RECONNAISSANCE REPORT **JUNE 2002**

GREAT LAKES NAVIGATION SYSTEM REVIEW

APPENDIX A- ECONOMIC ANALYSIS

Great Lakes - St. Lawrence River System

US Army Corps of Engineers®
Great Lakes & Ohio River Division

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SECTION 1. INTRODUCTION

1. PURPOSE AND SCOPE

The purpose of the Economics Appendix is to describe and evaluate, at a reconnaissance level, the existing Great Lakes/St. Lawrence Seaway System (GL/SLS) and an array of alternative future conditions. The formulation of alternative future conditions is the result of the entire study team's work, and this appendix focuses on the economic aspects of each alternative future, whether without-project condition or with-project condition alternative futures. More specifically, benefits accruing to investments both in the Great Lakes connecting channels and harbors and in the Seaway channels are estimated and presented in this study. In both instances, Lakes and Seaway, possible channel improvements include, but are not limited to, alternative maintenance regimes, channel dredging/deepening, and lock improvements. The evaluation of future conditions will rely on both traditional benefit-costs analysis to estimate national economic development (NED) benefits and input-output analysis to estimate other economic development benefits. Both analytical methods will be used to indicate whether there is a federal interest in making capital investments in the GL/SLS.[1]

This waterway system presents the analyst with a number of unique challenges owing to its international character and its two distinct sub-regions or sub-systems, namely the Great Lakes Navigation System (GLNS) and the St. Lawrence Seaway. With regard to its international character, there are two waterborne transportation data bases—one Canadian (maintained by TAF Consultants for Transport Canada) and one American (maintained by the U.S. Army Corps of Engineers' Waterborne Commerce Statistics Center). Two lock-based data collection systems are also in-place. One covers the Seaway and is jointly administered by the Canadian St. Lawrence Management Corporation (SLSMC) and the American Saint Lawrence Seaway Development Corporation (SLSDC), the other covers the Soo Locks administered by the U.S. Army Corps of Engineers, Detroit District. Detailed movement-level information, most importantly vessel, vessel cost, commodity and tonnage data, between foreign origin and foreign destination points is not uniformly available. Economic evaluations presented in this report necessarily deal with the strengths and weaknesses of a geographically comprehensive data set that is uneven with regard to level of detail.

The implications of not having vessel-specific, movement-level foreign data are most acute on the Seaway. Traffic here is dominated by foreign traffic (especially Canada-to-Canada movements).[2] Additionally, lock reliability and maintenance data are largely in the domain of Canada, which operates 13 of the 15 Seaway locks. While not required in the reconnaissance phase, it is important to note that a complete evaluation of Seaway

[1] The GL/SLS is part of the larger Great Lakes/St. Lawrence River waterway, which includes the deep-water lower reaches of the St. Lawrence River between Montreal and the Gulf of St. Lawrence.
[2] In this report, foreign traffic includes any movement with an origin or destination that is located outside of the United States.

improvement benefits is not possible without this kind of information. Also, the ability to apply navigation system modeling is limited by the absence of critical data.

The two sub-systems' marine trade patterns are unique, as well. The U.S. fleet operates, for the most part, on the upper lakes. Dedicated, one-way moves of coal, iron ore, and stone dominate the trade. Stone flows from Lake Huron terminals to the basin's major cities, iron ore from the Mesabi and Marquette ranges to lake-basin steel mills, and coal from Wyoming's Powder River Basin to Lake Superior terminals for final carriage by lake vessel to electric utility plants. Relatively small, Class V vessels (600' – 649' in length), Class VIII vessels (731' – 849' in length) and the large Class X vessels (950' – 1,099' in length) are the backbone of the U.S. fleet that handles this trade. Canada's trade is more intricate, involving the shuttling of grain from Lake Superior to Quebec grain elevators in Class VII, Seaway compatible boats (vessels 700' - 730' in length). The now empty boats continue down the St. Lawrence to nearby terminals where iron ore is loaded for eventual delivery to steel plants back upstream on lakes Ontario and Erie. The U.S. trade depends on economies of scale, while the Canadian trade depends upon balanced flows in offering competitive transportation services. Both the Canadian and American trade is indicative of the geographic sweep of this study, stretching from the Great Plains of North America, through the lakes basin, down the St. Lawrence River, and out to the Atlantic Ocean.

2. BACKGROUND

This reconnaissance-level study is set against a backdrop of continuing growth in world trade, growth in inter-continental trade, increasing stress on ports and inland transportation systems, and stagnating Lake and Seaway trade. Floating intercontinental bridges created by massive investments in huge ships, standardized cargoes, deeper ports, and land side handling infrastructure have allowed manufacturing to disperse globally, further fueling global trade and ocean traffic growth. This dispersion in manufacturing has adversely affected the heavy manufacturing base of the Great Lakes basin and the waterway traffic that supported it, as have international trade practices, particularly as these apply to steel. Agricultural trade and transportation policies in North America and Europe have hurt grain trade on the GL/SLS.

Transportation planners and industry alike look to addressing both immediate and longer term needs and opportunities. In the U.S., the U.S. Army Corps of Engineers' Detroit District is completing a limited re-evaluation report of a 1985 study that recommends replacing two of the older lock chambers at Soo Locks with a new 110' x 1200' Poe-sized lock chamber. The district is also preparing this reconnaissance report for the GL/SLS. Outside the Corps, American transportation experts expect the U.S. Marine Transportation System, a system that handles 20 percent of global oceanborne trade, to grow at an average annual rate of 3.3 percent through 2020.[3] They see a possible role for waterways like the GL/SLS in alleviating future port and inland transportation system congestion. In Canada, the 1998 Marine Act privatized the St. Lawrence Seaway and

[3] *Economic Growth and the U.S. Marine Transportation System*, sponsored by the Marine Transportation System National Advisory Council, c/o U.S. Department of Transportation, Maritime Administration.

reorganized the governance and operation of the port system in order to make both more cost effective and ultimately more competitive. Companion to this legislative effort are standing government and industry forums that actively look to addressing the needs of current users and securing a healthy future for the GL/SLS and the St. Lawrence River as a gateway for international commerce into North America.[4]

3. DEFINITION OF TERMS

All references to tons in this report refer to short tons, unless specifically stated otherwise.

An array of names and definitions are applied to the various waterway segments in the Great Lakes-St. Lawrence River Basin. Some waterway designations overlap others. What follows are the definitions that will be used in this study to describe the navigable waterways in the basin. These are based on most common usage in government reports and industry publications.

Great Lakes/St. Lawrence Waterway (GL/SLW) – navigable waterways from the Gulf of St. Lawrence to the Head-of-the-Lakes.

Great Lakes/St. Lawrence Seaway (GL/SLS) – navigable waterways from Montreal west to the Head-of-the-Lakes. GL/SLS includes the St. Lawrence Seaway and the Great Lakes Navigation System.

Great Lakes Navigation System (GLNS) – all five of the Great Lakes and the Great Lakes connecting channels.

Great Lakes Connecting Channels (GLCC) – navigable connecting channels between the Great Lakes: the St. Marys River, the Straits of Mackinac, the St. Clair/Detroit River system and the Welland Canal. This does not include shallow draft channels that connect with the lakes.

St. Lawrence River – navigable straight between Lake Ontario and the Gulf of St. Lawrence. It has two distinct reaches – the canalized, 26’3” draft Montreal-Lake Ontario (MLO) section of the Seaway and the minimum 35’ draft reach from Montreal to the Gulf.[5] This later stretch of river is referred to in this report as the lower St. Lawrence River.

St. Lawrence Seaway – the waters of the St. Lawrence River above Montreal, Lake Ontario, the Welland Canal, and Lake Erie as far west as Long Point. It includes the

[4] Refer to “The Great Lakes-St. Lawrence Waterway, A 20/20 Vision for the Future,” sponsored by the Canadian Shipowners Association, Chamber of Maritime Commerce, and the St. Lawrence Seaway Management Corporation in collaboration with the St. Lawrence Economic Development Council, the St. Lawrence Ship operators Association and the Shipping Federation of Canada. The Waterways Strategic Forum is chaired by the SLSMC and vice chaired by the SLSDC.
[5] The 26’3” draft presently allowed in the Seaway is not available all of the time because of variable water levels.

Welland Canal and the Montreal-Lake Ontario section. Data displays in this appendix conform to SLSMC and SLSDC Seaway statistical presentations, which do not include intra-Lake Ontario waterway traffic.

Welland Canal Section – eight lock canal linking lakes Erie and Ontario. This section of the St. Lawrence Seaway is the only all Canadian Great Lakes connecting channel.

Montreal-Lake Ontario (MLO) Section – seven-lock canalized section of the St. Lawrence Seaway lying entirely within the St. Lawrence River and extending from the St. Lambert Lock to Lake Ontario beyond the Iroquois Lock.

4. REPORT ORGANIZATION

The Lakes and the Seaway are discussed separately and as part of the encompassing GL/SLS throughout the report. Section 2 generally describes the geographic area of concern, the governments that share responsibility for the system, the system's commerce and how it developed. Section 3 describes the key waterway features of the GL/SLS, including channels, locks and harbors. Historic and projected traffic are presented in Section 4 for both the entire Great Lakes/St. Lawrence Waterway and for its component pieces: the Great Lakes, the Seaway (both the Welland Canal and the Montreal-Lake Ontario section) and the deep water reaches of the St. Lawrence River between Montreal and the Gulf of St. Lawrence. Section 5 describes the existing fleet and future fleets under alternative Seaway configurations. Benefit categories and estimating procedures are discussed in Section 6. Problems and needs, a set of alternatives for addressing the problems and needs, and a preliminary screening of alternatives are presented in Section 7. Section 8 evaluates these alternatives with the economic information developed during the course of this study. Attachments to this appendix provide more detailed documentation supporting analyses referred to in the body of the appendix.

SECTION 2. STUDY AREA

1. GENERAL

It is important to note the distinction in terms as applied to the navigable waters that stretch between the Head-of-the-Lakes at Duluth and Thunder Bay on Lake Superior to the Gulf of St. Lawrence. The definitions used in this report attempt to conform to standard usage, recognizing that multiple names for the same groupings of lakes, channels, and rivers are used in practice, trade publications, and general literature on the subject. The designation Great Lakes, or Lakes, pertains to the five major lakes: lakes Superior, Huron, Michigan, Erie and Ontario. The smaller Lake St. Clair is considered part of the St. Clair-Detroit River System connecting channel. The St. Lawrence River links Lake Ontario with the Gulf of St. Lawrence. The upper 190 miles are part of the St. Lawrence Seaway. This section is referred to as the Montreal-Lake Ontario (MLO) section of the Seaway. The lower 340 miles of deep water between Montreal and the Gulf will be referred to as the lower River. Lakes Erie and Ontario are linked by the Welland Canal section of the Seaway. The St. Lawrence Seaway in total includes the waters of the St. Lawrence River above Montreal, Lake Ontario, the Welland Canal, and Lake Erie as far West as Long Point. The Great Lakes/St. Lawrence Seaway navigation system comprises the Lakes and the Seaway, while the more encompassing Great Lakes/St. Lawrence Waterway comprises the Lakes and the entire St. Lawrence River.

The two Canadian provinces and eight U.S. states that border the Great Lakes/St. Lawrence Waterway (**Figure 2-1**) are home to "…nearly one-third of the combined population of Canada and the U.S…."[1] These states (Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania and New York) contain one-fourth of U.S. industrial facilities, and the two Canadian provinces (Quebec and Ontario) contain two-thirds of Canada's industry. Canadian sources estimate that this waterway "…contributes upwards of $6 billion annually and more than 65,000 direct jobs to both the Canadian and U.S. economies…" in handling over 296 million tons of traffic each year.[2] An American study sponsored by the United States' SLSDC estimated that nearly 44,000 direct U.S. jobs were associated with the Great Lakes/St. Lawrence Seaway (GL/SLS).[3] The subsections that follow briefly discuss the commerce on the GL/SLS, the development of navigation, the geography of the region, and its governments as they relate to the GL/SLS.

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[1] Refer to *The Present and Future of the St. Lawrence-Great Lakes Waterway: What are the Issues?* prepared by Jean-Claude Lasserve for Transport Canada, August 1997.

[2] Refer to *The Great Lakes-St. Lawrence Waterway, A 20/20 Vision for the Future*, sponsored by the Canadian Shipowners Association, the Chamber of Maritime Commerce, and the St. Lawrence Management Corporation and published in 2000.

[3] The study is the *Economic Impact Study of the Great Lakes-St. Lawrence Seaway System* prepared by Martin Associates and released in August 2001. This study estimated a total of 150,000 direct, indirect, and induced jobs are linked to the GL/SLS.

FIGURE 2-1
Great Lakes/St. Lawrence Waterway Navigation System

2. OVERVIEW OF COMMERCE ON THE GL/SLS SYSTEM

a. The Lakes Trade. The principal commodities transported on the Great Lakes are iron ore, coal, limestone and grain. Iron ore is primarily mined at the head of the Lakes in the Arrowhead region of northeastern Minnesota referred to as the Mesabi Iron Range and in the Marquette Iron Range in Michigan's Upper Peninsula. Lesser but substantial amounts of iron ore are mined in eastern Canada in the vicinity of the Quebec-Labrador boundary. Steel companies on lakes Michigan, Erie and Ontario are the predominate shippers of iron ore. Coal is principally mined in two regions – the Appalachian region of the eastern U.S. and the Powder River Basin of Wyoming and Montana in the Western U.S. Coal produced in Appalachia is railed to harbors on Lake Erie for shipment to electric utilities with plants on the lakes in both Canada and the U.S. Limestone, or stone, is principally mined in the northern part of Michigan's Lower Peninsula and the eastern tip of Michigan's Upper Peninsula and is used in iron ore processing plants to make iron pellets and in construction activities. Grain (especially wheat, but including corn, soybeans and other grains and oilseeds) is produced extensively across the American Midwest and on the Great Plains of the U.S. and Canada. Though it's not a major commodity on the Great Lakes, potash is produced in the prairie province of Saskatchewan. Steel products also move in relatively smaller quantities, often brought-in by ocean-going vessels commonly referred to as salties.

b. The Seaway Trade. The St. Lawrence Seaway bulk trade is strongly linked to the Great Lakes commodity trade. Grains, predominately from the Canadian plains, are moved in Seaway-size boats from Lake Superior to terminals along the St. Lawrence

River for eventual shipment to overseas ports. These same boats make return trips up the St. Lawrence into Lakes Ontario and Erie with iron ore mined in Labrador and Quebec. Grain is also carried directly from Lake Superior to foreign ports by the sea-going salties compatible with the dimensions of the Seaway's locks. The salties often enter the system carrying foreign-produced commodities like steel.

3. HISTORY OF DEVELOPMENT

a. The Great Lakes. Commercial navigation on the Great Lakes was first reported in 1678 when La Salle built a small, 10-ton sailing vessel to transport supplies from what is now Kingston, Ontario to a site on the Niagara River. The cargo was a load of grain obtained by trade with Seneca Indians.[4] In 1679, La Salle built a larger ship, the Griffon, with which he sailed the full length of Lake Huron, through the Straits of Mackinac and down Lake Michigan to Green Bay.

The first wave of major commercial navigation upon the lakes began with the opening of the Northwest Territory in 1787. By the early 1800s, about two-dozen communities had been established along the shores of lakes Ontario and Erie, and on the St. Lawrence River. Grain and furs were the basic commodities transported out of the region. In 1797, the first of a series of locks that eventually culminated in the Soo Locks was constructed on the Canadian side of the St. Marys River, the connection between Lakes Superior and Huron. This made the entire upper Great Lakes navigable to canoes and bateaux of the fur trade.

The opening of the Erie Canal in 1825, connecting the Hudson River with Lake Erie, initiated the second stage of commercial navigation on the lakes. The canal's four foot depth and 40 foot width enabled mule drawn canal boats to transport as much as 30 tons of freight. The opening of the Erie Canal initiated the commercial grain trade on the lakes. With much less expensive water transportation across New York State, it was possible for grain grown as far west as Illinois to be efficiently transported to eastern markets. Chicago, with its proximity to the fertile, productive soils of the tall-grass prairie of central Illinois, became the leading grain shipping port on the lakes. Buffalo became the major grain receiving port and eventually the world's largest grain milling center.

Until the opening of the first Welland Canal across the Niagara Peninsula of southern Ontario in 1829, commercial navigation across the lakes was restricted to the Great Lakes Basin. With the exception of the Erie Canal, there was no access to the Atlantic Ocean because of the presence of Niagara Falls on the Niagara River and a series of falls and rapids on the St. Lawrence River. Once the Welland Canal opened, boats originating on the Great Lakes could proceed into Lake Ontario and then into the St. Lawrence River. By 1850, a nine-foot channel had been established from the Atlantic Ocean to Lake

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[4] Much of this discussion is taken from *An Overview of the Commercial Navigation Industry of the United States on the Great Lakes*, prepared by the Buffalo District, U.S. Army Corps of Engineers for the Institute for Water Resources, U.S. Army Corps of Engineers, IWR Report 92-R-6, June 1992.

Ontario. By that date the second Welland Canal had been completed (in 1844) and all but Lake Superior was accessible to commercial navigation by ships.

Construction of a canal to bypass the falls on the St. Marys River between Lakes Huron and Superior had to await the need for commercial access to Lake Superior. That need developed with the discovery in 1844 and subsequent development of substantial iron ore deposits in the Upper Peninsula of Michigan. By 1855, a canal had been built to bypass the St. Marys Falls, and Lake Superior became accessible to commercial navigation. A nine-foot channel was available from the Atlantic Ocean to the "Head of the Lakes" (western end of Lake Superior).

Water did not have a monopoly on transportation in the Great Lakes Basin for very long. By the 1840s railroads had become relatively efficient and they began to expand into the Great Lakes Basin. This initiated a period of railroad expansion that was to extend the railroad network across the basin. The port at Rochester, N.Y., on Lake Ontario was connected to the Hudson River at Albany, N.Y. in 1841. Toledo, Ohio, on Lake Erie was connected to the Ohio River in 1848. Chicago was connected eastward in 1852 and to the west by 1854.

The Canadian cities of Montreal and Toronto were connected by rail in 1856. Construction of the Canadian Pacific Railway (the first transcontinental railway in Canada) began at Port Arthur (Thunder Bay, Ontario) in 1884 and proceeded westward. The establishment of that rail line opened the Canadian Prairie and began the movement of grain by rail from the prairies to Port Arthur for shipment down the lakes.

By 1905, largely as a result of Canadian investment in canals, a 14-foot channel was available from the Atlantic Ocean into Lake Superior. This marked the reemergence of water transportation across the lakes and brought to an end the dominance of rail transportation established a half-century earlier. Now, relatively large (for the time) freighters could move bulk commodities across the basin cheaper than could rail.

Probably the most important single construction project affecting commercial navigation on the Great Lakes was the construction of the new Welland Canal in 1932. Its design was farsighted in that it was designed to pass boats larger than existed on the Great Lakes at that time. It was not until the completion of the St. Lawrence portion of the Seaway in 1959, more than a quarter century after completion of the new Welland Canal, in which boats as long as 730 feet, as broad as 75 feet, drafting as much as 25 feet, began to appear on the lakes. These Seaway-size boats are capable of carrying 25,000 tons or more of cargo per trip.

b. The St. Lawrence Seaway. The St. Lawrence River, the great strait connecting the Great Lakes with the Atlantic Ocean, is an integral part of the Canadian identity. Canada grew from its banks. Following Jacques Cartier's 16th Century voyages of discovery, Sieur Samuel de Champlain de Brouge established a tenuous foothold for France at Quebec City in 1608. The indefatigable Champlain set upon explorations intended to secure the future of his little colony. These explorations took him up the St.

Lawrence to the mouth of the Ottawa River, up the Ottawa to the vicinity of Lake Nipissing and then down the French River to Lake Huron's Georgian Bay in 1615.[5] In becoming the first European to record sighting of the Great Lakes, Champlain opened a pathway that was to be followed by explorers searching for a path to China, fur-traders exploiting the wealth of the interior, and Jesuit priests seeking to convert the aboriginal people of the area.

Rapids, most notably the Lachine, Soulanges, and Long Sault, and the falls over the Niagara escarpment blocked a direct navigable path from Montreal up the St. Lawrence and into the Great Lakes. It was the Ottawa River that carried furs from the North American wilderness to Montreal's deepwater and ocean going sailing vessels destined for Europe. Champlain's path became a rival route to the Great Lakes, the grandest scheme being the proposed Georgian Bay Ship Canal. This alternative Seaway was considered as recently as 1912 before being dropped in favor of continued navigation improvement to the St. Lawrence route, which promised to link Canada's major population centers along the Lakes and St. Lawrence River.

Efforts at canalization on the St. Lawrence began with circumvention of rapids in the Soulanges section linking Lakes St. Louis and St. Francis immediately upstream of Montreal. Four small canals were opened in 1781. Measuring 6 to 7 feet wide and 2'6" deep, they accommodated the small bateaux used at this time. The potential of the much larger steamboat was demonstrated by John Molson, who launched the *Accommodation* in 1809 and established regular steamboat service between Montreal and Quebec City. From this time on, efforts were directed at extending the navigable reach of the St. Lawrence, enlarging existing projects and completing a navigable link between the Atlantic Ocean and the Great Lakes.

The rapids just upstream of Montreal at Lachine were solved with a six-lock canal in 1825. Niagara Falls and the rapids at Long Sault remained barriers between the Lakes and the Atlantic Ocean. Rail assisted portage around Niagara Falls offered a land bridge between Lakes Erie and Ontario until the mid-1800s. William H. Merritt, spurred by the coming competition of the Erie Canal, built the first of four Welland Canals that were to by-pass Niagara Falls. His system of forty 100'x22'x7' locks was opened in 1829, providing the first all water transportation link between Lakes Erie and Ontario. This series of timber locks was replaced in 1845 with 27 masonry structures that were compatible with the dimensions of the six 200'x45'x9'locks of the new Cornwall Canal. The Cornwall Canal opened in 1843 and skirted the Long Sault rapids. The final piece in connecting the Atlantic and the Great Lakes fell into place with the completion of the Williamsburg, Rapide Plat, and Iroquois-Galop Canals in the 1847 to 1851 time period.

In 1871, a Canadian commission recommended development of a 14' channel. The Lachine, Cornwall and Welland Canals and the smaller Williamsburg, Rapide Plat, and Iroquois-Galop were all rebuilt to larger dimensions, generally 270'x45'x14', while the

[5] Much of this historical discussion is taken from The Seaway, Robert F. Leggett, Clarke, Irwin & Co. Ltd., Toronto, 1979 and from "The Montreal/Lake Ontario Section of the Seaway," The St. Lawrence Seaway Management Corporation, March 2000.

Soulanges canal was replaced with a new Beauharnois Canal of similar dimensions. This 14' system was completed in 1904 and, with the exception of the Welland Canal, remained in service until 1959. The Welland Canal underwent a fourth upgrade, completed in 1931, which reduced the number of locks from 26 to 8 (one being a guard lock) and increased lock chamber dimensions to 859'x80'x30'. These new Welland Canal lock sizes anticipated developments that were to occur twenty years later.

Up until this point in time, much of the navigation development along the St. Lawrence and Niagara rivers had been driven by Canada's need to compete with commercial interests in the United States, securing these shipping lanes by hugging the northern shore of the St. Lawrence River. Eighteenth and nineteenth century political rivalries and twentieth century commercial rivalries were eventually overwhelmed by the extraordinary hydroelectric and navigation potential of the Niagara and St. Lawrence Rivers. The next generation of improvements would be made possible through unprecedented international cooperation.

The U.S. and Canada appointed a Deep Waterways Commission in 1895, which reported in favor of a deep-water route on the St. Lawrence. This 1897 report was followed by a series of engineering studies and creation of the International Joint Commission (IJC). The 1909 treaty that created the IJC gave the commission authority to study power and navigation issues on the St. Lawrence and to address all other boundary water questions. A larger, deeper transportation corridor between the Lakes and the Atlantic, a Seaway, with hydroelectric stations to harness the power of the Lakes was envisioned by proponents. However, sovereignty issues in the United States and Canada, and the opposition of rail and other private interests, proved insurmountable through the first half of the Twentieth Century. Despite the hydroelectric power potential and the wartime demand for power, a 1941 treaty agreement by the U.S. and Canada to develop navigation and power was never signed.

The tremendous hydroelectric potential of the Long Sault coupled with the explosive post-war growth in electric power demands, and the decision to mine Labrador iron ore deposits made development difficult to resist. In 1951, the Canadian Parliament approved the *St. Lawrence Seaway Authority Act* and the *International Rapids Power Development Act,* demonstrating the Canadian government's determination to develop navigation on its own and jointly develop electric power with a U.S. power generating entity. The U.S. government responded by agreeing to build two of the necessary seven locks with enactment of the *Wiley-Dondero Act*.

Construction of the Seaway began in 1954. The St. Lawrence Seaway Authority of Canada and the Saint Lawrence Seaway Development Corporation (U.S.) were responsible for the development of navigation facilities, while the Hydroelectric Power Commission of Ontario and the Power Authority of the State of New York jointly developed the hydroelectric power works. Navigation costs were shared proportionally and power development costs jointly between the two nations, with the total cost for the project being $1 billion. Hydroelectric work culminated with the damming of the St. Lawrence at the Long Sault and the construction of powerhouses at Cornwall, Ontario and Massena, New York. The entire project includes two control structures, the Iroquois and Long Sault Dams and the Robert Moses-Robert H. Saunders Power Dam. The Moses-Saunders Dam has 32 turbine-generators divided equally by the international border and operated separately by Ontario Hydro and the New York Power Authority. The Canadian portion of the project is called the Robert H. Saunders Power Dam and the U.S. portion is called the St. Lawrence-Franklin D. Roosevelt Power Project.

The Wiley-Dondero Ship Channel and its two locks, the Eisenhower and Snell lock, by-pass the Moses-Saunders Dam. These two locks were part of the massive navigation works resulting in the construction of seven 800'x80'x30' locks on the St. Lawrence to complement the 8 locks on the Welland. By 1959, the Great Lakes were linked to the Atlantic Ocean with a 26' draft channel. With the exception of the completion of the Welland by-pass channel in 1973, the St. Lawrence Seaway has remained largely unchanged over the last 42 years.

4. GEOGRAPHY

a. General. The Great Lakes/St. Lawrence River Basin (GLSLB) consists of 427,000 square miles, extending east-west from a point about 50 miles west of Lake Superior to Quebec City, Province of Quebec, Canada.[6] Its north-south extent reaches from Lake Nipigon in the province of Ontario, Canada to about the center of the State of Ohio. It comprises two subset regions – the Great Lakes Basin (see **Figure 2-2**) and the St. Lawrence River Basin. The Great Lakes Basin proper contains 297,000 square miles, while the St. Lawrence River Basin contains the remaining 130,000 square miles. The Great Lakes Basin is defined to include an area that extends upstream to the point of origin (headwaters) of all streams and rivers flowing into the Great Lakes. The St. Lawrence River Basin is similarly defined to include that area that extends upstream to the point of origin (headwaters) of all streams and rivers flowing into the St. Lawrence River and the Gulf of St. Lawrence. The boundary between the two units is set at the Thousand Islands. Water flows generally from west to east as elevation descends from 600' at Lake Superior to 243' at Lake Ontario (see **Figure 2-3**). From Lake Ontario down the St. Lawrence the flow is generally east and north. Each of the lakes, the channels that connect them, and the St. Lawrence River are discussed below.

b. The Great Lakes Basin. About one-third of the total surface area of the Great Lakes Basin (94,250 square miles) consists of water in the five Great Lakes – Superior, Michigan, Huron, Erie and Ontario – and the much smaller Lake St. Clair. Not to be excluded are connecting channels that physically link the lakes. It's estimated that the Great Lakes Basin contains 5,439 cubic miles of fresh water, making it the largest depository of freshwater in the world.

[6] See IWR Report 92-R-6

FIGURE 2-2
Great Lakes Basin

1.) Lakes. The five Great Lakes differ significantly from each other in physical characteristics. In reviewing the brief description of the physical character of each of the lakes presented below, it is useful to refer to **Table 2-1** and to **Figure 2-3**. The latter provides a schematic profile of the five lakes; it is particularly important in understanding the differences in elevation of the lakes.

Lake Superior is the largest of the Great Lakes. Its surface area (31,700 square miles), volume of water (2,900 cubic miles), and retention time (191 years) is greater than that of any other Great Lake. Lake Superior is the deepest of the lakes with an average depth of 483 feet. It is also the lake at the highest elevation – 600 feet above sea level. Lake Superior empties into Lake Huron via the St. Marys River, which drops 23 feet between the two lakes. Natural rapids and falls on the river necessitated the constructions of locks at Sault St. Marie, which permit commercial navigation between Lake Superior and Lake Huron.

FIGURE 2-3
Great Lakes/St. Lawrence River Profile

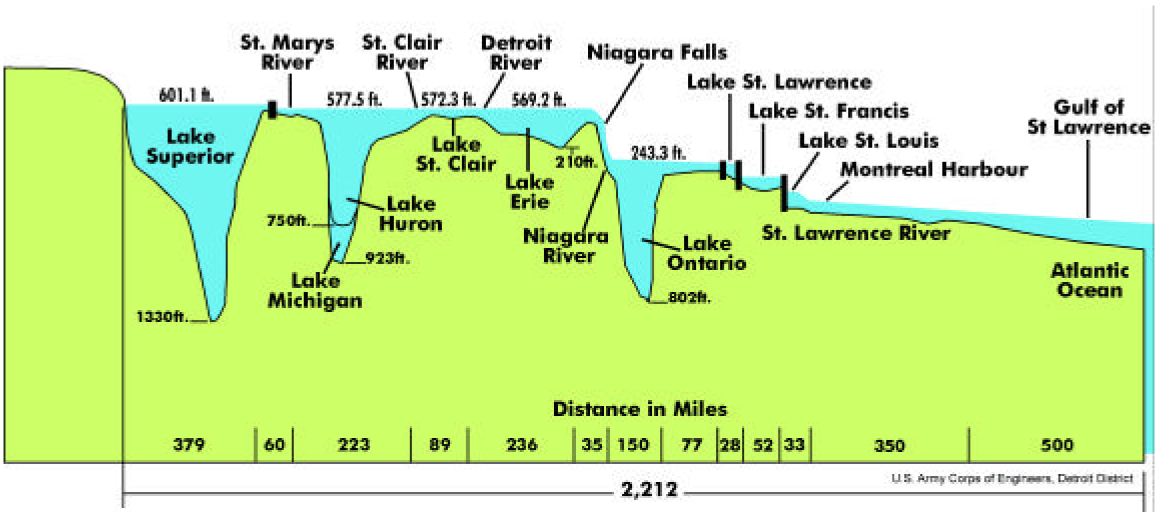


TABLE 2-1
Physical Features of the Great Lakes

	Superior	Michigan	Huron	Erie	Ontario
Elevation (ft.)	600	577	577	569	243
Length (miles)	350	307	206	241	193
Breadth (miles)	160	118	183	57	53
Average Depth (ft.)	483	279	195	62	283
Maximum Depth (ft.)	1,330	923	750	210	802
Volume (cu. Miles)	2,900	1,180	850	116	393
Water Area (mi^2)	31,700	22,300	23,000	9,910	7,340
Total Drainage Area (mi^2)	49,300	45,600	51,700	30,140	24,720
Retention Time[1] (years)	191	99	22	2.6	6

(1) Retention time is a measure based on the volume of water in the lake and the mean rate of outflow.

Source: The Great Lakes: An Environmental Atlas and Resource Book, Ottawa, Canada & Washington, D.C.: Environment Canada and United States Environmental Protection Agency, 1987.

Lakes Huron and Michigan are at the same elevation – 577 feet and for purposes of commercial navigation may be considered as one entity. Though they have approximately the same water surface area, 22,300 square miles for Lake Michigan and 23,000 square miles for Lake Huron; the average depth of the former is 279 feet versus 195 feet for the latter. Thus Lake Michigan has a larger volume of water (1,180 cubic miles) than does Lake Huron (850 cubic miles). The connection between the two, which being at the same elevation is unrestricted, is via the Straits of Mackinac. The connection between Lake Huron at 577 feet and Lake Erie at 569 feet is via the St. Clair River –Lake St. Clair – Detroit River connecting channel.

Lake Erie is significantly smaller than Lakes Superior, Huron and Michigan though it is somewhat larger than Lake Ontario; its water surface area encompasses 9,910 square miles. It is the shallowest of the five lakes; its average depth is only 62 feet. The combination of relatively modest size and shallow depth limits its retention capacity; its water volume amounts to 116 cubic miles, about four percent of the total capacity of Lake Superior. Its average elevation of 569 feet is only eight feet below that of Lake Huron but it is 326 feet above Lake Ontario. The Niagara River, which flows over the Niagara Escarpment at Niagara Falls, N.Y. and Ontario, is the natural outlet for Lake Erie into Lake Ontario.

Lake Ontario is the smallest of the lakes; its surface area is 7,340 square miles. Lake Ontario is much deeper than Lake Erie. The average depth of Lake Ontario is 283 feet whereas the average depth of Lake Erie is only 62 feet. Thus Lake Ontario holds considerably more water (393 cubic miles) than does Lake Erie (116 cubic miles). It is, however, situated at a considerable lower elevation (243 feet) than Lake Erie (569 feet); its average elevation is 326 feet below that of Lake Erie. The outlet from Lake Ontario is the St. Lawrence River, which empties into the Gulf of St. Lawrence and the Atlantic Ocean.

Upper vs. lower lakes refers to the location of the individual lakes with respect to the Niagara Escarpment. Lakes Superior, Michigan, Huron and Erie, located upstream of the escarpment, are termed upper lakes. Lake Ontario, located below the escarpment, is termed a lower lake; it is the only lower lake.

2.) Lake Levels. Given their large surface area and considerable depth, the Great Lakes retain a large volume of water; they are the largest reservoir of freshwater on the surface of the earth. To a significant degree, the Great Lakes regulate themselves. However, the volume of water and thus the level (elevation) of the water surface varies; it varies seasonally (from month to month) and secularly (from one year to another). Though the amount of variation is not insignificant, particularly to individual user groups who are accustomed to and have adjusted to a limited range of variation, neither is it great.

Water levels in the Great Lakes have been monitored since 1860; thus there is a long record of mean monthly water surface elevations for the individual lakes. The range of variation in monthly mean levels from the lowest to the highest elevation is about 1.0 foot for Lake Superior to 1.6 feet for Lake Ontario. The variation for the remaining lakes – Michigan, Huron and Erie – lies between these figures. As expected of a mid latitude location, mean water levels are at minimum in winter and at a maximum in summer, mostly in early summer, when they begin to decline to the winter minimum.

Long-term cyclical fluctuations in lake levels on the Great Lakes are not predictable as various factors, principally climatological factors, that affect levels cannot be predicted. The best available indicator of long-term fluctuations is the historic record of water levels for the five lakes. During the period between 1950 and 1988, the variation in water levels from extreme high to extreme low monthly means has been: 4.0 feet on Lake Superior; 6.0 feet on lakes Michigan, Huron and Erie; and 6.5 feet on Lake Ontario. These are not absolute limits. Geologic and archaeological evidence for the past 2,500 years indicates even greater variations have occurred.

Not all the water loss from the lakes is due to natural causes; some has been diverted by human activity. There are three physical locations where water has been physically diverted into or out of the Great Lakes Basin (see **Figure 2-4**). There are two diversions that divert water into the Great Lakes Basin. These two diversions are Long Lac and Ogoki, both in Canada. Each diverts some of the tributary flow of the Hudson Bay southward <u>into</u> the Lake Superior basin. The effect of these two diversions into the lake is to raise the level of the Great Lakes by very minor amounts. One diversion, the Sanitary Ship Canal at Chicago, diverts water <u>out</u> of the Great Lakes Basin. This diverts water from the Great Lakes into the Illinois River and eventually the Mississippi River for purposes of sanitation, navigation and hydroelectric production. It lowers water levels of the Great Lakes by minor amounts.

There are two diversions that are inter-basin – they divert water from one Great Lakes watershed to another, but do not divert water form the Great Lakes Basin as a whole (see **Figure 2-4**). These are the Welland Canal in the Province of Ontario and the New York State Barge Canal. The Welland Canal passes water from Lake Erie to Lake Ontario and thus does have some minor effect in lowering water levels on Lakes Erie, Michigan and Huron. The New York State Barge Canal has two interconnections with the Great Lakes, one into the Niagara River at Tonawanda, N.Y. and a second at Oswego, N.Y. In both cases, however, the canal is part of natural river system and thus has no significant effect on lake levels.

Channel and/or shoreline modifications have been undertaken in two connecting channels: the St. Clair/Detroit River system and along the Niagara River. In the case of the St. Clair/Detroit Rivers system, there has been substantial channel dredging to facilitate commercial navigation; additionally, dikes have been constructed for confinement of the dredged material. These modifications have lowered the levels of lakes Michigan and Huron by minor amounts. Channel and shoreline modifications also have been constructed along the Niagara River. Additionally, construction of two bridges and of the Black Rock Lock at Buffalo has caused restrictions in the flows of the Niagara River, which in turn has had the effect of raising the level of Lake Erie by very minor amounts.

FIGURE 2-4
Great Lakes Diversions

3.) Connecting Channels. The lakes are linked one to another by the Great Lakes Connecting Channels, while other connecting channels link the lakes with shallow draft waterways or, in the case of the St. Lawrence River, with the ocean (refer back to **Figure 2-2**). The connecting channels are important in that not only do they canalize commercial navigation on the lakes, they also constrain it. A brief discussion of each is presented below. More information on the connecting channels is in **Section 3, GL/SLS Navigation System**.

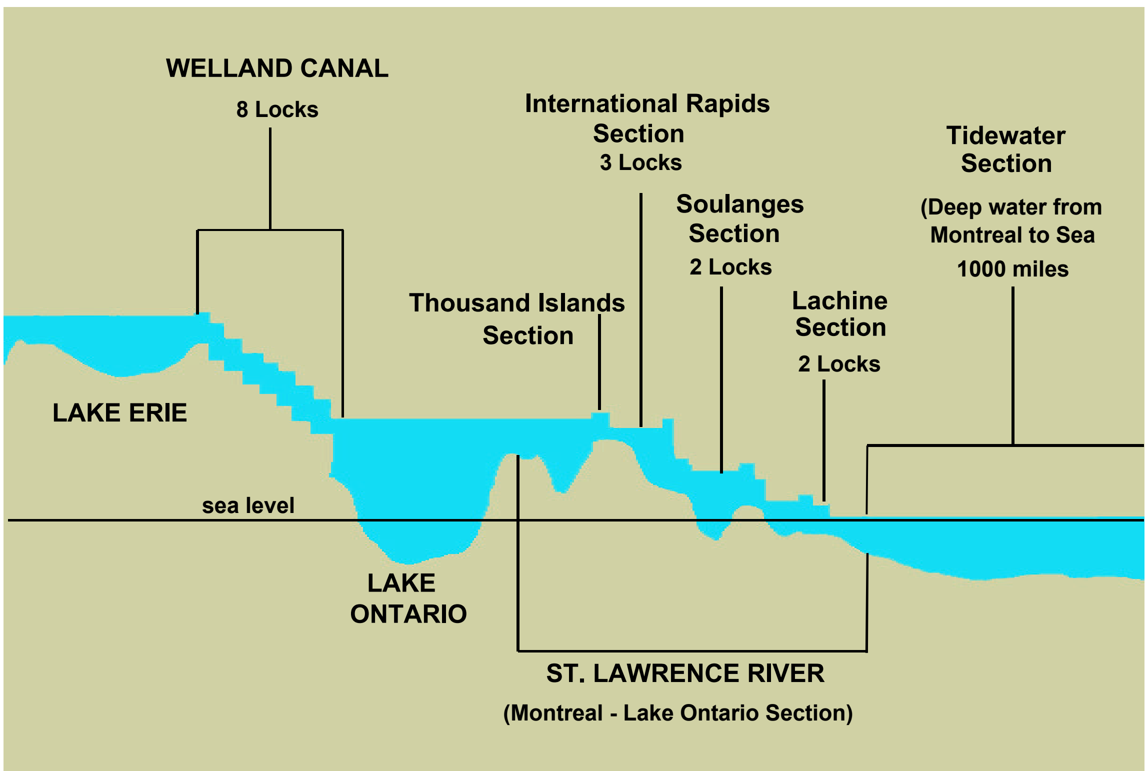
The St. Marys River is the connection between Lake Superior and Lake Huron. All traffic exiting or entering Lake Superior passes through one of the several passages through the river. Depending upon the route chosen, the St. Marys River channel varies from 63 to 75 miles in length. In that distance, the river drops 23 feet from Lake Superior to Lake Huron, with most of this drop (20 feet) occurring at the St. Marys Falls Canal, where four U.S. locks and one Canadian lock permit transit of boats.

The Straits of Mackinac connects lakes Michigan and Huron. The two lakes are at the same elevation and in most places the channel is more than a mile wide and 50-feet deep.

The St. Clair – Detroit River System is the connection between lakes Huron and Erie. The St. Clair River connects Lake Huron with the much smaller Lake St. Clair. The latter is a shallow basin situated between the St. Clair and Detroit Rivers; its total length is about 89 miles. The Detroit River connects Lake St. Clair to Lake Erie. The total vertical drop in the river system, from Lake Huron to Lake Erie is eight feet.

The Welland Canal is the commercial navigation link between Lakes Erie and Ontario; the Niagara River is the natural link. In the short span of 36 miles, the river flows from Lake Erie at an elevation of 569 feet into Lake Ontario at an elevation of 243 feet. The canal extends 27 miles from Port Colborne to St. Catherines, Ont. and includes eight locks that raise and lower boats between the two lakes (see **Figure 2-5**).

FIGURE 2-5
The Welland Canal and MLO Sections of the Seaway



The Chicago Sanitary and Ship Canal flows southwest from Lake Michigan on a course along the Chicago River through downtown Chicago and then west to the Illinois Waterway. The Chicago Harbor Lock provides access to Lake Michigan. The Chicago Sanitary Ship Channel serves Chicago Harbor, part of the larger Port of Chicago.

The Calumet-Sag Channel (Cal-Sag) is linked to Lake Michigan by Lake Calumet and the Calumet River to the north. Access to the Cal-Sag is provided by the Thomas O'Brien Lock, and from this point the channel flows west to its junction with the Illinois Waterway. The Cal-Sag serves Calumet Harbor, part of the larger Port of Chicago.

The Black Rock Canal connects Lake Erie with the New York State Barge Canal. The channel and its single lock are situated in the Niagara River at Buffalo, N.Y.

The final connecting channel is the St. Lawrence River that connects the Great Lakes with the Gulf of St. Lawrence. It is discussed below.

c. St. Lawrence River Basin. Ocean vessels enter the inland waterway through the Gulf of St. Lawrence, sailing a further 700 miles westward to the mouth of the river at Father Point. The Seaway itself begins at Montreal, some 340 miles west of the river's terminus and more than 1000 miles from the Atlantic. The river level at the Seaway entrance is 20 feet above sea level, having risen gradually over more than 300 miles. Navigation to this point is assured by the Canadian government, which maintains a minimum navigable depth of 35 feet in this 1,000-mile stretch of open water.

From Montreal to Lake Ontario, boats travel 190 miles further inland, rising more than 225 feet over this distance. Rapids and lakes alternate throughout this section, providing a scenic background for the commercial water route. The section itself is comprised of five sub-sections, three of which are solely in Canadian waters; the others in international boundary waters (see **Figure 2-5**).

The first of the sub-sections, some 31 miles in length enables marine traffic to bypass the Lachine Rapids and to rise 50 feet above the level of Montreal harbor. Two locks-the St. Lambert, opposite Montreal and the Cote Ste. Catherine, eight and a half miles upstream-are employed to overcome differences in water levels.

After transiting through Lake St. Louis, boats enter the second sub-section-the Soulanges-a 16-mile stretch through the Beauharnois Canal that extends into Lake St. Francis. Here, two flight-locks lift ships 82 feet above the lake level of Lake St. Louis.

The third sub-section, that of Lake St. Francis, is 29 miles in length and terminates just east of Cornwall, Ontario, the headquarters of the St. Lawrence Seaway Management Corporation (SLSMC). This stretch has no locks but required extensive channel improvement and development in order to satisfy navigational requirements. It is the last of the three all-Canadian subsections in the Montreal-Lake Ontario section of the Seaway.

The international segment of the section is entered at the upstream end of Lake St. Francis and extends to a point just east of Ogdensburg, New York. This area used to be a swift-flowing section of the river which rose 90 feet over its 44 mile length. It is now a reservoir, dammed by the Moses-Saunders Power complexes and known as Lake St. Lawrence, a manmade lake covering some 100 square miles of area. The differences in elevation is overcome by the United States' Eisenhower and Snell locks near Massena, New York-headquarters of the Saint Lawrence Seaway Development Corporation-and by the Canadian control lock at Iroquois, Ontario.

The remaining sub-section of the river journey extending 68 miles into Lake Ontario is known as the Thousand Islands section, and is maintained by the United States' Seaway

Corporation (SLSDC). It is free of rapids but many rock shoals were removed when the channels were widened and deepened.

d. Constraints to Navigation. All five of the Great Lakes are deep enough such that the lakes are not a constraint to commercial navigation. The only exception to this is that the approach channel to individual harbors may require dredging. It is the connections between the lakes (connecting channels) that are the principal natural constraints to commercial navigation on the lakes. In addition, the climate within the basin places a significant constraint on navigation across the lakes.

The fundamental constraints to commercial navigation are water depth and climate. In the long term the two are interrelated in that the volume and depth of water in the lakes are affected by long term, continental changes in climate. For all practical purposes changes in the climate of this magnitude are not relevant in that they occur over very long periods of time – thousands of years.

Short-term variations of climate that are significant largely relate to variations in the amount of precipitation falling within the Great Lakes Basin. These fluctuations tend to occur over a period of a few to several years. Deficiencies in precipitation tend to produce a lowering of water levels in the lakes while precipitation excesses tend to produce a rise in lake levels. Such variations have occurred in the past and will continue to occur in the future; they are the reason lake levels are regulated.

In addition to variations of climate that exist from year to year, there are seasonal variations in the volume of water, and thus in the level of the water surfaces of the lakes, that are the indirect effect of climate. This is the annual pattern of seasonal variation due to the seasonal pattern of precipitation in the Great Lakes Basin and to seasonal variations in runoff. The Great Lakes Basin receives a slight majority of its precipitation in the summer months when precipitation falls in the form of rain. It receives less than half of its annual average amount in the winter months when much, but not necessarily all, of the precipitation comes in the form of snow. Unless there is a winter rain on top of the snow cover, runoff in the winter is less than in summer. Thus, lake levels tend to fall in autumn/winter and to rise in spring/summer.

