RECONNAISSANCE REPORT

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GREAT LAKES NAVIGATION SYSTEM REVIEW

APPENDIX B – COST ENGINEERING

Great Lakes - St. Lawrence River System

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

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1. STUDY BACKGROUND: In 1999 Congress provided a broad-range authority to review the feasibility of improving commercial navigation on the Great Lakes navigation system, including locks, dams, harbors, ports, channels, and other related features. The first phase of the review is a reconnaissance study, ear-marked as a two-year effort. If capital improvements appear to be warranted more detailed studies could follow. Fiscal Year (FY) 2001 funds were received to initiate the reconnaissance study. Coordination with Federal and state agencies and the St. Lawrence Seaway Authorities resulted in the establishment of a multi-district project delivery team, which in turn solicited input from users and stakeholders, developing the study scope and creating a web site to share information on the study. Substantial input was received, and system improvements proposed, including deepening the Great Lakes Connecting Channels, deepening individual Great Lakes Ports, and modernization of the St. Lawrence Seaway. Those actions and other potential structural and non-structural measures were considered.

2. ALTERNATIVES: Based on the input of the various interests referenced above, the following alternatives have been identified which will require evaluation of benefits and estimated costs:

a. <u>Deepening the Great Lakes Connecting Channels</u>

This alternative proposes to evaluate potential improvements to the Great Lakes Connecting Channels to include; modifications to improve existing infrastructure (locks, navigation structures, etc.) and modifications to the existing channels to accommodate deeper draft vessel traffic. The current minimum, safe vessel depth for the navigation system is 25.5 feet at Low Water Datum (LWD). Evaluation of deepening of the channels would include incremental depths from 25.5 feet LWD to 30 feet LWD (specifically, proposed depths of 26, 27, 28, 29, and 30 feet). The connecting channels will be separated as follows:

St. Marys River (includes upper and lower St. Marys River)
St. Clair River (includes channels in Lake St. Clair and the St. Clair River)
Detroit River (includes the Detroit River and channels in Lake Erie)

b. <u>Deepening Great Lakes Harbors</u>

This alternative proposes to evaluate potential improvements to the ports and harbors within the Great Lakes System to include; modifications to improve existing infrastructure and modifications to the existing channels to accommodate deeper draft vessel traffic. The current maximum, safe vessel draft for the Great Lakes – Connecting Channels navigation system is 25.5 feet at Low Water Datum (LWD), however, the maximum safe vessel draft at each harbor varies. Evaluation of deepening of the individual harbors would include incremental depths from the existing project depth at each harbor to accommodate a maximum safe vessel draft of up to 30 feet. In addition, scenarios entailing deepening to accommodate a 35 foot vessel draft were considered for three harbors (Calumet, Detroit and Cleveland) affiliated with potential improvements to the St. Lawrence Seaway. The following ports were considered:

Alpena Harbor, MI	Escanaba Harbor, MI	Saginaw Harbor, MI
Ashtabula Harbor, OH	Fairport Harbor, OH	Sandusky Harbor, OH
Buffalo Harbor, NY	Gary Harbor, IN	Saugatuck Harbor, MI
Burns Harbor, IN	Green Bay Harbor, WI	Sheboygan Harbor, WI
Calcite Harbor, MI	Indiana Harbor, IN	Silver Bay Harbor, MN
Calumet Harbor, IL/IN	Lorain Harbor, OH	St. Clair (Edison) Harbor, MI
Cleveland Harbor, OH	Menominee Harbor, WI	Stoneport Harbor, MI
Conneaut Harbor, OH	Milwaukee Harbor, WI	Taconite Harbor, MN
Detroit Harbor, MI	Monroe Harbor, MI	Toledo Harbor, OH
Port Drummond Harbor, MI	Presque Isle Harbor, MI	Two Harbors, MN
Duluth-Superior Harbor, MN,WI	Rouge River Harbor, MI	

c. Ice Control Measures

This alternative proposes to evaluate potential improvements to the St. Clair delta area within the Great Lakes system. 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. One of the most problematic areas is the St. Clair River and its many channeled delta, and the jamming of large ice floes from Lake Huron. The problem could be reduced by the proper placement of ice retaining booms across the mouth of the St. Clair and Detroit rivers. Ice booms have been found to be quite effective in controlling the movement of ice in the St. Marys River, in Lake Erie at the Niagara River, and in the St. Lawrence Seaway.

Previous studies have been conducted on the installation of an ice boom at the head of the St. Clair River and the Detroit River. These studies have provided details on the location of the boom, its costs, and its benefits. Problems previously identified with ice jams in the river include: delays to navigation due to vessels stuck in the ice in the navigation channel; scouring of the river bottom; and flooding of shore property. The installation of ice booms would improve the hydraulic efficiency of the rivers, allowing them to pass more water during winter season, thereby providing some means to reduce water levels on the upper Great Lakes during of high water.

d. Improved Water Level Data Access

This alternative proposes to evaluate potential improvements to the water level data access within the Great Lakes system. An integral part of navigation of the Great Lakes, their connecting channels and the St. Lawrence River is a knowledge of past, current and forecasted water levels. These data are collected and disseminated by a variety of agencies in several ways. Improvements in access to these data by the navigation interests and some additional equipment installations could provide benefits to the navigation industry and improved safety to the Great Lakes, their connecting channels and the St. Lawrence River.

Currently, real-time water level data are collected by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Army Corps of Engineers (USACE) in the U.S. and the Marine Environmental Data Service (MEDS) in Canada. Data are displayed at three different web sites, in different formats. Some data are available for instantaneous access by telephone to the gages directly. Some data are provided in elevation referenced to the International Great Lakes Datum of 1985 (IGLD 1985) directly, while some data are provided as inches or centimeters above or below low water datum (LWD). Some data are provided in graphic format, showing the past three hours, the past 7 days or the past month. The inconsistency in access and presentation of these data can lead to misunderstanding of the current water level conditions throughout the system and therefore under utilization of commercial navigation capacity, or possibly safety problems from groundings.

The proposal is to work with all agencies supplying water level information to coordinate one consistent access point for all water level data. Information would be displayed for specific regions regardless of the ownership of the data, although proper credit and notations will be provided. Graphics will be consistent to show past information along with the current data, as past trends in water level changes are important future indicators. All data will be available in tabular format as well with elevations referenced to both IGLD 1985 and LWD. Other data needs and dissemination issues important to the navigation interests will be explored and incorporated if possible.

Additional equipment may also be necessary. The ability of the navigation interests to obtain real-time water level data can be important. As storms and other disturbances occur, water levels can change rapidly. Voice announcing capability at many of the gages would give the navigation interests the immediate current water level information they require during critical events. This would require the

purchase of additional equipment and the installation of additional phone lines in order to provide this service while not compromising the operation of the water level gage itself. Operations and maintenance would then be required for any installations to ensure their operability and replace outdated equipment

e. Aids to Navigation

This alternative proposes to evaluate potential improvements to the Great Lakes system through replacing buoys with permanent beacons. Great Lakes waterways are currently marked mostly by lighted buoys which must be removed in the fall prior to the onset of ice, and reset in the spring after the thaw, even though 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 structures replace a greater number of buoys. Such an aids to navigation system would be more robust by providing more reliable aids and year round service. Definitive selection of beacon placement and numbers would be determined during future feasibility studies through use of vessel bridge simulators.

3. COST DEVELOPMENT METHODOLOGY:

a. Use of Existing Studies & Data

Limited time and funds were available to develop the required cost estimates for the extensive scope of this study. As such, and as is appropriate for a reconnaissance level study effort, all estimates were developed utilizing existing information to the maximum extent possible. The majority of the data was obtained from various past studies that have analyzed in detail many of the individual alternatives under consideration. The time and cost limitations on this reconnaissance effort prohibited revisiting the majority of the analyses and investigations undertaken during the previous study efforts. The Corps of Engineers' Civil Works Construction Cost Index System was used to escalate past cost estimates to today's price levels. This approach was followed for all of the alternatives considered. However, in the case of the channel and harbor deepening alternatives, it was felt that additional evaluation of more recent operation and maintenance experience at most of the sites could be utilized to refine the previous assumptions and estimates.

b. Channel/Harbor Deepening

(1). Limitations

The broad scope of this reconnaissance study prohibited any detailed site by site assessment of disposal options and locations, review of potential channel/harbor dimension changes that might be required to facilitate deeper draft vessels, or analysis of potential Federal and non-Federal structure modifications which would be required in association with channel and harbor deepening. For the purpose of this study, it was assumed that the subsurface sediment at each harbor was the same as that identified in the previous studies. Existing project depths reflect vessel bottom clearance criteria for each type of bottom condition, including allowances for vessel squat, bottom material (soft versus hard) and exposure (wave effects in the open lakes). The figure at the end of this appendix demonstrates these allowances as they are currently applied to the connecting channels. Similar allowances are reflected at each harbor. As such, where existing project depths change as the channel transitions from open lake to protected harbor, similarly, the deepened project conditions will maintain the same transitions. Furthermore, it was assumed that there would be no change in channel widths or turning basins, based on minimal anticipated fleet changes. The following paragraphs summarize how the major items of work associated with a deepening project were addressed previously, and how they will be reflected in this study. In general, a cost range was established for each deepening scenario, with the low end of the range established using updated and/or revised dredging quantities coupled with assumed disposal requirements, and the high end of the range established using previous study dredging quantities and disposal assumptions.

(2). Dredged Material Quantities

Wherever available, the most current harbor soundings were, as a minimum, used to spot check the magnitude of the quantities developed and used in the previous studies. Previous quantities were calculated based on the assumption that the various harbors were at their authorized project depths. However, actual conditions were often found to be deeper than current project depth. In addition, wherever possible the location of the primary commercial users of the ports was used to limit the scope of required deepening. Where electronic files of the current sounding data were readily available, deepening quantities were generated using Microstation Inroads end-area calculations. It should be noted that previous studies also estimated deepening quantities for non-Federal slips and channels, as well as attempted to account for potential changes in channel dimensions required for deeper draft navigation. No sounding data was readily available for the areas outside the existing Federal project limits, and as such, no attempt was made to validate these quantities. In light of the above, it was decided that using the higher quantities from the 1982 GLCCH study would represent the upper end of potential dredging quantities, while the limited, Federal channel only quantities would provide the low end of the range.

(3). Dredging & Disposal Costs

For the high end of the cost range, initial estimates were developed using uniform/parametric prices for the various items of work associated with deepening, including dredging, hauling, offloading, disposal facility construction, etc. No attempt was made to differentiate between types of bottom material or site specific conditions at each harbor or channel location. Previous studies analyzed dredging and disposal costs using alternative distribution scenarios of pollution quantities, i.e. – assuming 20, 40, 60 and 80 percent of any given harbor quantity would be polluted. Based on the more restrictive environmental constraints in place today, and due to the time and cost limitations of this study, the high end estimates assumed that all dredged material would be disposed of in confined disposal facilities (CDF) to be constructed as part of any deepening project. This assumption was considered the worst case scenario for dredged material disposal. Attachment 1 provides a representative example of development of the high end cost range, as was completed for one incremental depth at Sandusky, Ohio.

After completion of the high end estimates, a general review of each estimate was made for each specific location. Based on a review of annual O&M dredging and disposal activities (including recent contract quantities and costs, method of disposal, etc.), alternative disposal options (primarily unconfined open water disposal) was assumed for certain harbors where existing operational activities currently entail this method of disposal. Where appropriate, revisions to disposal costs to reflect this information were made, often limiting the revisions to only a portion of the deepening material dependent upon location. For those deepening scenarios where only minimal dredged material quantities were estimated, upland disposal and/or beneficial reuse was assumed. For those locations where confined disposal was still required, the low end cost estimates reflect utilizing historical CDF construction costs (as shown in Table B-1) as an alternative to the above parametric estimating. The estimated CDF cost for each harbor was based on the historic cost for similar size facilities and similar location, adjusted for the estimated deepening quantity.

Construction durations were estimated (for the purpose of estimating interest during construction in the economic analyses) on a rough basis, and assumed that contractors would utilize sufficient resources to be able to remove approximately 1,000,000 CY of material per year. For the purpose of the reconnaissance study, it was also assumed that other construction activities could be performed concurrently. Although this approach may be low for sites where new confined disposal facilities would be required, it may be high for sites where existing facilities may be utilized or open water disposal utilized. It is noted that actual durations will be dependent upon character of material to be removed and associated production rates, disposal requirements and environmental restrictions.

TABLE B-1
CONSTRUCTION COSTS
EXISTING DETROIT DISTRICT CDFs

CDF:	*Year Built*	*Design Capacity (CY)*	*Original Construction Cost*	*Construction Cost in 2002 dollars**
Bolles Harbor, (U – Lake Erie)	1978	335,000	$972,230	$2,040,000
Dickinson Island, (L – Lake St. Clair)	1975	2,000,000	$5,072,000	$10,650,000
Clinton River, (U – Inland MI)	1989	370,000	$2,618,000	$5,500,000
Pointe Mouillee, (L – Lake Erie)	1979	18,000,000	$55,856,000	$117,300,000
Erie Pier (L – Lk Superior)	1979	1,000,000	$1,558,000	$3,270,000
Renard Island, (L –Lk Michigan)	1979	1,200,000	$5,565,000	$11,700,000
Crooked River (U – Inland MI)	1982	19,500	$176,000	$370,000
Kewuanee, WI (L – Lk Michigan)	1982	500,000	$2,016,000	$4,230,000
Keweenaw, MI (U – Lk Superior)	1987	308,000	$941,000	$1,975,000
Manitowoc, WI (L – Lk Michigan)	1975	800,000	$4,147,000	$8,700,000
Milwaukee, WI (L – Lk Michigan)	1975	1,600,000	$5,963,000	$12,500,000
Sterling State Park Monroe, MI (L – Lake Erie)	1983	4,300,000	$38,380,000	$80,600,000
Saginaw Bay, MI (L – Lake Huron)	1978	10,000,000	$14,845,000	$31,175,000

* - Costs inflated using Civil Works Construction Cost Index System
U = upland site, L = in water site

(4). Structure Modifications

Potential structural modifications and costs were identified in the 1982 GLCCH study, and included; bulkhead modifications in either overburden or rock, pier extensions in either overburden or rock and breakwater removal and/or relocations. These costs were estimated for both Federal harbor structures and non-Federal facilities. It was assumed that no structure modifications would be required for the first two feet of deepening at any harbor. A representative unit price was then developed for each type of structure modification. This unit price was then applied at each harbor where potential modifications were identified in the Survey of Possible Modifications and Relocations of Facilities Directly Affected by Improvement of Great Lakes Connecting Channels and Harbors, prepared by the Detroit District of the U. S. Army Corps of Engineers in September 1980. For the purpose of this study, the total costs from the 1982 GLCCH study were inflated to current price levels and included in both the high and low range cost estimates. If, for a particular harbor, it was assumed that a reduced area of deepening would be proposed, then the inflated 1982 costs were reduced appropriately in the low end estimates.

(5). Utility Relocations

The Survey of Possible Modifications and Relocations of Facilities Directly Affected by Improvement of Great Lakes Connecting Channels and Harbors, prepared by the Detroit District of the

U. S. Army Corps of Engineers in September 1980, was used as the basis for identifying potential utility relocations. Submerged utilities include power, communication and signal cables, as well as water, gas, petroleum and sewer pipelines. The diameters of the submerged utilities range from 6 inches to 72 inches, with an average size of 16 inches. The study then developed a single representative unit price for utility relocations. For the purpose of this study, the total costs from the 1982 GLCCH study were inflated to current price levels and included in both the high and low range cost estimates. Similar to the structure modification costs, if a reduced dredging area is proposed, the utility relocation costs were reduced proportionately in the low end estimates.

(6). Compensating Structures

The Great Lakes-St. Lawrence waterway system consists of 95,000 square miles of lake area with a navigation system for deep-draft vessels stretching 2,300 miles from the Gulf of St. Lawrence to Duluth, Minnesota. The development of this inland waterway necessitated the deepening of the channels between the lakes, the improvement of the harbors on the lakes, and the eventual opening of the lakes to ocean shipping. The upper and lower St. Marys River was deepened and the locks built at Sault Ste. Marie, Michigan, to bypass the rapids of the river; the shoal areas in the St. Clair and Detroit Rivers and Lake St. Clair were deepened; the Welland Canal and locks were built to overcome the 326-feet drop from Lake Erie to Lake Ontario; and, the locks and canals of the St. Lawrence Seaway project were built to open the Great Lakes and their ports to ocean shipping.

Past improvements at the outlets of Lakes Superior, Michigan-Huron and Erie have resulted in more efficient flow conditions in the connecting channels, requiring less slope than previously needed to flow the same amount of water, and have affected levels of Lakes Superior and Michigan-Huron and their connecting channels.

