canal and in the St. Lawrence Seaway. All of the interim reports were completed between May 1959 and September 1965.

b. Depths in the existing project for the Great Lakes Connecting Channels, as authorized by the Act of 21 March 1956, vary from 27 feet to 30 feet below low water datum. The varying depths were established to provide a safe draft of 25.5 feet for a Great Lakes bulk cargo carrier throughout the connecting channels system when the level of the ruling lake was its low water datum plane. It is also considered that 25.5 feet is the safe draft for the St. Lawrence Seaway. Varying allowances were made between depth and draft to accommodate

different conditions encountered in the connecting channels system. In general, allowances between depth and draft were as follows:

(1) Squat of ship when under way from 1.0 to 2.0 feet, with squat increasing with speed of ship and with thrust of propeller.

(2) Clearance between bottom of ship and bottom of channel:

- 0.5 foot in sheltered areas with soft bottom.
- 1.5 feet in sheltered areas with hard bottom, such as ledge rock or boulders.
- 1.5 feet in areas with soft bottom exposed to wave action.
- 2.5 feet in areas with hard bottom exposed to wave action.

The minimum allowance provided between depth and safe draft is 1.5 feet with maximum allowance of 4.5 feet.

c. The same allowances between depth and draft, as were used in the connecting channels, were used in developing the plans of improvement for the harbors in this report. Additional depth is provided in entrances and outer harbors as may be required, due to wave action in exposed areas, due to squat of ships under way, and due to presence of hard bottom. Depths provided for safe draft of 25.5 feet vary from 27 to 30 feet. For design safe drafts less than 25.5 feet, the same allowances are used between depth and draft as for 25.5-foot draft.

d. Based on engineering and economic studies, it was determined that improvements were justified at 30 harbors. It was also determined that construction of one new harbor was justified. Thirty-eight interim reports were submitted on 31 harbors, with two interim reports submitted on each of 7 harbors. Table 16 presents a brief statement of the plan of improvement included in the 38 interim reports, and the status as of 30 June 1966, of the work accomplished on each of the projects recommended at the 31 harbors. Table 17 presents similar information on improvements recommended in separate reports since 1956 at 7 harbors on the Great Lakes in response to separate Congressional authorizations. Details of plans of improvement for each project listed in Tables 16 and 17 will be found in the individual reports. The depths shown under Plans of Improvement in Tables 16 and 17 are the depths provided in the sheltered areas. Where depths of 27 and 28 feet are shown, the project will provide for a safe draft of 25.5 feet when the lake level is at its low water datum, which is the design safe draft for the connecting channels system.

Table 16 - Plans of Improvement Submitted in Interim Reports
And Status on 30 June 1966

Harbor	Plan of Improvement	House Document (1)	R&H Act (2)	Status 30 June 1966
<u>LAKE SUPERIOR</u>				
Two Harbors, Minn.	Deepen harbor to 28 feet to ore docks.	146/86/1	1960	Work is substantially complete Work stopped due to cessation of iron ore shipments.
Duluth-Superior, Minn. & Wis. (Interim Report No. 1)	Deepen channels to Duluth and Superior ore docks, including channels to overseas general cargo dock, and deepen Superior Front Channel to 27 feet.	150/86/1	1960	Work authorized in 150/86/1 was completed in November 1963.
(Interim Report No. 2)	Deepen channels in Allouez Bay, Howards Bay and North Channel, including 21st Avenue West, to 27 feet for grain, and deepen South, Upper and Minnesota Channels to 23 feet for coal, limestone, and iron and steel scrap.	196/86/1	1960	Work authorized in 196/86/1 was completed in October 1964, except for North Channel which is scheduled for completion in June 1967, and for 21st Avenue West Channel work which is deferred indefinitely for lack of local cooperation.
Ashland, Wis.	Deepen harbor for iron ore to 27 feet, and to Power Co.'s coal dock to 21 feet.	165/86/1	1960	Work completed in November 1962.
Presque Isle, Mich.	Deepen harbor to 28 feet for iron ore.	145/86/1	1960	Work completed in November 1963.
Marquette, Mich.	Deepen harbor to 27 feet for iron ore.	154/86/1	1960	Work has been delayed due to lack of local cooperation, but is now scheduled for accomplishment in 1966.

- (1) Document number/Congress/Session.
(2) River and Harbor Act authorizing project.

Table 16 - Plans of Improvement Submitted in Interim Reports
And Status on 30 June 1966 (continued)

Harbor	Plan of Improvement	House Document (1)	R&H Act (2)	Status 30 June 1966
<u>LAKE MICHIGAN</u>				
Green Bay, Wis.	Deepen channel through city of Green Bay to 24 feet for petroleum products, coal, cement, limestone and overseas general cargo.	470/87/2	1962	Work scheduled to start in 1966 and be completed in 1968.
Manitowoc, Wis.	Deepen harbor to 23 feet and 22 feet for limestone, coal, grain, sand and gravel, and overseas general cargo.	479/87/2	1962	Work not started.
Milwaukee, Wis.	Deepen south outer harbor and channel between piers to 28 feet, and inner harbor below first bridges to 27 feet for overseas general cargo, petroleum products, coal, limestone, grain, sand and gravel, and for iron and steel scrap.	134/87/1	1962	Work under way and scheduled for completion in 1966.
Kenosha, Wis.	Deepen harbor to 25 feet for overseas general cargo.	496/87/2	1962	Work completed in May 1965.
Chicago, Ill.	Deepen outer harbor to 28 feet for overseas general cargo.	485/87/2	1962	Work under way and scheduled for completion in 1966.
Calumet Harbor, Ill. & Ind. (Interim Report No. 1)	Deepen outer harbor and channel between piers to first bridge to 28 feet for iron ore and stone.	149/86/1	1960	Work authorized in 1960 Act is substantially complete. Remaining work, which requires removing small rock shoals, scheduled for completion in 1966.

- (1) Document number/Congress/Session.
(2) River and Harbor Act authorizing project.

(Continued on following sheet)

Table 16 - Plans of Improvement Submitted in Interim Reports
And Status on 30 June 1966 (continued)

Harbor	Plan of Improvement	House Document (1)	R&H Act (2)	Status 30 June 1966
<u>LAKE MICHIGAN</u> (continued)				
Calumet Harbor, Ill. & Ind. (Interim Report No. 2)	Deepen remaining harbor channel from below first bridge to inner end in Lake Calumet to 27 feet for iron ore, overseas general cargo, coal, grain and limestone.	581/87/2	1962	Work authorized in 1962 Act is under way and is scheduled for completion in 1966, except for minor widening and straightening at bends, which will be done when and as required.
Indiana Harbor, Ind. (Interim Report No. 1)	Deepen outer harbor to 28 feet, and channel between piers to first bridge to 27 feet for iron ore and stone.	195/86/1	1960	Work authorized in 1960 Act completed in August 1963.
(Interim Report No. 2)	Deepen Indiana Harbor canal for distance of 2,860 feet upstream of work authorized in 1960 to a depth of 25 feet for iron ore.	227/89/1	1965	Work authorized in 1965 Act scheduled for completion in 1967.
Burns Waterway, Ind.	Construct new harbor, including breakwaters and dredged basin inside of breakwaters with depth of 27 feet for iron ore, stone, coal, grain and overseas general cargo.	160/88/1	1965	State of Indiana plans on initiating construction in 1966. State plans on receiving contribution from United States as provided for in authorizing act.
Muskegon, Mich.	Deepen harbor to 27 feet for limestone, coal, cement, petroleum products and overseas general cargo.	474/87/2	1962	Work completed in May 1965.

- (1) Document number/Congress/Session.
(2) River and Harbor Act authorizing project.

Table 16 - Plans of Improvement Submitted in Interim Reports
And Status on 30 June 1966 (continued)

Harbor	Plan of Improvement	House Document (1)	R&H Act (2)	Status 30 June 1966
<u>LAKE HURON</u>				
Alpena, Mich.	Deepen harbor to 23 feet for coal.	151/88/1	1965	Work not started.
Saginaw, Mich.	Deepen river channel to 25 feet up to first bridge for coal, limestone, petroleum products, and overseas general cargo.	544/87/2	1962	Work scheduled to start in 1966 and to be completed in 1968.
<u>DETROIT RIVER</u>				
River Rouge, Mich.	Deepen lower portion of river to 25 feet for overseas general cargo, iron and steel scrap, and petroleum products.	509/87/2	1962	Work not started. Scheduled to be completed in 1967.
Trenton Channel, Mich.	Deepen channel from Detroit River down to McLouth Steel Company plant for iron ore and stone.	319/86/2	1960	Work completed in November 1963.
<u>LAKE ERIE</u>				
Toledo, Ohio	Deepen harbor to 27 feet and 28 feet for iron ore, grain and overseas general cargo.	153/86/1	1960	Work completed in October 1964.
Sandusky, Ohio	Deepen to 24 feet for coal.	144/86/1	1960	Work completed in September 1965.
Huron, Ohio	Deepen harbor to 27 feet and construct detached breakwater for iron ore, grain and coal.	165/87/1	1962	Work not started.

(1) Document number/Congress/Session.

(2) River and Harbor Act authorizing project.