This seasonal fluctuation in lake levels is significant to commercial navigation on the lakes and to the Corps of Engineers maintenance-dredging program. Because lake levels are significantly higher in spring and early summer, the boats are able to load to a deeper draft thus reducing their costs per ton of commodity transported. As the summer season progresses into autumn and winter, and lake-levels decline, the fleet operators must necessarily load their boats to a lesser draft with a corresponding increase in unit transportation costs.

Seasonal climatic change in the mid-latitudes produces ice in the winter. Ice on the Great Lakes, principally ice at the Soo Locks and in the connecting channels between the lakes, limits the extent of the navigation season. Extension of the season is physically possible though costly. Additionally, it would introduce environmental effects that are of considerable concern. The onset of winter and ice condition limits the navigation season.

5. GOVERNMENTS AND REGULATION OF THE LAKES

a. General. A number of different government agencies and private enterprises participate in the operation and management of the commercial waterway system on the Great Lakes and St. Lawrence Seaway. The U.S. federal interest in waterborne commerce has been established by tradition from the earliest days of the nation; by legislation, beginning in 1824 with the *General Survey Act* and the first *Rivers and Harbors Act*; and by court decisions defining the Federal power to regulate commerce. Canadian interest began with the earliest days of French settlement at Montreal, was followed by the work of England's Royal Army Engineers in the late 18th century and continued under Canadian governments through the 19th and 20th centuries. The unique international character of the GL/SLS and the common interests of Canada and the U.S. created the need for bi-lateral commissions, which began to take shape in the late-1800s, culminating in today's International Joint Commission (IJC).

b. Bi-national Regulation and the IJC. The Great Lakes are an international water body shared by Canada and the United States. Most commercial navigation projects implemented by the U.S. government are entirely within the territorial limits of the U.S. and are only subject to U.S. jurisdiction. However any project, whether new or a modification to an existing project, that has a systematic effect on water levels and flows on the lakes must be coordinated with and agreed upon by the agency established by the two countries for that purpose. Thus, decisions, which for most inland waterways are made at the federal level in the United States, on the Great Lakes may have to be considered at the international level. Additionally, the federal government of each country has to interact with its constituents – states and provinces.

The IJC was established by the U.S. and Canadian governments to address boundary disputes and to regulate the Great Lakes. Historically, the principal area of concern for the IJC has been regulation of water volumes and levels in the lakes. Two of the Great Lakes, Superior and Ontario, are regulated to affect the level of their water surfaces. In both cases the regulation does not ensure full control of the levels of the lake because the major factors that affect the supply of water to the Great Lakes – over-lake precipitation, evaporation and runoff – can neither be controlled nor can they be accurately predicted over the long term. The impact of regulation upon water levels of Lake Superior has been small compared to the natural factors that affect its water level. Upon various occasions, the regulation of Lake Ontario has had a significant effect on its water level.

1.) Lake Superior. Regulation was first applied to Lake Superior by the IJC *Order of Approval* issued in 1914 that permitted the construction of hydroelectric facilities on the Canadian and U.S. sides of the St. Marys River. The IJC Order also established the International Lake Superior Board of Control to oversee the operation of the facilities in the St. Marys River. The Board has two members: one from the U.S. Army Corps of Engineers and one from Environment Canada.

The 1914 Order established the basic objective for, and the limits to, regulation. A principal condition specifies a target range for the water-surface elevation. Regulation was to be done "in such manner as not to interfere with navigation." The 1914 IJC consent order has been updated over the years to meet the changing condition and requirements of the Great Lakes-St. Lawrence River System. In 1979, the I JC further amended its *Order of Approval* to require that the levels of lakes Michigan-Huron also be taken into account in determining Lake Superior's outflows. The amendment also specified that adequate flows must be ensured for fish habitat in the rapids section of the St. Marys River.

Physical structures that have been constructed to control the flow through the St. Marys River are three hydropower plants (one in Canada and two in the U.S.), five navigation locks (four in the U.S. and one in Canada) and the 16-gate Lake Superior Compensating Works. The last was built to compensate for the increased outflow capacity of the St. Marys River that resulted from the hydropower developments.

The IJC issued four different regulation plans to regulate Lake Superior between 1928 and 1979. In all four the main factor considered in determining outflows into the St. Marys River was the level of Lake Superior. In its 1979 *Order of Approval*, the IJC implemented Plan 1977. This plan differed from its predecessors in that it required consideration be given to the levels of lakes Michigan-Huron when determining outflows.

2.) Lake Ontario. Regulation of Lake Ontario was made possible by construction of the hydropower facilities along the international reach of the St. Lawrence River. The IJC issued its initial *Order of Approval* in 1952 authorizing Ontario Hydro and the New York Power Authority to construct and operate the facilities.

In 1956, the IJC amended its order to include regulation criteria designed to reduce the range of levels experienced on Lake Ontario, facilitate navigation in the St. Lawrence River, and provide protection for riparian and other interests upstream and downstream in the Province of Quebec. The amended order also established the International St. Lawrence River Board of Control to ensure compliance with provisions of the orders by operators of the facilities.

Upon completion of construction in 1960, the Board began to implement its charge. Currently, the Board consists of 10 members. The members represent the U.S. Army Corps of Engineers, Transport Canada and Environment Canada, states, provinces and local communities.

Three dams were constructed on the St. Lawrence River as part of the hydroelectric project – the Moses-Saunders, Long Sault and Iroquois. The Moses-Saunders power dam is the principal regulatory structure. The dam at Long Sault, New York acts as a spillway when outflows from Lake Ontario are larger than the capacity of the power dam. The dam at Iroquois, Ontario can be used to regulate flows, but it is principally used to prevent water levels from rising too high in Lake St. Lawrence, upstream of the power dam.

Three plans have been used to regulate the outflows of Lake Ontario. The current plan is Plan 1958-D. It consists of a family of operating curves for different trends in the water supply conditions for Lake Ontario. Depending upon the supply conditions in the lake, a specific curve is selected and the outflow adjusted accordingly.

As with Lake Superior, the regulation of Lake Ontario does not ensure full control of the levels of the lake because the same major factors that affect the water supply – precipitation, evaporation and runoff – are not controlled. Further, it should be noted that fluctuations of Lake Ontario's water level cannot affect the upper lakes because of the presence of Niagara Falls.

On some occasions, the impact of regulation of Lake Ontario has been significant. In the extreme low water period of the mid-1960s the lake's level was maintained somewhat lower than it would otherwise have been. Toward the end of the high water period in 1986-1988, when water levels were unusually high, the lake's level was maintained as much as 2.9 feet below what it would have been without regulation.

In some cases, regulation of Lake Ontario has not been as successful. In the early and mid-1970s, when the water level was critically high, the water level was held to more than a foot below pre-project levels. However, despite regulation, the water level of the lake reached 248.0 feet, more than a foot above the IJC's target level of 246.8 feet.

c. Bi-national Operation and the Seaway Corporations. The U.S. Saint Lawrence Seaway Development Corporation (SLSDC) and the St. Lawrence Seaway Authority of Canada constructed the modern St. Lawrence Seaway. The SLSDC and the Seaway Authority's successor organization, the recently formed St. Lawrence Management Corporation (SLSMC), jointly operate and maintain the waterway. The SLSDC is a wholly-government owned corporation administered by the U.S. Department of Transportation. The SLSMC operates the 13 Canadian locks on the St. Lawrence Seaway, all of which are owned by Transport Canada. The SLSDC operates the two Seaway locks owned by the U.S. The two agencies operate the Seaway's locks and channels and furnish vessels sailing the Seaway with vessel traffic control assistance. They jointly publish transit regulations for boats, negotiate and establish the level of Seaway tolls, and set the Seaway's annual opening and closing dates. Additionally, the two agencies are members of the Operations Advisory Group (OAG), and as such, participate in meetings of the St. Lawrence River Board of Control, an adjunct of the International Joint Commission.

d. U.S. and Canadian Federal Government. The U.S. Federal agencies most directly involved in development and operation of the waterway system are the U.S. Army Corps of Engineers and the U.S. Department of Transportation. The responsibilities of both agencies within the waterway system are part of their broader jurisdictions that include maritime as well as inland waterway transportation. As steward of the waterway system, the basic responsibility of the Army Corps of Engineers is to facilitate the movement of boats. It does so by deepening, widening, and straightening channels, by regulating river water levels with dams, and by providing associated locks. As part of its broader jurisdiction, the Corps evaluates, plans, and constructs improvements to inland harbors and channels.

The U.S. Department of Transportation through the U.S. Coast Guard has responsibility for vessel and navigation safety, and provides navigation aids and search and rescue services. The Maritime Administration in the Department of Transportation promotes the development and efficient operation of port facilities and waterway vessels.

The U.S. Environmental Protection Agency (EPA) indirectly affects commercial navigation upon the lakes through its charge to manage water quality. Management of water quality affects commercial navigation in the disposal of materials that are removed from channels by the Corps of Engineers. The individual states and the EPA share responsibility for establishing and implementing standards that specify the method of disposal for dredged materials. The Corps of Engineers must meet these standards.

SECTION 3. GREAT LAKES/ST. LAWRENCE SEAWAY NAVIGATION SYSTEM

1. GENERAL DESCRIPTION

The Great Lakes/St. Lawrence Seaway navigation system comprises the Great Lakes, the navigable channels that connect them, and the St. Lawrence Seaway.[1] Hundreds of ports line the banks of the GL/SLS and are an integral part of this waterway system. This section provides physical descriptions of both the channels and the largest of the U.S. Great Lakes harbors. Physical information for Canadian harbors is not presented, being outside the scope of this report. Nevertheless, it is important to note that prominent Canadian cities, like Montreal, Quebec City, Toronto, Hamilton, and Windsor, are located on the system. Each is a major port in its own right, as are locations such as Nanticoke, Sarnia, Sault Ste. Marie, and Thunder Bay in Ontario and Sept-Iles, Port Cartier, Pointe Noire in Quebec to name a few.

2. CONNECTING CHANNELS

a. General. Two types of connecting channels are discussed. The first are the Great Lakes connecting channels, that is, the navigable waterways that connect the Great Lakes to one another. There are four of these: the St. Marys River, the Straits of Mackinac, the St. Clair/Detroit River System, and the Welland Canal. The remaining connecting channels, the Chicago Sanitary and Ship Canal, the Cal-Sag Ship Channel, the Black Rock Canal, and the St. Lawrence River (including the Montreal-Lake Ontario Section of the Seaway) connect the lakes with inland, shallow draft systems in the first three instances and with the Gulf of St. Lawrence in the last instance (see **Figure 3-1**).

b. Great Lakes Connecting Channels. The Great Lakes are interconnected by various connecting channels. The connecting channels are important in that not only do they channelize commercial navigation on the Lakes and the St. Lawrence River, they also constrain it. The navigation constraint is the actual depth of water through the channel at any given time during the shipping season. The actual depth of water in the channel varies because of daily and seasonal weather conditions. For discussion purposes, the controlling depth of the connecting channels will be the depth of the water at Low Water Datum (LWD). **Table 3-1** displays the controlling depth at LWD for the connecting channels.

[1] As mentioned in Section 2, Study Area, the GL/SLS is part of the more extensive GL/SL Waterway, which includes the deepwater lower reaches of the St. Lawrence River. This report and section focuses on the GL/SLS and its locks, dams and harbors.

FIGURE 3-1
Great Lakes/St. Lawrence Seaway Connecting Channels and Ports

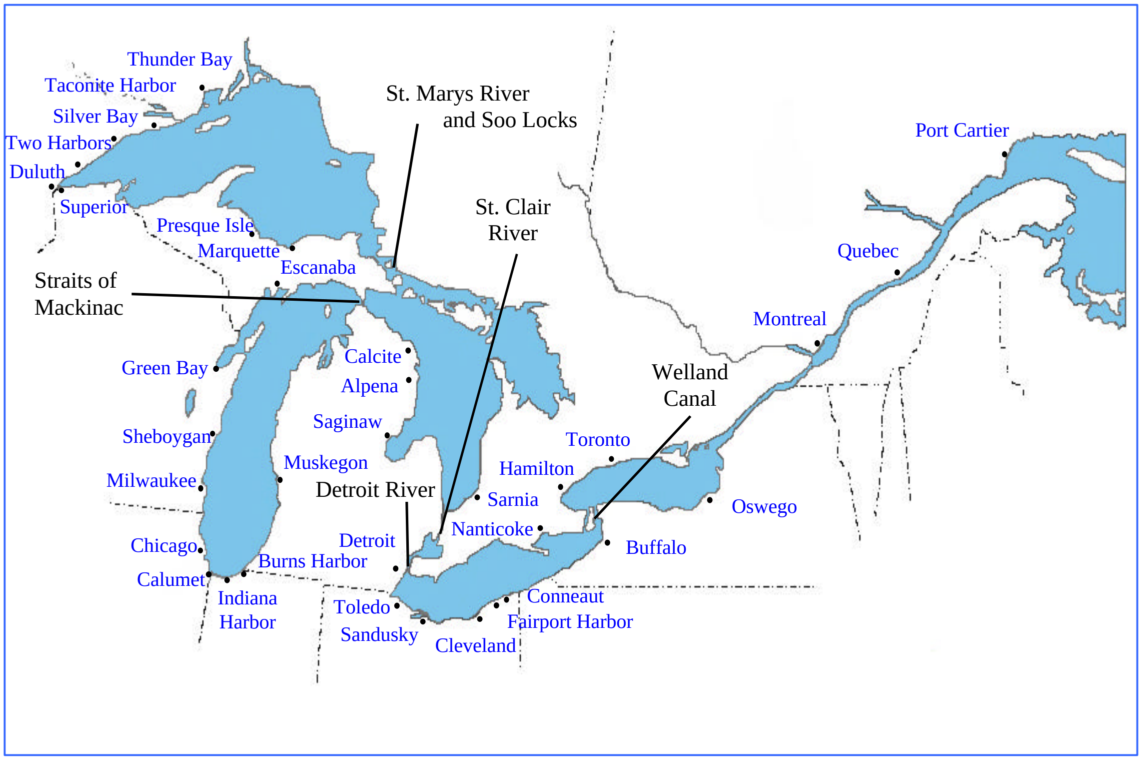


TABLE 3-1
Great Lakes Navigation System Channels

Channel	Controlling Depth (feet)	Length (miles)	General Channel Width (feet)	Fall (feet)	Restrictive Width (feet)
St. Marys River	27	63-75	300-1,500	22	76,105 1/
Straits of Mackinac	30	1	1,250	0	NA
St. Clair River	27	46	700-1,400	5	600 2/
Lake St. Clair	27.5	17	700-800	0	NA
Detroit River	27.5	32	300-1,260	3	600
Welland Canal	27	27	192-350	326	78 3/

1/ 76-footrestrictive width for MacArthur Lock, 105-foot for Poe Lock.
2/ Width restrictions at the Blue Water Bridge
3/ A 3.0 mile section of the reach between Locks 7 and 8 is restricted to one-way navigation
Source: *"General Description of Great Lakes/St. Lawrence Seaway Physical Description,"* submitted to the Department of the Army, North Central Division, Chicago, IL by ARCTEC, Inc., September 1981 as updated by the U.S. Army Corps of Engineers, Detroit District.

1). St. Marys River. The St. Marys River is the connection between Lake Superior and Lake Huron. It is the only connection between Lake Superior and the remaining lakes. All traffic exiting or entering Lake Superior passes through the St. Marys River. There are several passages through the river and the length (as well as the width) of the channel depends upon which passage is utilized. Vidal Shoals is a restrictive reach of the upper St. Marys, Little Rapids is the restrictive reach on the lower St. Marys. The channel bottom of the St. Marys River is rock.

Depending upon the route chosen, the St. Marys River channel varies from 63 to 75 miles in length. In that distance the river drops 23-feet from Lake Superior to Lake Huron. Most of this drop (20-feet) occurs at the St. Marys Falls Canal, where four U.S. locks and one Canadian lock permit transit of vessels. Besides providing transit between the two lakes, the locks, associated compensating works, and power houses, partially regulate the flow from Lake Superior into Lake Huron.

The five locks at the St. Marys Falls Canal are collectively known as the Sault Ste. Marie, or Soo Locks. The four U.S. locks are the MacArthur, Sabin, Davis and Poe. The lock on the Canadian side, referred to as the Canadian Lock, suffered a physical failure in the 1980s and has since been replaced with a new lock that became operable in 1998. **Table 3-2** presents the dimensions of the locks.

TABLE 3-2
Characteristics of the Soo Locks

Feature	MacArthur Lock	Poe Lock	Sabin Lock	Davis Lock	Canadian Lock
On-line date	1943	1969	Closed	Closed	1998
Width, feet	80	110	NA	NA	49
Length, feet	800	1,200	NA	NA	252
Max. ship beam, ft.	76	105	NA	NA	n.a.
Max. ship length, ft.	730	1,100	NA	NA	n.a.
Max. ship draft, ft. [1/]	29.5	30.5	NA	NA	n.a.
Min. sill depth, ft.	31.0	32.0	NA	NA	10.0

1/ The depth of the St. Marys River is the current limiting factor for vessels transiting the Soo Locks. Vessels transiting the locks are in practice limited to 26.0-feet of draft at LWD.
Source: *General Description of Great Lakes/St. Lawrence Seaway Physical Description,* submitted to the Department of the Army, North Central Division, Chicago, IL by ARCTEC, Inc., September 1981 as updated by the U.S. Army Corps of Engineers, Detroit District.

All commercial traffic through the Soo Locks uses either the Poe or the MacArthur locks. The Poe Lock is the most important of the locks at the Soo as it is the only one capable of passing Class X vessels (vessels of 1,000-feet in length). Iron ore and western coal (coal from the Powder River Basin of Wyoming) are the principal U.S. commodities transported across Lake Superior and most of both commodities are transported in Class X vessels. Canada's principal commodity is grain transported in the Seaway-sized Class VII vessel. Class VII vessels can use either the Poe or the MacArthur lock, while the Class X vessels are restricted to using the large Poe Lock. The depth at the sill of the Poe Lock is 32-feet below LWD. However, virtually no vessels pass through the Poe Lock with a draft in excess of 28-feet due to the 1 to 1.5-footunder-keel requirements of the lake vessels.

2). Straits of Mackinac. The Straits of Mackinac connect lakes Michigan and Huron. The two lakes are at the same elevation and in most places the channel is more than a mile wide and 50-feet deep. At two locations, Round Island Passage and the Poe Reef Shoal, channel depth is 30-feet – the authorized channel depth at LWD. These two locations function as a constraint to vessels drafting in excess of 29-feet.

3). St. Clair - Detroit River System. The St. Clair River connects Lake Huron to Lake St. Clair and the Detroit River connects Lake St. Clair to Lake Erie. In effect, the St. Clair – Detroit River system subdivides the Great Lakes into two sub-basins that consist of lakes Superior, Michigan and Huron upstream of the Detroit-St. Clair River system and lakes Erie and Ontario downstream of this river system. All traffic passing between the two sub-basins must pass through the Detroit-St. Clair River system thus it is a major connecting channel.

All three components – the St. Clair River, Lake St. Clair and the Detroit River – are comparatively shallow and all three require considerable dredging to maintain the channels at their authorized depth. The controlling depth of the system is 27.1-feet below LWD. However because of varying lakes levels, which by definition are above LWD 95 percent of the time, vessels can usually pass through this system safely with drafts of 27.5-feet. In periods of high water levels, vessels have passed through this system with drafts as deep as 28.5-feet.

4). Welland Canal. The Niagara River connects lakes Erie and Ontario. In the short span of 36 miles, the river flows from Lake Erie at an elevation of 569-feet into Lake Ontario at an elevation of 243-feet. The vertical drop of 326-feet at Niagara Falls is a barrier to commercial navigation. Two canals, the Welland and the single-lock Black Rock, allow commercial vessels access to and from Lake Erie. The Black Rock Canal, not considered a Great Lake connecting channel, is the link between Lake Erie and the New York State Barge Canal.

The Welland Canal is the major commercial navigation link between lakes Erie and Ontario, and is one of two major sections of the St. Lawrence Seaway. The western (upstream) terminus of the canal is Port Colborne, Ontario. The eastern (downstream) terminus is St. Catherines, Ontario. Thus, the Welland Canal is entirely situated in Canada and its operation is entirely funded and controlled by the Canadian Federal government. It is a major connecting channel as virtually all waterborne traffic entering the St. Lawrence Seaway destined for U.S. harbors (or traffic originating from a U.S. harbor that exits the Great Lakes via the Seaway) must pass through the Welland. All major commercial U.S. harbors on the Great Lakes are situated upstream of the Welland Canal.

The Welland extends across 27 miles of the Niagara Peninsula and it includes eight locks, 7 lift-locks and 1 guard-lock that raise and lower vessels between the two lakes (**Table 3-3**). Locks 1, 2, 3, 7 and 8 are single chamber locks. Locks 4, 5, and 6 are tandem-chambered flight locks that allow two-way traffic. The controlling depth of the system is 26.3-feet below LWD. The maximum beam is 78-feet and the maximum length is 740-feet, meaning that the largest Great Lakes vessels that can navigate through the Welland are Class VII vessels. This class of vessels has a maximum length of 740. The maximum draft of Class VII vessels varies but some draft as much as 30-feet. Vessels larger than Class VII – Classes VIII, IX and X cannot navigate through the Welland; they are restricted to navigation within the upper lakes.

TABLE 3-3
Characteristics of the Welland Canal Locks

Feature	Lock 1	Lock 2 – 7	Guard Lock 8
On-line date	1932	1932	1932
Width, feet	80	80	80
Length, feet	865	859	1,380
Max. ship beam, ft.	78	78	78
Max. ship length, ft.	740	740	740
Max. ship draft, ft. [1/]	26'3"	26'3"	26'3"
Min. sill depth, ft.	30	30	30

Source: *General Description of Great Lakes/St. Lawrence Seaway Physical Description,* submitted to the Department of the Army, North Central Division, Chicago, IL by ARCTEC, Inc., September 1981 and *The Welland Canal Section of the St. Lawrence Seaway,* The St. Lawrence Seaway Management Corporation, November 2000.
1/ The 26'3" draft presently allowed in the Seaway is not available all of the time due to variable water levels.

c. Other GL/SLS Connecting Channels. These channels link the Great Lakes with other waterways. They are the Chicago Sanitary and Ship Channel, the Cal-Sag Channel, the Black Rock Canal, and the St. Lawrence River.

1). The Chicago Sanitary and Ship Channel moves from Lake Michigan on a course along the Chicago River through downtown Chicago and then west to the Illinois Waterway. The Chicago Harbor Lock provides access to Lake Michigan. The Chicago Sanitary Ship Channel serves Chicago Harbor, part of the larger Port of Chicago.

2). The Calumet-Sag Channel (Cal-Sag) is linked to Lake Michigan by Lake Calumet and the Calumet River to the north. Access to the Cal-Sag is provided by the Thomas O'Brien Lock, and from this point the channel flows west to its junction with the Illinois Waterway. The Cal-Sag serves Calumet Harbor, part of the larger Port of Chicago.

3). The Black Rock Canal is a physically segregated, slack-water channel within the Niagara River created by a jetty wall and the Black Rock Lock. The Black Rock Canal handles modest amounts of coal destined for a local electric power plant. The Black Rock Canal links the Great Lakes with the New York State Barge Canal and is a popular route for recreational boaters.

4). The St. Lawrence River connects Lake Ontario, and thus all of the Great Lakes, to the Gulf of St. Lawrence and the Atlantic Ocean. From its source near Kingston, Ontario on Lake Ontario to the mouth at Father Point, Quebec, the St. Lawrence flows a distance of 343 miles. The first 190 miles of the St. Lawrence River, the reach between Kingston and St. Lambert Lock at Montreal, Quebec is referred to as the Montreal-Lake Ontario (MLO) section of the St. Lawrence Seaway. Below and east of St. Lambert Lock the St. Lawrence River is a free-flowing stream that is navigable by ocean-going ships.

The seven single-chamber locks on the St. Lawrence River are of identical size to those on the Welland and are designed to accommodate the same maximum vessel dimensions of 730-feet in length, 76-feet in beam, and 26-feet of draft. Associated channels in this, the MLO section of the Seaway, are excavated to a depth of 27-feet below LWD. The U.S operates two locks and Canada operates the remaining five. The two U.S. locks are the Snell and Eisenhower locks; they are located near Massena, NY on the Wiley-Dondero Canal. Canada's five locks and locations are: St. Lambert and Cote St. Catherine locks, located near Montreal; the Upper and Lower Beauharnois locks located in the Beauharnois Power Canal; and the Iroquois lock located at Iroquois, Ontario. All seven locks accommodate Class VII vessels. **Table 3-4** presents the dimensions of these locks.

TABLE 3-4
Characteristics of the MLO Section of the St. Lawrence Seaway

	Iroquois Lock and Canal	**Wiley-Dondero Canal**	**Beauharnois Canal**	**South Shore Canal**
Feature	**Iroquois Lock**	**Snell & Eisenhower Locks**	**Upper & Lower Locks**	**Cote St. Catherine & St. Lambert Locks**
On-line date	1959	1959	1959	1959
Width, feet	80	80	80	80
Length, feet	766	766	766	766
Max. ship beam, ft.	78	78	78	78
Max. ship length, ft.	740	740	740	740
Max. ship draft, ft. [1/]	26'3"	26'3"	26'3"	26'3"
Min. sill depth, ft.	30	30	30	30

Source: *General Description of Great Lakes/St. Lawrence Seaway Physical Description,* submitted to the Department of the Army, North Central Division, Chicago, IL by ARCTEC, Inc., September 1981 and *The Montreal/Lake Ontario Section of the St. Lawrence Seaway,* The St. Lawrence Seaway Management Corporation, March 2000.
1/ The 26'3" draft presently allowed in the Seaway is not available all of the time due to variable water levels.

3. PORTS

a. Great Lakes/St. Lawrence Waterway Ports. There are hundreds of ports and harbors from the Head-of-the-Lakes on Lake Superior to the Gulf of St. Lawrence. Ports on the St. Lawrence River below St. Lambert Lock with their deepwater harbors serve as ocean ports, while ports above St. Lambert serve as deep-draft lake ports. Grain, steel, and iron ore are the dominant commodities that move through the Seaway. U.S. produced iron ore, stone, and coal are the dominant commodities that stay within the upper lakes. Canadian grain railed to river elevators, Canadian iron ore for overseas export, containers, petroleum products, and aluminum related products are the dominant commodities that move on the St. Lawrence River without moving through the Seaway.

The top 15 U.S. ports are in 6 different Great Lakes basin states (see **Table 3-5**). Duluth-Superior and Chicago handled over 68 million tons of waterborne traffic and ranked as the number one and number two GL/SLW ports in 1998. These two ports handled over seven million tons of Seaway borne traffic. From a percentage standpoint, the Toledo-Detroit area was more dependent on the Seaway with 25 percent of all port traffic moving through the Seaway. The ports of Cleveland, Ashtabula, and Duluth-Superior all ship or receive over 10 percent of their total waterborne traffic through the Seaway.

TABLE 3-5
Great Lakes/St. Lawrence Waterway, Selected U.S. Ports, 1998

Port	State	Seaway Traffic (Ktons)	Total Traffic (Ktons)
Duluth-Superior	Minnesota/Wisconsin	5,892	42,442
Chicago[1/]	Illinois	2,001	25,958
Indiana/ Burns Harbor [2/]	Indiana	2,681	23,917
Detroit	Michigan	4,645	19,453
Cleveland	Ohio	3,151	17,865
Ashtabula	Ohio	2,372	15,602
Lorain	Ohio	251	14,168
Toledo	Ohio	3,504	13,250
Two Harbors	Minnesota	0	13,223
Presque Isle	Michigan	0	10,483
Calcite	Michigan	0	9,389
Stoneport	Michigan	0	9,114
Gary	Indiana	100	9,083
Taconite	Minnesota	0	8,761

Source: *The St. Lawrence Seaway Traffic Report – 1998 Navigation Season*, prepared by the St. Lawrence Seaway Management Corporation and the Saint Lawrence Seaway Development Corporation, 1998 and *Waterborne Commerce of the United States, Calendar Year 1998*, Waterborne Commerce Statistics Center, U.S. Army Corps of Engineers.
1/ The Port of Chicago includes the Chicago River, Chicago Harbor, Calumet Harbor and River, and Lake Calumet.
2/ *The St. Lawrence Seaway Traffic Report – 1998 Navigation Season* reports Burns Harbor and Indiana Harbor as one port location, while the Waterborne Commerce data reports them separately.

Major GL/SLW Canadian ports are located in both Ontario and Quebec. The largest ports are all located below St. Lambert Lock; this includes Montreal/Contrecoeur and Sept-Iles/Pointe Noire, the third and fourth largest GL/SLW ports in 1998. Each of these ports depends upon the Seaway to handle significant portions of its total traffic (see **Table 3-6**). The most Seaway-dependent Canadian port is the steel-making center of Hamilton, Ontario. Thunder Bay and Windsor, Ontario both rely upon the Seaway to handle over 50 percent of their total traffic.

TABLE 3-6
Great Lakes/St. Lawrence Waterway, Selected Canadian Ports, 1998

Port	Province	Seaway Traffic (Ktons)	Total Traffic (Ktons)
Montreal/Contrecoeur	Quebec	1,982	23,348
Sept-Iles/Pointe Noire	Quebec	8,320	22,890
Port Cartier	Quebec	5,030	19,763
Quebec/Levis	Quebec	2,587	15,493
Hamilton	Ontario	12,322	12,989
Nanticoke	Ontario	0	11,386
Thunder Bay	Ontario	6,752	9,066
Sorel	Quebec	490	5,972
Sault St. Marie	Ontario	403	5,646
Port Alfred	Ontario	0	4,285
Windsor	Ontario	2,151	4,252

Source: *The St. Lawrence Seaway Traffic Report – 1998 Navigation Season*, prepared by the St. Lawrence Seaway Management Corporation and the Saint Lawrence Seaway Development Corporation, 1998 and data prepared by TAF Consultants for Transport Canada.

The shipping season on the Great Lakes system varies slightly, but is generally from the first of April through early January, closing the system for approximately 9-10 weeks. The Seaway season is similar, generally running from late March to late December. Open and close dates for GL/SLS locks for the 1998 navigation season are shown in **Table 3-7**.

TABLE 3-7
Open and Close Dates for GL/SLS Locks, 1998 Shipping Season

	Open Date	Close Date	Closed time
Soo Locks	25 March 1998	15 January 1999	68 days
Welland Canal	30 March 1998	25 December 1998	94 days
St. Lawrence Seaway	31 March 1998	25 December 1998	95 days

b. U.S. Great Lake Harbors. The study area contains 33 U.S. harbors located on the Great Lakes system (see **Table 3-8**). These harbors were selected on the basis of (1) volume of commodity traffic handled or (2) specific requests from local interests.

This subsection provides a profile of each of the study area harbors. Each is numbered to correspond with the list provided in **Table 3-8** below. **Attachment 9**, **Great Lake Harbor Physical Dimensions**, provides specific requests from local interests, more detail of the physical dimensions, and operation and maintenance costs for each of the U.S. harbors.

1.) Alpena Harbor, Michigan. Alpena Harbor, Michigan is located at the mouth of Thunder Bay River on the northwest shore of Thunder Bay, Lake Huron, 100 miles southeast of Cheboygan Harbor, Michigan.

TABLE 3-8
Great Lakes Navigation System, U.S. Harbors Selected for Study

No.	Harbor	No.	Harbor
1.	Alpena Harbor, MI	18.	Lorain Harbor, OH
2.	Ashtabula Harbor, OH	19.	Marinette/Menominee, WI/MI
3.	Buffalo Harbor, NY	20.	Milwaukee, WI
4.	Burns Harbor, IN	21.	Monroe Harbor, MI
5.	Calcite Harbor, MI	22.	Presque Isle/Marquette, MI
6.	Calumet Harbor and River IL/IN	23.	Rouge River, MI
7.	Chicago Harbor, IL	24.	Saginaw, MI
8.	Cleveland, OH	25.	Sandusky Harbor, OH
9.	Conneaut, OH	26.	Saugatuck, MI
10.	Detroit, MI	27.	Sheboygan, WI
11.	Drummond Island, MI	28.	Silver Bay, MN
12.	Duluth/Superior Harbor, MN/WI	29.	St Clair River, MI
13.	Escanaba Harbor, MI	30.	Stoneport, MI
14.	Fairport, OH	31.	Taconite, MN
15.	Gary, IN	32.	Toledo Harbor, OH
16.	Green Bay, WI	33.	Two Harbors, MN
17.	Indiana Harbor, IN		

The existing project provides for depths varying from 19-feet at the mouth of the river to 25-feet at the bay channel. The harbor contains several commercial docks along Thunder Bay River, which are primarily used for receipt of coal, petroleum products, salt, and bulk cement. It contains a municipal marina basin about 0.25-mile southwest of the river mouth.

Table 3 – 9 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Alpena Harbor.

TABLE 3 – 9
WCSC 1998 Tonnage and 2001 Passenger Data for Alpena Harbor

Cargo		**Tonnage**
Coal		478,089
Aggregates		172,727
Ores and Minerals		12,233
Iron and Steel		105,523
Other		2,309,172
Total Cargo		**3,077,744**
Vessel	**Dockings**	**Passengers/docking**
Arcadia	2	224 per docking

2.) Ashtabula Harbor, Ohio. Ashtabula Harbor, Ohio is located on Lake Erie approximately 119 miles southwest of Buffalo, New York and 59 miles northeast of Cleveland, Ohio. Authorized depths are maintained at 29-feet (soft) / 30-feet (hard) at the entrance channel to a point inside the breakwaters, 28-feet/29-feet in the section parallel to the west breakwater and the area inside the east breakwater, 27-feet/28-feet from the Ashtabula River mouth and channel to 2,000-feet point, then 18-feet decreasing to 16-feet at the upper river limit, and 22-feet/23-feet in the turning area in front of the inner breakwater.

The harbor contains 16 piers and wharves including 10 docks: 3 ore unloading docks (two of which are self-unloaders only), 1 coal unloading dock, 5 stone, sand, and dry bulk cargo docks (four of which are self-unloaders only), and 1 general cargo dock.

Table 3 – 10 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Ashtabula Harbor.

TABLE 3 – 10
WCSC 1998 Tonnage and 2001 Passenger Data* for Ashtabula Harbor

Cargo		Tonnage
Coal		8,320,221
Aggregates		682,877
Chemicals		3,988
Ores and Minerals		427,860
Iron and Steel		6,057,053
Other		109,746
Total Cargo		**15,601,745**

* Ashtabula Harbor did not receive passenger traffic during the 2001 season.

3.) Buffalo Harbor, New York. Buffalo Harbor, New York is located at the eastern end of Lake Erie, at the head of Niagara River, 176 miles east of Cleveland, Ohio.

The harbor contains 27 piers, wharves, and docks, 5 on the Outer Harbor, 9 on the Lackawanna, Union, and Buffalo Ship Canals, and 13 along the deep-draft section of the Buffalo River. Twenty terminals have rail access. Gateway Metroport, a division of Gateway Trade Center, Inc., owns and operates wharves at Lackawanna for the receipt and shipment of general cargo and bulk commodities with buildings formerly owned by Bethlehem Steel Corp. utilized for transit and long-term storage of cargo as required. The Niagara Frontier Transportation Authority owns Terminals A and B in the Outer Harbor for handling general cargo. The city of Buffalo owns a slip on the right bank of Buffalo River just north of Michigan Avenue Bridge used for mooring the city fireboat. Coast Guard facilities are at the mouth of Buffalo River along the left bank.

Table 3 – 11 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Buffalo Harbor.

TABLE 3 –11
WCSC 1998 Tonnage and 2001 Passenger Data for Buffalo Harbor

Cargo		Tonnage
Coal		134,792
Petroleum		440,607
Aggregates		459,305
Grain		387,446
Chemicals		12,200
Ores and Minerals		690,097
Iron and Steel		28,041
Other		188,559
Total Cargo		**2,341,047**
Vessel	**Dockings**	**Passengers/docking**
Niagara Prince	3	84
Cape May Light	8	226

4.) <u>Burns Harbor, Indiana</u>. Burns Harbor, Indiana is located on the southern shore of Lake Michigan approximately 9 miles east of Gary, Indiana and 14 miles southeast of Michigan City, Indiana.

The existing federal project is authorized and maintained for a 30-feet approach channel, 28-feet outer harbor, 27-feet east harbor arm, and 27-feet west harbor arm.

The harbor contains both federal and non-federal facilities including 3 stone, sand, and dry bulk cargo docks, (two of which are self-unloaders only), 1 ore unloading dock, and 2 general cargo docks. Eleven berths are owned and administered by the Indiana Port Commission: 1 for grain on the outer harbor, 4 on the East Harbor Arm for handling dry and liquid bulk commodities, 6 on the West Arm primarily used for the shipment and receipt of general cargo. The East Harbor Arm also has a small-boat harbor designed to accommodate working tugs for vessel assistance and barge movement. The Indiana Port Commission also administers the west side of the West Harbor Arm for barge fleeting. The remaining available harbor berthing on the east side of the East Harbor Arm is privately owned (Bethlehem Steel).

Table 3-12 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Burns Harbor.

5.) <u>Calcite Harbor, Michigan</u>. Calcite Harbor is located just southeast of Rogers City, Michigan on the upper northeast side of the Lower Peninsula of Michigan on Lake Huron 3.3 miles west of Adams Point.

Depth through the center channel into the harbor is privately maintained at 26-feet with direct access to rail. The harbor is protected on the north and northwest by a point and breakwater and to the southeast by Quarry Point. The harbor offers no shelter from north

TABLE 3-12
WCSC 1998 Tonnage and 2001 Passenger Data* for Burns Harbor

Cargo		Tonnage
Coal		624,313
Petroleum		145,634
Aggregates		896,255
Grain		166,905
Chemicals		166,905
Ores and Minerals		42,306
Iron and Steel		6,660,042
Other		141,581
Total Cargo		**9,006,079**

* Burns Waterway Harbor is not scheduled to receive passenger traffic during the 2001 season.

to east winds except for small craft, which can enter the tug basin on an emergency only basis.

Calcite harbor contains one terminal operated by Oglebay Norton Co., which acquired Michigan Limestone Operations, Ltd. in April of 2000, handling limestone. Calcite Harbor is private, no operations or maintenance costs are available.

Table 3-13 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Calcite Harbor.

TABLE 3-13
WCSC 1998 Tonnage and 2001 Passenger Data* for Calcite Harbor

Cargo		Tonnage
Aggregates		9,209,317
Ores and Minerals		179,419
Total Cargo		**9,388,736**

* Calcite Harbor is not scheduled to receive passenger traffic.

6.) Calumet Harbor and River, Illinois/Indiana. Calumet Harbor is located at the mouth of the Calumet River on the southwestern shore of Lake Michigan. The harbor is located approximately 14 miles northwest of Gary, Indiana and 12.5 miles south of Chicago Harbor. The harbor is in the south portion of the city of Chicago, IL and comprises an outer harbor protected by breakwaters and the Calumet River.

Calumet Harbor and River combine to form one of the largest inland ports in the world having deep draft traffic from Lake Michigan and barge traffic from the Mississippi

River via the Illinois Waterway.

The area is authorized for a 29-feet approach channel, 28-feet outer harbor, 27-feet river entrance, 27-feet(soft)/ 28-feet(hard) for the river turning basin three, and 27-feet in all remaining areas. Vessels of 1,000-feet or greater length are restricted to the entrance channel and outer harbor. Vessel length and beam limitations are based on a dock length of 1,840-feet and a depth of 27-feet.

The Calumet River and outer harbor contain 33 docks for handling various cargoes. The principal commerce in the port includes receipt of iron ore, coal, and limestone.

Table 3-14 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Calumet Harbor and River.

TABLE 3-14
WCSC 1998 Tonnage and 2001 Passenger Data* for Calumet Harbor

Cargo		Tonnage
Coal		3,556,807
Petroleum		2,085,806
Crude		2,335
Aggregates		1,616,647
Grain		647,033
Chemicals		336,567
Ores and Minerals		1,603,545
Iron and Steel		5,853,363
Other		1,001,375
Total		**16,703,478**

* Calumet Harbor is not scheduled to receive passenger traffic.

7.) Chicago Harbor, Illinois. Chicago Harbor is located in northeast Illinois, on the southwest shore of Lake Michigan, in Cook County, within the corporate limits of the city of Chicago.

Chicago Harbor has 5 docks with 18 berths for passenger excursion boats and 10 for visiting large vessels. Commercial activity in Chicago Harbor evolves around the passenger/tourist industry.

Table 3-15 presents Chicago Harbor WCSC passenger data for the 2001 season.

TABLE 3-15
WCSC 2001 Passenger Data for Chicago Harbor

Vessel	Dockings	Passengers per
Columbus	5	423
Arcadia	4	230

8.) Cleveland Harbor/Cuyahoga River, Ohio. Cleveland Harbor, Ohio is located on Lake Erie approximately 176 miles southwest of Buffalo, New York, and 76 miles east of Toledo Harbor, Ohio.

The harbor is authorized for a depth of 29-feet on the lake approach channel, 28-feet from the west basin and entrance channel to Cuyahoga River, 25-feet-28-feet from the mouth of the Cuyahoga River for approximately 0.25 miles, 27-feet from this point to the junction with Old River to its upper limit, 28-feet from the Cuyahoga River to its upper limit, and 18-feet in the turning basin. Actual depths are 28-feet in the East Basin and 21-feet-23-feet in the Old River.

The harbor contains 72 piers and wharves which handle a variety of commodities including containerized cargo in foreign trade. More than 18 companies, utilizing 1,600 vessel transits per year, depend on the Cuyahoga River as a primary transportation mode for delivery of bulk supplies.

Table 3-16 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Cleveland Harbor

TABLE 3-16
WCSC 1998 Tonnage and 2001 Passenger Data for Cleveland Harbor

Cargo		**Tonnage**
Coal		134,474
Petroleum		461,318
Aggregates		5,744,757
Chemicals		10,605
Ores and Minerals		1,694,037
Iron and Steel		8,772,957
Other		1,046,519
Total		**17,864,667**
Vessel	**Dockings**	**Passengers/docking**
Arcadia	3	230
Niagara Prince	3	84

9.) Conneaut, Ohio. Conneaut Harbor, Ohio is located on Lake Erie approximately 73 miles northeast of Cleveland and 28 miles southwest of Erie, Pennsylvania. The harbor is maintained at the authorized depths of 28-feet(soft)/29-feet(hard) in the easterly outer harbor, 22-feet/23-feet in the westerly outer harbor, 27-feet/28-feet in the inner harbor, and 8-feet in the access channel to the city dock.

The harbor contains 1 ore unloading dock and 2 stone, sand, and dry bulk cargo docks one of which is a self-unloader only. **Table 3-17** presents the WCSC data for the year 1998 and passenger traffic scheduled during the 2001 season for Conneaut Harbor.

TABLE 3-17
WCSC 1998 Tonnage and 2001 Passenger Data* for Conneault Harbor

Cargo		Tonnage
Coal		3,531,549
Aggregates		937,950
Ores and Minerals		19,200
Iron and Steel		3,291,548
Other		5,318
Total		**7,785,565**

* Conneaut Harbor is not scheduled to receive passenger traffic during the 2001 season.

10.) Detroit River, Michigan. The Detroit River, Michigan is located along a 31-mile stretch on the U.S. side of the Detroit River channel, which connects Lake St. Clair with Lake Erie. The harbor has 35 commercial installations used for handling coal, iron ore, limestone, steel products, petroleum products, and other items including overseas general cargo. A new passenger facility is to be constructed at the foot of Clark Street in Southwest Detroit with an expected completion date toward the end of 2002 or near the spring of 2003.

Table 3-18 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Detroit Harbor.

TABLE 3-18
WCSC 1998 Tonnage and 2001 Passenger Data for Detroit River

Cargo		Tonnage
Coal		1,885,558
Petroleum		1,181,896
Aggregates		3,705,284
Grain		11,965
Chemicals		68,849
Ores and Minerals		783,053
Iron and Steel		10,340,697
Other		1,738,876
Total Cargo		**19,716,178**
Vessel	**Dockings**	**Passengers/docking**
Arcadia	23	230

11.) Port Drummond, Michigan. Port Drummond is located on Drummond Island, MI across De Tour Passage, the entrance to St. Mary's River, from De Tour Village on the easternmost end of the Upper Peninsula. The navigation channel depth is 23-feet.

Port Drummond contains a single terminal owned by Osborne Materials Co. handling dolomite and limestone. Total tonnage for 1997 reached 1,522,000. Port Drummond is a private facility.

Table 3-19 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Port Drummond.

TABLE 3-19
WCSC 1998 Tonnage and 2001 Passenger Data* for Port Drummond

Cargo		Tonnage
Aggregates		1,567,879
Ores and Minerals		14,330
Other		198,408
Total Cargo		**1,780,617**

* Port Drummond is not scheduled to receive passenger traffic.

12.) Duluth-Superior Harbor, Minnesota-Wisconsin. Duluth-Superior Harbor, MN-WI is located at the extreme western end of Lake Superior between the cities of Duluth, Minnesota on the north and Superior, Wisconsin on the south.

The harbor contains 113 docks and terminals all privately owned except one, for handling iron ore, coal, limestone, petroleum, steel and scrap iron, cement, general cargo, and grain. **Table 3-20** presents the WCSC data for the year 1998 and passenger traffic scheduled during the 2001 season for Duluth-Superior Harbor.

TABLE 3-20
WCSC 1998 Tonnage and 2001 Passenger Data for Duluth-Superior

Cargo		Tonnage
Coal		15,622,273
Grain		5,158,221
Chemicals		41,672
Ores and Minerals		316,543
Iron and Steel		17,995,754
Other		572,672
Total Cargo		**42,442,971**
Vessel	**Dockings**	**Passengers/docking**
Arcadia	2	230

13.) <u>Escanaba Harbor, Michigan</u>. Escanaba Harbor is situated on the west shore of Little Bay de Noc on northern Lake Michigan in Delta County 6 miles NE of Ford River and 7 miles NW of Peninsula Point. The harbor is 100 miles north of Milwaukee Wisconsin and approximately 110 miles west of the Straits of Mackinaw. Escanaba Harbor is a natural harbor 4.5 miles up Little Bay de Noc, which opens to the south into Green Bay on Lake Michigan. The harbor is 3.5 miles wide at Escanaba with a natural channel adjacent to the west shore, 1.5 miles wide with depths of 28-feet to 40-feet within 0.4 mile of shore.