Lake Superior is the largest and deepest of the Great Lakes. It is a major component of the Great Lakes-St. Lawrence Seaway navigation system. The water from Lake Superior discharges into Lakes Michigan-Huron through the St. Marys River.

The St. Marys River extends from Lake Superior at Whitefish Bay approximately 70 miles downstream to Lake Huron and falls about 22 feet. From Lake Superior to the upstream lock approach, a distance of 14 miles, the river falls approximately 0.2 foot. From this point to below the rapids, a distance of 0.75 miles, the river falls approximately 20 feet. The remaining fall in the lower 48 miles of the river is about two feet. Because of the moderate slope in the lower river the water levels at the foot of the St. Marys Rapids can be affected by the water levels of Lake Huron.

The outflow from Lake Superior is completely controlled in the mile long reach between the cities of Sault Ste. Marie, Michigan, and Sault Ste. Marie, Ontario. This area originally was a series of rapids which held Lake Superior at an elevation about 21 feet higher than Soo Harbor. The flow of the river has been completely controlled at this point since 1921 by means of a gated control dam above the rapids. A series of five locks and three power plants are also located within this area. The International Lake Superior Board of Control, which was established pursuant to Orders of Approval issued by the International Joint Commission in May 1914, determines monthly flow releases from Lake Superior. The Board directly supervises the operation of the river control works and distribution of flow to the power plants, navigation facilities and in the rapids in accordance to the existing plan of regulation.

Extensive dredging has occurred in the navigation channels throughout the St. Marys River since 1797 when the first lock was built on the Canadian side of the rapids. The waterway was deepened to 25 feet in 1933 and 27 feet from 1958 to 1962. These channel improvements have altered the water levels and distribution of flows in all the channels.

Lakes Michigan and Huron stand at virtually the same level since they are connected by the broad and deep straits of Mackinac and they are usually treated as one lake in hydrologic and hydraulic considerations. Lakes Michigan and Huron have a single natural outlet, the St. Clair River which has its head at the extreme southern tip of Lake Huron. The St. Clair River discharges into Lake St. Clair. The outlet of Lake St. Clair is the Detroit River, which discharges into Lake Erie. From Lake Huron to Lake St. Clair, the fall is about five feet, and from Lake St. Clair to Lake Erie the fall is about three feet. The total fall from Lake Huron to Lake Erie occurs in a sufficiently uniform manner so that locks are not required to provide vessel passage

Prior to any channel improvements, the St. Clair River had natural depths of 20 feet or more at low water datum throughout most of its length excluding isolated shoals. The least depth available to navigation in the Detroit River in its natural state was about 13 feet which existed in a section of the lower river known as Limekiln Crossing. Navigational improvements started as early as 1855 on the St. Clair River and 1876 on the Detroit River. The two major improvements on the St. Clair and Detroit Rivers made since 1933 involved the 25-foot project, completed in 1937, and the 27-foot project completed in 1962.

The broad, deep, gently-sloped St. Clair-Detroit River system has no single point of hydraulic control. As a result, the volume of water flowing in the system depends to a considerable extent on concurrent levels of Lakes Huron and Erie. Further, the effects of a regime change, even in the downstream extremity of the system, is transmitted, although in diminished amount, to Lake Michigan-Huron.

Deepening of the St. Clair-Detroit River system, where necessary to provide navigation channels, disturbs the natural hydraulic regimen of the system to some extent. If the deepening is large or in a critical reach, it would significantly increase the discharge capacity of the system and thus materially lower the water surface elevations in the river system and in Lakes Michigan-Huron. The consequences to navigation of a lowering of the levels are that the available draft in the river system is something less than the depth of the increased dredging, and that somewhat decreased depths are available in Lake Michigan-Huron harbors and in the lower St. Marys River. Therefore to restore the water surface from the lower elevation which would occur as the result of an improvement, to the elevation which would have existed had the improvement not been undertaken, some sort of compensation measure is required.

With the deepening of the connecting channels for navigation, the rivers become more efficient and require less slope to flow the same amount of water. As a result, the water level of an upstream lake, adjusts to a lower level unless some restriction to the flow of the river is made to prevent lowering.

The proposed navigation channel deepening associated with this study will affect the existing regime of levels and flows in the Great Lakes and their connecting channels. The impact upon levels and flows is of considerable importance to navigation on the Great Lakes system, since many of the vessels engaged in Great Lakes commerce are designed to take full advantage of the total range of lake levels. An increase in the channels depths creates a new relationship between lake levels and river flows. A reduction in lake levels reduces available depth and imposes limitations on lake shipping as well as on overseas shipping that enter the lakes via the St. Lawrence Seaway. Changes may also be felt in the possibility of newly created areas of navigational hazards. Velocities in the connecting channels that were once suitable could now become difficult to navigate.

Deepening of the navigation channels could also result in altered flow distributions across the channels, especially related to the flow split around islands in the rivers and in areas along the shoreline. If the change in flow distribution is significant enough at a particular location, impacts could be felt by all interest groups. These types of impacts would need to be quantified by hydraulic modeling to determine their possible magnitude and extent. Any related compensation could also have similar impacts and should be analyzed in a similar fashion.

Any deepening and associated compensation placed would also need to be analyzed for possible impacts on ice flows and jams in the connecting channels. Channel deepening could create a more efficient channel to move ice out of the system during breakup times. The reduction of normal ice retardation of winter flows could increase the flow in the river, further lowering lake levels. It could also create, by way of altered flow distribution, some areas of lower flow in the river which might cause ice to accumulate and create jams.

Municipalities and commercial/industrial interests could be impacted by lower water levels caused by channel deepening as well. Water intakes that serve as drinking water supply and water for manufacturing processes could be jeopardized due to the fact they could now be located in areas of insufficient depth. Water treatment and sewer outfalls could become exposed and discharge onto land rather than in the water and cause contamination problems if they rely on sufficient water for dilution purposes.

Hydropower production could be negatively impacted if lower water levels reduced the amount of head available for the generation of power. Altered flow distributions could also direct discharge away from plant forebays, reducing power generation.

The International Joint Commission (IJC), established by the Boundary Waters Treaty of 1909 between the United States and Great Britain, has jurisdiction to oversee any issues related to the boundary waters between the U.S. and Canada. Accordingly, any proposal to deepen the channels would need to be forwarded to the U.S. State Department, which would in turn forward it to the IJC for their analyses and concurrence. The IJC's recent position on such boundary waters projects has been to require zero impact on levels and flows as a result of the project. Hydraulic modeling would likely be required to ensure that the deepening and any associated compensation would result in a zero impact on water levels upstream and downstream of the proposed project. Additionally, any changes in the flow distribution across the channel or around neighboring islands may need to be documented and compensated for.

The decrease in water levels due to past deepening of the navigational channels in the St. Marys River under both the 25- and 27-foot projects was not considered of sufficient magnitude to have any appreciable effect on navigation.

As determined by the IJC in the report "Further Regulation of the Great Lakes" (1976), the net effect of the past navigational improvements between 1933 thru 1962 in the St. Clair-Detroit Rivers was to lower the level of Lakes Michigan-Huron approximately 0.59 foot. Since the outflow of Lakes Michigan-Huron is not controlled, dredging temporarily increased the flows in the St. Clair and Detroit Rivers and permanently lowered the level of those lakes. The temporary increase of outflow into Lake Erie caused a temporary rise in the levels of that lake which in turn temporarily increased its outflow. The transitory effect on Lake Erie levels due to the dredging program became negligible by 1969.

During construction of the 25- and 27-foot projects in the St. Clair River, dredged material was dumped in the deeper sections of the river to partially offset the lowering effects of the project channel deepening. No other compensation was provided in connection with the 25-foot project. Additional compensation works were studied in connection with the 27-foot project, but never constructed. Submerged sills for the St. Clair River were investigated in a physical model study in 1972 and found to be effective. As a result of these studies, it was determined that a combination of several sills and locations would raise the level of Lake Michigan-Huron by a maximum of 0.75 feet. These sills would be constructed such that they would have no impacts on navigation.

Prior to 1907, little or no consideration was given to compensation for the Detroit River. However, the problem was considered in connection with construction of the Livingston Channel (1907-1912) and material excavated from this channel was deposited in the river to form dikes constricting the flow and thereby compensating for the increased flow through the deepened channel area (22 feet depth).

Additional compensation was determined to be required in the lower Detroit River prior to the construction of the 25-foot project in order to maintain water levels throughout the system. Additional dikes were constructed in the Livingston Channel area. After completion of the 25-foot project in the Detroit River, including the deepening of the Livingston Channel, it was found that the dike system placed in the river, including the extension of the system constructed as part of the 25-foot project, had raised water levels upstream somewhat more than necessary to offset the effects of the channel improvements.

It was recognized that channel deepening for the 27-foot project would require further compensation despite the overcompensation resulting from the dikes placed in 1936. Provision was made for further constriction of the flow in the upper reach of the Amherstburg Channel and for the construction of an additional dike alongside the lower reach of this channel.

For the purposes of this reconnaissance study, it has been assumed that construction of compensating structures of some type will be required for the various deepening scenarios proposed for the connecting channels. However, as noted above, accurate determination of the extent of hydraulic impacts and associated compensation requirements would require detailed modeling. As such, the costs associated with construction of compensating structures have been estimated as a percentage (2%) of the estimated deepening and disposal cost.

(7). Real Estate Costs

Real estate costs associated with the construction of disposal facilities for the 1982 GLCCH study were based on a telephone survey of realtors and property owners at one typical harbor (Lorain, Ohio) at that time. Land costs were estimated for different types of land (commercial, marshland, waterfront), and the total acreage required was based on the total quantity of dredged material. These land costs did not entail any formal appraisal or compilation of appraisals, and were assumed to be representative of the general Great Lakes region. For the purpose of this study, no attempt was made to estimate disposal related land costs, nor was it considered appropriate to inflate previous estimates. It is noted that real estate costs for upland and/or near shore confined disposal could be significant, particularly at the harbors located at highly developed locations. The methodology used for estimating dredged material disposal costs, to a limited extent, reflects potential real estate costs by utilizing actual past CDF costs as a basis for estimating the current disposal costs for the low end estimates. Real estate studies will be a significant effort under any feasibility studies beyond the reconnaissance effort.

4. RESULTS

a. CHANNEL AND INDIVIDUAL GREAT LAKES PORTS DEEPENING

Initial high end cost estimates reflect deepening quantities from previous studies (where available) and a base assumption that all material will require confined disposal. As noted in the cost estimating methodology discussion, this is considered the most conservative set of parameters under which deepening would occur. Adjustments made to the deepening and disposal costs estimates reflected in the low end estimates are detailed below under the specific channel/harbor description. The summary cost estimate tables for each channel/harbor are included at the end of the appendix.

(1). St. Clair River-Lake St. Clair-Detroit River (TABLES B-2/B-3)

These connecting channels connect Lake Huron and Lake Erie. The system is approximately 89 miles long and has a relatively uniform water surface profile with a fall of 8 feet from Lake Huron to Lake Erie. The St. Clair River has a length of about 39 miles. Lake St. Clair, extending between the mouth of of the St. Clair River and the head of the Detroit River (a distance of about 18 miles) occupies a shallow basin having an average depth of about 10 feet, with low, marshy shores. The shallow depth requires a dredged commercial navigation channel 27.5 feet deep and 800 feet wide throughout its length. The Detroit River extends about 32 miles to Lake Erie, with channel widths varying from 300 to 1200 feet, and depths ranging from 27.5 to 29.5 feet.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current channel conditions, as well as adjusting utility relocation estimates to account for existing conditions being deeper than current project depth.

(2) St. Marys River (TABLE B-4)

The St. Marys River is a connecting channel forming the outlet of Lake Superior and leaves the lake at Point Iroquois, flowing generally in a southeast direction through several channels to Lake Huron, a distance of from 63 to 75 miles according to the route traversed. The river drops approximately 22 feet with most of the drop (20 feet) occurring at the St. Marys Falls, where there are four parallel U.S. locks and one Canadian lock to provide navigation around the falls. Many submerged cables are situated at various points, mainly throughout the lower river downstream from the locks. Channel widths vary from 300 to 1500 feet, while depths vary from 27 to 30 feet.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current channel conditions, as well as adjusting utility relocation estimates to account for existing conditions being deeper than current project depth. The low end estimate was also adjusted to reflect disposal of some deepening material via beneficial upland disposal/beneficial reuse.

(3). Alpena Harbor, Michigan (TABLE B-5)

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. The bay channel has a depth of 25’ with a width of 200’ from deep water in Thunder Bay to a point 300’ lakeward of the Alpena Light. The entrance channel is 24 feet deep narrowing to 100’ in width to a point 700’ upstream from the light. The river channel has a depth of 23’ and a width of 100’ to the Second Avenue Bridge. At the upper limit, the Federal project is 18.5’ deep with a width of 75’ and a length of 1,600’.

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.

Alpena Harbor has not been included in previous studies, and as such, no previous deepening quantities or estimates had been developed. For the purpose of this study, quantities were estimated based on current soundings and assumed confined disposal would be required.

(4). Ashtabula Harbor, Ohio (TABLE B-6)

Ashtabula Harbor, Ohio is located on Lake Erie approximately 119 miles southwest of Buffalo, New York and 59 miles northeast of Cleveland, Ohio. The entrance channel has a project depth of 29’ with a width of 600’ and a length of 200’. The outer harbor has a project depth of 27’ with the width varying from 600’ to 4917’ and a length of 3590’. The Ashtabula River channel has a project depth of 27’ with the width varying from 160’ at 645’ south of the outer harbor to 118’ at 3015’ south of the outer harbor and a length of 3015’. The river channel has one non-federal dock facility on the western and eastern sides with the distance between these facilities ranging from 300’ at the north end to 280’ at the southern end.

Authorized depths are maintained at 29’(soft)/30’(hard) at the entrance channel to a point inside the breakwaters, 28’/29’ in the section parallel to the west breakwater and the area inside the east breakwater, 27’/28’ from the Ashtabula River mouth and channel to 2,000’ point, then 18’ decreasing to 16’ at the upper river limit, and 22’/23’ in the turning area in front of the inner breakwater.

The harbor contains 16 piers and wharves including 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.

Neither high nor low end quantity estimates include any deepening of the river channel portion of the project. Adjustments made for low end estimates included reducing previous quantity estimates to limit deepening to access only the primary commercial slip (slip No. 1). The assumption of all confined disposal was maintained based on environmental concerns with the bottom materials at the harbor. Previous studies indicated outer harbor area (primary location of required deepening) to be rock. As such, the parametric unit price used for dredging is likely on the low side. However, confined disposal could possibly be avoided for disposal of primarily rock materials. Class 10 vessels already access Ashtabula harbor so structural modification costs identified in the previous study were reduced to reflect only modifications to slip and revetment structures, with no breakwater modifications assumed.

(5). Buffalo Harbor, New York (TABLE B-7)

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 lake approach channel to the south entrance has an authorized project width of 1000', length of 2,000', and depth of 30'. The south entrance has an authorized project width varying between 1,200 and 400', a length of 1,950', and depth of 29'. The inner harbor, south section has an authorized project width varying between 1,100 and 1,600', a length of 3,900', and depth of 28'. The inner harbor, mooring area has an authorized project of 900', a length of 4,200', and depth of 23'. The inner harbor, middle section has an authorized project width varying between 500 and 1,600', a length of 11,150', and depth of 27'. The north entrance channel has an authorized project width of 800', a length of 3,000', and depth of 25'. The inner harbor, north section has an authorized project width varying between 1,370 and 1,200', a length of 4,800', and depth of 23'. The Buffalo River entrance channel has widths varying down to 40', project depths of 22' in soft material and 23' in hard material, and a length of 3,950'. The Black Rock Canal Entrance Channel has widths varying from less than 40' to 800' at the Buffalo River Entrance, project depths varying from 20 to 21', and a length of 4,700'.

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, 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.

Adjustments made for low end estimates included reducing previous quantity estimates to limit deepening to the south entrance only and to the harbor areas required to service the primary users. Required structure modifications and utility relocations identified in the previous study were also reduce to reflect the limited deepening area. The assumption that confined disposal would be required was maintained based on discussions with Buffalo District operations personnel.

(6). Burns Harbor, Indiana (TABLE B-8)

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 for a 30' approach channel, 28' outer harbor, 27' east harbor arm, and 27' west harbor arm. The actual depths are 26' for the outer harbor and east harbor arm and 25' for the west harbor arm. The Entrance Channel has a project depth of 29' with a width of 385' and a length of 1885'. The Outer Harbor Basin has a project depth of 28' with a width varying from 1582' at the eastern end to 1000' at the western end and a length of 3650'. The existing dimension of the outer harbor allows the current fleet to use it as a turning basin. The East Harbor Arm is divided approximately in half between federal and non-federal facilities. The federal facilities extend from the outer harbor basin 930' to the south, with the non-federal facility continuing south from this point 1320'. Both the federal and non-federal areas have a water depth of 27' with the width being 620' between the federal limits and 820' overall between dock facilities. The West Harbor Arm consists of a federal navigation channel and a non-federal facility on both the eastern and western sides. The federal facilities extend from the outer harbor basin 3900' to the south to the end of the harbor arm. The west harbor arm has a project depth of 27' and a federal channel width of 620'.

