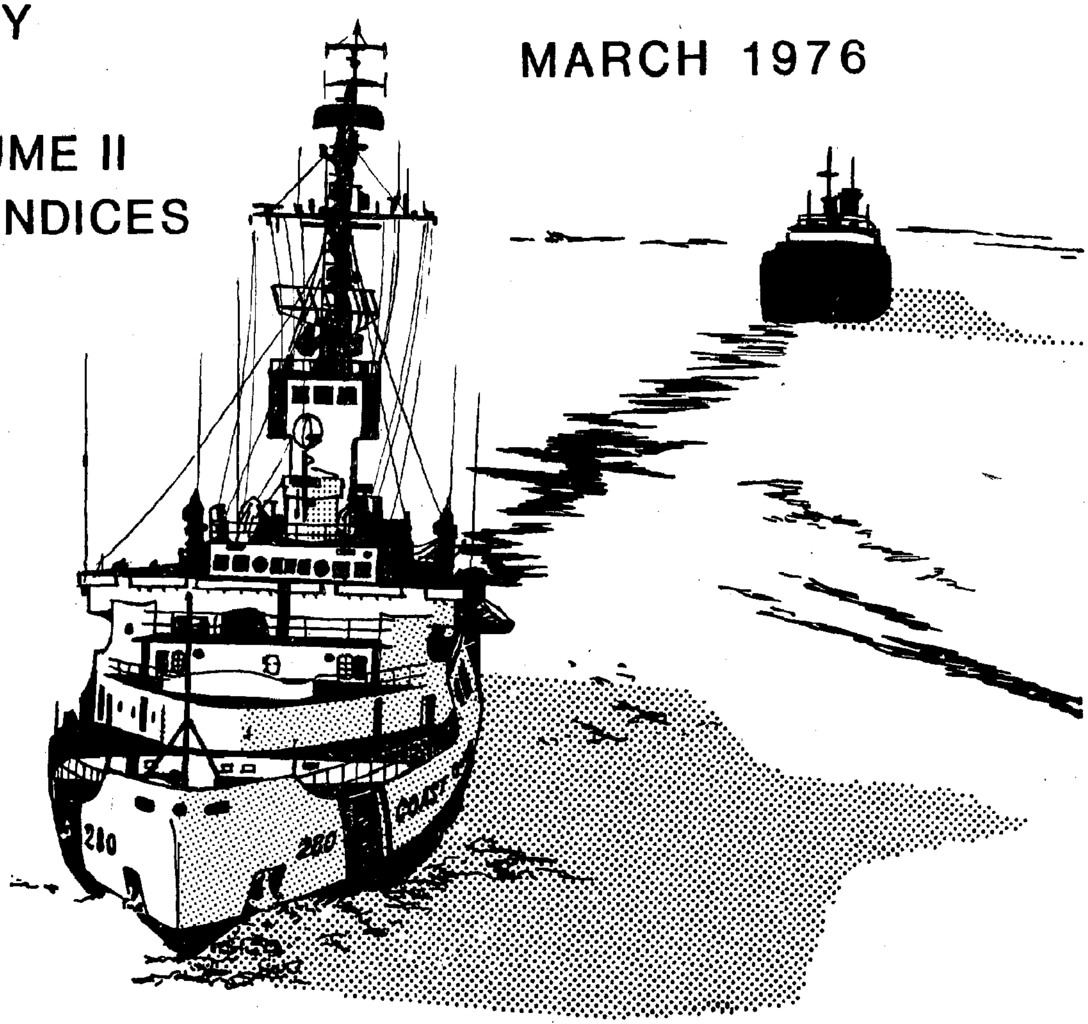
INTERIM
FEASIBILITY
STUDY

MARCH 1976

VOLUME II
APPENDICES



GREAT LAKES-
ST. LAWRENCE SEAWAY
NAVIGATION SEASON
EXTENSION

U.S. ARMY ENGINEER DISTRICT, DETROIT
CORPS OF ENGINEERS DETROIT, MICHIGAN

GREAT LAKES-ST. LAWRENCE SEAWAY
NAVIGATION SEASON EXTENSION

INTERIM FEASIBILITY STUDY

APPENDICES

VOLUME II of III

MARCH 1976

U.S. ARMY ENGINEER DISTRICT, DETROIT
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GREAT LAKES-ST. LAWRENCE SEAWAY
NAVIGATION SEASON EXTENSION
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PROGRAM PARTICIPANTS

&

COORDINATION

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GREAT LAKES-ST. LAWRENCE SEAWAY
NAVIGATION SEASON EXTENSION

PRELIMINARY FEASIBILITY STUDY

STUDY PARTICIPANTS & COORDINATION

FEDERAL

Members of Congress
U.S. Coast Guard
St. Lawrence Seaway Development Corporation
U.S. Department of Interior
Fish and Wildlife Service
Bureau of Outdoor Recreation
Bureau of Mines
Maritime Administration
National Oceanic and Atmospheric Administration
Federal Power Commission
Environmental Protection Agency
National Aeronautics and Space Administration
Atomic Energy Commission
U.S. Department of State
International Joint Commission, U.S. Section
Saint Lawrence Seaway Authority of Canada
Advisory Council on Historic Preservation
U.S. Department of Commerce
U.S. Department of Agriculture
Public Health Service
National Park Service
National Weather Service
Energy Research & Development Administration

STATE

Great Lakes Commission
Great Lakes Basin Commission
Illinois - Department of Conservation
- Department of Transportation
- Environmental Protection Agency
Indiana - Department of Natural Resources
- Stream Pollution Control Board
Michigan - Office of the Governor
- Department of State Highways & Transportation
- Department of Natural Resources
- Department of Agriculture

Minnesota - House of Representatives
- Pollution Control Agency

Ohio - Office of the Governor
- Department of Natural Resources
- Environmental Protection Agency

Pennsylvania - Department of Transportation
- Department of Environmental Resources

New York - State Office of Planning
- Department of Environmental Conservation

Wisconsin - Department of Natural Resources
- Department of Local Affairs and Development

LOCAL

Great Lakes Port Authorities & Commissions
Michigan State Chamber of Commerce
U.S. Great Lakes Shipping Association
Power Authority of the State of New York
Seafarers International Union
Masters, Mates, and Pilots
Great Lakes Task Force
Lake Marine Engineers Beneficial Association
Industrial Users Group
International Longshoremen's Association
International Shipmaster's Association
Lake Carriers' Association
Chippewa County, Michigan - Board of Supervisors
Hydro-Electric Power Commission of Ontario
Neebish Pioneers Association
Sierra Club
Edison Sault Electric Company
Lake Michigan Federation
Save Lake Superior Association
Great Lakes Landowners Association
County of Marquette Office of the Controller
Southeast Michigan Council of Governments
Municipalities - Detroit Planning Department
- Duluth, Minnesota
- Virginia, Minnesota
- Hibbing, Minnesota
- Mountain Iron, Minnesota
- Chisholm, Minnesota
- Eveleth, Minnesota

Greater Cleveland Growth Association
Northeast Minnesota Development Association
Superior Wisconsin League of Women Voters
Lake St. Clair Advisory Committee
Sault Ste. Marie Area Public Schools
American Steamship Company

Others as displayed in Public Meeting Digests (Appendix III)

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APPENDIX II

GREAT LAKES - ST. LAWRENCE SEAWAY
NAVIGATION SEASON EXTENSION

INTERIM FEASIBILITY STUDY

PERTINENT CORRESPONDENCE

Letters and statements presented at the public meetings and summarized in Appendix III "Public Meetings "are not repeated below, with the exception of Members of Congress.

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STATEMENT BY PHILIP E. RUPPE
WINTER NAVIGATION BOARD HEARING
SAULT STE. MARIE, MICHIGAN
February 19,1976

Mr. Chairman and Members of the Winter Navigation Board:

I have reviewed the Public Participation Brochure outlining alternatives for extending the navigation system on the Great Lakes and have had access to your draft interim feasibility study.

I am impressed by the great attention given to operational aspects of the demonstration effort -- that is, providing these tools and those investments which may assist vessel movements. I do, however, want to be certain that the Winter Navigation Board extends like attention to the human and environmental aspects of extended season operation.

I share your real sense of responsibility in giving very serious consideration to the potential for economic growth in the Great Lakes region which extended navigation represents. I recognize, for example, the benefits which may accure to the iron ore and steel industry but also those benefits which year-round movement through the St. Lawrence Seaway System would spur in terms of employment opportunities at our ports and feeder systems.

There are international shipping companies which might make greater use of the Lakes as the nation's fourth seacoast were it not for the ice-limited navigation season. This is one problem I expect will be addressed at the Great Lakes Port Development and Shippers Conference I am co-sponsoring and which will be held in Dearborn this coming April.

As for costs, your Board reports a cost-benefit ratio of 3.7 for extended season operations on the Upper Four Great Lakes through January 31. This report, of course, will come under close security by the Congress as it debates whether it should fund a permanent extended navigation season.

Though I am generally supportive of your effort and applaud you for your years of effort, I am not about to present a blank check of support for this experiment without several responsibilities of this Board first being met.

First, as I stated many times, I firmly believe that the winter navigation program sponsors must adequately provide for the needs, the lives, and the concerns of the St. Marys River Island residents. No segment of the populations living around the Great Lakes have been as affected by winter navigation as have these citizens of the Eastern Upper Peninsula.

Specifically, I strongly believe and will work to ensure that island transportation problems caused by winter navigation -- and few doubt that winter shipping has caused significant disruptions in the lives of these island citizens -- must be fully and honestly addressed in the report this Board submits to Congress. I would hope the Board will make specific recommendations to Congress as to which solution they feel will be the most feasible from a cost-benefit standpoint. Furthermore, should the solution involve, for example, a bridge to Sugar Island or perhaps a new ice breaking ferry at Sugar or Drummond Islands the Board must - and I will insist that it does - tell the Congress such capital improvements are needed. The Board must spell out to the Congress what a bridge or a new ferry will cost and whether or not these additional costs are reflected in the cost-benefit ratio.

If Congress is to consider financing winter shipping on the Great Lakes on a permanent basis, I firmly and immovably believe it should recognize the government's responsibility to those individuals who have suffered the adverse effects of winter shipping activities.

There can be no substitution for the principle that problems caused by a Federal financed activity must not be paid for at the local level. It would be a gross injustice to simply shift the burden of relieving these serious transportation problems to the State and Local governments.

After all, these governments did not cause the problem or, perhaps, even desire winter shipping. It was the Federal government who caused the problems and the Federal government alone holds the responsibility to solve them.

The Winter Navigation Board, I believe, should also give more attention and offer specific recommendations on the safety and survival meausures needed to cope with the hazards faced by those engaged in winter navigation operations.

Your study recognizes "the effects of winter storms...are critical elements which have to be overcome for winter operations to be successful." But where are the specific means for fulfilling this obligation and the expenditure requests identified with them?

A vessel reporting system, more sophisticated aids to navigation (such as LORAN C), more seaworthy and properly positioned vessels to meet all-weather and all-season needs are only a few of the essentials which come to mind.

However, on inspecting your report, I see listed only such items as icebreaking assistance, navigation aids such as buoys and RACONS, ice information and reporting systems, booms,bubblers, and so on.

But what happens in a storm if a vessel is foundering like the Streamer Fizgerald? What size rescue vessels and, indeed, icebreakers are needed?

In those areas, as in the St. Marys River islands transportation need, this Board has a responsibility to report fully and honestly to the Congress the services that are needed and equipment additions necessary to conduct a winter navigation effort.

The Winter Navigation Board should tell the Congress, based on your experience over the past five years, exactly what type of new icebreakers will be needed, how many will be needed, and the cost per unit. I believe it is clear that the Mackinaw and the temporarily assigned Westwind cannot possibly be expected to patrol the entire Great Lakes-St. Lawrence Seaway region.

In summary, the human/people needs must be addressed and quantified as to type, quantity, and cost of the provisions or equipment essential to their interests and their interests alone. The responsibility for securing this equipment lies solely with the Winter Navigation Board.

Winter navigation does present an opportunity to help bring the Great Lakes into competition with the nation's other three seacoasts. But in so doing, we must solve the problems it causes for those who live along the shores of these majestic water resources.

ROBERT W. KASTEN, JR.
WISCONSIN

Congress of the United States
House of Representatives
Washington, D.C. 20515

February 20, 1976

Colonel James E. Hays
District Engineer
Corps of Engineers
Detroit District
Department of the Army
Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Thank you for notifying me of the public meetings on the Study of the Extension of the Navigation Season for the Great Lakes and St. Lawrence Seaway and inviting me to participate.

Although I am unable to attend the hearings, I want to take this opportunity to endorse efforts to extend the navigation season on the Great Lakes.

I am particularly concerned with the impact it will have on the Port of Milwaukee and the economy of the entire State of Wisconsin.

Unless the navigation season is extended, we are underutilizing the public's investment in locks and channels and the private sector's investment in docks, vessels and loading/unloading facilities.

Presently, companies in Wisconsin are being forced to stockpile raw materials for the winter season or resort to more costly land transportation systems. Neither of these alternatives to year-round shipping is acceptable.

Most important, inland ports such as Milwaukee, have the potential to play a major role in the next several years in expanding exports and conserving energy. The Great Lakes region can greatly increase its exports, particularly if low-cost transportation is available on a year-round basis. Quite simply, increased exports mean additional jobs for Americans.

I am pleased with the progress to date of the Winter Navigation Board and will support all efforts to convert the present experiment into a practical reality.

Again, many thanks for the opportunity to comment on this vital issue.

Best regards,

ROBERT W. KASTEN, JR.
Member of Congress

RWK:jc

TESTIMONY OF THE HONORABLE CHARLES A. VANIK ON THE EXTENSION OF THE GREAT LAKES SHIPPING SEASON

Cleveland, Ohio February 23, 1976

Mr. Chairman:

I appreciate the opportunity to comment on the extension of the navigation season on the Great Lakes. The extension of the shipping season would work to the benefit of the entire Great Lakes industrial region. Productivity and commerce which must be halted or suspended because of seasonal limitations may be permanently lost to the community.

The costs of extending the shipping season appear to be well within the ratio of benefits, more than three times the cost.

According to the Interim Report the $18.7 million in benefits resulting from a season extension accrue to two areas, transportation savings -- both in increased efficiency of the shipping fleet and lower rates compared to winter land transport (a combined total of $8 million), and savings from reduced stockpiling requirements by industries depending on ship transportation - mainly the steel industry ($10.7 million).

However, I am concerned about the effect the extended season will have on shore erosion which has developed into a major problem. As you well know, Lake Erie, particularly the southern shore of Lake Erie, and even more particularly the high bluff shores of my Congressional district east of Cleveland, have suffered staggering losses due to high water erosion. We can not stand one more inch of water in Lake Erie. Lake Huron and Lake St. Clair residents feel exactly the same way. My support for an extension of the shipping season is contingent upon continued efforts to limit lake levels.

I would strongly oppose extension of the shipping season if it means any increase in lower lakes levels. I support an extension of the shipping season to determine the effect on lake shore erosion. It may be that the development and maintenance of channels through the ice in winter months may accelerate a run-off of lake waters to lower levels. It is my hope that the extension of the shipping season could have a two-fold effect - continued commerce with its economic benefits and lower lake levels to prevent the crushing burden of erosion.

AMERICAN STEAMSHIP COMPANY
A SUBSIDIARY OF GATX CORPORATION
3250 MARINE MIDLAND CENTER
BUFFALO, NEW YORK 14203

February 2, 1976

James E. Hays
Colonel, Corps of Engineers
Chairman, Winter Navigation
Working Committee
Department of the Army
Box 1027
Detroit, Michigan 48231

Dear Jim:

Now that I am a transplanted Buffalonian and can look out of my office windows and see the Niagara River Ice Boom, I must make comment on the first item on page 9 of your public participation brochure sent with your covering letter of January 26, 1976.

In the first instance there is very little traffic through the North Entrance of Buffalo Harbor that either goes into the main harbor or down the Black Rock Canal in winter. No commercial vessel goes down the Niagara River, it's too risky. See Great Lakes Pilot, 1975, page 275.

Also on the same page is a general description of the Ice Boom. Actually, it is in several sections and is placed as follows: N. End Lt. to West Breakwater Fl R Lt. to the old Erie Beach dock on the Canadian shore.

Thus you can see by plotting these points on Chart 314 there is little chance for a vessel to bother the ice boom. This may well be understood by all concerned but the item on page 9 sounds as if a major effort will be undertaken. In my opinion this item could well be put last on any priority list and not interrupt any plans for extending the navigation season.

Best regards.

Sincerely,

Louis E. Ervin
Special Assistant to the President

LEE:sg

THE NEEBISH PIONEERS ASSOCIATION, INC.