Table 16 - Plans of Improvement Submitted in Interim Reports
And Status on 30 June 1966 (continued)

Harbor	Plan of Improvement	House Document (1)	R&H Act (2)	Status 30 June 1966
<u>LAKE ERIE</u> (continued)				
Lorain, Ohio	Deepen harbor to 27 feet, additional break-water construction and replacement of New York, Chicago and St. Louis R.R. swing bridge for iron ore and stone.	166/86/1	1960	Work is well advanced, except for replacement of railroad bridge which has not been started.
Cleveland, Ohio (Interim Report No. 1)	Deepen west outer harbor and west end of east outer harbor to 28 feet, Cuyahoga River to junction of Old River and lower part of Old River to 27 feet for iron ore, limestone and molding sand.	152/86/1	1960	Work completed in November 1962.
(Interim Report No. 2)	Extend deepening of east outer harbor to 27 feet, and approach channel to Nicholson Cleveland Terminal Co. to 25 feet for overseas general cargo and newsprint.	527/87/2	1962	Work completed in April 1965.
Fairport, Ohio	Deepen harbor to 27 feet for stone and coal.	347/86/2	1960	Work not started due to lack of local co-operation.
Ashtabula, Ohio (Interim Report No. 1)	Deepen channel to ore docks to 27 feet.	148/86/1	1960	Work completed in June 1963.
(Interim Report No. 2)	Deepen east outer harbor to 23 feet for stone and overseas general cargo.	269/89/1	1965	Work not started.

- (1) Document number/Congress/Session.
(2) River and Harbor Act authorizing project.

Table 16 - Plans of Improvement Submitted in Interim Reports
And Status on 30 June 1966 (continued)

Harbor	Plan of Improvement	House Document (1)	R&H Act (2)	Status 30 June 1966
<u>LAKE ERIE</u> (continued)				
Conneaut, Ohio	Extend east breakwater to shore and deepen harbor to 27 feet for iron ore and stone.	415/87/2	1962 ²	Work under way. Scheduled for completion in 1968.
Erie, Pa. (Interim Report No. 1)	Deepen to iron ore and stone docks to 27 feet.	199/86/1	1960	Work completed in July 1962.
(Interim Report No. 2)	Deepen channel to general cargo dock to 27 feet.	340/87/2	1962	Work scheduled for accomplishment in 1966.
Buffalo, N. Y. (Interim Report No. 1)	Deepen south outer harbor to 28 feet for iron ore, limestone and grain.	151/86/1	1960	Work completed in May 1964.
(Interim Report No. 2)	Deepen channel in outer harbor for overseas general cargo and stone.	451/87/2	1962	Work completed in October 1965.
<u>LAKE ONTARIO</u>				
Rochester, N. Y.	Deepen channel to general cargo dock to 23 feet, and to 21 feet for remainder of harbor for coal.	409/86/2	1960	Work completed in November 1963.
Great Sodus, N. Y.	Deepen harbor to 22 feet for coal.	138/87/1	1962	Work not started due to lack of local cooperation.
Oswego, N. Y.	Deepen channel to general cargo dock to 24 feet for overseas general cargo and aluminum.	471/87/2	1962	Work completed in November 1965.

(1) Document number/Congress/Session.

(2) River and Harbor Act authorizing project.

Table 17 - Plans of Improvement which have been Recommended Since 1956,
In Response to Congressional Authorizations, At 7 Harbors
In Reports Not Included in Great Lakes Harbors Report and
Status of Each on 30 June 1966

Harbor	Plan of Improvement	Congressional Document <u>1</u>	R&H Act <u>2</u>	Status 30 June 1966
Ontonagon Harbor, Mich. (Lake Superior)	Deepen inner harbor from 15 feet to 21 ft. (coal & petroleum products)	House 287-87-2	1962	Not funded
Kipling, Mich. (Lake Michigan)	Provide channel 24 ft. deep (petroleum products)	House 480-87-2	1962	Work Completed
Menominee Harbor, Mich. & Wis. (Lake Michigan)	Deepen channel from 21 feet to 24 feet (coal and limestone)	House 113-86-1	1960	Not funded
Kewaunee Harbor, Wis. (Lake Michigan)	Extend existing project channel in inner harbor at 20 ft depth (petroleum & steel products)	Senate 19-86-1	1960	Work Completed
Manistee Harbor, Mich. (Lake Michigan)	Deepen channel from 21 ft to 23 ft (coal and sand)	House 358-86-2	1960	Work Under way
Frankfort Harbor, Mich. (Lake Michigan)	Deepen channel from 18 feet to 22 feet (petroleum products)	Senate 16-89-1	1965	Not funded
Saginaw River, Mich. (Lake Huron)	Deepen Bay City Section from 22 ft to 25 ft, extending 25-ft depth upstream about 2 miles to NYC RR bridge (limestone and ship building terminal)	House 240-89-1	1965	Work Under way

NOTE: 1 Document number-congress-session.
2 River and Harbor Act authorizing project.

ECONOMIC ANALYSIS

14. SUMMARY OF COSTS AND BENEFITS

a. Table 18 presents for each of the 38 interim reports the data used for evaluating the plans of improvement.

b. In a few cases the estimates of prospective traffic shown in Table 18 do not include all traffic which will be benefited by the improvements recommended. At Duluth-Superior and Toledo Harbors the interim reports do not contain estimates of prospective overseas general cargo traffic as these reports were completed before such estimates were available from the overseas general cargo traffic analysis. Consequently, estimates of benefits were not made for this traffic. In many cases the prospective commerce for which benefits are estimated as shown in Table 18 is less than the prospective commerce presented in the section of this report on Prospective Commerce. In general the reasons for this are that part of the total prospective commerce will be handled in portions of harbors where further improvement is not justified at this time or part will be carried in smaller ships with maximum loaded drafts such that no increase in loading will result from the increased depths recommended. The final estimates of prospective grain commerce had not been developed in the Grain Traffic Analysis at the time interim reports were completed for Duluth-Superior, Calumet Harbor and River, and Toledo. The conservative estimates used in these reports were considerably lower than the final estimates which would result from prospective grain traffic developed in the Grain Traffic Analysis.

c. Evaluation of benefits in each of the 38 interim reports was on the basis of savings in water transportation costs. Alternate means of transportation were not used as water transportation costs are much lower under conditions obtaining both before and after the improvements. In many cases both shipping and receiving harbors were improved. Where indicated the savings in transportation costs were divided between the shipping and receiving harbors to preclude duplication of benefits. Total estimated Federal construction costs were \$154,399,000 and non-Federal costs were \$32,925,000 for a total of \$187,324,000 with annual charges, including increase in cost of maintenance of \$7,965,000. Average annual benefits were estimated at \$25,237,000 resulting in a composite benefit-cost ratio of about 3.2 for harbor improvements without considering the associated costs for improving the connecting channels.

d. In the report on improving the Great Lakes Connecting Channels published in Senate Document 71, 84th Congress, 1st Session authorized by Act of 21 March 1956 it was recognized that in order to realize the benefits from deepening the connecting channels it would be necessary to provide increased depths at shipping and receiving harbors. Studies made in the connecting channels study established that the costs of improvement of harbors to accommodate the prospective traffic used in that study would be fully justified by the savings in cost of transportation to such traffic. The connecting channels report considered only iron ore, limestone and grain. The Great Lakes Harbors study considered all traffic that would

require improvements to harbors in order to take advantage of the 27 foot controlling depths in the connecting channels and also in the St. Lawrence Seaway including the Welland Canal.

e. The improvement of the connecting channels to provide a controlling depth of 27 feet, as authorized in 1956, is now 93 percent complete, with a presently estimated cost of \$127,500,000. This presently estimated cost includes items of work authorized in 1946, with an estimated cost of \$10,982,000 at that time, and the construction of compensating works in the St. Clair River, with a presently estimated cost of \$6,400,000. The improvement of the connecting channels improvements was estimated to cost \$115,818,000 when authorized. Considering the additional work mentioned above, which is now included in the total presently estimated cost of \$127,500,000, it is evident that the actual cost of completing the connecting channels improvements will be substantially lower than estimated at time of authorization. The estimated annual charges for work included in the District Engineer's report on the connecting channels were \$4,466,700, which include annual charges for providing South East Bend cut-off channel in the St. Clair River in lieu of widening South East Bend. After the District Engineer's report was completed, and prior to the time the report was submitted to Congress, it was determined that an additional foot of depth should be provided in South Canal westerly approach to the Soo Locks, at an estimated first cost of \$1,300,000 with annual charges of \$48,100, making the total annual charges \$4,514,800 for the work authorized in 1956.

f. The annual charges for the combined connecting channels-Great Lakes Harbors projects, including \$7,965,230 for the harbor improvements and \$4,514,800 for the connecting channels improvements, are \$12,480,000. Total annual average benefits for improvements included in this harbors study are estimated at \$25,237,100. These benefits are required to justify the connecting channels improvements, as well as the harbor improvements. With total average annual benefits of \$25,237,100 and annual charges for the combined connecting channels-harbors improvements of \$12,480,000, the over-all benefit-cost ratio for the combined system is 2.0.

g. As indicated in subparagraph e. above, the current project for improving the connecting channels will be completed at a total cost which is substantially lower than the estimated cost on which annual charges are based. The harbor improvements covered by this report are now about 52 percent complete, with presently estimated total cost of \$131,200,000, which is much lower than the estimated cost of \$154,400,000 on which annual charges are based. The reduction in costs of both the connecting channels and harbor improvements will result in enhancing the benefit-cost ratio of 2.0 for the combined projects.