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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. Required structure modifications identified in the previous studies were reduced to reflect that Class 10 vessels can already access the primary commercial users. The assumption that confined disposal would be required was maintained based on discussions with Chicago District operations personnel.

(7). Calcite Harbor, Michigan (TABLE B-9)

Calcite Harbor is a private harbor 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’ with direct access to rail. The harbor is protected on the northwest and north by a point and breakwater and to the southeast by Quarry Point. The harbor offers no shelter from north 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. (MLO) in April of 2000, handling limestone.

Calcite Harbor is a private harbor not evaluated under previous studies, and only minimal existing data could be obtained for this reconnaissance study. As such, the cost estimate developed for Alpena Harbor was used as a proxy estimate for Calcite Harbor. Alpena is also located on Lake Huron, and handles similar commodities. Limited estimates of dredged material quantities were made based on assumed channel widths and approximate lengths as a rough, order of magnitude check.

(8). Calumet Harbor/Lake Calumet, Illinois/Indiana (TABLE B-10)

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 1/2 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. The entrance channel and outer harbor is 3000 feet wide with a 12,000-foot breakwater along the north side and extends from the Illinois-Indiana border approximately 20,000 feet into Lake Michigan at an existing depth in excess of 27 feet. The Calumet River Federal channel continues from the Indiana-Illinois border up river approximately 8 miles to Lake Calumet. The river has a width of approximately 400 feet and contains numerous bends and obstructions.

Calumet and Chicago Harbors 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 principal commerce in the port includes receipt of iron ore, coal, and limestone.

The area is authorized for a 29’ approach channel, 28’ outer harbor, 27’ river entrance, 27’(soft)/ 28’(hard) for the river turning basin three, and 27’ in all remaining areas. Vessels of 1000' 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’ and a depth of 27’.

The Calumet River and outer harbor contains 33 docks for handling various cargoes. Lake Calumet has 3 transit sleds, 2 grain elevators, and 3 private cargo docks.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. The assumption that confined disposal would be required was maintained based on discussions with Chicago District operations personnel.

(9). Cleveland Harbor/Cuyahoga River, Ohio (TABLE B-11)

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' on the lake approach channel, 28' from the west basin and entrance channel to Cuyahoga River, 25'-28' from the mouth of the Cuyahoga River for approximately ¼ mile, 27' from this point to the junction with Old River to its upper limit, 28' from the Cuyahoga River to its upper limit, and 18' in the turning basin. Actual depths are 28' in the East Basin and 21'-23' in the Old River. The Lake Approach Channel has a project depth of 29' with the width varying from 600' to 750' and a length of 1162'. The West Basin has a project depth of 28' with the width varying from 1150' to 1570' and a length of 4800'. The Entrance Channel from the lake approach channel to the pier range has a project depth of 28' with a width varying from 750' to 225' and a length of 1162'. The East Basin Western Section has a project depth of 28' with the width varying from 1300' to 1540' and a length of 1478'. The East Basin Eastern Section has a project depth of 27' with the width varying from 1540' to 1250' and a length of 3800'. The East Basin Airport Range has a project depth of 27' with a width of 500' and a length of 16,420'. The Pier Range which connects the outer harbor to the Old River and Cuyahoga River has a project depth of 27' with a width of 225' and a length of 1584'. The Old River has a project depth of 27' with a width of 120' and a length of 5800'.

The harbor contains 72 piers and wharves which can handle cement, fish, general and containerized cargo in foreign trade, grain, iron ore, limestone, sand, gravel, salt, marl, coke breeze, pig iron, sulfur, linseed oil, latex, chemicals, fluorspar, dolomite, steel products, ferrous scrap, petroleum products, asphalt, and petrochemicals. 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.

Neither high nor low end quantity estimates include any deepening of the river channel portion of the project, thereby limiting deepening to the outer harbor. Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. The assumption that confined disposal would be required was maintained based on discussions with Buffalo District operations personnel.

(10). Conneaut, Ohio (TABLE B-12)

Conneaut Harbor Ohio is located on Lake Erie approximately 73 miles northeast of Cleveland and 28 miles southwest of Erie, Pennsylvania. The Lake Approach Channel has a project depth of 30' with the width varying from 850' to 450' and a length of 500'. The Outer Harbor has a project depth of 27' with the width varying from 450' at the lake approach channel to 2850' at the southern end and a length of 3530'. The Entrance Channel has a project depth of 27' with the width varying from 257' at the northern end to 167' at the southern end and a length of 2250'.

The harbor is maintained at the authorized depths of 28'(soft)/29'(hard) in the easterly outer harbor, 22'/23' in the westerly outer harbor, 27'/28' in the inner harbor, and 8' 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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. In addition, based on discussions with Buffalo District operations personnel, low end estimates were revised to reflect potential use of open water disposal.

(11). Detroit River, Michigan (TABLE B-13)

The Detroit River Harbor Front, Michigan is located along the 31-mile stretch of the Detroit River, on the United States side of the Detroit River Federal channel, which connects Lake St. Clair with Lake Erie. The private 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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. In addition, quantities were reduced to reflect accessing only the primary commercial facilities. The low end estimate was also adjusted to reflect disposal of material at existing Point Mouilee confined disposal facility based on the low disposal quantities required.

(12). Drummond Island, Michigan (TABLE B-14)

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’. Port Drummond is a private harbor and 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 harbor not evaluated under previous studies, and only minimal existing data could be obtained for this reconnaissance study. As such, the cost estimate developed for Alpena Harbor was used as a proxy estimate for Port Drummond Harbor. Alpena is also located on Lake Huron, and handles similar commodities. This is considered a conservative estimate based on Port Drummond being located adjacent to the existing commercial navigation channel.

(13). Duluth-Superior Harbor, Minnesota-Wisconsin (TABLE B-15)

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 Superior Entry Channel has a project depth varying from 33’ at the lake entrance to 27’ at the Superior Harbor Basin entry, the width varies from 415’ to 1100’, and has a length of 3500’. The Allouez Bay Channel has a project depth of 27’ with a width of 400’ and a length of 2218’. The Superior Harbor Basin has a project depth of 27’ with a length of 8026’ and the width varying from 600 to 1500’. The Superior Harbor anchorage area is on the north side of the Superior Harbor basin with a length of 3,600’, a width of 950 – 1300’ and a project depth of 27’. The Superior Front Channel has a project depth of 27’ with a width of 600’ and a length of 14,098’. The East Gate Basin has a project depth of 27’ with a length of 5500’ and the width varying from 600 to 3700’.

The Duluth Ship Canal has a project depth varying from 32’ at the lake entrance to 28’ at the Duluth Harbor Basin entry, with a width of 250’, and a length of 1700’. The Duluth Harbor Basin has a project depth of 28’ with a length of 9400’ and a width varying of 2200’. The Duluth Anchorage Area has a project depth of 27 - 28’ with a length of 4000’ and a width of 1300’. The West Gate Basin has a project depth of 27’ with a length of 4000’ and a width varying from 400’ to 850’. There is a horizontal opening of 175’ on the Burlington Northern railroad bridges, one located in each the north and south channel eastern sections. There is a vertical clearance of 123’ under the John Blatnik Bridge. The 21st Ave. W. Channel, outer end, is located at the northeast end of the North Channel and northwest end of the West Gate Basin and has a project length of 2000’, width of 200’, and depth of 27’. Howard’s Bay is located at the east end of the South Channel and southern end of the West Gate Basin and has a project depth of 27’, a length of 6,000’ and a width that varies from 100’ to 300’. The North Channel Eastern Section has a project depth of 27’, a length of 10,085’, and a width of 400’. At the Burlington Northern Railroad Bridge there is a horizontal clearance is 175’. The North Channel Western Section has a project depth of 27’, a length of 3590’ and a width of 400’. The Cross Channel connects the center of the North and South Channels and has a project depth of 27', length of 2000' and width of 1300'. The Southern Channel Eastern Section has a project depth of 27', a length of 4013' and the width varying from 400' to 800'. There is a horizontal clearance at the Burlington Northern Railroad Bridge of 175'. The Southern Channel Western Section has a project depth of 27', a length of 4488' and a width of 400'. The Upper Channel extends north to south from the western end of the North and South Channels to the Minnesota Channel and has a project depth of 23', a length of 6,100' and a width of 500'. The Grassy Point Burlington Northern Railroad Bridge has two horizontal openings of 175'. There are two other bridges located in this channel: the new Arrowhead highway bridge with a horizontal clearance of 400'and a vertical clearance of 120', and the bascule Grassy Point Arrowhead highway bridge with a horizontal clearance of 211'. The Minnesota Channel, Outer End, extends from the Upper Channel on the east to the Minnesota Channel, Inner End on the west and has a project depth of 23', length of 5,750', and a width of 600'. The Minnesota Channel, Inner End extends from the Minnesota Channel, Outer End around the west side of Clough Island and has a project length of 14,500', width of 200', and depth of 20'.

The harbor contains 3 private terminals handling coal and limestone. 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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions, as well as reducing the qunatities to reflect accessing only the primary commercial facilities. Structure modification and utility relocation costs were also reduced to reflect the limited deepening area. The low end estimate was also adjusted to reflect disposal of some deepening material via beneficial re-use.

(14). Escanaba Harbor, Michigan (TABLE B-16)

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 4½ miles up Little Bay de Noc, which opens to the south into Green Bay on Lake Michigan. The harbor is 3½ miles wide at Escanaba with a natural channel adjacent to the west shore, 1½ mile wide with depths of 28 to 40' within 0.4 mile of shore.

This private 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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect accessing only the primary commercial facilities. Structure modification costs were also reduced to reflect the limited deepening area. The low end estimate was also adjusted to reflect upland.beneficial reuse for disposal based on the limited disposal quantities.

(15). Fairport Harbor, Ohio (TABLE B-17)

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 entrance channel behind the west and east breakwaters extends for approximately 2200' with a depth of 23' and a width of 800' narrowing to 200' at the mouth of the Grand River. The channel continues from the mouth of the Grand River at the west and east pier lights, 3900' inland at a depth of 21' and a width of 200' narrowing to 130'. This segment includes federal ramps, Ronyak & Sidley, Inc., Painesville Grand River Dock Co., and Morton Salt Co., Fairport Mine on the west and Union San & Supply Corp., The Northeastern Road Improvement Co., and U.S. Industrial Chemical Co. on the east. The channel continues for 2000' inland with a width of 130' widening to a width of 200' at a depth of 19'. Located along this segment are Republic Steel Corp., Grand River Lime Plant and

Osborne Concrete & Stone Co. which has a trapezoidal harbor maintained at a depth of 15’ with a length of 600’ on the inner edge and 900’ on the river edge.

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.

Fairport Harbor was not included in previous studies, and as such, no previous deepening quantities or estimates had been developed. For the purpose of this study, quantities were estimated based on current soundings and confined disposal was assumed for the high end estimate. Based on discussions with Buffalo District operations personnel, open water disposal was asumed for the low end estimates.

(16). Gary, Indiana (TABLE B-18)

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 Outer Harbor has a water depth and width that vary from 30’ and 300' at the non-federal facility channel to 33’ and 1100’ at the lake entrance and a length of 2400’. There is a turning basin located at the southern end of the non-federal dock-facility and has a water depth that varies from 18’ to 27’ and is approximately 750’ in diameter.

No cost estimate range was developed. Quantities were taken from previous studies, and confined disposal was assumed based on environmental conditions at the harbor.

(17). Green Bay, Wisconsin (TABLE B-19)

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. Lakeward from mile 02 to mile 09, from Grassy Island into open harbor, depths are maintained at 26’, and width narrows from 500’ to 300’. From Grassy Island at mile 01 to the mouth of the Fox River depth is maintained at 24’ with a width of 300’. From the mouth of the Fox River to the turning basin, just over a mile long, depth is maintained at 24’ with an irregular width averaging 300’ to the turning basin. This segment includes: American Can Co., Charmin Paper Co., Texaco Inc., Philips Petroleum Co., Sinclair Refining Co., Green Bay Yacht Club, and McDonald Lumber Co. on the east shore and, Universal Atlas Cement Co., Green Bay Soap Co., American Oil Co., Mobil Oil Co. Inc., Cities Service Oil Co., F. Hurlbut Co., Clark Oil & Refining, Gustafson Oil Co., Wisconsin Public Service Corp., and Northwestern Hanna on the west shore. The next 2 mile long segment is maintained at a depth of 24’ with an irregular width averaging 325’. This segment services: Fort Howard Paper Co., Leight Tr. & Storage Co., Huron Cement, Shell Oil Co. Inc., and C. Reis Coal Co. all on the west shore. The channel continues upstream another 3 miles with a project depth of 18’ and a width of 150’, and includes an upstream turning basin with a depth of 21’ and a width of 600’ servicing Nicolet Paper Corp., and Northwestern Hanna.

Authorized depths are maintained at 26’ and 24’ sections in the entrance channel, 24’ in the lower Fox River and turning basin, 20’ in the middle turning basin, and 18’ in the upper Fox River and turning basin. The dock length of 1100’ 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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions and deepening of only a one-way channel. The low end estimate was also adjusted to reflect creation of off-shore disposal islands, consistent with other studies currently underway recommending this form of disposal for O&M dredging.

(18). Indiana Harbor, Indiana (TABLE B-20)

Indiana Harbor, Indiana is an artificial harbor at 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 federal entrance channel extends from the North Breakwater, north approximately 8000' into Lake Michigan at depths of 28' and 29'. The approach channel width is 800 feet except at the north breakwater where it narrows to 550'. The outer harbor is an irregular area south of the north breakwater, approximately 1700' by 2000' with a 28' depth. The entrance channel from the outer harbor to the Railroad Bridge is 250' in width and approximately 3500' in length with a depth of 27'.

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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. Required structure modifications identified in the previous studies were reduced to reflect that Class 10 vessels can already access the primary commercial users. The assumption that confined disposal would be required was maintained based on discussions with Chicago District operations personnel.

(19). Lorain Harbor, Ohio (TABLE B-21)

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. The Entrance Channel has a depth of 28', a width that varies from 800' at the lake entrance to 525' at the outer harbor and a length of 2,375'. The Outer Harbor has a project depth of 27', a width that varies from 525' at the entrance channel to 2,361 at the widest point to 220' at the Black River entrance and a length of 4000'. The Black River Channel has a project depth of 27', a width that varies from 220' at the outer harbor to 690' at the Black River Turning Basin, and a length of approximately 15,840'. Due to sharp river bends, a narrow river channel, and vertical clearance obstructions, vessels greater than 730' are restricted from navigating the channel.

Lorain Harbor has existing federal project limits that are at a depth of 27', 1000' or greater vessels are limited to the outer harbor, and the Black River channel is limited to vessels 730' or less.

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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. The assumption that confined disposal would be required was maintained.

(20). Marinette/Menominee, Wisconsin/Michigan (TABLE B-22)

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. The outer entrance channel is 2500' in length with a project depth of 26', currently dredged to 23', with a 600' width. The inner entrance channel is 2100' in length from the breakwalls to the Michela Coal & Dock Co.on the Wisconsin side and Ann Arbor R.R. and Marathon Corp., Div of Amer. Can Co. on the Michigan side at the mouth of the

Menominee River. This segment is 300’ to 500’ wide with a project depth of 24’, currently dredged to 21’. The channel continues upstream for a total distance of 9000’, with project depths ranging from 24’ (maintained to 21’) to 12’.

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

Harbor was not included in previous studies. No cost estimate range was developed. Quantities were run from current harbor soundings, with confined disposal assumed.

(21). Milwaukee, Wisconsin (TABLE B-23)

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 ½ miles of shoreline with the main entrance in the center and breakwaters on the north and south. The Outer Entrance Channel has a length of 1,800’ with a width varying from 800’ in Lake Michigan, narrowing to 300’ between the north and south breakwaters then expanding to 600’ inside the breakwalls. Project depth in this area is 30’. The area behind the South Breakwater has a project length varying between 4,960 and 5,920’, a width of 2,240’, and a depth of 28’, while the area behind the North Breakwater has a project length of 4,400’, a width varying between 1,160 and 1,560’ and a depth of 21’. The Inner Entrance Channel has a project length of 2,000’, a width varying between 180 and 440’, and a depth of 28’. The area between the Milwaukee and Kinnickinnic Rivers has a project length of 5,000’, a width varying between 240 and 560’, and a depth of 27’. The Kinnickinnic River portion of the project area has a length of 2,200’, a width varying between 180 and 80’, and a depth of 27’. The area to the north of the entrance has a length of 4,100’ with 2 branches; north on Milwaukee River for 680’ and around Lakeshore Sand and Stone to the south for 920’ then west for 680’. The width of this segment varies from as much as 240’ to 70’ with a project depth of 21’.