BARBEAU P.O., MICHIGAN

RAINS ISLAND

PLEASE ADDRESS
REPLY TO

79 So. Deere Park Drive
Highland Park, Ill. 60035

February 5, 1976

James E. Hays
Colonel, Corps of Engineers
Chairman, Winter Navigation Working Committee
Department of the Army
Detroit District, Corps of Engineers
Box 1027
Detroit, Mich. 48231

RE: NCEED-PB

Dear Colonel Hays:

Thank you for sending me the brochure giving the summary of the interim feasibility report to be discussed at the public meetings, Third Series, to be held during the month of February.

I note that further discussion will be addressed to, among other things, "NEEDS & METHODS FOR PROTECTING SHORE STRUCTURES ALONG THE ENTIRE ST. MARYS RIVER" (P 7).

It seems that we have, over and over, established the need for such protection. What has been denied us is compensation or assistance of some sort to repair the damage that has already been done as a result of the winter extension program.

On page 12 figures are given to outline the costs and benefits which would result from continuation of this program. We strongly urge that a portion of the cost of the program, especially in view of the resulting huge economic benefit, should be allocated to give us the help we have heretofore been denied, to restore our destroyed shore structures.

I would greatly appreciate your making this letter part of the record of the forthcoming meetings.

Very truly yours,

Frank M. Fucik
Chairman, Ecological Committee
Neebish Pioneers Association

FMF/lhw

United States Department of the Interior

OFFICE OF THE SECRETARY
NORTH CENTRAL REGION
230 S. DEARBORN STREET, 32nd FLOOR
CHICAGO, ILLINOIS 60604

XER 75/1195

February 12, 1976

Colonel James E. Hays
District Engineer
U.S. Army Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

This letter is to provide preliminary comments on the Draft Interim Feasibility Report on extending the navigation season on the Great Lakes-St. Lawrence Seaway System, from my perspective as the Department of the Interior member of the Winter Navigation Board. The U. S. Fish and Wildlife Service will provide a fish and wildlife report on this proposal for the upper four lakes in about two weeks, and official Department of the Interior comments will be made when the final report is circulated by the Chief of Engineers.

The interim report proposes a continuation of existing measures on the four upper lakes, to extend navigation to about January 31 each winter. In general, this degree of shipping season extension appears to be environmentally feasible. Our short-term observations and our studies during the demonstration indicate that the proposed operation would not significantly affect the valuable fish and wildlife populations or their habitats. However, we have not determined long-term effects at this point. There are also a number of unanswered questions with regard to outdoor recreation activities, primarily ice fishing. We have some concern about secondary operational items that can become apparent later. These might include channel modifications, lock modifications or new locks and the use of untested methods of ice suppression or control (the unproven warm water system). We understand that these items, if thought to be needed, would be submitted to the same scrutiny as the present measures.

The discussion of outdoor recreation is of a very general nature and does not fully address the effects of an extended navigation season on the recreational use of the Great Lakes-St. Lawrence Seaway system. There is little discussion of existing and potential winter-recreation which would be lost with the implementation of the extended season. We believe that specific areas which are heavily used as winter recreation sites in times of stable ice cover should be identified, and the impacts on these areas should be addressed.

A principal loss will be in ice fishing, in that this activity would be eliminated a certain distance from the vessel tracks, and access to other fishing areas across the tracks would be denied. This has happened whenever ice-breaking has occurred in the past. The following areas have been identified where a significant fishing loss would occur: Whitefish Bay, St. Marys River, Lake Nicolet, Muskegon Lake, Lake Munuscong, St. Clair River, and Lake St. Clair. At present, there are no known feasible means of compensating for these losses. However, for fisherman safety, we recommend that vessel tracks and channels, where ice-breaking and bubbler systems are constructed, be plainly marked, warning fishermen of the unsafe condition.

The Bureau of Outdoor Recreation, in agreement with the Corps of Engineers, will survey winter recreational use of 29 harbors and four connecting channels to observe the extent of recreational activity and estimate the social impact of the extended navigation season on winter recreation participation. Survey conclusions will contain recommendations for more detailed studies which will be needed to accurately assess the impacts of the extended season on winter recreational use of the lakes, harbors, and channels.

In addition to the direct loss of recreation opportunities, we believe that economic losses to the surrounding communities resulting from losses of recreational opportunities should be addressed. These losses may be in the form of fewer tourists, a decline in equipment sales, loss in taxes on gasoline sales and license purchases, and damage to commercial and private recreation properties.

Some species of terrestrial wildlife occasionally move across the ice. Species such as moose, wolves, and lynx move across the ice from Canada to the Upper Peninsula of Michigan and to other places as well. These areas constitute the southern extremity of their range. Other animals, such as deer, bear, coyotes, and the fox move over the ice to adjoining islands. Ice-breaking and the bubbler systems would eliminate this movement. The amount of animal movement across the ice is not precisely known, but it is generally considered to be minor. Much of the area, though formerly occupied by these northern species, is not now considered to be good habitat due to man's developmental activities.

Oil spills under ice conditions, though adequately described in the report, are not treated adequately in the section outlining the remedial measures to be taken. Accidental oil spills constitute a serious threat to fish and wildlife as well as other environmental aspects. For this reason, we recommend that, instead of a single location for the oil spill strike group, several strategically placed groups be established. These locations might include Duluth-Superior, Sault Ste. Marie, and Milwaukee.

Our concern that shoreline wetlands and other habitats might be damaged or destroyed by erosion caused by the season extension appears to be unsupported. The report description shows that erosion damage from ice-breaking and from the natural spring break-up are mostly indistinguishable from each other. Because spring break-up melting starts at the shorelines, thus releasing the main ice mass and allowing it to move with the wind, it would appear that much of the erosion damages occur at that time. During the time of ice-breaking the ice is firmly anchored to the shore. Ice movement in the shore zone at that time would only occur on a raising water level. We recommend that during the ice-breaking season, water levels be held as constant as possible.

There would be a certain amount of enhancement in polluted harbors associated with the bubbler systems. This is particularly true where the waters contain depressed dissolved oxygen levels. The increased dissolved oxygen from the bubblers could allow a greater number of more desirable fish to use the affected areas. By extending the bubbler systems through the areas of polluted waters in most ports (which generally are located in river mouths), the fish might be able to traverse these areas to spawning areas. Polluted areas, areas of low dissolved oxygen, constitute migratory barriers or blocks. We must point out that this also may allow the noxious sea lamprey access to spawning areas. This would negate the enhancement of increased sport fish and fishing that would occur. Therefore, we recommend that this possible enhancement feature be studied further to determine whether the enhancement benefits warrant the increased costs associated with the increased lamprey control that may be involved.

On page C-18 and C-19 concerns of recreationists in the Sault Ste. Marie, Michigan, area are mentioned in the report. However, no mention is made of problems which have been encountered in many other sites encompassed by the study area. We urge that any available information on other areas be included in the final report.

There appear to be discrepancies in the formulation of the benefit/cost ratios for the three alternatives. Economic Criteria, page D-3, indicates that the "development should provide the maximum net benefits (including economic, environmental, and social)." We also note on page D-4, Environmental, Social, and Other Criteria, that "human environment benefits and costs are shown with status equal to money units." However, on page D-10 and D-11 no benefits or costs are calculated for the no action alternative or for the fixed season alternative. It seems that there are benefits and costs involved in each of these alternatives although they cannot be directly attributed to transportation-related benefits or costs. We believe that benefits of these two alternatives should include winter recreational use of the lakes, harbors, and channels. Project justification based on benefit/cost ratios cannot adequately evaluate all alternatives if there is no benefit/cost ratio for two of the three alternatives.

Table D-3 on page D-34 under "Social Well-Being Effects; Leisure, Cultural, and Recreational Opportunities", notes that a detailed investigation of recreational activities is required for the St. Lawrence River in the extended season alternative. We feel detailed investigations should be done for the entire study area rather than just the St. Lawrence River area. The results of all of these should be included in future reports.

In table D-4 on page D-46 under "Social Well-Being, Adverse, Potential Disruption of Recreational and Leisure Activities", timing should include Item III, because ice cover and recreation will be disrupted throughout the life of the project.

Under Social Effects, page D-63, paragraph 3, it is suggested that areas of recreational activity would have to move because of unstable ice conditions. We feel that the statement should indicate a loss of recreation areas if ice in heavily used areas is broken up or otherwise rendered unstable.

Page 2 of Appendix III does not include loss of winter recreation opportunities or economic losses as project costs. We feel these issues should be included as a cost for the extended season alternative.

My final point concerns treatment of the St. Lawrence River in this document. It is clearly pointed out that the presently-proposed action involves only the upper four lakes; the present status on the St. Lawrence is not as well defined. For example, conclusion (1) in Section K is incorrect in the beginning sentence, which states that a navigation season extension on the St. Lawrence Seaway is environmentally feasible. Environmental feasibility has in fact not been shown, and additional long-term study will be necessary before decisions can be made on the St. Lawrence River. The St. Lawrence is being considered separately, and comments on the upper four lakes may or may not apply to it. The analysis in Appendix V leading to the conclusion that only large-scale dredging would have a significant effect, is inadequate. The present lack of ecological data on the St. Lawrence precludes anything but the most subjective judgments as to environmental effects. The measures proposed to remove navigation constraints do have potential for adverse environmental impacts. We need more data on which to base judgments.

I appreciate the opportunity to provide these preliminary comments, and would be pleased to discuss them further if you desire.

Sincerely,

for Daniel F. Dennis

Madonna F. McGrath
Acting Special Assistant
to the Secretary

cc: COE Div. Eng., NCD

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
LWR

FEB 12 1976

Colonel James E. Hays
District Engineer
U.S. Army Engineer District
  Detroit
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

This responds to your letter of January 27, requesting our review, comments and recommendations of the Draft Interim Feasibility Study of Great Lakes-St. Lawrence Seaway Navigation Season Extension. As we advised your planning section in a telecon on February 9, we cannot provide a fish and wildlife report for the proposed work by the time you requested, February 13. We are providing, as requested, the following preliminary comments and recommendations for your immediate use with the understanding that they are preliminary and that more complete comments under the Fish and Wildlife Coordination Act will follow by February 24.

The draft report is weak in its descriptions of fish and wildlife resources and of the effects of the proposed plan of operation on these resources. We hope our report will aid in correcting that situation.

Our preliminary comments follow:

The U.S. Fish and Wildlife Service has studied the various aspects of extending the navigation season that have been investigated to date during the demonstration phase. Since the selected plan contains only those aspects that have been demonstrated, will be used during a given period in the winter (to January 31), and are incorporated into an operation plan for the upper four lakes, we can make some general observations on the selected plan of operation. We have some concern about secondary operational items that can become apparent later. These might include channel modifications, lock modifications or new locks and the use of untested methods of ice suppression or control (the unproven warm water system). We understand that these items, if thought to be needed, would be submitted to the same scrutiny as the present measures.

Under the outlined operation, time frame, and within the area described (the upper four lakes), we believe that it would be environmentally

AMERICAN REVOLUTION BICENTENNIAL 1776-1976 feasible to extend the navigation season. Our short-term observations and our studies during the demonstration indicate that the proposed operation would not significantly effect the valuable fish and wildlife populations or their habitats. However, we cannot determine what long-term effects, if any, may occur. We recommend that as the operation progresses, long-term effects on fish and wildlife, if any, should be studied and indicated remedial actions taken.

The proposed operation, principally the ice-breaking and the bubbler systems, will affect ice fishing in that this activity would be eliminated a certain distance from the vessel tracks and access to other fishing areas across the tracks would be denied. This has happened whenever ice-breaking has occurred in the past. The following areas have been identified where fishing loss would occur: Whitefish Bay, St. Marys River, Lake Nicolet, Lake Munuscong, St. Clair River, and Lake St. Clair. At present, there are no known feasible means of compensating for these losses. However, for fisherman safety, we recommend that vessel tracks and channels, where ice-breaking and bubbler systems are constructed, be plainly marked, warning fishermen of the unsafe condition.

Some species of terrestrial wildlife also occassionally move across the ice. Species such as moose, wolves, and lynx move across the ice from Canada to the Upper Peninsula of Michigan and to other places as well. These areas constitute the southern extremity of their range. Other animals, such as deer, bear, coyotes, and fox move over the ice to adjoining islands. Ice-breaking and the bubbler systems would eliminate this movement. The amount of animal movement across the ice is not precisely known, but it is generally considered to be minor. Much of the area, though formerly occupied by these northern species, is not now considered to be good habitat due to man's developmental activities.

Oil spills under ice conditions, though adequately described in the report, are not treated adequately in the section outlining the remedial measures to be taken. Accidental oil spills constitute a serious threat to fish and wildlife as well as other environmental aspects. For this reason, we recommend that, instead of a single location for the oil spill strike group, several strategically placed groups be established. These locations might include Duluth-Superior, Sault Ste. Marie, and Milwaukee.

Our concern that shoreline wetlands and other habitats might be damaged or destroyed by erosion caused by the season extension appears to be unsupported. The report description shows that erosion damage from ice-breaking and from the natural spring break-up are mostly indistinguishable from each other. Because spring break-up melting starts at the shorelines, thus releasing the main ice mass and allowing it to move with the wind, it would appear that much of the erosion damages occur at that time. During the time of ice-breaking the ice is firmly anchored to the shore. Ice movement in the shore zone at that time would only occur on a raising water level.

We recommend that during the ice-breaking season that water levels be held as constant as possible.

There would be a certain amount of enhancement in polluted harbors associated with the bubbler systems. This is particularly true where the waters contain depressed dissolved oxygen levels. The increased dissolved oxygen from the bubblers could allow a greater number of more desirable fish to use the affected areas. By extending the bubbler systems through the areas of polluted waters in most ports (which generally are located in river mouths), the fish might be able to traverse these areas to spawning areas. Polluted areas, areas of low dissolved oxygen, constitute migratory barriers or blocks. We must point out that this also may allow the noxious sea lamprey access to spawning areas. This would negate the enhancement of increased sport fish and fishing that would occur. Therefore, we recommend that this possible enhancement feature be studied further to determine whether the enhancement benefits warrant the increased costs associated with the increased lamprey control that may be involved.

We hope these comments will be of help in your deliberations. We must make it clear that these comments and recommendations are of a preliminary nature and further analysis may indicate changes in our present thinking on this interim operation plan.

Sincerely yours,

Assistant Regional Director
Environment

United States Department of the Interior
BUREAU OF MINES
4800 FORBES AVENUE
PITTSBURGH, PENNSYLVANIA 15213

February 5, 1976

Colonel James E. Hays
U. S. Department of the Army
Detroit District, Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

We have reviewed the Interim Feasibility Report on extension of the navigation season on the Great Lakes-St. Lawrence Seaway System, as requested.

Extension of the navigation season should benefit mineral producers and users in the region by permitting year-round shipping of mineral commodities on the Great Lakes. Mineral commodity shipments could be redistributed over a 12-month season, thus permitting a more regular mine production schedule as well as greatly reducing stockpiling by both the producers and users. Present stockpile areas could be diverted to other more critical land uses.

Sincerely yours,

Robert D. Thomson

Robert D. Thomson, Chief
Eastern Field Operation Center

FEDERAL POWER COMMISSION
REGIONAL OFFICE
31st Floor, Federal Building
230 South Dearborn Street
Chicago, Illinois 60604

February 6, 1976

Col. James E. Hays
District Engineer
Department of the Army
Detroit District, Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

We have reviewed the draft of the Interim Feasibility Report, Great Lakes - St. Lawrence Seaway Navigation Season Extension, in accordance with your letter request of January 27, 1976.

I have some difficulty in agreeing with the statement in the second sentence of the fourth paragraph of the Syllabus (and elsewhere in the main report) that "season extension on the entire system is economically feasible, ..." It seems to me that we have not proven or demonstrated that winter navigation on the St. Lawrence Seaway is feasible from an engineering or economic viewpoint. Economic feasibility implies consideration of all benefits and costs and it appears that studies to date on the Seaway portion have considered only those costs associated with physical improvements and the operation and maintenance thereof. For example, it has not been demonstrated that the ice booms on the St. Lawrence can be successfully navigated without causing ice jams and the attendant losses in power production and flood damages. Thus, it appears that some caveat should be placed on any statement as to economic feasibility to the effect that certain possible negative effects of operations have not been recognized or, on the other hand, that it is assumed there would be no negative effects. Otherwise, why should there be any need for further demonstration activities on the St. Lawrence?

The opportunity to review the report is appreciated and I will be pleased to discuss my somewhat limited comments thereon in more detail should you so desire. These comments are made at field level and are not to be construed as those of the Federal Power Commission itself.

Sincerely yours,

Lenard B. Young
Regional Engineer

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE Room 101, 1405 South Harrison Road
East Lansing, Michigan 48823

February 9, 1976

Colonel James E. Hays
District Engineer
Department of the Army
Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

We have received a copy of the draft Interim Feasibility Report on the extension of the navigation season on the Great Lakes-St. Lawrence Seaway System.

We have no comments or recommendations regarding the draft report, however, we do appreciate the opportunity for review and comment.

Sincerely yours,

Arthur H. Cratty
State Conservationist

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Md. 20852

NC

February 10, 1976

To: Colonel James E. Hays, CE

From: R.Adm. Harley D. Nygren, NOAA

Subject: Interim Feasibility Report (WNB)

Assuming that you make changes in the Interim Feasibility Report in accordance with comments made at the last meeting of the Winter Navigation Board, I find it to be acceptable.