Table 18 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non-Federal \$	Total \$				
<u>LAKE SUPERIOR</u>							
Two Harbors, Minn	162,000	46,000	208,000	8,000	Iron Ore	543,000	68.0
Duluth-Superior, Minn & Wis (Interim Rpt No. 1)	2,364,000	172,500	2,536,500	91,800	Iron Ore Grain Limestone	1,650,000 51,000 74,000 <u>1,775,000</u>	19.3
(Interim Rpt No. 2)	2,513,000	556,000	3,069,000	115,000	Grain Limestone Coal Metals & Mfgs Iron-Steel Scrap Repair Savings at Shipyard	870,000 18,000 110,000 3,000 13,000 <u>60,000</u> <u>1,074,000</u>	9.3
Ashland, Wis.	1,495,000	207,500	1,702,500	65,400	Iron Ore Coal	103,800 65,000 <u>168,800</u>	2.6
Presque Isle, Mich	215,300	23,800	239,100	8,930	Iron Ore	230,800	25.8
Marquette, Mich	236,000	12,000	248,000	9,200	Iron Ore	23,700	2.6

Table 18 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non- Federal \$	Total \$				
<u>LAKE MICHIGAN</u>							
Green Bay, Wis.	4,270,000	215,000	4,485,000	191,000	General Cargo Petroleum Prod. Coal Cement Limestone	97,900 203,600 142,700 24,600 8,800 <u>477,600</u>	2.5
Manitowoc, Wis.	719,000	193,000	912,000	38,500	Limestone Coal Grain Sand & Gravel	47,400 5,100 10,600 500 <u>63,600</u>	1.7
Milwaukee, Wis.	4,029,000	627,000	4,656,000	191,000	General Cargo Petroleum Prod. Coal Limestone Grain Sand & Gravel Iron & Stl. Scrap	628,000 325,900 23,500 17,500 116,900 3,000 <u>14,800</u> 1,129,600	5.9
Kenosha, Wis.	672,000	-	673,000	30,200	General Cargo	47,300	1.6
Chicago, Ill.	1,505,000	-	1,505,000	69,000	General Cargo	423,000	6.1

Table 18 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non- Federal \$	Total \$				
<u>LAKE MICHIGAN (cont.)</u>							
Calumet Harbor, Ill & Ind (Interim Rpt No. 1)	5,240,000	5,000	5,245,000	192,400	Iron Ore Limestone	1,185,800 142,700 <u>1,328,500</u>	6.9
(Interim Rpt No. 2)	11,464,000	12,081,000	23,545,000	1,010,000	General Cargo Iron Ore Limestone Grain Coal	1,289,000 630,000 349,800 84,700 <u>39,100</u> <u>2,392,600</u>	2.4
Indiana Harbor, Ind. (Interim Rpt No. 1)	974,000	32,000	1,006,000	37,200	Iron Ore Limestone	821,700 190,400 <u>1,012,100</u>	27.0
(Interim Rpt No. 2)	96,000	197,000	293,000	11,400	Iron Ore	507,400	44.0
Burns Waterway, Ind.	25,000,000	-	25,000,000	1,073,000	General Cargo Grain Coal	110,000 91,000 409,000	1.5

For Burns Waterway Harbor, elimination of private harbor to serve Midwest Steel Co. for annual average of 5,800,000 tons of iron ore, 900,000 tons of limestone, 3,000,000 tons of coal, 200,000 tons of fuel oil and 100,000 tons of rolled steel bands, estimated benefits are..... 700,000
For reduction of delays to ships in private harbor, estimated benefits are..... 270,000
1,580,000

NOTE: In the report of the Chief of Engineers on Burns Waterway Harbor, as published in House Document No. 160, 88th Congress, 1st Session, a re-evaluation of the proposed project resulted in the conclusion that the benefit to cost ratio should be 1.65 instead of 1.5, as shown in the report of the District Engineer.

Table 18 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non-Federal \$	Total \$				
<u>LAKE MICHIGAN (cont.)</u>							
Muskegon, Mich.	609,000	450,000	1,059,000	48,000	General Cargo Limestone Coal Cement Petroleum Prod.	88,300 11,900 49,500 37,300 39,000 <u>226,000</u>	4.7
<u>LAKE HURON</u>							
Alpena, Mich.	806,000	33,000	839,000	33,400	Coal	41,100	1.4
Saginaw River, Mich.	4,780,000	85,000	4,865,000	218,300	General Cargo Coal Limestone Petroleum Prod. Benzol Grain Savings in ship time	19,500 47,400 113,000 44,500 45,700 28,600 <u>19,100</u> <u>294,800</u>	1.3
<u>DETROIT RIVER</u>							
Rouge River, Mich.	257,000	1,240,000	1,497,000	77,600	General Cargo Iron & Steel Scrap Non-Metallic Min. Petroleum Prod.	80,400 58,800 9,500 8,600 <u>157,300</u>	2.0

Table 18 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non- Federal \$	Total \$				
<u>DETROIT RIVER</u>							
Trenton Channel, Mich.	8,570,000	1,780,000	10,350,000	401,000	Iron Ore Limestone 4,870,000 3,180,000	1,411,000 361,000 1,772,000	4.4
<u>LAKE ERIE</u>							
Toledo, Ohio	14,684,000	1,320,000	16,004,000	601,100	Iron Ore Grain 5,750,000 800,000	628,000 40,000 668,000	1.1
Sandusky, Ohio	5,800,000	428,000	6,228,000	263,900	Coal Reduction in Damages to ships 15,000,000 -	956,500 50,000 1,006,500	3.8
Huron, Ohio	8,557,000	1,080,000	9,637,000	421,800	Iron Ore Coal Grain Reduction in Delays in shipping 2,654,000 1,200,000 26,000 -	420,000 16,000 7,000 6,000 149,000	1.1
Lorain, Ohio	19,323,000	2,455,000	21,778,000	881,300	Iron Ore Limestone Reduction in Ship & Dock Delays and Ship Damages 7,267,000 1,680,000 -	937,000 141,600 148,100 1,226,700	1.4

Table 13 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non- Federal \$	Total \$				
<u>LAKE ERIE (cont.)</u>							
Cleveland, Ohio (Interim Rpt No. 1)	2,486,000	2,869,500	5,355,500	272,300	Iron Ore Molding Sand 12,410,000 250,000	1,231,100 4,600 <u>1,235,700</u>	4.5
(Interim Rpt No. 2)	888,000	182,000	1,070,000	67,000	General Cargo Newsprint 750,000 173,000	252,000 236,000 <u>488,000</u>	7.3
Fairport, Ohio	2,768,000	3,312,000	6,080,000	282,000	Limestone Coal 2,319,000 2,200,000	698,600 49,000 <u>747,600</u>	2.6
Ashtabula, Ohio (Interim Rpt No. 1)	4,077,000	980,000	5,057,000	210,400	Iron Ore 9,950,800	877,900	4.2
(Interim Rpt No. 2)	1,840,000	-	1,840,000	81,400	General Cargo Limestone Overseas Bulk Cargo (Rutile, Zircon and Manganese) 120,000 413,000 265,000	43,700 38,400 <u>43,800</u> <u>125,900</u>	1.5

Table 13 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits,
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefitted By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non- Federal \$	Total \$				
LAKE ERIE (cont.)							
Conneaut, Ohio	6,060,000	180,000	6,240,000	279,300	Iron Ore Limestone Reduction in Ship Damages Reduction in Ship Delays	1,260,000 53,000 26,000 <u>1,367,000</u>	4.9
Erie, Pa. (Interim Rpt No. 1)	1,729,000	-	1,729,000	95,000	Iron Ore Limestone	34,000 27,000 <u>111,000</u>	1.3
(Interim Rpt No. 2)	671,000	-	671,000	26,000	General Cargo	58,000	2.2
Buffalo, N. Y. (Interim Rpt No. 1)	2,352,000	1,248,000	3,600,000	180,000	Iron Ore Limestone Grain	538,000 161,400 25,100 <u>724,700</u>	4.0
(Interim Rpt No. 2)	2,797,000	300,000	3,097,000	132,600	General Cargo Limestone	193,100 18,000 <u>211,100</u>	1.6

Table 18 - Estimates of Costs, Annual Charges, Prospective Commerce and Benefits
And Comparison of Benefits and Costs as Presented in Interim Reports (cont.)