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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. The assumption that confined disposal would be required was maintained.

(22). Monroe Harbor, Michigan (TABLE B-24)

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. The outer channel, which includes the area from the mouth of the River Raisin to the intersection with the Toledo Channel in Lake Erie, is approximately 9 miles in length, with a width of 300’ and a project depth of 21’. The River Raisin reach of the channel runs 3000’ upstream to the mouth of the River Raisin, is 200’ wide and has a current depth of 21’. The turning basin located at this location is trapezoidal in shape, 1200’ by an average of 1400’, has a depth of 18’, 3’ less than the outer channel depth. The innermost segment of the federal project area spans a length of 3,800’ with a width of 100’ and a depth of 9’.

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

Detroit District completed a reevaluation report in September 1989 which addressed authorized modifications to Monroe Harbor, including 2, 4, and 6-foot deepening scenarios. Channel was assumed to be a one-way channel. This study was the source of the high end deepening quantities, with low end quantities adjusted to reflect some more recent runs made with actual soundings of the existing harbor. Assumption that confined disposal would be required was maintained.

(23). Presque Isle/Marquette, Michigan (TABLE B-25)

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 federal harbor is 1000' wide at the dock area with a maximum width of 3000 feet and length of 2800 feet with water depths of 28 feet or greater.

The harbor has a breakwater 2,816' 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 1000' wide at the dock area, with a maximum width of 2300'. It is approximately 50 acres in area and has a project depth of 28'. The outer harbor adjoins the inner harbor at its southern extremity, widens to a maximum width of 3000', is approximately 38 acres in size, and has a project depth of 30'. Together, the inner and outer harbors provide a combined length of 2800' on a direct line from the major dock area to the 30' contour in Lake Superior. The harbor contains two terminals handling coal, iron ore, and limestone.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. Low end estimate also adjusted to assume upland/beneficial reuse for disposal based on limited disposal quantities.

(24). Rouge River, Michigan (TABLE B-26)

The Rouge River rises in Oakland and Washtenaw Counties and is 30 miles long flowing southeasterly through Wayne County and joining the Detroit River at the westerly limit of the city of Detroit, Michigan. The Old Channel is 1-½ miles in length from the Detroit River to the point where the Short Cut Canal reaches the Rouge River. Depths in this segment range from 25' at the mouth of the Rouge to 17' at various points along the reach. The width of the Old Channel varies throughout its length from 240' at the mouth of the river to 150' where it meets the Short Cut Canal and narrowing to 100' at points. The project depth of the first ¾ miles is 17'; the remainder is 21', but is not currently maintained. The Short Cut Canal is ½ mile long, extending from the Detroit River to the Rouge River with a project depth varying from 25' at the Detroit River to 21' at the Rouge. The width of this segment narrows from 400' at the Detroit River to less than 200' at the Rouge. Depths are currently about 21' throughout the segment. The Rouge River segment of the channel extends 2-¼ miles inland to Dix Avenue, having project depths that vary between 21 and 25' and an average width of 200'. A turning basin located at this point has an irregular shape, with a project depth of 21', a width of approximately 600', and length up to 1,088'. The final ¼ mile long segment extends from the turning basin and is not maintained. It has depths that vary between 6 and 18' and widths between 150 and 200'.

Harbor was not included in previous studies. No cost estimate range was developed. Quantities were run from current harbor soundings, with disposal at existing Pt. Mouillee disposal facility assumed.

(25). Saginaw, Michigan (TABLE B-27)

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 entrance channel has a project depth varying from 27' at 14 miles out from the mouth of Saginaw River to 26' and a width of 350'. For 2 miles inland from the mouth of Saginaw River the project depth is 25' with a width of 200'. The first of several turning basins begins and ends with a width of 200' reaching a maximum width of 675' in the center. The south side is 425' in length with a 20' project depth; the remainder has a project depth of 25'. The channel continues with a 2-mile segment of the Saginaw River having a width of 200’ and a project depth of 25’. The project depth decreases to 22’ for a 3½-mile segment, with a width of 200’. The second turning basin is located along this segment. This turning basin is 1300’ long on the north and 200’ long on the south side of the river, width varies from 200’ and the outset to a maximum of 650’ with a project depth of 22’. The next 2-mile segment extends to the county line between Bay County and Saginaw County with a project depth of 22’ and a width of 200’. Followed by another segment extending 4 miles into Saginaw County with a project depth of 22’ and a width of 200’. The project depth decreases to 20’ for the next 2 mile segment, with a width of 200’, ending with a pair of turning basins, both with project depths of 20’. The final 5 miles of the project has a project depth of 16.5’, with the project ending at confluence of the Tittabawasee and Shiawasse Rivers.

The river contains 24 large commercial docks for handling animal feed, bulk commodities, calcium chloride, cement, cement clinker, coal, fertilizer, general cargo, grain, heavy equipment, petroleum, potash, salt, sand, slag, and stone.

Harbor was not included in previous studies. No cost estimate range was developed. Quantities were run from current harbor soundings, with confined disposal for outer harbor material assumed and upland confined disposal assumed for inner harbor material.

(26). Sandusky Harbor, Ohio (TABLE B-28)

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. Moseley Channel is the entrance channel to Sandusky Bay running just north of Cedar Point, south of Bay Point. The project dimensions are 2.15 nautical miles in length, 400’ in width with a depth of 26’. At this point, the channel splits. The Upper Straight Channel runs 1.04 nautical miles from the Moseley Channel to the intersection of the Lower Straight Channel and the Upper Bay Channel with a width of 400’ and a project depth of 25’. The Lower Straight Channel connects the Upper Straight Channel to the Dock Channel along the shore of Sandusky, Ohio. Project length is .77 nautical miles with a width of 400’ and a depth of 21’. The Dock Channel runs along the coast of Sandusky, Ohio between the Lower Straight Channel and the Turning Basin with a project length of 1.1 nautical miles, a width of 300’ and a depth of 22’. The Upper Bay Channel extends from the Upper Straight Channel to the north side of the Lower Bay Channel for a distance of 1.64 nautical miles, a width of 1.64 nautical miles and a project depth of 25’. The Lower Bay Channel extends from the Upper Bay Channel to the Turning Basin connecting to the Dock Channel. Project dimensions are a length of .24 nautical miles, a width of 350’, and a depth of 24’. The Turning Basin connects with the Dock Channel on the east and the Lower Bay Channel on the north. Project length is .5 nautical miles with a width varying between 300 and 1,725’ and a depth of 24’.

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.

Adjustments made for low end estimates included reducing previous quantity estimates to delete any deepening of the southern loop, to limit deepening to a one way channel, and reduced to reflect current harbor conditions. In addition, based on discussions with Buffalo District operations personnel, it was assumed that one half of the deepening material could be disposed of via open water disposal, with the balance requiring confined disposal.

(27). Saugatuck, Michigan (TABLE B-29)

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. The lake entrance channel leading to the north and south breakwaters at the mouth of the Kalamazoo River is 800’ in length, with an initial width of 750’narrowing to 120’ at the breakwaters, and has a project depth of 16’. The north and south breakwaters extend 700’ into Lake Michigan and an additional 1,800’ into the Kalamazoo River. Project depth is 16’ with a width of 120'. The remainder of the project area extends to 2 miles upstream in the Kalamazoo River to Saugatuck, Michigan. Project depth is 14' with a width varying from 160 to 90'.

Saugatuck has a natural turning basin at the end of the federal project limit in Kalamazoo Lake. According to the U.S. Army Corps of Engineers, Detroit District project map dated September 30, 1986, the depth in this area is 17', although current depths are significantly less.

Harbor was not included in previous studies. Quantities were run from current harbor soundings, with confined disposal assumed for the high end estimate, and upland unconfined assumed for the low end estimate.

(28). Sheboygan, Wisconsin (TABLE B-30)

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 outer entrance channel has a length of 700' coming up to the breakwater protected area, and is 450' wide with a project depth of 25'. The North Breakwater extends 3,300', the South Breakwater 2,340' into Lake Michigan. The entrance channel has a trapezoidal shape with a length 4,840' on the south side and 1,000' on the north. Project depth starts at 25 decreasing to 21' through southern 500' of width and 20' through the northern 400' of width. The Sheboygan River segment of the harbor has a total length of 4,800' with an irregular width. The project depth ranges from 21' at the harbor entrance channel, declining to 15' at the upper limit.

According to an EPA Federal Register Notice dated June 10, 1986, Sheboygan Harbor basin and turning basin have been recognized as containing PCB's generally lower than 5 mg/kg but do exceed 50 mg/kg in spots within the U.S. Army Corps of Engineers official navigation dredging channel. As a result, the channel has not been dredged since 1973. A March 1980 report of the U.S. Army Corps of Engineers estimated that about 163,000 cubic yards of contaminated soil containing 3.5 tons of PCB's would have to be dredged from the mouth of the river and the harbor to protect human health and the environment. The harbor is listed as an NPL (National Priorities List) Superfund site by the U.S. EPA.

The harbor has 3 wharves for handling coal, petroleum products, and miscellaneous commodities and the city provides a public wharf.

Harbor was not included in previous studies. Quantities were run from current harbor soundings, with an increase for extending channel to deeper water. Based on severe environmental conditions at the harbor, a range of disposal costs was established to reflect variations in superfund level disposal requirements.

(29). Silver Bay, Minnesota (TABLE B-31)

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

The primary user is the Reserve Mining Company. This non-federal facility has a water depth that varies from 27' at the dock to 100' at the harbor entrance, the width varies from 500' at Beaver Island Entrance to 1080' in the harbor and a length 3970'.

Silver Bay is a non-Federal harbor with no current soundings available. As such, quantities were taken from previous studies and no cost estimate range developed.

(30). St. Clair River (Edison), Michigan (TABLE B-32)

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. This non-federal facility is 1000’ in length parallel to the Federal St. Clair River navigation channel approximately 330’ back of the west channel line at the north end and 250’ at the south. The slip between the St. Clair River channel and the dock face is 27’ deep.

The St. Clair River in the dock area is approximately 1700’ wide and has a natural channel depth of 27 to 32’. 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’ and a dredged channel width of 900 and 1000’ respectively.

This is a non-Federal harbor with no current soundings available. As such, quantities were taken from previous studies and no cost estimate range developed.

(31). Stoneport Harbor, Michigan (TABLE B-33)

Stoneport Harbor, Michigan is a non-federal 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 to 28’ with areas of 18, 12, and 6’ moving toward the shore with a length of 950’ along the pier and a width of 1,110’ 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.

Stoneport Harbor is a private harbor not evaluated under previous studies, and only minimal existing data could be obtained for this reconnaissance study. As such, the cost estimate developed for Alpena Harbor was used as a proxy estimate for Stoneport Harbor. Alpena is also located on Lake Huron, and handles similar commodities. Limited estimates of dredged material quantities were made based on assumed channel widths and approximate lengths as a rough, order of magnitude check.

(32). Taconite Harbor, Minnesota (TABLE B-34)

Taconite Harbor, MN is a non-federal harbor and is located on Lake Superior approximately 76 miles northeast of Duluth, MN and 25 miles northeast of Silver Bay, MN. The Erie Mining Company facility is the primary user. This non-federal facility has a water depth that varies from 27’ at the dock to 65’ in the harbor, with the width varying from 400’ at the eastern and western entrances to 1500’ in the harbor and a length of 2560’.

Taconite is a non-Federal harbor with no current soundings available. As such, quantities were taken from previous studies and no cost estimate range developed.

(33). Toledo Harbor, Ohio (TABLE B-35)

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

The Entrance Channel has a water depth of 28’ with the width varying from 500’ at the northern end to 967’ at the Maumee Mooring Basin, located at the mouth of the Maumee River, and a length of 97,118’. The Maumee River Channel has a water depth of 27’, a width varying from 200’ to 850’ and a length of 32,748’. The river channel does not meet the width or vessel clearances for the 1000’ or larger vessels south of the Toledo Terminal Railroad Bridge.

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.

Adjustments made for low end estimates included reducing previous quantity estimates to reflect current harbor conditions. In addition, based on discussions with Buffalo District operations personnel, it was assumed that one half of the deepening material could be disposed of via open water disposal, with the balance requiring confined disposal.

(34). Two Harbors, Minnesota (TABLE B-36)

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.

The existing federal limits in the harbor vary because of the configuration. The water depth within the federal limits varies from 28' in the northern section to 30' in the southern section. 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.

Adjustments made for low end estimates included reducing previous quantity estimates to limit to primary commercial users, and assuming upland/beneficial reuse for limited disposal quantities.

b. <u>PERMANENT AIDS TO NAVIGATION</u>

This alternative proposes to evaluate potential improvements to the Great Lakes system through replacing bouys with permanent beacons. Great Lakes waterways are currently marked mostly by lighted buoys which must be removed in the fall prior to the onset of ice, and reset in the spring after the thaw, even though 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 structures replace a greater number of buoys. Such an aids-to-navigation system would be more robust by providing more reliable aids and year round service. The ultimate selection of beacon placement and numbers would be further refined during feasibility studies.

A variety of factors affects the cost for a permanent navigation aid structure, including: depth of water, bottom type (hard, soft), number of structures combined on one contract, expected level of competition in bidding for the contract, need for soil borings for geotechnical testing, need for fabrication and inspection services during construction, and required resistance to heavy ice conditions. Table B-37 summarizes the estimated cost for structures through a range of depths and for hard or soft bottoms. It also lists the estimated cost for soil borings for varying depths. Finally, it calculates the estimated total cost per structure, using the higher costs according to bottom type. It also includes geotechnical testing at 50% of the sites and for inspection services.

Table B-37
PERMANENT NAVIGATION
BEACONS
ESTIMATED COST PER STRUCTURE

WATER DEPTH (FEET)	**SOFT SOIL** ($K)	**HARD BOTTOM** ($K)	**WORST-CASE COST** ($K)*	**GEOTECH. (BORINGS)** (per site)($K)	**EST. COST PER STRUCTURE** ($K)**
0-5	115	95	115	25	143
6-10	225	325	325	33	336
11-15	275	350	350	38	361
16-20	290	365	365	43	377
21-30	325	425	425	50	435

* The higher of the soft- and hard-bottom costs; based on structures contracted individually.

** An estimated savings of 10-15% can be achieved when construction is accomplished by building structures in quantities of 6 or more. A savings will also be found in Geotechnical work as fewer soil borings would normally be required. For purposes of this estimate, borings are assumed to be done at 50% of the sites. For this estimate, it is assumed that six structures will be contracted together. Construction inspection is estimated at $162k for six structures, or $27k per structure.

Estimated cost / structure is calculated by: (Worst-case Cost X 0.90) + (Geo Borings / 2) + 27

The above costs are based on past U.S. Coast Guard construction contracts as noted in Table B-38 below:

Table B-38
PERMANENT NAVIGATION BEACONS
CONSTRUCTION COST
OF EXISTING BEACONS

PROJECT	**WATER DEPTH (Feet)**	**BOTTOM CONDITION**	**TOWER COST ($K)**
Sandusky Ranges	8	Hard	367.5
Alpena BKW Lt.	4	Hard	91
Saginaw Ent RF	3	Med.Hard	190
Maumee Lt. 9	33	Soft to Med. Hard	698

The charted depths at the 28 proposed beacon sites were compiled. Table B-39 summarizes the number of structures, broken down by depth, for the three waterways in the study:

Table B39

PERMANENT NAVIGATION BEACONS
NUMBER OF STRUCTURES PER DEPTH/LOCATION

Depth	Lake St. Clair	Detroit River	Maumee Bay	Total No. of Struct.	Est. Cost Ea. ($K)	Total Est. Cost ($K)
Ashore	0	2	0	2	80	160
0-5'	0	1	2	3	143	429
6-10'	0	1	3	4	336	1344
11-15'	3	0	1	4	361	1444
16-20'	5	0	1	6	377	2262
21-30'	2	1	6	9	435	3915
Totals:	10	5	13	**28**		**9554**

Average cost per Structure: $9554K / 28 = **$341.2K per structure**.

c. IMPROVED WATER LEVEL DATA ACCESS

Commercial navigation could benefit from having real-time access to all water level gaging stations on the Great Lakes and their connecting channels. It may be that only certain critical water level stations would be needed. Also, there are various levels of service that could be implemented. Each would cost different amounts and provide different data. Commercial navigation interests would be be consulted during the feasibility phase to determine the best options.