UNITED STATES DEPARTMENT OF COMMERCE
Maritime Administration
Great Lakes Region
666 Euclid Avenue, Room 576
Cleveland, Ohio 44114

February 11, 1976

Colonel James E. Hays
Department of the Army
Detroit District, Corps of Engineers
P. O.Box 1027
Detroit, MI 48231

Dear Colonel Hays:

Our office has reviewed the Interim Feasibility Report on the extension of the navigation season on the Great Lakes-St. Lawrence Seaway system. The overall report appears complete and seems to consider all the salient aspects of the season extension program. The following comments and recommendations are submitted for your attention and inclusion within the final interim report.

The Maritime Administration supports the Report's conclusions that navigation season extension on the entire Great Lakes and St. Lawrence Seaway is economically feasible and that it is environmentally feasible on the upper four Great Lakes. Further, the conclusion to extend the season over time and traffic segments, as measures and means for each required stage are developed, is a progressive approach. It is MarAd's view that, the next major traffic segment to concentrate resources must be the St. Lawrence Seaway segment of the system. Only when the St. Lawrence Seaway navigation season extension becomes a reality will the Great Lakes ports and international manufacturing and shipping industries derive full benefits from the season extension.

Concerning the recommended extension to 31 January on the four upper Great Lakes, it may be considered arbitrary to close down the season on any specific date after the target date of 31 January. The recommendation appears to have not taken into consideration the high probability of good weather conditions in some years which would permit navigation beyond 31 January without additional capital expenditure. It is our recommendation that the operation plan should be to extend the navigation season in the upper four Great Lakes at least to 31 January and remain open longer as weather permits.

Concerning the high capital replacement cost of ice reconnaissance aircraft and the ensuing operation expenses of same, it is recommended that a careful continuous review be made of the utility of the ice cover data received from reconnaissance aircraft before actual aircraft replacement is made. It is our belief that vessel operating personnel will find this data of little value in making on board vessel navigation decisions. It is recognized, however, that a certain degree of ice condition air reconnaissance is necessary for government and industry decisions concerning the trade routes in which the vessels will be employed and the probabilities of extention beyond 31 January.

The benefit/cost ratio of 3.7 is based solely on the costs of an extension in the upper four Great Lakes and the benefits to Canadian and U. S. vessels operating in interlake trade to or from U. S. ports. The ratio would be greater if these same waterways were used by cargo vessels in international trade which enter the Great Lakes through the St. Lawrence Seaway. This benefit will accrue when the St. Lawrence Seaway and Lake Ontario portions of the system have their navigation season extended.

As a final note, a typographical error appears in several places (see Page D-5 and D-8) where the normal shipping season is indicated as 9½ months. This should read 8½ months.

Sincerely yours,

George J. Ryan
Director, Great Lakes Region

POWER AUTHORITY OF THE STATE OF NEW YORK
ST. LAWRENCE POWER PROJECT
BOX 700 - MASSENA, N. Y. 13662 AREA CODE 315 764-0226

February 10, 1976

Colonel James E. Hays
Detroit District, Corps of Engineers
P. O. Box 1027
Detroit, Michigan 48231

Dear Jim:

I have the Draft Interim Feasibility Study on Navigation Season Extension. Time constraints have precluded anything but a cursory review of all material contained therein. However, I would like to offer several general comments for your consideration in finalizing the report.

In my view, the overall tone of the report appears overly optimistic when one balances both the concrete achievements of the program since the beginning and the as yet unresolved or unaddressed questions which remain if season extension is ever to be realized.

I think the major findings of the program to date include the fact that vessels can move from Lake Superior ports through the Soo Locks and the St. Marys River into Lakes Michigan-Huron. To accomplish this, increased Coast Guard activity is necessary, the island inhabitants have been inconvenienced and I understand that the output of the Edison Sault plant has been reduced at times, imposing additional costs on their consumers.

I am not aware of any definitive findings to overcome the problems in the St. Clair-Detroit River system other than paper and/or model studies. With continuous breaking of a vessel track through the ice bridge above the Blue Water Bridge and my recollection of the winds which prevail in that area, I am not convinced that an ice boom will be successful in retaining the lake ice and preclude spilling this ice into the river. It would be a situation quite similar to the Lake Erie ice boom and, as you know, even though there is no vessel activity above that boom it often spills large quantities of ice down the Niagara River because of winds. As regards the St. Clair situation, were I a Michigan congressman, I think I would be disturbed by the statement on page E-18 that with the selected plan "Ice jams in the lower St. Clair River would continue..." or on page C-20 "...a reduction in ice retardation effects on flow in the St. Clair-Detroit Rivers will affect the historic pattern of lake levels (a lowering of the Lakes Michigan-Huron levels)."

All of the above leads me to question statements such as on page E-1, "This capability was proven when ships moved to 29 January, 1 February, 8 February and 7 February, respectively, through the St. Marys River between 1971 and 1975 and continued their voyages throughout the four upper Great Lakes," and on page D-11 that "The 1975 operation in the St. Marys River and upper Great Lakes went to a record year-round extension..." While I cannot be positive, I am almost sure there was no traffic into or out of the Port of Buffalo as late as the dates quoted and certainly there was not year-round operation there in 1975.

While I have not seen the detailed economic analysis, I seriously question the benefit-cost ratios provided in the report. The statements on page D-12 such as "This plan would provide and enhance national economic and environmental benefits and would contribute to the social well-being of the entire 19-state Great Lakes region," in my view could be seriously questioned by the railroads and trucking industry, by the island residents in the St. Marys River and by the consumers of Edison-Sault power and certainly by Eastern and Gulf Coast ports. In other words, I feel the benefits are overstated since no mention has been given to the disbenefit side of the ledger. I recall conversations with some of those making the economic analysis who indicated their assumption that vessels would move with the same frequency in winter as in summer which is fallacious. I see no reference to the fact that in the St. Lawrence, winter operation means that drafts would have to be reduced 10 percent or more even if devices were discovered to maintain both a vessel track and a stable ice cover. Would winter voyages be economically attractive to overseas vessel operators if they could only load to 21 or 22 feet rather than the nearly 26 feet they have available in open water months. I also question the implication of statements on pages D-64 and D-67 that navigation on the St. Lawrence closes during the winter months "... to enable installation of ice booms at selected locations in the river for power production purposes." I think it should be clear to everyone by now that navigation stops because of ice and the problem ice produces; the ice booms are installed to stabilize the ice to minimize the possibility of ice jams. The report does state this on page 6 of Section G.

Going back to the statement on page D-11, no explanation is provided as to how the environment will benefit from extended season operation. In fact, a reading of the report points out that several environmental problems have developed thus far in the program - shoreline erosion, structural damage, disruption of recreational activity, extended periods of noise to vessel crewmen and to shoreline residents - where are the beneficial effects listed? In fact on page D-61 you state "As a result, the potential for damages to the shore and shore structures increases." In fact, on pages 6 and 7 of Section G, six of the 20 problems you list bear directly on the environmental problems posed by a shipping season extended into an ice environment.

On page 10 of Section G, you list the conclusions reached by the report. In (1) the report states that "...navigation season extension on the entire Great Lakes-St. Lawrence Seaway System is economically and environmentally feasible." Yet two sentences later the report states "Additional environmental study is required to make a judgment on the St. Lawrence River." In (2) the report notes "...an entire environmental evaluation and assessment is required on the St. Lawrence River." These conclusions seem somewhat inconclusive to say the least.

On page 11 in Paragraph 5 (a) are listed the existing operational measures necessary to extend the season on the upper Great Lakes, and in 5 (b) the annual cost of these measures is given as five million. Can it be assumed in reviewing these costs that only monitoring will be done insofar as the St. Clair River is concerned and nothing to stabilize the ice bridge is included?

As a final point, the last sentence on page 9 of Section G states "In addition, United States efforts on the lower Great Lakes and St. Lawrence River must be carefully coordinated with parallel Canadian efforts in these areas." Since four of the five Great Lakes and all of the connecting channels are international in character, why are the lower Great Lakes different than the upper Great Lakes?

In summary, my rather hurried review of this draft interim report points out that the program of extending the navigation season into the winter months has been successful in producing benefits to several shipping interests and to those industries who rely on them. However, in the process, many real problems have arisen and many unanswered questions remain. Again, while I have not reviewed the methodology employed, I cannot at this time endorse the findings of benefits claimed for season extension without evidence that disbenefits are also considered. This judgment is probably somewhat influenced by my understanding that Canada's Treasury Board has not funded a parallel Canadian program because of their analysis that costs outweighed benefits.

Sincerely yours,

Robert D. Conner
Resident Manager

RDC:ml

DEPARTMENT OF STATE

Washington, D.C. 20520

February 11, 1976

Mr. James E. Hays
Colonel, Corps of Engineers
District Engineer
Department of the Army
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Thank you for your letter of January 27 which forwarded for our comments and concurrence the Great Lakes-St. Lawrence Seaway Navigation Season Extension Interim Feasibility Study. We have reviewed the report and believe it accurately portrays those potential problems which may arise with the Canadian Government and Canadian interests.

With respect to the problem of ice boom placement in the St. Lawrence River by the power entities, we believe that it is important to note that while the booms are placed to help assure power production, they also can have a significant effect on outflows from Lake Ontario by impeding the formation of ice jams in the St. Lawrence River. As noted in the report, Lake Ontario and the other Great Lakes have experienced record high levels in the past several years, and interruption of these outflows by ice jams could have a material effect on the level of Lake Ontario.

Sincerely,

Louis F. Janowski
Office of Canadian Affairs

DEPARTMENT OF TRANSPORTATION
SAINT LAWRENCE SEAWAY DEVELOPMENT CORPORATION
WASHINGTON, D.C. 20590 MASSENA, NEW YORK 13662

800 Independence Avenue, SW
Washington, D. C. 20591

13 FEB 1976

Colonel James E. Hays
District Engineer
U.S. Army Engineer District, Detroit
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Your letter of January 27, 1976, transmitted revisions dated 29 January 1976 to the Interim Feasibility Report on Great Lakes - St. Lawrence Seaway Navigation Season Extension which you provided to members of the Winter Navigation Board at their meeting in Detroit on January 20. You request our comments by February 13, 1976, and indicate this reply will be included in the final interim report scheduled to be completed by March 1, 1976.

The review time is too short and the report too long to provide all of our detailed and specific comments here. Rather, I shall take this opportunity to make several important points of a more general nature. Specific comments, both written and verbal, are being provided to your staff in Detroit and to North Central Division staff in Chicago by Messrs. Robb, Lewis, and Gelston of the Corporation in order to meet your tight deadlines.

The subject report summarizes the findings of the multi-agency, Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Program to date, discusses three general alternatives for season extension, and recommends that authority be provided for ..."a continuing ice operation and maintenance project at an average annual cost of $5.0 million." The specific plan recommended is a so-called operational plan, providing for navigation on the upper four lakes through January 31. This plan does not contemplate any actions dealing with the Welland Canal and St. Lawrence River portions of the Seaway. It has a benefit/cost/ratio of 3.7, as compared to a B/C ratio of 3.9 for the so-called guaranteed plan for season extension through January 31. Some explanation of why the operational, rather than the guaranteed plan was chosen would be helpful. I am sure you are aware of our concern and that of the users with your selection of a January 31 closing date for the recommended program in light of the full 12 month season in 1974-75 and the history of successful operations beyond that date in previous years and in the present year. The current draft provides no rationale for selection of the January 31 date.

In order to avoid confusion for the reader, the title and the syllabus should be modified to clarify the fact that this report provides recommendations solely for the upper lakes.

Nothing has been brought to our attention to indicate the several Federal entities with operational responsibilities in the Great Lakes-St. Lawrence Seaway system do not presently enjoy adequate authorization to provide services during the winter. (We certainly have such authority.) If such authorization deficiencies do exist elsewhere, they should be specifically identified. Since the interim report is thus primarily a medium for providing authority for Corps of Engineers funding for operating the Soo Locks, the St. Marys River ice boom, the Sugar Island bubbler-flusher and the Lime Island airboat beyond the historical winter closing the report should so state so as to not prejudice the position of the other agencies.

Section D, Formulation of Alternative Plans, deals with the entire system and considers a full range of alternatives. These are summarized in three specific alternatives:

Alternative 1 - NO ACTION is a non-structural plan, which contemplates no federal investment or activities. This plan assumes the Soo Locks, the Welland Canal and the St. Lawrence River will operate during the historical navigation season. Specific dates of opening and closing, based on recent history and recognizing the effect of varying winter severity, must be provided if this alternative is to be evaluated meaningfully.

Alternative 2 - FIXED NAVIGATION SEASON is also a non-structural plan, which contemplates no federal investment. Specific dates for the opening and closing of the navigation season are also required for this alternative if it is to be evaluated.

Alternative 3 - EXTEND THE NAVIGATION SEASON should be expanded to reflect the possibility of differing seasons for the three portions of the system controlled by the Soo Locks, the Welland Canal and the St. Lawrence River portion of the system.

Section D contains numerous erroneous statements as to the role which the power entities' ice booms play in regards to navigation. Navigation on the St. Lawrence River portion of the system ceases when, in the judgment of the Seaway operating entities, the St. Lawrence Seaway Authority of Canada and the U.S. Saint Lawrence Seaway Development Corporation, weather and ice conditions preclude safe and efficient navigation. Unauthorized closings to the contrary notwithstanding this determination controls the installation of the power entities' ice booms.

That navigation takes precedence over power in the use of navigable waters is well-established in the domestic law of both the United States and Canada and recognized in the 1909 Boundary Waters Treaty between the two countries. This principle is reflected throughout the institutional approvals under which the St. Lawrence River was developed. Specifically, the International Joint Commission Order of Approval, the Federal Power Commission License and the Corps of Engineers permit authorizing construction in navigable waters all state unequivocally that the power works, including ice booms, shall be operated so as not to interfere with navigation.

The Seaway entities (and the Winter Navigation Board) realize their obligations to riparian interests and the practical operating necessity of maintaining a satisfactory levels and flows regime, in the winter as well as in the remainder of the year. We have concluded that significant extension of the navigation season on the St. Lawrence River will necessitate an improvement in the stability of the ice cover and the winter levels and flows regime over that currently maintained during the period when navigation has been shut down. These improvements will result in benefits to riparian owners and to the power entities, as well as allowing navigation into the winter months.

Early in the Winter Navigation Demonstration Program, the power entities expressed grave reservations about the fesibility of navigating through their ice booms. These reservations have been answered, we feel, by several demonstration projects. Specifically, installation and testing of a movable gate in the Ogdensburg-Prescott boom showed the feasibility of this technique to allow boom installation prior to the close of the navigation season, thus simplifying boom installation and permitting navigation at least up to the time of ice formation. Installation and field testing throughout the winter of a test navigation boom at Copeland Cut showed the feasibility of navigating through in the field behind a boom and through the boom itself in a location with water velocities comparable to those at Ogdensburg-Prescott while maintaining the stability of the ice cover and a clearly defined navigation channel. Installation and field testing during this current winter of an ice navigation boom at Little Rapids Cut on the

St. Marys River has clearly demonstrated the feasibility of commercial navigation through an ice boom and the ice field behind it in an area where water velocities approach the highest velocities experienced in the St. Lawrence River navigation channel.

Appendix V of your interim report reproduces a summary report on the System Plan for All-Year Navigation on the St. Lawrence River, performed for us under contract. This report concludes that extended season navigation on the St. Lawrence River is technically, economically and environmentally feasible for all periods from one week of extension to year-round navigation. The environmental evaluation is based more upon the basic concept utilized during the study of choosing alternatives which minimized changes in the ice cover and the winter environment in general, and which proposed as few structural alternatives as possible. The Seaway Development Corporation realizes the need to obtain additional environmental baseline data before a final environmental judgment can be made. We have supported in the past, are supporting, and will continue to support in the future funding for these studies.

In accordance with a recent joint decision by the Saint Lawrence Seaway Development Corporation and the St. Lawrence Seaway Authority, vessels not exceeding 730 feet in length, 76 feet in beam, and 26 feet in draft are accepted for transit on the St. Lawrence River and Welland Canal portions of the Seaway. Further studies are underway to assess the possibility of increasing this size. Statements in Section B should be corrected to support these changes.

Section F - Economics of Selected Plan - would be improved if agency responsibility were designated for each of the proposed improvements listed in tables F-1 and F-5. A brief discussion of the factors which led to selection of the "operational" plan as opposed to the "guaranteed" plan should also be included. By way of specific comment, the traffic levels listed for both 1977 and 1980 in Table III-2 for the entire system are obviously in error. They appear to be very close to the levels to be expected through the Soo Locks alone and are considerably below recent historical levels for the system.