Harbor	Construction Costs			Annual Charges \$	50-Year Prospective Average Annual Commerce Benefited By Improvements Recommended (tons)	Annual Benefits \$	Benefit Cost Ratio
	Federal \$	Non-Federal \$	Total \$				
<u>LAKE ONTARIO</u>							
Rochester, N. Y.	2,445,000	300,300	2,745,300	147,000	General Cargo Coal Cement Newsprint	19,500 294,000 31,000 29,500 <u>374,000</u>	2.5
Great Lakes Bay, N. Y.	765,000	314,000	1,079,000	61,000	Coal	198,000	3.2
Oswego, N. Y.	1,180,000	-	1,180,000	48,700	General Cargo Aluminum	41,500 58,300 <u>99,800</u>	2.0
TOTALS	<u>154,399,300</u>	<u>32,924,600</u>	<u>187,323,900</u>	<u>7,965,230</u>		<u>25,237,100</u>	

DISCUSSION AND RECOMMENDATION

15. DISCUSSION

a. The Great Lakes navigation system includes two major elements, the harbors and the through channels between the lakes, including the Welland Canal. Full utilization of the system also requires a deep-draft channel from Lake Ontario to the sea, via the St. Lawrence Seaway. In 1956, improvement of the connecting channels from Lake Erie to the three upper lakes, Huron, Michigan and Superior, was authorized to increase the controlling depth in downbound channels from 24.8 feet to 27 feet, and in upbound channels from 21 feet to 27 feet. An increase in controlling depth from 25 feet to 27 feet was being provided in the Welland Canal between Lakes Erie and Ontario at the same time. Between Lake Ontario and Montreal, and the St. Lawrence Seaway was being constructed to provide modern ship locks and provide a 27-foot controlling depth to replace the small locks and canals with limiting depths of 14 feet. From Montreal to the sea, a 35-foot ship channel was available. Depths of 27 feet have been available in the Welland Canal and St. Lawrence Seaway since 1952, and in the connecting channels above Lake Erie since June 1962.

b. Maximum controlling depth in Great Lakes harbors was 25 feet when this study was authorized, with many harbors with lesser depths. Deepening of harbors was necessary in order to take advantage of increased depths in the through channels. Consideration was given to all commercial harbors to determine the increased depths and other improvements which could be justified at this time to accommodate the traffic which would take advantage of the 27-foot depths in the through channels. Comprehensive traffic analyses were made of the five major commodities which would be carried in ships that could take advantage of these channel depths. Such traffic analyses were made for iron ore, coal, limestone, grain and overseas general cargo. Traffic studies for other commodities were made as required for individual harbors. Coordination with all interests was effected through public hearings and contacts with navigation interests, industry, port authorities and other local interests, and with other interested Federal agencies. Full consideration was given to the views of all concerned.

c. Improvements were determined to be justified at 31 harbors. These improvements were recommended in 38 interim reports, all of which have been authorized and construction of improvements is about 52 percent completed. The composite benefit-cost ratio for all improvements recommended in the interim reports is 3.2. Excess benefits over costs for harbor improvements are required to justify the current improvements to the connecting channels. Consequently, a combined benefits-cost ratio was developed for the connecting channels-harbors system using total costs for both, and using benefits developed for only the harbors. The benefit-cost ratio of combined connecting channels-harbors system improvements is 2.0.

d. In view of the general nature of the benefits to be realized, all costs for channel dredging and improvements to harbor structures

or construction of new structures, and the cost of aids to navigation will be borne by the United States. Lands, easements and rights-of-way, dredging outside of Federal channels, including deepening along docks, reconstruction and strengthening of docks as may be required, and alteration of utilities is being accomplished by local interests. Local interests have been very active in a major program of improving existing dock facilities and constructing new docks to handle the large increase anticipated in overseas general cargo. Most of the facilities required were constructed so as to be available when the harbors were deepened to accommodate this traffic. Local interests are also required to provide assurances that they will hold and save the United States free from claims for damages due to the construction and maintenance of the improvements.

e. There are several outstanding Congressional authorizations for studies of Great Lakes harbors. The results of these studies will be submitted in separate reports. Additional information on recommended and alternative project modifications called for by Senate Resolution 148, 85th Congress is contained in attachments to each of the 38 interim reports.

16. CONCLUSION

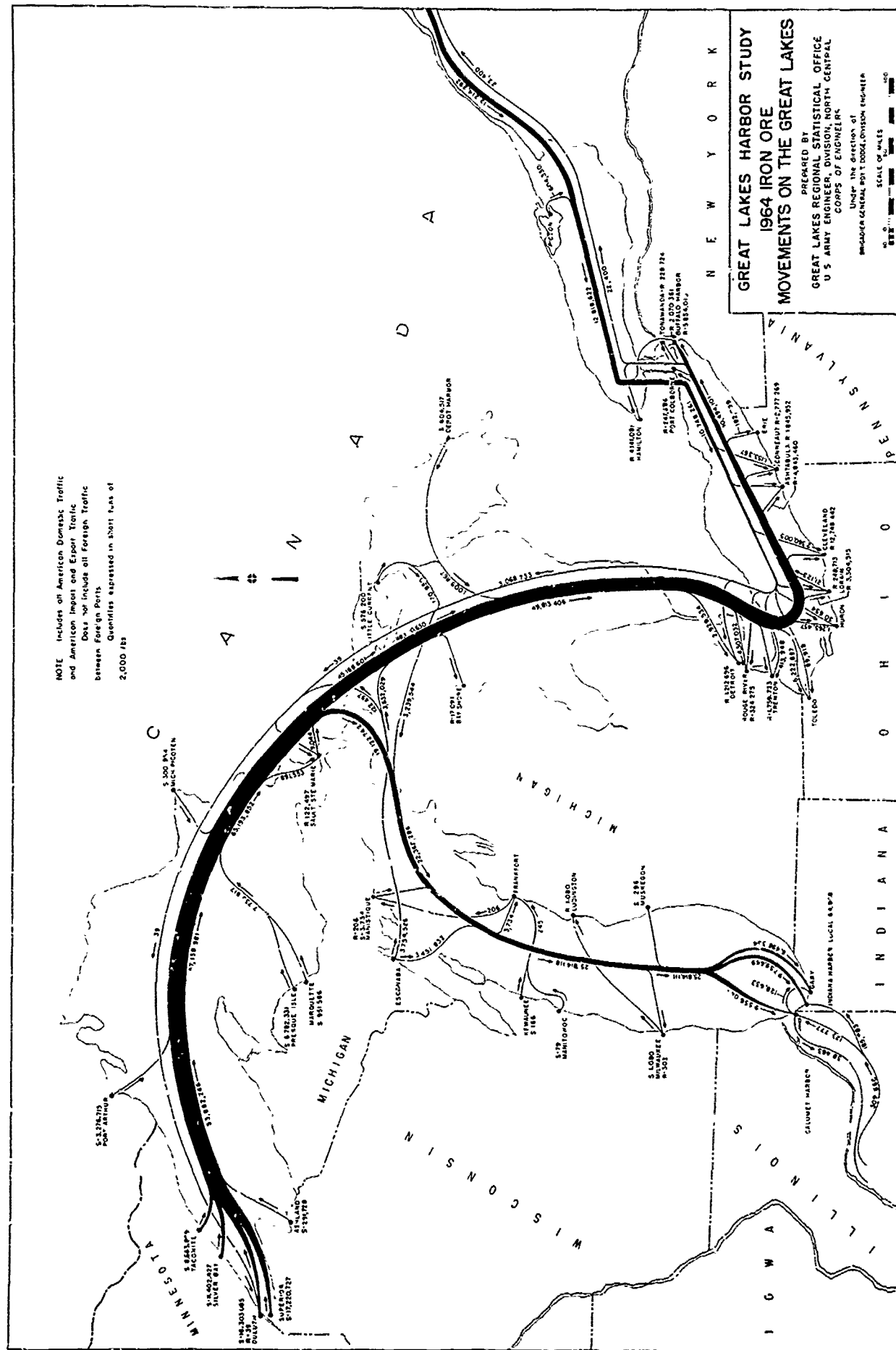
It is concluded that the harbor improvements recommended in the interim reports and the Great Lakes Connecting Channels project authorized in 1956 are justified by a wide margin of benefits over costs as a combined system. It is further concluded that the harbor improvements recommended will permit full utilization of the St. Lawrence Seaway.

17. RECOMMENDATION

It is recommended that this final summary report be accepted as completing the survey investigations in response to the authorizations for the Great Lakes Harbors Study. Because of the public interest in this study and its value to the local authorities, it is further recommended that this report, with its accompanying plates, be published.

ROY T. DODGE
Brigadier General, USA
Division Engineer

NOTE Includes all American Domestic Traffic
and American Import and Export Traffic.
Data not include all Foreign Traffic
between Foreign Ports
Quantities expressed in short tons of
2,000 lbs