Currently the National Oceanic and Atmospheric Administration (NOAA) has installed one of their Lite Physical Oceanographic Real-Time Systems (PORTS) at Sault Ste. Marie Michigan at the S.W. Pier and U.S. Slip stations. This system provides real-time 6-minute water level readouts to the lock operators, who in turn relay them to ships in the area. The data are also posted to a web site which is accessible by anyone with internet access. The web site shows plots of the last three hours of data so that recent trends in water level fluctuations at the site can be viewed. But it has the disadvantage of only being accessible through the internet. Upgrades proposed for a full PORTS at the Soo would cost approximately $50,000 for a full range of equipment, backup systems and meteorologic sensors. Annual operations and maintenance costs would be about $7,000 per year.

Alternatively, the Detroit District, USACE has installed a voice modem at the Rock Cut gage site on the lower St. Marys River. This gage can be interrogated by anyone with a telephone and gives the user the water level instantaneously. This has the advantage of being available to anyone with a telephone.

The disadvantage is that only one water level reading is obtained, with no data for the past few hours or days to compare it to for accuracy. A recent installation of this type cost approximately $5,000 for equipment. Installation costs would be about $5,000 as well with some economies of scale being achieved if multiple sites in the same area were upgraded at the same time. Yearly operations costs would consist of maintaining telephone service, costing approximately $300 per year. Additionally, provisions would need to be made for replacement equipment if parts went bad or a new system when the current one passed its useful life.

Currently the Great Lakes and St. Lawrence River system has 45 gages in place operated by NOAA, 33 by the Marine Environmental Data Service (MEDS) in Canada, and 16 by the Corps of Engineers.

In addition to real time access, the creation of a new central web site to serve all water level data in the Great Lakes in a consistent fashion is also proposed. Available data would be pulled in from NOAA, MEDS, USACE, hydropower entities, and any other data source known.   Coordination with navigation interests would be important to ensure the users needs are being met with this web site.

The data would all be available in the following formats:

- English and Metric units
- Referenced to feet/meters IGLD 1985
- Referenced to inches/cm above/below low water datum
- Tabular and graphic formats
- Detailed data for the most recent several hours
- Data for the most recent few days
- Data for the most recent month
- Historical data as available

It is anticipated that it would take approximately six months to develop this web site and create the tables and graphs. This would also need to include automated updating of the data and some error checking. It is estimated that this initial development would cost approximately $60,000. Annual efforts to keep this site up to date would likely take about 2 hours per day, or approximately $40,000 per year. Equipment and software costs would be likely as new servers and storage space would be required by the agency serving this new web site. Maintenance of this equipment and software would be required as well as planning for eventual replacement.

d. <u>ICE CONTROL MEASURES</u>

The St. Clair delta area has been highly susceptible to ice jamming in the past. The occurrence of the ice jams is caused by the development of ice cover in Lake St. Clair and the delta channels, followed by the transport of large volumes of ice from Lake Huron through the St. Clair River. When the ice floes reach the vicinity of Russell Island, jamming develops and the jam advances upstream. The buildup of ice jams results in increased water levels upstream and lowered water levels downstream of the jam. Past flooding in the vicinity of Algonac and Harsens Island has been partially related to ice jams.

The stability of ice cover in the lakes is very sensitive to wind direction and velocity. Vessel tracks in the lakes can be closed by wind forces within a very short time of the passage of a vessel. When a vessel track is maintained by frequent vessel passage, the broken ice in the track breaks down and becomes saturated by repeated immersion to form mush ice. Mush ice can develop to depths of 2 to 10 feet. Operation in mush ice results in increased frictional resistance along the hull of Great Lakes vessels, as well as restricted flow of water to the propeller. The operating capability of all types of vessels is severely restricted in ice fields when ice pressure is developed by wind forces. Most vessels operating in the Great Lakes do not have any hull strengthening for operation in ice.

Examination of the design ice conditions and the movement of ice through the rivers has indicated that one solution would be to control the movement of ice from Lakes Huron and St. Clair. As previously discussed, the major cause of ice jams in the lower St. Clair River and delta area is the movement of large volumes of ice from Lake Huron into the St. Clair River in conjunction with stable ice cover in Lake St. Clair and the delta area. The installation of an ice control boom extending from Fort Gratiot to Point Edward with an opening for vessel passage would cut off most of the supply of ice which causes problems in the lower St. Clair River. Some ice would pass through the navigation opening as a result of vessel passage. However, the ice would tend to arch across the boom opening between vessel passages.

The effective use of ice booms for the control of ice movement has been demonstrated for a number of years on the St. Lawrence River and at the outlet of Lake Erie. Operational costs are involved for the installation each fall and the removal each spring. Some repair work is typically required during the summer. The main operational difficulty with the Lake Erie ice boom has been the occasional failure of connections at the ends of boom sections. These failures have been caused by wear due to wave action prior to the formation of ice cover. Heavier design of the connections and a method of forecasting the initial time of formation of ice cover could minimize this problem. The size of the booms required for Lake Huron and Lake St. Clair are approximately 4,500 and 6,000 feet respectively

Tables B-40 and B-41 present the estimated costs for construction of Lake Huron and Lake St. Clair ice booms.

TABLE B-40
Lake Huron Ice Boom

Description	Quantity	Unit Cost	Construction Cost
Boom sections & Connecting chains, etc.	4,450 ft	$230/ft	$1,023,500
Anchors	16	$57,360/ea	$917,780
Lightpier	1	Lump Sum	$1,644,350
Ice Buoys	2	$47,800/ea	$95,600
Subtotal			$3,681,230
25% Contingency			$920,300
Subtotal			$4,601,530
Engineering and Design (10%)			$460,150
Supervision & Administration (7%)			$322,100
TOTAL			$5,383,780

Note: Useful life assumed as follows: 10 years for booms, 50 years for anchors and lightpier, and 25 years for ice buoys.

TABLE B-41
Lake St. Clair Ice Boom

Description	Quantity	Unit Cost	Construction Cost
Boom sections & Connecting chains, etc.	6,000 ft	$230/ft	$1,380,000
Anchors	23	$57,360/ea	$1,319,280
Ice Buoys	2	$47,800/ea	$95,600
Subtotal			$2,794,880
25% Contingency			$698,720
Subtotal			$3,493,600
Engineering and Design (10%)			$349,360
Supervision & Administration (7%)			$244,550
TOTAL			$4,087,510

Note: Useful life assumed as follows: 10 years for booms, 50 years for anchors, and 25 years for ice buoys.

REFERENCES

Great Lakes Connecting Channels (GLCC) Project – Determination of Quantities & Costs for Dredging and Disposal in Harbors and Turning Basins of the Great Lakes for Various Ship Sizes – February 1982. Estimated deepening costs (dredging & harbor structure modifications) for various Great Lakes harbors and the connecting channels associated with looking at the feasibility of increased vessel sizes and drafts.

Survey of Possible Modifications and Relocations of Facilities Directly Affected by Improvement of Great Lakes Connecting Channels and Harbors – September 1980

St. Larwence Seaway Additional Locks Study – Preliminary Feasibility Study – July 1982. Estimated deepening and lock construction costs for St. Lawrence Seaway elements.

Great Lakes Connecting Channels & Harbors – Final Feasibility Report & EIS – March 1988. Estimated connecting channels estimates and lock construction (Soo Replacement Lock) estimates.

Modifications to Monroe Harbor, Michigan – Final Reevaluation Report – September 1989. Estimated deepening and disposal costs for Monroe Harbor, MI

Replacement Lock, Sault Ste. Marie, MI – Final Limited Reevaluation Report – October 2000. Estimated lock construction (Soo Replacement Lock) estimates.

Financial Analysis of the Buoys to Beacons Initiative – December 1999
Analysis of the financial impacts of the U.S. Coast Guard's Buoys to Beacons initiative which was proposed to improve the USCG's aids to navigation and ice breaking mission performance.

Buoys to Beacons Proposal – Ocean Engineering Cost Summary – May 2001
Cost Analysis completed by LCDR D.C. Ressel, Chief of the Ocean Design Section of CEU Cleveland. Provided an analysis & confirmation of costs used in December 1999 Financial Analysis of the Buoys to Beacons Initiative.

System Study to Extend Navigation Season on St. Clair-Detroit River System – August 1974
Report generated as part of the Great Lakes and St. Lawrence Seaway Navigation Season Extension Demonstration Program, which included development of concept designs for Lake St. Clair and Lake Huron ice booms and associated costs.

EM 1110-2-1304, Civil Works Construction Cost Index System – 30 September 2001

TABLE B-2
Great Lakes Navigation System Review

Connecting Channels *Detroit River-Lake Erie*	*Alt. 1* *0.5 ft below* *project depth*	*Alt. 2* *1.5 ft below* *project depth*	*Alt. 3* *2.5 ft below* *project depth*	*Alt. 4* *3.5 ft below* *project depth*	*Alt. 5* *4.5 ft below* *project. depth*	*Alt. 6* *9.5 ft below* *project. depth*
Deepening Quantity Range (cy) (Review of current soundings: Detroit R. channel very deep, Lk. Erie channels near current project depth – low estimates reflect this, high based on current conditions raised to levels on the order of the '82 GLCCH study)	High – 11,200,000 Low – 1,965,000	High – 14,200,000 Low – 5,895,000	High – 17,800,000 Low – 9,825,000	High – 21,800,000 Low – 13,755,000	High – 26,200,000 Low – 17,685,000	High – 37,335,000
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $215,800 Low - $80,400	High - $253,200 Low - $137,000	High - $302,500 Low – $189,400	High - $346,400 Low - $258,100	High - $403,100 Low - $321,000	High – $672,030
Utility Relocation Cost ($000) (escalated '82 study costs, reduced to reflect Detroit R. channel already deeper than current project depths)	$1,500	$1,500	$1,500	$2,900	$4,400	$4,400
Compensating Structures (assuming 2% of deepening/disposal cost)	High - $4,300 Low - $1,600	High - $5,100 Low - $2,700	High - $6,000 Low - $3,800	High - $6,900 Low - $5,200	High - $8,100 Low - $6,400	High - $13,400
Total Cost ($000)	High - $221,600 Low - $83,500	High - $259,800 Low - $141,200	High - $310,000 Low - $194,700	High - $356,200 Low - $266,200	High - $415,600 Low - $331,800	High - $689,830
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 7 seasons Low – 2 seasons	High – 7 seasons Low – 4 seasons	High – 7 seasons Low – 6 seasons	High – 7 seasons Low – 7 seasons	High – 7 seasons Low – 7 seasons	7 seasons

TABLE B-3
Great Lakes Navigation System Review

Connecting Channels *St. Clair River-Lake St. Clair*	*Alt. 1* *0.5 ft below project depth*	*Alt. 2* *1.5 ft below project depth*	*Alt. 3* *2.5 ft below project depth*	*Alt. 4* *3.5 ft below project depth*	*Alt. 5* *4.5 ft below project. depth*	*Alt. 6* *9.5 ft below project. depth*
Deepening Quantity Range (cy) (Review of current soundings: St. Clair River channel very deep, Lk. St. Clair channels near current project depth)	Low – 4,100,000	Low – 7,000,000	Low – 10,000,000	Low – 13,500,000	Low – 17,900,000	Low – 37,900,000
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	Low - $100,500	Low - $136,700	Low – $175,200	Low - $239,500	Low - $302,100	Low – $644,300
Utility Relocation Cost ($000) (escalated '82 study costs, reduced to reflect St. Clair R. channel already deeper than current project depths)	$1,500	$1,500	$1,500	$2,900	$4,400	$4,400
Compensating Structures (assuming 2% of deepening/disposal cost)	Low - $2,000	Low - $2,700	Low - $3,500	Low - $4,800	Low - $6,000	High - $12,900
Total Cost ($000) (high estimate inflated from '82 GLCCH study) *all costs include 25% contingency, 10% E&D, 7% S&A)	High - $219,760 Low - $104,000	High - $369,790 Low - $140,900	High - $528,485 Low - $180,200	High - $728,580 Low - $247,200	High - $933,800 Low - $312,500	Low - $699,500
Construction Duration	High – 7 seasons Low – 3 seasons	High – 7 seasons Low – 5 seasons	High – 7 seasons Low – 6 seasons	High – 7 seasons Low – 7 seasons	High – 7 seasons Low – 7 seasons	7 seasons

TABLE B-4
Great Lakes Navigation System Review

Connecting Channels *St. Marys River*	*Alt. 1* *0.5 ft below* *project depth*	*Alt. 2* *1.5 ft below* *project depth*	*Alt. 3* *2.5 ft below* *project depth*	*Alt. 4* *3.5 ft below* *project depth*	*Alt. 5* *4.5 ft below* *project. depth*
Deepening Quantity Range (cy) (Review of current soundings: St. Marys River channel very deep)	Low – 528,000	Low – 1,633,000	Low – 3,900,000	Low – 7,447,000	Low – 11,500,000
Deepen & Dispose Cost Range ($000) (assumes ½ upland unconfined and ½ beneficial reuse/island habitat creation)	Low - $14,600	Low - $40,000	Low – $108,400	Low - $142,000	Low - $218,500
Utility Relocation Cost ($000) (escalated ‘82 study costs, reduced to reflect St. Marys R. channel already deeper than current project depths)	$730	$730	$850	$1,000	$1,000
Compensating Structures (assuming 2% of deepening/disposal cost)	Low - $290	Low - $800	Low - $2,200	Low - $2,800	Low - $4,400
Total Cost ($000) (high estimate inflated from ’82 GLCCH study) *all costs include 25% contingency, 10% E&D, 7% S&A)	High - $79,116 Low - $15,620	High - $97,318 Low - $42,530	High - $133,652 Low - $111,450	High - $192,584 Low - $145,800	High - $257,884 Low - $223,900
Construction Duration	High – 2 seasons Low – 1 season	High – 4 seasons Low – 2 seasons	High – 6 seasons Low – 4 seasons	High – 7 seasons Low – 7 seasons	High – 7 seasons Low – 7 seasons

TABLE B-5
Great Lakes Navigation System Review

Alpena Harbor, MI	*Alt. 1* *2.0 ft below* *project depth*	*Alt. 2* *4.0 ft below* *project depth*	*Alt. 3* *6.0 ft below* *project depth*	*Alt. 4*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (Harbor not included in ’82 GLCCH study – quantities estimated from current soundings)	High – 89,000	High – 178,000	High – 300,000			
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $3,700	High - $4,700	High - $5,900			
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $3,700	High - $4,700	High - $5,900			
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season	1 season	1 season			

TABLE B-6
Great Lakes Navigation System Review

Ashtabula Harbor, OH	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project. depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to a limited deepening area based on current operational conditions at the harbor and reflects current harbor depths)	High – 1,500,000 Low – 28,150	High – 1,800,000 Low – 127,650	High – 2,200,000 Low – 227,150	High – 2,500,000 Low – 326,650	High – 2,900,000 Low – 426,150	
Deepen & Dispose Cost Range ($000) (High - assumes confined disposal) (Low – assume open water disposal)	High - $40,175 Low - $311	High - $44,895 Low - $893	High - $51,510 Low – $1,475	High - $55,960 Low - $2,060	High - $62,545 Low - $2,640	
Utility Relocation Cost ($000) (no utility relocations required)						
Structure Modification Cost ($000) (High - inflated from '82 study) (Low – none req'd for limited deepening area)			High - $30,300 Low - $0	High - $30,300 Low - $0	High - $30,000 Low - $0	
Total Cost ($000)	High - $40,175 Low - $311	High - $44,895 Low - $893	High - $81,810 Low - $1,475	High - $86,260 Low - $2,060	High - $92,545 Low - $2,640	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 2 seasons Low – 1 seasons	High – 2 seasons Low – 1 seasons	High – 2 seasons Low – 1 seasons	High – 3 seasons Low – 1 seasons	High – 3 seasons Low – 1 seasons	