As you are aware, the SPAN (System Plan for All-Year Navigation) report economic analysis for season extension on the St. Lawrence River portion of the system used an interest rate of 6-7/8 percent, rather than the 6-1/8 percent used in the interim report. The SPAN benefits are based on traffic forecasts provided to us by the Corps of Engineers. It is our understanding that the forecasts provided us have been since superceded. We should appreciate receipt of the latest forecasts and any updates as they become available.

The material in Appendix III is difficult to evaluate without additional information. Since no indication is given as to agency responsibility for or the character of the specific components of the alternatives for the three periods of extension on the total system, we have no basis for concurrence with either the costs or the contemplated system plan.

We have a number of additional questions in regards to the economic analysis which my staff has tried to resolve by telephone. Since it now appears that more extensive dialogue is necessary before the problem can be resolved, meetings in Chicago and Detroit next week have been scheduled to discuss the methodology, the traffic forecast results, and the system plan components and costs.

Of particular concern with respect to the economic analyses is the treatment of vessel utilization savings versus shipper rate savings within the calculation of benefits and operation of the Kearney/Arctec models for both the Upper Lakes and Total System approaches.

Limited time has not permitted review of all primary commodity forecasts for the total system tonnage schedules, but we have looked at the grain commodity section and have several reservations concerning the forecasting procedure methodology and resulting tonnage levels.

Major areas of concern affecting the economic analysis will be covered in more detail under separate transmittal by my staff to NCD and your office.

The above comments and recommendations represent our views as constrained by the very limited amount of time available to review the draft interim report. In light of the rather extensive changes which must be made in the draft as provided, we should like to reserve concurrence until the final version is available.

Sincerely,

D. W. Oberlin
Administrator

THE ST. LAWRENCE SEAWAY AUTHORITY
ADMINISTRATION DE LA VOIE MARITIME DU SAINT-LAURENT

202 Pitt Street,
Cornwall, Ontario.
K6J 3P7

February 13, 1976.

Col. James E. Hays,
District Engineer,
Corps of Engineers,
Department of the Army,
P.O. Box 1027,
Detroit, Michigan. 48231

Dear Colonel Hays:

Thank you for the copy of the Interim Feasibility Report on extension of the navigation season on the Great Lakes - St. Lawrence Seaway System. We have reviewed the report and find that the problems and needs connected with a longer navigation season have been well defined - particularly for the upper four Great Lakes - through the Demonstration Program.

Your recommendation for an operational season running to January 31 in the 1976-77 winter on the Upper Great Lakes is a practical one based on your achievements in that area over the last four years. I also feel that you have satisfactorily addressed the problems which exist on the St. Lawrence River and the approach which should be taken. I understand that this subject will be discussed in more detail in the report which is being prepared on the Demonstration Program.

Yours very truly,

U. J. Blair

A. M. Luce,
Director of Operations.

Advisory Council
On Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

February 13, 1976

Col. James E. Hayes
District Engineer, Detroit District
U. S. Army Corps of Engineers
P.O. Box 1027
Detroit, Michigan 48231

Dear Col. Hayes:

We have received your request of January 27, 1976, for comments on the Interim Feasibility Report on the extension of the navigation season on the Great Lakes- St. Lawrence Seaway System. We recommend that as part of your environmental study the effects of your undertaking on cultural resources, especially those due to shore erosion and shore structure damage, be made explicit instead of just a reference to another publication. In connection with this, we urge you to contact the State Historic Preservation Officers for the affected states (Wisconsin, Michigan, Ohio, Minnesota, Illinois, Indiana, Pennsylvania, and New York) for coordination of your consideration of cultural resources. It may be helpful to them and to us to receive a copy of Apendix 22 of the Great Lakes Basin Framework Study.

We request that implementation of any selected plan be done in accordance with our "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800).

Thank you for your interest in historic preservation.

Sincerely yours,

John D. McDermott
Director, Office of Review and
Compliance

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

Address reply to:
COMMANDER(osr)
Ninth Coast Guard District
1240 East 9th St.
Cleveland, Ohio 44199
Phone: 216-522-3981

•LINER-76
Ser, 32-76
17 February 1976

COL James E. Hays
Corps of Engineers
Chairman, Winter Navigation Working Meeting
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

I have reviewed the draft Interim Feasibility Study, March 1976, on the Great Lakes-St. Lawrence Seaway Navigation Season Extension. Comments on various specific items are enclosed.

Throughout the study we talk of a 9½ month season, based on a normal closing of 15 December and opening of 1 April. The season, based on the dates, should be 8½ months. I mention this here in the unlikely event that this error may have been carried over to the economic calculations. If not, then it is a relatively minor point.

The report considers the continued use of proven operational measures to extend the season. Reading the entire interim study, it was fairly clear that an extension of navigation on the upper four Lakes until about 31 January could be expected by continuing these measures. However, the syllabus, fifth paragraph, and section F (page F-8), when read alone, appear to specify that an arbitrary fixed closing date of 31 January is contemplated. The discussion on page E-1 is much clearer, as is the treatment on page D-11. While a firm date is clearly essential to permit equating benefits to costs, there is a hazard that the intent of the interim operational plan may be misinterpreted based on the statements in the syllabus and on page F-8.

A number of questions were raised during the review about some specific statements in the report which do not fully reflect some of the developments or events of the current season. For the most part comment on these has been omitted. Any that are appropriate and significant can be provided for consideration in later updates of the study.

Sincerely,

H. E. LINDEMANN
Captain, U. S. Coast Guard
Chief of Staff
Ninth Coast Guard District

JOHN J. SPANISH
DISTRICT 5B
ST. LOUIS COUNTY
P.O. BOX 575
HIBBING, MINNESOTA 55746
STATE CAPITOL: (612) 296-4254
HOME: (218) 263-4879

State of Minnesota
HOUSE OF REPRESENTATIVES
MARTIN OLAV SABO, Speaker

COMMITTEES:
HIGHER EDUCATION, VICE-CHAIRMAN
CRIME PREVENTION AND CORRECTIONS
HEALTH AND WELFARE

February 17, 1976

James E. Hays
Colonel, Corps of Engineers
Chairman, Winter Navigation
Working Committee
U.S. Army Corps District, Detroit
Attention: NCEED-PB
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

This is to indicate my interest in extending the shipping season in the Great Lakes area. Taconite pellets, coal, wheat and other cargo is shipped through the Great Lakes area, and it would be most beneficial if this shipping could continue on a year-round basis.

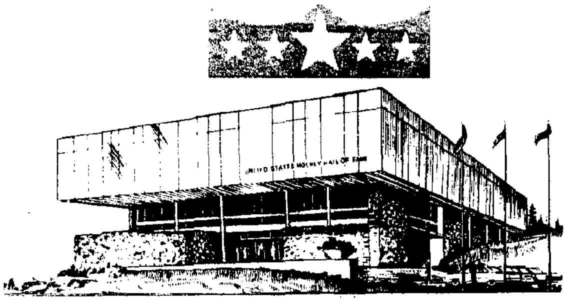
To allow this would mean a continuation of jobs and would be beneficial to the economy of Northeastern Minnesota.

Continuation of the year-round shipping season on the Great Lakes could eventually induce other vessel companies to participate in this type of shipping season.

Sincerely,

John J. Spanish
John J. Spanish
State Representative

JJS:dp
cc: Warren Norman, U.S. Steel



City of Eveleth

City Hall / Phone (218) 741-2501
EVELETH, MINNESOTA 55734

CLEMENT A. COSSALTER
MAYOR
ELMER A. MILBRIDGE
CITY CLERK

COUNCILMEN
BRUCE O. JOHNSON
HENRY A. JOHNSON
JOHN F. FILIPOVICH
JAMES D. WAINIO

February 18, 1976

Colonel James E. Hayes
Corps of Engineers
Chairman Winter Navigation
Working Committee

Dear Sir:

I am Clement Cossalter, Mayor of Eveleth, Minnesota, which is located in the taconite producing area and derives numerous benefits from year around lake shipping on the Great Lakes. With the increased production of taconite pellets on the Iron Range this would mean more benefits to our cities through production taxes, and in order to keep a steady flow in this operation I would feel safe to say that speaking for the people of this area they would be 100% in favor of a year around shipping program on the Great Lakes.

Yours truly,

Clement A. Cossalter
Clement A. Cossalter
Mayor

CAC:ss

COUNTY OF MARQUETTE

OFFICE OF COUNTY CONTROLLER

GARY R. YODER, CONTROLLER

MARQUETTE, MICHIGAN

February 18, 1976

Department of the Army
Detroit District-Corps of Engineers
Box 1027
Detroit, MI 48231

Attn: Col. James E. Hayes

Dear Col. Hayes:

In February, the Environmental Quality Committee of the Marquette County Board of Commissioners met and discussed the brochure regarding the navigational season extension for the Great Lakes and St. Lawrence Seaway.

After considerable discussion, the Environmental Quality Committee went on record in support of extending the season to January 31st of each year. They also felt that, if the January 31st navigational season meets the findings of your study and no ill consequences have developed, that a further extension to February 28th as proposed should be implemented.

We would like to thank you for sending us the brochure on this study and we would request any further or new developments in the area be brought to our attention.

Very truly yours,

Gary R. Yoder
Gary R. Yoder
County Controller

/djv

Northeastern Minnesota Development Association

500 ALWORTH BUILDING / DULUTH, MINNESOTA 55802 / (AREA 218) 722-1484

February 18, 1976

To the U.S. Army Corps of Engineers

NEMDA is a regional organization devoted to attracting new business to Northeastern Minnesota and aid those businesses now here to sustain and expand their operations. NEMDA is working to make full utilization of this area's unique assets to create jobs and economic opportunities to the region.

It is in this connection that NEMDA supports the extended navigation season on the Great Lakes-St. Lawrence Seaway Waterway. This program on which an experimental effort has been conducted for the past several years has proven economically viable and offers great future promise. The ability to handle bulk cargoes made up of this region's natural resource products plus the fuels this area needs at cost lower than for other forms of transportation contribute greatly to this area's economy. At a time when fuels are short in supply it is comforting to note that water transportation is the nation's lowest energy-consuming mode of transportation.

Continuing the shipping season on a year-around basis was found to be possible, based on last years results. This kind of response best uses the capital assets represented by lake vessels, and the industries they and their bulk cargoes serve. Moving the products of this area's mines and forests on a year-around basis avoids lengthy and costly delays when these products are stock-piled, plus contributing to the competitive capabilities of these same products. And, it goes without saying, that to do so firms up the stability of the jobs of all those who produce them.

It is NEMDA's hope that the year-around water transportation on the Great Lakes-St. Lawrence Seaway can be made a permanent part of this area's economy and future economic plan.

It is a privilege to present these views to you at this Duluth meeting.

Sincerely,

Sylvester Laskin
President

SL/am

GUTHRIE-HUBNER, INCORPORATED

SHIP AGENTS AND BROKERS
BOARD OF TRADE
DULUTH, MINNESOTA 55802

TELEPHONES 218 727-5011 TELEX 29-4410 TWX 910-561-2491 CABLE LAKESHEAD

February 19, 1976

Colonel James E. Hays
U. S. Army Engineer District, Detroit
Attention: NCEED-PB
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Since the inception of the Corps' study for the extension of the navigation season on the Great Lakes, I have been interested in the progress made. However, to be better informed I would appreciate receiving a copy of your "Interim Feasibility Report - March 1976" and any past reports on this subject that are available.

Our firm represents foreign shipowners as well as Canadian and United States Laker Fleets. Although we are employed for twelve months, our productive work is seasonal and this firm does not generate revenue between the months of January and April. Of course, our success is based not only on performance but on the world economic situation at any given time, as you rightly pointed out during the meeting on the 18th.

There is no doubt that an extended season would help this firm prosper by allowing more grain to be routed through this area for overseas markets, and it would increase export and import cargoes as businesses would be able to develop a more economical inland transportation route. Again, increases would depend on the world's economic picture at any given time.

Although our livelihood depends on water transportation, we are concerned over the environmental and pollution impact and are willing to keep an open mind as to the best cause to support.

Yours very truly,

Edward A. Ruisi

COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF ENVIRONMENTAL RESOURCES
P. O. BOX 1467
HARRISBURG, PENNSYLVANIA 17120

In reply refer to
RM-R
F 110:7
Your ref. NCEED-PB

February 20, 1976

Col. James E. Hays
District Engineer
U. S. Army Corps of Engineers - Detroit District
Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Secretary Goddard asked that I respond to your request of February 13, 1976, for comments on the draft Interim Feasibility Report on the extension of the navigation season in the Great Lakes - St. Lawrence Seaway System.

We find the draft adequately covers the problems and feasible alternatives for winter navigation in the upper Great Lakes, but is lacking in sufficient coverage of the St. Lawrence Seaway. Although the draft notes that many of the items concerned with the Seaway, e.g. environmental assessments, will be added in the final draft, we are concerned that some of the issues cannot be adequately addressed, e.g., demonstration of the navigational feasibility through stable ice covers used by power plants, within the time remaining in the authorized program. Consequently, we suggest, in order to provide complete information on the entire system, that the final draft identify and outline the unfinished and needed projects in the Demonstration Program with recommendations for time extensions toward their completion.

Pennsylvania fully endorses a program for an extended navigation season in Great Lakes - St. Lawrence Seaway System. The economic benefits would be significant, and the adverse environmental impacts are either minimal or can be reduced by existing engineering techniques. We recommend early implementation of such a program through the adoption of a national policy for winter navigation on the Great Lakes and the St. Lawrence Seaway and authorization of the Demonstration Program's recommendations.

Sincerely yours,

C. H. McConnell, Deputy Secretary
Resources Management

Great Lakes Basin Commission

February 20, 1976

Brigadier General Robert L. Moore
Division Engineer
North Central Division
U.S. Army Corps of Engineers
536 South Clark Street
Chicago, Illinois 60605

Dear General Moore:

The Commission staff has reviewed the "Draft Interim Feasibility Study, Great Lakes-St. Lawrence Seaway Navigation Season Extension" (March 1976), and I am enclosing the comments as requested.

As the comments indicate, there are certain considerations which should be addressed in the study and which could reasonably be raised by members of the public. These considerations should be addressed to provide a more complete study document.

We appreciated the opportunity to comment on this study, which we have all been monitoring very closely.

Sincerely,

Frederick O. Rouse
Chairman

3475 Plymouth Road, Post Office Box 999, Ann Arbor, Michigan 48106
313/763-3590 FTS: 313/769-7431

REVIEW COMMENTS
"Draft Interim Feasibility Study, Great Lakes-
St. Lawrence Seaway Navigation Season Extension, March 1976"

p. D - 10, "Fixed Navigation Season"

A brief benefit/cost presentation is made in this section, as follows:

"Estimated costs and benefits, at March 1976 price levels, are as follows:

Investment Cost:	$0
Annual Cost:	$0
Annual Benefits:	$0
Benefits/Costs:	0.0"

It is assumed that the necessary information will be used to estimate the costs and benefits of this alternative later. In light of the discussion in the text preceding this presentation, it would appear that there are benefits and costs of this alternative which could be estimated and incorporated into this benefit/cost analysis.

By fixing closing dates for the navigation season, traffic which might have otherwise occurred will not move. This traffic could be estimated from historical records and projections of longer shipping seasons could be estimated from meterological records. Estimates of costs and benefits could then be assigned.

Also, fixing the navigation dates would permit certain winter and ice-related recreational activities to occur immediately after the established closing date, physcial and meterological factors permitting. Activities might include: ice-fishing, snowmobiling, ice skating. These activities might occur earlier under an established navigation date than they might otherwise. Thus, benefits and costs could be assigned to this activity.

If this alternative would "enhance power production because of the reduction of vessel movement", this circumstance could be assigned an estimated benefit. This benefit could be estimated using probabilities of the various meterologic and hydrologic aspects involved, estimating the benefits (and costs), and evaluating the benefits and costs over the live of the power station or project.

There may be other costs and benefits which could reasonably be assigned to this alternative.

Sections: D - F, and Appendix III

These sections do not completely address the regional shifts in transportation, particularly during the winter, which would occur with the implementation of the Selected Plan. On Table D-6, Page D-60, there is some acknowledgment of this regional shift (see items: "Value of income lost," "Quantity of jobs lost," and "Undesirable growth" under "Adverse Effects" in column "Rest of Nation"). "No estimate" was presented for income lost, jobs lost, and undesirable growth in the "Rest of (the) Nation. Certainly there is a cost, or at least a lower rate of return, that is attributable to existing transportation industries from which traffic would be diverted.

P. D-38, Table D-3

Under "Dredging" - "Extend the Navigation Season," Table D-3 indicates "possible long-term damage in (the) St. Lawrence River" without indicating that any mitigation measures will be investigated. The public should reasonably be assured that mitigation measures will be examined if possible long-term adverse damage occurs.

On this same table, increased air pollution and an increase in the potential for oil pollution of water are indicated under "Extend the Navigation Season," without indicating that mitigation measures will at least be examined. These circumstances should also be addressed.

P. D-39, Table D-3

Under "Reduce effects on shore structures" - "Extend the Navigation Season," there is no response. Will shore structures be protected? According to other portions of the text, this protection possibility is being examined.