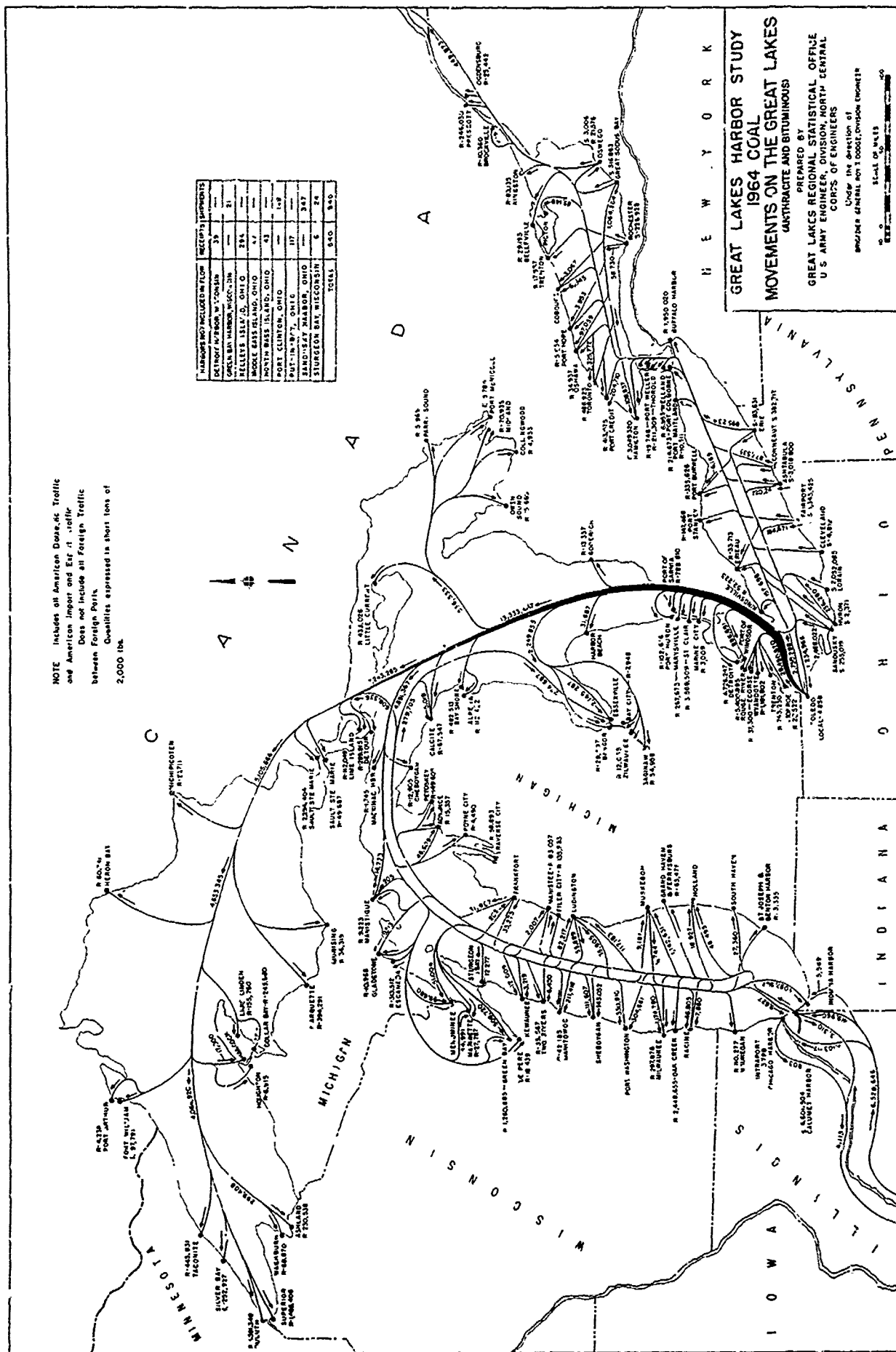
GREAT LAKES HARBOR STUDY 1964 IRON ORE MOVEMENTS ON THE GREAT LAKES

PREPARED BY
GREAT LAKES REGIONAL STATISTICAL OFFICE
U S ARMY ENGINEER, DIVISION, NORTH CENTRAL
CORPS OF ENGINEERS
Under the direction of
BRIGADIER GENERAL ED T DODGE, DIVISION ENGINEER

SCALE OF MILES
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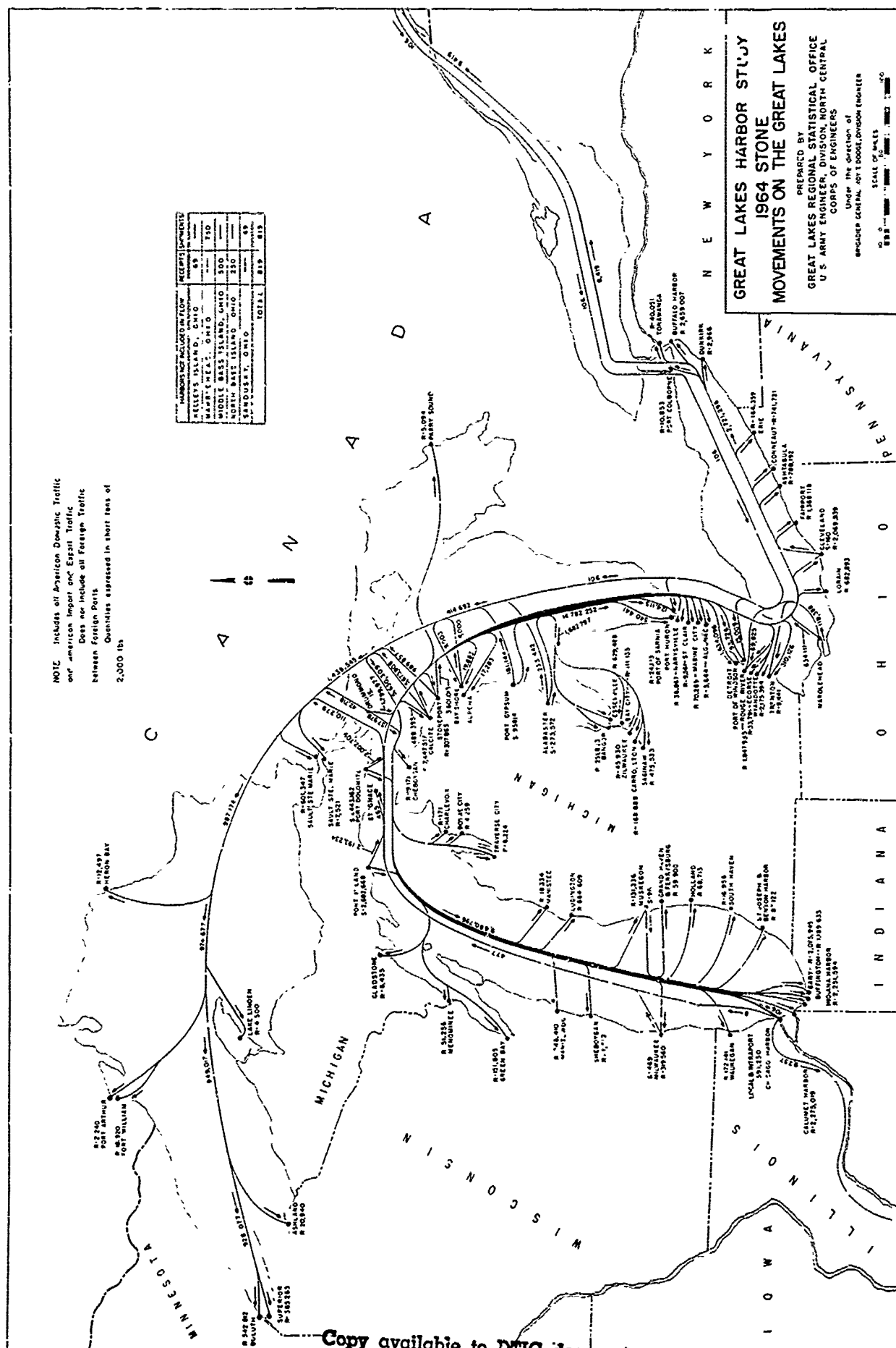
NOTE Includes all American Domestic Traffic
and American Import and Export Traffic
Does not include all foreign Traffic
between Foreign Ports
Quantities expressed in short tons of
2,000 lbs.

HARBORS NOT INCLUDED IN FIG.	RECEIPTS (SHORT TONS)
DETROIT W/PORT W/ONIA	39
GREEN BAY W/ONIA	21
SELLEYS ISLAND, OHIO	294
MOORE BASIN, OHIO	47
NORTH BASIN, OHIO	43
PORT CLINTON, OHIO	148
PUT-IN-BAY, OHIO	17
SANDUSKY HARBOR, OHIO	347
STURGEON BAY, WISCONSIN	6
TOTAL	840