TABLE B-7
Great Lakes Navigation System Review

Buffalo Harbor, NY	*Alt. 1* *0.5 ft below* *project depth*	*Alt. 2* *1.5 ft below* *project depth*	*Alt. 3* *2.5 ft below* *project depth*	*Alt. 4* *3.5 ft below* *project. depth*	*Alt. 5* *4.5 ft below* *project. depth*	*Alt. 6* *9.5 feet below* *project depth*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to a limited deepening area based on current operational conditions at the harbor)	High – 2,900,000 Low – 250,000	High – 4,100,000 Low – 350,000	High – 5,300,000 Low – 612,200	High – 7,000,000 Low – 825,000	High – 8,700,000 Low – 1,095,000	High – 18,700,000
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $74,355 Low - $6,700	High - $93,653 Low - $7,400	High - $112,766 Low – $9,700	High - $138,540 Low - $11,400	High - $165,147 Low - $13,600	High – $270,000
Utility Relocation Cost ($000) (High – inflated from '82 study) (low – none under limited deepening area)	High - $2,913	High - $2,913	High - $2,913	High - $2,913	High - $2,913	High - $2,913
Structure Modification Cost ($000) (High – inflated from '82 study) (low – reduced under limited deepening area)			High - $462,380 Low - $60,840	High - $462,380 Low - $60,840	High - $462,380 Low - $60,840	High - $462,380
Total Cost ($000) *all costs include 25% contingency, 10% E&D, 7% S&A)	High - $77,268 Low - $6,700	High - $96,566 Low - $7,400	High - $578,059 Low - $70,540	High - $187,683 Low - $72,240	High - $630,440 Low - $74,080	High - $735,293
Construction Duration	High – 7 seasons Low – 1 season	High – 7 seasons Low – 1 season	High – 7 seasons Low – 2 seasons	High – 7 seasons Low – 3 seasons	High – 7 seasons Low – 3 seasons	High – 7 seasons

TABLE B-8
Great Lakes Navigation System Review

Burns Harbor, IN	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project. depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to reflect current harbor depths)	High – 364,100 Low – 23,200	High – 731,200 Low – 133,500	High – 1,129,500 Low – 341,500	High – 1,529,400 Low – 660,400	High – 1,931,700 Low – 1,012,000	
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $5,860 Low - $415	High - $9,550 Low - $1,670	High - $17,260 Low – $3,200	High - $23,230 Low - $10,300	High - $28,125 Low - $14,060	
Utility Relocation Cost ($000) (none required per '82 study)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (inflated from '82 study – no range estimated)	$0	$0	$30,000	$30,000	$30,000	
Total Cost ($000)	High - $5,860 Low - $415	High - $9,550 Low - $1,670	High - $47,260 Low - $33,200	High - $53,230 Low - $40,300	High - $58,125 Low - $44,060	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 2 seasons Low – 1 season	High – 2 seasons Low – 1 season	

TABLE B-9
Great Lakes Navigation System Review

Calcite Harbor, MI	*Alt. 1* *2.0 ft below project depth*	*Alt. 2* *4.0 ft below project depth*	*Alt. 3* *6.0 ft below project depth*	*Alt. 4*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (Harbor not included in '82 GLCCH study – see note below)	High – 89,000	High – 178,000	High – 300,000			
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $3,700	High - $4,700	High - $5,900			
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $3,700	High - $4,700	High - $5,900			
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season	1 season	1 season			

* NOTE: Calcite Harbor is a private harbor not evaluated under previous studies, and only minimal existing data could be obtained for this reconnaissance study. As such, the cost estimate developed for Alpena Harbor was used as a proxy estimate for Calcite Harbor. Alpena is also located on Lake Huron, and handles similar commodities. Limited estimates of dredged material quantities were made based on assumed channel widths and approximate lengths as a rough, order of magnitude check.

TABLE B-10
Great Lakes Navigation System Review

Calumet Harbor, IL	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.6 ft below project. depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6 9.5 ft below project. depth*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – reduced based on a review of current soundings)	High – 6,000,000 Low – 375,000	High – 7,400,000 Low – 1,275,000	High – 9,900,000 Low – 2,490,000	High – 12,300,000 Low – 4,040,000	High – 14,700,000 Low – 6,375,000	Low – 7,281,000
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $117,000 Low - $7,500	High - $136,500 Low - $32,400	High - $170,500 Low – $42,000	High - $199,500 Low - $67,500	High - $230,000 Low - $91,000	Low - $100,000
Utility Relocation Cost ($000) (inflated from '82 study)			$1,100	$1,100	$1,100	$1,100
Structure Modification Cost ($000) (inflated from '82 study)			$351,000	$351,000	$351,000	$351,000
Total Cost ($000)	High - $117,000 Low - $7,500	High - $136,500 Low - $32,400	High - $522,600 Low - $394,100	High - $551,600 Low - $419,600	High - $582,100 Low - $443,100	Low – $452,100
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 5 seasons Low – 1 season	High – 6 seasons Low – 2 seasons	High – 7 seasons Low – 3 seasons	High – 7 seasons Low – 4 seasons	High – 7 seasons Low – 6 seasons	7 seasons

TABLE B-11
Great Lakes Navigation System Review

Cleveland Harbor, OH	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.7 ft below project. depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6 9.5 ft below project. depth*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – reduced based on a review of current soundings)	High – 3,600,000 Low – 1,800,000	High – 4,600,000 Low – 2,300,000	High – 5,600,000 Low – 3,900,000	High – 6,500,000 Low – 4,600,000	High – 7,500,000 Low – 6,000,000	High – 12,700,000
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $68,740 Low - $31,000	High - $83,300 Low - $35,200	High - $97,700 Low – $60,000	High - $106,500 Low - $65,500	High - $122,900 Low - $80,800	High – 193,000
Utility Relocation Cost ($000) (inflated from '82 study, no range estimated)	$840	$840	$840	$840	$840	$840
Structure Modification Cost ($000) (inflated from '82 study, no range estimated)			$94,800	$102,000	$107,600	$128,000
Total Cost ($000)	High - $69,580 Low - $7,500	High - $84,140 Low - $36,040	High - $193,340 Low - $155,640	High - $209,340 Low - $168,340	High - $231,340 Low - $189,240	High - $321,840
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 5 seasons Low – 1 season	High – 6 seasons Low – 2 seasons	High – 7 seasons Low – 3 seasons	High – 7 seasons Low – 4 seasons	High – 7 seasons Low – 6 seasons	7 seasons

TABLE B-12
Great Lakes Navigation System Review

Conneaut Harbor, OH	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project. depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to reflect current harbor depths)	High – 700,000 Low – 350,000	High – 1,000,000 Low – 500,000	High – 1,300,000 Low – 975,000	High – 1,700,000 Low – 1,275,000	High – 2,000,000 Low – 1,600,000	
Deepen & Dispose Cost Range ($000) (high – assumes confined disposal) (low - assumes open water disposal)	High - $7,930 Low - $2,800	High - $11,242 Low - $4,100	High - $13,675 Low – $7,800	High - $17,060 Low - $10,200	High - $19,476 Low - $14,860	
Utility Relocation Cost ($000) (inflated from '82 study - no range estimated)	$2,000	$2,000	$2,000	$2,000	$2,000	
Structure Modification Cost ($000) (inflated from '82 study – no range estimated)			$30,425	$30,425	$33,100	
Total Cost ($000)	High - $9,930 Low - $4,800	High - $13,242 Low - $6,100	High - $46,100 Low - $40,225	High - $49,485 Low - $42,625	High - $54,576 Low - $49,960	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 2 seasons Low – 1 season	High – 3 seasons Low – 2 seasons	High – 4 seasons Low – 3 seasons	High – 5 seasons Low – 4 seasons	High – 6 seasons Low – 5 seasons	

TABLE B-13
Great Lakes Navigation System Review

Detroit Harbor, IL	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6 9.5 ft below project. depth*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – reduced to areas adjacent to dock facilities)	High – 310,000 Low – 116,400	High – 390,000 Low – 232,800	High – 470,000 Low – 349,200	High – 580,000 Low – 502,600	High – 700,000 Low – 636,400	High – 2,000,000
Deepen & Dispose Cost Range ($000) (assumes expansion of Pt. Mouilee confined disposal)	High - $16,655 Low - $5,300	High - $19,890 Low - $6,500	High - $21,680 Low – $7,800	High - $23,747 Low - $9,500	High - $26,024 Low - $10,900	High – 30,000
Utility Relocation Cost ($000) (no utility relocations required)	$0	$0	$0	$0	$0	$0
Structure Modification Cost ($000) (inflated from '82 study, no range estimated)	$0	$0	$61,000	$61,000	$61,000	$61,000
Total Cost ($000)	High - $16,655 Low - $5,300	High - $19,890 Low - $6,500	High - $82,680 Low - $68,800	High - $84,747 Low - $70,500	High - $87,024 Low - $71,900	High – 91,000
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction duration	1 season 1 season	1 season 1 season	1 season 1 season	1 season 1 season	1 season 1 season	2 seasons

TABLE B-14
Great Lakes Navigation System Review

Drummond Harbor, MI	*Alt. 1* *2.0 ft below* *project depth*	*Alt. 2* *4.0 ft below* *project depth*	*Alt. 3* *6.0 ft below* *project depth*	*Alt. 4*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (Harbor not included in '82 GLCCH study – see Note below)	High – 89,000	High – 178,000	High – 300,000			
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $3,700	High - $4,700	High - $5,900			
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $3,700	High - $4,700	High - $5,900			
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season	1 season	1 season			

** NOTE: Drummond Harbor is a private harbor not evaluated under previous studies, and only minimal existing data could be obtained for this reconnaissance study. As such, the cost estimate developed for Alpena Harbor was used as a proxy estimate for Drummond Harbor. Alpena is aslo located on Lake Huron, and handles similar commodities. Limited estimates of dredged material quantities were made based on assumed channel widths and approximate lengths as a rough, order of magnitude check.

TABLE B-15
Great Lakes Navigation System Review

Duluth-Superior Harbor, MN/WI	*Alt. 1* *0.5 ft below* *project depth*	*Alt. 2* *1.5 ft below* *project depth*	*Alt. 3* *2.5 ft below* *project depth*	*Alt. 4* *3.5 ft below* *project depth*	*Alt. 5* *4.5 ft below* *project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to reflect current harbor depths and limited deepening area)	High –3,800,000 Low – 217,700	High – 4,700,000 Low – 846,400	High – 6,100,000 Low – 1,990,000	High – 7,800,000 Low – 3,560,000	High – 10,300,000 Low – 5,290,000	
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $100,020 Low - $6,300	High - $112,600 Low - $15,600	High - $131,950 Low – $39,100	High - $156,280 Low - $70,152	High - $189,115 Low - $96,487	
Utility Relocation Cost ($000) (high – inflated from '82 study) (low – reduced under limited deepening area)	High - $3,812 Low - $1,096	High - $3,812 Low - $1,096	High - $3,812 Low - $1,096	High - $3,812 Low - $1,096	High - $3,812 Low - $1,096	
Structure Modification Cost ($000) (High inflated from '82 study) (Low reduced under limited deepening area)	$0	$0	High - $214,638 Low - $70,000	High -$228,670 Low - $70,000	High - $248,880 Low - $75,000	
Total Cost ($000)	High - $103,832 Low - $7,396	High - $116,412 Low - $16,696	High - $350,400 Low - $110,196	High - $388,762 Low - $141,248	High - $441,807 Low - $172,583	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 4 seasons Low – 1 season	High – 5 seasons Low – 1 season	High – 6 seasons Low – 2 seasons	High – 7 seasons Low – 4 seasons	High – 7 seasons Low – 5 seasons	

TABLE B-16
Great Lakes Navigation System Review

Escanaba Harbor ,MI	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (non-Federal, quantities from '82 GLCCH study) (high assumes all slips deepened) (low assumes only primary ore dock)	High –487,500 Low – 24,400	High – 548,500 Low – 27,400	High – 611,500 Low – 30,600	High – 676,000 Low – 33,800	High –740,000 Low – 37,000	
Deepen & Dispose Cost Range ($000) (low assumes upland/beneficial reuse) (high assumes confined disposal)	High - $25,700 Low - $1,300	High - $26,510 Low - $1,350	High - $27,330 Low – $1,400	High - $32,270 Low - $1,600	High - $33,265 Low - $1,700	
Utility Relocation Cost ($000) (no utility relocations required)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (High inflated from '82 study, assuming four docks to be modified) (Low assumes one dock facility)	$0	$0	High - $48,800 Low - $12,200	High - $48,800 Low - $12,200	High - $48,800 Low - $12,200	
Total Cost ($000)	High - $25,700 Low - $1,300	High - $26,510 Low - $1,350	High - $76,130 Low - $13,600	High - $81,070 Low - $13,800	High - $82,065 Low - $13,900	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 1 season Low – 1 season	

TABLE B-17
Great Lakes Navigation System Review

Fairport Harbor, OH	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (Port not included in previous studies – quantity estimate made from current soundings – no range established)	Low – 34,500	Low – 114,700	Low – 214,800	Low – 336,000	Low – 482,600	
Deepen & Dispose Cost Range ($000) (high assumes confined disposal) (low assumes open water)	High - $3,900 Low - $336	High - $5,400 Low – $817	High - $5,900 Low - $1,400	High - $6,200 Low - $2,100	High - $6,700 Low - $2,970	
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $3,900 Low - $336	High - $5,400 Low – $817	High - $5,900 Low - $1,400	High - $6,200 Low - $2,100	High - $6,700 Low - $2,970	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season	1 season	1 season	1 season	1 season	

TABLE B-18
Great Lakes Navigation System Review

Gary Harbor, IN	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (NonFederal harbor – quantities from '82 GLCCH study, no actual soundings available)	160,000	210,000	280,000	370,000	470,000	
Deepen & Dispose Cost Range ($000) (assumes confined disposal – no range estimated)	$5,600	$6,000	$6,800	$8,800	$9,000	
Utility Relocation Cost ($000) (inflated from '82 study - no range estimated)	$925	$925	$925	$925	$925	
Structure Modification Cost ($000) (inflated from '82 study - no range estimated)	$0	$0	$53,500	$53,500	$53,500	
Total Cost ($000)	$6,525	$6,925	$61,225	$63,225	$63,425	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season	1 season	1 season	1 season	1 season	

TABLE B-19
Great Lakes Navigation System Review

Green Bay Harbor, WI	*Alt. 1* *24/26 ft project depths to 27 ft*	*Alt. 2* *24/26 ft project depths to 28 ft*	*Alt. 3* *24/26 ft project depths to 29 ft*	*Alt. 4* *24/26 ft project depths to 30 ft*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (High from '82 GLCCH study, reduced to one-way channel width) (Low from current soundings with one-way channel and % increase for channel extension)	High – 5,180,000 Low – 745,000	High – 7,000,000 Low – 1,480,000	High – 9,100,000 Low – 2,375,000	High – 11,450,000 Low – 3,380,000		
Deepen & Dispose Cost Range ($000) (assumes offshore disposal island creation for lake material, upland confined for river material)	High - $43,537 Low - $6,262	High - $58,835 Low – 12,438	High - $76,485 Low - $19,962	High - $96,237 Low - $28,409		
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $43,537 Low - $6,262	High - $58,835 Low – 12,438	High - $76,485 Low - $19,962	High - $96,237 Low - $28,409		
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	5 seasons 1 season	6 seasons 2 seasons	7 seasons 3 seasons	7 seasons 3 seasons		

TABLE B-20
Great Lakes Navigation System Review

Indiana Harbor, IN	*Alt. 1* *0.5 ft below* *project depth*	*Alt. 2* *1.5 ft below* *project depth*	*Alt. 3* *2.5 ft below* *project depth*	*Alt. 4* *3.5 ft below* *project. depth*	*Alt. 5* *4.5 ft below* *project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to reflect current harbor depths)	High –75,000 Low – 75,000	High – 313,000 Low – 254,000	High – 690,000 Low – 492,000	High – 1,140,000 Low – 762,000	High – 1,620,000 Low – 1,055,000	
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $1,376 Low - $1,376	High - $3,565 Low - $3,270	High - $8,450 Low – $7,460	High - $13,700 Low - $11,812	High - $20,100 Low - $17,260	
Utility Relocation Cost ($000) (none required per '82 study)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (High inflated from '82 study) (Low assumes significant deepening limited to outer harbor where larger vessels dock)	$0	$0	High - $28,800 Low - $10,000	High -$39,800 Low - $13,000	High - $44,800 Low - $16,000	
Total Cost ($000)	High - $1,376 Low - $1,376	High - $3,565 Low - $3,270	High - $37,250 Low - $17,460	High - $53,500 Low - $24,812	High - $64,900 Low - $33,260	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 2 seasons Low – 1 season	High – 2 seasons Low – 2 seasons	

TABLE B-21
Great Lakes Navigation System Review

Lorain Harbor, OH	*Alt. 1* *0.5 ft below project depth*	*Alt. 2* *1.5 ft below project depth*	*Alt. 3* *2.5 ft below project depth*	*Alt. 4* *3.5 ft below project depth*	*Alt. 5* *4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (High from ’82 GLCCH studyl) (Low - reduced to reflect current soundings)	High – 930,000 Low – 697,500	High – 1,370,000 Low – 1,027,500	High –1,820,000 Low – 1,478,000	High – 2,330,000 Low – 1,988,000	High – 2,890,000 Low – 2,548,000	
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $31,842 Low - $14,300	High - $41,190 Low – $18,000	High - $45,850 Low - $34,400	High - $54,980 Low - $38,000	High - $62,865 Low - $42,000	
Utility Relocation Cost ($000) (no utility relocations required)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (Inflated from ’82 study)	$0	$0	$86,925	$86,925	$86,925	
Total Cost ($000)	High - $31,842 Low - $14,300	High - $41,190 Low – $18,000	High - $132,775 Low - $121,325	High - $141,905 Low - $124,925	High - $149,790 Low - $128,925	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season 1 season	2 seasons 1 season	2 seasons 2 seasons	2 seasons 2 seasons	3 seasons 3 seasons	