The area under consideration extends from the Escanaba River on the north to sand point and the Escanaba Yacht Club on the south.

The harbor contains 3 private terminals handling coal, limestone, salt, and iron ore. Total tonnage for 1996 was 9,253,000; of this, iron ore comprised 8,405,000 tons. During the week ending June 2, 2001, the Sault Ste. Marie Bridge Co. loaded six vessels here with 163,628 tons of iron ore pellets bound for Indiana Harbor. The Escanaba Marina has a total of 165 boat slips, docks and moorings with designated seasonal and transient berthings. The harbor has highway access through US-2, US-41, and M-35 and rail access through Escanaba & Lake Superior Railroad and Wisconsin Central Ltd.

Escanaba Harbor is private. In 2000, the City of Escanaba and the Michigan State Waterways Commission constructed new Harbor Service Buildings with restrooms, showers, laundry accommodations and office space. The project included construction of 400-feet of broadside docking for vessels 60-feet and larger, parking and landscaping.

Table 3-21 presents the WCSC data for the year 1998 and passenger traffic scheduled during the 2001 season for Escanaba Harbor.

TABLE 3-21
WCSC 1998 Tonnage and 2001 Passenger Data* for Escanaba Harbor

Cargo		**Tonnage**
Coal		243,016
Aggregates		596,385
Iron and Steel		7,690,447
Total Cargo		**8,529,848**

* Escanaba Harbor is not to receive passenger traffic during the 2001 season.

14.) <u>Fairport Harbor, Ohio</u>. Fairport Harbor, Ohio is located on the south shore of Lake Erie at the mouth of Grand River, 33 miles east of Cleveland, OH.

The harbor contains at least 19 public and private facilities along the Grand River handling salt, sand, chemicals, steel, stone and several charter fishing companies and yacht clubs. One facility is owned by the Coast Guard, 9 have railroad connections and ten mechanical-handling facilities.

Table 3-22 presents the WCSC data for Fairport Harbor for the year 1998.

TABLE 3-22
WCSC 1998 Tonnage and 2001 Passenger Data* for Fairport Harbor

Cargo		**Tonnage**
Aggregates		2,278,005
Ores and Minerals		601,547
Total Cargo		**2,879,552**

* Fairport Harbor has no passenger traffic scheduled for the 2001 season.

15.) Gary, Indiana. Gary Harbor, Indiana is a private, entirely artificial harbor located at the southern end of Lake Michigan approximately 22 miles southwest of Michigan City, Indiana and 26 miles southeast of Chicago. The entire harbor was developed and is owned by the United States Steel Corporation.

The harbor contains the non-federal dock facility of U.S. Steel Corporation. Existing-water depth in the non-federal harbor varies from 18-feet to 33-feet.

Table 3-23 presents the WCSC data for Gary Harbor for the year 1998.

TABLE 3-23
WCSC 1998 Tonnage and 2001 Passenger Data* for Gary Harbor

Cargo		**Tonnage**
Coal		141,076
Petroleum		8,387
Aggregates		194,003
Ores and Minerals		1,658
Iron and Steel		8,580,925
Other		157,021
Total Cargo		**9,083,070**

* Gary Harbor is not scheduled to receive passenger traffic during the 2001 season.

16.) Greenbay, Wisconsin. Green Bay Harbor, Wisconsin is located at the mouth of Fox River at the head of Green Bay, about 180 miles from Milwaukee, WI via Sturgeon Bay Canal, and about 49 miles southwest of Marinette/Menominee Harbor, MI/WI.

Authorized depths are maintained at 26-feet and 24-feet sections in the entrance channel, 24-feet in the lower Fox River and turning basin, 20-feet in the middle turning basin, and 18-feet in the upper Fox River and turning basin. The dock length of 1,100-feet is the only limitation on vessel length.

The harbor contains 16 wharves containing 37 docks for the handling of coal, petroleum products, cement, limestone, general overseas cargo and miscellaneous commodities. The 3 coal docks and the 2 stone, sand and dry bulk cargo docks are self-unloaders only.

Table 3-24 presents the WCSC data for the year 1998 and passenger traffic scheduled during the 2001 season for Green Bay Harbor.

TABLE 3-24
WCSC 1998 Tonnage and 2001 Passenger Data for Green Bay Harbor

Cargo		**Tonnage**
Coal		694,953
Petroleum		56,861
Aggregates		790,297
Chemicals		23,340
Ores and Minerals		315,653
Iron and Steel		63,738
Other		408,083
Total Cargo		**2,352,925**
Vessel	**Dockings**	**Passengers/docking**
Arcadia	2	230

17.) Indiana Harbor, Indiana. Indiana Harbor is in East Chicago, Indiana, on the southwest shore of Lake Michigan in Lake County, 19 miles southeast of Chicago Harbor and 31 miles west of Michigan City, Indiana.

The project study area includes the outer harbor and entrance channel and the Indiana canal entrance channel, all of which are at 27-feet or greater water depth.

The harbor contains 15 docks and wharves, 6 for handling iron ore and limestone, 6 for petroleum products, and 3 for gypsum, scrap metal and steel, and bulk products. Not all docks are currently being used for the shipment or receipt of waterborne commodities.

Table 3-25 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Indiana Harbor.

18.) Lorain Harbor, Ohio. Lorain Harbor, Ohio is located 25 miles west of Cleveland, OH on the south shore of Lake Erie at the mouth of the Black River.

Lorain Harbor has existing federal project limits that are at a depth of 27-feet, 1,000-feet or greater vessels are limited to the outer harbor, and the Black River channel is limited to vessels 730-feet or less.

TABLE 3-25
WCSC 1998 Tonnage and 2001 Passenger Data* for Indiana Harbor

Cargo		**Tonnage**
Coal		183,129
Petroleum		2,181,328
Crude		2,335
Aggregates		1,121,686
Grain		32,326
Chemicals		36
Ores and Minerals		32,682
Iron and Steel		10,902,878
Other		453,198
Total Cargo		**14,909,598**

* Indiana Harbor is not scheduled to receive passenger traffic during the 2001 season.

This harbor has 23 piers and wharves, 3 of which are on the outer harbor with the remainder along the banks of a Black River. The city owns 2 terminals, 8 have railroad connections, and 15 have mechanical-handling facilities.

Table 3-26 presents the WCSC data for Lorain Harbor for the year 1998 and the passenger traffic scheduled during the 2001 season.

TABLE 3-26
WCSC 1998 Tonnage and 2001 Passenger Data* for Lorain Harbor

Cargo		**Tonnage**
Aggregates		551,619
Ores and Minerals		15,757
Iron and Steel		13,521,105
Other		77,978
Total Cargo		**14,166,459**

* Lorain Harbor is not scheduled to receive passenger traffic during the 2001 season.

19.) Marinette/Menominee, Wisconsin/Michigan. The Marinette Fuel and Dock Co. shipped 259,902 tons in 1999 and 283,208 tons in 2000 consisting of 196,634 tons of pig iron, 50,375 tons of road salt, 15,933 tons of coal, 16,500 tons of limestone, and 3,766 tons of pulp. All commodities were up in 2000 from 1999 figures except pulp.

The harbor is located on Lake Michigan at the mouth of Menominee River on the western shore of Green Bay, 16 miles northwest of the mouth of Sturgeon Bay, 49 miles northeast of Green Bay Harbor, and about 155 miles from Milwaukee via Sturgeon Bay Canal. The Menominee River forms the boundary between the commercial harbors at Marinette, WI and Menominee, MI. Local authorities have requested dredging assistance.

The harbor contains 9 wharves for the handling of coal, limestone, pulp and miscellaneous commodities. The city of Marinette, WI provides a public wharf.

Table 3-27 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Marinette/Menominee Harbor.

TABLE 3-27
WCSC 1998 Tonnage and 2001 Passenger Data* for Marinette/Menominee Harbor

Cargo		**Tonnage**
Coal		10,309
Aggregates		134,107
Chemicals		152
Ores and Minerals		37,847
Iron and Steel		181,433
Other		23,751
Total		**387,599**

* Marinette/Menominee Harbor is not scheduled for passenger traffic in 2001.

20.) Milwaukee Harbor, Wisconsin. Milwaukee Harbor is located on the west shore of Lake Michigan approximately 85 miles north of Chicago, Illinois, and approximately 83 miles west of Grand Haven, Michigan. It is a harbor of refuge covering 3.5 miles of shoreline with the main entrance in the center and breakers on the north and south.

The harbor contains 4 car-ferry slips and 57 other wharves, both private and municipal, used for handling coal, grain, building materials, cement, petroleum products, and miscellaneous commodities. Facilities in the inner harbor were inadequate for existing commerce, so Milwaukee Harbor Commission constructed nine docks in the outer harbor for handling general cargo.

Table 3-28 presents the WCSC data for the year 1998 and passenger traffic scheduled during the 2001 season for Milwaukee Harbor.

21.) Monroe Harbor, Michigan. Monroe Harbor, Michigan is located at the mouth of the River Raisin on Lake Erie, approximately 36 miles south of Detroit, Michigan and 14 miles north of Toledo, Ohio.

WRDA 1986 authorized modifications to: deepen the River Raisin portion of the existing 200-feet navigation channel from 21 to 27-feet, widen the channel from 200 to 500-feet for a distance of approximately 47,000-feet from the river's mouth to the Maumee Bay Entrance Channel, dredge a new turning basin 24-feet deep with a diameter of at least 1,600-feet at the river's mouth, and construct a 190 acre confined disposal area in Plum Creek Bay. These harbor modifications have not yet been accomplished.

TABLE 3-28
WCSC 1998 Tonnage and 2001 Passenger Data for Milwaukee Harbor

Cargo		Tonnage
Coal		771,535
Petroleum		230,278
Aggregates		188,921
Grain		241,360
Chemicals		295
Ores and Minerals		915,441
Iron and Steel		204,635
Other		555,963
Total Cargo		**3,108,428**
Vessel	**Dockings**	**Passengers/docking**
Arcadia	4	230
Niagara Prince	7	84

Monroe Harbor has several privately owned docks and a municipal terminal handling coal, asphalt, asphalt flux, coke, limestone, and traprock. Total tonnage for 1997 was 2,673,653, comprised of 2,573,000 tons of coal.

Table 3-29 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Monroe Harbor.

TABLE 3-29
WCSC 1998 Tonnage and 2001 Passenger Data* for Monroe Harbor

Cargo		Tonnage
Coal		1,646,560
Petroleum		71,141
Aggregates		13,024
Ores and Minerals		48,501
Iron and Steel		24,970
Other		125,298
Total Cargo		**1,929,494**

* Monroe Harbor is not scheduled to receive passenger traffic during the 2001 season.

22.) Presque Isle/Marquette, Michigan. Presque Isle Harbor is located on the south shore of Lake Superior within the city limits of the city of Marquette, Michigan. The harbor is 158 miles west of Sault Ste. Marie, Michigan and 255 miles east of Duluth, Minnesota. The bay that forms the harbor is an indentation of about one-half mile into the west coast line of Lake Superior and extends about one and one-half miles in a north-south direction along the coast. Presque Isle Point protects the harbor on the north. The harbor opens directly into Lake Superior to the east.

The harbor has a breakwater 2,816-feet long off Presque Isle Point. The irregular shape of the dredged harbor consists of an inner harbor and an adjoining outer harbor. The inner harbor is 1,000-feet wide at the dock area, with a maximum width of 2,300-feet. It is approximately 50 acres in area and has a project depth of 28-feet. The outer harbor adjoins the inner harbor at its southern extremity, widens to a maximum width of 3,000-feet, is approximately 38 acres in size, and has a project depth of 30-feet. Together, the inner and outer harbors provide a combined length of 2,800-feet on a direct line from the major dock area to the 30-feet contour in Lake Superior.

The only dock included in the project study area is the Lake Superior and Ishpeming R.R. Ore Dock #2, (L.S. & I. R.R.) which is at 27-foot depth.

The harbor contains two terminals handling coal, iron ore, and limestone with a total tonnage of 10,557,000 in 1998, including 7,612,000 tons of iron ore. Vessels utilizing the harbor are limited to a length of 1,000-feet and a beam of 54-feet.

Table 3-30 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Presque Isle Harbor.

TABLE 3-30
WCSC 1998 Tonnage and 2001 Passenger Data for Presque Isle Harbor

Cargo		**Tonnage**
Coal		1,994,618
Aggregates		917,398
Iron and Steel		8,439,227
Total Cargo		**11,351,243**

* Presque Isle Harbor is not scheduled to receive passenger traffic during the 2001 season.

23.) Rouge River, Michigan. The Rouge River rises in Oakland and Washtenaw Counties and is 30 miles long flowing southeasterly through Wayne County and joining Detroit River at the westerly limit of the city of Detroit, Michigan.

The river contains numerous large commercial docks for handling various types of cargo. **Table 3-31** presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for the Rouge River.

24.) Saginaw, Michigan. Saginaw River is formed by the union of Tittabawassee and Shiawassee Rivers, 22 miles long, and flows northerly into the extreme inner end of Saginaw Bay, Lake Huron. The Bay is 26 miles wide at its entrance between Point aux Barques to the southeast and Au Sable Point to the northwest, extending about 52 miles to its head.

The river contains 24 large commercial docks for handling animal feed, bulk commodities, calcium chloride, cement, cement clinker, coal, fertilizer, general cargo,

TABLE 3-31
WCSC 1998 Tonnage and 2001 Passenger Data* for Rouge River

Cargo		**Tonnage**
Coal		1,173,123
Petroleum		745,444
Aggregates		2,821,988
Grain		30
Chemicals		2,903
Ores and Minerals		411,074
Iron and Steel		7,051,329
Other		419,771
Total Cargo		**12,625,662**

* The Rouge River is not scheduled to receive passenger traffic during the 2001 season.

grain, heavy equipment, petroleum, potash, salt, sand, slag, and stone. Total tonnage for 1996 was 5,264,000, stone and sand comprised the largest segment involving 3,756,000 tons.

Table 3-32 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Saginaw/Lake Huron.

TABLE 3-32
WCSC 1998 Tonnage and 2001 Passenger Data* for Saginaw River

Cargo		**Tonnage**
Petroleum		12,891
Aggregates		1,847,653
Chemicals		38,799
Ores and Minerals		298,144
Other		75,681
Total Cargo		**2,273,168**

* Saginaw River is not scheduled to receive passenger traffic during the 2001 season.

25.) Sandusky Harbor, Ohio. Sandusky Harbor, Ohio is located on the south shore of Lake Erie in the southeastern portion of Sandusky Bay, 50 miles west of Cleveland, Ohio.

The harbor contains 14 piers and wharves, 3 at the west end of the harbor and the remainder along the dock channel. One facility is a base for State-owned fish research and patrol boats. Seven other sites are used for mooring fishing boats and recreational craft and for ferry service, one publicly owned and six privately owned. Five terminals have railroad connections and 5 have mechanical handling facilities.

Table 3-33 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Sandusky Harbor.

TABLE 3-33
WCSC 1998 Tonnage and 2001 Passenger Data* for Sandusky Harbor

Cargo		**Tonnage**
Coal		4,158,911
Petroleum		50
Aggregates		54,305
Chemicals		15
Ores and Minerals		47,326
Other		72,963
Total Cargo		**4,333,570**

* Sandusky Harbor is not scheduled to receive passenger traffic during the 2001 season.

26.) Saugatuck, Michigan. Saugatuck Harbor, Michigan is located on the east shore of Lake Michigan, 90 miles northeast of Chicago, Illinois and 22 miles north of South Haven, Michigan.

At the city of Saugatuck, Michigan, there are several landing places for recreational craft and one for small commercial vessels. At the village of Douglas, Michigan, there is a landing pier.

WCSC data for Saugatuck Harbor does not indicate any cargo traffic for the year 1998. **Table 3-34** presents the passenger traffic scheduled during the 2001 season for Saugatuck Harbor.

TABLE 3-34
WCSC 2001 Passenger Data* for Saugatuck Harbor

Vessel	**Dockings**	**Passengers/docking**
Le Levant	2	90

* Saugatuck Harbor did not receive any cargo traffic in 1998.

27.) Sheboygan, Wisconsin. Sheboygan Harbor, Wisconsin is located on the west shore of Lake Michigan approximately 26 miles south of Manitowoc and 55 miles north of Milwaukee, Wisconsin.

The North Breakwater extends 3,300-feet, the South Breakwater 2,340-feet into Lake Michigan. The harbor has 3 wharves for handling coal, petroleum products, and miscellaneous commodities and the city provides a public wharf.

WCSC data for the year 1998 indicates no cargo traffic for Sheboygan Harbor Sheboygan Harbor is not scheduled to receive passenger traffic during the 2001 season.

28.) Silver Bay, Minnesota. Silver Bay Harbor, Minnesota is a non-federal, private harbor and is located on Lake Superior approximately 51 miles northeast of Duluth, Minnesota and 5 miles southwest of Taconite Harbor, Minnesota.

Lake Superior Water Trail of Minnesota has issued a caution to boaters in the area; "Large, commercial vessels transit this area 24 hours a day."
The harbor is the home of the Reserve Mining Co. handling iron ore.

Table 3-35 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Silver Bay Harbor.

TABLE 3-35
WCSC 1998 Tonnage and 2001 Passenger Data* for Silver Bay Harbor

Cargo		**Tonnage**
Coal		414,522
Aggregates		182,018
Iron and Steel		4,585,325
Total Cargo		**5,181,865**

* Silver Bay Harbor is not scheduled to receive passenger traffic during the 2001 season.

29.) St. Clair, Michigan. The Detroit Edison Company Power Plant and coal receiving dock is the major commercial dock facility on the St. Clair River, which connects Lake Huron on the north to Lake St. Clair. The dock is located on the west, United States, side of the river, 4 miles downstream from the city of St. Clair, Michigan and 18 miles downstream from the foot of Lake Huron.

The St. Clair River in the dock area is approximately 1700-feet wide and has a natural channel depth of 27-feet to 32-feet. The federal channel at Marine City, Michigan, 3 miles below the Detroit Edison dock, and at St. Clair, Michigan, 4 miles above the dock, is maintained at a project depth of 27.3-feet and a dredged channel width of 900 and 1000-feet respectively. In the 1986 study, the only dock considered for potential improvement on the St. Clair River was the Detroit Edison Company St. Clair Power Plant coal receiving dock.

The St. Clair River serves through traffic between the upper and lower Great Lakes. A number of privately owned piers and wharves are at Port Huron, Marysville, St. Clair, and Marine City, Michigan which handle coal, limestone, petroleum products, wood-pulp, salt, and general cargo.

Federal facilities in the harbor area are limited to the St. Clair River Channel. At the time of the 1986 study, the current fleet vessels up to 1000-feet length successfully maneuvered in, out, and turned around in the limited unloading slip area plus the approximately 1000-feet of channel width available.

Table 3-36 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for St. Clair River.

TABLE 3-36
WCSC 1998 Tonnage and 2001 Passenger Data* for St. Clair River

Cargo		**Tonnage**
Coal		5,492,996
Petroleum		38,291
Chemicals		1,190
Other		172
Total Cargo		**5,532,649**

* St. Clair River is not scheduled to receive passenger traffic during the 2001 season.

30.) Stoneport Harbor, Michigan. Stoneport Harbor, Michigan is a non-federal, private harbor located on Lake Huron approximately 20 miles north of Alpena, 4 miles south southeast of Presque Isle Harbor, and 7 miles north northwest of Rockport Harbor servicing one of the largest stone quarries in the U.S.

Depths along the northeast pier range from 25-feet to 28-feet with areas of 18, 12, and 6-feet moving toward the shore with a length of 950-feet along the pier and a width of 1,110-feet in a westerly direction from the tip of the pier to the shore.

The facility at Stoneport Harbor is privately maintained by Lafarge Corporation, which purchased all of the outstanding stock of Presque Isle Corporation in July of 2000.

Table 3-37 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Stoneport Harbor.

TABLE 3-37
WCSC 1998 Tonnage and 2001 Passenger Data for 2001 Stoneport Harbor

Cargo		**Tonnage**
Aggregates		9,113,958
Total Cargo		**9,113,958**

* Stoneport Harbor is not scheduled to receive passenger traffic.

31.) Taconite Harbor, Minnesota. Taconite Harbor, MN is a non-federal, private harbor and is located on Lake Superior approximately 76 miles northeast of Duluth, MN and 25 miles northeast of Silver Bay, MN.

Table 3-38 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Taconite Harbor.

TABLE 3-38
WCSC 1998 Tonnage and 2001 Passenger Data* for Taconite Harbor

Cargo		**Tonnage**
Coal		645,592
Iron and Steel		8,114,994
Total Cargo		**8,760,586**

* Taconite Harbor is not scheduled to receive passenger traffic.

32.) Toledo Harbor, Ohio. Toledo Harbor, Ohio is located on Lake Erie approximately 76 miles west of Cleveland, Ohio, and 61 miles south of Detroit, Michigan.

The Port of Toledo contains 35 piers, wharves, and docks. Seven are located on Maumee River and 28 are equally divided along the right and left banks of the lower 7 miles of the Maumee River. The Toledo-Lucas County Port Authority Facility No. 1 Wharf handles conventional and containerized general cargo as well as an increasing amount of miscellaneous bulk materials. Fifteen of the terminals have rail connections and mechanical handling facilities.

Table 3-39 presents the WCSC data for the year 1998 and the passenger traffic scheduled during the 2001 season for Toledo Harbor.

TABLE 3-39
WCSC 1998 Tonnage and 2001 Passenger Data for Toledo Harbor

Cargo		**Tonnage**
Coal		5,518,109
Petroleum		631,195
Aggregates		349,797
Grain		1,777,515
Chemicals		220,968
Ores and Minerals		332,846
Iron and Steel		4,240,341
Other		157,820
Total Cargo		**13,228,591**
Passenger Traffic scheduled in 2002		

* Toledo Harbor is not scheduled to receive passenger traffic during the 2001 season.

33.) Two Harbors, Minnesota. Two Harbors, Minnesota is located on Lake Superior on the north side of Agate Bay, approximately 26 miles northeast of Duluth, Minnesota and 25 miles southwest of Silver Bay, Minnesota.

Two Harbors contains 3 ore docks, a tug wharf, an unused coal dock, and a merchandise wharf which are all privately owned, there are no publicly owned wharves.

Table 3-40 presents the WCSC data for Two Harbors for the year 1998.

TABLE 3-40
WCSC 1998 Tonnage and 2001 Passenger* Data for Two Harbors

Cargo		**Tonnage**
Iron and Steel		13,222,545
Total Cargo		**13,222,545**

* Two Harbors is not scheduled to receive passenger traffic during the 2001 season.

c. Canadian Great Lake/St. Lawrence Seaway Harbors. There are over 100 Canadian harbors on the Great Lakes and the St. Lawrence River. **Table 3-41** lists a selected few of these harbors, displaying their year 2000 traffic and current depth. Formulation of deepening plans might begin with, but would not be limited to, these ports.

TABLE 3-41
Great Lakes/St. Lawrence Seaway Selected Canadian Harbors

No.	**Harbor**	**2000 Traffic (in ktons)**	**Harbor Depth (in feet)**
1.	Montreal, QUE	1,832	35
2.	Toronto, ONT	1,334	27
3.	Hamilton, ONT	11,819	27
4.	Nanticoke, ONT	574	30
5.	Windsor, ONT	1,756	27
6.	Sault St. Marie, ONT	300	23
7.	Thunder Bay, ONT	6,455	27

SECTION 4. HISTORIC AND PROJECTED GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC

1. DATA SOURCES AND DEFICIENCIES

Traffic analysis and forecasting for the Great Lakes and St. Lawrence Seaway was complicated by the lack of a consistent and comprehensive traffic database that would be adequate for navigation modeling purposes. The traffic data maintained by six separate entities were used for various purposes in the current analysis. These include data from the Waterborne Commerce Statistics Center (WCSC), Detroit District's Soo Area Office, Statistics Canada, the Lake Carriers' Association, the Saint Lawrence Seaway Development Corporation, and the St. Lawrence Seaway Management Corporation.

WCSC maintains separate collection systems for U.S.-U.S. and foreign (meaning foreign-U.S. or U.S.-foreign) traffic data. U.S.-U.S. traffic data are reported directly to WCSC by shippers. Foreign traffic data were, until recently, collected separately by the Census Bureau in cooperation with the Maritime Administration and provided to WCSC. Data items presented in the foreign traffic database are somewhat less extensive than the U.S.-U.S. database.

The Soo Area Office traffic data are Soo Locks data collected at the locks. These data are collected from ship captains whose vessels are transiting the locks. The data provided are much less extensive than the information in the waterborne commerce database, but it does include origin-destination information. Units of measurement reported are sometimes inconsistent from vessel to vessel, and conversions to short tons are done at the Soo Area Office.

Statistics Canada collects origin-destination shipping data for domestic and international Canadian waterborne traffic. These data are based both on customs reports and surveys of the shippers involved with the waterborne movements. The Statistics Canada commodity traffic used in the current analysis was the Canada-Canada; Canada-foreign; and foreign-Canada traffic. Canada-U.S. and U.S.-Canada traffic data are from Waterborne Commerce Statistics Center databases.

The St. Lawrence Seaway Management Corporation and the Saint Lawrence Seaway Development Corporation collect commodity traffic data from shippers prior to vessels transiting locks on the St. Lawrence Seaway. Information is collected only for vessels that generate tolls, meaning vessels that transit locks. The traffic data collected is subsequently summarized and published in an annual Seaway traffic report.

The Lake Carriers Association, which represents operators of U.S.-flag self-propelled vessels on the Great Lakes, collects annual traffic and vessel data from its member companies. These data include physical data on the ships, traffic volumes by commodity, port volumes, cross-lakes traffic, and traffic volumes at the Soo Locks. These data are summarized and published in the Lake Carriers' annual report.

For purposes of historic description and trend analysis, the data from the Lake Carriers' Association and the St. Lawrence Seaway Management Corporation and Saint Lawrence Seaway Development Corporation were used. For forecasting and navigation modeling, the Waterborne Commerce Statistics Center data were used in combination with the Canada-Canada; Canada-foreign; and foreign-Canada data from Statistics Canada. Time and resource constraints prevented the assembly of WCSC and Statistics Canada data for any more than one historic year. The year chosen for the analysis was calendar year 1998.

2. HISTORIC TRAFFIC

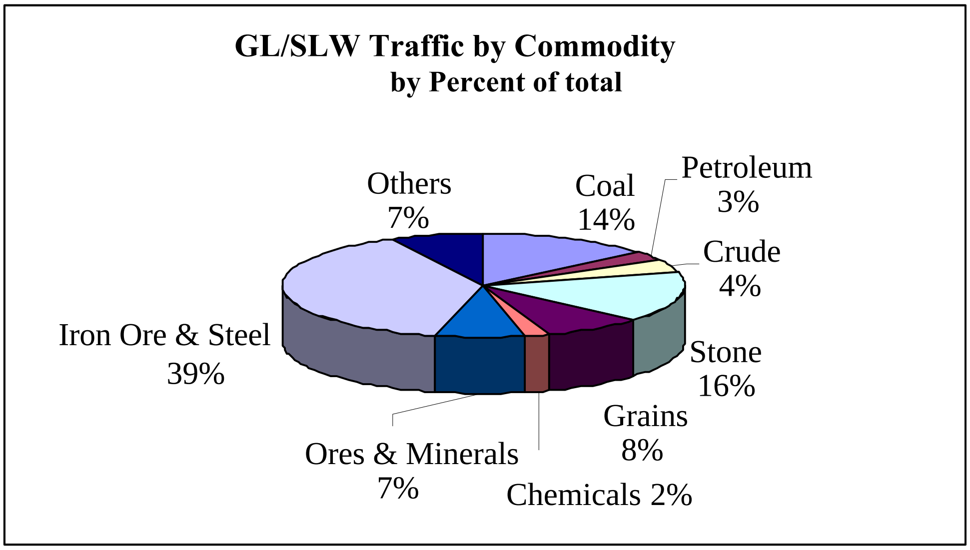
a. General. There are a multitude of meaningful waterway definitions that apply to the navigable waterways of the Great Lakes/St. Lawrence River basin. A description of the basin-wide Great Lakes/St. Lawrence Waterway (GL/SLW) serves as a useful backdrop for the subsequent focus on its major subsystem, the Great Lakes/St. Lawrence Seaway (GL/SLS). In describing the GL/SLS, its two major components, the Great Lakes Navigation System (GLNS) and the St. Lawrence Seaway, are also examined. To facilitate these discussions a 1998 database including both U.S. and Canadian waterway traffic from three data sets: U.S. Waterborne Commerce Statistic data, Statistics Canada (as prepared for Transport Canada by TAF Consultants) data, and Detroit District U.S. Army Corps of Engineers' Soo Area Office data.

While this basin-wide-constructed database provides detailed origin, destination, and commodity information, the difficulty in assembling and compiling the necessary data prevented preparation of more than the 1998 data set. Comprehensive (bi-national) time-series data displays are available only for the Seaway as prepared and presented by the two Seaway corporations. No such time series displays are available for the GLNS. U.S. domestic and U.S. foreign traffic data is available from the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center for the GLNS. It is also available from the Lake Carriers Association (LCA). As a matter of convenience, the LCA data are used, along with the Seaway corporation displays, in the discussion of past traffic trends.

b. GL/SLW. This all-encompassing definition includes all navigable waterways from Lake Superior to the Gulf of St. Lawrence. No historic series of data are readily available; however, as mentioned above, a comprehensive 1998 data base has been constructed from three separate data sets – one Canadian, the other two U.S. An examination of the GL/SLW system is useful in describing the general waterborne commodity flows in the basin.

Iron ore and steel, stone and coal (see **Figure 4-1**) dominate shipments on the GL/SLW. All four commodities support the steel industry in part or in whole, though shipments of coal are primarily to electric utilities. Both the agriculture and aluminum industries are also important waterway users. An important trade, not apparent from the figure below, is containers. Containers hold a wide variety of commodities and, though low in volume, this traffic is high in per ton value. Imports of finished or semi-finished commodities dominate the container trade. The vast majority of this traffic occurs at the Port of Montreal, below St. Lamberts lock, in the deepwater, lower reaches of the St. Lawrence River.

FIGURE 4-1



Shipments and receipts to U.S. ports dominate GL/SLW traffic, though Canada and overseas countries make heavy use of the basin waterways (see **Table 4-1**). Shipments between U.S. ports are the largest flow (127.6 million tons), flows from Canada to overseas countries are the next largest flow (39.6 million tons), followed by flows between Canadian ports (37.4 million tons). The trade between Canada and the U.S. totals 52.9 million tons (U.S. to Canada 32.4 million tons plus Canada to U.S. 20.5 million tons).

TABLE 4-1
GL/SLW System, 1998 Traffic by Country

	Origin			
Destination	**U.S.**	**Canada**	**Overseas**	**Total**
U.S.	127.6	20.5	5.9	154.0
Canada	32.4	37.4	28.6	98.5
Overseas	4.6	39.6	0.0	44.2
Total	164.6	97.6	34.5	296.6

Source: Canadian waterborne shipment database prepared by TAF Consultants for Transport Canada using Statistics Canada data, and waterborne commerce data collected and compiled by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

The GL/SLW encompasses two important, overlapping subsystems – the Great Lakes/St. Lawrence Seaway System and the St. Lawrence River. Great Lakes traffic dominates

GL/SLS, while the St. Lawrence River serves both a connection between the Great Lakes and the sea and as a coastal deepwater port region for Canada. Iron ore and steel account for over one third of all traffic on both the GL/SLS and the St. Lawrence River, but they differ with respect to the other major commodities (see **Table 4-2**). On the GL/SLS aggregates account for over 20 percent of traffic, coal nearly 20 percent. On the St. Lawrence River, grains are the second largest commodity, accounting for over 25 percent of traffic. Coal and stone each account for less than 10 percent of St. Lawrence River traffic.

TABLE 4-2
GL/SLW System, 1998 Traffic on Major Subsystems

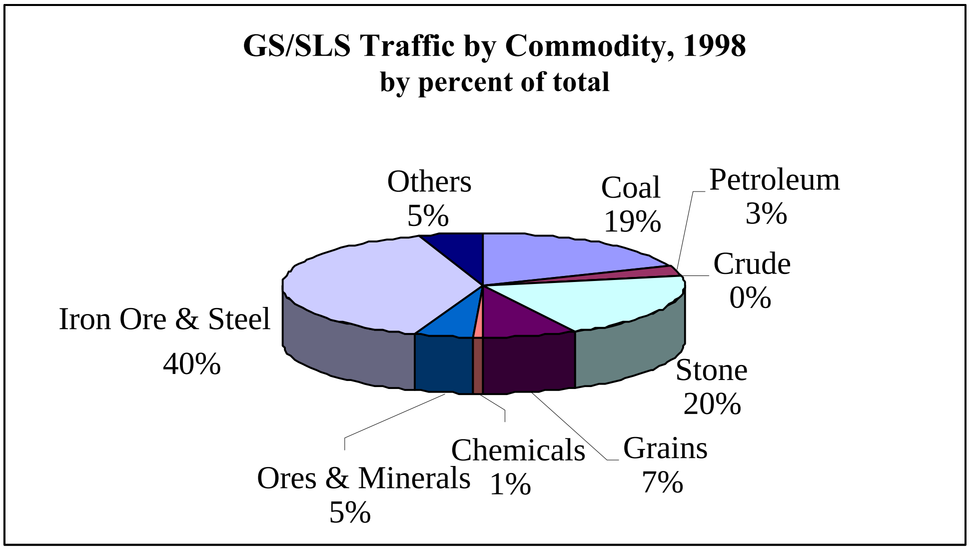
Major Commodity Group	GL/SLS		St. Lawrence River[1]		GL/SLW	
	Traffic	%	Traffic	%	Traffic	%
Coal & Coke	41.5	18.7%	1.6	9.6%	41.8	14.1%
Petroleum Fuels	7.3	3.3%	8.5	5.1%	8.5	2.9%
Crude	0.6	0.3%	7.1	1.0%	12.3	4.2%
Aggregates	45.1	20.3%	2.1	6.8%	46.0	15.5%
Grains	16.5	7.4%	19.7	25.5%	23.8	8.0%
Chemicals	1.9	0.8%	4.9	2.1%	5.8	2.0%
Ores & Minerals	10.8	4.9%	12.2	6.6%	21.4	7.2%
Iron Ore	77.6	35.0%	36.9	31.7%	103.3	34.8%
Iron & Steel	9.4	4.2%	10.7	9.2%	11.5	3.9%
Others	11.4	5.1%	12.8	5.8%	22.2	7.5%
Total	222.0	100.0%	116.5	100.0%	296.6	100.0%

Source: Canadian waterborne shipment database prepared by TAF Consultants for Transport Canada using Statistics Canada data, and waterborne commerce data collected and compiled by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

c. GL/SLS. As mentioned above and shown in **Figure 4-2** the movement of iron ore and steel, coal and stone dominates Great Lakes/St. Lawrence Seaway (GL/SLS) traffic. Again, all four commodities support the steel industry in part or in whole, though shipments of coal are primarily to electric utilities. The agriculture industry is also an important waterway user, shipping grains from Lake Superior ports through the St. Lawrence Seaway to ports along the lower St. Lawrence (mostly for eventual shipment overseas) or directly to overseas destinations.

[1] Of the 116.5 million tons of St. Lawrence River traffic, 42.0 million tons are Seaway traffic, the other 74.4 million tons is vessel traffic that does not use the Seaway. Canadian exports of iron ore and grain to overseas destinations, and Canadian imports of ores, petroleum products, and containerized products dominate this trade.

FIGURE 4-2



The difference between GL/SLW and GL/SLS traffic is the 74.4 million tons of lower St. Lawrence River traffic, waterborne commerce that uses neither the Seaway nor the Great Lakes.[2] None of this deepwater St. Lawrence River traffic is with the U.S., making the U.S. component of the GL/SLS trade dominated even more heavily by waterborne trade between U.S. ports (127.6 million tons). The next three largest flows are traffic from the U.S. to Canada (32.4 million tons), from Canada to Canada (26.1 million tons), and from Canada to the U.S. (20.5 million tons). The overseas trade is relatively small, 9.4 million tons enter the GL/SLS as imports, and 6.0 million tons leave the GL/SLS as exports from Canada and the U.S. to overseas destinations (see **Table 4-3**).

TABLE 4-3
GL/SLS System, 1998 Traffic by Country

	Origin			
Destination	**U.S.**	**Canada**	**Overseas**	**Total**
U.S.	127.6	20.5	5.9	154.0
Canada	32.4	26.1	3.4	62.0
Overseas	4.6	1.4	0.0	6.0
Total	164.6	48.1	9.4	222.0

Source: Canadian waterborne shipment database prepared by TAF Consultants for Transport Canada using Statistics Canada data, and waterborne commerce data collected and compiled by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

Downbound flows dominate both the Canadian and U.S. waterborne commodity flows (see **Table 4-4**). The movement of iron ore from U.S. ports on Lake Superior to steel mills along Lake Michigan, the Detroit River, Lake Erie and Lake Ontario is the largest

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[2] Grains that originate on the upper lakes and move through the Seaway are stored in elevators along the lower St. Lawrence for eventual loading into ocean-going vessels. The 74.4 million tons of non-Seaway traffic cited here include these transshipments.

commodity flow (60.4 million tons). The second and fourth largest flows are aggregates moving from U.S. ports on Lake Huron and Lake Erie, primarily to iron ore processing mills on Lake Superior, steel mills, and construction material yards in major metropolitan areas. Downbound flows of coal are the third largest commodity flow; Powder River Basin coals moving from Lake Superior to lakeside electric utility plant in both the U.S. and Canada dominate this flow. The fifth largest flow is Quebec/Labrador iron ores moving up the St. Lawrence River to steel mills primarily on lakes Ontario and Erie. Grain moves are almost exclusively downbound and are almost equally divided between U.S. and Canadian origins. The largest upbound flows are coal and aggregates from U.S. origins and iron ore and steel from Canadian origins. Upbound flows from overseas origins are concentrated in the iron ore and steel commodity group.

TABLE 4-4
GL/SLS System, 1998 Traffic by Originating Country and Direction

		Downbound		
Commodity Group	**U.S. Origin**	**Canada Origin**	**Overseas Orig.**	**Total**
Coal & Coke	20.0	1.5	N/A	21.4
Petroleum Fuels	2.6	1.6	N/A	4.2
Crude	*	0.6	N/A	0.6
Aggregates	21.3	6.8	N/A	28.1
Grains	7.2	9.0	N/A	16.1
Chemicals	0.2	0.9	N/A	1.1
Ores & Minerals	1.0	4.0	N/A	5.0
Iron Ore	59.7	0.3	N/A	60.0
Iron & Steel	0.7	0.1	N/A	0.8
Others	2.2	3.6	N/A	5.8
Total	115.0	28.2	N/A	143.2
		Upbound		
Commodity Group	**U.S. Origin**	**Canada Origin**	**Overseas Orig.**	**Total**
Coal & Coke	19.9	0.1	0.1	20.0
Petroleum Fuels	1.4	1.5	0.2	2.9
Crude	0.6	*	0.0	0.2
Aggregates	16.0	0.9	*	16.9
Grains	0.2	*	0.1	0.3
Chemicals	0.5	*	0.2	0.7
Ores & Minerals	1.3	3.9	0.6	5.8
Iron Ore	6.2	11.4	0.0	17.6
Iron & Steel	0.8	0.5	7.4	8.6
Others	3.6	1.4	0.7	5.7
Total	49.7	19.8	9.4	78.8

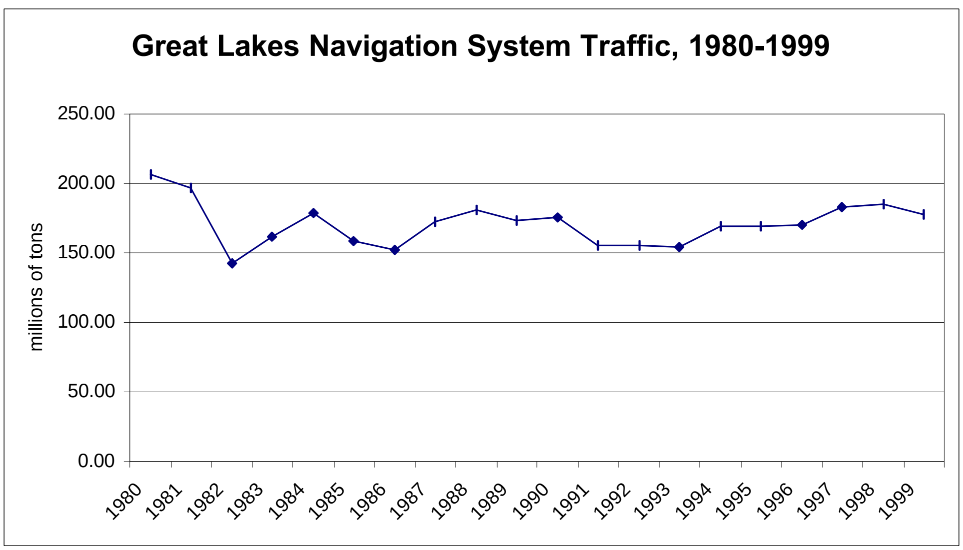
Source: Canadian waterborne shipment database prepared by TAF Consultants for Transport Canada using Statistics Canada data, and waterborne commerce data collected and compiled by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

There are two distinct components to the GL/SLS: the Great Lakes Navigation System (GLNS) and the St. Lawrence Seaway. Each is discussed separately in order to highlight important historical traffic trends on the GL/SLS.

1.) GLNS. The GLNS comprises the five Great Lakes and their navigable connecting channels – the St. Marys River, the Straits of Mackinac, the St. Clair/Detroit River System, and the Welland Canal. The U.S. Army Corps of Engineers collects and compiles U.S. traffic on the GLNS, but no traffic between Canadian ports and between Canadian and foreign ports. Likewise, Canada collects and compiles Canadian traffic only. The Lake Carriers Association collects information from its members, which generally matches the data collected by the Corps of Engineers. The LCA publishes these data in their annual report, a ready source of historic Great Lakes traffic by major commodity group. The following discussion of historic trends relies upon these data.

In the past 20 years, the most dramatic change in GLNS traffic occurred between 1980 and 1982. Traffic declined by 64 million tons in this two year period; the drop coinciding with a recession induced downsizing of the U.S. steel industry, primarily affecting integrated mills on Lake Erie and in the Ohio and Monongahela River valleys. Some recovery occurred over the next two years, but the GLNS has not reached the 200 million ton traffic level since 1980.

FIGURE 4-3



Source: Annual reports prepared by the Lake Carriers Association.

Table 4-5 indicates that the 1980s were largely a period of GLNS traffic decline, led by the dramatic decline in grain traffic. Iron ore traffic's rate of decline was less than that experienced by grain traffic, but greater in absolute terms. In the 1990s, both iron ore and grain held steady, while coal, stone, and cement all showed positive growth. During this same period petroleum traffic disappears from the data set, though it continues to move in small volumes on the lakes.

TABLE 4-5
Great Lakes Bulk Commodity Traffic, Selected Years from 1980–1999
(millions of tons)

	1980	1990	1999	Growth rate 80-90	Growth rate 1990-99	Growth rate 1980-99
Iron ore	81.2	68.9	68.9	- 1.7%	0.0%	- 0.9%
Coal	41.3	38.0	41.1	- 0.8%	0.9%	0.0%
Stone	28.0	30.1	38.4	1.9%	1.4%	1.7%
Salt	n.a.	5.9	7.0	--	--	--
Cement	4.2	4.5	5.8	0.7%	2.9%	1.7%
Potash	0.9	1.5	0.6	5.4%	- 9.6%	- 2.0%
Petroleum	12.9	n.a.	0.0	--	--	--
Grain	31.5	15.8	16.0	- 6.6%	0.1%	- 3.5%
Total	206.8	164.7	177.6	- 1.6%	0.1%	- 0.8%

Source: Annual reports prepared by the Lake Carriers Association.

2.) St. Lawrence Seaway. The St. Lawrence Seaway connects the Great Lakes with the deepwater channel of the lower St. Lawrence River and from there on to the Atlantic Ocean. The Seaway is defined as the waters of the St. Lawrence River above Montreal, Lake Ontario, the Welland Canal, and Lake Erie as far west as Long Point. It includes the Welland Canal and the Montreal-Lake Ontario section. Data displays in this appendix conform to SLSMC and SLSDC Seaway statistical presentations, which do not include intra-Lake Ontario waterway traffic. The U.S. Army Corps of Engineers collects and compiles data on U.S. Seaway traffic (traffic that has a U.S. origin, destination, or both), but not on Canadian Seaway traffic (traffic that has no U.S. destination or origin). In order to identify general commodity flows, which are summarized in **Table 4-6**, it was necessary to construct a data set from both Canadian and U.S. data sources. Total 1998 traffic for the Seaway was 55.2 million tons. The largest Seaway flow is Canada-to-Canada (19.9 million tons), followed by U.S. to Canada (9.0 million tons) and Canada to U.S (8.4 million tons). U.S. traffic is 30.5 million tons and Canadian traffic is 42.1 million tons, recognizing that there is overlap in these two traffic figures.

As with the GLNS, no traffic between Canadian ports and between Canadian and foreign ports is available from the Corps' waterborne commerce data. However, the two Seaway corporations, Canada's St. Lawrence Seaway Management Corporation and America's Saint Lawrence Seaway Development Corporation, jointly compile data on transits required to pay tolls at the Seaway locks. The Seaway corporations' annual publication, *The St. Lawrence Seaway, Traffic Report*, presents this information. This publication is the only ready source of historic Seaway traffic, and the following discussion of historic trends relies upon this source. The tables display navigation season data, a year that generally runs from March to December, the Seaway being closed during the winter season.