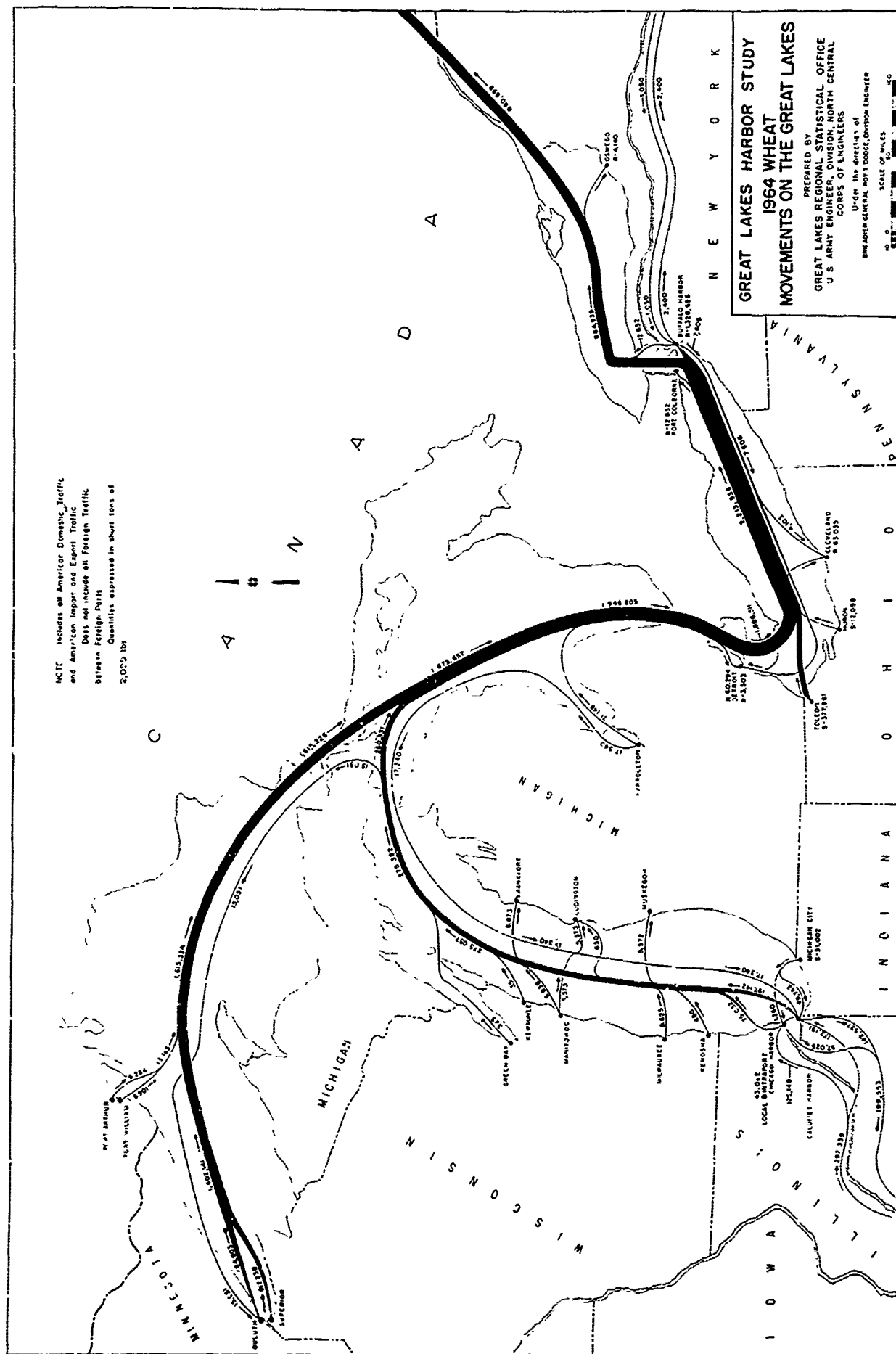


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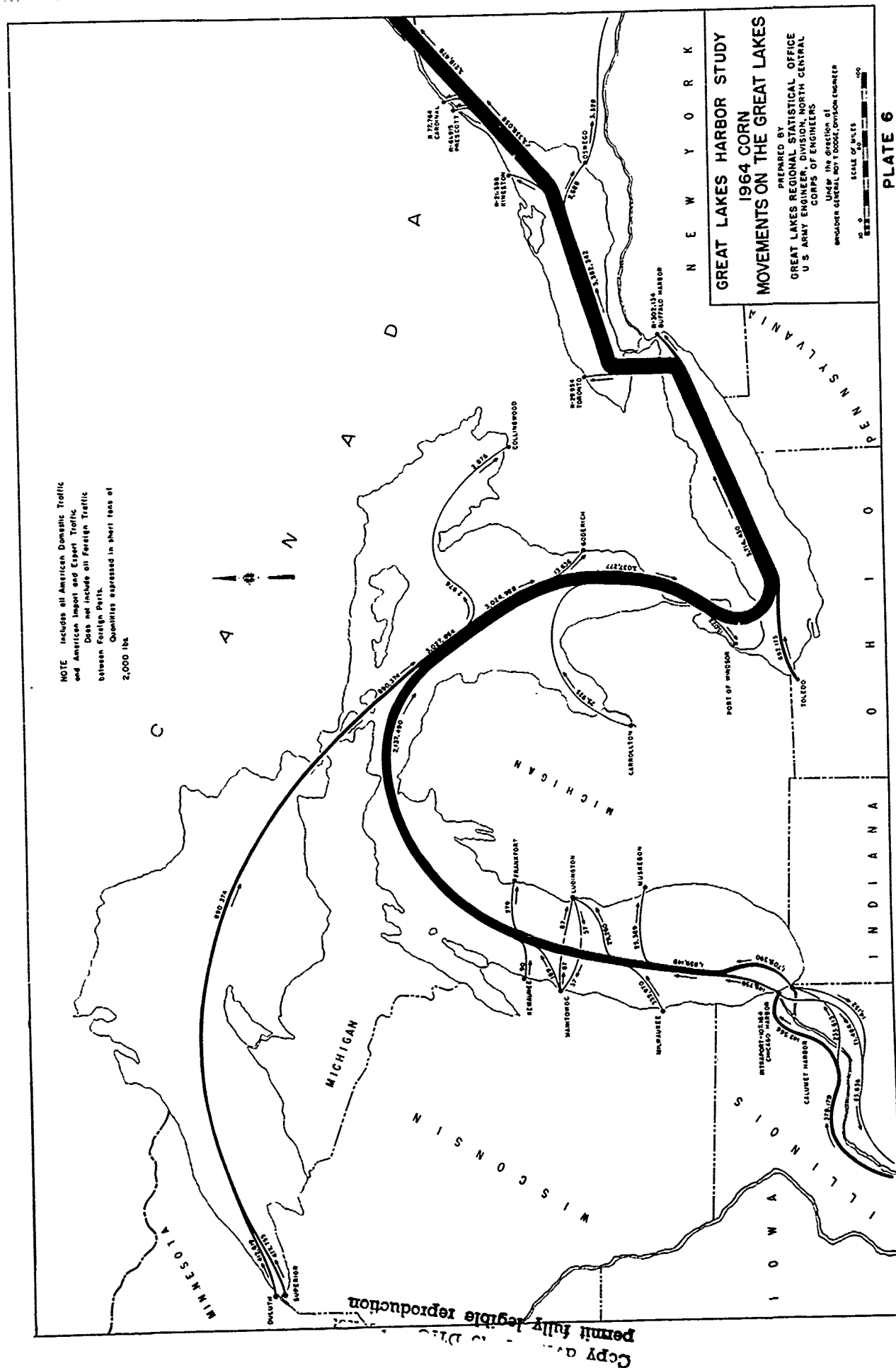
HANDS NOT INCLUDED IN FLOW		RECEIPTS (HANDS)	
NAME	DATE	DATE	NUMBER
HELLEY'S ISLAND, OHIO	10-1-78	10-1-78	69
MAHON'S ISLAND, OHIO	10-1-78	10-1-78	150
MIDDLE BASS ISLAND, OHIO	10-1-78	10-1-78	300
NORTH BASS ISLAND, OHIO	10-1-78	10-1-78	250
SANDUSKY, OHIO	10-1-78	10-1-78	69
TOTAL			818



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NOTE: Includes all American Domestic Traffic
and American Import and Export Traffic.
Does not include all Foreign Traffic
between Foreign Ports.
Quantities expressed in short tons of
2,000 lbs.



GREAT LAKES HARBOR STUDY 1964 CORN MOVEMENTS ON THE GREAT LAKES

PREPARED BY
GREAT LAKES REGIONAL STATISTICAL OFFICE
U.S. ARMY ENGINEER, DIVISION, NORTH CENTRAL
CORPS OF ENGINEERS
Under the direction of
BRIGADIER GENERAL ROY T. DOOLE, DIVISION ENGINEER

SCALE OF MILES
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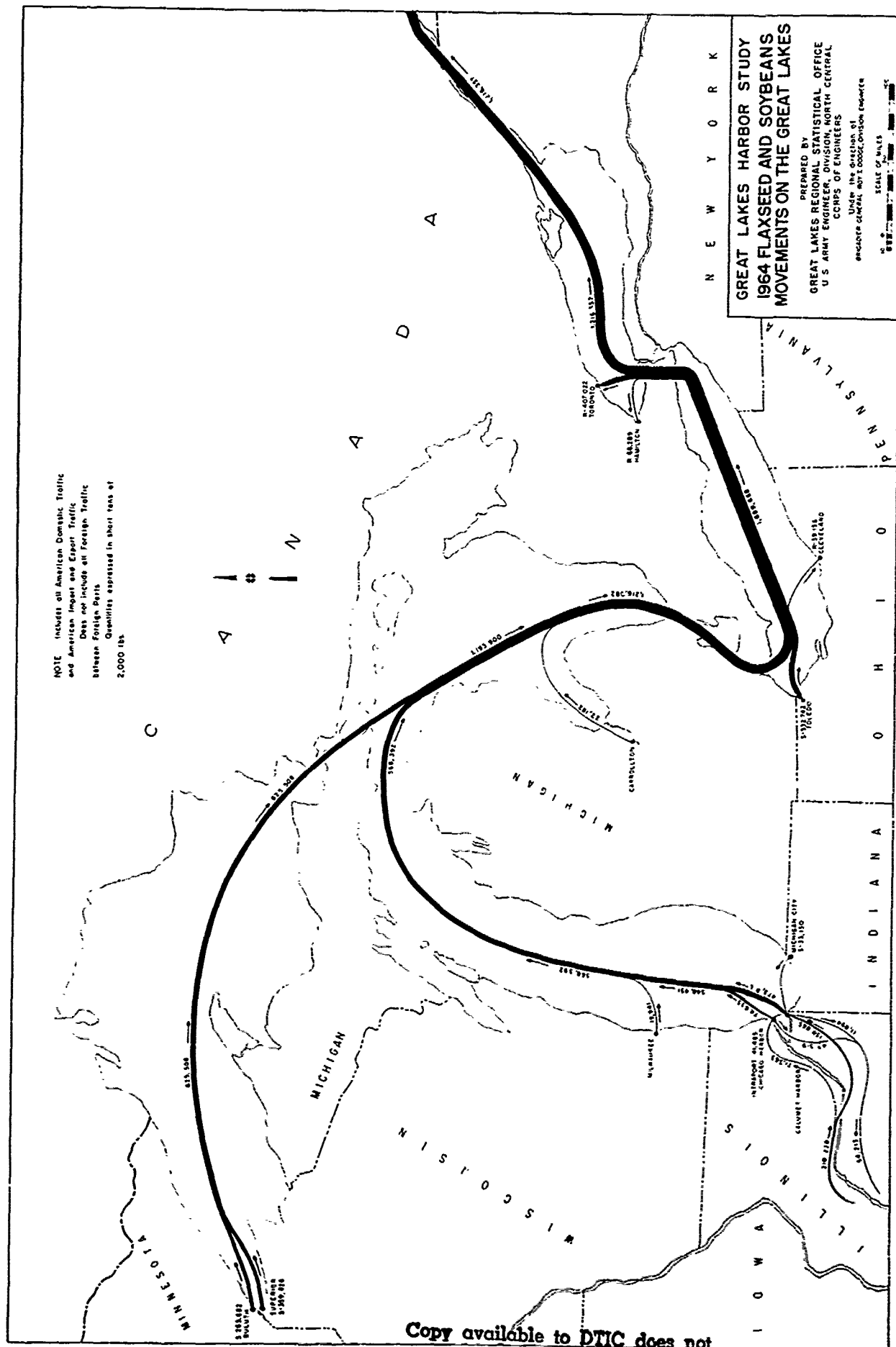
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CORPS OF ENGINEERS
Under the direction of
ENGINEER GENERAL ROY T. COOPER, DIVISION ENGINEER