Also on this table (this page), under "Adverse - Impairment to life styles/recreation. . .," there is no indication of further examination of measures to mitigate adverse effects of disrupting recreation and leisure opportunities.

P. D-40, Table D-3, and throughout text

Under "Regional Development - Increased Stability of Regional Economic Growth," and throughout the text, it would appear that regional economic growth stability should be tied to the stability (or vagaries) of national, and in some cases international, economic activity, particularly for this industrial region, rather than to the provision of extended water transportation services on the Great Lakes during the winter season to areas within and outside the region.

P. D-62, fourth paragraph

It is stated here that "on-going research and new vessel construction would reduce the potential damages" from oil spills. This statement might be clarified by changing the word "would" to "might" and also indicate that increased transportation of oil in a greater number of ships and/or in larger volumes might negate advantages produced by research or new vessel construction in the area of reducing potential oil spill damage.

P. D-68 through D-70, "Further Investigation"

Apparently there is to be no further investigation of diversion of traffic from other modes to the water mode during the winter season.

General:

With regard to Alternative 3 (Extend the Navigation Season), no adverse aesthetic effects are mentioned with regard to riprapping of shoreline to reduce erosion caused by the effects of winter navigation, nor to the installation of pile clusters near shore structures for protection.

General:

Fuel consumption considerations are all but hidden in this study. The use of a fuel efficient transport mode, and indeed proposing to increase its use, would appear to be a favorable item. Fuel consumption comparisons for transporting general cargo and bulk commodities according to the appropriate transport modes would certainly be useful in this study, and should be a requisite in future transportation reports which address themselves to commodity transport by more fuel efficient modes. Fuel consumption analysis might also include fuel consumed to maintain "pathways" (waterways, roadbeds, etc.).

City of Superior, Wisconsin

A MAYOR-ALDERMAN CITY

The Heart of the Continent

OFFICE OF

James C. Sautei

February 21, 1976

Col. James E. Hays
Corps of Engineers
P.O. Box 1027
Detroit, MI 48231

Dear Col. Hays:

We of the Superior Harbor Commission would like to go on record as favoring an extension of the commercial navigation season. Several reasons have prompted this descision. Amoung them is the fact that shipping via waterborn transportation has certainly proven to be the most economical form of transportating cargo. Also the ton miles per gallon should certainly weigh heavily regarding economy in the use of fuel and consequently less discharge of pollutents into the atmosphere. Noise is another factor taken into consideration and many reports have been written referring to the sea lanes as the "quite highways".

Looking in on the not to distant future, we here in the Port of Superior are expecting a great increase in the movement of coal and taconite and if the season were to be extended this would certainly have a cost benefit to those particular industries, in so much as the additional costs in double handling could be lowered. Some of the spin off of an extended season for these two movements will be the construction of new high powered and reinforced ships for the trade, resulting in jobs for constructing and maning these ships.

Already because of the demonstration last year in the Superior Harbor of a bubbling system, leading into our local shipyard, we were able to enhance our local economy

A PORT CREATED TO SERVE

by the fact that the shipyard was able to triple the work force number of employees than they normally would have. This came about because they were able to accept ships after the normal season closing dates.

In closing, I would like to mention the fact that benefit over cost being almost 4 to 1, would seem imparitive from a business standpoint to proceed to the ultimate goal of year round shipping to include the total seaway system.

Sincerely,

James C. Sauter
Port Director

STATE OF OHIO
OFFICE OF THE GOVERNOR
COLUMBUS 43215

JAMES A. RHODES
GOVERNOR

February 23, 1976

Colonel James E. Hays, District Engineer
U.S. Army Engineer District, Detroit
150 Michigan Avenue- P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

Reference is made to the interim feasibility report on the Extension of the Navigation Season For the Great Lakes and St. Lawrence Seaway that was provided for our review with your letter of February 13, 1976.

Although I have not had an opportunity to review the report in detail, I can say that I strongly support the increase in commerce that would result from an extension to the navigation season. We in Ohio are vitally concerned with increasing job opportunities and expanding the economic prosperity of our state. Therefore, I strongly urge that continued efforts be directed towards investigating means of extending the navigation season on the Great Lakes and St. Lawrence Seaway.

Sincerely,

James A. Rhodes

JAMES A. RHODES
Governor

JAR/slv

International Shipmasters' Association
Lodge # 12
Duluth - Superior

February 24, 1976

Colonel James E. Hays
U.S. Army Engineer District
P.O. Box 1027
Detroit, Michigan 48231
Attention: NCEED - PB

Dear Colonel Hays:

As promised, we are forwarding herewith comments on our position regarding winter navigation.

We hope that the above mentioned will be helpful.

Yours truly,

INTERNATIONAL SHIPMASTERS' ASSOCIATION

Robert F. McDowell, Secretary

ENC: (1)

RFM:jrw

INTERNATIONAL SHIPMASTERS' ASSOCIATION

LODGE # 12

DULUTH - SUPERIOR

POSITION REGARDING WINTER NAVIGATION

As we read the arguments, pro and con, regarding winter navigation, one fact rings out loud and clear. Without exception, all those in favor are concerned with economic advantages to business and shoreside activity, problems of locks and channel operations and environmental factors. No one shows concern for the safety of ships and crews.

With minor exceptions, improvements in vessel safety have not kept pace with the demands of winter operations. Vessels are outdated with no distinction made between a vessel certified for summer or winter sailing. Deeper loading has been permitted on individual vessels with questionable improvements in vessel stability. Load lines now permit as much as nearly three feet deeper loads on the same ship.

We question the wisdom of non-watertight construction of holds in great lakes vessels. A rupture in one hold is free to flood all holds and sink the vessel. Our extreme cold, fresh water operation is without parallel in the world. Foreign classification societies and regulatory agencies would not permit such construction to operate in the North Baltic in winter months. The Baltic and Gulf of Finland are the most similar areas which come to mind. Why do we permit such an operation without radical improvements in stability and design? Some way must be found to minimize icing of equipment such as radar antennae, RDF antennae, searchlights, frozen wheel house doors which cannot be used for access, liferafts with slow cold weather inflation times, frozen hydrostatic releases on liferafts, frozen lifeboats and all other topside safety and firefighting equipment. What has happened to the strict standards which exist during the summer? They remain the same during winter months without regard to the radically different conditions? Year after year goes by with word that testing continues on inflatable liferafts and exposure suits. So far, there are no answers. Crews that are subjected to constant noise and vibration in ice cannot rest properly in their off hours which makes them less efficient while on duty. This detracts from vessel safety and is a major morale factor.

In the area of aids to navigation the talk is of "Loran C" and other radio navigational aids. These should be developed for open lake piloting, however there is no substitute for fixed aids to replace lighted buoys in the river. There has been no move to improve fixed aids. As a matter of fact, the record for replacement of damaged crib lights and ranges has been poor. We do encourage further study of "laser" and "follow the wire" systems for the rivers. We have witnessed brief experiments in both areas, but no follow through. We would also like to see more study of airport type "strobe lights" on selected fixed aids.

So far, shipboard personnel are the ones from which the most has been demanded. It is only through sacrifice and skill that winter navigation, particularly nighttime river piloting, has been possible to this point.

Another area of concern is safety at loading and discharging ports and lock walls which become more hazardous when icy. Taconite pellets are a hazard to safe footing at best. Improvements in protective railings and lighting must take place, particularly with our ancient system of landing men by boom to tend the vessel's own lines.

Admittedly, shipmasters' do not have the figures or expertise to evaluate the overall cost picture, however, we seriously refute the reasoning that favors twelve month sailing and yet finds more ships idle each year through the regular season. In 1974 U.S. Steel ran 35 ships, in 1975 they ran 26 and the forecast for 1976 is 19 ships. The increase in jobs is certainly not for shipboard personnel.

Fuel costs, insurance and repair costs to the owner are greater in the winter. Icebreaking, bubbler systems, special aids to navigation, ice information centers, air reconnaisance, longer lock operations, ice booms, etc., are staggering expenses borne by the taxpayer for an operation that we believe is not in the public interest. How can public expenditures of this size be justified for private gain?

Lodge # 12, International Shipmasters', is opposed to winter sailing, primarily from a safety standpoint. We will maintain this position until safety questions have been resolved.

How precious do we hold human life?

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Ogden Reid,
Commissioner

February 24, 1976

Colonel James E. Hays
District Engineer
Corps of Engineers
Department of the Army
Box 1027
Detroit, Mich. 48231

Dear Colonel Hays:

This is in reply to your request to Commissioner Reid for comments on the Interim Feasibility Report on the Extension of the Navigation Season on the Great Lakes-St. Lawrence Seaway System. The report considers the use of operational measures to enable extension of the navigation season on the Upper 4 Great Lakes. The work relative to the St. Lawrence-Lake Ontario part of the System is still underway. We are vitally interested in the environmental and economic aspects on this portion of the system. In particular, we want the demonstration projects proposed for the St. Lawrence River System to provide for a greater intensity of environmental evaluations.

We anticipate having comments during the course of the remaining investigations on the St. Lawrence-Lake Ontario portion of the system.

Sincerely,

Thomas P. Eichler
Director, Office of Program
Development, Planning and Research

City of Two Harbors

LAKE COUNTY

610 Second Avenue

TWO HARBORS, MINNESOTA 55616

JOHN D. OLSVIK
City Clerk

ROGER P. SIMONSON
City Treasurer

WATER, LIGHT AND NATURAL
GAS DEPARTMENT

Tel. 834-4386
(Area Code 218)

February 25, 1976

Mr. James E. Hays
Colonel, Corps of Engineers
Detroit District
P. O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

At the last regular meeting of the City Council of the City of Two Harbors, Minnesota, the Council went on record favoring extending the navagation season for the Great Lakes and St. Lawrence Seaway.

A certified copy of this resolution is attached.

Very truly yours,

John D. Olsvik
City Clerk

JDO:mp
Enc.

cc: Jack Burke, DM&IR Railway Co., Duluth

RESOLUTION

WHEREAS an extension of the navagation season would help the economic conditions in Two Harbors and other North Shore communities,

BE IT RESOLVED, That the Mayor and the City Council of the City of Two Harbors hereby goes on record as favoring the extension of the navagation season for the Great Lakes and St. Lawrence Seaway

RESOLVED FURTHER That a copy of this resolution be sent to the Department of Army, Detroit District Corps of Engineers.

ADOPTED This 23rd day of February, A. D. 1976.

/s/ Charles R. Christensen
President, City Council

ATTEST:

/s/ John D. Olsvik
City Clerk

APPROVED By the Mayor of the City of Two Harbors this 24th day of February 1976.

/s/ David Battaglia
Mayor

CERTIFICATION

STATE OF MINNESOTA)
COUNTY OF L A K E) SS
CITY OF TWO HARBORS)

I, John D. Olsvik, City Clerk of the City of Two Harbors, do hereby certify that the foregoing resolution is a true and correct copy of the original resolution duly passed by the City Council on February 23, 1976, and now on file in my office.

Given under my hand and seal this 25th day of February, A. D. 1976.

John D. Olsvik
City Clerk

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Federal Building, Fort Snelling
Twin Cities, Minnesota 55111

IN REPLY REFER TO:
LWR

Colonel James E. Hays
District Engineer
U.S. Army Engineer District
Detroit
P.O. Box 1027
Detroit, Michigan 48231

Dear Colonel Hays:

This transmits the U.S. Fish and Wildlife Service Report on the Interim Feasibility Study for the Great Lakes - St. Lawrence Seaway Navigation Season Extension - March 1976. This report was prepared in compliance with the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

As we understand, your report is to be the authorizing document for the interim operational mode of the navigation season extension for the upper four Great Lakes. Because of the importance of this step, we feel that our report is warranted. The following summarizes our conclusions and recommendations.

The U.S. Fish and Wildlife Service has studied the various aspects of extending the navigation season that have been investigated during the Demonstration Program. All items being considered for navigation season extension, from December 15 to January 31 under the selected plan, are those which have been demonstrated. Concern remains for operational items or improvements to implemented items of the selected plan which may be suggested in the future. However, it is assumed that opportunity to scrutinize these measures will be provided. Therefore, under the operational plan presented in the selected plan, the time frame of the navigation season extension (December 15 to January 31, only), and within the area described (the upper four Great Lakes), we believe the season extension to be environmentally feasible. Our short-term observations and studies during the Demonstration Program indicate that the proposed operation would not greatly affect the valuable fish and wildlife populations and habitats. Also the utilization of these resources will not be greatly affected with the exception of Muskegon Lake. However, it cannot be determined at this time what long-term effects, if any, may occur.

However, the U.S. Fish and Wildlife Service recommends:

1. That commercial vessel traffic (navigation season extension) be terminated in Muskegon Harbor when ice formation begins.

2. That vessel tracks (ship channels) containing broken, retarded, or reduced ice cover be plainly marked with signs warning of the unsafe conditions in areas where sport or commercial ice fishing activity has been indicated.

3. That movement of oil shipping during the navigation season extension be limited to the ice-free portions of the upper four Great Lakes and especially from movement through or within the connecting channels; or as an alternative, to establish several strategic oil strike force locations, such as Duluth, Minnesota, Milwaukee, Wisconsin, and Sault Ste. Marie, Michigan in addition to the base at Cleveland, Ohio.

4. That water levels be held as constant as possible during the period of winter navigation extension.

5. That should areas of shoreline erosion attributable to winter navigation extension be identified, suitable shore protective measures be undertaken.

6. That needs for further lamprey control resulting from bubbler installation, should they be used, be determined.

We believe the implementation of these recommendations will minimize adverse effects of the proposed plan on the fish and wildlife resources of the Great Lakes.

We are also including an errata sheet that should replace page 69 of our report.

Sincerely yours,

Attachments: (2)

cc: Acting Special Assistant to the Secretary, USDI, Chicago
U.S. FWS, Region V, Boston
Great Lakes Basin Commission
New York DNR
Pennsylvania DNR
Ohio DNR
Indiana DNR
Illinois DNR
Michigan DNR
Wisconsin DNR
Minnesota DNR

APPENDIX III

PUBLIC MEETINGS

DEPARTMENT OF THE ARMY
DETROIT DISTRICT. CORPS OF ENGINEERS
P. O. BOX 1027
DETROIT, MICHIGAN 48231

DIGEST OF PROCEEDINGS OF THE
FIRST PUBLIC MEETING CONCERNING THE
EXTENSION OF THE NAVIGATION
SEASON ON THE GREAT LAKES AND ST. LAWRENCE SEAWAY

1. GENERAL

An initial public meeting was held by the Division Engineer, North Central Division, Corps of Engineers, in the Dirksen Federal Building, Chicago, Illinois, on 24 May 1972. The meeting began at 1:00 P.M. A total of 89 persons were present, representing various Federal and State agencies, shipping and railroad interests, business interests, conservation interests, and shore property owners.

2. MEETING

The meeting was opened by Major General Ernest Graves, Division Engineer, Chicago, who explained the purpose of the meeting. He stated that the meeting was being held to obtain ideas from all concerned interests on an extension of the navigation season and to learn of resultant problems and their possible solution. He also explained that he was present in his capacity as Chairman of the Winter Navigation Board which is an organization set up to investigate and conduct demonstration activities on the practicality of extending the navigation season on the Great Lakes and through the St. Lawrence Seaway. General Graves then introduced the members of the Winter Navigation Board and Colonel Myron Snoke, Detroit District Engineer, whose office has specific responsibility for carrying out the study for which this public meeting was held.

3. Colonel Myron D. Snoke, District Engineer, Detroit, then discussed the background of the study and stated that the subject of the meeting pertained to a survey study authorized by Congress in 1970. In conjunction with the survey study, he explained that a demonstration program, also authorized in 1970, was already underway and together with the survey study formed interdependent parts of the overall investigation to determine the engineering, economic and environmental feasibility of an extended navigation season. Colonel Snoke emphasized

that the meeting was an opportunity for individuals or groups to submit alternative solutions, ideas, or opposing views. He urged both opponents and proponents of the navigation season extension to present detailed information concerning technical, economic, and ecological and environmental material.

4. Statements presented during the session are summarized in the following paragraphs.

a. A letter from United States Senator Robert P. Griffin declared that Senator Griffin trusts the statement made by General Graves, that he is confident the Winter Navigation Board can assure vehicular ferry service for Sugar Island residents, will also be extended to all affected islands in the St. Marys River. Senator Griffin stated that problems created in this matter by the demonstration program requires priority attention and solution before the next winter shipping season and that one of the principal purposes of Congress in establishing a demonstration program for winter navigation was to examine the problems created by such navigation and to determine what solutions were needed.

b. State of Illinois. - Mr. John F. Hynes, Manager of Transportation Services stated on behalf of the Governor of Illinois, Richard B. Ogilvie, that the State of Illinois supports the 1973 fiscal year funding for the demonstration program and survey study on the extension of the navigation season on the Great Lakes and St. Lawrence Seaway. Mr. Hynes stated that the healthy economy of the state depends greatly upon waterborne commerce and international trade and expressed several benefits which Illinois would derive from an extended navigation season, particularly in the forms of additional income and employment.

c. Great Lakes Commission. - Mr. Leonard J. Goodsell, Executive Director of the Great Lakes Commission and Secretary of the Great Lakes Task Force spoke on behalf of these groups and also as a representative of the following:

(1) Governors of the eight states bordering the Great Lakes.