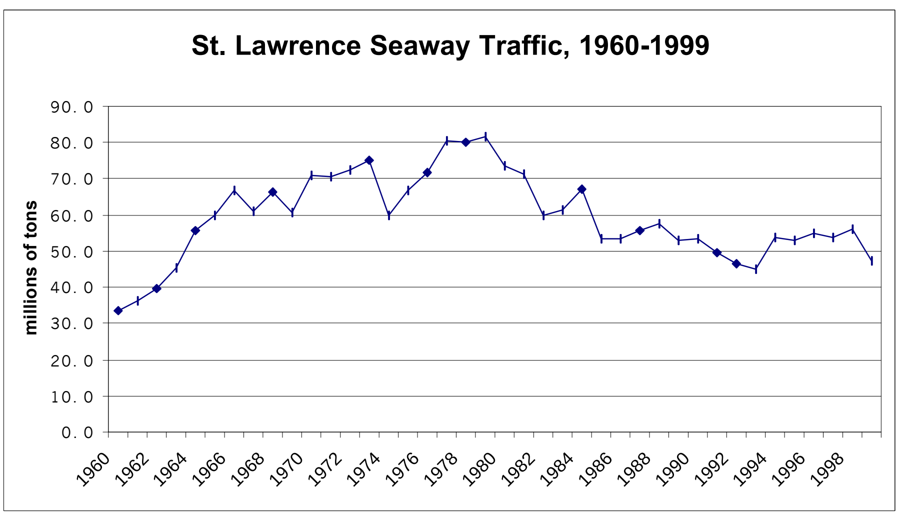
TABLE 4-6
St. Lawrence Seaway, 1998 Traffic by Country

	Origin			
Destination	**U.S.**	**Canada**	**Overseas**	**Total**
U.S.	2.6	8.4	5.9	16.9
Canada	9.0	19.9	3.4	32.3
Overseas	4.6	1.4	N/A	6.0
Total	16.2	29.7	9.3	55.2

Source: Canadian waterborne shipment database prepared by TAF Consultants for Transport Canada using Statistics Canada data, and waterborne commerce data collected and compiled by the U.S. Army Corps of Engineers, Waterborne Commerce Statistics Center.

Traffic on the Seaway grew rapidly its first seven years and continued to grow, with some interruption, up until 1980 (see **Figure 4-4**). This 20-year period of growth was followed by fairly sharp decline with traffic falling from a high of 82 million tons in 1979 to 53 million tons in 1985. Grain exports through the Seaway weakened as the former Soviet Union withdrew from the world grain market, Western Europe became more agriculturally self-sufficient, and rail subsidies favored the movement of Canadian grains to developing west coast ports servicing the rapidly growing Asian market. Iron ore moving from Canadian mines in Quebec and Labrador to U.S. steel mills declined as the industry retrenched and currency exchange rates became less favorable, both causing U.S. steelmakers to focus on domestic sources for ore. Seaway traffic stabilized in the 1990s. Because Canadian ore producers lost share in the U.S. market in the 1980s, the effect on Seaway traffic of the gathering crisis faced by U.S. integrated steel producers has been muted.[3] In fact, steel traffic on the Seaway is in some ways a symptom of the U.S. integrated mills' difficulties.

FIGURE 4-4



Source: Annual St. Lawrence Seaway traffic reports jointly prepared by the SLSMC and the SLSDC.

[3] *The Present and Future of the St. Lawrence-Great Lakes Waterway: What Are the Issues?*, prepared by Jean-Claude Lasserve for Transport Canada, August 1997.

Detailed commodity trends are not readily available. **Table 4-7** does clearly indicate that grain traffic has suffered a steep decline since the big export years in the late 1970s. Between 1978 and 1999 the bulk commodity category, predominately iron ore and coal, declined from 43 million tons to 27 million tons.

TABLE 4-7
St. Lawrence Seaway Bulk Commodity Traffic, Selected Years from 1980–1999
(millions of tons)

	1980	1990	1999	Growth rate 1980-90	Growth rate 1990-99	Growth rate 1980-99
Bulk	39.1	34.9	27.0	- 1.2%	- 2.8%	- 1.9%
Grains	31.4	14.1	15.5	- 7.7%	1.0%	- 3.7%
Govt. Aid	0.2	0.1	*	- 6.3%	- 0.9%	- 3.8%
Containers	0.2	*	*	-17.6%	- 7.7%	-13.1%
General Cargo	2.8	4.1	4.6	4.1%	1.2%	2.7%
Total	73.7	53.3	47.2	- 3.2%	- 1.3%	- 2.3%

Source: Annual St. Lawrence Seaway traffic reports prepared by The St. Lawrence Seaway Management Corporation and the Saint Lawrence Seaway Development Corporation.

d. Conclusion. The GL/SLW waterway system has two distinct, but overlapping subsystems: the GL/SLS and the St. Lawrence River. While both are founded upon the carriage of bulk commodities, specifically, iron ore, coal, stone, and grain, the lower reaches of the St. Lawrence River have a more coastal, deepwater port aspect. Shippers along the lower St. Lawrence at the ports of Montreal, Sept-Iles, Pointe Noire, Port Cartier and Quebec City are heavily dependent upon direct trade with countries overseas, and some of this trade is containerized. The GL/SLS is dependent solely upon bulk commodity traffic, primarily within the GLNS. The industry fundamentals for the iron ore and grain trade "…are fragile, and traffic volumes are consequently at their lower historical…" levels of performance throughout the basin, but especially on the St. Lawrence Seaway.[4]

3. TRAFFIC DEMAND PROJECTION METHODOLOGY

a. Forecasting Procedures. As a part of a current analysis, a forecast of potential traffic demands was prepared. This forecast reflects the level of traffic that would be expected to materialize if system constraints were not a consideration. To the extent practicable, future traffic demands for the Great Lakes and St. Lawrence Seaway were projected as a function of future economic growth in the markets served by waterway-using industries. These markets include both end-use/industry markets and geographic markets, whether local, broader regional, national, or international. In this context, the

[4] *Traffic Trends: Future Competitiveness of the St. Lawrence Seaway System,* prepared by Hazem Ghonima, TAF Consultants for Transport Canada, March 2001

traffic demand projections were developed by reference to specific company plans; industry-produced supply/demand forecasts; economic and demographic forecasts from U.S. and Canadian government sources and private consultants; and other transportation-related forecasts.

Actual waterway traffic is the most visible component of traffic demand, and consequently, existing traffic served as the starting point for identifying and forecasting waterway traffic demands. From the combined WCSC-Statistics Canada database, a base year of commodity movements was identified that was considered to be representative in terms of tonnage volumes and commodity flows. In this instance, the base year selected was calendar year 1998.

Iron ore and utility coal are two of the largest-volume and most important commodities moving on the Great Lakes and St. Lawrence Seaway. They were treated somewhat differently in the forecasting process than the other commodities. Initially, market surveys were conducted involving the major U.S. and Canadian regional utilities, steel companies, and resource suppliers. These surveys are described in greater detail in subsequent paragraphs. The major purpose of the surveys was to obtain information on expected future waterborne shipments/receipts of iron ore, coal and other commodities. This information was the major source of short-term forecasts for these commodities. These short-term forecasts were then extrapolated over the planning horizon using growth indices developed from longer-term economic and demographic forecasts.

For most of the other commodities, flow forecasts were developed by applying growth indices to the 1998 base traffic. Over the short term, industry forecasts were sometimes available. Similar to iron ore and utility coal, extrapolation over the planning horizon was accomplished using growth indices developed from long-term economic and demographic forecasts.

The current analysis included an investigation of potential shift-of-mode traffic demand that could materialize with improvements to the St. Lawrence Seaway. This traffic comprises potential grain, steel, and containerized traffic. For the purposes of these reconnaissance-level investigations, the bulk commodity traffic identified as potential shift-of-mode traffic was held constant over the forecasting horizon. Container traffic demand was forecast using growth rates for freight traffic from the Federal Highway Administration.

b. Market Surveys. Because of the importance of iron ore and utility coal to the Great Lakes and St. Lawrence Seaway systems, market surveys were conducted involving the U.S. and Canadian regional utilities, steel companies, resource suppliers, and transportation and related companies.

For the utilities, the shipper survey was targeted mainly toward utility companies operating waterside coal-fired power plants. Other companies contacted included operators of coal-handling facilities, and shipping companies. A formal mail-type survey was sent out to nine major utility companies that are either currently receiving coal via the Great Lakes or the St. Lawrence Seaway or that could potentially use these waterways for coal delivery. In addition to these companies, 23 other utilities and related companies were contacted informally to solicit coal movement information. As a result of these efforts, four companies contacted in the formal survey and an additional 15 companies contacted in subsequent informal contacts provided coal movement information. The major finding from the shipper survey was that utility respondents planned to continue to shift from eastern to western coal producing areas, with increased utilization of both the Great Lakes and rail modes.

Informal, confidential surveys were conducted with steel companies, iron ore mining and processing firms, steel companies and grain brokering entities. These firms represented the largest Canadian or U.S. firms of their kind operating on the Great Lakes/St. Lawrence Seaway system. Responses were given in direct interviews or through questionnaires. These firms responses framed both the near term waterway demand forecasts for iron ore and steel traffic and the potential for induced and shift-of-mode iron ore and grain traffic under an improved St. Lawrence Seaway scenario.

4. SOURCES OF LONG-TERM FORECASTS

a. General. The forecasts used in the current effort came from a variety of U.S. and Canadian and government and private sources. A listing of the specific sources used, by major commodity grouping, is provided in **Table 4-8**. Descriptions of these forecasts are provided in the following paragraphs. Specific growth rates from each of these forecast series are provided in **Tables 4-9, 4-10, and 4-11**.

b. Woods and Poole Economics. A principle source of both short and long term U.S. regional forecasts is the Woods and Poole 2001 Economic and Demographic Database. The Woods and Poole database provides forecasts of economic and demographic variables down to the county level through year 2025. The principle forecast variables are personal income, earnings by industry, employment by industry, and population. The methodology begins by forecasting the economic and demographic variables for the entire U. S. Forecasts are then generated for economic areas (EAs), with the U.S. forecast providing control totals. County-level forecasts, in turn, are generated using EAs for control totals.

c. Research Data International (RDI). Within its PowerDat database, RDI provides load forecasts for U.S. and some Canadian utility planning areas. The U.S. utilities provide these forecasts to their respective National Electric Reliability Council (NERC) regions. These forecasts are generally limited to a 10-year horizon and are used in developing the short-term forecast of utility coal receipts.

TABLE 4-8
Summary of Short and Long Term Forecasts

Commodity Group	Short-Term Forecasts	Long-Term Forecasts
Coal & Coke	1. utility company responses 2. RDI electricity demands 3. Woods & Poole EA mfg earnings 4. National Energy Board electricity / met coal demands 5. steel company responses 6. World Steel Dynamics-iron ore	1. Woods & Poole EA personal income 2. Woods & Poole EA mfg earnings 3. National Energy Board electricity / met coal demands 4. EIA U.S met coal consumption
Petroleum Fuels	1. Woods & Poole EA population 2. Woods & Poole EA mfg earnings 3. Ontario Ministry of Finance-population 4. TAF Consultants-MLO forecast	1. Woods & Poole EA population 2. Woods & Poole EA mfg earnings 3. Ontario Ministry of Finance-population 4. TAF Consultants-MLO forecast
Crude Petroleum	1. Woods & Poole EA population 2. Ontario Ministry of Finance-population 3. TAF Consultants-MLO forecast	1. Woods & Poole EA population 2. Ontario Ministry of Finance-population 3. TAF Consultants-MLO forecast
Aggregates	1. Woods & Poole EA constr earnings 2. TAF Consultants-Ontario GDP 3. TAF Consultants-MLO forecast	1. Woods & Poole EA constr earnings 2. TAF Consultants-Ontario GDP 3. TAF Consultants-MLO forecast
Grains	1. Woods & Poole EA mfg earnings 2. TAF Consultants-MLO forecast 3. Woods & Poole EA mfg earnings 4. TAF Consultants-Ontario GDP	1. Woods & Poole EA mfg earnings 2. TAF Consultants-MLO forecast 3. Woods & Poole EA mfg earnings 4. TAF Consultants-Ontario GDP
Chemicals	1. Woods & Poole EA mfg earnings 2. TAF Consultants-Ontario GDP 3. TAF Consultants-MLO forecast	1. Woods & Poole EA mfg earnings 2. TAF Consultants-Ontario GDP 3. TAF Consultants-MLO forecast
Ores & Minerals	1. Woods & Poole EA mfg earnings 2. Woods & Poole EA constr earnings 3. Ontario Ministry of Finance-population 4. TAF Consultants-Ontario GDP 5. TAF Consultants-MLO forecast	1. Woods & Poole EA mfg earnings 2. Woods & Poole EA constr earnings 3. Ontario Ministry of Finance-population 4. TAF Consultants-Ontario GDP 5. TAF Consultants-MLO forecast
Iron and Steel	1. steel company responses 2. World Steel Dynamics-iron ore	1. EIA U. S. met coal consumption 2. National Energy Board electricity met coal demands
All Others	1. Woods & Poole EA mfg earnings 2. Woods & Poole EA constr earnings 3. Woods & Poole EA population 4. Woods & Poole EA personal income 5. TAF Consultants-MLO forecast 6. Ontario Ministry of Finance-population	1. Woods & Poole EA mfg earnings 2. Woods & Poole EA constr earnings 3. Woods & Poole EA population 4. Woods & Poole EA personal income 5. TAF Consultants-MLO forecast 6. Ontario Ministry of Finance-population

d. Canadian National Energy Board. The National Energy Board published electricity demands by province and metallurgical coal demands in a report entitled Canadian Energy Supply and Demand to 2025 (1999). These forecasts are used in the development of utility and metallurgical coal traffic to Canadian destinations over both the short and long term.

e. World Steel Dynamics. Forecasts of North American iron ore pellet production are provided in a World Steel Dynamics report entitled North American Iron Ore Industry: Globalization and Competitive Response (December 2000). These forecasts are short-term, extending to year 2006, and are used in developing the short-term forecasts of iron ore and metallurgical coal (U.S. destinations) traffic.

f. Traffic Analysis and Forecasting Consultants (TAF). TAF Consultants, under contract to Transport Canada prepared national-level commodity transportation forecasts by mode for a report entitled Freight Transport Trends and Forecasts to 2015 (March, 2000). This report presents, as well, provincial GDP forecasts. TAF Consultants also prepared traffic forecasts for the St. Lawrence Seaway system for a report entitled Traffic Trends: Future Competitiveness of the St. Lawrence Seaway System (March, 2001). In this report, TAF Consultants forecasts U.S. and Canadian traffic, by commodity group, for the two major segments of the Seaway—the Montreal-Lake Ontario (MLO) section and the Welland Canal.

g. Ontario Ministry of Finance. The Ministry of Finance published population projections in the report Ontario Population Projections, 1999-2028 (July, 2000). The population projections are generated using a cohort-component methodology for a reference case as well as high and low cases.

h. Energy Information Administration. For the Annual Energy Outlook 2001 (December 2000), EIA forecasts U.S. metallurgical coal consumption through 2020. This forecast is used to develop both iron ore and metallurgical coal traffic demand forecasts for U. S. destinations.

Table 4-9

Forecast Growth Rates - U.S. and Canadian Sources

Source/Region	Variable	Period	Annual Growth Rate Low	Mid	High
RDI:					
Consumers Energy	electricity demand	2000-09	-	2.6	-
Detroit Edison	electricity demand	1999-09	-	1.2	-
Northern States Power	electricity demand	1999-08	-	1.7	-
WEPCO	electricity demand	1999-09	-	2.1	-
World Steel Dynamics:					
U.S. & Canada	iron ore pellet productior	1998-05	-	0.2	-
EIA:					
U.S.	met coal consumption	1999-20	-0.9	-0.5	0.1
National Energy Board:					
Ontario	electricity demand	1997-25	1.7	-	2.2
Quebec	electricity demand	1997-25	0.9	-	1.4
New Brunswick	electricity demand	1997-25	0.9	-	1.2
Nova Scotia	electricity demand	1997-25	0.6	-	0.9
Canada	met coal imports	1997-25	-0.6	-	-0.4
World Steel Dynamics:					
U.S. & Canada	iron ore pellet productior	1998-05	-	0.2	-
Ontario Ministry of Finance:					
Ontario	population	1999-28	0.5	1.0	1.3

Table 4-10

Forecast Growth Rates - Woods and Poole

Region	Annual Growth 1998-2025 Population	Personal Income	Mfg Earnings	Construction Earnings
EA 6 - Syracuse, NY	0.1	1.4	0.9	0.9
EA 7 - Rochester, NY	0.2	1.4	0.7	0.7
EA 8 - Buffalo, NY	0.02	1.4	0.9	0.8
EA 54- Erie, PA	0.08	1.5	0.8	1.8
EA 55- Cleveland, OH	0.2	1.6	1.7	1.6
EA 56- Toledo, OH	0.2	1.5	1.0	1.1
EA 57- Detroit, MI	0.3	1.7	1.1	1.5
EA 58- Northern MI	1.3	2.5	2.0	2.2
EA 59- Green Bay, WI	0.6	2.0	1.7	1.8
EA 60- Appleton, WI	0.9	2.0	1.7	1.8
EA 61- Traverse City, MI	1.5	2.9	2.0	2.2
EA 62- Grand Rapids, MI	0.9	2.0	1.4	1.5
EA 63- Milwaukee, WI	0.5	1.8	1.0	1.7
EA 64- Chicago, IL	0.5	1.9	1.0	1.7
EA 65- Elkhart, IN	0.5	1.7	1.5	1.6
EA 108-Wausau, WI	0.8	2.1	1.7	1.8
EA 109-Duluth, MN	0.2	1.5	1.0	1.3

5. FORECAST RESULTS

a. General. The waterways under consideration for navigation improvements in this study are the Great Lakes Navigation System, defined previously to include the five Great Lakes and their connecting channels (and U.S. harbors) and the St. Lawrence Seaway, made up of the Montreal-Lake Ontario section and the Welland Canal. Traffic demand forecasts are presented for the Great Lakes Navigation System, the St. Lawrence Seaway, and the aggregation of the two, the Great Lakes/St. Lawrence Seaway. The overlap in these waterway definitions is considered in data compilation and forecasting. The forecasts are comprehensive, including all Canadian and U.S. traffic.

Table 4-11

Forecast Growth Rates - TAF Consultants

Source/Region	Variable	Period	Annual Growth Rate Low	Mid	High
TAF Consultants:					
Ontario	Ontario GDP	1998-15	-	2.7	-
MLO	total traffic	2001-20	0.5	1.2	2.1
	grain	2001-20	0.7	1.3	2.3
	iron ore	2001-20	0.4	0.9	1.5
	coal	2001-20	-1.6	3.6	3.9
	steel	2001-20	1.4	2.9	3.7
	coke	2001-20	0.7	-2.4	-4.0
	petroleum products	2001-20	0.1	1.3	2.8
	scrap iron and steel	2001-20	1.9	8.1	15.7
	chemicals	2001-20	-0.4	0.4	2.4
	salt	2001-20	0.3	2.6	3.9
	stone	2001-20	-0.8	1.8	4.9
	cement	2001-20	-1.3	0.8	14.1
	all other	2001-20	0.4	1.5	2.7
Welland Canal	total traffic	2001-20	0.1	0.9	2.1
	grain	2001-20	0.6	1.2	2.3
	iron ore	2001-20	-1.0	0.1	1.8
	coal	2001-20	-0.4	-1.0	0.9
	steel	2001-20	2.6	3.3	4.6
	coke	2001-20	-3.8	-2.3	0.8
	petroleum products	2001-20	1.4	1.9	2.2
	scrap iron and steel	2001-20	-3.1	0.2	3.7
	chemicals	2001-20	1.8	2.0	3.2
	salt	2001-20	1.2	2.6	3.4
	stone	2001-20	0.6	1.9	3.5
	cement	2001-20	2.0	3.9	4.9
	all other	2001-20	-0.2	0.6	1.3

Detailed deep-draft navigation modeling was performed only for a subset of existing commodities moving on the Great Lakes Navigation System. In general, these consisted of the major dry bulk commodities involving U.S. origins and/or destinations. These were the commodities considered most likely to generate benefits from channel/harbor deepening projects and account for over 80 percent of commodity traffic moving on the Great Lakes Navigation System. The analytical method used to evaluate potential improvements to the St. Lawrence Seaway was more generalized and did not involve detailed navigation system modeling. The analysis included an evaluation of potential modal shifts that could result from navigation improvements. Forecasts for the St. Lawrence Seaway presented in this section are limited to forecasts of existing traffic. Potential modal shifts are considered separately.

b. Total Traffic Demands. Total traffic demands for the Great Lakes Navigation System, the St. Lawrence Seaway, and the aggregate Great Lakes/St. Lawrence Seaway system are presented in **Table 4-12**. Total traffic demand for bulk commodities on the Great Lakes/St. Lawrence Seaway is shown to increase from a level of 228 million tons in 1998 to about 357 tons by year 2060, reflecting annual growth of about 0.7 percent. The St. Lawrence Seaway subsystem grows slightly faster, at about 0.8 percent per annum and annually accounts for about one quarter of the traffic on the larger system. The Great Lakes Navigation System grows at a rate of about 0.7 percent and annually accounts for around 99 percent of traffic demand in the overall system.

c. Commodity Mix of Projected Traffic Demand. Traffic demand forecasts by major bulk commodity group for the Great Lakes/St. Lawrence Seaway system are shown in **Table 4-13**. **Tables 4-14** and **4-15** show the commodity group forecasts for the Great Lakes Navigation System and the St. Lawrence Seaway, respectively. Potential container traffic demand is discussed separately.

Coal and Coke traffic demand on the Great Lakes/St. Lawrence Seaway system is expected to grow at an annual rate of 1.1 percent over the 1998-2060 period. Over that period, coal and coke is expected to grow from 19 to about 24 percent of total system traffic demand. Most of the growth in coal is expected to be in western coal moving from Lake Superior to lakeside electric utility plants in the U. S. and Canada. Metallurgical coal and coke traffic demand should continue to decline in line with contraction in the integrated steel sector. Seaway coal and coke traffic is expected to remain constant over the forecast period.

Petroleum fuels and crude petroleum traffic demand on the Great Lakes/St. Lawrence Seaway system is shown to grow at annual rates of 0.5 and 0.4 percent respectively over the forecast period. Petroleum fuels accounts for about 3 percent of total system traffic demand throughout the period, while crude petroleum accounts for about 0.2 percent. The major petroleum flows in the Great Lakes region are to relatively slow-growing an areas, which accounts for the slow growth in these commodity groups. Seaway

TABLE 4-12

Bulk Commodity
Traffic Demand Forecasts, Great Lakes and
St. Lawrence Seaway, 1998-2060
(Millions of Tons)

Year	Great Lakes Navigation System	St. Lawrence Seaway	Great Lakes/ St. Lawrence Seaway
1998 base	227	61	228
2000	232	62	232
2010	255	67	255
2020	275	73	276
2030	291	80	292
2040	314	87	315
2050	335	93	336
2060	356	99	357
Annual Growth 1998-60	0.7%	0.8%	0.7%

NOTE: Data include both U.S. and Canadian traffic.

petroleum traffic originates mostly at Canadian refining areas and is destined for ports along the lower St. Lawrence and in the eastern U.S.

The aggregates group, which, in this instance includes limestone flux as well as sand, gravel, and crushed rock, is shown to grow at an annual rate of 1.1 percent on the Great Lakes/St. Lawrence Seaway system between 1998 and 2060. Aggregates traffic demand increases from 20 to 25 percent of total system traffic demand over the forecast period. Although traffic in limestone flux is expected to diminish in line with contraction in the integrated steel sector, demand for limestone by the construction industry; by the utility industry for use in coal desulfurization; and by manufacturers of cement and lime is expected to grow.

TABLE 4-13

Bulk CommodityTraffic Demand Forecasts,
Great Lakes\St.Lawrence Seaway, 1998-2060

	(Millions of Tons)							Annual % Change	Annual % Change	Annual % Change
	1998									
Commodity Group	actual	base	2000	2010	2020	2030	2060	1998-10	2010-60	1998-60
Coal and Coke	41.5	41.5	42.2	46.7	53.3	60.4	83.6	1.0%	1.2%	1.1%
Petroleum Fuels	7.3	7.3	7.5	7.9	8.4	8.8	9.9	0.6%	0.5%	0.5%
Crude Petroleum	0.6	0.6	0.6	0.7	0.7	0.7	0.8	0.7%	0.4%	0.4%
Aggregates	45.1	45.1	47.7	55.9	64.0	71.6	90.0	1.8%	1.0%	1.1%
Grains	16.5	22.5	22.3	24.4	27.7	31.5	44.2	0.7%	1.2%	1.1%
Chemicals	1.9	1.9	1.9	2.1	2.3	2.4	2.9	0.9%	0.7%	0.7%
Ores & Minerals	10.8	10.8	11.0	12.1	12.8	13.5	15.2	0.9%	0.5%	0.5%
Iron Ore	77.6	77.6	77.1	79.5	77.4	70.6	70.2	0.2%	-0.3%	-0.2%
Iron & Steel	9.4	9.5	10.0	11.9	13.5	14.9	18.1	1.9%	0.8%	1.0%
Others	11.4	11.4	12.2	14.3	16.1	17.9	22.3	1.9%	0.9%	1.1%
TOTAL	222.0	228.1	232.4	255.4	276.2	292.3	357.1	0.9%	0.7%	0.7%

Table 4-13 shows grains traffic demand growing at an annual rate of 1.1 percent over the 1998-2060 period. The forecast of grain traffic demand includes an increment of about 6 million tons of potential shift-of-mode traffic, identified as a result of shipper contacts. Over the forecast period, grains increases from about 10 percent of total system traffic demand to about 12 percent. On the Seaway, grains traffic demand increases from 33 percent to 39 percent of the total. Much of the growth in system grains traffic demand is explained by stronger U. S. grain exports. Backhaul opportunities for grain carriers using the Seaway can potentially make the Seaway routing attractive. Growth in Canadian grain exports from this system is expected to be less robust.

Chemicals traffic demand, made up of industrial chemicals and chemical fertilizers, is shown to grow at an annual rate of about 0.7 percent over the forecast period. Chemicals traffic accounts for less than 1 percent of traffic demand on the system throughout the forecast period. Nearly half of the chemicals traffic is made up of potash originating on the Canadian side of Lake Superior and destined for the lower lakes and the export market through the Seaway.

TABLE 4-14

Bulk Commodity Traffic Demand Forecasts,
Great Lakes Navigation System, 1998-2060

	(Millions of Tons)							Annual %	Annual %	Annual %
	1998							Change	Change	Change
Commodity Group	actual	base	2000	2010	2020	2030	2060	1998-10	2010-60	1998-60
Coal and Coke	41.5	41.5	42.2	46.7	53.3	60.4	83.6	1.0%	1.2%	1.1%
Petroleum Fuels	7.3	7.3	7.4	7.9	8.3	8.7	9.8	0.6%	0.5%	0.5%
Crude Petroleum	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.7%	0.4%	0.4%
Aggregates	44.8	44.8	47.3	55.6	63.7	71.3	89.6	1.8%	1.0%	1.1%
Grains	16.4	22.4	22.2	24.3	27.6	31.4	43.9	0.7%	1.2%	1.1%
Chemicals	1.8	1.8	1.8	2.0	2.2	2.3	2.8	0.8%	0.7%	0.7%
Ores & Minerals	10.7	10.7	10.9	12.0	12.7	13.4	15.0	0.9%	0.5%	0.5%
Iron Ore	77.6	77.6	77.1	79.5	77.4	70.6	70.2	0.2%	-0.3%	-0.2%
Iron & Steel	9.4	9.5	10.0	11.8	13.5	14.9	18.0	1.8%	0.8%	1.0%
Others	11.4	11.4	12.1	14.2	16.1	17.8	22.2	1.9%	0.9%	1.1%
TOTAL	221.3	227.5	231.7	254.6	275.3	291.4	355.9	0.9%	0.7%	0.7%

Ores and minerals traffic demand, comprising in large part salt, and gypsum, is shown to grow at an annual rate of 0.5 percent on the system over the forecast period. Throughout the period, ores and minerals remains about 4 percent of the system total. The major flows of salt are to slow-growing urban areas along the Great Lakes, the lower St. Lawrence and the east coast for use as road salt. Gypsum is used in the manufacture of wallboard and cement, and is expected to grow somewhat faster.

System iron ore traffic demands are expected to diminish over the forecast period, in line with ongoing contraction in the integrated steel sector. Between 1998 and 2060, iron ore diminishes by about 0.2 percent per annum. Iron ore traffic demand is also shown to diminish from 34 percent of the system total in 1998, to about 20 percent in 2060.

TABLE 4-15

Bulk Commodity Traffic Demand Forecasts,
St. Lawrence Seaway, 1998-2060

	(Millions of Tons)							Annual %	Annual %	Annual %
	1998							Change	Change	Change
Commodity Group	actual	base	2000	2010	2020	2030	2060	1998-10	2010-60	1998-60
Coal & Coke	5.3	5.3	5.8	4.9	5.0	5.1	5.7	-0.7%	0.3%	0.1%
Petroleum Fuels	2.8	2.8	2.9	3.1	3.3	3.5	4.0	0.8%	0.5%	0.6%
Crude Petroleum	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7%	0.3%	0.4%
Aggregates	3.7	3.7	3.9	4.7	5.6	6.3	8.0	2.0%	1.1%	1.2%
Grains	14.1	20.1	20.0	21.8	24.7	28.0	39.0	0.7%	1.2%	1.1%
Chemicals	1.1	1.1	1.2	1.3	1.4	1.5	1.9	0.9%	0.8%	0.8%
Ores and Minerals	3.6	3.6	3.7	4.1	4.4	4.6	5.1	1.0%	0.4%	0.6%
Iron Ore	12.1	12.1	11.6	11.3	11.6	11.8	12.4	-0.5%	0.2%	0.0%
Iron & Steel	8.7	8.8	9.2	11.0	12.5	13.8	16.9	1.9%	0.9%	1.1%
Others	3.2	3.2	3.4	3.9	4.4	4.8	5.7	1.8%	0.7%	1.0%
TOTAL	55.3	61.4	62.4	66.8	73.4	80.2	99.5	0.7%	0.8%	0.8%

Iron and steel traffic demand, which includes iron and steel scrap, is shown to increase at an annual rate of 1.0 percent between 1998 and 2060, and to account for 4-5 percent of total system traffic demand throughout the forecast period. It should be noted that the forecast includes an incremental increase of about 100,000 tons of shift-of-mode traffic, obtained as a result of shipper contacts. The increase in iron and steel coincides with decline in the integrated steel sector. The iron and steel traffic demand is made up of imported steel as well as movements of iron and steel scrap to steel minimill operations and to the export market.

The largest single commodity in the All Others category is cement, since several major cement manufacturing facilities are located in the Great Lakes region. Traffic demand in the All Others category is expected to grow at an annual rate of 1.1 percent between 1998 and 2060 and to increase from 4 percent of total system traffic demand in 1998 to about 6 percent in 2060. For forecasting purposes, the principal linkage is to the regional construction industry.

d. Containerized Traffic. Investigations of proposed Seaway improvements identified containerized traffic as potential traffic for an improved system. As part of a container analysis, the 1999 Surface Transportation Board (STB) Waybill Sample was examined to identify container transportation patterns and volumes and a transportation rate analysis was prepared to determine the rate savings that would be generated by routing this traffic by way of the St. Lawrence Seaway (Attachment 4). The container analysis demonstrated the potential for a substantial amount of the existing overland East Coast-Great Lakes container traffic to divert to the Seaway with an improved system. In total, about 3.4 million twenty-foot container equivalents (TEUs) showed a transportation rate savings with a routing via the Seaway. About half of this total, or 1.7 million TEUs, was considered to be likely to divert to the improved Seaway and accordingly, this traffic was used in the current analysis. Future growth in containerized traffic demand, estimated at 2.9 percent per annum, was based on forecasts of growth in freight traffic from the Federal Highway Administration.

e. Commodity Groups Modeled. The traffic demand subjected to detailed deep-draft system modeling was confined to traffic that originated in or was destined for U.S. ports on the Great Lakes Navigation System. Additionally, the modeling was confined to specific commodities. These commodities were selected based on the potential for the commodity to generate savings in the modeling process. Since most of the improvements under consideration involve channel or harbor deepening, the commodities would have to move in vessels with sufficiently deep drafts to generate benefits from the improvement. Generally speaking, the commodities not selected for detailed deep-draft modeling move in relatively shallow draft vessels.

The commodities selected for detailed modeling are displayed in bold type in **Table 4-16**. It should be noted that the tonnages displayed for these commodities are tonnages for the entire Great Lakes Navigation System.

TABLE 4-16

Traffic Demand for Modeled Commodity Groups
Great Lakes Navigation System, 1998-2060

Commodity Group/ Commodity	1998 actual	1998 base	2000	2010	2020	2030	2060	Annual % Change 1998-10	Annual % Change 2010-60	Annual % Change 1998-60
	(Millions of Tons)									
Coal & Coke	41.5	41.5	42.2	46.7	53.3	60.4	83.6	1.0%	1.2%	1.1%
Petroleum Fuels	7.3	7.3	7.4	7.9	8.3	8.7	9.8	0.6%	0.5%	0.5%
Crude Petroleum	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.7%	0.4%	0.4%
Aggregates	43.3	43.3	45.8	53.8	61.8	69.3	87.3	1.8%	1.0%	1.1%
--limestone flux	36.2	36.2	38.3	44.9	51.3	57.3	71.8	1.8%	0.9%	1.1%
--sand and gravel	4.9	4.9	5.1	6.2	7.3	8.3	10.8	1.9%	1.1%	1.3%
Grains	16.4	22.4	22.2	24.3	27.6	31.4	43.9	0.7%	1.2%	1.1%
--wheat	8.6	14.6	14.2	15.2	17.0	19.1	26.2	0.4%	1.1%	0.9%
--barley	0.3	0.3	0.3	0.3	0.4	0.5	0.8	0.4%	1.7%	1.4%
--corn	2.6	2.6	2.7	3.1	3.6	4.2	6.1	1.5%	1.4%	1.4%
--oats	0.2	0.2	0.2	0.2	0.2	0.3	0.4	1.0%	1.3%	1.2%
--soybeans	2.7	2.7	2.7	3.1	3.7	4.3	6.4	1.2%	1.5%	1.4%
Chemicals	1.8	1.8	1.8	2.0	2.2	2.3	2.8	0.8%	0.7%	0.7%
Ores & Minerals	12.2	12.2	12.5	13.7	14.6	15.4	17.3	1.0%	0.5%	0.6%
--clay	1.6	1.6	1.7	2.0	2.2	2.3	2.6	2.0%	0.5%	0.8%
--salt	7.9	7.9	7.8	8.4	8.9	9.3	10.5	0.5%	0.4%	0.5%
--gypsum	1.5	1.5	1.5	1.8	1.9	2.0	2.3	1.6%	0.5%	0.7%
Iron Ore	77.6	77.6	77.1	79.5	77.4	70.6	70.2	0.2%	-0.3%	-0.2%
Iron & Steel	9.4	9.5	10.0	11.9	13.5	14.9	18.1	1.9%	0.8%	1.0%
All Others	11.4	11.4	12.1	14.2	16.1	17.8	22.2	1.9%	0.9%	1.1%
--cement	7.3	7.3	7.8	9.2	10.5	11.8	15.0	1.9%	1.0%	1.2%
GRAND TOTAL	221.3	227.4	231.7	254.6	275.3	291.4	356.0	0.9%	0.7%	0.7%

NOTE: Numbers in bold are a subset of the overall categories.

SECTION 5. VESSEL FLEET AND OPERATING COSTS

1. GENERAL

Vessel fleets are a critical consideration in planning future investments on any waterway. The Great Lakes/St. Lawrence Seaway (GL/SLS) is unique in the world in that it has three distinct fleets operating in its waters: 1) an intra-laker fleet, 2) a laker/Seaway fleet, and 3) a laker/Seaway oceangoing fleet of salties.[1] Each fleet is compatible with the traffic and market the fleet is designed to serve. The intra-laker fleet, a U.S. fleet, is dominated by the Class X thousand footers and the smaller Class VIIIs that shuttle between ore and coal docks on Lake Superior and power plants and steel mills on the upper lakes. The laker/Seaway fleet, primarily a Canadian fleet, is dominated by the Class VII vessel making complementary moves of grain from Lake Superior to grain elevators on the lower St. Lawrence and iron ore from the lower St. Lawrence to steel mills on Lake Ontario and the upper lakes. The oceangoing fleet of salties is dominated by tramp operators bringing commodities such as steel slab from overseas origins into the lakes, taking-on light loads of grain in Lake Superior before moving back to the lower St. Lawrence where they are topped-off with grain before continuing on to overseas destinations.

These individual fleets uniquely take advantage of the existing GL/SLS's physical configuration. The intra-laker fleet trades a limited market for tremendous economies of scale in keeping operating costs competitive. The relatively smaller sized boats of the laker/Seaway fleet take advantage of compatible commodity flows to minimize empty backhauls and keep operating costs competitive. The salty fleet attempts to minimize empty backhauls by carrying imported commodities, primarily steel, into the upper lakes, picking-up grain and then topping-off in the lower St. Lawrence River in order to maintain competitive rates. Collectively, these vessel fleets comprise the existing fleet for the GL/SLS. The salty fleet can vary dramatically from year to year as these tramp vessels can enter and leave the system for other parts of the world as the trade dictates.

In addition to describing the existing fleet mentioned above, this section describes the fleet that would use a future, alternative GL/SLS system configuration of channels, locks and harbors. Forecasting a future fleet for a deeper, wider Seaway will start with an examination of the world fleet. While 70 percent of the world fleet can transit the 80' x 766' locks and the 26'3'' draft channel of the Seaway, these Seaway capable vessels represent only 13 percent of world vessel capacity (**see Table 5-1**). The standardization of vessel loads in pallets, big bags, barge carriers, roll-on/roll-off and, most importantly, containers, and the coincidental investment in port infrastructure to handle these standard loads has allowed vessel owners to build bigger ships without increasing time-in-port for loading and unloading. These technical advances support the rapid growth of intercontinental trade. Ever larger ships are being built, indicating that the percentage of the world fleet that is Seaway capable will continue to decline in the foreseeable future.

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[1] Deepwater, minimum 35' drafts begin at Montreal and reach approximately 50' around Quebec City.

However, a deeper, wider Seaway could accommodate 34 percent (in terms of capacity) of the world fleet, most importantly, 27 percent of the world container fleet in terms of gross ton capacity.[2]

Finally, this section discusses vessel operating costs used in the estimation of cost reduction benefits.

2. EXISTING FLEET

a. General. The currently configured GL/SLS is the culmination of major capital investments that began almost two hundred years ago, but which has been limited, with the major exception of the construction of the Poe lock in 1969, to maintenance and major repair since the late 1950s. The system's current length and width dimensions were set in the 1930s by the latest version of the Welland Canal. Not surprisingly, the fleet operating on the GL/SLS is more reflective of the 1930s world fleet than the fleet operating today. Only the bulk class of vessels has been freed to operate larger vessels on the upper Lakes, and that as a result of the last major investment in the system – the Poe lock. Infrastructure throughout the lakes, connecting channel and port depths, conform to the less than Panama Canal size dimensions first imposed by the Welland Canal. The newest vessels in the world fleet, the Panamax vessels, post-Panamax vessels and soon to appear ultra-large container ships, cannot enter the GL/SLS system. **Table 5-1** indicates the limitations. Less than 2 percent of the world's bulk fleet by capacity and less than 5 percent of its container fleet can use the GL/SLS.

TABLE 5-1
Seaway Capable Fleet under Existing Seaway Configuration[1/]

	Number of Vessels	% World Fleet	Gross Tons	% World Fleet
Bulk	1,028	15.4%	2,778,325	1.6%
Container	663	21.8%	3,596,327	4.7%
Gas	722	60.7%	1,793,053	7.6%
General Cargo	12,048	81.2%	26,506,134	44.6%
Miscellaneous	16,496	92.8%	18,346,314	60.8%
Passenger	3,405	83.5%	9,762,675	32.8%
Reefer	959	71.5%	3,153,159	44.9%
RoRo	1,093	60.5%	5,796,004	19.4%
Tanker	5,495	58.7%	10,821,003	5.3%
Total	**41,909**	**69.7%**	**82,549,994**	**12.9%**

1/ Based on Seaway capable of handling vessels 740' long and 78' wide drafting 26'3".
Source: "Saint Lawrence Seaway Vessel Fleet Study, 2001," prepared by Lloyd's Maritime Information Ltd. for the U.S. Department of Transportation, Saint Lawrence Seaway Development Corporation, June 2001.

2 This discussion of the Seaway capable and potential fleet is based upon the "Saint Lawrence Seaway Vessel Fleet Study, 2001," prepared by Lloyd's Maritime Information Ltd. for the U.S. Department of Transportation, Saint Lawrence Seaway Development Corporation, June 2001.

The unevenness of the waterborne commerce data described in Section 1 causes the subsequent detailed discussion of the existing fleet to focus on the U.S. and Canadian intra-lake and lake/Seaway fleets. U.S. domestic data (U.S. ports to U.S. ports) is the most complete in providing vessel names, which can then be linked to data bases containing the physical of individual vessels. U.S. foreign data (U.S. ports to/from foreign ports) is less complete. At the time this report was prepared, Canadian domestic and Canadian foreign data (Canadian ports to/from non-U.S. foreign ports) contained no vessel identification information.

b. Composition of the Fleet. The commercial navigation fleet on the Great Lakes can be categorized three ways: by nation, by vessel type and by vessel size. This section examines the fleet in terms of its composition by vessel type and size. It also examines changes that have occurred in the fleet in the past two decades. Differences between the U.S. and Canadian fleets will be discussed. The fleet discussion will be limited to bulk carriers, self-unloaders and powered tankers, and will focus on the U.S. and Canadian fleet to the exclusion of the international fleet of salties.

1). By Vessel Type. There were 147 commercial vessels operating on the Great Lakes in 2001 compared to 185 in 1990 and 302 in 1980 (see **Table 5-2**). The total fleet declined by 39 percent from 1980 to 1990. The decline slowed to 21 percent between 1990 and 2001. Most of the decline occurred in the American fleet. In the twenty-one years from 1980 to 2001 the American fleet declined by 62 percent. The corresponding decline in the Canadian fleet was 41 percent.

The decline in the number of vessels between 1980 and 1990 was most pronounced in the bulk carrier category. One hundred and one bulk carriers were removed from service between 1980 and 1990. This constituted 62 percent of the bulk carriers that were in service in 1980. An additional twenty bulk carriers were retired between 1990 and 2001, leaving a total bulk fleet of 42 vessels.

Bulk carriers accounted for 54 percent of the fleet in 1980 and self-unloading vessels 31 percent. This situation was almost reversed by 2001. Bulk carriers now only represented 29 percent of the fleet while self-unloaders had risen to represent 59 percent of the fleet.

An examination of the data on the composition of the U.S. fleet in 1980 and 2001 indicates that the drastic decline (virtual elimination) of bulk carriers during this 21-year period accounted for the decline in the U.S. fleet. Out of the 93 U.S. vessels removed from 1980 through 2001, bulk freighters accounted for 74 of these vessels. There were also nine self-unloaders and 10 tankers removed from the U.S. fleet during this time period. The U.S. fleet only had 4 bulk carriers by 2001. The Canadian fleet declined by 62 vessels from 1980 to 2001, with bulk freighters accounting for 47 of these vessels. The Canadian fleet had 38 bulk carriers in service in 2001.

The substantial difference in the magnitude of the decline in bulkers between the U.S. and Canadian fleet has to do with the differences in the commodity mix transported by the two fleets. Grain has historically been more prominent in the Canadian than in the

U.S. trade. Also, Canadian grain was traditionally exported out of the lakes via the St. Lawrence Seaway. On the return haul the downbound grain vessel returned with an upbound load of iron ore from the iron ore ports on the north shore of the St. Lawrence River. Finally, the Canadian bulk carriers are more modern than their American counterparts since most were constructed after the opening of the Seaway in 1959. Thus in the 1980s the Canadian fleet of bulk carriers was more efficient than the U.S. fleet of bulk carriers. As a result bulkers were eliminated to a much greater extent from the United States than the Canadian fleet.

In 1980, the U.S. and Canadian fleet were approximately the same size: 150 U.S. vessels and 152 Canadian vessels. This changed drastically between 1980 and 2001. By 2001, the U.S. fleet numbered 57 vessels (a 62 percent decrease) and the Canadian fleet numbered 90 vessels (a 41 percent decrease).

TABLE 5-2
Composition of the Great Lakes Fleet by Vessel Type and Nationality: 1980, 1990, and 2001

Type of Vessel	1980	1990	2001	1980-2001
Bulk Carriers				
United States	18	7	4	-94.9%
Canada	85	55	38	-55.3%
Subtotal	163	62	42	-74.2%
Self Unloaders				
United States	58	55	49	-15.5%
Canada	35	35	38	+8.6%
Subtotal	93	90	87	-6.5%
Tankers				
United States	14	6	4	-71.4%
Canada	32	27	14	-56.3%
Subtotal	46	33	18	-52.2%
Total Fleet	**302**	**185**	**147**	**-51.3**
United States	150	68	57	-62.0%
Canada	152	117	90	-40.8%

Source: Greenwood's Guide to Great Lakes Shipping, 1980, 1990 and 2001.

Although the number of vessels in the aggregate fleet declined from 302 in 1990 to 147 in 2001, the aggregate capacity of the fleet has not declined commensurately. In 1980, the 256 freighters (self-unloaders and bulk freighters) had an aggregate carrying capacity of 5,611,980 tons per trip. The 2001 fleet of 129 freighters had an aggregate carrying capacity of 4,396,627 tons per trip. This retention of fleet carrying capacity was accomplished by increasing the average capacity per trip of the vessels in the fleet. Only the most efficient vessels were retained, and the majority of the Class X vessels were built during this period.

Table 5-3 shows the average capacity per trip increased for bulk carriers and for self-unloading vessels. The average trip capacity for bulk carriers increased from 16,463 tons in 1980 to 26,195 in 2001. For self-unloading vessels the average increased from 26,990 to 37,890 tons. The much lower growth in average trip capacity of bulk carriers compared to self-unloaders is the principal reason for the much more pronounced decline of the former.

The same data indicate that the average capacity per trip of United States bulk carriers and self-unloaders increased more than their Canadian counterparts. The increase is most pronounced for self-unloading vessels. The United States self-unloading fleet more increased its average trip capacity by 49 percent: from 27,951 to 41,736 tons per trip. The Canadian self-unloading fleet increased its average trip capacity by less than 30 percent: from 25,397 to 32,930 tons per trip.