SCALE OF 1000S

PLATE 7

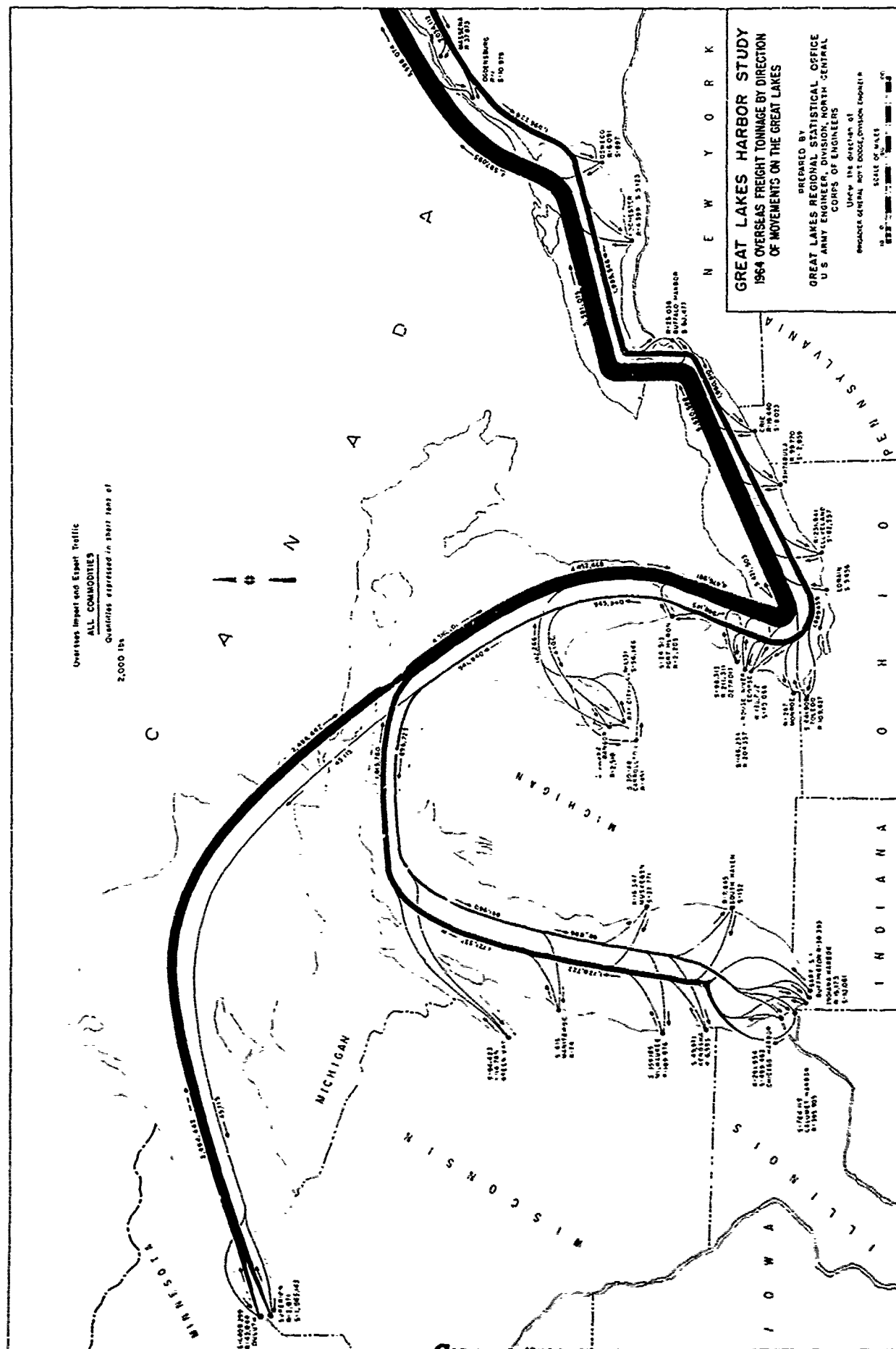
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NOTE: Includes all American Domestic Traffic
and American Import and Export Traffic.
Does not include all Foreign Traffic
between Foreign Ports.
Quantities expressed in short tons of
2,000 lbs.

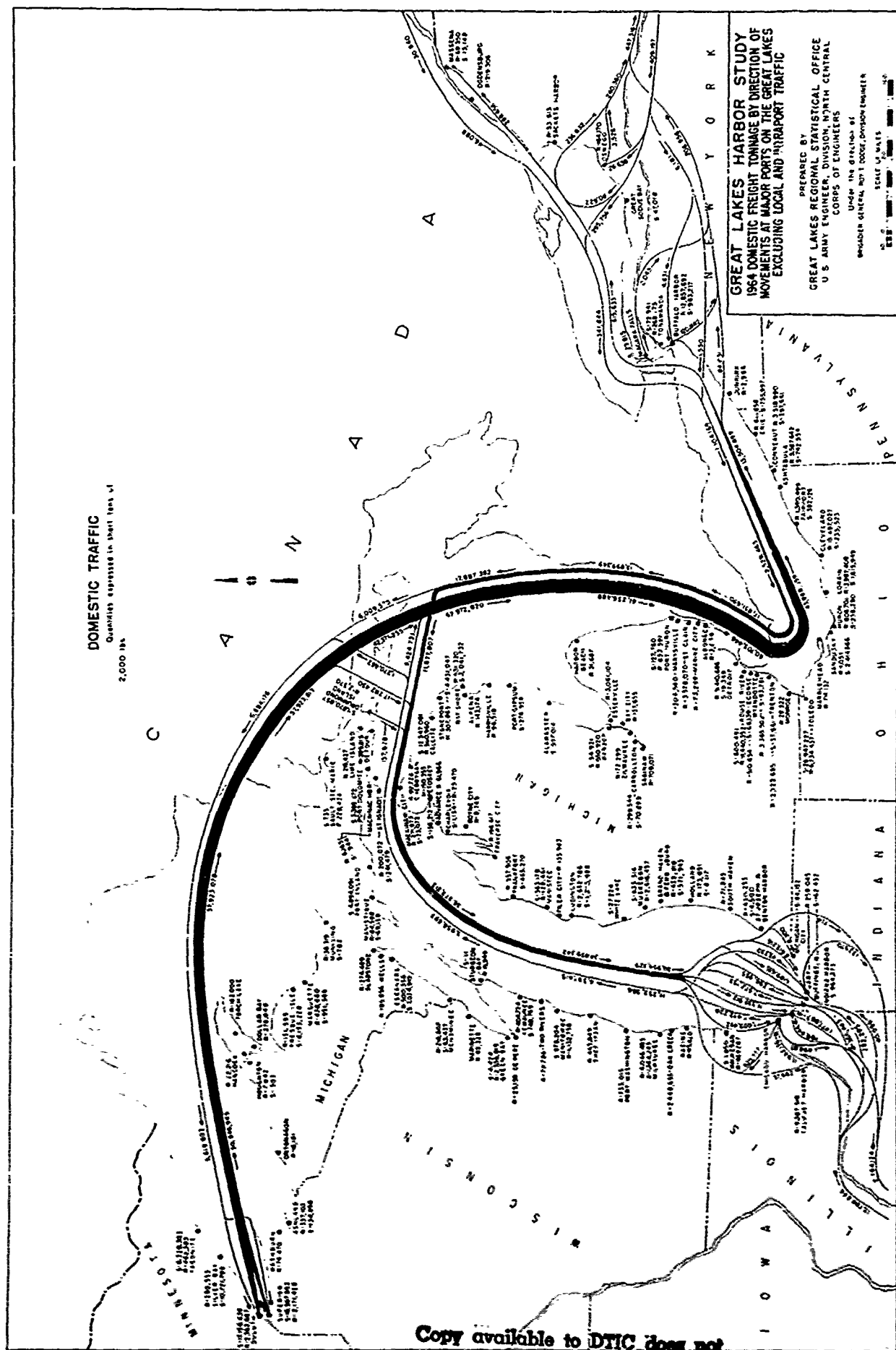


GREAT LAKES HARBOR STUDY
1964 FLAXSEED AND SOYBEANS
MOVEMENTS ON THE GREAT LAKES

PREPARED BY
GREAT LAKES REGIONAL STATISTICAL OFFICE
U S ARMY ENGINEER, DIVISION, NORTH CENTRAL
CORPS OF ENGINEERS
Under the direction of
Executive General, 401 0000, Division Engineer
SCALE OF MILES
0 10 20 30 40 50