(2) Industrial Users Group

(3) Lake Carriers' Association

(4) Michigan State Chamber of Commerce

(5) President, Illinois River Carriers

(6) President, Propeller Club

(7) President, Hannah Inland Waterways Corporation

(8) Ports of Chicago, Green Bay, Milwaukee, Erie, and Indiana

(9) Port Authorities of Cleveland - Cuyahoga County and Toledo - Lucas County, Ohio.

(10) Detroit - Wayne County Port Commission, Michigan

(11) Seaway Port Authority of Duluth, Minnesota

(12) The Niagara Frontier Transportation Authority, New York.

Mr. Goodsell expressed his support of the program and studies on the extension of the navigation season and stated that he testified on their behalf before Congress for sufficient funding that would permit an orderly and progressive prosecution of the work. Mr. Goodsell also presented a justification statement covering the complete extended navigation season program.

d. Power Authority of the State of New York. - Mr. Robert D. Conner, representing the Power Authority, stated that the Authority has no objection to an extended season if such can be accomplished without disrupting ice control measures which now protect property owners and power production. He stated that since the St. Lawrence Seaway development in the International Section was designed and constructed in accordance with the requirements imposed by the International Joint Commission, which did not contemplate joint use of the river by navigation and power during the winter months, should an open-water track for navigation through the ice cover appear feasible the costs of such alterations should be borne entirely by navigation and not imposed on power consumers. He also stated that the demonstration program should carry an acceptance of responsibility for any adverse effects which may occur to private and public property owners and other interests.

e. Chippewa County Board of Supervisors. - Dr. Gale Gleason, representing Chippewa County in Michigan, expressed his belief that the Upper St. Marys River must be designated as an area of intense research with regards to methods of employing and maintaining navigation routes in the St. Marys River during the ice forming months. He stated that the ice breaking activities coupled with rapid formation of new ice, vessel speed and draft, and high water in the Upper St. Marys River is causing extensive damage along the shoreline. He also stated that he would like to have the Winter Navigation Board give serious consideration to a research grant to be given to Lake Superior State College or research scientists available in the area for further study of this problem.

f. Hydro - Electric Power Commission of Ontario. - Mr. D. M. Foulds, River Control Engineer, stated that Ontario Hydro has no objection to the extended navigation season provided that some means can be found to avoid disruption of present ice control measures on the St. Lawrence and St. Clair Rivers. He stated that attention should be directed to the basic problems of controlling ice at the locks and their approaches before considering ice booms and modifications thereto. He emphasized that feasible winter operations through all downstream navigational facilities in the St. Lawrence Seaway need to be demonstrated so as not to jeopardize the operation of the current St. Lawrence Power Project.

g. The Neebish Pioneers Association. - Mr. Frank Fucik, Chairman, Ecological Committee, stated that if the navigation season is extended, conventional ice breaking techniques will cause severe damage to shore side facilities. He felt the study should emphasize methods of keeping the St. Marys River clear of ice so as to not damage shoreside facilities and that the costs involved in the study should be borne by the shipping interests since they would be the benefactors of an extended navigation season. He also stated that other methods of extending the season other than ice breaking may cause ecological changes in the river of great magnitude.

h. Edison Sault Electric Company. - Mr. Gordon Malcolm, Engineering Consultant, stated that the operation of ships in the St. Marys River last winter, allowing quantities of broken ice to move downstream, created icing at the power plant intakes and ice jams downstream from the plant which resulted in severe power losses and considerable monetary losses. He explained that this kind of situation results in having to purchase power from other sources at a much higher rate, and the additional costs must be passed on to the consumer.

i. Industrial Users Group and Dow Chemical Company. - Mr. Arthur J. Chomistek stated that the industrial users are generally in favor of the extended navigation season, not only for realizing benefits of transportation savings, but also to benefit the economy of the mid-continent itself. He referred to a report written by Dr. Eric Schenker entitled "Special Report #15 - Extending the St. Lawrence Seaway Navigation Season: A Cost - Benefit Approach" with regard to the extended season's value to industry as well as the general population of the mid-continent. This report discusses the benefits and costs of incremental extensions of the navigation season and the resultant economic justification for these plans.

j. Sierra Club. - Mr. Jonathan Ela, Midwest Representative, stated that his organization wants to be kept informed of any future developments concerning the Great Lakes. He hopes that the environmental consequences of any action are analyzed on a step by step basis with an environmental impact statement prepared that inventories the environmental effects. He feels decisions should be made based on the impact statement and that the resulting plans should be broadly publicized.

k. Chicago Regional Port District. - Mr. Maxim M. Cohen, General Manager, stated that in his opinion, Special Report #15 developed by Dr. Eric Schenker on the cost-benefit approach to the extension of the navigation season, deserves the Winter Navigation Board's serious consideration. He feels very little could be added to its summation or the methods of evaluation. He stated that a 10 month navigation season is the minimum time length which would bring the volume of the Great Lakes and Seawav tonnage to a level that is meaningful. Confining the Seaway and Great Lakes closure to 2 months would create a practical basis for tonnage solicitation as it would immediately impress the shipping world of its availability and would result in an increase of at least one quarter of the gross flow. Mr. Cohen stressed the increasing competitive influences by other carriers in the Great Lakes region and that the changes constantly pressing the United States and Canada with regards to the sale and distribution of raw materials, processing of goods, their sale, production by cheaper labor, and the availability of modern techniques to all nations extends these influences to a world wide area and we need to meet the challenge.

l. Lake Michigan Federation. - Miss Kathryn West speaking on behalf of Mrs. Lee Botts, Executive Secretary, expressed her organization's opinion that inadequate notice and information was distributed regarding the public meeting and urged that for future public meetings an effort be made to expand the notification to additional concerned citizens and conservation organizations.

m. Port Director for Bay County, Michigan. - Mr. Jim McGowan expressed his formal support of the positions of Mr. Leonard J. Goodsell of the Great Lakes Commission, Mr. Maxim M. Cohen of the Chicago Regional Port District, and Mr. Arthur J. Chomistek of the Dow Chemical Company and Industrial Users Group.

5. Letters that were submitted for public record in connection with the public meeting are summarized in the following paragraphs.

a. City of Escanaba, Michigan. - A letter submitted by Mr. George M. Harvey, City Manager, invited the Winter Navigation Board to set up their headquarters for the study of an extended shipping season in Escanaba. He mentioned the iron ore docking facilities at their port and felt that new developments in iron ore mining may well dictate at least an extended shipping season. Mr. Harvey stated that the iron ore supply is vital to our national defense.

b. Board of Commissioners, Chippewa County, Michigan. - A letter submitted by Mr. Royce E. Curlis, Chairman, stated his opposition to the extended navigation season and its appurtenant projects until steps have been taken by the Federal Government to correct the transportation problem to Sugar, Neebish, Lime, and Drummond Islands in the St. Marys River; relieve the erosion and shoreline damage in the St. Marys River; and reduce vessel speeds in the St. Marys River. Mr. Curlis expressed the opinion that the expenditure of funds will only benefit the large shipping interests at the expense of the local citizens.

c. Board of Commissioners, Calhoun County, Michigan. - A letter submitted by Mr. Joseph P. Romanchuk, Chairman, stated he wished to be kept informed of future developments and meetings on the extended navigation season subject.

d. Reebie Associates, Consultants to Management. - A letter submitted by Mr. Carl J. Liba, Principal, referenced a recent study their organization prepared for the Maritime Administration, U.S. Department of Commerce, entitled "Relationship of Land Transportation Economics to Great Lakes Traffic Volume". Within that study, in-depth analyses of the total distribution costs of several representative commodities were performed which indicated that the current need to cease all shipping on the Great Lakes for three months, and on the St. Lawrence Seaway for four or more months, was found to be a significant cost factor for every commodity considered. He stated that a significant benefit for a season extension appears to exist, but suggested additional studies on the cost-benefit ratio to more reliably quantify this ratio.

e. The Neebish Pioneers Association. - A letter submitted by Mr. Frank M. Fucik was read which reiterated the position that he stated during his individual presentation earlier in the public meeting.

f. Federation of the St. Lawrence River Pilots. - A letter submitted by Mr. Guy St. Marseille, President, stated he fully supported the study on the extension of the navigation season and felt that economy and unemployment were the principle factors in the study.

g. Neebish Island Resident. - A letter submitted by Mrs. Charlotte Laitinen stated her concern about the floating ice as a result of winter navigation in the St. Marys River and the inability of the existing ferries to get through the ice. She feels that ice breaking ferries are not the answer to maintaining the river crossing for island residents and that bridges to the islands is the answer. She listed several business interests who make trips to the islands as well as tourists and stated that most of the island residents must go off the island daily to work or school.

h. Michigan United Conservation Club. - A letter submitted by Mr. Paul J. Leach, Executive Director, stated that when an environmental impact statement has been prepared, his organization would like a copy.

He feels that conservationists do not have the technical expertise to properly evaluate the effects of an extended navigation season and that the environmental impact statement is critical to informing the layman of the studies involved.

i. Furness Withy Agencies (USA). - A letter submitted by Mr. A. J. Nuzzi, Midwest Regional Manager, stated that certain commercial aspects should be considered in the study of an extended navigation season. Namely, these are the cost and loss of efficiency in having to change modes of transportation during the winter months and the concept of establishing a feeder system between the Great Lakes and Montreal, Canada, to link transatlantic shippers with the midwestern United States. He stated that an extended navigation season would improve transportation efficiency between the midwest and eastern seaboard by smoothing out existing seasonal fluctuations and the overall economical potential of the midwest would be enhanced.

6. ADDITIONAL STATEMENTS FOR THE RECORD

Statements that were received for public record after the date of the meeting are summarized in the following paragraphs.

a. International Minerals and Chemical Corporation. - A letter submitted by Mr. Paul A. Johnson expressed the company's vital interest in the extension of the navigation season with regard to the movement of potash to various Great Lakes and European ports and the shipment of bentanite clay to European destinations. Mr. Johnson presented estimates of potential annual savings for these commodities based on extended season operations.

b. Board of County Road Commissioners, Chippewa County, Michigan. - A letter submitted by Mr. R. T. Ronquist, Engineering Superintendent, stated that the Commission is opposing the continued winter navigation program until adequate provisions are made for uninterrupted transportation between Drummond Island and the mainland. He made reference to last winter's flowing ice problem and resultant delays and equipment damages which intermittently impeded the operation of the Drummond Island Ferry.

c. United States Great Lakes Shipping Association. - Mr. Werner Burchard submitted a memorandum which outlined an example of extra insurance rates per gross registered tonnage covering specific time periods over an entire year for German vessels trading in the Great Lakes area.

7. CONCLUSION

Major General Graves concluded the meeting by briefly describing the actions that will occur after the meeting. He stated that additional meetings are tentatively scheduled for Cleveland, Ohio and Duluth, Minnesota to get the views of the public and interested parties before beginning the survey study. Data will be gathered from the demonstration program, field investigations conducted, and analyses made of the engineering, economic and environmental aspects of the project. As specific ideas or proposals are developed, additional public meetings will be held to obtain public comments and suggestions. At the completion of the study a final series of public meetings will be held to obtain the public views on the final product after which a final report will be sent to Congress with formal recommendations.

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
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IN REPLY REFER TO

DIGEST OF PROCEEDINGS OF THE SECOND PUBLIC MEETING CONCERNING THE EXTENSION OF THE NAVIGATION SEASON ON THE GREAT LAKES AND ST. LAWRENCE SEAWAY

1. GENERAL

The second of three public meetings was held by the Division Engineer, North Central Division, Corps of Engineers, in the Federal Office Building, Cleveland, Ohio, on 10 July 1972. The meeting began at 1:30 P.M. A total of 91 persons were present, representing various Federal and State agencies, shipping and railroad interests, business interests, conservation interests, and shore property owners.

2. MEETING

The meeting was opened by Major General Ernest Graves, Division Engineer, Chicago, who explained his capacity as chairman of the Winter Navigation Board which is an organization of senior field representatives of participating Federal agencies and invited non-Federal, public, and private interests. The Winter Navigation Board has the responsibility to investigate and conduct a Survey Study, as well as demonstration activities, on the practicality of extending the navigation season on the Great Lakes and through the St. Lawrence Seaway. General Graves introduced the members of the Winter Navigation Board and Colonel Myron D. Snoke, Detroit District Engineer, whose office has the specific responsibility of carrying out the Survey Study for which this public meeting was held. The purpose of the meeting was to hear the views of the public on the Survey Study, to gather ideas, and document specific questions the public felt should be answered.

3. Colonel Myron D. Snoke, District Engineer, Detroit, stated the meeting was being conducted because the Congress of the United States directed the Corps of Engineers to investigate and study means of extending the navigation season on the Great Lakes and St. Lawrence Seaway pursuant to the 1970 River and Harbor Act. He explained that this was the second study on this subject authorized by Congress. The first was authorized in 1965 and was to investigate and determine the preliminary engineering and economic feasibility of extending the navigation season. Based on recommendations from the first study which emphasized the complexity of the project, a second study was authorized

in 1970 to proceed as a full survey scope study to define cost, economic justification, and degree of Federal interest in a program which would, in fact, extend the navigation season. He explained that the 1970 authorization consisted of three parts, a survey study and demonstration program to be conducted by the Corps of Engineers and an insurance study to be conducted by the Department of Commerce. He stated that the survey study and demonstration program are interdependent parts of the overall investigation to determine the engineering, economic, and environmental feasibility of an extended navigation season and that these initial public meetings are the first step in the survey study. General Graves then stated the survey study is to determine three things, (1) engineering feasibility, (2) economic feasibility, and (3) environmental acceptability. He urged both opponents and proponents of the navigation season extension to present detailed information in support of any statement they make.

4. Statements presented during the session are summarized in the following paragraphs.

a. Cleveland Port Authority. - Mr. Peter Colarochio, Manager of Trade Development, stated the Port Authority has been instrumental in promoting international trade development, pier operation, and expanding employment opportunities in the Greater Cleveland area through the provision of efficient marine transportation facilities for all users of the Port. Confining his statements to international trade, he stated the Port Authority staff has made a study of the potential benefits from a navigation season extension and estimated an increase of 1.6 times the present tonnage and a 10% savings in transportation costs in the Cleveland area due to extending the navigation season from 8 to 12 months. He estimated that in 45 years, on the average, tonnage shipped would increase threefold. He also estimated the overseas trade related labor force would approximately triple in size within the Greater Cleveland area and whereas 5 jobs per 100 on a national average are affected directly with overseas shipments, the Cleveland area has an effective range of between 9.8 and 10.4 jobs per 100.

b. Lake Carriers' Association. - Vice Admiral Paul E. Trimble (USCG- Ret.), President, stated his organization includes substantially all the operators of U. S. registry bulk freight vessels engaged in transportation on the Great Lakes and they fully supported the navigation season extension program. He felt that because of the sizable public investment in improvements in the Great Lakes - St. Lawrence Seaway system, full utilization or year around use should be strived for. He was confident that the economic evaluation portion of the demonstration program would bring out regional benefits and he encouraged all shipping and industrial enterprises to contribute to the program. He also stated that his organization has made a number of recommendations regarding areas to be studied in the navigation season extension program and stated that more emphasis should be put on navigational aids, environmental issues, and the island transportation problem in the St. Marys River.

c. Masters, Mates, and Pilots - Great Lakes and Rivers District. - Mr. Neil G. MacPherson, referring to Mr. Peter Colarochio's presentation, wanted to know who else would benefit from an extended navigation season besides the immediate Cleveland area. He expressed vital interest in safety and survival techniques and wanted to see a great deal of study directed towards these techniques.

d. Consolidation Coal Company. - Mr. George P. Cooper, Vice President of Lake Division, expressed his concern for his company's employees on Lime Island and requested the provision of adequate transportation facilities on the St. Marys River during the winter navigation season. He stated that all responsible agencies should help solve this problem.

e. Cleveland Stevedore Company. - Rear Admiral Edward H. Thiele (USCG - Ret.), Marine Consultant, referenced a statement he made on 7 June 1968 at a public hearing on the study of the extension of the navigation season on the Great Lakes and St. Lawrence Seaway. He desired that this statement again be entered in the record. His statement, supporting the extended navigation season, cited several economic benefits of the extended season and listed several techniques which were being used in European ports to extend their navigation season. At the 10 July 1972 public meeting he stated several areas of progress, particularly, an extension of inter-lake navigation, a more concise definition of economic benefits, and employment of additional ice breaking capabilities. He expressed concern about lack of progress in advanced navigational aids and techniques to protect land facilities, and encouraged contributions on the ecological factors related to open navigation channels.

f. Sea Grant Program - The University of Michigan. - Mr. Ernest W. Marshall, Research Glaciologist, stated there is not sufficient knowledge available to evaluate the environmental effects of disrupting the Great Lakes ice cover due to an extended navigation season. He also suggested that if quantitative, as well as qualitative, data is to be made available for evaluating the feasibility of extending the navigation season, programs must be developed at this time to acquire this knowledge.

g. Michigan Department of Natural Resources. - Mr. Herbert J. Miller, representing Mr. Ralph MacMullan, stated the State of Michigan has a real and valid interest in the program primarily relating to alternatives for increasing shipping capacity through the Great Lakes and has an obligation to assure maximum protection of the public's interest in the Great Lakes surrounding Michigan. Therefore, he requested that the Department of Natural Resources be given the opportunity to review and comment on each specific sectional phase of the survey study and demonstration program to promote mutual coordination between Federal and state interests. He stated that increasing the length of the shipping season or increasing the number of ships involved in commerce would be less damaging to fish and wildlife interests and the ecology than the alternative of using larger and deeper draft vessels which would require extensive channel dredging.

h. Lorain Port Authority. - Mr. E. C. Brohl, Secretary, expressed his full support of the navigation season extension program.