TABLE 5-3
Total Carrying Capacity per Trip and Average Carrying Capacity per Trip by Vessel Type: 1980, 1990 and 2001

	1980	1990	2001
Bulk Carriers (1)			
United States	1,380,790	147,050	105,056
Canada	1,721,110	1,301,245	995,154
Subtotal	3,101,900	1,448,295	1,100,210
Self Unloaders (1)			
United States	1,621,185	1,893,275	2,045,075
Canada	888,895	986,475	1,251,342
Subtotal	2,510,080	2,879,750	3,296,417
Total Fleet (1)	5611980	4,328,045	4,396,627
Tankers (2)			
United States	401,335	168,500	205,500
Canada	2,036,224	1,781,101	988,710
Subtotal	2,437,559	2,049,601	1,194,210
Average Trip Capacity			
Bulk Carriers (1)			
United States	17,702	21,007	26,289
Canada	20,248	23,659	26,188
Subtotal	16,463	23,360	26,195
Self Unloaders (1)			
United States	27,951	34,423	41,736
Canada	25,397	28,185	32,930
Subtotal	26,990	31,997	37,890
Tankers (2)			
United States	28,667	44,750	51,375
Canada	63,632	65,967	70,622
Subtotal	52,990	62,109	66,345

Notes: (1) Capacity of bulk carriers and self-unloaders are in short (2,000 lbs.) tons.
(2) Capacity of tankers is in barrels.
Source: Greenwood's Guide to Great Lakes Shipping, 1980, 1990 & 2001.

2). By Vessel Size. Ships are subject to economies of scale. For a given commodity, unit transportation costs per ton mile are less for large than for small vessels. Thus, the composition of the existing commercial navigation fleet by size of vessel is an important concern.

The Corps of Engineers has developed a comprehensive vessel size classification system for vessels operating on the Great Lakes that encompasses vessels of all sizes operating on the lakes. The categories in the classification are presented in **Table 5-4**. **Table 5-5** presents the data on the size composition of the fleet. To simplify the discussion of vessel size, groups of vessels classes have been aggregated as follows: small vessels are defined as vessel Classes I through IV, medium vessels as vessel Classes V through VIII and large vessels, vessel Classes IX and X.

TABLE 5-4
U.S. Army Corps of Engineers' Great Lakes Vessel Classification

Vessel Classes	Vessel Length
X	950-1,099 ft.
IX	850-949 ft.
VIII	731-849 ft.
VII	700-730 ft.
VI	650-699 ft.
V	600-649 ft.
IV	550-599 ft.
III	500-549 ft.
II	400-499 ft.
I	400 ft. or less

Source: Greenwood's Guide to Great Lakes Shipping, 2001.

There are more small vessels navigating the lakes than is commonly believed. Of the total 147 vessels, 28 (19 percent) are in Classes I through IV (see **Table 5-5**). Most small vessels (18 out of 28) are small tankers; engaged in transporting petroleum products within the lakes. These tankers distribute petroleum products from the refinery centers to numerous lake ports within Canada and the United States. By far, most tankers are Canadian, 14 of the 18 tankers on the lakes are of Canadian registry. The remaining 10 small vessels are small bulk carriers. They tend to be rather specialized vessels used to transport specific commodities to a limited number of ports.

TABLE 5-5
Composition of the 2001 Fleet by Vessel Class
Number of Vessels

Vessel Class	U.S.	Canadian	Total
Freighters			
I	0	7	7
II	0	2	2
III	0	0	0
IV	0	1	1
V	14	7	21
VI	7	4	11
VII	6	48	54
VIII	12	7	19
IX	1	0	1
X	13	0	13
Total	**53**	**76**	**129**
Tankers			
I	1	3	4
II	3	11	14
III	0	0	0
IV	0	0	0
V	0	0	0
VI	0	0	0
VII	0	0	0
VIII	0	0	0
IX	0	0	0
X	0	0	0
Total	**4**	**14**	**18**
All Vessels			
I	1	10	11
II	3	13	16
III	0	0	0
IV	0	1	1
V	14	7	21
VI	7	4	11
VII	6	48	54
VIII	12	7	19
IX	1	0	1
X	13	0	13
Total	**57**	**90**	**147**

Source: Greenwood's Guide to Great Lakes Shipping, 2001.

All medium vessels are freighters -- bulk carriers and self- unloaders. There are 105 medium size vessels, accounting for 71 percent of the fleet. Most of the medium sized vessels are Canadian (66) as opposed to United States registry (39). The largest concentration of medium vessels is the Class VII vessels; 54 of the 105 medium vessels are Class VII vessels. Not only are Class VII vessels more than half of the total number of medium vessels, Class VII vessels constitute more than one-third (37 percent) of all vessels on the lakes. Nearly all are Canadian; of the 54 Class VII vessels 48 are Canadian and six are American.

The reason for the large number of Canadian Class VII vessels is that Class VII vessels are the largest size vessels that can pass through the Welland Canal. These vessels are primarily used to ship wheat down the lakes from Thunder Bay, Ontario and on the return trip transport iron ore from the St. Lawrence River ports to the Canadian steel mills on the Upper Lakes. Thus, Class VII vessels account for most of the Canadian fleet. Of the 90 vessels in the Canadian fleet, 48 (53 percent) are Class VII vessels. Although most of the Canadian Class VII vessels are self-unloaders, a significant number are bulk carriers.

There are 14 large vessels (Class IX and X), on the Great Lakes; all 14 are under United States registry. All are self-unloaders that principally transport iron ore from the Minnesota and Michigan ports to the integrated steel mills, and trans-shipment ports, situated on Lakes Michigan and Erie (including the Detroit River). They are, however, increasingly used to move western coal from Superior, WI to electric utilities across the Great Lakes.

As a group these vessels are the largest, most efficient and most recently constructed ships operating upon the Great Lakes. The single Class IX vessel has a capacity to transport 44,500 tons at mid-summer draft of 27.0 feet. With mid-summer drafts of 28.0 to 34.0 feet, a Class X vessel has the capacity to transport 60,500 to 78,850 tons. Their combined total capacity per trip at mid-summer draft, 975,000 tons, amounts to 22 percent of the total per trip capacity of the entire Great Lakes fleet. Given a United States fleet capacity of 2,150,131 tons per trip, these 14 vessels account for 45 percent of the per trip capacity of the American fleet. The large vessels are the backbone of the United States fleet on the Great Lakes and are increasingly used to move western coal from Superior, WI to electric utilities distributed across the Great Lakes.

3. PROJECTED FLEET

a. General. Two GL/SLS system configurations are being examined in this study: the existing system configuration and a proposed larger Seaway. Variations of each are analyzed; however, these two basic configurations frame the evaluations and dictate the need to develop two future fleets, one for the existing system and one for the larger Seaway.

b. Existing System Configuration.

1). U.S. Great Lakes/Seaway Fleet. The description of the future U.S. Great Lakes commercial navigation fleet is based on meetings with the CEOs of two major U.S. Great Lakes (GL) fleet operators in June and July, 2001 and phone conversations with the CEO of a third, smaller fleet operator in May and July, 2001. The three fleets operate 23 of the total 58 GL self-unloading vessels – bulk freighters – which comprise the U.S. GL fleet in 2001; thus they account for 40 percent of all vessels in the U.S. GL fleet. The three fleets own or operate five of the 13 Class X vessels, which in the GL navigation industry are referred to as 1,000-footers because of their length, the largest and most efficient vessels on the Great Lakes. Thus the in-depth, personal or telephone interviews of the three CEOs are believed to be representative of the U.S. GL fleet.

None of the three fleet operators has any plan to construct or otherwise add a new vessel to their existing fleet in the foreseeable future. This is not surprising given the high degree of uncertainty facing the U.S. steel industry, and in particular, the integrated steel mills, situated in the Great Lakes Basin – their main customers. These mills are firms that contract the lake carriers to transport iron ore, the dominant commodity transported on the Great Lakes, from the Head-of-the-Lakes to mills situated along or in the vicinity of lakes Michigan, Erie, and Ontario. The two large fleet operators did indicate, however, that they might well replace one or more existing vessels with a new vessel(s) at some unspecified future date.

Though the fleet operators do not foresee addition of new vessels to their fleet in the foreseeable future they did agree that technologic improvements will be made to vessels in the existing fleet, particularly to the Class X vessels. The improvement would include automation of the engine room and pilothouses to reduce crew sizes. Both of the large fleet operators did not foresee reduction of crew size for a Class X vessel to less than 21. They are concerned that a smaller crew size would impinge upon safety standards. All three said any new vessels would be conventional, self-unloading vessels with automated engine room and pilot house. In each case the cost of an integrated tug-barge, like the Great Lakes Trader, was said to be too high.

Each CEO of the large fleets was asked which category (vessel class) of vessel would be dropped from their fleet if demand for waterborne shipment of bulk commodities was insufficient to support continued operation of all of the vessels in their fleet. The question was not asked of the third CEO because his fleet was too small.

Both CEOs responded in the same answer: the Class VII and VIII vessels would be dropped from their U.S. fleets. The consensus was that the Class X vessels are the most profitable vessels to operate and they would be maintained in operation in as long as demand was sufficient. Class V and VI (but predominantly Class V) vessels, the riverboats, are small vessels that can more easily navigate the navigable river channels of many Great Lakes harbors. These would not likely be dropped as they are comparatively few in number and the demand for their service is quite high.

The long term, future U.S. Great Lakes bulk fleet associated with an improved GL/SLS system is presented in **Table 5-6**. This future fleet is indicated by results from the GLLAST model runs. Near term traffic demands indicate the fleet may contract between now and 2030 in all vessel classes save Class Xs. Demands in 2060 lead to a growth in the number of vessels.

TABLE 5-6
Composition of the Future U.S. Great Lakes Bulk Freighter Fleet for an Improved GL/SLS System[1/]

Vessel Class	2001	2030	2060
I	0	0	0
II	0	0	0
III	0	0	0
IV	0	0	0
V	14	10	12
VI	7	6	6
VII	6	5	7
VIII	12	9	10
IX	1	1	1
X	13	17	21
Total	**53**	**48**	**57**

1/ Excludes cement carriers.

2). Canadian Great Lakes/Seaway Fleet. Four Canadian fleet operators account for 65 of the 76 Canadian bulk freighters/self unloaders: Algoma Central Marine (23), the Upper Lakes Group (22), Canada Steamship Lines (13) and N.M. Paterson & Sons Limited (7).

Algoma Central is the largest Canadian ship owner on the Great Lakes. Algoma Central and the Upper Lakes Group have formed a partnership (Seaway Marine Transport) to optimize the management of their bulk commodity/self unloading fleet. This combined fleet allows the vessels to be scheduled more efficiently based on the vessels location and type of commodity needing delivery. Also, Seaway Marine Transport has developed several cargo handling improvements ranging from covered unloading booms to dust suppression systems to a soft drop system that protects sensitive cargoes during loading or unloading.

Algoma Central allocated C$85 million and implemented a five-year Fleet Renewal Program in 1997. The program determined the improvements that would need to be made to the fleet to insure its operation for another 15 years. The majority of the funds went to renewing six vessels, including mid life refits of three vessels. Algoma Central has also been converting suitable bulk freighters to self-unloaders. This conversion process takes approximately six months and costs around C$20 million.

The Upper Lakes Group converted one of its Class VII bulk freighters to a self-unloading vessel in 1997 at a cost of C$15.5 million. The Upper Lakes Group plans to extensively rebuild one of its Class VII vessels for use in the Spring of 2002. The vessel will receive a new mid body and be widened to 78 feet. The improvements will increase its carrying capacity and reduce crew costs, maintenance costs and fuel costs.

Canada Steamship Lines is renovating three vessels as part of its C$100 million capital investment project started in 1999. Each of the vessels will receive a new fore-body section. These vessels will have renovated self-unloading systems to make them more efficient. Other projects underway on other vessels in its fleet include major hull steel renewal, upgrading of belt unloading systems and widening a Class VII vessel to 78 feet.

Over 90 percent of the Canadian fleet can use the Seaway. Class VII vessels, which are the largest size vessel that can transit the Seaway, account for over 60 percent of the Canadian fleet. Almost all of these Class VII vessels were constructed after 1959. Given that the Canadian fleet was built to maximize vessel carrying capacity through the Seaway, the number and composition of the fleet should not change in the near future. The Canadian fleet will continue to be renovated, especially with renovations that reduce crew, maintenance, and fuel costs. The conversion of self-unloading vessels will continue, making the fleet more flexible in the ports that it can service.

c. Proposed GL/SLS Configuration. The proposed Seaway being examined in this study dramatically increases the number and capacity of the world's fleet of vessels capable of using the GL/SLS. The percentage of vessels grows from 69 percent to 83 percent and the percentage of vessel capacity grows from 13 percent to 34 percent. The most notable change occurs in the bulk and container vessels where Seaway capable bulk capacity increases from the current 2 percent to nearly 20 percent of the world bulk fleet, the Seaway compatible container capacity increases from the current 5 percent to over 25 percent (see **Table 5-7**).

TABLE 5-7
Seaway Capable Fleet under Proposed Seaway Configuration[1/]

	Number of Vessels	% World Fleet	Gross Tons	% World Fleet
Bulk	3,028	46.2%	35,466,371	19.8%
Container	1,719	56.5%	20,535,846	26.7%
Gas	867	72.9%	3,657,938	15.5%
General Cargo	14,104	95.1%	50,088,989	84.4%
Miscellaneous	16,839	94.7%	23,095,232	76.6%
Passenger	3,960	97.1%	2,5572,431	85.9%
Reefer	1,332	99.3%	6,993,496	99.5%
RoRo	1,695	93.9%	26,238,017	87.6%
Tanker	6,406	68.4%	23,415,632	11.5%
Total	**50,004**	**83.2%**	**215,063,952**	**33.7%**

1/ Based on Seaway capable of handling vessels 1,000' long and 110' wide drafting 35'.
Source: "Saint Lawrence Seaway Vessel Fleet Study, 2001," prepared by Lloyd's Maritime Information Ltd. for the U.S. Department of Transportation, Saint Lawrence Seaway Development Corporation.

4. VESSEL OPERATING COSTS

The Maritime Administration (MARAD) has traditionally provided the Corps of Engineers with vessel operating cost data by vessel class. Vessel class operating cost data was developed based on the most recent information provided by MARAD (1998) as well as vessel operating costs provided in the Soo Locks study. These vessel costs reflect October 2000 price levels. Operating cost data fell into two basic categories: Construction costs and daily vessel operating expenses. These costs were calculated based on a 275-day navigation season.

A non-descript (prototype) vessel was developed for each vessel class based on characteristics of vessels in each class. Vessel characteristics included deadweight tonnage, draft, immersion factors, horsepower, etc.

Daily vessel operating expenses included such items as wages, subsistence, stores, supplies and equipment, other, maintenance and repair and fuel. (**Table 5-8**). Daily vessel operating expenses ranged from $16,181 for a Class II vessel to $25,300 for a Class X vessel. Essentially wages and subsistence costs were the same for vessel Classes II through IV. Wages and subsistence costs were also the same for vessel Classes IX and X. All vessels had different Stores Supplies and Equipment (SS&E) costs, insurance costs, maintenance and repair costs fuel costs and other costs.

Vessel construction costs have characteristically been based on estimates from region shipyards. However, there has been no spurt of new vessel construction since the early 1980s when Class X vessels were constructed for the Great Lakes. The most recently built vessel on the Great Lakes is the Class IX Great Lakes Trader, built in 2000. This information was used, along with other vessel capital construction costs used in the Soo locks study, to develop vessel construction costs for the various vessel classes. Vessel construction costs were the same for Class IX and X vessels. Vessel construction costs range from $44.7 million for a Class II vessel to $106.7 million for a Class X vessel, in October 2000 price levels.

This information on vessel variable operating costs and construction costs (see **Table 5-8**) were converted to: first daily operating costs and then hourly vessel operating costs. An overhead factor of 12 percent was added to daily variable operating costs. Vessel construction costs were converted to an average annual cost using a 50-year evaluation, and a 6.125 percent annual interest rate. This was then converted to a daily fixed cost based on a 275-day season. This resulted in total daily vessel costs ranging from $30,069 for a Class II vessel to $56,859 for a Class X vessel. These daily total vessel-operating costs were then converted to hourly vessel operating costs by dividing by the number of hours in a day (24). Total hourly vessel operating costs ranged from $1,253 per hour for a Class II to $2,369 per hour for a Class X. These hourly vessel operating costs can be used to calculate total yearly transportation costs for given commodity movements, once the total hours associated with that movement is calculated.

TABLE 5-8
U.S. Flag Great Lakes Vessels
Estimated Hourly Operating and Construction Costs[1], Selected Vessel Classes
October 2000 Prices

Army Corps Class	**II**	**V**	**VI**	**VII**	**VIII**	**X**
Vessel Characteristics						
Deadweight (GT)	9,050	17,675	25,000	28,880	32,000	60,000
Gross Weight (GT)	5,494	10,100	12,500	13,390	15,480	34,400
Length Overall (Feet)	450	625	730	730	806	1,000
Crew (People)	26	28	28	29	30	29
Engines	Diesel	Diesel	Diesel	Diesel	Diesel	Diesel
BHP	2,200	5,000	7,000	7,500	10,000	15,000
Expenses/Voyage Day						
Wages	$10,547	$10,651	$10,781	$10,913	$11,330	11,821
Subsistence	$3,000	$300	$300	$350	$350	350
SS&E	$431	$674	$709	$758	$896	1,043
Insurance	$937	$1,271	$1,582	$2,018	$2,744	3,381
Maint & Repair	$1,624	$1,972	$2,102	$2,284	$2,470	2,581
Fuel	$1,424	$3,135	$3,408	$3,822	$4,418	4,883
Other	$918	$1,120	$1,143	$1,176	$1,215	1,241
Total	**$16,181**	**$19,123**	**$20,025**	**$21,321**	**$23,423**	**25,300**
Construction Costs	$44.7m	$59.9m	$66.4m	$75.5m	$91.1m	106.7m
Total Daily Cost	$18,122	$21,418	$22,428	$23,880	$26,234	$28,336
Daily Variable Costs	$11,947	$15,995	$17,737	$20,175	$24,349	$28,514
Daily Fixed Costs	----	----	----	----	----	----
	$30,069	$37,412	$40,165	$44,056	$50,583	$56,849
Total Hourly Costs	**$1,253**	**$1,559**	**$1,674**	**$1,836**	**$2,108**	**$2,369**

1. Construction costs reflect October 2000 price levels.

5. EFFECT OF VESSEL SIZE ON TRANSPORTATION COSTS

Vessel size is extremely important in affecting the cost of moving a commodity across the Great Lakes. Transportation rates are affected by numerous factors, but paramount amongst them is the cost to the carrier of providing the service. Thus vessel size has a direct and substantial bearing upon transportation rates.

This section discusses the influence that vessel size has upon constructed transportation rates. A constructed transportation rate is a theoretical rate developed for a shipment of a given commodity to/from a given origin/destination set of ports given assumed values for essential variables -- most importantly for variables affecting capital and vessel operating costs. While the resulting transportation rate is not a "real" (market determined) rate, it is consistent for vessels of the same size.

A constructed transportation rate is determined by calculating an estimated total cost to operate a vessel for one season. Total annual operating costs include an allowance for capital costs (a fixed cost) and for operating costs (a variable cost). Additionally, it is necessary to determine the total quantity of commodity that the vessel can transport in one navigation season for one port origin/destination pair. Total quantity shipped is a function of vessel draft, available draft, the vessel's immersion factor and the time required to complete one round trip (including loading and unloading time). Once total operating costs and total quantity shipped have been determined, the former is divided by the latter to produce the resulting constructed transportation rate.

The transportation rates presented assume a fixed vessel draft that is constant for all 3 vessel categories. The draft used is 26.0 feet. **Table 5-9** presents the constructed transportation rates. The effect of size on the transportation rate is substantial. Where it is estimated that the transportation rate for a Class V vessel at a 26.0 foot draft would be $8.53 per ton, the corresponding rate for a Class X vessel drafting 26.0 feet would be $5.67 per ton. For the illustrative example the Class X transportation rate is 66 percent of the Class V transportation rate.

If 2,754,908 tons of iron ore were transported from Duluth/Superior to Cleveland each year (see "Tons Moved per Season" in **Table 5-9**), the total cost to do so via Class V vessels would be $23,513,027. It would require 2.29 Class V vessels to transport that much ore. If one were to transport the same amount in a Class X vessel, only one Class X vessel would be needed, the total cost would be $15,633,668. The difference, $7,879,140, is the savings that would accrue through use of the larger vessel.

TABLE 5-9
Synthetic Transportation Rates

Vessel Characteristics & Operating Costs	**Vessel Class I**	**Vessel Class VII [1]**	**Vessel Class X[1]**
Vessel Characteristics			
Midsummer Draft (feet)	27.90	30.70	28.00
Maximum Vessel Operating Draft [2]	26.00	26.00	26.00
Carrying Capacity at MSD (short tons)	26,700	39,400	66,900
TPI Factor (short tons)	106	137	265
Reduction in vessel capacity	2,417	7,727	6,360
Adjusted Carrying Capacity (short tons)	24,283	31,673	60,540
Total round Trip Hours	13,295	13,541	145.04
Round Trips per Season	4,964	48.74	45.51
Tons Moved per Season	1,205,470	1,543,723	2,754,908
Vessel Operating Cost [3]			
Vessel Construction Cost [4]	59,873,172	75,522,520	106,730,577
Daily Variable Operating Costs[5]	$21,418	$23,880	$28,366
Annual Fixed Operating Costs [6]	$4,251,557	$5,362,807	$7,578,872
Yearly Variable Operating Costs[7]	$5,889,884	$6,566,868	$7,792,400
Total Annual Operating Costs per Season	$10,141,441	$11,929,675	$15,371,272
Transportation Rate per Ton	$8.41	$7.73	$5.58
Tons Moved per Season	2,754,908	2,754,908	2,754,908
Transportation Cost	$23,176,631	$21,289,538	$15,371,272

1) The vessel characteristics are for specific vessels in the appropriate class.

Vessel Class	Vessel Name
V	Fred R. White, Jr.
VII	H. Lee White
X	George Stinson

2) For purposes of analysis, maximum vessel operating draft has been restricted to 26.0 ft.
3) Vessel operating costs represent October 2000 prices.
4) Vessel Construction costs include a 10% profit.
5) Daily Vessel Variable operating costs include a 12% overhead factor.

6) Annual fixed operating costs are vessel construction costs with profit converted to an average annual dollar value using a 50 year project life and a 6.125% annual interest rate.
(7) Yearly variable operating costs are daily variable operating costs with a 12 % overhead factor times the number of shipping days in the season.

SECTION 6. BENEFIT ESTIMATION PROCEDURES

1. INTRODUCTION

The nature of the system - its multiple and distinctive vessel fleets and waterways, the bi-national setting, and the traffic's international character - complicate evaluations of alternative improvement plans for the Great Lakes/St. Lawrence Seaway (GL/SLS) navigation system. The range of alternatives offered is wide, from deepening existing channels and ports by a matter of inches to enlarging locks and deepening channels and ports by several feet, thereby opening the GL/SLS to a dynamic sector of world trade it cannot currently accommodate.

The bi-national setting and international aspect of the GL/SLS traffic most affects the availability of data. U.S. domestic waterborne traffic is readily available in great detail, that is, origin, destination, commodity and routing information is available at the vessel level. U.S. foreign waterborne traffic is available for origin, destination, commodity, and sometimes vessel. Canadian traffic is available for both domestic and foreign Canada moves at the origin, destination, and commodity level, but no vessel data is available. The effect of this data inconsistency is to limit the application of the GLLAST model (a system-wide vessel costing model) to U.S. domestic traffic and that U.S. foreign traffic where vessel information is provided. On the Great Lakes Navigation System (GLNS) this is not a critical limitation as 57 percent of this traffic is U.S. domestic traffic and another 31 percent is U.S. to/from Canada traffic, which sometimes has vessel information. Cost reduction benefits estimated with the GLLAST are representative of potential benefits gained by channel and port deepening in the GLNS. The GLLAST is not applied to the Seaway, where U.S. domestic traffic accounts for less than 5 percent of traffic, due to the lack of detailed vessel information.

Evaluating the economics of enlarging Seaway locks and deepening channels by several feet requires its own set of data and analytical tools. Two targeted transportation rate analyses provided an estimate of benefits accruing from existing land-routed moves shifting to the deeper and wider GL/SLS waterways. These benefit estimates are in turn used as key inputs in the Maritime Input Output (MIO) model. The MIO model estimates economic development benefits in terms of output, income, and employment.

A separate benefit analysis was performed for the Chicago Sanitary and Ship Canal (CSSC) and Calumet-Sag Channel (CSC) connecting channels and the Great Lakes cruise industry. The methodologies, data and models employed in benefit estimation are discussed briefly below. More detail on the GLLAST model, potential container traffic, the MIO model, the CSSC-CSC connecting channels, and the cruise industry can be found in the attachments to this economics appendix.

2. FRAMEWORK

As previously mentioned, the approach used to estimate benefits of GL/SLS improvements is dictated not only by the available data, but also by the problems and opportunities being addressed in the study. Given the set of problems and opportunities, the economics must address five potential benefit sources:

1. deepening GLNS channels and ports to the benefit of future U.S. waterborne commodity flows based upon existing traffic;

2. deepening channels and increasing lock sizes on the Seaway to the benefit of future U.S. and Canadian waterborne commodity flows based upon:

    a. existing waterway flows,
    b. existing overland flows, and
    c. induced, new flows of traffic;

3. increasing bridge clearances, providing fleeting areas, and widening congested reaches of the Chicago Sanitary and Ship Canal and Calumet-Sag Channel to the benefit of future U.S. waterborne commodity flows based upon existing traffic;

4. deepening channels and ports, and increasing lock sizes to the benefit of ambient air quality, reduced highway congestion, and increased economic activity in terms of output, income and employment; and

5. deepening channels and ports, and increasing lock sizes to the benefit of future passenger cruise ship growth.

The first component focuses upon the Great Lakes portion of this larger system. The Great Lake Levels Analysis for System Transportation (GLLAST) model is used to estimate transportation-cost-reduction benefits. Any channel or port improvements that allow for less time-consuming trips or for fewer trips (through heavier loadings) result in vessel cost reductions. Projected traffic based upon existing bulk commodity flows are evaluated in this analysis.

The second component deals with the St. Lawrence Seaway. Seaway improvement benefits shall be based upon shift-of-mode benefits for existing overland container and waterborne bulk commodity flows. A comparative transportation-cost analysis of existing overland-routed container moves against alternative water-routed moves through the GL/SLS was conducted to identify potential moves and estimate the water-routed cost savings for each. A similar, though more limited, analysis was completed for existing overland bulk commodity moves. Transportation costs for the existing overland routing were estimated and compared with the estimated costs of moving on an improved Seaway between the same markets.

The third evaluation looks at the benefit of improving the ability of the Chicago Sanitary and Ship Canal and Calumet-Sag Channel to safely and efficiently move traffic through the channel's congested and constricted reaches. Transportation-cost savings for future traffic based upon existing commodity flows are estimated.

The fourth evaluation estimates other transportation impacts like emission reduction and highway congestion reduction. More efficient use of the vessel fleet permitted by channel and port improvements reduces fuel consumption and the related emission of pollutants. Freight traffic that shifts to water routings also reduces congestion on the highways. Benefits associated with emission and congestion reduction are estimates based upon results from prior studies. The study will also estimate changes in employment, output and income associated with transportation-cost savings.

And finally, the study estimates the benefit of the existing passenger cruise industry and its potential for growth with an improved system.

3. GLLAST

a. Introduction. The Great Lakes Levels Analysis for System Transportation model (GLLAST) is a modified version of the IJC model which was developed in Buffalo District and used as part of the *Levels Reference Study: Great Lakes - St. Lawrence River Basin* and submitted to the International Joint Commission, March 1993. GLLAST serves as the primary tool used in this study to determine shipping costs on the Great Lakes.

b. Model Description. The GLLAST model is a costing model. It uses a set of input data that describe the types and amounts of commodities shipped between Great Lakes ports. Information considered by GLLAST includes, beginning and ending shipment dates, types and costs of the boats that transport the commodities, depths of ports and connecting channels, and 101 years of monthly lake levels. Based upon the input data, the model determines the cost to ship all of a specified annual tonnage. It does this by determining, for each movement, the maximum tonnage that can be carried. Factors considered when determining maximum loading include the vessel carrying capacity, commodity type, depths at the ports and connecting channels along the route, shipping season, and water level. The model continues to load commodities onto boats until all commodities have been shipped. It then calculates shipment costs based on the time the vessel is operating and the cost of the vessel. Alternatives can be analyzed by making a change to a key input item, e.g. a port depth, and running the model again. The transportation-cost impact can then be determined by comparing the total transportation costs before and after the port deepening. In the GLLAST model, the only factor that affects transportation cost is the number of trips required to move all commodities. A full description of the GLLAST model is provided in **Attachment 2, GLLAST**.

The GLLAST uses several input files to calculate the time required to transport a given amount of commodities in a given fleet of boats for a given set of monthly average water levels and a given set of port/connecting channel depths. Calculations are made on a movement-by-movement basis. That is, if it takes 25 vessel trips to move a given annual commodity tonnage from Port A to Port B, the time required to make each of the 25 movements is calculated separately. This way the seasonal variations in lake levels and vessel load line limits are included in the analysis.

The most important output from GLLAST is a file that lists 39 data items for each of the 6,000+ movements in a year. This file is then imported into a database where boat-operating costs are applied to calculate transportation cost.

GLLAST is run on an annual basis; that is, one run moves one year's worth of commodities through one year's worth of average monthly water levels. The impact of yearly lake level variation is included in the analysis by running the model several times, each time with a different set of monthly lake levels. Average monthly lake levels for the period 1900-2000 were used in this study. In order for the model to calculate the time required to move a given set of commodities with a given fleet, commodity flow and fleet information must be defined. A detailed description of how this information was developed is provided in **Section 4** and **Section 5** of the Economics Appendix. The input file that defines the fleet and commodity flow information consists of a movement-by-movement list, called a shipment list, for each of the approximately 6,300 movements that could be sufficiently identified in 1998.

The entire Great Lakes Navigation System (GLNS) was included in the analysis; however, transportation costs were calculated only for commercial commodity movements. Recreational and passenger traffic were not included in the analysis, nor were shallow draft vessels movements coming off the inland waterway system. Shipments of the top 13 commodities, which accounted for 92 percent of all commodity traffic, were included in the analysis. All vessel shipments of these commodities were considered for U.S.-to-U.S. movements and for movements involving foreign origins or destinations to the extent that detailed vessel data permitted.

c. Input Data Development.

1.) Shipment List. The GLLAST model is driven by a list of shipments that describe the flow of commodities throughout the Great Lakes system. The list contains approximately 6,300 movements and is based on 1998 data. **Section 4** of the Economic Appendix describes how this list was developed. **Table 6-1** displays the data fields contained in the shipment list.

TABLE 6-1
Shipment List Data Items

Data Item	*Description*
Vessel Number	Unique five digit number assigned to the vessel
Trip Flag	One digit number that identifies whether this movement is part of a multi-origin or multi-destination movement
Origin Date	The date the vessel departed the origin port
Origin Port	Five digit identifier for the origin port
Destination Date	Date the vessel arrived at the destination
Destination Port	Five digit identifier for the destination port
Commodity Number	Five digit identifier for the commodity
Tons	Tons of the commodity moved

Significant problems arose during the creation of the shipment list. The problems were directly related to inaccurate, incomplete, or non-existent vessel data. Vessel information was usually sufficient for movements that traveled between U.S. ports, or U.S. and Canadian ports. Vessel information for movements that traveled in foreign vessels, that are not U.S. or Canadian, was much less useful. Generally speaking, foreign flag vessels could not be identified. Therefore, those vessels were not included in this analysis.

2.) Commodities and Tonnage Modeled. **Table 6-2** shows the thirteen commodities modeled by GLLAST. The table also shows the number of movements that could be sufficiently identified in 1998 for each commodity.

TABLE 6-2
Commodities Types and Number of Movements Identified in 1998

Commodity	***Number of Movements***
Iron Ore	1,996
Coal	1,083
Limestone	1,939
Salt	260
Cement	566
Stone	155
Gypsum	81
Clay	77
Soya	43
Maize	50
Wheat	57
Barley	11
Oats	6

Section 4 of the Economic Appendix describes how projected future tonnage levels were developed. **Table 6-3** displays commodity tonnages for 1998 and 2000, 2030 and 2060. In many cases projected 2000 traffic is substantially higher than 1998. This is because the 1998 tonnage excludes vessels that could not be fully identified. Transportation costs are therefore calculated for all projected tonnage moved in vessels that could be identified.

TABLE 6-3
Tonnage by Commodity
1998 Identified and 2000, 2030, 2060 Projected

Commodity	*1998 Identified Tons*	*2000 Projected Tons*	*2030 Projected Tons*	*2060 Projected Tons*
Iron Ore	70,429,568	71,102,736	63,998,751	62,893,999
Coal	34,062,650	39,422,080	56,773,296	78,925,263
Limestone	33,628,257	36,261,296	53,376,942	66,465,155
Salt	5,133,343	5,561,401	6,370,729	7,031,616
Cement	4,863,899	5,639,549	8,308,887	10,548,949
Stone	2,135,300	2,297,556	3,390,904	4,221,741
Gypsum	1,207,255	1,260,712	1,691,938	1,936,157
Clay	1,140,869	1,299,779	1,782,598	2,029,938
Soya	1,097,772	1,186,303	1,858,933	2,693,997
Maize	1,018,158	1,277,263	2,005,703	2,921,260
Wheat	729,782	847,083	1,220,349	1,642,478
Barley	198,393	202,637	331,854	530,151
Oats	78,607	94,353	154,520	246,853

3.) Vessel Information. GLLAST calculates transportation costs using a fleet that is as near as possible to the fleet of vessels that ply the Great Lakes. **Section 5** of the Economic Appendix describes the Great Lakes fleet in general terms. The GLLAST model uses detailed information about each of the 143 boats that are modeled. **Table 6-4** displays the boat information that is used in the GLLAST Model.

4.) Port Information. **Section 3** of the Economic Appendix provides a detailed description of the 33 ports that were selected for study. The GLLAST model uses information for 411 ports within the GLNS. Port information used by the GLLAST model include, depth at the dock relative to Low Water Datum (LWD), additional maneuvering time if needed, commodity loading rate if the port has loading equipment, and commodity unloading rate if the port has unloading equipment. These four pieces of information are commodity specific. *GLLAST uses 1 foot under keel clearances at all ports for all commodities.* The GLLAST was developed to replicate, to the greatest extent possible, the transportation costs associated with the existing and expected future Great Lakes vessel movements. To this end, shipping companies were interviewed to ascertain the existing shipping practices of vessel captains in soft and hard bottom transits. From these interviews it was determined that the boat captain makes this decision and that one foot under keel clearance was the predominant existing practice through the St. Marys River. Using one foot in the model was deemed the most accurate reflection of vessel operating practices.

5.) Connecting Channel Information. **Section 3** of the Economic Appendix describes the connecting channels within the GLNS. GLLAST considers 9 connecting channels, with their associated depths relative to LWD, **Table 6-5**. GLLAST uses an under keel clearance of 1.0 foot at all connecting channels.

6.) Water Levels. Water level fluctuations on the Great Lakes affect commercial vessels. Changes in water levels affect the cost of delivering bulk commodities. In general, low water levels reduce the water column available to a shipper on a given origin/destination route. This lower water column means that the vessel operator cannot load the vessel to capacity (or the maximum number of tons of cargo it is allowed to hold). Consequently more trips are required to deliver the same amount of tons to the end user. More trips equate to higher transportation costs. Conversely, higher water levels usually allow the vessel operator to load more tons per trip. The vessel operator will load up to the maximum amount of tons that vessel is allowed to carry which may result in less trips having to be made to deliver the same amount of tonnage to the end user. Fewer trips equate to lower transportation costs.

TABLE 6-4
Boat Information Used in GLLAST

Information	Description
Vessel Number	Five digit vessel identifying number
Length	Vessel length
Beam	Vessel width
Dense Com MS Draft	Draft at mid-summer[1] capacity for dense commodities [2]
Dense Com MS Cap	Mid-summer capacity in tons for dense commodities
Coal MS Draft	Draft at mid-summer capacity for coal
Coal MS Capacity	Mid-summer capacity in tons for coal
Salt MS Draft	Draft at mid-summer capacity for salt
Salt MS Capacity	Mid-summer capacity in tons for salt
Wheat MS Draft	Draft at mid-summer capacity for wheat
Wheat MS Capacity	Mid-summer capacity in tons for wheat
Corn MS Draft	Draft at mid-summer capacity for corn
Corn MS Capacity	Mid-summer capacity in tons for corn
Barley MS Draft	Draft at mid-summer capacity for barley
Barley MS Capacity	Mid-summer capacity in tons for barley
Oats MS Draft	Draft at mid-summer capacity for oats
Oats MS Capacity	Mid-summer capacity in tons for oats
Soya MS Draft	Draft at mid-summer capacity for soya
Soya MS Capacity	Mid-summer capacity in tons for soya
Summer Draft	Maximum allowable draft for period 16 April-30 April and 16 September-30 September
Intermediate Draft	Maximum draft allowed for period 1 April-15 April and 1 October-31 October
Winter Draft	Maximum draft allowed for period 1 November – 31 March
Immersion Factor	Load carrying ability in tons per inch
Class	Vessel class based on Corps of Engineer classification system
Type	Vessel type, self-unloader, bulk freighter, etc.

1. Mid-summer is the period from 1 May-15 September
2. Iron ore, limestone, stone, gypsum, clay, and cement are considered dense commodities

Water Levels for the GLNS GLLAST Model were developed from two sources. The first portion was derived from water levels generated for the International Joint Commission (IJC) Water Levels Reference Study (March 1993). Because of existing control works and lake level regulation on Lakes Superior and Ontario and the St. Lawrence River, actual historical levels (which pre-date the construction of the St. Lawrence Seaway and associated control works) would not properly reflect the expected levels of the lakes in the future. Therefore, a lake level simulation plan, Basis of Comparison (BOC) was used to simulate historical levels as if they were regulated through existing Great Lakes control works (Regulation Plan 77A, (Criteria C) on Lake Superior and Regulation Plan 58D, with deviations on Lake Ontario/ St. Lawrence River) and existing diversions and consumptive uses. This portion of the water level data represents the monthly mean levels by lake for the period 1900 through 1989. Actual recorded mean monthly levels by lake for the period 1990 to 2000 were added to the BOC levels by lake to comprise the full set of historic average monthly lake levels from 1900-2000 that were used in this study.

TABLE 6-5
GLLAST Connecting Channels and Depths Relative to LWD

Connecting Channel	***Depth (feet)***
St Lawrence River	27.25
Welland Canal	27.25
Detroit River	27.5
Lake St Clair	27.5
St Clair River	27.0
Straits of Mackinac	30.0
St Marys River 1/	27.5
Soo Locks	32.0
Vidal Shoals	28.5

1/ St. Marys' controlling depth is currently 27 feet; however, improvements aimed at providing 25'6" minimum draft are expected to increase this depth to 27'6". This depth was used in the modeling as it was deemed reflective of the most likely without project condition for channel depth at LWD on the St. Marys.

7.) Transportation Costs. The GLLAST model does not calculate transportation costs explicitly. Instead, it calculates the amount of time required to make every one of the 6,000+ annual movements. These operating times are then multiplied by operating costs to determine transportation costs. Transportation costs savings are realized by reducing the number of trips needed to transport the annual tonnage. If a port or connecting channel dredging results in fewer trips, the transportation cost savings are categorized as benefits of the dredging.

8.) Output. The GLLAST model produces one output file containing 39 data items for every one of the 6,000+ shipments. The 39 items are listed in **Table 6-6**.

4. TRANSPORTATION COST STUDY--CONTAINERS

a. General. The Tennessee Valley Authority (TVA) was contracted to estimate a range of transportation cost savings for existing, overland container movements to Great Lakes harbor cities by way of an improved St. Lawrence Seaway. The study was based on a survey of Atlantic port authorities, the 1999 Surface Transportation Board (STB) Waybill Sample, and current published container vessel charter rates. Eastern U.S. containers, counted in twenty-foot equivalent units (TEUs) and forty-foot equivalent units (FEUs), moving between deep-water Atlantic ports and Great Lake Ports by rail and truck were selected for rate analysis. This study costs these movements as they currently move and then costs these same moves through a GL/SLS with larger locks and a deeper draft throughout. Specifically, the container movements are defined by origin and destination Great Lake Ports[1]; origin and destination Atlantic Coast ports[2]; four vessel sizes: 500, 1500, 2500 and 3500 TEU capacity; three navigable drafts for the Seaway, connecting channels, and ports of 30', 32' and 35'; and two types of shipping service: shuttle and through.

TABLE 6-6
GLLAST Output Data Items

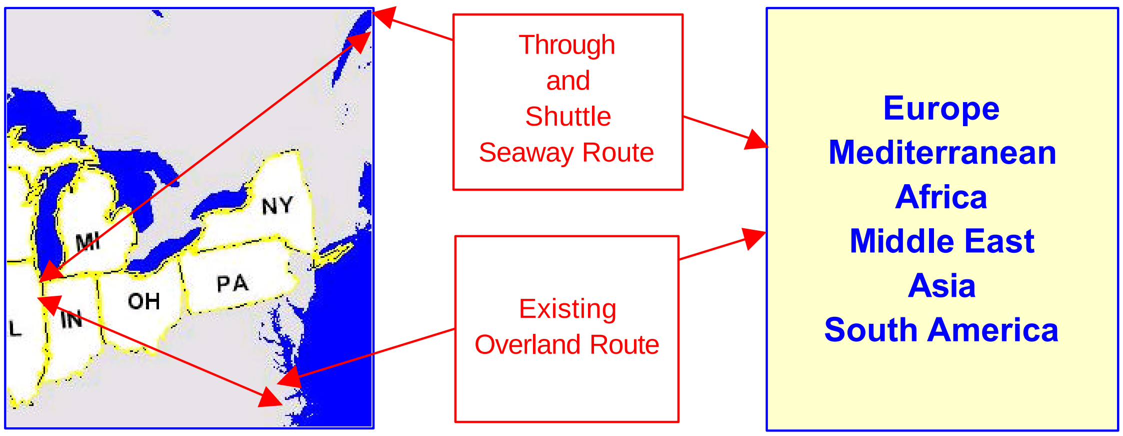
Output Item	*Description*
Shipment Date	Date the shipment begins
Vessel Number	Five digit identifying number of the boat
Class	Boat class
Commodity	Commodity number
Origin Port	Origin Port Number
Origin Depth	Depth of the origin port on the shipment date
Destination Port	Destination Port Number
Destination Depth	Depth of the destination port on the shipment date
OD Limit	Minimum depth of either the origin or destination
MS Draft	Coast Guard allowed mid-summer draft for the boat
Sum Draft	Coast Guard allowed summer season draft for the boat
Inter Draft	Coast Guard allowed intermediate season draft for the boat
Win Draft	Coast Guard allowed winter season draft for the boat
St Law Node	Depth of the St Lawrence on shipping date if trip uses St Lawrence
Well Node	Depth of the Welland on shipping date if trip uses Welland
Detroit Node	Depth of the Detroit River on shipping date if trip uses Detroit R.
LStCl Node	Depth of Lake St Clair on shipping date if trip uses Lake St Clair
StClR Node	Depth of the St Clair River on shipping date if trip uses St Clair R.
Mack Node	Depth of Straits of Mackinac on shipping date if trip uses Mackinac
StMary Node	Depth of the St Mary's River on shipping date if trip uses St Mary's
Sault Node	Depth of the Soo Locks on shipping date if trip uses Soo
Vidal Node	Depth of Vidal Shoals on shipping date if trip uses Vidal Shoals
Depth Limit	Minimum depth encountered during the entire trip
Immersion Factor	Immersion factor in tons per inch for the boat
MS Cap	Mid-Summer Capacity of the boat
Cap Reduce	Difference between Max Ton and Act Ton, the next two Output Items
Max Ton	Maximum tonnage the boat could have carried if no depth restriction
Act Ton	Actual tonnage the boat was able to carry
Load Min	Minutes needed to load the cargo
Oman Min	Minutes need to maneuver at the origin port
Tran Min	Minutes needed to travel from origin to destination
Dman Min	Minutes needed to maneuver at the destination port
Un-Load Min	Minutes needed to unload the cargo
Well Min	Minutes spent at Welland Locks and Canal (if appropriate)
Sault Min	Minutes spent at Soo Locks (if appropriate)
St Law Min	Minutes spent in SLS system (if appropriate)
Total Min	Total minutes needed to travel from origin to destination to next origin
Total Hr	Total hours needed to travel from origin to destination to next origin
Leftover	A flag indicating that this was leftover tonnage

[1] Chicago, Cleveland, Toledo, Buffalo, Detroit/Flint, and Syracuse/Oswego

[2] Charleston, Norfolk, New York/New Jersey, Baltimore/Philadelphia, Boston, Halifax, Montreal and Toronto

The difference in cost between the existing routing and the Seaway routing represents a potential shift-of-mode benefit from this traffic. **Figure 6-1** displays the alternative routings considered.

FIGURE 6-1
Shipping Alternatives



Freight rates for each origin destination pair are calculated based on the existing overland routing and the water-inclusive Seaway alternative routing. All computations reflect those rates and fees which were in effect on August 1, 2001, in United States dollars, and the rates are computed on a per forty foot equivalent unit (FEU) box basis.

b. Container Flows. **Table 6-7** below shows the flow of containers into and out of the Great Lakes area (further detail is provided in **Attachment 4, Great Lakes and St. Lawrence Seaway Potential Container Transportation Savings**). The flow of container commodities was derived from the STB Waybill Sample and interviews with port authorities[3]. The specific area of interest was constrained to those shipments that originated or terminated within 40 miles of the Great Lakes in the states of Illinois, Indiana, Ohio, and New York and in the port areas of Charleston, Norfolk, Baltimore/Philadelphia, New York/New Jersey, Boston, Halifax, Montreal, and Toronto.

TABLE 6-7
Container Flow Into and Out of the Great Lakes Area
Loaded and Empty Containers (in FEUs)

Container Receipts

Container Shipments

Ports	Buffalo	Chicago	Cleveland	Detroit/Flint	Toledo	Syracuse	Total
Charleston	200	7,728	240	667	200	200	9,235
Norfolk	200	98,259	3,140	21,185	200	200	123,184
New York/New Jersey	38,490	185,689	44,400	18,981	867	21,200	309,627
Baltimore/Philadelphia	200	262,102	200	8,667	5,200	200	276,569
Boston	200	37,511	2,400	1,245	2,400	7,000	50,756
Halifax	-	19,240	-	4,200	-	-	23,440
Montreal	200	66,800	1,760	67,733	200	200	136,893
Toronto	240	32,432	200	22,800	200	200	56,072
Total	39,730	709,761	52,340	145,478	9,267	29,200	985,776

[3] Port authority interviews provided a truck/rail modal split by port; see Appendix 1 of Attachment 4.