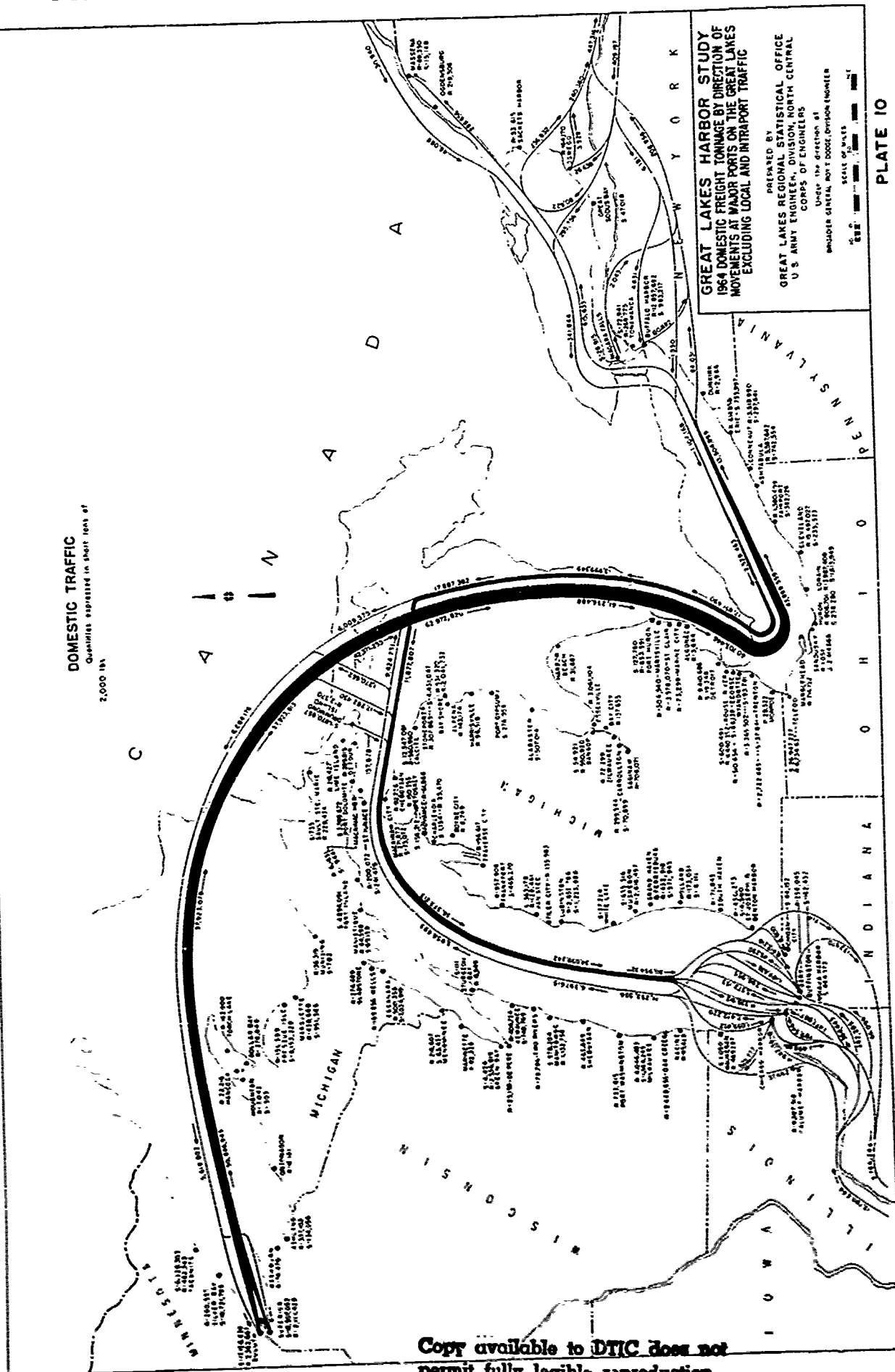


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DOMESTIC TRAFFIC
Quantities expressed in short tons of
2,000 lbs.



GREAT LAKES HARBOR STUDY
1964 DOMESTIC FREIGHT TONNAGE BY DIRECTION OF
MOVEMENTS AT MAJOR PORTS ON THE GREAT LAKES
EXCLUDING LOCAL AND INTRAPORT TRAFFIC

PREPARED BY
GREAT LAKES REGIONAL STATISTICAL OFFICE
U.S. ARMY ENGINEER, DIVISION, NORTH CENTRAL
CORPS OF ENGINEERS

Under the direction of
MAJOR GENERAL ROY T. DODGE, Division Engineer

SCALE OF MAPS
1:50,000

PLATE 10

CORPS OF ENGINEERS

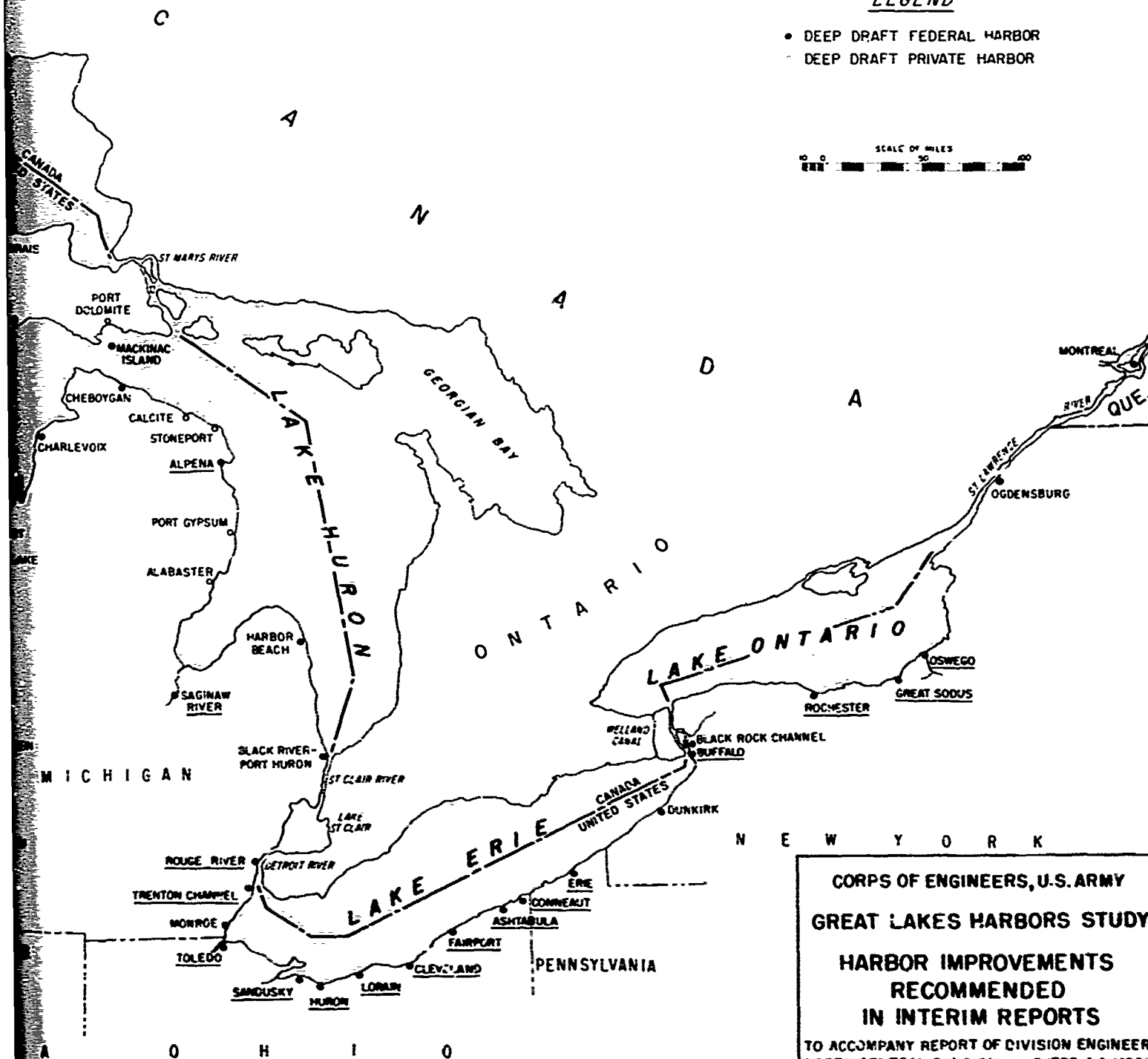


Note: Harbors with improvements recommended in interim reports to Great Lakes Harbors study are underlined.

LEGEND

- DEEP DRAFT FEDERAL HARBOR
- DEEP DRAFT PRIVATE HARBOR

SCALE OF MILES
0 10 20 30 40 50 60 70 80 90 100



CORPS OF ENGINEERS, U.S. ARMY
GREAT LAKES HARBORS STUDY
HARBOR IMPROVEMENTS
RECOMMENDED
IN INTERIM REPORTS

TO ACCOMPANY REPORT OF DIVISION ENGINEER,
NORTH CENTRAL DIVISION DATED NOV. 1966