5. Letters that were submitted for public record in connection with the public meeting are summarized in the following paragraphs.

a. International Ship Masters' Association. - A letter submitted by Captain Stuart C. Minton, Chairman, stated the prime interest of the navigation season extension program must be the safety of the crews of any vessels involved in winter sailing. He recommended the following be taken under consideration:

(1) inspection of lake vessels to insure complete seaworthiness under winter conditions,

(2) a study be made to determine the effect of extreme cold on the flexing strength of the ship's steel,

(3) installation of appropriate cold weather lifesaving equipment,

(4) providing additional icebreakers on the Great Lakes to insure prompt aid and rescue measures,

(5) reinstitution of the LAVERS system of reporting vessel position during the winter season,

(6) full season operation of all pertinent fixed aids to navigation (lights and radio beacons),

(7) implementation of additional navigational aids to overcome the lack of floating aids removed in the winter,

(8) consideration of additional hazards due to winter sailing

be made at Coast Guard hearings resulting from a marine disaster during the winter months, and

(9) a study be made to insure competent crews are available for winter sailing.

b. Consolidation Coal Company. - A letter submitted by Mr. George P. Cooper, Vice President, is summarized in the presentation given by Mr. Cooper under item 4d.

c. Chippewa County, Michigan, Board of Commissioners. - A letter submitted by Mr. Royce E. Curlis, Chairman, stated his opposition to the extended navigation season until the island residents in the St. Marys River have been assured transportation to the mainland during the winter and until such problems as shore erosion, ice damage, vessel speeds, and ecological problems have been resolved.

d. W. R. Filbin & Company. - A letter submitted by Mr. W. R. Filbin, President, stated the extension of the navigation season is essential to the operation of his company and should the St. Lawrence Seaway remain open until 15 January, a complete third voyage itinerary for vessels could be made. The extension of the navigation season would enable his company to provide a more economical and better means of transportation to satisfy his clients needs.

e. Detroit - Wayne County Port Commission. - A letter submitted by Mr. James R. Friesema, Chairman, stated his support of the extension of the navigation season and expressed that should the navigation season be extended to 15 January on the St. Lawrence Seaway, vessel operators could add a complete cycle of vessel calls to existing schedules for the Port of Detroit.

f. Twenty-Third Judicial Circuit of Michigan. - A letter submitted by Circuit Judge Allan C. Miller claims the Winter Navigation Board has no power or jurisdiction to extend the navigation season on the Great Lakes. He believes the present management of the upper waters of the Great Lakes has aggravated and prolonged the current high water period and would be further aggravated by an extension of the navigation season. He stated that shipping has never borne its fair and full share of the true costs of its operations and it is not in the public interest to further divert from overland carriers, who can carry with less ecological damage, to water carriers. He also stated water shipping should be taxed on a tonnage basis and the funds used to cover costs connected with water shipping.

g. Seaway Port Authority of Duluth. - A statement submitted by Mr. C. Thomas Burke expressed the Port Authority's support of the navigation season extension because of resulting developments which would increase waterborne commerce throughout the Great Lakes - St. Lawrence Seaway system. He stated specific support towards a proposed de-icing project in the Port of Duluth - Superior because (1) the Port is a major all-service port, (2) the adverse weather conditions in the Port area lends itself to further de-icing experiments which would be beneficial to other Great Lakes ports, (3) extension of the navigation season would lead to increased tonnages in other Great Lakes ports, and (4) the season extension would extend payrolls normally discontinued by winter unemployment.

6. CONCLUSION

Major General Graves concluded the meeting by briefly describing the actions that will occur after the meeting. He stated there would be one additional meeting tentatively schedule for Duluth, Minnesota, to get the views of the public and interested parties before beginning the survey study. Data will be gathered from the demonstration program, field investigations conducted, and analyses made of the engineering, economic and environmental aspects of the project. As specific ideas or proposals are developed, additional public meetings will be held to obtain public comments and suggestions. At the completion of the study a final series of public meetings will be held to obtain the public views on the final product after which a final report will be sent to Congress with formal recommendations.

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IN REPLY REFER TO

DIGEST OF PROCEEDINGS OF THE THIRD PUBLIC MEETING CONCERNING THE EXTENSION OF THE NAVIGATION SEASON ON THE GREAT LAKES AND ST. LAWRENCE SEAWAY

1. GENERAL

The third meeting of the initial set of three public meetings was held on 11 September 1972, by the Division Engineer, North Central Division, Corps of Engineers, at the Paulucci Hall of the Arena Auditorium, 350 South 5th Avenue West, Duluth, Minnesota. The meeting began at 1:30 P.M. and terminated at 3:30 P.M. A total of 110 were present, representing various Federal and State agencies, business and conservation interests, et. al.

2. MEETING

The meeting was opened by Major General Ernest Graves, Division Engineer, North Central Division, U.S. Army Corps of Engineers, acting in his capacity as the chairman of the Winter Navigation Board. He stated that the Board is constituted to direct the program authorized by Congress regarding an extension of the navigation season on the Great Lakes and St. Lawrence Seaway. General Graves then introduced the members of the Winter Navigation Board and Colonel Myron D. Snoke, Detroit District Engineer, whose office has specific responsibility for this investigation.

3. The meeting was held because the Congress of the United States directed the Corps of Engineers to further investigate and study the means for extending the navigation season on the Great Lakes and St. Lawrence Seaway. This study is pursuant to Section 107 of the River and Harbor Act, Public Law 91-611, approved 31 December 1970. Colonel Snoke explained that this was the second study authorized by Congress on extending the navigation season, the first being authorized in 1965. The purpose of the first study was to investigate and determine the preliminary engineering and economic feasibility of a navigation season extension. Based on recommendations from the first study, which emphasized the complexity of the project, a second study was authorized in 1970 to proceed as a full survey scope study to define cost, economic

justification and degree of Federal participation in a program which would, in fact, extend the navigation season. He explained that the 1970 authorization consisted of three parts: a survey study and demonstration program to be conducted by the Corps of Engineers and an insurance study to be conducted by the Department of Commerce. He stated that the survey study and demonstration program are interdependent parts of the overall investigation to determine the engineering, economic, and environmental feasibility of an extended navigation season and that these initial public meetings are the first step in the survey study. General Graves then stated that the survey study is to determine three things: (1) engineering feasibility, (2) economic feasibility, and (3) environmental acceptability. He urged both opponents and proponents of the navigation season extension to present detailed information in support of any statement they make.

4. Statements presented during the session are summarized in the following paragraphs.

a. Congressman John A. Blatnik, Chairman of the Conference of Great Lakes Congressmen, stated that the ultimate goal is year-round shipping on the Great Lakes and St. Lawrence Seaway. This would lower the costs of United States goods abroad, relieve chronic unemployment in the region three to four months of the year and to stem the export of jobs to cheaper markets overseas. Because of the importance of this project, not only to the Lakes but also to the entire nation at a time when the balance of payments is tipped against the United States, he hopes that the Corps of Engineers will give top priority to the program.

b. Executive Commissioner of the Department of Economic Development, Mr. A. M. Devoannes read a statement by Governor Wendell R. Anderson. Governor Anderson's statement read: "I strongly urge you to do everything possible to keep our port in operation as long as physically possible every shipping season. It is clear that the port of Duluth - Superior is one of the greatest economic assets that Northeastern Minnesota possesses. I might also say that the quality of productivity of our longshoremen at this port is unsurpassed. This port is a proven economic stimulation of great force. It has also already created many new jobs in a community with far too few jobs". Governor Anderson's letter further stated that the St. Paul Chamber of Commerce has recently completed a study which indicates that Minnesota's exports of manufactured goods will total more than $817 million this year, and that more than 39,000 people in Minnesota owe their jobs to export sales of manufactured goods. The same study adds that agricultural exports from Minnesota totaled $356 million last year; 30,000 new jobs resulted from those exports.

c. For the Governor of Wisconsin, Patrick J. Lacey, Mr. James Sauter read this statement: "I strongly support the extension of the shipping season in the St. Lawrence Seaway System. The economic benefits to all the States in this area and specifically Wisconsin, whose exports of agricultural and manufactured products is well documented. I hope, however, that all environmental protection requirements will be met in undertaking this effort. I am acutely aware that the extension of the shipping season would be most useful in fostering economic development opportunities for all upper Great Lakes States. whose ports are vital keys to increased employment for our citizens".

d. Executive Vice President of the Northeastern Minnesota Development Association, Mr. Robert J. Bobich, stated that NEMDA is a privately funded economic and industrial development association, which covers the six counties of Northeastern Minnesota. Their responsibilities lie primarily in bringing in new industry and working toward expanding existing industries. It is NEMDA's recommendation that every effort be made to extend the navigation season to allow for successful competition in the world trade market.

e. Executive Director, Seaway Port Authority of Duluth, Mr. Thomas Burke reiterated a statement submitted at the second public meeting urging that a bubbler system be installed along the east side of Burlington Northern No. 1 Ore Dock. Mr. Burke also read a letter from the Hanna Mining Company, indicating an intention to operate four vessels of the 700 - foot class between Superior, Wisconsin, and Detroit, Michigan, and/or Cleveland, Ohio into the first half of January. It was stated that past experience indicates that without the installation of a bubbler system in and around the Superior entrance, ore-docks, and ice breaker assistance over various parts of the route, this would be practically impossible beyond December 20. Mr. Burke further stated that, despite the restricted season, U.S. Lake ports handle approximately 3.5 percent of U.S. waterborne trade, and an extended season would allow them to handle approximately 1/3 more of mid-America's waterborne trade. He indicated that this would mean at least a 5 percent increase in international cargoes, or approximately 8-10 percent of available U.S. overseas trade.

f. Executive Vice President of the Duluth Area Chamber of Commerce, Mr. Charles Westin, stated that the Duluth Chamber of Commerce is vitally interested in the economic welfare of the community and the development of the Duluth port. He felt that it was imperative that further studies be made towards establishing an extension of the navigation season on the Great Lakes and St. Lawrence Seaway, if the Duluth port is to continue to expand.

g. Mr. Stephen Jacobs, Head of the Lake Council of Governments, questioned whether an extension of the navigation season would mean an increase in tonnage and thus revenue and employment for Duluth - Superior, or will it only mean a longer season to handle present tonnage? Mr. Jacobs remarked that his question had been partially answered by the Hanna Mining Company statement, but that he would like further qualifying statements regarding his question. In response General Graves suggested the possibility of further substantiating information.

h. Executive Vice President of the Minnesota Association of Commerce and Industry, Mr. Oliver Perry, summarized a resolution by the Associations's Board of Directors. It urged favorable consideration of the extension - proposal as a means for achieving greater utilization of the Duluth port facilities to allow greater export scheduling flexibility and provide an important means of strengthening the economy of the entire State of Minnesota.

i. Vice President of the Lake Carriers Association, Oliver T. Burnham, stated that maritime and related industries have long been concerned about the winter - enforced idleness of vessels and port facilities with adverse economic and employment impacts. He noted that these late season operations in the last four years have been possible as a result of outstanding cooperation from both the U.S. Coast Guard and the Corps of Engineers. Mr. Burnham discussed the commercial traffic volume in the St. Mary's Falls Canal from 1968 through February, 1972, and identified some of the winter problems such as navigation aids, ice-jamming, and improved survival equipment for cold-water operation. Mr. Burnham also expressed concern about environmental issues raised in connection with the extended navigation season, and urged that erosion - research be expedited.

j. Marine Engineers Beneficial Association representative, Mr. Ralph Rovinsky, stated that his organization represents the majority of the licensed personnel working on the Great Lakes. He stated that his people are shocked and horrified at the lack of progress being shown in the area of safety. He further pointed out particular problems such as frozen lifeboats, frozen life-rafts, frozen access doors and inadequate search and rescue equipment. Mr. Rovinsky also commented on what he called legal and bureaucratic problems dealing with the approval of life-saving equipment, and suggested that the winter operation of vessels should be suspended until a time when these problems can be resolved.

k. Pilot coordinator, Mr. Davis Helberg, submitted a statement on behalf of Captain A. F. Rico, President, Upper Great Lakes Pilots, Inc. The statement indicated that a one-month extension of the season would bring an additional quarter of a million dollars in revenue to the people of their organization and create a substantial employment - increase in many other related fields. As a final comment, he supported the Lake Carriers Association statement regarding environmental aspects and speed regulations on the St. Marys River.

l. Chaplain for the Twin Ports Ministry to Seamen, Mr. Norbert Mohros, stated that he was disappointed that the human dimension (personal needs, etc.) of an extended season are usually placed in a subservient position to more highly ranked technological priorities.

m. A University of Minnesota Biology professor, Paul H. Monson, said that he was seriously concerned about a lack of "wholistic thinking" in terms of the proposed extension. For example, he is concerned about the thermo-climb in the harbor, the tremendous accumulations of organic debris that have gathered for generations and the impacts of a bubbler system on increased amounts of effluence discharged by the newly proposed sanitary system in its developmental stages for the Duluth area. He speculated that the area may revert exclusively to recreational use within fifty years and thus questioned the need for further economic expansion.

n. Local program chairman of the League of Women Voters, Superior, Wisconsin, Mrs. Betty Lou Hetzel, remarked that the League was studying the many proposals for improving the harbor as a natural resource, as well as for providing solutions for the water pollution problem in the bay. Mr. Hetzel then posed the following question: "Are we talking about extending the season or are we talking about year-round shipping or is one going to lead into the other?"

In response General Graves mentioned that the plan of study entails an examination of different lengths of extension, the longest being of year-round duration. Also, the study necessitates an investigation into various geographic aspects of the extension, viz, extensions encompassing either selected small areas or the five Great Lakes.

o. President of the Save Lake Superior Association, Mrs. Arlene Lehto, stated that SLSA has not taken a position on the extended shipping season, but questioned whether the tax-payer would support it and if the average citizen wants it. She also questioned various statements included in the national Shoreline Study prepared by the Corps of Engineers, particularly regarding erosion along the northern Shore of Lake Superior. Mrs. Lehto concluded her remarks by stating that questions of ship-ballast and wastewater treatment must be a major consideration before SLSA would take a position on the extended navigation season.

General Graves pointed out that the U.S. Environmental Protection Agency did publish in the Federal Register proposed regulations on the control of waste discharge from ships; these published regulations were dated 23 June, 1972.

p. Representing the Northern Environmental Council, Mr. John Satterlee, echoed earlier statements saying that extreme care should be taken in preparation of an environmental impact statement which would analyze the effects on a biotic community with regard to bubbling systems. He noted that the Council is looking forward to analyzing the environmental impact statement.

q. Member of the Great Lakes Commission representing the State of Minnesota, Mr. Robert Scott reaffirmed the Minnesota Delegation's interest in the navigation season extension program; he stated that they support C. Thomas Burke's statement with regards to the Superior entry. He also stated that the Duluth - Superior Harbor is at a disadvantage as far as navigation is concerned since, just thirty miles up the shore, two harbors are open for more than a month after the Duluth - Superior harbor has closed. He concluded by saying that the delegation would like to see a bubbler system installed in the harbor.

5. Letters that were submitted for public record in connection with the public meeting are summarized in the following paragraphs.

(a) Representing the United Steel Workers of America, District 33 in Duluth, Mr. Peter J. Bensoni, stressed the importance of extending the season for regularity of employment. Furthermore, his union urges the U.S. Army Corps of Engineers to continue its work to develop practical methods for extending the length of the shipping season on the Great Lakes.

(b) Power Authority of the State of New York, Mr. Asa George, General Manager, writes that the authority's position as presented at the Chicago public meeting is unchanged. They are vitally concerned with proposals to extend the navigation season insofar as such extension and experimentation related thereto would affect the authority's power developments on the Niagara and St. Lawrence rivers, or would affect the regulations of Lake Ontario.