TABLE 6-7 (cont'd)

Container Receipts

Container Shipments

Ports	Charleston	Norfolk	New York/ New Jersey	Baltimore/ Philadelphia	Boston	Halifax	Montreal	Toronto	Total
Buffalo	200	200	200	240	200	-	200	200	1,440
Chicago	7,428	110,716	160,089	375,255	60,444	-	200	1,000	715,132
Cleveland	200	3,729	200	364	400	-	200	200	5,293
Detroit/Flint	280	16,949	200	5,067	360	-	200	200	23,256
Toledo	200	200	200	485	560	-	200	200	2,045
Syracuse	200	200	200	200	200	-	200	200	1,400
Total	8,508	131,994	161,089	381,611	62,164	-	1,200	2,000	748,566

As shown in the table above, the dominant Great Lakes container port is Chicago. On the Atlantic coast the Port of New York/New Jersey is the largest rail served port and the Port of Baltimore/Philadelphia the largest truck served port. One observation of note is that the Canadian ports of Halifax, Montreal, and Toronto originated container shipments to the Great Lakes, but these ports did not receive container shipments from the Great Lakes Region with the exception of the imposed minimum truck container shipments.

Also of interest but not shown in the table above is the modal split of the overland container movements. Appendix 1 of **Attachment 4** shows that overall 47 percent move by truck and 53 percent via rail.

c. Transportation Rates. The vessel rates for the study were based upon two different operating service patterns (through and shuttle), four vessel sizes, current transit times on the Great Lakes, vessel dwell time at port to load or discharge, and the current vessel charter rates for the North Atlantic container trades.

The vessel operating service patterns consist of a through service and a shuttle service. The through service could be described as container vessels originating in Europe, transiting the North Atlantic, entering the Gulf of St Lawrence, and transiting to a Great Lakes harbor such as Chicago. For this study the vessel cost or rate would be based upon the transit time for the vessel segment from the entrance of the Gulf of St Lawrence to the Great Lakes harbor point plus discharge time. The shuttle service vessel operating scheme could be described as a two vessel method whereby the first container vessel would move the containers from Europe to Halifax, and the second vessel would move the containers from Halifax to the Great Lakes harbor such as Chicago. The vessel costs for the shuttle service would be based on transit time from Halifax plus both container loading and discharge time. For both vessel service options an estimated toll was added for transiting the Seaway and Welland Canal Locks.

The four vessel sizes selected for this study reflect the currently available vessels on the North Atlantic trade that would meet the proposed channel, harbor, and lock development specifications. The vessel sizes are 500, 1500, 2500, and 3500 TEUs.

Vessel charter rates for the North Atlantic trade were obtained from a literature search and interviews with vessel charter brokers. The vessel charter rates are expressed as a daily rate that includes fuel costs for each class or vessel size. As an example, the daily charter rate for a 3500 TEU vessel would be $20,500 on the North Atlantic for the first of August 2001.

Rail rates for this study came from the 1999 STB Waybill Sample as reported by the Class 1 railroads serving the Great Lakes region. The rail rates are the average rate per container for all commodities from the port of origin to the Great Lakes harbor or the reverse trip whether empty or loaded.

Truck rates used in this study were obtained from regional truck operators, steamship lines, and truck brokers. The truck rates used were based on a rate per loaded mile times the number of miles for the fastest route from or to the Atlantic port.

Another cost category was added to this study in order to adjust for the difference in vessel transit time via the Seaway and the Great Lakes compared to the land route time from or to the Atlantic port. An inventory holding cost was computed at an average daily cost per container of $6.85. Handling rates for containers at ports and inland terminals were obtained from terminal tariffs and averaged $120 per container.

d. Results. The results of this study suggest that container shippers in the Great Lakes Region could potentially save up to $686 million in transportation costs for the movement of 1.674 million containers. **Table 6-8** summarizes the results by Great Lake port.

TABLE 6-8
Summary of Potential Container Shipments

Great Lake Port	Total Containers*	Potential (Latent) Transportation Savings Range**	
		Low***	High****
Chicago	1,364,773	$ 90,814,428	$ 579,612,135
Cleveland	57,633	$ 6,131,248	$ 23,456,129
Detroit	168,734	$ 12,324,810	$ 74,329,050
Toledo	11,312	$ 441,564	$ 3,959,148
Syracuse	30,400	$ (837,788)	$ 5,034,902
Buffalo	41,170	$ (12,706,206)	$ 162,520
Total	**1,674,022**	**$ 96,168,056**	**$ 686,553,884**

* includes inbound and outbound traffic
** scenarios include vessels of different size, different drafts and service
*** all involved 500 TEU ship,shuttle service, 30'-35' draft
**** all involved 3,500 TEU ship, through service and 35' draft

Shippers would benefit from the development of navigation opportunities in the Great Lakes region. In order to realize these shipper benefits, harbors and docks would need to be upgraded to project depths capable of accommodating the appropriate container vessels. Port facilities would need to be upgraded to handle and store waterborne containers, locks and channels would need to be sized for container operations, and the Seaway-shipping season lengthened significantly.

With a 20 percent modal shift, shipper savings for 1500 TEU shuttle service could be as much as $69 million (see Appendix 6 of **Attachment 4**). Whereas a 20 percent modal shift of 500 TEU shuttle service could produce benefits of $20 million, requiring only harbor dredging and no Seaway or Welland Canal improvements. The transportation-cost advantage lies with the larger vessel, deeper draft and through shipping service.

5. TRANSPORATION COST ANALYSIS – IMPROVED SEAWAY

a. General. Market analysis refers to the investigation of the likely types of service that carriers (shipping lines, tramp steamers, and lake-carriers) would be willing to supply and the likely demand for this service given an improved Great Lakes St. Lawrence Seaway (GL/SLS) system. This market analysis forms the basis for an industry analysis that balances the carrier service that could be supplied against the market (shipper) demands for that service. Martin Associates was contracted to conduct the fleet analysis, carrier and shipper surveys, port surveys and commodity flow-cost analysis that comprised this market analysis. A more detailed explanation of their work can be found in the LRD Navigation Planning Center.[4] The following critical information was obtained:

- industries affected by the improvements (new and existing industries)
- changes in commodity flows (origins, destinations, commodity, and annual tonnage for new flows and existing flows)
- changes in transportation cost for each affected commodity flow

b. Methodology. The contractor identified the ports and commodities of interest and developed vessel cost models in order to describe commodity specific scenarios that identify any cost savings realized from deploying larger or more fully laden vessels on the system (after deepening and widening harbors, channels and the Seaway).

Vessel costs under with- and without-project scenarios were combined with port terminal costs, inland leg costs (rail, truck and barge costs between the port and inland origin/destination) to estimate with- and without-project through cost. Terminal costs include stevedoring, grain elevation, and truck/rail loading/discharge rates. Stevedoring rates were obtained from interviews with terminal operators and key logistics companies and steel brokers.

Inland origins and destinations for each commodity under study were based on inland consumption and production points as identified in previous studies by the contractor. Terminal charges as well as rail, truck and barge rates were updated through interviews

[4] LRD is the symbol for the Great Lakes and Ohio River Division of the U.S. Army Corps of Engineers. The LRD Navigation Planning Center is located in Huntington, West Virginia, in the Huntington District office of the Corps of Engineers.

with logistics companies, importers and terminal operators. Key shippers and consignees provided laker rates. All dollar values are expressed in U.S. dollars.

The Martin analysis combined vessel costs with inland costs and terminal costs to identify changes in through transportation costs per net ton or *cost-reduction savings*. A comparison of alternative ports and routings to serve the inland origins/destinations, where appropriate, was also presented as potential *shift-of-mode savings*. The alternative routing analysis identifies inland origins and destinations that can be more cost effectively served with a Seaway that can accommodate Panamax-size ships. The through cost analysis was described for each commodity group under study.

c. Findings. Shift-of-mode benefits range anywhere from $2.00 to $12.00 a ton, depending on the commodity movement. Cost-reduction benefits, owing to using larger and more deeply laden vessels with an improved Seaway are presented in more detail below.

1.) Grain. Ports included in the through cost analysis for grains are Toledo, Duluth, Thunder Bay, Sarnia, and Hamilton. The least-cost routing under the without-project condition was the use of a 35,000-DWT vessel topping off in the St. Lawrence River with a continuing sail to Rotterdam and Jeddah. The with-project scenario used a light-loaded 60,000-DWT vessel for the Jeddah route and a fully loaded 35,000-DWT for the Rotterdam routing.

a.) U.S. Grain Exports to Northern Europe. In 2000, 3.8 million tons of grain moved via Duluth (72 percent of total U.S. grain exported via the Seaway), of which 38.5 percent moved to Northern Europe. Toledo exported 1.2 million tons of grain in 2000 (23 percent of total U.S. grain exports via the Seaway), of which 9 percent was exported to Northern Europe. The with-project transportation-cost reduction savings via Duluth is $2.81 and via Toledo $2.51 per ton.

b.) U.S. Grain Exports to Middle East/Mediterranean. In the year 2000, 56.8 percent of the grain of Toledo's exports moved to the Middle East /Mediterranean region. The with-project transportation-cost reduction savings via Duluth is $5.64 and via Toledo is $5.53 per ton.

c.) Canadian Grain Exports to Northern Europe. Thunder Bay exported 82 percent of the 7.2 million tons of grain exported via Canadian ports through the St. Lawrence Seaway in 2000. The with-project cost reduction savings via Thunder Bay is $3.57, via Sarnia is $3.24 per ton, via Hamilton $3.01 and via Windsor $3.09 per ton.

d) Canadian Grain Exports to Middle East/Mediterranean. Thunder Bay exported 82 percent of the 7.2 million tons of grain exported via Canadian ports through the St. Lawrence Seaway in 2000. Of the Canadian grain exported via the Seaway, about 36.3 percent is destined to the Middle East/Mediterranean region. The with-project cost reduction savings via Thunder Bay is $5.63, via Sarnia is $5.54 per ton, via Hamilton $5.66 and via Windsor $5.53 per ton. **Table 6-9** summarizes grain transportation-cost savings via an improved GL/SLS.

TABLE 6-9
GL/SLS Grain per ton Transportation-Cost-Reduction Savings

Destination	Lake Origin					
	Duluth	Toledo	Thunder Bay	Sarnia	Hamilton	Windsor
N. Europe	$ 2.81	$ 2.51	$ 3.57	$ 3.24	$ 3.01	$ 3.09
Mid East	$ 5.64	$ 5.53	$ 5.63	$ 5.54	$ 5.66	$ 5.53

2.) Steel. The steel ports included in the cost analysis are Detroit, Burns Harbor, Cleveland, Milwaukee, Hamilton, Toronto, Windsor, and Toledo, with overseas origins of Antwerp, Santos and Kobe. The without-project scenario included the use of a light loaded 35,000-DWT salty with a 27 ft. sailing draft. The with-project case assumed a fully loaded 35,000-DWT vessel with a 35-ft. sailing draft. For slab, a light loaded 60,000-DWT vessel is assumed for the Great Lakes.

a.) U.S. Steel Imports from Northern Europe. Northern Europe is the key source of imported steel into the U.S. Great Lakes. In 2000, 70 percent of the 3.3 million tons of steel products, excluding slab, imported via the Great Lakes were from Northern Europe. The ports of Burns Harbor and Chicago handled 40 percent of the steel imports, while Cleveland and Toledo together handled 28 percent of the European imports and Detroit handled 25.1 percent of the imported steel. The with-project cost reduction savings for steel imported via Chicago was $3.71, via Cleveland $3.26, and via Toledo and Detroit $3.31 per ton.

b.) U.S. Steel Imports from Asia. In 2000, 5.0 percent of the 3.3 million tons of steel products, excluding slab, imported via the Great Lakes were from Asia. The ports of Burns Harbor and Chicago handled 54,206 tons of the Asian steel imports, while Cleveland and Toledo together handled 22,871 tons of the Asian imports and Detroit handled 95,707 tons of the imported steel. The with-project cost reduction savings to serve the key steel destinations in the U.S. with Asian steel are $9.83 per ton via Chicago/Burns Harbor, $9.39 peer ton via Cleveland, $9.61 per ton via Toledo and $9.44 per ton via Detroit.

c.) U.S. Steel Imports from Brazil. In 2000, 273,296 tons of steel products were imported from Brazil, excluding slab, via the U.S. Great Lakes. The with-project cost reduction savings for steel imported into the U.S. Great Lakes from Brazil is $5.26 per ton via Chicago/Burns Harbor, $4.82 per ton via Cleveland, $4.86 per ton via Toledo and $4.87 per ton via Detroit.

d.) Canadian Steel Imports from Northern Europe. In 2000, 2.3 million tons of imported steel was imported via the Canadian Great Lakes ports, of which 42 percent was from Northern Europe. About 27.1 percent of the European steel was imported via Hamilton, 54 percent via Windsor, and 15.4 percent via Toronto. The with-project cost reduction savings for steel imported into the Canadian Great Lakes ports from Northern Europe is $3.11 per ton via Hamilton, $3.31 per ton via Windsor and $3.10 per ton via Toronto.

e.) Canadian Steel Imports from Asia. In 2000, only .2 percent of the 2.3 million tons of steel products imported via the Canadian Great Lakes ports originated in Asia. The with-project cost reduction savings for steel imported into the Canadian Great Lakes ports from Asia is $9.23 per ton via Hamilton, $9.44 per ton via Windsor and $9.21 per ton via Toronto.

f.) Canadian Steel Imports from Brazil. In 2000, 2.3 million tons of imported steel was imported via the Canadian Great Lakes ports, of which 14 percent was from Brazil. Nearly all of this steel (98.3 percent) was imported via Hamilton, and while it is not possible to identify the type of steel, it appears that this steel is actually slab. The with-project cost reduction savings for steel imported into the Canadian Great Lakes ports from Brazil is $4.63 per ton via Hamilton, $4.87 per ton via Windsor and $4.71 per ton via Toronto. **Table 6-10** summarizes steel transportation-cost-reduction savings via an improved GL/SLS.

TABLE 6-10
GL/SLS Steel per ton Transportation-Cost-Reduction Savings

Origin	Lake Destination						
	Chicago/Burns Harbor	Cleveland	Detroit	Toledo	Hamilton	Windsor	Toronto
N. Europe	$ 3.71	$ 3.26	$ 3.31	$ 3.31	$ 3.11	$ 3.31	$ 3.10
Asia	$ 9.83	$ 9.39	$ 9.61	$ 9.44	$ 9.23	$ 9.44	$ 9.21
Brazil	$ 5.26	$ 4.82	$ 4.86	$ 4.87	$ 4.63	$ 4.87	$ 4.71

3.) Slab. In 2000, 37,752 tons of slab moved into Burns Harbor. It is assumed that a light-loaded 60,000-DWT vessel is used for the slab in the with-project case since the trend is to use larger bulkers to move slab into the U.S. from Brazil. For the alternative case, an 80,000-DWT vessel is assumed to call New Orleans, LA and Philadelphia. (This assumes that the Delaware River will be dredged to 45 ft. in the near term). The project will result in cost reduction savings of $5.66 per ton for slab imported into Burns Harbor and Chicago, $5.11 for slab imported into Cleveland, $5.17 per ton for slab imported via Detroit, and $5.16 per ton for slab imported into Toledo. **Table 6-11** summarizes slab transportation-cost-reduction savings via an improved GL/SLS.

TABLE 6-11
GL/SLS Slab per ton Transportation-Cost-Reduction Savings

Origin	Lake Destination			
	Chicago/Burns Harbor	Cleveland	Detroit	Toledo
Brazil	$ 5.66	$ 5.11	$ 5.17	$ 5.16

4) Iron Ore. Key ore moves moving from the Seaway are from Sept-Iles to the key steel production areas on the Great Lakes served by the ports of Burns Harbor,

Ashtabula, Cleveland, and Hamilton. Under the without-project scenario the ore moves by light loaded 35,000-DWT vessels, while under the with-project case, two scenarios were assumed – a fully loaded 35,000-DWT vessel and a light loaded 60,000-DWT vessel. The fully loaded 35,000-DWT vessel provided the least costly route for ore from Sept-Iles to all Great Lakes ports except for Burns Harbor, where the light loaded 60,000-DWT vessel provided the lower cost with-project routing. This reflects the longer distance to Burns Harbor and the economies realized using a larger vessel over the longer hauls. Inland costs are not considered since the ore is typically consumed at the terminal/steel mill.

Interviews with regional steel producers indicated that the use of a self-unloading laker commands a premium over the use of a bulk vessel. The majority of the ore is delivered from Point Noire by laker at a cost of about $7.50 per net ton. The interviews further suggested that with a Panamax-size Seaway, rates could fall by about 20 percent to $6.00 per short ton.

In terms of tonnage of Canadian ore used by U.S. mills, census data identifies about 5 million tons of ore was consumed by the mills along the Great Lakes. The majority, 78 percent, was consumed by the integrated mills in the Chicago, Burns Harbor and Gary areas. Of that ore, 78 percent was received from Canada, and moved via the Seaway, and with the project would enjoy a $1.76 per ton cost reduction savings. Cleveland consumed 1.1 million tons of the 5 million tons of ore moving on the Seaway, all coming from the St. Lawrence River, and this ore would enjoy a $1.27 per ton cost reduction savings.

Currently, 6.4 million tons of ore are consumed by Canadian mills that move from the river. The majority, 97 percent, is consumed in Hamilton. This tonnage would enjoy a $1.42 per ton cost reduction savings with the project assuming the ore is moving by self-unloader lakers in excess of 1,000 ft. after the Seaway project is completed. **Table 6-12** summarizes iron ore transportation-cost-reduction savings via an improved GL/SLS.

TABLE 6-12
GL/SLS Iron Ore per ton Transportation-Cost-Reduction Savings

	Lake Destination			
Origin	**Chicago/Burns Harbor**	**Cleveland**	**Ashtabula**	**Hamilton**
Canada	$ 1.76	$ 1.27	$ 1.21	$ 1.42
Brazil	$ 5.18	$ 6.00	$ 6.07	na

5.) <u>Coal</u>. Since currently no coal is exported via the Great Lakes, a scenario was assumed. The scenario assumed coal is exported overseas to Spain from the U.S. Great Lakes ports of Ashtabula and Sandusky. The without-project scenario assumes the use of a direct light loaded 35,000-DWT bulker. The with-project scenario considers a 35,000-DWT bulker fully loaded, a light loaded 60,000-DWT vessel with a direct call to each overseas port, and a light loaded 60,000-DWT vessel with top-off at Sept-Iles. The least cost routing under the without-project case is the use of a direct light loaded 35,000-DWT vessel to serve Spain. Under the with-project case, the direct call with a light loaded 60,000-DWT vessel provides the least costly routing. The with-project scenario provides a cost-reduction savings of $3.79 per ton via Ashtabula and $3.97 per ton via Sandusky. **Table 6-13** summarizes coal transportation-cost-reduction savings via an improved GL/SLS.

TABLE 6-13
GL/SLS Coal per ton Transportation-Cost-Reduction Savings

Destination	Lake Origin	
	Sandusky	Ashtabula
Spain	$ 3.97	$ 3.79

6.) Fertilizer (Potash) Exports from Canadian Ports. In the year 2000, 73,806 tons of potash was exported via Thunder Bay destined for Italy. Under the without-project scenario the potash moves from Thunder Bay (originating in Esterhazy, SK) to Livorno via a light loaded 35,000-DWT vessel. A with-project through cost from Esterhazy to Livorno offers transportation-cost reduction savings of $4.49 per ton. **Table 6-14** shows fertilizer transportation-cost-reduction savings via an improved GL/SLS.

TABLE 6-14
GL/SLS Fertilizer per ton Transportation-Cost-Reduction Savings

Destination	Lake Origin
	Thunder Bay
Italy	$ 4.49

7.) Canadian Petroleum Products (gasoline, fuel oil). The key ports receiving petroleum products are Sarnia and Hamilton, and Sarnia is also a shipping port to Montreal for fuel oil. Under the without-project scenario, product (gasoline) is imported from the Netherlands via a 20,000-DWT tanker as well as a light loaded 35,000-DWT vessel. The with-project scenario assumes the use of a 35,000-DWT tanker with a direct call at Sarnia and Hamilton.

In 2000, 37,825 tons of petroleum moved from Antwerp to Hamilton while 26,818 tons moved from Antwerp to Sarnia. For Sarnia, the use of a fully loaded 35,000-DWT tanker provides a $6.81 per ton cost savings over the use of a 20,000-DWT vessel. For Hamilton, the use of 35,000-DWT tankers with the project provides a $6.35 per ton cost savings over the use of the 20,000-DWT vessel. **Table 6-15** summarizes petroleum transportation-cost-reduction savings via an improved GL/SLS.

TABLE 6-15
GL/SLS Petroleum per ton Transportation-Cost-Reduction Savings

Origin	Lake Destination	
	Hamilton	Sarnia
Antwerp	$ 6.35	$ 6.81

d. Summary of Findings. A summary of changes in transportation costs due to an improved Seaway is shown in **Table 6-16**. The contractor produced this information for the commodity flows most likely affected by an improved Seaway. Total cost reduction benefits in this analysis are over $76 million a year for the almost 25 million affected tons. The average cost reduction savings are $3.11 per ton.

TABLE 6-16
GL/SLS Total and per ton Transportation-Cost-Reduction Savings

Commodity	2000 Tonnage (Millions)	Cost Reduction Savings per Ton	Total Savings (Millions $)
Wheat	9.22	$ 4.67	$ 43.05
Steel Products	3.87	$ 3.90	$ 15.11
Slab	0.04	$ 5.66	$ 0.21
Iron Ore	11.21	$ 1.52	$ 17.08
Fertilizer	0.07	$ 4.49	$ 0.33
Petroleum Products	0.06	$ 6.54	$ 0.42
	24.48	$ 3.11	$ 76.21

Potential shift-of-mode benefits can be realized if traffic currently going by a different route and mode switches to a Great Lakes routing due to an improved Seaway. A limited survey of shippers indicated some potential for grains (6 million tons saving $5.63 per ton) and iron oxides (100,000 tons saving $0.60 per ton) to shift from existing overland routings to an improved Seaway. Total shift-of-mode benefits are estimated at $34.4 million. [5]

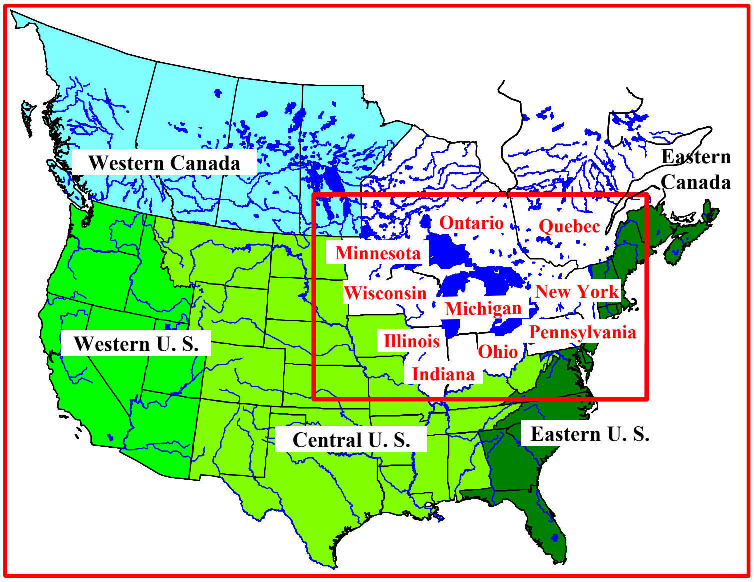
6. MARITIME INPUT-OUTPUT MODEL

a. General. Corps economic analysis of water resource improvements includes the direct and indirect regional economic development (RED) and national economic development (NED) impacts of navigation improvements. To estimate these impacts, the Corps and Oak Ridge National Laboratory (ORNL) are developing a Maritime Input-Output (MIO) model. The MIO is a multi-region input-output model comprised of data tables populated with commodity supply-and-demand data and commodity-flow data for the eight-state, two-province Great Lakes/St. Lawrence River Basin (see **Figure 6-2**). The model is being developed specifically for this study. A detailed description of the

[5] The $34.4 million savings is associated with a 35' channel throughout the GL/SLS. Plans providing 35' drafts to terminal points short of Lake Superior were assumed to provide half these savings ($17 million).

model, assumptions, sources and development of input data, and model results is provided in **Attachment 5, Maritime Input/Output Model**. The MIO is used to estimate regional production, income and employment impacts from increasing the dimensions of Great Lake ports, connecting channels and the St. Lawrence Seaway.

FIGURE 6-2
States and Provinces of the Great Lakes Region

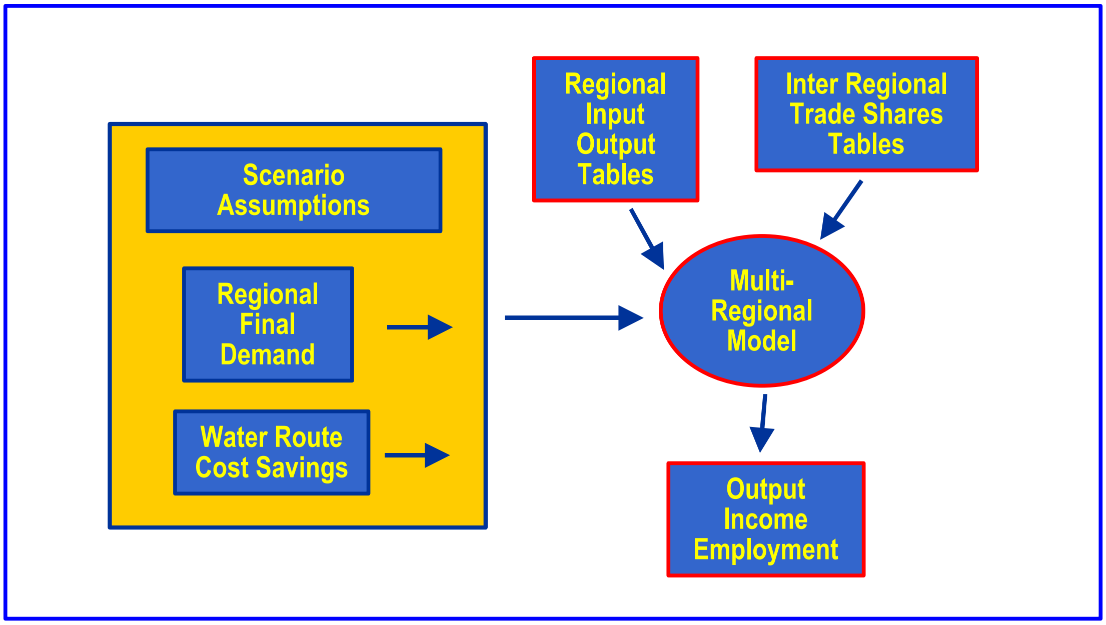


b. Model Description and Use. The MIO model uses a series of regional I-O tables showing the industrial distribution of input commodities purchased and output sold to trace the interactions of local industries with each other, industries outside the region, and with final-demand sectors. The central element in this type of model is a regional transaction table describing inter-regional trade shares. Final demand is the motivating force in the economy and an I-O analysis traces the flow of monies through the economy and shows the consequences of a change in final demand. To the extent that water-transportation cost effects final demand, the MIO is able to estimate these effects. **Figure 6-3** is a schematic diagram that represents the MIO.

The MIO model is derived from two data sources: a national I-O table which shows the input and output structure of national industry, and regional economic accounts which are used to adjust the national I-O table to show the Great Lake region's industrial structure and trading patterns (transaction table).

The transaction table describes the regional economy in equilibrium, at a specific point in time. Economic change, as traced through the MIO model, can take two forms: structural changes (change in technical production coefficients) or change in final demand (changes in total requirements tables). The analyst, using available information and best judgment, runs a vector of predicted exogenous demands through the model to estimate the effects on the economy in terms of production (output), income and employment. The MIO model is capable of analyzing a variety of scenarios as long as they are described by expected structural changes in the economy or changes in a sector's final demand.

FIGURE 6-3
The Maritime Input-Output (MIO) Model



c. Model Application. The MIO model's preliminary application utilized information developed from the two studies described earlier in this section. Direct impacts from potential container traffic, cost-reduction to existing bulk flows, and shift-of-mode benefits to overland bulk traffic that diverts to the GL/SLS were inputs to the MIO model. The scenario developed for this application assumed an improved system capable of accommodating vessels with a 35' draft, 110' width and 1000' length. Given this improvement to the system, it was further assumed that there would be an increase in container and bulk freight traffic at Great Lake ports from any transportation cost reduction. Reconnaissance level analysis shows vessel-cost reduction alone affecting almost 24 million tons of bulk commodities and 1.7 million containers.

The MIO model estimates regional impacts of shifting port activity to the Great Lakes due to the transportation savings. The increased port activity further leads to a growth in final demand from import savings, capacity expansion of existing infrastructure and additional Seaway tolls. The assumptions have a direct impact on regional production, income and employment. The direct impacts are used as inputs to generate other, indirect impacts that are simply additional expenditures and flows of money throughout the region. The indirect impacts are estimated by the MIO model and are also measured in terms of production, income and employment effects.

d. MIO Results. Total overall benefits from an improved GL/SLS system are shown in **Table 6 -17**. A 35' draft throughout and 1200' x 110' seaway locks will attract traffic currently moving overland and will reduce the cost of existing traffic resulting in substantial cost savings.

TABLE 6-17
Total Production, Income and Employment Annual Benefits

	Production ('000$)		Income ('000$)		Employment
Direct and Indirect Impacts					
U.S. Great Lakes	$	465,177	$	91,377	2,040
Ontario	$	198,357	$	46,718	1,472
Quebec	$	73,215	$	18,524	623
Sub-Total Great Lakes	$	736,749	$	156,619	4,135
Eastern United States	$	(43,651)	$	(5,450)	-237
Western United States	$	38,719	$	5,901	132
Central United States	$	394,248	$	90,953	2,841
Eastern Canada	$	6,973	$	2,048	72
Western Canada	$	111,106	$	25,015	794
US, Can.(includes Great Lakes)	$	1,244,144	$	275,085	7,737
Imports	$	102,485	$	17,181	333
Total US/Can Direct & Indirect	$	1,346,630	$	292,267	8,070

The total production number contains income and employment effects. Transportation cost-reductions generate direct impacts on production, income, and employment. To not double count the cost reductions, the direct impacts are removed from total MIO output. The net incremental impact on output from deepening the system to 35' throughout and increase seaway lock sizes to 1200' x 110' is approximately $800 million a year, not the $1,346 million reported in **Table 6-17**.

The increased production benefits result from a shift-of-port activity, increased import activity, an expansion of local capacity and from revenues collected from the taxation of one-half of the exports. These categories of benefits are displayed separately in Tables 6-18 through 6-21. Benefits from the shift-of-port activity from the East Coast to the Great Lake ports are shown in **Table 6-18**. There is no net gain to the nation, only a transfer of benefits to the Great Lakes ports.

TABLE 6-18
Net Annual Benefits from the Shift-of-Port Activity

	Production ('000$)		Income ('000$)		Employment
Direct and Indirect Impacts					
U.S. Great Lakes	$	180,862	$	30,476	672
Ontario	$	9,678	$	2,115	39
Quebec	$	(17,360)	$	(2,948)	-75
Sub-Total Great Lakes	$	173,181	$	29,643	636
Eastern United States	$	(114,484)	$	(19,440)	-419
Western United States	$	(5,663)	$	(1,170)	-21
Central United States	$	(113,311)	$	(19,050)	-499
Eastern Canada	$	(8,702)	$	(1,465)	-32
Western Canada	$	27,631	$	4,981	128
US, Can.(includes Great Lakes)	$	(41,349)	$	(6,502)	-207
Imports	$	41,348	$	6,502	185
Total US/Can Direct & Indirect	$	(0)	$	0	-22

Table 6-19 shows the benefit from increased import savings. These benefits accrue because the lower cost imports have a positive income effect overall.

TABLE 6-19
Distribution of Annual Benefits from Import Savings

	Production ('000$)	Income ('000$)	Employment
Direct and Indirect Impacts			
U.S. Great Lakes	$ 194,271	$ 43,990	1,214
Ontario	$ 57,842	$ 13,817	448
Quebec	$ 16,080	$ 3,893	124
Sub-Total Great Lakes	$ 268,192	$ 61,700	1,786
Eastern United States	$ 20,920	$ 3,987	26
Western United States	$ 5,879	$ 1,075	30
Central United States	$ 475,997	$ 104,046	3,323
Eastern Canada	$ 511	$ 92	0
Western Canada	$ 1,628	$ 272	0
US, Can.(includes Great Lakes)	$ 773,127	$ 171,171	5,165
Imports	$ 25,487	$ 4,632	66
Total US/Can Direct & Indirect	$ 798,614	$ 175,803	5,231

Table 6-20 shows the magnitude of benefit from the taxation of one-half of Canadian export savings.

TABLE 6-20
Distribution of Annual Benefits from Taxation of 1/2 Exports

	Production ('000$)	Income ('000$)	Employment
Direct and Indirect Impacts			
U.S. Great Lakes	$ 54,955	$ 10,696	110
Ontario	$ 110,037	$ 27,369	920
Quebec	$ 62,307	$ 15,505	529
Sub-Total Great Lakes	$ 227,299	$ 53,570	1,559
Eastern United States	$ 46,548	$ 9,361	152
Western United States	$ 37,970	$ 5,914	122
Central United States	$ 27,003	$ 5,199	15
Eastern Canada	$ 14,765	$ 3,355	104
Western Canada	$ 80,810	$ 19,597	665
US, Can.(includes Great Lakes)	$ 434,395	$ 96,995	2,617
Imports	$ 29,630	$ 5,153	75
Total US/Can Direct & Indirect	$ 464,025	$ 102,147	2,692

Table 6-21 shows the distribution of benefits from capacity expansion of industries utilizing waterborne commodities.

TABLE 6-21
Distribution of Annual Benefits from Capacity Expansion

	Production ('000$)	Income ('000$)	Employment
Direct and Indirect Impacts			
U.S. Great Lakes	$ 35,089	$ 6,215	44
Ontario	$ 20,799	$ 3,417	65
Quebec	$ 12,189	$ 2,074	45
Sub-Total Great Lakes	$ 68,077	$ 11,707	154
Eastern United States	$ 3,365	$ 642	4
Western United States	$ 532	$ 82	1
Central United States	$ 4,559	$ 758	2
Eastern Canada	$ 400	$ 66	0
Western Canada	$ 1,037	$ 166	1
US, Can.(includes Great Lakes)	$ 77,971	$ 13,421	162
Imports	$ 6,020	$ 894	7
Total US/Can Direct & Indirect	$ 83,991	$ 14,315	169

7. OTHER TRANSPORTATION IMPACTS

a. General. Great Lakes and Seaway navigation helps to reduce human exposure to the negative outcomes of transportation; like emissions, congestion and noise. Any diversion of Great Lakes and Seaway traffic to overland modes would result in increased rail and truck traffic that would increase human exposure to emitted pollutants, resulting in increased human morbidity and mortality. The increased traffic would also likely increase traffic delays to other motorists, requiring these motorists to incur costs which they currently avoid. It is important to consider these "external" costs when make transportation infrastructure investment decisions.

b. Methodology and Results. Due to limited resources it was necessary to estimate the other transportation impacts associated with Great Lakes and Seaway traffic using already developed methodologies and applying it to existing traffic. Greater detail of this work can be found in **Attachment 7, Great Lakes Shipping: A Preliminary Investigation of Land-Side Environmental Effects**. What follows is a brief summarization of **Attachment 7**.

Emission values developed as a part of the Soo Locks study were applied to total volume of existing Great Lake and Seaway. This approach necessarily overstates the magnitude of estimated benefits - it assumes, had Great Lakes and Seaway shipping been unavailable, all tonnage would divert to an overland routing. The Soo study estimates a $2.10 to $14.50 range of per ton emission benefit, depending on the commodity. When applied to the 222 million tons of 1999 Great Lake and Seaway traffic yields an excess of $878 million per year in air quality savings.

Emission savings were also estimated for the diversion of truck or truck-rail container traffic to a vessel-truck routing. Air quality savings from the diversion of existing container traffic to a Great Lakes routing is estimated to be over $ 320 million per year.

Diversion of one-half the container traffic would produce around $160 million in air quality savings per year.

The final other transportation impact estimated was congestion-delay-reduction benefits if the all-truck container movements diverted to the lakes. To the extent that off-road traffic diversions might help to diminish congestion-related problems in line-haul communities, Toledo, Ohio was selected as representative of the east-coast and mid-west highway container flows. The current analysis hints at the possible value of relieving the Toledo area of some portion of its current level of truck traffic. The estimated benefit of reduced traffic congestion in the Toledo area alone is around $10 million a year.

Other transportation impacts for an improved GL/SLS approach $1.2 billion a year. Incrementally, the value is $170 million each year. This effort represents a reconnaissance level study only and, as such, is valuable as a demonstration rather than a definitive quantification value.

8. PASSENGER CRUISE ANALYSIS

In 1994, there were two cruise vessels on the Great Lakes. By 2001, the Great Lakes had a total of 56 cruises scheduled on seven different vessels. The passenger cruise industry accommodated over 10,844 passengers in 2001. The cruise industry has experienced spectacular growth and is expected to see 7.5 percent annual growth in passengers through 2004.

Attachment 3, Cruise Ship Analysis provides an economic assessment of the Great Lakes passenger cruise industry and indicates its potential to accommodate more and larger cruise ships if the GL/SLS is improved. It is estimated that the total direct benefits of the passenger cruise industry to the Great Lakes area approach $10 million annually.

There are many existing cruise ships that are too large to serve the current system. **Attachment 3** recommends further evaluation of new vessels entering an improved GL/SLS system.

9. CSSC-CSC ANALYSIS

The Chicago Sanitary and Ship Canal (CSSC) and the Calumet-Sag Channel (CSC) are two man-made channels of commerce which connect the Great Lakes with the Illinois Waterway. The CSSC is 160 feet wide and between 20 and 28 feet deep. The CSC is 225 feet wide and 9 feet deep. There are navigation problems associated with the Lemont Reach of the CSSC. The Lemont Reach is narrow and congested with tow and barge staging activities and is vertically constrained by the Lemont railroad bridge. The reach is difficult and dangerous to navigate and recreational boaters add to the congestion.

Attachment 6, The Chicago Sanitary and Ship Canal and the Calumet-Sag Channel Connecting Channels presents an economic analysis of opportunities to remedy the problems facing commercial users of the CSSC-CSC. Four alternatives evaluated for their impact on reducing congestion and transit time in the Lemont Reach of the CSSC include: 1) opening a large existing flooded quarry in Lemont for commercial navigation, 2) making mooring space available along the 3-mile wall, 3) widening areas along the banks of the CSSC proximate to the areas of congestion, and 4) removing the vertical restriction from the Lemont Railroad Bridge.

Reconnaissance level findings show only the three-mile wall mooring area with positive net benefits (see **Attachment 6**). This plan will be carried forward in the feasibility phase of study.

SECTION 7. ALTERNATIVE FUTURE PLANS

1. PROBLEMS, NEEDS AND OPPORTUNITIES

With completion of the locks on the Montreal/Lake Ontario section (MLO) of the St. Lawrence River in 1959, the Great Lakes Navigation System (GLNS) were linked by navigable channel to the ocean. Over the next twenty years, as world demand for grains exploded and U.S. and Canadian steel production surged, both GLNS and Seaway traffic grew. Changes to the world economy begun in the 1960s quickened their pace in the 1980s. Trade barriers were removed and transoceanic trade routes essentially became inter-continental floating bridges. These bridges were first composed of huge dry and liquid bulk vessels, later to be augmented by huge container vessels, as the dominant trade shifted from bulk cargoes (like oil, grain and coal) to containerized cargoes of semi-finished and finished manufactured products. The early 1980s also brought rationalization of the integrated steel producers in the U.S., who were now facing growing competition from new technologies and foreign producers. Grain producers then lost their major customer (the former Soviet Union) and faced adverse European agricultural policies. Finally, around this same time, the railroads were de-regulated, first in the U.S. and later in Canada, allowing the railroads to challenge the lake carriers' ability to maintain their grip on long held traffic.

Accompanying these changes were massive investments, begun in the 1960s and still continuing, in ocean port infrastructure (both on land and in the water), vessels, containers, trucks, highways, rail lines, rail cars and locomotives, and rail terminals. By contrast, the last major capital investment made on the Great Lakes came during the 1960s at the height of Great Lakes and Mon Valley (Pittsburgh area) steel production. Rock cuts in the St. Marys River and a new 110' x 1200' lock chamber located at Sault Ste. Marie (the Poe Lock opened in 1969) allowed the large 1000' Class X vessels to move from Lake Superior to the other upper Lakes. The last major improvement on the Seaway was the Welland by-pass on the Welland Canal completed in the early 1970s. Other than these two important improvements, the system of locks, channels and harbors on the GL/SLS system has remained largely unchanged since the opening of the Montreal/Lake Ontario section of the St. Lawrence Seaway in 1959.

System-wide opportunities present themselves in two general ways: the first working within the man-made physical constraints, the second requiring more sweeping change. The current constraining feature on the GL/SLS is the depth of channels, the most restrictive of these being the St. Marys River and the St. Lawrence Seaway. The St. Marys River has channel depths of 27' at LWD. Sill depths at the St. Lawrence Seaway locks are 30', while channel depths on the Seaway accommodate drafts of 26'3". Channel and port improvements that would allow depths up to 30' would benefit shippers on the upper lakes and take greater advantage of the existing fleet of vessels.

Giving attention to both concerns about physical condition of the Seaway locks and the opportunities for better service requires a broader solution than channel and port deepening on the upper lakes. The locks on the Welland Canal are 69 years old; those on the MLO section are 42 years old. The single lock configuration of all but the Soo locks and Locks 4, 5, and 6 on the Welland makes the reliability of the Seaway structures an even greater concern; the consequences of any one lock closing could mean closure of the Seaway. Furthermore, lock sizes on the Seaway accommodate only a small percentage of the world vessel fleet by capacity, and less than 5 percent of world bulk and container vessel capacity. The adequacy of the Seaway locks to meet future needs is of concern to Seaway managers and users alike. Seaway adequacy and condition concerns could both be met through the construction of new, larger locks (110' x 1200') on the Seaway. To capture the full benefit of such an investment, coincident investment would be needed in deeper channels, deeper harbors, and modern port infrastructure capable of handling 35' draft vessels and their cargoes.

2. FORMULATION OF ALTERNATIVES

The table below summarizes the framework for the alternatives proposed to address the problems and opportunities discussed above. One without-project alternative is identified for the GL/SLS. It recognizes the second 1200' chamber authorized for Soo Locks, while maintaining the status quo elsewhere on the U.S. portion of the GLNS. On the U.S. portion of the GLNS a minimum draft of 25'6" LWD at all locks and connecting channels is maintained over the next 70 years. On the Seaway, a 26'3" draft is maintained. The aging locks are first maintained through normal operations and maintenance (O&M), then limited rehabilitation (LR), and ultimately major rehabilitations. Each successively more aggressive approach to maintenance is phased-in as the condition of Seaway locks deteriorates, requiring longer closures, which through time begin to occur during the navigation season, sometimes without advance notice to shippers. Based on the Engineering Team's visual inspection of the locks and their discussions with engineers from Canada's St. Lawrence Seaway Management Corporation (SLSMC) and America's Saint Lawrence Seaway Development Corporation (SLSDC), it appears that the maintenance practices described above will not be sufficient to insure the continuation of reliable navigation service beyond 2020. With some locks approaching 100 years of use by 2020, the likelihood that aggressive maintenance practices can maintain the current level of reliability will diminish, and the accelerating degradation of reliability may overwhelm the capabilities of the current operational plan of normal O&M, limited rehabilitations and major rehabilitations. It is likely that a lock replacement program begins sometime after 2020, starting with locks showing the greatest need, and ends by 2040.[1] This phased investment is possible because not all locks will be degrading at the same rate.

Five broad options are proposed for future investment (see **Table 7-1**). Each option has three descriptive components, as does the without-project condition. The first component is the U.S. portion of the GLNS, the second the Welland Canal section of the Seaway, and the third the MLO section of the Seaway. Option 1 encompasses the many combinations of improvement alternatives proposed for U.S. connecting channels and

[1] Lock replacement programs are limited to replacing the existing structure with a new structure of the same dimension or physical capacity. This type of investment is referred to as replacement in-kind (RIK).

harbors (including the Chicago Sanitary and Ship Canal), coupled with the Seaway's without-project condition -- systematic replacement of the Seaway locks with chambers the same size as those currently in-place. Option 2 contemplates the same U.S. GLNS improvements, coupled with construction of a deeper and larger replacement Welland Canal, thereby addressing reliability concerns associated with this 1932 vintage canal, and continuation of the without project condition on the MLO Seaway section. Option 3 builds upon Option 2, by replacing the MLO section of the Seaway with a deeper and larger system of locks and channels, and by extending this 35.0' draft system up to Detroit. Option 4 is the same as Option 3, except that the 35.0' draft now extends into lakes Michigan and Huron by deepening the entire St.Clair/Detroit River system. Finally, Option 5 extends the 35' draft throughout the GL/SLS system as a result of deepening the sill depth at Soo locks and the St. Marys River.

TABLE 7-1
GL/SLS Alternatives

Alternative	U.S. GLNS Connecting Channels & Ports	Welland Canal Section—Seaway	MLO Section--Seaway
Without Condition[2]			
2000	25'6" draft, O&M, MR	26'3" draft, O&M, LR	26'3" draft, O&M, LR
2030	25'6" draft, O&M, MR	26'3" draft, RIK underway	26'3" draft, RIK underway
2070	25'6" draft, O&M, MR	26'3" draft, RIK completed	26'3" draft, RIK completed
With Alternatives			
Option 1 U.S. Channels	Up to 30' draft	WOPC	WOPC
Option 2 GLNS Channels	Up to 30' draft	Locks 110'x1200', draft 35'	WOPC
Option 3 Detroit Terminus	Up to 30' draft, except Detroit R. at 35'	Locks 110'x1200', draft 35'	Locks 110'x1200', draft 35'
Option 4 Michigan/Huron	35' draft, except St. Marys R. at 30'	Locks 110'x1200', draft 35'	Locks 110'x1200', draft 35'
Option 5 Superior	Up to 35' draft all connecting channels	Locks 110'x1200', draft 35'	Locks 110'x1200', draft 35'

3. INITIAL SCREENING OF OPTIONS

Option 1 includes four categories of improvement plans: 1) connecting channel and harbor plans, 2) Chicago Sanitary and Ship Canal (CSSC) plans, 3) a comprehensive 30' channel plan, and 4) operational improvement plans for the St.Clair/Detroit River system. All but the 30' channel plan are presented in some detail in this section, while the 30' channel plan is discussed in **Section 8**. Preliminary screenings of the connecting channel and harbor plans rely upon projected year 2000 vessel traffic patterns as the basis for calculating the annual benefits accruing to improvement plans. A benefit-cost analysis identified those plans with positive net benefits, the results of which are presented below.