TABLE B-22
Great Lakes Navigation System Review

Menominee Harbor, WI	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6 5.5 ft below project depth*
Deepening Quantity Range (cy) (Port not included in previous studies – quantity estimate made from current soundings – no range established)	Low - 8,000	Low – 34,500	Low – 112,500	Low – 187,500	Low – 503,500	Low – 503,500
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	$1,800	$2,500	$4,000	$5,100	$7,800	$9,400
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	$1,800	$2,500	$4,000	$5,100	$7,800	$9,400
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season	1 season	1 season	1 season	1 season	1 season

TABEL B-23
Great Lakes Navigation System Review

Milwaukee Harbor, WI	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project. depth*	*Alt. 5 4.5 ft below project. depth*	*Alt. 6*
Deepening Quantity Range (cy) (High – from '82 GLCCH study) (low – '82 study reduced to reflect current harbor depths)	High – 560,000 Low – 200,000	High – 1,100,000 Low – 910,000	High – 1,300,000 Low – 975,000	High – 1,700,000 Low – 1,275,000	High – 2,000,000 Low – 1,600,000	
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $15,400 Low - $4,800	High - $29,100 Low - $11,500	High - $41,400 Low – $18,700	High - $50,060 Low - $23,000	High - $63,600 Low - $28,700	
Utility Relocation Cost ($000) (inflated from '82 study - no range estimated)	$500	$500	$500	$500	$500	
Structure Modification Cost ($000) (inflated from '82 study – no range estimated)	$0	$0	$75,500	$75,500	$84,800	
Total Cost ($000)	High - $15,900 Low - $5,300	High - $29,600 Low - $12,000	High - $121,400 Low - $98,700	High - $130,060 Low - $103,000	High - $138,900 Low - $114,00	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	High – 1 season Low – 1 season	High – 1 season Low – 1 season	High – 2 seasons Low – 2 seasons	High – 3 seasons Low – 3 seasons	High – 3 seasons Low – 3 seasons	

TABLE B-24
Great Lakes Navigation System Review

Monroe Harbor, MI	*Alt. 1* *2.0 ft below* *project depth*	*Alt. 2* *4.0 ft below* *project depth*	*Alt. 3* *6.0 ft below* *project depth*	*Alt. 4*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (High from '89 LRR study) (low– quantities estimated from current soundings + qty for channel extension from '89 study)	High – 2,025,000 Low – 1,310,000	High – 3,355,000 Low – 2,375,000	High – 4,745,000 Low – 3,630,000			
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $46,380 Low - $31,000	High - $67,785 Low - $49,400	High - $96,010 Low - $56,900			
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $46,380 Low - $31,000	High - $67,785 Low - $49,400	High - $96,010 Low - $56,900			
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	2 seasons 1 season	4 seasons 2 seasons	5 seasons 4 season			

TABLE B-25
Great Lakes Navigation System Review

Presque Isle Harbor, MI	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (High from '82 GLCCH studyl) (Low - reduced to reflect current soundings)	High – 96,500 Low – 20,000	High – 194,500 Low – 75,000	High – 323,500 Low – 155,000	High – 463,000 Low – 300,000	High – 619,000 Low – 396,000	
Deepen & Dispose Cost Range ($000) (High assumes confined disposal) (Low assumes upland/beneficial reuse)	High - $6,000 Low - $1,000	High - $10,700 Low – $2,300	High - $22,436 Low - $4,600	High - $28,510 Low - $8,000	High - $33,250 Low - $10,000	
Utility Relocation Cost ($000) (no utility relocations required)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (Inflated from '82 study, no range estimated)	$0	$0	$12,657	$12,657	$12,657	
Total Cost ($000)	High - $6,000 Low - $1,000	High - $10,700 Low – $2,300	High - $35,093 Low - $17,257	High - $41,167 Low - $20,657	High - $45,907 Low - $22,657	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season 1 season	1 season 1 season	1 season 1 season	1 season 1 season	1 season 1 season	

TABLE B-26
Great Lakes Navigation System Review

Rouge River Harbor, MI	*Alt. 1* *6.0 ft below project depth*	*Alt. 2*	*Alt. 3*	*Alt. 4*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (Port not included in previous studies, quantity estimated from current soundings)	205,000					
Deepen & Dispose Cost Range ($000) (assumes disposal at existing Pt. Mouillee CDF)	$3,246					
Utility Relocation Cost ($000) (based on ’82 GLCCH study unit prices, inflated – most utilities already deep)	$300					
Structure Modification Cost ($000) (narrow channel, highly devloped shoreline)	$2,000					
Total Cost ($000)	$5,546					
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season					

TABLE B-27
Great Lakes Navigation System Review

Saginaw Harbor, MI	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (Port not included in previous studies – quantity estimated from current soundings)	583,000	1,523,000	2,764,000	4,268,800	6,065,000	
Deepen & Dispose Cost Range ($000) (assumes outer harbor mtl confined disposal, inner harbor mtl upland confined)	$15,100	$23,100	$35,000	$45,000	$100,000	
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (no structure modifications estimated)						
Total Cost ($000)	$15,100	$23,100	$35,000	$45,000	$100,000	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season	2 seasons	3 seasons	4 seasons	6 seasons	

TABLE B-28
Great Lakes Navigation System Review

Sandusky Harbor, OH	*Alt. 1* *0.5 ft below* *project depth*	*Alt. 1* *1.5 ft below* *project depth*	*Alt. 1* *2.5 ft below* *project depth*	*Alt. 1* *3.5 ft below* *project depth*	*Alt. 1* *4.5 ft below* *project depth*	*Alt. 6*
Deepening Quantity Range (cy) (High from '82 GLCCH study, which include widening to a two-way channel) (Low - reduced to reflect current soundings, no channel widening and reduced deepening area)	High – 5,000,000 Low – 100,000	High – 6,200,000 Low – 386,750	High –7,400,000 Low – 736,750	High – 8,600,000 Low – 1,086,750	High – 9,900,000 Low – 1,451,350	
Deepen & Dispose Cost Range ($000) (high assumes confined disposal) (low assumes open water disposal)	High - $100,265 Low - $731	High - $117,120 Low – $2,400	High - $134,372 Low - $4,450	High - $150,995 Low - $6,500	High - $168,275 Low - $8,780	
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $100,265 Low - $731	High - $117,120 Low – $2,400	High - $134,372 Low - $4,450	High - $150,995 Low - $6,500	High - $168,275 Low - $8,780	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	5 seasons 1 season	6 seasons 1 season	7 seasons 1 seasons	7 seasons 1 seasons	7 seasons 2 seasons	

TABLE B-29
Great Lakes Navigation System Review

Saugatuck Harbor, MI	*Alt. 1* *0.5 ft below project depth*	*Alt. 2* *1.5 ft below project depth*	*Alt. 3* *2.5 ft below project depth*	*Alt. 4* *3.5 ft below project depth*	*Alt. 5* *4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (Harbor not included in ’82 GLCCH study – quantities estimated from current soundings)	113,000	159,000	206,000	252,000	300,000	
Deepen & Dispose Cost Range ($000) (High assumes confined disposal) (Low assumes upland unconfined disposal)	High - $4,300 Low - $1,700	High - $4,800 Low - $2,385	High - $5,260 Low - $3,090	High - $5,700 Low - $3,780	High - $6,200 Low - $4,500	
Utility Relocation Cost ($000) (no range estimated)	$152	$152	$152	$152	$152	
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $4,452 Low - $1,852	High - $4,952 Low - $2,537	High - $5,412 Low - $3,242	High - $5,852 Low - $3,832	High - $6,352 Low - $4,652	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season 1 season	1 season 1 season	1 season 1 season	1 season 1 season	1 season 1 season	

TABLE B-30
Great Lakes Navigation System Review

Sheboygan Harbor, WI	*Alt. 1* *0.5 ft below project depth*	*Alt. 2* *1.5 ft below project depth*	*Alt. 3* *2.5 ft below project depth*	*Alt. 4* *3.5 ft below project depth*	*Alt. 5* *4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (Port not included in previous studies – quantity estimated from current soundings w/o increase for extending channel to deep water)	796,000	873,000	967,000	1,032,000	1,111,000	
Deepen & Dispose Cost Range ($000) (reflects confined disposal for lake material & superfund disposal level costs for river material – range reflects high/low superfund disposal costs)	High - $227,100 Low - $137,100	High - $239,100 Low - $144,100	High - $252,100 Low - $152,100	High - $263,100 Low - $158,100	High - $277,200 Low - $167,200	
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (no structure modifications estimated)						
Total Cost ($000)	High - $227,100 Low - $137,100	High - $239,100 Low - $144,100	High - $252,100 Low - $152,100	High - $263,100 Low - $158,100	High - $277,200 Low - $167,200	
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season	1 season	1 season	1 season	2 seasons	

TABLE B-31
Great Lakes Navigation System Review

Silver Bay, MN	*Alt. 1* *0.5 ft below project depth*	*Alt. 2* *1.5 ft below project depth*	*Alt. 3* *2.5 ft below project depth*	*Alt. 4* *3.5 ft below project depth*	*Alt. 5* *4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (NonFederal harbor – quantities from ’82 GLCCH study, no actual soundings available)	6,300	8,300	18,200	32,000	48,200	
Deepen & Dispose Cost Range ($000) (assumes upland/beneficial reuse)	$500	$600	$1,300	$1,700	$2,125	
Utility Relocation Cost ($000) (no utility relocations required)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (inflated from ’82 study - no range estimated)	$0	$0	$15,815	$15,815	$15,815	
Total Cost ($000)	$500	$600	$17,115	$17,515	$17,940	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season	1 season	1 season	1 season	1 season	

TABLE B-32
Great Lakes Navigation System Review

St. Clair - Edison, MI	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (NonFederal harbor – quantities from ’82 GLCCH study, no actual soundings available)	10,700	21,500	32,200	43,000	53,700	
Deepen & Dispose Cost Range ($000) (small qty - assumes upland disposal)	$550	$650	$750	$850	$950	
Utility Relocation Cost ($000) (no utility relocations required)	$0	$0	$0	$0	$0	
Structure Modification Cost ($000) (inflated from ’82 study - no range estimated)	$0	$0	$4,422	$4,422	$4,422	
Total Cost ($000)	$550	$650	$5,172	$5,272	$5,372	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season	1 season	1 season	1 season	1 season	

TABLE B-33
Great Lakes Navigation System Review

Stoneport Harbor, MI	*Alt. 1* *2.0 ft below* *project depth*	*Alt. 2* *4.0 ft below* *project depth*	*Alt. 3* *6.0 ft below* *project depth*	*Alt. 4*	*Alt. 5*	*Alt. 6*
Deepening Quantity Range (cy) (Harbor not included in '82 GLCCH study – see note below)	High – 89,000	High – 178,000	High – 300,000			
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	High - $3,700	High - $4,700	High - $5,900			
Utility Relocation Cost ($000) (no utility relocations estimated)						
Structure Modification Cost ($000) (No structure modifications estimated)						
Total Cost ($000)	High - $3,700	High - $4,700	High - $5,900			
*all costs include 25% contingency, 10% E&D, 7% S&A)						
Construction Duration	1 season	1 season	1 season			

** NOTE: Stoneport Harbor is a private harbor not evaluated under previous studies, and only minimal existing data could be obtained for this reconnaissance study. As such, the cost estimate developed for Alpena Harbor was used as a proxy estimate for Stoneport Harbor. Alpena is aslo located on Lake Huron, and handles similar commodities. Limited estimates of dredged material quantities were made based on assumed channel widths and approximate lengths as a rough, order of magnitude check.

TABLE B-34
Great Lakes Navigation System Review

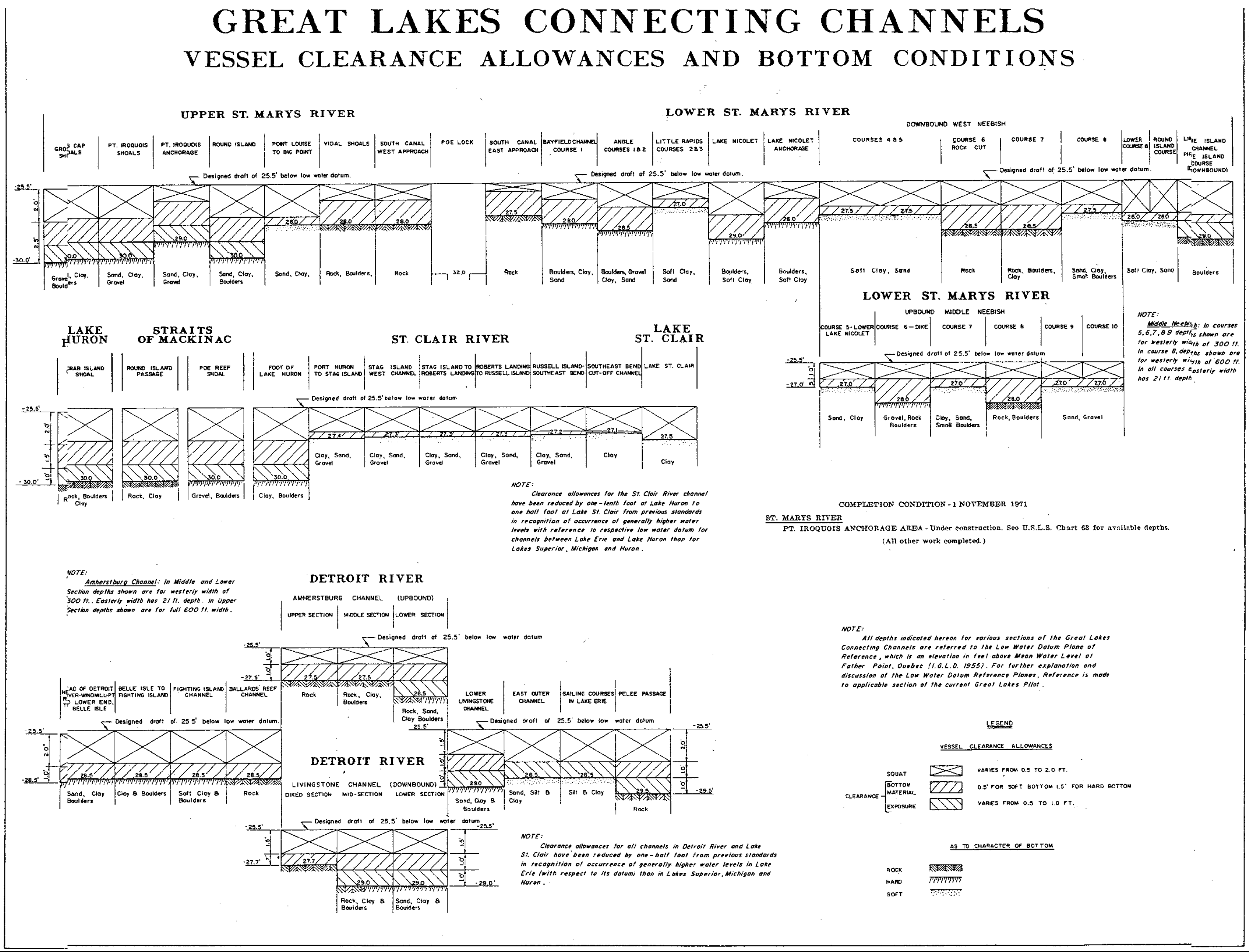
Taconite Harbor - MN	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (NonFederal harbor – quantities from '82 GLCCH study, no actual soundings available)	121,600	196,500	288,800	396,000	512,700	
Deepen & Dispose Cost Range ($000) (assumes confined disposal)	$3,000	$4,500	$7,000	$12,300	$15,454	
Utility Relocation Cost ($000) (inflated from '82 study - no range estimated)	$311	$311	$311	$311	$311	
Structure Modification Cost ($000) (inflated from '82 study - no range estimated)	$0	$0	$10,217	$10,217	$11,193	
Total Cost ($000)	$3,311	$4,811	$17,528	$22,828	$26,958	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season	1 season	1 season	1 season	1 season	