[2] Without-project condition assumed to include operation of authorized second 1200' chamber at Soo Locks in 2015 to 2070 timeframe.

Those Option 1 plans with positive net benefits were advanced to a more detailed level of evaluation presented in **Section 8**. Option 2 opens Lake Ontario to Class X vessels from the upper Lakes, but does not open the lakes to Panamax size container and bulk vessels. This alternative would be evaluated in a feasibility study, but cannot be evaluated with the models and information developed as part of this reconnaissance study; therefore, Option 2 is not carried forward for further analysis in this reconnaissance report. Options 3, 4, and 5 are each evaluated in more detail in **Section 8**.

4. INITIAL SCREENING OF OPTION 1 ALTERNATIVES

a. General. Connecting channel and port plans, CSSC plans, and St.Clair/Detroit River system plans are evaluated in this section. Benefits for the U.S. GLNS connecting channels and ports are estimated using a vessel-costing model. As currently configured, the model covers only the GLNS. A separate economic analysis of proposed improvement plans for the CSSC and St.Clair/Detroit River system operations is also presented.

Costs were estimated for Option 1 connecting channels and port plans, two plans on the CSSC plans, and the operational plans. Regarding the connecting channel and port improvements, the level of detail to which the cost estimates were developed varies from port to port and also between the connecting channels. The level of detail was dependent upon availability of existing data from past studies, accessibility of recent condition surveys, and availability of existing data for non-Federal ports. Schedule and funding constraints limited the extent to which previous cost estimates could be refined based on more current data and operational conditions at each port. Where minimal or no data was readily available for a specific port, cost estimates were based on costs for ports in close proximity with similar harbor configuration. As a result, a range of cost estimates was established in order to better reflect these uncertainties. In all cases, however, the same general methodology is employed in estimating the cost of improvements at all GLNS harbors and channels.

b. GLNS - U.S. Connecting Channels and Ports. Port deepening and connecting channel deepening plans were developed for the four upper Great Lakes: Superior, Michigan, Huron and Erie. Combination harbor deepening and channel improvement plans were developed for Lake Superior ports, Vidal Shoals, and the St. Marys River below the Soo locks.

A number of parameters affect the feasibility of harbor deepening. Some of these factors are: tonnage handled, origin-destination route distance, approach channel length, the existing fleet’s capability to draft deeper, the destination port’s draft relative to the origin port, and the connecting channel draft. Since benefits are measured as reduced transportation costs, harbors handling large tonnage with fleets that can take advantage of additional draft have the potential to generate enough benefits to justify deepening.

Dredging costs can be kept to a minimum by choosing harbors that have short approach channels, origin-destination routes where the destination port is deeper than the origin port, harbor pairs that use connecting channels that will not have to be deepened for the fleet to take advantage of the additional water column provided at the origin port, and origin-destination pairs that do not use any connecting channels (are located on the same water body). This means only the origin port needs to be deepened in order to capture the savings in transportation costs.

Based upon the above criteria, a number of screening procedures were developed to identify harbors that have potential for deepening. The first screening was by tonnage, all ports that ship or receive over 1 million tons per year. These ports could be grouped by geographical area: the iron ore and coal- shipping ports of Lake Superior, the iron ore receiving and coal shipping ports located on Lake Erie, and the iron ore movements taking place between ports located on Lake Michigan. Lake Superior iron ore shipping ports include: Duluth, MN; Presque Isle, MI; Silver Bay, MN; Superior, WI; Taconite Harbor, MN; and Two Harbors, MN. Major Lake Erie ports include Toledo Harbor, Sandusky, Lorain, Cleveland, Ashtabula and Conneaut Harbor, all in Ohio. Finally, a number of ports that have large tonnages moving on the same body of water were identified: iron ore shipments from Escanaba, MI, coal shipments from Sandusky, OH and limestone shipments from various Lake Huron ports. A short list of 26 harbors was developed. These 26 harbors are presented in **Table 7-2**.

TABLE 7-2
Preliminary List of Harbor Deepening Candidates

Port	Port	Port
1. Superior, WI	10. Detroit, MI	20. Alpena, MI
2. Indiana Harbor, IN	11. Calumet Harbor, IL	21. Lorain, OH
3. Dearborn, MI	12. Taconite, MN	22. Cleveland, OH
4. Escanaba, MI	13. Silver Bay, MN	23. Ashtabula, OH
5. St.Clair, MI	14. Two Harbors, MN	24. Conneaut, OH
6. Duluth, MN	15. Presque Isle/Marquette, MI	25. Fairport, OH
7. Saginaw, MI	16. Gary, IN	26. Toledo, OH
8. Monroe Harbor, MI	17. Burns Harbor, IN	
9. Sandusky Harbor, OH	18. Calcite, MI	

Each of these ports was further evaluated for the development of a harbor-deepening plan. Vessel movement data for 1998 was used to develop a port profile that included major commodities shipped, origin-destination (O-D) pair and vessel class. Once the origin-destination route was identified, the constraint points on the route could be identified. The constraint points included Vidal Shoals and Little Rapids of the St. Marys River, the Straits of Mackinac, the St. Clair River, Lake St. Clair, and the Detroit River. Next, the maximum ship draft that could be accommodated at the origin port, destination port and all the affected constraint points was determined. This information was compared to the fleet's maximum ship draft to determine various deepening plans for that harbor. Given this information, a deepening plan was developed. For example, consider iron ore moving from a Lake Superior port to a Lake Michigan port. Assume the origin port is shallower than the destination port, and there is a connecting channel constraint in the St. Marys River at Little Rapids. The deepening plan would allow the origin port to be deepened until the maximum ship draft allowed at the origin port equaled the maximum ship draft allowed at Little Rapids, assuming the vessels could utilize this additional draft.

Obviously, obtaining information on vessel maximum ship drafts for specific origin-destination routings is a key piece of information in the plan formulation process. Consequently, existing average "potential draft" was calculated for each of the origin ports, their destination ports and the major constraint points the vessels would travel through. Again, constraint points considered were Vidal Shoals and the Little River Rapids of the St. Marys River, the Straits of Mackinac, the St. Clair River, Lake St. Clair, and the Detroit River. Potential draft is defined as the average water depth available at a port or node, minus an underkeel clearance of one foot. Potential drafts were calculated from 101 years of water level data - 1900 to 2000, for all the origin ports, destination ports and constraint points. Whenever a vessel movement traveled through the Welland Canal or the St. Lawrence River, the potential draft used was 26' 3". These potential drafts were used to develop the harbor deepening and channel improvement plans.

1). Lake Erie Plans E1- E18. There are seven major ports on Lake Erie that were considered to have potential for harbor deepening: Sandusky, Ashtabula, Toledo, Conneaut, Lorain, Cleveland, and Fairport. The main commodities serviced at these ports consist of receipts of iron ore and shipments of coal. A summary of the plan evaluation process for each harbor follows.

a). Sandusky, OH - Plans E1-E4. Sandusky, OH is basically a coal shipping port. The port has two main receivers of coal: Nanticoke, ON (1,149,286 tons) located directly across Lake Erie; and Hamilton, ON (1,492,030 tons) located on Lake Ontario, the east side of the Welland Canal.

The maximum potential draft at Sandusky is about 26.6 feet. The Welland Canal limits all vessel drafts to 26.3 feet. Nanticoke and Hamilton have potential vessel drafts of up to 28.7 feet. The fleet servicing Nanticoke and Hamilton has an average draft of 26.8 feet with some vessels drafting as much as 29.0 feet. Therefore, the constraints on movements originating from Sandusky are: first, the Welland Canal (26.3 feet), secondly, the fleet servicing Nanticoke and Hamilton (26.8 feet), and finally, Sandusky harbor itself (26.6 feet). All vessels servicing Nanticoke and Hamilton can draft 26.3 feet. Deepening beyond 26.3 feet will not generate any additional benefits for the 1.4 million tons going to Hamilton. Its benefits are maximized since the Welland only allows a vessel draft of 26.3 feet. The next constraint is the fleet: 26.8 feet, however with some vessels drafting at 29.0 feet, the maximum this route would be deepened to would be 28.6 feet, the maximum potential draft available at Nanticoke. Harbor deepening plans for Sandusky, OH are displayed in **Table 7-3**.

TABLE 7-3
Harbor Deepening Plans for Sandusky Harbor

	Plan E1 Deepen (Feet)	Plan E2 Deepen (Feet)	Plan E3 Deepen (Feet)	Plan E4 Deepen (Feet)
Sandusky Harbor Deepening	0.5	1.0	1.5	2.0
Current Potential Draft	26.6	26.6	26.6	26.6
Plan Potential Draft	27.0	27.5	28.0	28.5

b). Ashtabula, OH - Plan E5. Ashtabula handles approximately 9.5 million tons per year. There are two major commodities: iron ore receipts (3.3 million tons) and coal shipments (5.2 million tons). With respect to iron ore, approximately 75 percent arrives from Lake Superior ports. The remaining iron ore tonnage comes from Canadian ports located above Montreal.

The existing potential draft for iron ore at Ashtabula (29.5 feet) is greater than the average potential draft of Lake Superior iron ore shipping ports (27.5 feet), as well as the vessel draft limitation on the Seaway of 26.3 feet. Consequently, any deepening of existing channel depths at Ashtabula for iron ore movements would generate no benefits. The transportation savings that would be generated from a Lake Superior to Ashtabula iron ore pairing would be credited to deepening the iron ore shipping ports on Lake Superior. Similarly, if the Seaway were deepened, iron ore benefits would be credited to the Seaway rather than Ashtabula.

The port has nine receivers of coal that include: Courtright, ON (3,089,856 tons), Port Credit, ON (731,244 tons), Nanticoke, ON (663,310 tons) and movements through the St. Lawrence (571,316 tons).

Coal movements to Port Credit, ON and through the St. Lawrence generate no benefits from deepening since the coal must pass through the Welland Canal, which restricts vessel draft to 26.3 feet. The potential draft at Nanticoke, ON is the same as the potential draft at Ashtabula under existing conditions (28.1 feet). This is essentially also true for the Courtright destination.

The only plan that would generate benefits, without necessitating any deepening of connecting channels, is to deepen the Ashtabula/Courtright route. This route carries 3,089,856 tons. All vessels servicing this route can draft at least 28.2 feet, and some can draft as high as 29.5 feet. The existing potential draft for coal at Ashtabula is 28.2 feet. The next constraint on the route is the St. Clair River with a potential draft of 29.2 feet. Given the above, the plan would be to deepen the coal dock at Ashtabula 0.5 feet, and deepen Courtright Ontario 0.5 feet (see **Table 7-4**).

TABLE 7-4
Plan E5: Deepen the O-D Pair of Ashtabula, OH and Courtright, ON

	Deepen (Feet)
Ashtabula Harbor Deepening	0.5
Courtright Harbor Deepening	0.5
Current Potential Draft	28.2
Plan Potential Draft	28.6

c). Toledo Harbor, OH - No Plan. Toledo's tonnage consists mainly of three commodities: iron ore receipts (4,281,000 tons), coal shipments (4,767,549 tons) and grain shipments (1,185,529 tons). In general, the potential harbor depth at Toledo (29.4 feet) is deeper than the iron ore shipment ports. Thus deepening Toledo Harbor would generate no iron ore benefits, unless the origin ports were deepened. The iron ore origin ports are basically Lake Superior ports with a potential draft of 27.5 feet. With respect to coal, Toledo's main coal receiving port (Hamilton, ON (1,123, 829 tons), has a potential draft (28.5 feet). However, this flow goes through the Welland Canal that restricts vessel draft to 26.3 feet. A majority of the remaining coal destination ports have potential drafts that are less than what is available at Toledo. Consequently, there are no coal benefits associated with deepening Toledo Harbor. Finally, grain shipments go through the Welland Canal. The Welland Canal restricts vessel draft to 26.3 feet. Consequently, unless the Welland Canal is deepened there are no grain benefits associated with deepening Toledo.

No deepening plan is submitted for Toledo Harbor. However, this does not mean that Toledo does not generate any benefits. It generates large benefits for iron ore movements out of Lake Superior ports. This is because Toledo Harbor's existing potential draft for iron ore is greater than the existing potential draft of the iron ore shipping ports located on Lake Superior. This means benefits can be generated by deepening only the Lake Superior ports.

d). Conneaut Harbor, OH - No Plan. Conneaut has two major flows: coal out (2,825,362 tons) and iron ore in (1,769,000 tons). The potential draft at Conneaut Harbor is around 29.5 feet. Almost all the coal receiving ports have potential drafts less than that available at Conneaut. Consequently, in order to generate any coal benefits associated with Conneaut, the destination ports would have to be deepened. The only O-D pair that seems to have some potential is the Conneaut/Courtright leg. Courtright has an existing potential draft of 28.3 feet. The fleet that carries this commodity has an average usable draft of 27.94 feet and a maximum usable draft of 29.5 feet. The major constraint on this O-D route is the St. Clair River with a potential draft of around 28.2 feet.

Deepening Courtright would generate coal benefits at Conneaut. A reasonable deepening would be 0.5 feet. This would raise the potential draft at Courtright to 28.8 feet, which is less than the fleet's maximum draft of 29.5 feet; however, if the Ashtabula/Courtright deepening plan is put in place, the Conneaut/Courtright benefits would be attributed to that plan. Consequently, no Conneaut deepening plans have been developed.

e). <u>Lorain, OH - No Plan</u>. Lorain Harbor handles around 16.0 million tons of bulk traffic each year. Around 93 percent of this tonnage is receipt of iron ore (15.4 million tons). Approximately 8.8 million tons of this iron ore goes to a steel plant located approximately two miles up the Black River. The remaining 6.6 million tons is transshipped to a steel plant in Cleveland.

Over 97 percent of this iron ore enters the system at Lake Superior ports where the average potential draft is around 27.5 feet. Thus, deepening Lorain Harbor for iron ore receipts would not generate benefits.

The 6.6 million tons transshipped to Cleveland is destined for a steel plant located at the head of navigation on the Cuyahoga River, five miles from the river's mouth. A special class 5 vessel was built for this shuttle service from Lorain to Cleveland. The vessel was built to maximize its carrying capacity on this route, which has a potential draft of 23.4 feet. The vessel can actually draft 28.3 feet. Consequently, any deepening plan for this O-D route would entail a deepening at Cleveland and not at Lorain. This deepening plan for the Cuyahoga River is presented in the Cleveland Harbor plan. No deepening plans were developed for Lorain.

f). <u>Cleveland, OH - Plans E6 – E10</u>. The harbor handles around 16.7 million tons per year. Traffic is composed of iron ore receipts (8.1 million tons), limestone receipts (3.0 million tons), sand and gravel receipts (0.8 million tons), and salt shipments (0.5 million tons). All this traffic goes to docks located on the Old River (LWD = 21.0 feet), or the Cuyahoga River (LWD = 23.0 feet). Because large tonnage flows up the Cuyahoga, a deepening plan for the Cuyahoga was developed. The existing potential draft on the Cuyahoga is 24.4 feet. The origin port for the iron ore is basically Lorain Harbor, which has a potential draft of 29.4 feet. The fleet servicing this route has an average draft of 27.4 feet. The one vessel that does the majority of the deliveries can draft to 28.3 feet. Consequently, the control points for this route are first: the Cuyahoga River (24.4 feet), then the fleet (28.3 feet), and then the origin port, Lorain Harbor (29.4 feet). Consequently, one would deepen to the fleet carrying capacity of 28.3 feet. The plans developed are displayed in **Table 7-5**. The plans would provide a range of benefits for various deepening scenarios. Dredging costs are high as each plan entails dredging at least five miles of river.

TABLE 7-5
Harbor Deepening Plans for Cleveland Harbor

	Plan E6 Deepen (feet)	Plan E7 Deepen (feet)	Plan E8 Deepen (feet)	Plan E9 Deepen (feet)	Plan E10 Deepen (feet)
Cleveland Harbor Deepening	0.5	1.5	2.5	3.5	4.5
Current Potential Draft	24.4	24.4	24.4	24.4	24.4
Plan Potential Draft	24.9	25.9	26.9	27.9	28.9

g). Fairport, OH - Plans E11 – E14, E17 & E18. Shipments of salt (522,888 tons) at Fairport Harbor account for over 95 percent of this port's traffic. Given information on Fairport's existing potential draft, the existing potential draft at the various receiving ports, the nodes on the route, and the fleet's carrying capacity, a number of deepening plans were developed (see **Table 7-6**). The constraints on salt shipments originating from Fairport are: (i) Fairport (25.5 feet potential draft), (ii) the receiving ports (26.5 feet potential draft) and (iii) the fleet (27.3 feet average draft). Fairport could be deepened at least to the average of its receiving ports (26.5 feet). The largest receiver of salt is Buffalo, NY (204,107 tons). Since Buffalo Harbor's potential salt draft is 27.5 feet, and the fleet servicing this route has a maximum draft of 26.5 feet, the majority of the salt benefits would be captured by deepening Fairport to 26.5 feet.

Fairport Harbor is also a major receiver of limestone with over 2 million tons in 1998. Both commodities salt and limestone are considered in the Fairport deepening evaluations.

TABLE 7-6
Harbor Deepening Plans for Fairport Harbor

	Plan E11	Plan E12	Plan E13	Plan E14	Plan E17	Plan E18
Fairport Harbor Deepening	0.5	1.0	1.5	2.0	1.0	1.0
Current Potential Draft	25.5	25.5	25.5	25.5	25.5	25.5
Plan Potential Draft	26.0	26.5	27.0	27.5	26.5	26.5

h). Economic Evaluation of the Lake Erie Plans. **Table 7-7** summarizes the preliminary economic evaluation of the sixteen plans for Lake Erie. Only the Cleveland plans indicate a negative net benefit, despite some significant potential benefits. Again, plans with positive net benefits were advanced to a more detailed level of evaluation and are presented in **Section 8**.

Restraining the analysis to the existing fleet underestimates benefits associated with some harbor deepenings. The fixed fleet assumption was relaxed with the Sandusky and Ashtabula plans E-15 and E-16 and the Fairport plans E-17 and E-18. Fleet operators have indicated a vessel change would take place if these shipping ports were deepened.

Economic evaluations of Option 1 alternatives follow techniques prescribed in ER 1105-2-100 for completing a Benefit-Cost Analysis. Both National Economic Development (NED) benefits and costs are estimated. NED costs include both the first cost and interest during construction (IDC). First costs are costs incurred implementing an alternative. First costs include planning and design, construction costs, operations and maintenance costs, rehabilitation costs, environmental mitigation costs and so on. These costs are amortized and presented as Average Annual Equivalent Costs (AAEC). The 50 year stream of benefits associated with the alternative being evaluated is likewise accumulated, discounted, and presented as Average Annual Equivalent Benefits (AAEB). The difference between AAEB and AAEC is net benefits. The ratio of AAEB to AAEC is the benefit-cost ratio (BCR). All benefits and costs presented are assumed to be incremental to the without project condition.

TABLE 7-7
Economic Evaluation of Lake Erie Plans
($ thousands)

Plan	Description	First Cost	IDC	AAEC	AAEB	Net Benefit	BCR
E1	Sandusky 0.5'	$ 731	$ 22	$ 48	$ 294	$ 246	6.1
E2	Sandusky 1.0'	$ 1,565	$ 47	$ 104	$ 662	$ 558	6.4
E3	Sandusky 1.5'	$ 2,400	$ 72	$ 159	$ 713	$ 554	4.5
E4	Sandusky 2.0'	$ 3,425	$ 103	$ 227	$ 883	$ 656	3.9
E5	Ashtabula 0.5'	$ 311	$ 9	$ 21	$ 35	$ 14	1.7
E6	Cleveland 0.5'	$ 16,550	$ 1,021	$ 1,131	$ 353	$ -778	0.3
E7	Cleveland 1.5'	$ 40,350	$ 3,815	$ 2,842	$ 1,034	$ -1,808	0.4
E8	Cleveland 2.5'	$ 55,175	$ 5,217	$ 3,886	$ 1,626	$ -2,261	0.4
E9	Cleveland 3.5'	$ 67,950	$ 8,748	$ 4,936	$ 1,834	$ -3,102	0.4
E10	Cleveland 4.5'	$ 80,800	$ 13,278	$ 6,054	$ 1,899	$ -4,155	0.3
E11	Fairport 0.5'	$ 336	$ 10	$ 22	$ -2	$ -24	-0.1
E12	Fairport 1.0'	$ 577	$ 17	$ 38	$ -4	$ -42	-0.1
E13	Fairport 1.5'	$ 817	$ 25	$ 54	$ 14	$ -40	0.3
E14	Fairport 2.0'	$ 1109	$ 33	$ 73	$ 8	$ -65	0.1
E15*	Sandusky 1.0'	$ 1,565	$ 47	$ 104	$ 13,245	$ 13,141	127.6
E16*	Ashtabula 0.5'	$ 311	$ 9	$ 21	$ 1,219	$ 1,198	59.1
E17*	Fairport 1.0'**	$ 577	$ 17	$ 38	$ 1,050	$ 1,012	27.5
E18*	Fairport 1.0'	$ 577	$ 17	$ 38	$ 1,044	$ 1,006	27.3

* plans allow fleet changes in response to harbor deepening
** additional 1million tons of limestone

2). <u>Lake Huron Plans H1-H10</u>. Three limestone shipment ports, located on Lake Huron, were identified in the initial group of 26 harbors to be investigated for harbor deepening: Calcite, MI; Stoneport, MI; and Drummond Island. (See **Table 7-8**). Saginaw Harbor received almost 4 million tons of limestone in 1998 and is also investigated for deepening.

TABLE 7-8
Major Limestone Shipping Ports

Limestone Shipping Ports	Commodity	Average Potential Drafts	Shipment Tons (000's)	Number Of Harbors Receiving Shipments	Rec. Harbors w/ Avg. Potential Drafts Greater Than Origin Ports	Average Fleet Draft
Calcite, MI	Limestone	26.5	9,516	31	11	27.1
Stoneport, MI	Limestone	26.5	9,307	32	12	28.0
Drummond Island, MI	Limestone	24.0	1,597	16	11	28.0

Information on maximum ship draft that can be accommodated at the various Lake Huron, Michigan and Erie ports was developed from 101 years of water level data. Consequently, average potential draft was calculated for each of the Lake Huron limestone shipping ports, their destination ports, and the major constraint points throughout the system. Again, potential draft is defined as the average water column available at a port or node minus an underkeel clearance of 1.0 foot. The results of these findings were used to develop the harbor deepening plans associated with limestone shipments from Lake Huron ports.

Limestone shipments are basically to ports located on Lake Michigan, Huron and Erie. Movements characteristically either pass through the Straits of Mackinac (average potential draft of 30.7 feet) or though the St. Clair River/Lake St. Clair/Detroit River connecting node (average potential drafts of 28.2, 28.7 and 28.9)). The derivation of individual port deepening plans follows.

a). Calcite, MI - Plans H1 – H4. Calcite, MI ships around 9.6 million tons of limestone to 32 different ports located mainly on lakes Michigan and Erie. There are only 11 destination ports that have potential drafts greater than Calcite, MI. These 11 ports account for 2,356,391 tons of the total limestone shipments that would generate transportation savings from deepening Calcite, MI only.

Two ports account for the majority of these tonnages: Windsor, ON (805,262 tons) and Conneaut Harbor, OH (789,698 tons). The maximum potential draft at Windsor and Conneaut Harbor are 28.4 and 29.4 feet, respectively. The fleets that service these two routes have average operating drafts of 28.7 feet (Windsor) and 27.6 feet (Conneaut). The fleet that serviced Conneaut performed about 36 movements. Twenty-eight of these movements were made at drafts of 27 feet or greater. Consequently, transportation savings should continue to climb with deepening up to 27.6 feet. Transportation savings with deepening beyond 27.6 feet should begin to level off. The connecting channels do not become a constraint until deepening Calcite exceeds a potential draft of 28.2 feet (the potential draft at the St. Clair River). The improvement plans developed are displayed in **Table 7-9**.

TABLE 7-9
Calcite Harbor Deepening Plans

	Plan H1 Deepen (Feet)	Plan H2 Deepen (Feet)	Plan H3 Deepen (Feet)	Plan H4 Deepen (Feet)
Calcite Harbor Deepening	0.5	1.0	1.5	2.0
Current Potential Draft	26.5	26.5	26.5	26.5
Plan Potential Draft	27.0	27.5	28.0	28.5

b). Stoneport, MI - Plans H5 – H8. Stoneport, MI ships around 9.3 million tons of limestone to 32 different ports located mainly on lakes Michigan and Erie (see **Table 7-10**). There are twenty ports that have potential drafts less than Stoneport that account for about 6.7 million tons. This tonnage would not generate any transportation savings from deepening Stoneport only.

The remaining 12 destination ports have potential drafts greater than Stoneport, MI and account for 2,608,025 tons of the total limestone shipments. There are six ports that account for the majority of these tonnages: Muskegon Harbor (101,683 tons), Windsor, ON (164,666 tons), Burns Waterway (830,174 tons), Indiana Harbor (236,146 tons), Calumet Harbor (456,356 tons), and Huron Harbor, OH (516,999 tons). Information on the average potential draft at these harbors, node restrictions, and average fleet drafts are provided below.

TABLE 7-10
Major Limestone Receiving Ports with Average Potential Drafts Greater than 26.5' for Stoneport, MI

Limestone Destination Port	Receipts (Tons)	Destina-Tion Point Average Potential Draft	Constraint Point	Constraint Point Average Potential Draft	Average Fleet Draft	Max. Fleet Draft
Muskegon Harbor, MI	101,683	27.5	Mackinac	30.7	30.2	30.6
Windsor, ON	164,666	28.6	St.Clair River	28.2	29.3	30.9
Burns Harbor Waterway, IN	830,174	27.4	Mackinac	30.7	26.9	29.1
Indiana Harbor, IN	236,146	28.5	Mackinac	30.7	27.8	28.1
Calumet Harbor, IN	456,356	27.6	Mackinac	30.7	27.0	28.5
Huron Harbor, OH	516,999	29.1	St.Clair Rvr	28.2	26.5	29.1

The existing potential draft at Stoneport is 26.5 feet. All six receiving ports have a potential draft of at least 27.4 feet. Three of the receiving ports have average potential drafts of 28.5 feet or more. The fleets that service these six routes have average operating drafts of at least 27.1 feet. Five of the six fleets have an average vessel draft of 27.0 feet or greater. All constraint points have potential drafts of at least 28.2 feet. Consequently, transportation savings should accrue for all fleets and destination ports with deepening up to 27.4 feet. Transportation savings should continue for three more harbors and the fleet that services them for deepening up to 28.2 feet. No new benefits would accrue from deepening beyond 28.2 feet due to the potential draft restriction at the St. Clair River of 28.2 feet. Again, the connecting channels are not a constraint for deepening plans until they reach 28.2 feet. The fleet is capable of generating benefits for improvement plans that provide vessel drafts up to 30.9 feet. The improvement plans are displayed in **Table 7-11**.

TABLE 7-11
Stoneport Harbor Deepening Plans

	Plan H5 Deepen (Feet)	Plan H6 Deepen (Feet)	Plan H7 Deepen (Feet)	Plan H8 Deepen (Feet)
Stoneport Harbor Deepening	0.5	1.0	1.5	2.0
Current Potential Draft	26.5	26.5	26.5	26.5
Plan Potential Draft	27.0	27.5	28.0	28.5

c). Drummond Island, MI - Plan H9. Drummond Island, MI ships around 1,596,575 million tons of limestone to 16 different ports located mainly on lakes Michigan and Erie (see **Table 7-12**). There are five ports that have potential draft less than Drummond Island that account for about 370,765 tons. These movements would not generate any transportation savings from deepening Drummond Island only.

The remaining 11 destination ports have a potential draft greater than Drummond Island and account for 1,225,810 tons of the total limestone shipments. There are seven ports that account for the majority of this tonnage: Presque Isle, MI (117,754 tons), Erie Harbor, PA (189,647 tons), Windsor, ON (92,364 tons), Fairport Harbor, OH (316,627 tons), Cleveland Harbor, OH (229,898 tons), Calumet Harbor, IL (92,986 tons) and Indiana Harbor, IN (90,340 tons). Information on the average potential draft at these harbors, node restrictions, and average fleet draft is provided below.

TABLE 7-12
Major Limestone Receiving Ports for Drummond Island, MI

Limestone Destination Port	Receipt (Tons)	Dest. Point Ave. Potential Draft	Con-Straint Point	Constraint Point Ave. Potential Draft	Ave. Fleet Draft	Max. Fleet Draft
Presque Isle, MI	117,754	27.7	Vidal Shoals	28.03	30.8	30.9
Erie Harbor, PA	189,647	26.6	St.Clair Rvr	28.2	29.3	30.6
Windsor, ON	92,364	28.5	St.Clair Rvr	28.2	28.9	29.2
Fairport Harbor, OH	316,627	25.3	St.Clair Rvr	28.2	28.7	30.6
Cleveland Harbor, OH	229,898	24.6	St.Clair Rvr	28.2	28.0	28.3
Calument Harbor, IL	92,986	27.6	Mackinac	30.7	26.9	27.7
Indiana Harbor, IN	90,340	28.4	Mackinac	30.7	27.6	27.7

The existing potential draft at Drummond Island, MI is 24.0 feet. All seven receiving ports have a potential draft of at least 24.6 feet. Six of the receiving ports have an average potential draft of 25.3 feet or more. The vessel fleets that service these seven routes have average operating drafts of at least 26.9 feet. Five of the seven fleets have vessel drafts of 28.3 feet or greater. All constraint points have potential drafts of at least 28.03 feet. Consequently, transportation savings should accrue for all fleets and destination ports with deepening up to 24.6 feet. Transportation savings should continue for six more harbors and the fleets that service them for deepening up to 25.3 feet. No new benefits would accrue from deepening beyond 28.5 feet due to the potential draft restriction at the destination ports of 28.5 feet. Again, the connecting channels are not a constraint for deepening plans until they reach 28.03 feet. Six out of the seven remaining destination ports have node restrictions starting at 28.2 feet. All vessels in the fleet can draft at least 26.9 feet. The fleet is capable of generating benefits for improvement plans that provide vessel drafts up to 30.8 feet. Based upon the above, deepening plans should be considered up to a potential draft of 28.2 feet, which is the maximum potential draft through the St. Clair River. Thus, the following improvement plan was developed (see **Table 7-13**).

TABLE 7-13
Drummond Island Harbor Deepening Plan

	Plan H9 Deepen (Feet)
DI Harbor Deepening	2.5
Current Potential Draft	24.0
Plan Potential Draft	26.5

d.) Saginaw Harbor, MI - Plan H10. Saginaw Harbor handled 5,609,000 tons in 1998, with receipts accounting for 5,515,000 of these tons. Limestone receipts accounted for 3,738,000 of these tons. Limestone originates from Port Dolomite (132,009), Port Inland (250,894) and Stoneport (1,444,933). Information on the origin ports and Saginaw Harbors potential drafts and the fleets mid summer draft, are provided below.

TABLE 7-14
Major Limestone Shipping Ports for Saginaw Harbor, MI

Limestone Origin	Origin Potential Draft	Saginaw Potential Draft	Fleet Draft	Limestone Tons
Port Dolomite	27.2	21.0	26.8	132,009
Port Inland	28.6	21.4	27.4	250,894
Stoneport	26.5	21.2	25.5	1,444,933

Given the above information, all tons from these three harbors could benefit from a four foot deepening. Thus a four foot deepening plan was evaluated for Saginaw Harbor.

TABLE 7-15
Saginaw Harbor Deepening Plan

	Deepen (Feet)
Saginaw Harbor Deepening	4.0
Current Potential Draft	21.0
Plan Potential Draft	25.0

e.) Economic Evaluation of Lake Huron Plans. All Lake Huron plans show potential benefit and indicate that future traffic demands might cause net benefits to become positive (see **Table 7-16**). Therefore, each is carried forward to the final screening.

TABLE 7-16
Economic Evaluation of Lake Huron Plans
($ thousands)

Plan	Description	First Cost	IDC	AAEC	AAEB	Net Benefit	BCR
H1	Calcite 0.5’	$ 1,756	$ 53	$ 116	$ 123	$ 7	1.1
H2	Calcite 1.0’	$ 3,513	$ 106	$ 233	$ 203	$ - 30	0.9
H3	Calcite 1.5’	$ 3,606	$ 109	$ 239	$ 251	$ 12	1.0
H4	Calcite 2.0 ’	$ 3,700	$ 112	$ 245	$ 275	$ 29	1.1
H5	Stoneport 0.5 ’	$ 1,756	$ 53	$ 116	$ 99	$ -17	0.9
H6	Stoneport 1.0 ’	$ 3,512	$ 106	$ 233	$ 157	$ -75	0.7
H7	Stoneport 1.5 ’	$ 3,606	$ 109	$ 239	$ 172	$ -67	0.7
H8	Stoneport 2.0	$ 3,700	$ 112	$ 245	$ 169	$ -76	0.7
H9	Drummond 2.5	$ 3,950	$ 119	$ 262	$ 337	$ 75	1.3
H10	Saginaw 4.0’	$72,500	$11,914	$5,432	$1,045	$ -4,387	0.2

3.) Lake Michigan Plans M1 - M5. Deepening plans were developed for harbors located on Lake Michigan. Five harbors were identified for deepening: Escanaba, MI; Indiana Harbor, IN; Calumet Harbor, IN; Gary, IN and Burns Harbor, IN. One of the major commodities moving through these ports is iron ore. Escanaba ships iron ore and all the other ports receive iron ore.

Average potential drafts were calculated for each of the Lake Michigan ports, their origin and or destination ports, and the major constraint points throughout the system. The potential drafts were calculated from GLLAST output data for the existing condition, and included 101 years of water level data. The results of these findings were used to develop the harbor deepening plans associated with Lake Michigan ports.

a). Escanaba, MI and Indiana Harbor, IN - Plans M1- M3. Escanaba Harbor is a major shipper of iron ore. It ships over 7.6 million tons of iron ore to eight different harbors located on lakes Michigan and Erie. Six of the eight harbors have existing potential drafts that are less than Escanaba’s existing potential draft of 28.5 feet. Consequently, the major restriction for Escanaba iron ore movements are at the destination harbors. Three harbors receive the majority of the iron ore shipped from Escanaba: Indiana Harbor, Calumet Harbor, and Ashtabula Harbor. Deepening plans concentrated on these destination ports. Information on potential draft, tons moved, and other pertinent information is provided in **Table 7-17**.

TABLE 7-17
Main Iron Ore Receiving Ports for Escanaba, MI

Iron Ore Destination Port	Receipts (Tons)	Destination Point Average Potential Draft	Constraint Point	Constraint Point Average Potential Draft	Avg Fleet Draft	Max Fleet Draft
Indiana Harbor, In.	5,632,714	27.4	Indiana Harbor	27.4	28.6	34.0
Calumet Harbor, IL	793,173	27.5	Calumet Harbor	27.5	27.5	28.5
Ashtabula Harbor, Oh	650,779	29.5	St. Clair River	28.2	28.3	30.9

The largest receiver of iron ore is Indiana Harbor, with 5,632,714 tons. The next largest receiver of iron ore is Calumet Harbor with 793,173 tons, followed by Ashtabula Harbor with 650,779 tons. Ashtabula has a deeper potential draft than Escanaba, 29.5 feet versus 28.5 feet. The other two harbors have existing potential drafts less than Escanaba. Indiana Harbor receives over 74 percent of Escanaba's shipments. Therefore, any deepening plans for Escanaba would involve deepening Indiana Harbor to Escanaba's depth and then deepening both ports to take advantage of the fleet's carrying capacity. The fleet that services Escanaba/Indiana Harbor has an average draft of 28.6 feet and some vessels in the fleet can draft up to 34.0 feet. All the vessels servicing these three destination ports can draft at least 27.5 feet. In order to keep the deepening plan for Escanaba straightforward, deepening combinations were only considered between Escanaba and Indiana Harbor (see **Table 7-18**).

TABLE 7-18
Escanaba/Indiana Harbor Deepening Plans - Iron Ore

	Plan M1 Deepen (Feet)	Plan M2 Deepen (Feet)	Plan M3 Deepen (Feet)
Escanaba Harbor Deepening	0.0	1.0	2.0
Indiana Harbor Deepening	1.0	2.0	3.0
Escanaba Harbor			
Current Potential Draft	28.5	28.5	28.5
Plan Potential Draft	28.5	29.5	30.5
Indiana Harbor			
Current Potential Draft	27.4	27.4	27.4
Plan Potential Draft	28.4	29.4	30.4

Including Calumet Harbor in the plan could generate additional benefits. However, this also increases cost since Calumet Harbor needs deepening. Ashtabula Harbor could generate iron ore benefits for potential draft deepening to 29.5 feet as well however, to get to Ashtabula vessels have to travel through the St. Clair River/Lake St. Clair/Detroit River. Deepening beyond 28.2 feet would necessitate deepening the St. Clair River. Deepening beyond 28.7 feet would involve deepening the St. Clair River and Lake St. Clair.

b). Calumet Harbor. Calumet is a major shipper of coal (see **Table 7-19**) shipping around 2.0 million tons a year to nine harbors located on lakes Michigan, Superior and Erie. None of the fleets servicing these harbors have average drafts greater than 21.7 feet. No vessel on these movements drafts more than 23.2 feet. Thus no coal benefits are generated when the available potential drafts at the harbors are greater than 23.2 feet. A simple switch to a fleet that could draft up to 27.3 feet (the existing potential draft at Calumet Harbor) would affect all 2.0 million of the tons shipped from Calumet Harbor.

TABLE 7-19
Main Coal Receiving Ports for Calumet Harbor, IL

Coal Destination Port	Receipts (Tons)	Destination Point Average Potential Draft	Constraint Point	Constraint Point Average Potential Draft	Average Fleet Draft	Maximum Fleet Draft
Greenbay, WI	31,619	23.6	Greenbay	23.6	21.7	23.2
Toledo Ohio	15,319	28.8	Calumet	27.3	20.6	20.6
Presque Isle, Mi.	650,095	27.6	Calumet	27.3	19.7	20.2
Muskegon Harbor, Mi	259,281	30.6	Calumet	27.3	20.4	20.8
Monroe Harbor, Mi.	15,740	22.9	Monroe	22.9	21.2	21.2
Milwaukee WI.	662,397	21.3	Milwaukee	21.3	20.8	21.2
Buffington Harbor, In.	166,199	26.9	Buffington	26.9	19.8	20.2
Holland Harbor, Mi.	39,546	21.2	Holland Harbor	21.2	20.4	21.2
Grand Haven Harbor, Mi.	121,853	21.6	Grand Haven	21.6	19.7	20.2

A simple plan (M4) was developed. Calumets coal potential draft is 27.3 feet (see **Table 7-20**). Three destination ports are deeper than Calumet: Toledo (28.8), Presque Isle (27.6) and Muskegon (30.6). These three harbors account for about 924,695 tons per year. The plan would be to deepen Calumet Harbor by one foot and change the coal fleet that services these three destination ports to take advantage of that additional draft.

TABLE 7-20
Calumet Deepening Plan

	Deepening
Calumet Harbor Deepening	1.0 feet
Current Potential Draft	27.3 feet
Plan Potential Draft	28.3 feet

Calumet is a major receiver of iron ore from Escanaba Michigan: 793,173 tons per year. Escanaba currently has a potential draft of 28.5 feet. Calumet's potential draft is 27.5 feet. The fleet that services this route has a mid-summer draft of 27.9' with some vessels drafting up to 30'. A plan (M5) that would deepen Calumet by one foot for iron ore, and change the iron ore fleet to draft at least 28.5 feet was evaluated (Table 7-21).

c). Burns Waterway and Gary, IN - No Plan. Two of the harbors, Burns Waterway, and Gary, IN, receive iron ore from Lake Superior ports. Burns Waterway receives 5,769,923 tons of iron ore from Superior, WI and Gary receives

7,918,335 tons of iron ore from Two Harbors, MI. The major constraint for movements to these two Michigan ports is the St. Marys River with a potential draft of 28.03 feet. The two origin ports have potential drafts of 27.6 feet. Burns Waterway and Gary Indiana have potential drafts of 28.6 and 29.6 feet, respectively. Consequently, deepening the two Lake Michigan ports would generate no iron ore benefits since the origin ports have existing potential drafts of 27.6 feet. Deepening plans for the two origin ports capture the iron ore benefits associated with Burns Waterway and Gary Indiana iron ore movements. Deepening Burns Waterway would provide additional benefits only if the Lake Superior ports, Vidal Shoals and the St. Marys River Little Rapids are improved to provide a potential draft greater than 28.6 feet. Lake Superior deepening plans that provide potential drafts greater than 29.6 feet could also generate benefits for deepening Gary, Indiana. In summary, these two Lake Michigan ports would be components of Lake Superior/Vidal Shoals/St. Marys River deepening plans that provided potential drafts greater than 28.6 and 29.6 feet. Multi-lake/multi-port combination plans have not been formulated. This could be one such multi-lake/multi-port scenario.

d). Economic Evaluation of Lake Michigan Plans. Three of the five Lake Michigan plans show positive net benefits using year 2000 traffic levels (see **Table 7-21**). Plan M3 is marginally infeasible; however, iron ore traffic is forecast to decline in the future, so further evaluation will not change these results. Plans M3 and M5 were not carried forward.

TABLE 7-21
Economic Evaluation of Lake Michigan Plans
($ thousands)

Plan	Description	First Cost	IDC	AAEC	AAEB	Net Benefit	BCR
M1	Indiana Harbor 1.0	$ 2,323	$ 70	$ 154	$ 921	$ 767	6.0
M2	Indiana Harbor 2.0 & Escanaba 1.0	$11,690	$353	$ 775	$1,298	$ 523	1.7
M3	Indiana Harbor 3.0 & Escanaba 2.0	$28,611	$863	$1,897	$1,522	$ -375	0.8
M4*	Calumet Harbor 1.0 for Coal	$19,950	$1,231	$1,363	$2,559	$1,196	1.9
M5*	Calumet Harbor 1.0 for Iron Ore	$19,950	$1,231	$1,363	$201	$-1,162	0.2

* both plans allow fleet changes in response to harbor deepening

4). Lake Superior and St. Marys River Plans S1 – S11. Deepening plans were developed for six harbors located on Lake Superior: Duluth, MN; Presque Isle, MI; Silver Bay, MN; Superior, WI; Taconite Harbor, MN and Two Harbors, MN. The commodity flows from Lake Superior ports are essentially iron ore and coal to ports located below the Soo locks. Consequently, all flows must pass through Vidal Shoals, the Soo Locks, and the St. Marys River Little Rapids. The potential drafts that can be accommodated at the Lake Superior ports and the connecting channels were calculated for each of the Lake Superior ports, their destination ports, and the major constraint points throughout the system. The results of these findings were used to develop the harbor deepening plans associated with individual Lake Superior ports (see **Table 7-22**).

Based on the average of 101 years of water levels, Lake Superior iron ore shipping ports can currently accommodate vessels that draft 27.5 feet. All shipments from Lake Superior ports must transit Vidal Shoals, the Soo locks and the Little Rapids, all in the St. Marys River. Any deepening of Lake Superior ports would have to take into consideration the controlling depths at the other key nodes in the traffic flow. On average, the potential draft at Vidal Shoals and the Little Rapids on the St. Marys River is 28.03 feet and the Poe lock at the Soo can accommodate vessels with drafts up to 31.0 feet. The fleets servicing these harbors can draft at least 28.0 feet, with the majority drafting 28.5 feet and about 25 percent drafting 29.0 feet or more. Almost all of the receiving ports have potential drafts of 28.5 feet. Some receiving ports can accommodate drafts as great as 29.4 feet.

TABLE 7-22
Individual Harbor Deepening Plans - Lake Superior

	Plan S1 Iron Ore Deepen Duluth (feet)	Plan S2 Iron Ore Deepen Presque Isle (feet)	Plan S3 Iron Ore Deepen Silver Bay (feet)	Plan S4 Iron Ore Deepen Superior (feet)	Plan S5 Iron Ore Deepen Taconite Harbor (feet)	Plan S6 Iron Ore Deepen Two Harbors (feet)	PlanS7 Iron Ore Coal Deepen Superior (feet)
Harbor Deepening	0.5	0.5	0.5	0.5	0.5	0.5	1.0
Current Potential Draft	27.5	27.5	29.5	27.5	29.5	27.6	27.5
Plan Potential Draft	28.0	28.0	30.0	28.0	30.0	28.0	28.5

Thus the constraint points on commodities leaving Lake Superior are: the Lake Superior origin ports (27.5 feet), Vidal Shoals (28.03 feet), St Marys River Little Rapids (28.03 feet), the receiving ports (28.5 feet), and the fleet (29.0).

a). Individual Harbor Deepening Plans S1 – Plans S7 . Given this information, most Lake Superior ports could be deepened 0.5 feet and generate benefits with no improvement needed to the connecting channels. Based on the above, a half-foot iron ore deepening plan was developed for each of the six harbors on Lake Superior. Plans S1 – S6 look at deepening these six Lake Superior ports by 0.5 feet, individually. Benefits generated from each individual harbor are compared to the dredging costs associated with each harbor deepening. All vessels in the fleet can take advantage of the additional 0.5 feet of draft. In addition almost all destination ports are 1.0 feet deeper than Lake Superior origin ports.

Plan S7 takes a closer look at Superior, Wisconsin. Superior is the largest port on the Great Lakes shipping over 23.0 million tons per year. Two commodities comprise the majority of this tonnage: iron ore and coal. Summary information on the iron ore and coal receiving ports is provided in **Table 7-23**. Given that most destination ports are deeper than Superior by at least one foot, a one-foot deepening plan for iron ore and coal at Superior was developed (see **Table 7-22**, Plan S7).