TABLE B-35
Great Lakes Navigation System Review

Toledo Harbor - OH	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (high quantities from '82 GLCCH study, low reduced to reflect actual soundings)	High - 4,700,000 Low – 2,350,000	High – 6,700,000 Low – 3,350,000	High – 8,700,000 Low – 5,350,000	High – 10,700,000 Low – 7,350,000	High – 12,800,000 Low – 9,450,000	
Deepen & Dispose Cost Range ($000) (high assumes confined disposal, low assumes ½ open water – ½ confined)	High - $92,700 Low - $43,600	$130,900 $45,500	High - $159,600 Low - $61,700	High - $183,400 Low - $76,200	High - $213,900 Low - $93,300	
Utility Relocation Cost ($000) (inflated from '82 study - no range estimated)	$2,900	$2,900	$3,650	$4,400	$6,100	
Structure Modification Cost ($000) (inflated from '82 study - no range estimated)	$0	$0	$160,000	$169,300	$195,200	
Total Cost ($000)	High - $95,600 Low - $46,500	High - $133,800 Low - $48,400	High - $323,250 Low - $225,350	High - $357,100 Low - $249,900	High - $415,200 Low - $294,600	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	5 seasons 2 seasons	7 seasons 3 seasons	7 seasons 5 seasons	7 seasons 7 seasons	7 seasons 7 seasons	

TABLE B-36
Great Lakes Navigation System Review

Two Harbors - MN	*Alt. 1 0.5 ft below project depth*	*Alt. 2 1.5 ft below project depth*	*Alt. 3 2.5 ft below project depth*	*Alt. 4 3.5 ft below project depth*	*Alt. 5 4.5 ft below project depth*	*Alt. 6*
Deepening Quantity Range (cy) (high quantities from ’82 GLCCH study including all non-Federal facilities, low reduced to limit to Federal channel limits)	High – 460,000 Low – 4,700	High – 520,000 Low – 16,600	High – 580,000 Low – 31,000	High – 660,000 Low – 49,600	High – 740,000 Low – 66,200	
Deepen & Dispose Cost Range ($000) (high assumes confined disposal, low assumes upland/beneficial reuse)	High - $16,490 Low - $500	$17,560 $600	High - $18,697 Low - $700	High - $19,970 Low - $800	High - $21,635 Low - $1,000	
Utility Relocation Cost ($000) (inflated from ’82 study - no range estimated)	$584	$584	$584	$584	$584	
Structure Modification Cost ($000) (inflated from ’82 study - no range estimated)	$0	$0	$34,556	$34,556	$37,728	
Total Cost ($000)	High - $17,074 Low - $1,084	High - $18,144 Low - $1,184	High - $53,837 Low - $35,840	High - $55,110 Low - $35,940	High - $59,947 Low - $39,312	
*all costs include 25% contingency, 10% E&D, 7% S&A						
Construction Duration	1 season 1 season	1 seasons 1 seasons	1 season 1 season	1 season 1 season	1 season 1 season	


GREAT LAKES CONNECTING CHANNELS
VESSEL CLEARANCE ALLOWANCES AND BOTTOM CONDITIONS
UPPER ST. MARYS RIVER
LOWER ST. MARYS RIVER
DOWNBOUND WEST NEEBISH
Designed draft of 25.5' below low water datum.
LAKE HURON
STRAITS OF MACKINAC
ST. CLAIR RIVER
LAKE ST. CLAIR
LOWER ST. MARYS RIVER
UPBOUND MIDDLE NEEBISH
NOTE:
Clearance allowances for the St. Clair River channel have been reduced by one-tenth foot at Lake Huron to one half foot at Lake St. Clair from previous standards in recognition of occurrence of generally higher water levels with reference to respective low water datum for channels between Lake Erie and Lake Huron than for Lakes Superior, Michigan and Huron.
COMPLETION CONDITION - 1 NOVEMBER 1971
ST. MARYS RIVER
PT. IROQUOIS ANCHORAGE AREA - Under construction. See U.S.L.S. Chart 63 for available depths.
(All other work completed.)
DETROIT RIVER
AMHERSTBURG CHANNEL (UPBOUND)
DETROIT RIVER
LIVINGSTONE CHANNEL (DOWNBOUND)
NOTE:
Clearance allowances for all channels in Detroit River and Lake St. Clair have been reduced by one-half foot from previous standards in recognition of occurrence of generally higher water levels in Lake Erie (with respect to its datum) than in Lakes Superior, Michigan and Huron.
NOTE:
All depths indicated hereon for various sections of the Great Lakes Connecting Channels are referred to the Low Water Datum Plane of Reference, which is an elevation in feet above Mean Water Level at Father Point, Quebec (I.G.L.D. 1955). For further explanation and discussion of the Low Water Datum Reference Planes, Reference is made to applicable section of the current Great Lakes Pilot.
LEGEND
VESSEL CLEARANCE ALLOWANCES
SQUAT
BOTTOM MATERIAL
EXPOSURE
CLEARANCE
AS TO CHARACTER OF BOTTOM
ROCK
HARD
SOFT

CHARTS 19

ATTACHMENT 1
SAMPLE REPRESENTATIVE PARAMETRIC COST ESTIMATE
SANDUSKY, OHIO 1-1/2 FOOT DEEPENING

CONSTRUCTION QUANTITIES FOR CDF -- DEEPENING TO 26.0 FEET										
	LENGTH OF DIKE		**WIDTH OF DIKE**		**DEPTH OF DIKE**		**27.00**		**CAPACITY OF OF CDF IN CY**
	2,150.00	*	2,150.00	*	35.00	/	27.00	=	5,992,100.00
TYPE	**END AREA**	*	**LENGTH OF DIKE**	/	**27**	*	**1.35 LB/CY**	=	**TONS OF MATERIAL**
1) RIPRAP STONE	22.50		8,600.00		27.00		1.35		9,700.00
2) COVER STONE	330.00		8,600.00		27.00		1.35		141,900.00
3) UNDERLAY STONE	187.50		8,600.00		27.00		1.35		80,600.00
4) MATTRESS STONE	80.00		8,600.00		27.00		1.35		34,400.00
5) PREPARED LIME STONE	2,073.75		8,600.00		27.00		1.35		891,700.00
TYPE	**LENGTH OF DIKE**	*	**660 POUNDS PER L.F.**	/	**2,000**			=	**TONS OF MATERIAL**
6) ROAD	8,600.00		660.00		2,000.00				2,840.00

CONSTRUCTION QUANTITIES FOR CDF -- DEEPENING TO 27.0 FEET

	LENGTH OF DIKE		**WIDTH OF DIKE**		**DEPTH OF DIKE**		**27.00**		**CAPACITY OF OF CDF IN CY**
	2,350.00	*	2,350.00	*	35.00	/	27.00	=	7,158,800.00
TYPE	**END AREA**	*	**LENGTH OF DIKE**	/	**27**	*	**1.35 LB/CY**	=	**TONS OF MATERIAL**
1) RIPRAP STONE	22.50		9,400.00		27.00		1.35		10,600.00
2) COVER STONE	330.00		9,400.00		27.00		1.35		155,100.00
3) UNDERLAY STONE	187.50		9,400.00		27.00		1.35		88,100.00
4) MATTRESS STONE	80.00		9,400.00		27.00		1.35		37,600.00
5) PREPARED LIME STONE	2,073.75		9,400.00		27.00		1.35		974,700.00
TYPE	**LENGTH OF DIKE**	*	**660 POUNDS PER L.F.**	/	**2,000**			=	**TONS OF MATERIAL**
6) ROAD	9,400.00		660.00		2,000.00				3,100.00

CONSTRUCTION QUANTITIES FOR CDF -- DEEPENING TO 28.0 FEET										
	LENGTH OF DIKE		**WIDTH OF DIKE**		**DEPTH OF DIKE**		**27.00**		**CAPACITY OF OF CDF IN CY**
	2,550.00	*	2,550.00	*	35.00	/	27.00	=	8,400,000.00
TYPE	**END AREA**	*****	**LENGTH OF DIKE**	**/**	**27**	*****	**1.35 LB/CY**	**=**	**TONS OF MATERIAL**
1) RIPRAP STONE	22.50		10,200.00		27.00		1.35		11,500.00
2) COVER STONE	330.00		10,200.00		27.00		1.35		168,300.00
3) UNDERLAY STONE	187.50		10,200.00		27.00		1.35		95,600.00
4) MATTRESS STONE	80.00		10,200.00		27.00		1.35		40,800.00
5) PREPARED LIME STONE	2,073.75		10,200.00		27.00		1.35		1,057,600.00
TYPE	**LENGTH OF DIKE**	*****	**660 POUNDS PER L.F.**	**/**	**2,000**			**=**	**TONS OF MATERIAL**
6) ROAD	10,200.00		660.00		2,000.00				3,370.00

CONSTRUCTION QUANTITIES FOR CDF -- DEEPENING TO 29.0 FEET

	LENGTH OF DIKE		**WIDTH OF DIKE**		**DEPTH OF DIKE**		**27.00**		**CAPACITY OF OF CDF IN CY**
	2,725.00	*	2,725.00	*	35.00	/	27.00	=	9,600,000.00
TYPE	**END AREA**	*	**LENGTH OF DIKE**	/	**27**	*	**1.35 LB/CY**	=	**TONS OF MATERIAL**
1) RIPRAP STONE	22.50		10,900.00		27.00		1.35		12,300.00
2) COVER STONE	330.00		10,900.00		27.00		1.35		179,900.00
3) UNDERLAY STONE	187.50		10,900.00		27.00		1.35		102,200.00
4) MATTRESS STONE	80.00		10,900.00		27.00		1.35		43,600.00
5) PREPARED LIME STONE	2,073.75		10,900.00		27.00		1.35		1,130,200.00
TYPE	**LENGTH OF DIKE**	*	**660 POUNDS PER L.F.**	/	**2,000**			=	**TONS OF MATERIAL**
6) ROAD	10,900.00		660.00		2,000.00				3,600.00

CONSTRUCTION QUANTITIES FOR CDF -- DEEPENING TO 30.0 FEET

	LENGTH OF DIKE		**WIDTH OF DIKE**		**DEPTH OF DIKE**		**27.00**		**CAPACITY OF OF CDF IN CY**
	2,900.00	*	2,900.00	*	35.00	/	27.00	=	10,900,000.00
TYPE	**END AREA**	*	**LENGTH OF DIKE**	/	**27**	*	**1.35 LB/CY**	=	**TONS OF MATERIAL**
1) RIPRAP STONE	22.50		11,600.00		27.00		1.35		13,100.00
2) COVER STONE	330.00		11,600.00		27.00		1.35		191,400.00
3) UNDERLAY STONE	187.50		11,600.00		27.00		1.35		108,800.00
4) MATTRESS STONE	80.00		11,600.00		27.00		1.35		46,400.00
5) PREPARED LIME STONE	2,073.75		11,600.00		27.00		1.35		1,202,800.00
TYPE	**LENGTH OF DIKE**	*	**660 POUNDS PER L.F.**	/	**2,000**			=	**TONS OF MATERIAL**
6) ROAD	11,600.00		660.00		2,000.00				3,830.00

CONSTRUCTION QUANTITIES FOR CDF -- DEEPENING TO 35.0 FEET

	LENGTH OF DIKE		WIDTH OF DIKE		DEPTH OF DIKE		27.00		CAPACITY OF OF CDF IN CY
	3,750.00	*	3,750.00	*	35.00	/	27.00	=	18,200,000.00
TYPE	**END AREA**	*****	**LENGTH OF DIKE**	**/**	**27**	*****	**1.35 LB/CY**	**=**	**TONS OF MATERIAL**
1) RIPRAP STONE	22.50		15,000.00		27.00		1.35		16,900.00
2) COVER STONE	330.00		15,000.00		27.00		1.35		247,500.00
3) UNDERLAY STONE	187.50		15,000.00		27.00		1.35		140,600.00
4) MATTRESS STONE	80.00		15,000.00		27.00		1.35		60,000.00
5) PREPARED LIME STONE	2,073.75		15,000.00		27.00		1.35		1,555,300.00
TYPE	**LENGTH OF DIKE**	*****	**660 POUNDS PER L.F.**	**/**	**2,000**			**=**	**TONS OF MATERIAL**
6) ROAD	15,000.00		660.00		2,000.00				4,950.00

MOBILIZATION AND DEMOBILIZATION COST

	MOBILIZATION					DEMOBILIZATION				
	# DAYS		$/DAY		TOTAL	# DAYS		$/DAY		TOTAL
1. PREPARE DREDGE FOR TRANSFER	2.00	x	$3,608.00	=	$7,216.00	1.00	x	$3,658.00	=	$3,658.00
2. TRANSFER ALL PLANT	150.00		Miles			50.00		Miles		
@ 72.00	2.08	x	$23,539.00	=	$48,961.12	0.69	x	$23,014.00	=	$15,879.66
3. PERMANENT PERSONNEL & MISC.	L.S.			=	$1,158.00			L.S.	=	$1,158.00
4. PREPARE DREDGE AFTER TRANSFER	2.00	x	$6,958.00	=	$13,916.00	1.00	x	$6,574.00	=	$6,574.00
5. OTHER	Permit Towing			=	$4,000.00	Permit Towing			=	$4,000.00
	SUBTOTAL MOBILIZATION				$75,251.12	SUBTOTAL DEMOBILIZATION				$31,269.66

6. SUBTOTAL MOBILIZATION & DEMOBILIZATION			$75,251.12
7. OVERHEAD	12.00	+	$9,030.13
SUBTOTAL		=	$84,281.25
8. PROFIT	10.00	+	$8,428.13
SUBTOTAL		=	$92,709.38
9. BOND	1.50	+	$1,390.64
10. TOTAL MOBILIZATION & DEMOBILIZATION		=	$94,100.02
11. USE FOR TOTAL MOBILIZATION & DEMOBILIZATION			$94,100.00

10. TOTAL DAYS MOBILIZATION & DEMOBILIZATION = 8.77

DREDGING COST

1. MONTHLY EQUIPMENT COST	+	$64,326.00	Taken from Exc. Info F58
2. MONTHLY PERSONNEL COST	+	$30,135.84	Taken from Exc. Info F85
SUBTOTAL	=	$94,461.84	
3. DREDGING TIME	*	144.00	Taken from Dredging D 68
SUBTOTAL	=	$13,602,504.96	
4. OVERHEAD RATE		12.00	Taken from Exc. Info E21
SUBTOTAL	=	$15,234,805.56	
5. PROFIT	=	10.00	Taken from Exc. Info E22
SUBTOTAL	=	$16,758,286.11	
6. BOND	=	1.50	Taken from Exc. Info E23
TOTAL	=	$17,009,660.40	
7. NET PAY YARDAGE	/	6,200,000.00	Taken from Exc. Info E32
8. UNIT COST	=	$2.70	Round to Nearest .10 Cent
9. PAY YARDAGE	*	6,200,000.00	Taken from Exc. Info E32
10. DREDGING COST	=	$16,740,000.00	

TOWING COST [TRANSPORTATION]

1. MONTHLY EQUIPMENT COST	+	$101,093.00	Taken from Exc. Info F54
2. MONTHLY PERSONNEL COST	+	$6,333.60	Taken from Exc. Info F77
SUBTOTAL	=	$107,426.60	
3. DREDGING TIME	*	144.00	Taken from Either Hauling A D81 or Dredging Time whichever is greater
SUBTOTAL	=	$15,469,430.40	
4. OVERHEAD RATE		12.00	Taken from Exc. Info E21
SUBTOTAL	=	$17,325,762.05	
5. PROFIT	=	10.00	Taken from Exc. Info E22
SUBTOTAL	=	$19,058,338.25	
6. BOND	=	1.50	Taken from Exc. Info E23
TOTAL	=	$19,344,213.33	
7. NET PAY YARDAGE	/	6,200,000.00	Taken from Exc. Info E32
8. UNIT COST	=	$3.10	Round to Nearest .10 Cent
9. PAY YARDAGE	*	6,200,000.00	Taken from Exc. Info E32
10. TOWING COST	=	$19,220,000.00	

OFFLOADING COST

1. MONTHLY EQUIPMENT COST	+	$64,326.00	Taken from Exc. Info F58
2. MONTHLY PERSONNEL COST	+	$10,045.28	Taken from Exc. Info F85
SUBTOTAL	=	$74,371.28	
3. DREDGING TIME	*	144.00	Taken from Either Offloading D 60 or Dredging Time whichever is greater
SUBTOTAL	=	$10,709,464.32	
4. OVERHEAD RATE		12.00	Taken from Exc. Info E21
SUBTOTAL	=	$11,994,600.04	
5. PROFIT	=	10.00	Taken from Exc. Info E22
SUBTOTAL	=	$13,194,060.04	
6. BOND	=	1.50	Taken from Exc. Info E23
TOTAL	=	$13,391,970.94	
7. NET PAY YARDAGE	/	6,200,000.00	Taken from Exc. Info E32
8. UNIT COST	=	$2.20	Round to Nearest .10 Cent
9. PAY YARDAGE	*	6,200,000.00	Taken from Exc. Info E32
10. OFFLOADING COST	=	$13,640,000.00	