TABLE 7-23
Main Iron Ore, Coal Receiving Ports for Superior, Wisconsin

Destination Port	Receipts (Tons)	Dest. Point Average Potential Draft	Constraint Point	Const. Point Average Potential Draft	Ave Fleet Draft	Max Fleet Draft
Iron Ore						
Ashtabula Harbor, Oh.	931,458	29.4	Vidal Shoals	28.03	29.7	30.4
Burns Waterway	5,705,557	28.6	Vidal Shoals	28.03	31.0	34.0
Dearborn Mi	2,965,599	26.2	Dearborn Mi	26.2	28.5	34.0
Hamilton, Ont	339,927	28.3	Vidal Shoals	28.03	29.8	30.9
Huron Harbor, Oh.	31,174	29.2	Vidal Shoals	28.03	30.6	30.9
Presque Isle, Mi.	60,370	27.1	Presque Isle, Mi.	27.1	29.1	29.1
Sault St. Marie, Ont	718,390	23.4	Sault St. Marie	23.4	29.0	29.0
Coal Ports						
Ashland Harbor, Wi	46,728	21.8	Fleet Draft	21.2	20.3	21.2
Burns Waterway	64,366	27.6	Burns Waterway	27.6	28.7	28.7
Essexville Mi..	171,199	23.6	Essexville, Mi.	23.6	28.7	28.7
Indiana Harbor	15,493	27.9	Fleet Draft	21.1	21.1	21.1
Marine City, Mi	3,153,880	28.2	Vidal Shoals	28.03	28.6	28.6
Marquette Harbor, Mi	162,258	29.7	Fleet Draft	22.9	22.8	22.9
Monroe Harbor, Mi	445,000	22.5	Monroe Harbor	22.5	28.7	28.7
Muskegon Harbor, Mi.	682,604	30.5	Vidal Shoals	28.03	28.7	28.7
Nanticoke, Ont.	5,095,869	28.5	Vidal Shoals	28.03	28.3	29.6
Port Arthur, Ont.	581,395	29.8	Vidal Shoals	28.03	28.4	28.4
Presque Isle, Mi.	419,545	27.6	Fleet Draft	24.8	24.2	24.8
Sault St. Marie, Ont	23,600	21.3	Sault St. Marie	21.3	28.4	28.4
Silver Bay, Mn	421,644	29.7	Fleet Draft	28.7	28.7	28.7
St. Clair, Mi.	5,358,492	23.5	St. Clair, Mi.	23.5	28.7	30.1

Superior, Wisconsin Potential Draft is 27.5 feet

b). Multi Port/Channel 1.5-Foot Deepening - Plan S8. Plan S8- (see **Table 7-24**) is a "Lakewide" plan. It looks at deepening all six Lake Superior iron ore ports by 1.5 feet**.** However, deepening the Lake Superior iron ore ports by 1.5 foot now moves the origin/destination constraint to the St. Marys River (refer to **Table 7-23**). In order to capture all of the potential benefits, Vidal Shoals and the Little Rapids on the St. Marys River need to be deepened a half-foot.

TABLE 7-24
Multi Port/Channel Deepening Plans
Deepen the following six harbors and the St. Marys River

	Plan S8 (Feet)	Plan S9 (Feet)	Plan S10 (Feet)
a. Duluth, MN	1.5	2.0	2.5
b. Presque Isle, MI	1.5	2.0	2.5
c. Silver Bay, MN	1.5	2.0	2.5
d. Superior, WI	1.5	2.0	2.5
e. Taconite Harbor, MN	1.5	2.0	2.5
f. Two Harbors, MN	1.5	2.0	2.5
St. Marys River	0.5	1.0	1.5
Current Potential Draft	27.5	27.5	27.5
Plan Potential Draft	29.0	29.5	30.0

Given the large costs associated with deepening connecting channels, no one port could justify this improvement. Also deepening the St. Marys River would not just benefit one port on Lake Superior, but all the major iron ore shipping ports located on the lake. Consequently all the benefits associated with deepening these six iron ore ports 1.5 feet would be used to offset the costs of deepening the ports and the St. Marys River all at once.

c). Multi Port/Channel 2.0-Foot Deepening - Plan S9. Plan S9 (see **Table 7-24**) looks at deepening all six Lake Superior ports by 2.0 feet**.**

d). Multi Port/Channel 2.5-Foot Deepening - Plan S10 . Plan S10 (see **Table 7-24**) looks at deepening all six Lake Superior ports by 2.5 feet. This plan should generate close to the maximum level of benefits.

e). Two-Foot Deepening of Two Harbors, MN - Plan S11. Plan S11 looks at deepening Two Harbors, Minnesota two feet and Vidal Shoals and the Little Rapids on the St. Marys River by one foot. Two Harbors is a large port shipping iron ore (over 12 million tons per year). The ports it ships to have potential drafts greater than Two Harbors by around two feet, and the fleets that service these movements also have high draft capabilities (average draft of around 28.5 feet and maximum draft of 30.9 feet). Information on the receiving ports is provided in **Table 7-25**. **Table 7-26** identifies the components of Plan S11.

TABLE 7-25
Main Iron Ore Receiving Ports For Two Harbors, Minnesota

Destination Port	Receipts (Tons)	Dest. Point Average Potential Draft	Constraint Point	Const. Point Average Potential Draft	Ave. Fleet Draft	Max. Fleet Draft
Iron Ore						
Conneaut Harbor, Oh.	3,148,607	29.3	Vidal Shoals	28.03	29.4	32.1
Dearborn, Mi.	83,307	26.6	Dearborn Mi.	26.6	27.5	28.0
Gary, In	7,903,199	29.6	Vidal Shoals	28.03	29.5	32.1
Indiana Harbor, In.	440,580	27.6	Indiana Harbor	27.6	29.1	30.9
Lorain Harbor, Oh.	1,352,776	29.4	Vidal Shoals	28.03	28.1	30.0

TABLE 7-26
Plan S11: Deepen Two Harbors and Vidal Shoals

	Deepen (Feet)
Two Harbors Deepening	2.0
St. Marys River Deepening	1.0
Current Potential Draft-Two Harbors	27.5
Current Potential Draft-Vidal Shoals	28.03
Plan S11 Potential Draft-Two Harbors	29.5
Plan S11 Potential Draft-Vidal Shoals	29.03

f). Economic Evaluation of Lake Superior Plans. A number of Lake Superior plans are economically justified using year 2000 traffic levels (see **Table 7-27**). Plans S2, S4, S6-S8, and S11 are all advanced to final screening using traffic projections for 2000 through 2060.

TABLE 7-27
Economic Evaluation of Lake Superior Plans
($ thousands)

Plan	Description	First Cost	IDC	AAEC	AAEB	Net Benefit	BCR
S1	Duluth 0.5’	$ 6,226	$ 188	$ 413	$ 293	$ - 120	0.7
S2	Presque Isle 0.5’	$ 825	$ 25	$ 55	$ 172	$ 117	3.1
S3	Silver Bay 0.5’	$ 500	$ 15	$ 33	$ 0	$ - 33	0.0
S4	Superior 0.5’	$ 6,226	$ 188	$ 413	$ 1,678	$ 1,265	4.1
S5	Taconite 0.5’	$ 2,031	$ 61	$ 135	$ 0	$ - 135	0.0
S6	Two Harbors 0.5’	$ 275	$ 8	$ 18	$ 1,031	$ 1,012	57.3
S7	Superior 1.0’	$ 12,451	$ 376	$ 825	$ 1,730	$ 905	2.1
S8	Six Harbors 1.5, St. Marys 0.5’	$103,692	$ 7,251	$ 7,140	$ 8,536	$ 1,396	1.2
S9	Six Harbors 2.0, St. Marys 1.0’	$181,214	$11,946	$12,431	$ 9,671	$ -2,760	0.8
S10	Six Harbors 2.5, St. Marys 1.5’	$270,682	$29,451	$19,315	$10,374	$ -8,941	0.5
S11	Two Harbors 2.0 & Vidal Shoals 1.0’	$ 29,225	$ 1,824	$ 1,998	$ 2,223	$ 225	1.1

5). St Clair/Detroit River Plans SD1 - SD7. Two major ports were identified for potential harbor deepening plans that involved the use of the St. Clair/Detroit River: Dearborn, MI and Monroe Harbor, MI. Dearborn and Monroe Harbor are basically receiving ports. Dearborn receives iron ore, limestone and coal, while Monroe Harbor receives coal. Potential drafts of the origin ports and fleets that service these two harbors were, developed. These data, in conjunction with potential drafts at the various route nodes, were used to develop deepening plans.

a). Dearborn, MI, Rouge River. Dearborn receives iron ore (6.0 million tons) from Lake Superior ports, limestone (2.2 million tons) from Lake Huron ports and coal from Lake Erie. Dearborn’s flow of iron ore and limestone all need to transit the St. Clair River, Lake St. Clair, and Detroit River connecting channels. The constraint point for iron ore is Vidal Shoals and Little Rapids on the St. Marys River (potential draft of 28.03 feet). The channel restriction for limestone movements start at the St. Clair River (28.2 feet). Channel restrictions for coal are at the Detroit River (28.9). **Table 7-28** provides data on the destination ports, the location of the limiting channel and the fleet’s draft.

TABLE 7-28
Potential Drafts of Origin Ports that Service Dearborn, Michigan

Iron Ore - Dearborn, MI – Potential Draft is 26.4 feet

Iron Ore Origin Port	Receipts (Tons)	Origin Point Average Potential Draft	Constraint Point	Constraint Point Average Potential Draft	Average Fleet Draft	Maximum Fleet Draft
Presque Isle, Mi.	3,152,595	27.6	Presque Isle	27.6	27.5	28.5
Superior , Wi	2,965,599	27.4	Superior,Wi	27.4	29.1	34.0

Limestone - Dearborn, MI – Potential Draft is 22.5 feet

Limestone Origin Port	Receipts (Tons)	Origin Point Average Potential Draft	Constraint Point	Constraint Point Average Potential Draft	Average Fleet Draft	Maximum Fleet Draft
Calcite Mi.	964,779	26.7	Dearborn, Mi	22.6	27.4	30.6
Port Inland, Mi.	309,334	28.5	Dearborn, Mi	22.5	28.3	30.9
Stoneport, Mi.	1,049,079	26.6	Dearborn, Mi	22.4	28.4	30.9

Coal - Dearborn, MI – Potential Draft is: 22.4 and 22.5 feet

Coal Origin Port	Receipts (Tons)	Origin Point Average Potential Draft	Constraint Point	Constraint Point Average Potential Draft	Average Fleet Draft	Maximum Fleet Draft
Sandusky, Oh	457,024	26.4	Dearborn, Mi	22.3	22.3	22.9
Toledo Oh	628,668	29.6	Dearborn, Mi	22.5	21.5	22.9

Dearborn Michigan's potential drafts are: iron ore - 26.4 feet, limestone – 22.5 feet, and coal – 22.5 feet. Since the iron ore origin ports have potential drafts of 27.4 feet or more there is a need to deepen Dearborn for iron ore movements.

Limestone comes mainly from Lake Huron ports. The limestone receipts must transit the St.Clair River, Lake St. Clair, and Detroit River channels also. The potential drafts for the St. Clair River, Lake St. Clair and the Detroit River are around 28.2 feet, 28.7 feet and 28.9 feet, respectively. The constraint on this route is the St. Clair River with a potential draft of 28.2 feet. Since the limestone fleet's average draft is at least 27.0 feet, Dearborn Harbor's average potential draft is 22.5 feet, and all the limestone-origin ports have potential drafts of at least 26.6 feet, limestone deepening plans would look at deepening Dearborn Harbor up to three feet. **Table 7-29** shows the plans developed for Dearborn Harbor.

TABLE 7-29
Dearborn, MI – Limestone-Deepening Plans

	PlanSD1 Deepen (Feet)	PlanSD2 Deepen (Feet)	Plan SD3 Deepen(Feet)
Dearborn Harbor Deepening	0.5	1.5	2.5
Current Potential Draft	22.5	22.5	22.5
Plan Potential Draft	23.0	24.0	25.0

Given the amount of iron ore, limestone and coal that moves to Dearborn, deepening plans for all three of these commodities were developed. Dredging costs would now be carried by three commodities instead of just one. Two deepening plans were developed: a three foot and six foot deepening plan. **Table 7-30** provides the components of these plans.

TABLE 7-30
Dearborn, MI – Iron Ore, Limestone, Coal-Deepening Plans

	Plan SD4 Deepen (Feet)	PlanSD5 Deepen (Feet)
Dearborn Harbor Deepening	3.0	6.0
Current Potential Draft	22.5	22.5
Plan Potential Draft	25.5	28.5

b). Monroe Harbor, MI**.** Monroe Harbor receives around 1.8 million tons of traffic per year, with coal accounting for over 97 percent of the tonnage. One of the main ports of origin of coal to Monroe Harbor is Superior Harbor (see **Table 7-31**). Coal flows from Lake Superior through the Soo locks and the St Marys River and through the connecting channels of the St. Clair River, Lake St. Clair and the Detroit River to Monroe Harbor, located on Lake Erie. Given that St. Marys River has a potential draft of 28.03 feet, the first constraint on the route is the destination port (Monroe Harbor at a potential draft of 22.5 feet). The second constraint is at the origin port Superior (27.6 feet). Thus Monroe Harbor could be deepened to allow a draft of 27.6 feet, and the fleet would be able to take advantage of the entire additional water column. At least 445,000 tons of coal could be delivered in vessels drafting 5 feet more than they currently do. Consequently, a five foot deepening plan was developed for Monroe Harbor (see **Table 7-32**).

TABLE 7-31
Potential Drafts of Superior, WI and Monroe Harbor, MI - Coal

Coal Origin Port	Receipts (Tons)	Origin Point Average Potential Draft	Constraint Point	Constraint Point Ave Potential Draft	Ave. Fleet Draft	Max. Fleet Draft
Superior , Wi	445,000	27.6	Monroe, Mi	22.5	28.7	28.7

TABLE 7-32
Monroe Harbor Deepening Plan

	Plan SD6 Deepen (Feet)
Monroe Harbor Deepening	5.0
Current Potential Draft	22.5
Plan Potential Draft	27.5

c). St. Clair, MI. St Clair, Michigan Harbor receives around 5.4 million tons of coal per year from Superior Harbor, on Lake Superior. St. Clair Harbor has a potential draft of 23.5 feet and Superior Harbor has a potential draft of 27.5 feet. Class VII and Class X vessels are used to transport the coal. The fleet has an average draft of 28.7 feet, with some vessels drafting up to 30.1 feet. The coal must transit the St. Marys River (potential draft of 28.03), the Soo locks (depth over sills is 31 to 32 feet), and the St. Clair River (potential draft of 28.2 feet). Given the above, a five-foot deepening plan was developed for St. Clair, Michigan (see **Table 7-33**).

TABLE 7-33
St. Clair Harbor Deepening Plan

	Plan SD7 Deepen (Feet)
St. Clair Harbor Deepening	5.0
Current Potential Draft	23.5
Plan Potential Draft	28.5

d). Economic Evaluation of St. Clair/ Detroit River Plans. All but one of the St. Clair/Detroit River plans indicates positive net benefits at year 2000 traffic levels (see **Table 7- 34**). All plans, save Plan SD6, are carried forward to final screening.

TABLE 7-34
Economic Evaluation of St. Clair/Detroit River Plans
($ Thousands)

Plan	Description	First Cost	IDC	AAEC	AAEB	Net Benefit	BCR
SD 1	Dearborn 0.5’	$ 477	$ 14	$ 32	$ 263	$ 232	8.3
SD 2	Dearborn 1.5’	$ 1,431	$ 43	$ 95	$ 715	$ 620	7.5
SD 3	Dearborn 2.5’	$ 2,386	$ 72	$ 158	$ 1,134	$ 976	7.2
SD 4	Dearborn 3.0	$ 2,863	$ 86	$ 190	$ 2,998	$ 2,808	15.8
SD 5	Dearborn 6.0	$ 5,726	$ 173	$ 380	$ 3,252	$ 2,872	8.6
SD 6	Monroe- Coal 5.0	$ 53,150	$ 6,843	$ 3,861	$ 553	$ - 3,308	0.1
SD 7	St. Clair, MI- 4.0	$ 5,322	$ 161	$ 353	$ 4,514	$ 4,161	12.8

c. Canadian Great Lakes/St. Lawrence Seaway Harbors. While the formulation and evaluation of deepening plans for the Canadian harbors was beyond the scope of this reconnaissance level study, a number of ports would benefit from deepening plans. The necessary information for conducting such evaluations was not immediately available. Possible Canadian port deepening plans will be developed as part of the feasibility level effort.

d. Chicago Sanitary and Ship Canal. The Lemont reach is a 12.5 mile segment of the Chicago Sanitary and Ship Canal (CSSC) between Lockport Lock and the confluence with the Calumet Sag Channel (CSC). This reach is very difficult and dangerous to navigate, particularly along the 10 miles of channel referred to as the Lemont Narrows. Among the factors contributing to a risk and safety concern is the original narrowness (160 feet) of the rock cut channel. Being a rock cut, there are no natural widenings of the canal over this 10 miles of channel between mile 293.6 (just above Lockport Lock) and mile 303.4 at the junction of the CSC. This segment also incorporates a large bend in the waterway between river miles 296.0 and 299.0. It is on the upstream end of this bend, which traveling downstream redirects traffic from a West-Southwest direction to a South direction, that the most intense tug and barge mooring, fleeting, docking and servicing activity is located. This intense activity occurs over a five stretch from river mile 299 through river mile 303.4 at the CSC junction. In a 2.5 mile reach, mile 299 – mile 301.5, there are 7 slips that offer barge and tow marine services. It is in this area that tow and barge staging activities cause traffic congestion.

Four plans were developed to deal with traffic congestion that delays tows and increases safety concerns along the Lemont reach of the Chicago Sanitary and Ship Canal (CSSC). The inadequacy of mooring facilities is a major contributing factor in most instances. Low bridge clearances, specifically the Lemont-Railroad bridge, also impose time penalties and risks on commercial users. Plan CSSC 1, Quarry Site, takes advantage of an existing quarry site to provide additional mooring opportunities. Plan CSSC 2, Three Mile Wall, proposes opening to mooring a three mile stretch of the Cal-Sag Channel located a few miles from the primary congestion point on the CSSC. Plan CSSC 3, Canal Widening, proposes widening a reach on the CSSC some miles distant from the Lemont-Railroad bridge, but away from the CSSC and CSC junction. The final plan is CSSC 4, Re-operation of the Lemont-Railroad bridge. This plan would repair and replace the machinery necessary to reactivate the swing mechanism of the low-clearance, Lemont-Railroad bridge. Each is discussed in more detail below.

1). Quarry Site, Plan CSSC 1. This plan involves opening a large existing flooded quarry in Lemont for commercial navigation utilization. From approximately RM 301.11 to 301.4 along the left bank descending, ¾ of a mile upstream of the restrictive Lemont RR bridge is an abandoned quarry known as Commoners Quarry. This quarry site is the largest of a group of eight abandoned and flooded quarry sites or pockets between the CSSC and Illinois and Michigan (I&M) canal waterway. A number of the smaller quarry sites are under consideration by the Village of Lemont for recreational or/and conservation use. The Commoners site is situated opposite bank from three slips on the right bank descending (shown as Lemont industrial slips A, B, and C in the Corps navigation chart records). The owner of the slips is shown as the MWRD, and the operators are some of the larger commercial operators in the area. The quarry site is approximately 2,000’ in length and 800’ in width, covering approximately 37 acres.

Based on square footage the quarry site could store 195 standard size barges allowing for five feet spacing of the barge length and width. Alternatively, a portion of the quarry site could be used for a turning basis or a passing notch. The location of the site is in the most heavily congested area of the 10 mile Lemont narrows. The land bridge separating the quarry from the CSSC is approximately 175' in width.

2). Three Mile Wall, Plan CSSC 2. Many operators believe making more mooring space available along the Three mile wall, a CSC north bank wall directly upstream of the juncture (the right wall descending), would alleviate much of the congestion in the CSSC canal. The land use for this property is designated "corporate use channel maintenance & access" by the owner: MWRD. The land in the vicinity immediately off the bank is Cook County Park District, Forest Preserve land. This use extends for nearly three miles upstream from the junction. The bank is rock cut and is suitable for tie-off (e.g., dead men, cable and chain). Not the entire three mile length is vacant unused. Nearest the juncture on the CSC Illinois Marine Towing has their Lemont Cal-Sag Mooring operation which extends from mile 303.9 to mile 304.1 and has a capacity for 5 barges. The Illinois Central Railroad Company and the Illinois DOT also own portions of the mooring. For a three mile length, this reach would have an estimated capacity for 75 standard 200' barges allowing for 10'spacing between each. Many of the tanker barges are larger size, of 290' by 50' dimensions. Use by the larger tank barges would reduce the overall capacity, but would not impair the overall goal of the additional area - to relieve obstruction in the narrow CSSC caused by barge mooring.

3). Canal Widening, Plan CSSC 3. There remain areas along the banks of the CSSC proximate to the areas of congestion which could be widened by 50' to 60' along the left side descending, from the Lemont-RR bridge to the Romeo Highway Bridge. Not only would widening allow barge mooring outside the current channel, but it would also potentially allow for a passing area, where one tow could pull aside to let another vessel or tow pass without having to delay at the extreme upstream or downstream end of the 10 mile long Lemont Narrows. A review of diagrams provided by MWRD indicates the existing use for right of way consideration of channel banks. Reviewing this information resulted in two lengths within the strategic location that are not currently shown as leased, but are shown as vacant. One location is a half mile stretch just downstream of the restrictive RR bridge in Lemont, RM 300 – 300.5 left bank descending. The second location is a 1.2 mile reach at the downstream portion of the bend in the canal; RM 296.2 to 297.3 left bank descending. Widening one or both of these canal areas to permit passing, or/and to accept moored barges that would otherwise be in the narrow canal, or/and to permit for a tow turning maneuver, would serve to relieve the congestion in the area. The two sites would provide 1.7 miles of fleeting for 42 barges at single width and 84 barges at double width.

4). Lemont Bridge, Plan CSSC 4. The navigation constraints caused by the vertical limitations of the Lemont-RR bridge could be relaxed by raising the bridge or returning it to a swing operation. The impact would be to permit all tows requiring no more than 24.4' vertical clearance to navigate clear through the CSC to the Great Lakes. This would be roughly a 5' improvement in the air draft over the existing vertical limits;

however, vessels would not be able to use the CSSC into the Chicago Harbor Lock due to many additional vertical constraints along the CSSC beginning at river mile 312.0 of the CSSC. Additionally, the need to ballast barges which are not continuing up the CSSC beyond river mile 312.0 would be removed. The cruise ship or promotional vessels (like the "Niagara Prince") wanting to navigate through Lockport lock would be allowed. The large commercial crane barges and large equipment and parts movers (like the Corps Crane Barge "Hercules") would also gain access through the currently vertically constricted portion of the waterway allowing connections between the Great Lakes, the Illinois and Mississippi Rivers, the Gulf ports, and beyond. An additional benefit would be the safety enhancement of not having to lower the pilot house, thereby maintaining maximum field of vision for the tow captain. This benefit is especially important in this area as distances between structures are so short that navigation radar is useless.

5). Economic Evaluation of Chicago Sanitary & Ship Canal Plans. All benefit estimates are based upon reducing transit times through the Lemont reach of the Chicago Sanitary and Ship Canal (CSSC). It is emphasized that these benefit estimates are not comprehensive as they do not account for savings attributable to reduced damage to property and life that would likely result from the proposed improvements. These potential benefits should be considered as quantifiable in any future analyses.

A complete benefit-cost analysis was possible for just two of the four plans. No cost estimate is available for Plan CSSC1, Quarry Site or for Plan CSSC 3, Canal Widening. Cost estimates for Plan CSSC 2 and Plan CSSC 4, Three Mile Wall and Lemont Bridge, are incomplete as they do not include lands, easements, relocations and rights of way. This deficiency is accounted for through a fifty percent contingency. The cost estimate available for re-operation of the Lemont RR bridge is $3,016,000. The cost estimate for mooring piers along one mile of the Three Mile Wall is $1,208,000. Expanding this estimate out to the 2.8 miles of wall not yet being used increases the total cost to $3,081,000.

The annualized available cost estimates, at the discount rate of FY01 0.06375, over a 50 year project life, are $205,830 for the Three Mile Wall and $201,436 for the Lemont RR bridge (see **Table 7-35**). Available quantified benefit estimates for these two plans are $284,000 and $34,000, respectively. The resultant benefit and cost ratio for these two plans are 1.38 and 0.17, respectively.

TABLE 7-35
Summary of Average Annual Benefits by Category
Chicago Sanitary and Ship Canal Plans

Alternative	First Cost	AAEC	AAEB	Net Benefit	BCR
CSSC 1,Quarry site	n.a	n.a	$ 741,000	n.a	n.a
CSSC 2, Three mile wall	$ 3,381,000	$ 225,820	$ 284,000	$ 58,180	1.26
CSSC 3, Canal widening	n.a.	n.a.	$ 298,000	n.a.	n.a.
CSSC 4, Lemont RR bridge	$ 3,016,000	$ 201,436	$ 34,000	$ (167,436)	0.17

e. GLNS 30’ Connecting Channel. The GLLAST model was run for a condition where vessels can draft to their maximum depth. Using year 2000 traffic levels, it was estimated that cost reduction for existing movements would be $87 million annually. This estimate acts to represent the benefits of having the ability to draft 30’ throughout the GLNS channels and ports, excepting the Welland Canal (see **Section 8** and **Table 8-4**). No shift-of-mode, economic development or other transportation impact benefits accrue to this Option 1 plan because the Seaway’s 26’ 3” draft effectively prohibits overland moves, specifically containers, from using a GS/SLS waterway routing.

f. Operational Plans. Two sets of operational improvements were formulated and evaluated for the St. Clair/Detroit River system. The first proposes a set of permanent beacons to replace the buoys that are placed each spring, and pulled each winter, to mark the navigation channel. The detailed analysis is presented in **Attachment 1, Economic Evaluation of the Placement of Navigation Beacons ion the Detroit Area.** The second operational improvement plan proposes ice booms to replace ice breaking ships in controlling ice flows into the St. Clair/Detroit River system. The detailed analysis of this plan is presented in **Attachment 8, St. Clair Ice-Boom Alternative Analysis**.

1.) Beacons. This alternative evaluates potential improvements to navigation aids in the Great Lakes system through replacing buoys, which are floating navigation aids, with permanent beacons. Lighted buoys are currently the primary marker system utilized in Great Lakes waterways. They must be removed in the fall prior to the onset of ice and reset in the spring after the thaw. Commercial shipping extends several weeks past the fall withdrawals and starts well before buoys can be placed in the spring. This practice increases risk to mariners and costs to shippers. The Coast Guard envisions a system in which ice resistant permanent structures replace a considerable number of buoys. Such an aid to navigation system would be more robust by providing more reliable aids and year round service.

Table 7-36 presents the summary of the average annual benefits and costs for 29 beacons. Benefits presented in the table below are all associated with reducing the labor, equipment and material costs necessary to operate a series of in-water navigation aids. While the benefits reflect the difference in the operational economics between buoys and permanent beacons, benefits associated with the reduced risk to buoy tending personnel and to mariners and vessels has not been estimated. Estimating safety benefits was beyond the scope of this reconnaissance study. Given this deficiency and the closeness of the BCR to unity, this operational plan warrants further investigation in any feasibility study of the Great Lakes connecting channels.

2.) Ice Booms. Navigation on the middle lakes of the Great Lakes can occur all year depending on winter conditions. Ice formation and breakup on the lakes and in the rivers can cause delays to navigation interests and flooding problems for riparian properties. The St. Clair and Detroit rivers are problematic areas with their many-channeled delta, and the jamming of large ice floes from lakes Huron and St. Clair.

The ice problems could be reduced by the proper placement of ice-retaining booms across the headwaters of the rivers. Ice booms have been found to be quite effective in controlling the movement of ice in the St. Marys River, the Niagara River and in the St. Lawrence Seaway.

TABLE 7-36

AVERAGE ANNUAL SUMMARY
(-0 @ 6.125% discount w/base year 2010)

Total First Costs	
Beacon Construction Cost	$ 10,140,000
IDC	$ 1,666,355
Total Cost	$ 11,806,355
Avg. Ann. Costs for this PLAN	**$ 759,782**

Ave. Ann. Benefits	
Av.Ann. Operating Cost Savings	$ 69,117
Av.Ann. Personnel Savings	$ 344,160
Av.Ann. Barge Savings (lay up)	$ 209,153
Savings	**$ 622,430**

Net Benefits and BCR	
Average Annual Benefits	$ 622,430
Average Annual Costs	$ 759,782
Net Benefits	**-$ 137,352**
BCR	**0.8**

Previous studies conducted on the installation of ice booms at the heads of the St. Clair and Detroit Rivers provide details on the location of the booms and their costs. Problems previously identified with ice jams in the rivers include: delays to navigation due to vessels stuck in the ice in the navigation channel; scouring of the river bottom; and flooding and other damage to shore property.

The brief outline presented here relies heavily on information obtained from a report generated in March of 1995, *Analysis of Great Lakes Icebreaking Requirements, Final Report*, prepared by the U.S. Department of Transportation for the U.S. Coast Guard. This report determines Federal and user requirements, reviews icebreaker capabilities and operating costs and historical ice conditions, and presents a benefit-cost ratio for the overall icebreaking program. In the course of achieving this end, the referenced report developed a cost model for the steel industry looking at alternatives such as stock piling and alternate modes of transportation. The frequent references to the "ice season" on the great lakes involve the months December through March. Ice boom costs were adjusted from the 1974 Navigation Season Extension report.

A cost summary of the annual cost of ice-breaking vessels and the annual cost of the proposed ice booms is shown in **Table 7-37**. The ice booms offer an annual cost savings of $251,900, the difference between the vessel's annual cost ($1,425,900) and the ice-boom annual cost ($1,174,000).

A caveat to the direct financial comparison is the assumption that ice booms would eliminate the need for ice breaking vessels. Additionally, a comparison of the alternative costs should include an estimate of the potential costs of any damage associated with ice breaking by vessels. Thus, the annual cost of ice booms is probably understated by not accounting for any additional need for the use of ice breaking vessels in extreme weather situations and the annual cost of the use of ice breakers is understated by not including a value for the hazardous nature of ice removal. Quantification of these costs is not possible given the time and resources for this reconnaissance level effort.

TABLE 7-37

Direct Cost Comparison	
Current Annual Cost of Ice Removal Attributable to Area 2	**$1,425,906**
Proposed Booms Annual Cost	
Average Annual Cost	$791,000
Annual O&M	$383,000
Annual Cost of Ice Booms	**$1,174,000**
Annual Cost Difference	**$251,906**

SECTION 8. ECONOMIC EVALUATION FINAL ALTERNATIVES

1. INTRODUCTION

a. Options Evaluated. Four broad waterway improvement investment options (Options 1, 3, 4, and 5) are advanced to the more detailed economic evaluation presented in this section (see **Table 8-1**). Each option has three descriptive components, as does the without-project condition. The first component is the U.S. portion of the GLNS, the second component is the Welland Canal Section of the Seaway, and the third is the MLO section of the Seaway. Option 1 encompasses the many combinations of improvement alternatives for U.S. connecting channels and harbors (including the Chicago Sanitary and Ship Canal), coupled with the Seaway's without-project condition - systematic replacement of the Seaway locks with chambers the same size as those currently in-place. Option 3 replaces both the Welland Canal and the MLO section of the Seaway with a deeper and larger system of locks and channels, thereby extending a 35' draft system up to Detroit. Option 4 is the same as Option 3, except that the 35' draft now extends into lakes Michigan and Huron by deepening the entire St.Clair/Detroit River system. Finally, Option 5 extends the 35' draft throughout the GL/SLS system as a result of lowering the sill depth at Soo locks and deepening the St. Marys River. **Table 8-1** summarizes the description of each option.

TABLE 8-1
GL/SLS Alternatives

Alternative	U.S. GLNS Connecting Channels & Ports	Welland Canal Section—Seaway	MLO Section--Seaway
Without Condition[1]			
2000	25'6" draft, O&M, MR	26'3" draft, O&M, LR	26'3" draft, O&M, LR
2030	25'6" draft, O&M, MR	26'3" draft, RIK underway	26'3" draft, RIK underway
2070	25'6" draft, O&M, MR	26'3" draft, RIK completed	26'3" draft, RIK completed
With Alternatives			
Option 1 U.S. Channels	Up to 30' draft	WOPC	WOPC
Option 3 Detroit Terminus	Up to 30' draft, except Detroit R. at 35'	Locks 110'x1200', draft 35'	Locks 110'x1200', draft 35'
Option 4 Michigan/Huron	35' draft, except St. Marys R. at 30'	Locks 110'x1200', draft 35'	Locks 110'x1200', draft 35'
Option 5 Superior	Up to 35' draft all connecting channels	Locks 110'x1200', draft 35'	Locks 110'x1200', draft 35'

b. Limits of the Analysis. No costs have been developed for the without-project condition on the St. Lawrence Seaway. Because lock reliability is a concern on the Seaway, a complete description and evaluation of the without-project condition alternatives is an especially important, analytically intensive effort. Completing the

[1] Without-project condition includes operation of authorized second 1200' chamber at Soo Locks.

requisite engineering surveys, analyses, designs, and cost estimates for the 15-lock Seaway system is beyond the scope of this reconnaissance study.

A limited set of cost estimates was developed for the with-project alternatives, specifically: for Option 1 port and connecting channel plans, for some Chicago Sanitary and Ship Canal plans, and for the St. Clair/Detroit River system operational plans. No cost estimates were prepared for Options 3, 4, and 5, or for the 30' connecting channel plan under Option 1.

As discussed in **Section 6**, benefits for Option 1 harbor and channel plans are based on U.S. domestic traffic and a portion of U.S. foreign traffic. It was not possible to model all traffic owing to data deficiencies discussed earlier in **Section 4**. These benefits, along with costs provided by the Engineering Team, are the basis of the benefit-cost analysis presented for Option 1 plans. Benefits only are presented for the 30' connecting channel plan under Option 1 and the 35' draft alternatives described in Options 3, 4, and 5. As such, these benefits are intended as indicators of the possible presence or absence of federal interest. Finally, the shift of mode benefits presented for the 30' and 35' draft alternatives assume extension of the navigation season for the Seaway and accompanying federal and non-federal waterside and landside infrastructure investments.

2. OPTION 1 ALTERNATIVES

a. General. This subsection reports estimated benefits for: 1) specific plans that improve U.S. Great Lakes harbors and connecting channels, 2) specific plans that improve the Chicago Sanitary & Ship Canal, and 3) a general plan that provides a 30' draft at all U.S. Great Lakes Navigation System (GLNS) connecting channels. Benefits for the GLNS connecting channels and ports are estimated using a vessel-costing model. Chicago Sanitary & Ship Canal benefits are estimated using a spreadsheet model designed specifically for this purpose.

b. GLNS—U.S. Connecting Channels and Ports. All plans carried forward to the final screening, with the exception of Plan S11, showed positive net benefits. The final screening used projections of future traffic in making the final economic evaluation. The results are summarized in **Table 8-2**.

c. Chicago Sanitary & Ship Canal. One plan shows positive net benefits; however, the other three cannot be screened-out as either benefits or costs are incompletely developed. The economic analysis for the four plans considered is presented in **Section 7** and a complete discussion is presented in **Attachment 6, Chicago Sanitary and Ship Canal Analysis**. **Table 8-3** summarizes the average annual benefits.

TABLE 8-2
Economic Evaluation of Connecting Channel & Port Plans
($ thousands)

Plan	Description	First Cost	IDC	AAEC	AAEB	Net Benefit	BCR
E1	Sandusky 0.5’	$ 731	$ 22	$ 48	$ 276	$ 228	5.7
E2	Sandusky 1.0’	$ 1,566	$ 47	$ 104	$ 634	$ 530	6.1
E3	Sandusky 1.5’	$ 2,400	$ 72	$ 159	$ 688	$ 529	4.3
E4	Sandusky 2.0’	$ 3,425	$ 103	$ 227	$ 783	$ 556	3.4
E5	Ashtabula 0.5’	$ 311	$ 9	$ 21	$ 12	$ -9	0.6
E15*	Sandusky 1.0’ w/ vessel change	$ 1,566	$ 47	$ 104	$10,163	$ 10,059	97.9
E16*	Ashtabula 0.5’ w/ vessel change	$ 311	$ 9	$ 21	$ 2,295	$ 2,274	111..3
E17*	Fairport 1.0’ w/ vessel change+1M tons	$ 577	$ 17	$ 38	$ 1,384	$ 1,346	36.2
E18*	Fairport 1.0’ w/ vessel change	$ 577	$ 17	$ 38	$ 1,100	$ 1,062	28.8
H1	Calcite 0.5’	$ 1,756	$ 53	$ 116	$ 166	$ 50	1.4
H2	Calcite 1.0’	$ 3,513	$ 106	$ 233	$ 285	$ 52	1.2
H3	Calcite 1.5’	$ 3,606	$ 109	$ 239	$ 355	$ 116	1.5
H4	Calcite 2.0 ’	$ 3,700	$ 112	$ 245	$ 396	$ 150	1.6
H5	Stoneport 0.5 ’	$ 1,756	$ 53	$ 116	$ 144	$ 28	1.2
H6	Stoneport 1.0 ’	$ 3,512	$ 106	$ 233	$ 245	$ 12	1.1
H7	Stoneport 1.5 ’	$ 3,606	$ 109	$ 239	$ 276	$ 37	1.2
H8	Stoneport 2.0	$ 3,700	$ 112	$ 245	$ 282	$ 37	1.2
H9	Drummond 2.5	$ 3,950	$ 119	$ 262	$ 469	$ 207	1.8
M1	Indiana Harbor 1.0	$ 2,323	$ 70	$ 154	$ 959	$ 805	6.2
M2	Indiana Harbor 2.0 & Escanaba 1.0	$ 11,690	$ 353	$ 775	$ 1,360	$ 585	1.8
M4*	Calumet Harbor 1.0’ for coal	$ 19,950	$ 1,231	$ 1,363	$ 4,034	$ 2,671	3.0
S2	Presque Isle 0.5’	$ 825	$ 25	$ 55	$ 131	$ 76	2.4
S4	Superior 0.5’	$ 6,225	$ 188	$ 413	$ 4,436	$ 4,024	10.7
S6	Two Harbors 0.5’	$ 275	$ 8	$ 18	$ 814	$ 796	44.6
S7	Superior 1.0’	$ 12,451	$ 376	$ 825	$ 4,388	$ 3,563	5.3
S8	Six Harbors 1.5, St. Marys 0.5’	$103,692	$ 7,251	$ 7,140	$12,751	$ 5,611	1.8
S11	Two Harbors, MN 2.0’, St. Marys R 1.0’	$ 29,225	$ 1,824	$ 1,998	$ 1,727	$ - 271	0.9
SD 1	Dearborn 0.5’	$ 477	$ 14	$ 32	$ 300	$ 269	9.5
SD 2	Dearborn 1.5’	$ 1,431	$ 43	$ 95	$ 870	$ 775	9.2
SD 3	Dearborn 2.5’	$ 2,386	$ 72	$ 158	$ 1,371	$ 1,213	8.7
SD 4	Dearborn 3.0	$ 2,863	$ 86	$ 190	$ 3,229	$ 3,039	17.0
SD 5	Dearborn 6.0	$ 5,726	$ 173	$ 380	$ 3,478	$ 3,098	9.2
SD 7	St. Clair, MI- 5.0	$ 5,322	$ 161	$ 353	$ 5,979	$ 5,626	16.9

* plans include fleet changes after deepening

TABLE 8-3

Summary of Average Annual Benefits by Category
Chicago Sanitary and Ship Canal Plans

Alternative	First Cost	AAEC	AAEB	Net Benefit	BCR
CSSC 1,Quarry site	n.a	n.a	$ 741,000	n.a	n.a
CSSC 2, Three mile wall	$ 3,381,000	$ 225,820	$ 284,000	$ 58,180	1.26
CSSC 3, Canal widening	n.a.	n.a.	$ 298,000	n.a.	n.a.
CSSC 4, Lemont RR bridge	$ 3,016,000	$ 201,436	$ 34,000	$ (167,436)	0.17

d. Potential Benefits from 30' Connecting Channels. The GLLAST model was run for a condition where vessels can draft to their maximum depth. Using year 2000 traffic levels, it was estimated that cost reduction for existing movements would be $87 million annually. This estimate acts to represent the benefits of having the ability to draft 30' throughout the GLNS channels and ports, excepting the Welland Canal (see **Table 8-4**). No shift-of-mode, economic development or other transportation impact benefits accrue to this Option 1 plan because the Seaway's 26'3" draft effectively prohibits the diversion of overland moves, specifically containers, from using a GS/SLS waterway routing.

TABLE 8-4
Summary of Average Annual Incremental Benefits
Option 1, U.S. Channels Up to 30' Draft
($ millions)

Category	Option 1
Incremental Annual Benefits	
Cost Reduction	$ 87
Shift of Mode	
Container	$ 0
Bulk flows	$ 0
Economic Development	$ 0
Other Transportation Impacts	n.a.
Total Benefits	$ 87

Note: Economic Development benefits are Regional Economic Development benefits and are not used to determine project feasibility.

e. Operational Plans. Two sets of operational improvements were formulated and evaluated for the St. Clair/Detroit River system. The first proposes a set of permanent beacons to replace the buoys that are placed each spring, and pulled each winter, to mark the navigation channel. The analysis of this plan is presented in **Section 7** and a detailed analysis is presented in **Attachment 1, Economic Evaluation of the Placement of Navigation Beacons in the Detroit Area**. The second operational improvement plan proposes ice booms to replace ice breaking ships in controlling ice flows into the St. Clair/Detroit River system. The analysis of this plan is also presented in **Section 7** along with detailed analysis of this plan in **Attachment 8, St. Clair Ice-Boom Alternative Analysis**. The beacon plan is marginally infeasible (-$137,352 net benefits) with the limited information gathered and is recommended for more thorough evaluation in a feasibility-level study. The ice boom plan proposed for the St. Clair/Detroit River System was economically feasible ($251,906 net benefits) using reconnaissance-level information gathered from secondary sources.

3. OPTION 3 ALTERNATIVES

Option 3 includes a deeper and larger (110' x 1200' locks) St. Lawrence Seaway and a deeper Detroit River. This would result in a shift of some container and bulk traffic from existing overland routings. Incremental shift-of-mode traffic will increase imports and exports and hence Great Lake port activity, reduce highway congestion and reduce human exposure to pollutant emissions. These benefits are estimated as economic development benefits and other transportation impacts (see **Table 8-5**).

Providing a minimum 35' channel from the Atlantic Ocean to Detroit, with a 30' channel above Detroit, only provides full benefits to approximately 20 percent of the potential East Coast-Great Lakes container traffic. Container shift-of-mode benefits of $240 million a year (assuming that 50 percent of existing containers shift) for this option are based on an analysis of a 30' deep Chicago Harbor (see **Attachment 4, Great Lakes and St. Lawrence Seaway Potential Container Transportation Savings**). Also assumed here is that one-half of any bulk shift-of-mode benefits (increased grain exports from Duluth and Thunder Bay) would develop with 30' GLNS channels above Detroit.

The economic development benefits of a 35' draft system throughout were estimated with the Maritime Input-Output (MIO) model (see **Attachment 5, Maritime Input/Output Model**). To estimate the economic development benefits of 35' channel below Detroit and 30' GLNS channels above Detroit, it was assumed that only one-half of the economic development benefits would be realized. Other transportation impacts in the form of reduced highway congestion and fewer emission-related disease are also estimated at one-half the potential of a full-35'-draft GL/SLS system. **Table 8-5** displays the average annual incremental benefits expected from Option 3 improvements.

TABLE 8-5
Summary of Average Annual Incremental Benefits
Option 3, Improved Seaway, 35' Draft up to Detroit,
30' GLNS Channels Above
($ millions)

Category	Option 3
Incremental Annual Benefits	
Cost Reduction	$87
Shift of Mode	
Container	$293
Bulk	$17
Economic Development	$400
Other Transportation Impacts	$88
Total Benefits	$885

Note: Economic Development benefits are Regional Economic Development benefits and are not used to determine project feasibility.

4. OPTION 4 ALTERNATIVES

Option 4 builds upon Option 3 by extending 35' channel draft into lakes Michigan and Huron. Chicago can accommodate container vessels drafting at 35'. Container shift-of-mode benefits increase, as well as the economic development and other transportation impacts associated with the modal shift. **Table 8-6** summarizes the benefits of this incremental improvement.

TABLE 8-6
Summary of Average Annual Incremental Benefits
Option 4, Improved Seaway, 35' Draft up to Lakes Michigan & Huron,
30' GLNS Channels Above
($ millions)

Category	Option 4
Incremental Annual Benefits	
Cost Reduction	$87
Shift of Mode	
Container	$343
Bulk	$17
Economic Development	$800
Other Transportation Impacts	$170
Total Benefits	$1,417

Note: Economic Development benefits are Regional Economic Development benefits and are not used to determine project feasibility.

5. OPTION 5 ALTERNATIVES

Option 5 maximizes system dimensions to 35' draft throughout the GL/SLS, along with larger locks on the Seaway. This option allows for the full realization of potential container and bulk shift-of-mode benefits and economic development benefits. **Table 8-7** displays the incremental benefits associated with Option 5.

TABLE 8-7
Summary of Average Annual Incremental Benefits
Option 5, Improved Seaway, All GLNS Channels 35' Draft
($ millions)

Category	Option 5
Incremental Annual Benefits	
Cost Reduction	$163
Shift of Mode	
Container	$343
Bulk	$34
Economic Development	$800
Other Transportation Impacts	$170
Total Benefits	$1,510

Note: Economic Development benefits are Regional Economic Development benefits and are not used to determine project feasibility.

6. SUMMARY OF OPTION BENEFITS

Table 8-8 summarizes reconnaissance-level, average annual incremental benefits for the four with-project Options. No costs were developed for these general, comprehensive alternatives. Specific connecting channel and port plans, Chicago Sanitary and Ship Canal, and St. Clair/Detroit River operational plans were presented in **Section 7**.

TABLE 8-8
Summary of Average Annual Incremental Benefits
($ millions)

Category	Option 1[1]	Option 3	Option 4	Option 5
Incremental Annual Benefits				
Cost Reduction	$87	$87	$87	$163
Shift of Mode				
Container	$0	$293	$343	$343
Bulk Flows	$0	$17	$17	$34
Economic Development	$0	$400	$800	$800
Other Transportation Impacts	$0	$88	$170	$170
Total Benefits	**$87**	**$885**	**$1,417**	**$1,510**
Incremental Annual Costs	n.a.[2]	n.a.	n.a.	n.a.
Net Annual Benefits	n.a.	n.a.	n.a.	n.a.
Benefit-Cost Ratio	n.a.	n.a.	n.a.	n.a.

1. costs are available
2. not available
Note: Economic Development benefits are Regional Economic Development benefits and are not used to determine project feasibility.