6. Additional Statements for the record.

(a) Port Direction for the City of Superior, Mr. James Sauter, pointed out that at least one and undoubtedly other firms are making plans for operations into and possibly through the month of January. He notes that an extension of the season would provide longer periods of employment, which would benefit all segments of the local economy. Mr. Sauter hoped that immediate and favorable consideration would be given to the installation of a bubbler system in the harbor to facilitate an extension of the shipping season at the Head of the Lakes.

(b) Mr. Stanley Silverton, representing a family devoted to commercial fishing since the 1890's, reported that his company has experienced difficulties with accumulated ice between the approximate dates of February 22 and June 10 at Duluth. Prior to the former date, the employment of such devices as the bubbler system has been successfull in efforts to clear ice formations. If, he concludes, the ice outside of the harbor could be broken at times during the February to June period, a more substantial smelt-catch would be facilitated.

7. Statements submitted though not included in the Official Transcript.

(a) A written statement signed by Mr. Thomas F. Schweigert, Federal Co-Chairman, Upper Great Lakes Regional Commission, stated that a fundamental point to be emphasized is that the Duluth - Superior has a larger lake cargo-traffic than has any other Great Lakes port and its needs should be considered especially with respect to three specific flows--viz, iron ore, coal and agricultural commodities. Moreover, he believes that the study should relate the lake-traffic potentials to the other modes of transportation, especially to unit trains and pipelines.

(b) Robert G. Gebrz, General Solicitor for the Soo Line Railroad Company, described his company as a principle rail carrier, serving the Twin Port of Duluth and Superior and the tributary territory to the west and to the south; it employed an average of 5052 employees on its system in 1971. The welfare of these employees, he believes, must be considered in the evaluation of the extended season project. Mr. Gebrz notes the abundant public transportation via railroads, highway networks and the publicly subsidized Mississippi Waterway system. He proposes that the Secretary of the Army take these things into full consideration in his report to Congress in order to ensure sound channeling of public monies and the avoidance of wasted natural resources. Mr. Gebrz concludes his report with a request that the Corps of Engineers consider their evaluations of the extended season program in conjunction with an examination of existing land-transportation systems.

(c) A report submitted by the International Longshoreman's Association (A.F.L. - C.I.O.). Mr. E. L. Slaughter, International Vice President, endorses the proposals for the extended navigation season. He cited two primary advantages accruing from the project. They are: (1) economic benefits derived by company memberships and subsequently by the communities; (2) additional employment increments of about one-hundred more men per month.

(d) A statement submitted by the Minneapolis Chamber of Commerce. Mr. Orin T. Hanson, Manager of the World Trade and Agricultural Departments, endorses the concept of feasiblity studies and/or projects leading toward an extension-of the Great Lakes' navigation season. He hopes for advantageous economical ramifications.

8. CONCLUSION

Major General Graves concluded by briefly describing the actions that would occur following the meeting. General Graves stated that a data-gathering stage has been initiated in the demonstration program itself, along with interviews of people engaged in shipping on the Great Lakes. Alternatives will be formulated and examined as to their practicability. At approximately midway through the study, we will hold another series of meetings to acquire views on the results at that time. We will then take the results of those meetings and prepare our final report, which will also be the subject of a series of public meetings.

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IN REPLY REFER TO

DIGEST OF PROCEEDINGS OF THE
SECOND SERIES OF PUBLIC MEETINGS CONCERNING
THE EXTENSION OF THE NAVIGATION SEASON
ON THE GREAT LAKES AND ST. LAWRENCE SEAWAY

1. GENERAL

The first meeting of the second set of three public meetings was held on 7 January 1974, by the District Engineer, Detroit District, Corps of Engineers, in Palucci Hall of the Duluth Arena Auditorium, 350 South 5th Avenue West, Duluth, Minnesota. The meeting began at 1:00 P.M. and terminated at 3:30 P.M.. A total of 58 people were present, representing various Federal and state agencies, business and conservation interests, et. al.

2. MEETING

The meeting was opened by Colonel James E. Hays, District Engineer, Detroit District, U.S. Army Corps of Engineers, acting in his capacity as the Chairman of the Winter Navigation Working Committee. Colonel Hays introduced the members of the Working Committee and stated that the purpose of the meeting was to present to the public, proposals to extend the navigation season on the upper four Great Lakes and to hear public views and suggestions for further work to be undertaken as a part of the Survey Study and Demonstration Program.

3. The meeting was held because the Congress of the United States directed the Corps of Engineers to further investigate and study the means for extending the navigation season on the Great Lakes and St. Lawrence Seaway. This study is pursuant to Section 107 of the 1970 River and Harbor Act, Public Law 91-611, approved 31 December 1970. The 1970 authorization consisted of three parts: a Survey Study and Demonstration Program to be conducted by the Corps of Engineers and an insurance study to be conducted by the Secretary of Commerce acting through the Maritime Administration. He stated that the Survey Study and Demonstration Program is an overall investigation to determine the engineering, economic, and environmental feasibility of an extended navigation season.

Colonel Hays presented the history of the study which led to the currently proposed Interim Survey Report. The report would address implementation of an extended navigation season on the upper four Great Lakes with a long-range objective of extending the navigation season in the entire Great Lakes-St. Lawrence Seaway System.

Colonel Hays discussed the problems attributable to extended season navigation, outlined the solutions being considered to address the problems, defined the alternative plans for the upper four Great Lakes and displayed the preliminary costs and benefits related to the alternative plans. He stated that initial analyses indicate that navigation season extension on the upper four Great Lakes is economically feasible.

4. Statements presented during the session are summarized in the following paragraphs.

a. Seaway Port Authority of Duluth. - Mr. C. Thomas Burke, Executive Director, submitted two written statements, one for himself and one for Mr. John F. McGrath, President of the Seaway Port Authority of Duluth (see paragraph 6). Mr. Burke expressed concern over the delay in implementing the extended navigation season and stated that the program should encompass the entire Great Lakes-St. Lawrence Seaway System.

b. League of Women Voters of Superior, Wisconsin. - Ms. Eunice Perry, President, requested that the final survey report stipulate Duluth-Superior Harbor as the site of any future expenditures for developing and experimenting with materials and methods related to ice conditions, because of the area's severe weather and large shipping volume.

c. Minnesota Public Interest Research Group (MPIRG). - Ms. Debbie Fellows, member of the University of Minnesota at Duluth Affiliate of MPIRG, stated that MPIRG has strong reservations about the feasibility of the extension of the Great Lakes shipping season. She further stated these reservations are based on the design and operation of Great Lakes vessels in ice conditions, the economic feasibility of extending the season, assumptions of the Environmental Evaluation Work Group concerning the extrapolation and applicability of test data, and the problem of identifying the party responsible for damage to shoreside structures and shore erosion. In conclusion, Ms. Fellows expressed MPIRG's opinion that an extention of the shipping season would be inappropriate at this time.

d. Great Lakes Commission. - Mr. Robert T. Scott, Vice Chairman, reviewed the progress of the Demonstration Program to date and noted that the extension of the navigation season in the four upper Great Lakes meets the test of economic feasibility. He further noted such beneficial aspects as the low cost of water transportation, fuel economy, and the lesser demand for land transportation corridors and facilities. He urged that the Great Lakes-St. Lawrence Seaway System be operated as a single system along with the inland waterways system, the rail system, the truck-highway system and other transportation systems. Mr. Scott requested that the Interim Survey Report emphasize the need for the system-wide approach and a year-round navigation season.

e. Marine Engineers Beneficial Association. - Mr. Herbert Nelson, District Two Representative, stated that the Winter Navigation Board had purchased survival suits last year to be placed aboard vessels on the winter run, but these suits had not been made available. He asked what had happened to the suits and wanted to know why the Winter Navigation Board had not acted on this.

f. Lake Carriers' Association. - Vice Admiral Paul E. Trimble (U.S. Coast Guard - retired), President, expressed support for the extension of the navigation season. Admiral Trimble stated that greater utilization of the Great Lakes System will provide substantial public benefits, noting the favorable cost-benefit analysis for the extension, more efficient use of vessels, and the low costs and efficient use of energy resources provided by water transportation.

Admiral Trimble outlined the progress that has been made to date in the Demonstration Program. He noted efforts to identify the environmental impacts of the extended navigation season, and the progress being made on shipboard crew survival systems and precise navigational aid systems. He described several facets of the extended season program that must immediately be considered by the Winter Navigation Board. They are: (a) ice control for Little Rapids Cut and West Neebish Channel in the St. Marys River, (b) icebreakers for extended season navigation, and (c) a marine forecast and research center.

He urged: implementation of winter navigation on the Great Lakes as national policy, authorization of the survey study's present recommendations, prompt decision by the Coast Guard concerning icebreaking fleet replacement policy, and action by the National Oceanic and Atmospheric Administration on a marine weather and ice forecast research center for the lakes. He also urged that Congress act on H.R. 10203, the Water Resources Development Act of 1973, which provides a two-year extension of the winter navigation Demonstration Program to finalize unfinished projects and devote more attention to the St. Lawrence Seaway section of the system.

g. Save Lake Superior Association of Minnesota, Michigan, and Wisconsin. - Ms. Arlene Lehto, Executive Committee Chairwoman, requested that the public record be left open since the Association did not receive an official notice of the public meeting and did not have sufficient time to prepare a statement. Ms. Lehto asked that additional facilities be constructed for treatment of shipboard wastes and ballast waters, and that consideration be given to public opinion which questions the need for increased activity and consumption in a time of fuel shortages and high water. Ms. Lehto stated that the Association questions the environmental impact of the bubbler system, noting that results of the impact studies are not yet available. She requested that the results of environmental impact studies be made available 30 days in advance in order to allow the public to have the information needed to allow them to act knowledgeably at a public hearing.

5. Letters read into the public record in connection with the public meetings are summarized in the following paragraphs.

a. Conference of Great Lakes Congressmen. - A letter submitted by Congressman John A. Blatnik (D-Minn.), Chairman, expressed his full support and encouragement in extending the navigation season on the Great Lakes. Congressman Blatnik emphasized the value of shipping as the least expensive mode of transportation and also as the most economical from the standpoint of energy conservation. He stated that a 10-month assured season, which this program has already made a reality in the upper lakes, and will hopefully achieve in the Seaway, will improve our ability to attract trade, provide longer employment for crews and dockworkers throughout the lakes, and contribute to the nation's trade and energy conservation efforts.

b. Fraser Shipyards, Inc. - A letter submitted by Mr. Trevor White, Vice President-Engineering, recommended that the port of Duluth-Superior, including Howards Bay, be maintained in a navigable condition during the extended navigation season, not only for cargo movement but for use of shipyard facilities. He noted the planned expansion of the harbor facilities to meet increases in shipments of taconite pellets, low-sulfur coal, newsprint and oil products, and planned construction of new shipyard improvements.

c. Industrial Users of the Great Lakes and St. Lawrence Seaway. - A letter submitted by Mr. James M. Scovic, Chairman, expressed continued support of the extension of the winter navigation on the Great Lakes and St. Lawrence Seaway System. He also expressed support for increased water movement of goods as the most efficient method of transportation.

6. Additional statements submitted for the public record in connection with the public meeting are summarized in the following paragraphs.

a. International Association of Great Lakes Ports and the Seaway Port Authority of Duluth. - A statement submitted by Mr. C. Thomas Burke, Chairman of the United States Section and Executive Director respectively, expressed his support of the extended navigation season. Mr. Burke reviewed the bubbler system program at Duluth-Superior Harbor and noted its benefits in increased shipping. He stated that new development at the Port of Duluth-Superior will involve construction of new facilities for grain, low-sulfur coal and roll-on, roll-off cargo shipments of newsprint from Canada and emphasized the need for the longest navigation season possible. Mr. Burke expressed concern that the progress of international cargoes through the St. Lawrence Seaway has not paralleled that of interlake shipments. He stated that it is imperative to use the cheapest transportation source, water commerce, and urged that all feasible means of extending the navigation season be implemented as quickly as possible.

b. Seaway Port Authority of Duluth. - A statement submitted by Mr. John F. McGrath, President, reviewed the increases in international cargoes moving through the port in recent years. He reported new development projects planned for the Duluth-Superior area, including: construction of a new grain elevator and meal-handling plants, construction of a low-sulfur coal bulk terminal, a container-handling facility, a roll-on, roll-off shipping service to shuttle railroad cars of newsprint to and from Ontario,Canada, and expansion of a petroleum terminal. He stated that these industries will rely on waterborne transportation, and any further innovations toward extending their seasonal operations toward year-round, waterborne commerce will promote more new development.

7. DISCUSSION

Following the presentation of formal statements, Colonel Hays opened the meeting for a question and answer period. The only question raised by the attendees concerned the issuance of survival suits. Captain Gerald Brown of the U.S. Coast Guard and Vice Chairman of the Working Committee stated that he does not believe there is an effective survival suit suitable for distribution to the fleet. He described inherent defects in the suit such as inadequate floatation and a tendency to fill with water.

Mr. Imre Szekelyhidi, representing the chairman of the Environmental Evaluation Work Group, explained the Environmental Protection Agency's involvement in the program, emphasizing that the environmental impacts of all activities are being considered. He stated that the work group had concluded that it cannot extrapolate all effects of large-scale bubbler operations from small-scale bubblers. He stated that as an example, effects on fish migration cannot be extrapolated; however, there are other aspects of bubbler operations which can be extrapolated, assuming that baseline conditions are similar.

8. CONCLUSION

Colonel Hays concluded by noting future actions concerning the program. He stated that an Interim Survey Report as now proposed would be submitted to Congress in July 1974, and that the knowledge gained through public meetings would be used in the further development of alternatives in the next few months. Digests of the public meetings and an Environmental Impact Statement would accompany the Interim Survey Report. He stated that at least one more set of public meetings would be held prior to submitting an Interim Survey Report to Congress.

DEPARTMENT OF THE ARMY
DETROIT DISTRICT, CORPS OF ENGINEERS
P. O. BOX 1027
DETROIT, MICHIGAN 48231

IN REPLY REFER TO

DIGEST OF PROCEEDINGS OF THE
SECOND SERIES OF PUBLIC MEETINGS CONCERNING
THE EXTENSION OF THE NAVIGATION SEASON
ON THE GREAT LAKES AND ST. LAWRENCE SEAWAY

1. GENERAL

The second meeting of the second set of three public meetings was held on 9 January 1974, by the District Engineer, Detroit District, Corps of Engineers, in the Commissioners Room of the City-County Building, Bingham and Court Streets, Sault Ste. Marie, Michigan. The meeting began at 1:05 P.M. and terminated at 4:30 P.M.. A total of 76 people were present, representing various Federal and state agencies, business and conservation interests, et. al.

2. MEETING

The meeting was opened by Colonel James E. Hays, District Engineer, Detroit District, U.S. Army Corps of Engineers, acting in his capacity as the Chairman of the Winter Navigation Working Committee. Colonel Hays introduced the members of the Working Committee and stated that the purpose of the meeting was to present to the public, proposals to extend the navigation season on the upper four Great Lakes and to hear public views and suggestions for further work to be undertaken as a part of the Survey Study and Demonstration Program.

3. The meeting was held because the Congress of the United States directed the Corps of Engineers to further investigate and study the means for extending the navigation season on the Great Lakes and St. Lawrence Seaway. This study is pursuant to Section 107 of the 1970 River and Harbor Act, Public Law 91-611, approved 31 December 1970. The 1970 authorization consisted of three parts: a Survey Study and Demonstration Program to be conducted by the Corps of Engineers and an insurance study to be conducted by the Secretary of Commerce acting through the Maritime Administration. He stated that the Survey Study and Demonstration Program is an overall investigation to determine the engineering, economic, and environmental feasibility of an extended navigation season.

Colonel Hays presented the history of the study which led to the currently proposed Interim Survey Report. The report would address implementation of an extended navigation season on the upper four Great Lakes with a long-range objective of extending the navigation season in the entire Great Lakes-St. Lawrence Seaway System.

Colonel Hays discussed the problems attributable to extended season navigation, outlined the solutions being considered to address the problems, defined the alternative plans for the upper four Great Lakes and displayed the preliminary costs and benefits related to the alternative plans. He stated that initial analyses indicate that navigation season extension on the upper four Great Lakes is economically feasible.

4. Statements presented during the session are summarized in the following paragraphs.

a. Mr. Wilbur Tubman, hydro operator for the Corps of Engineers, expressed concern over the effects of winter navigation upon power generation. He asked if passage of vessels caused additional ice to enter plant intakes. He stated that power losses must be made up by additional use of fossil fuel at other powerplants, and that the power companies might pass on the additional costs to the consumers. He stated that consumers should be reimbursed if these costs are passed on.

b. Sugar Island Resident. - Dr. Wayne Switzer stated that he was concerned with the ecological effects of the extended season, shoreline damage and the economic involvements. He stated that he had observed that extended season navigation has tended to block the flow of water through the normal west channel and create additional flow through the north channel around Sugar Island. He expressed his concern that the increased flow results in additional ice activity and dock and shoreline damage. He stated that he has lost extensive amounts of shoreline due to erosion and thinks that this is partly due to extended season activity. Dr. Switzer also related the problems and inconveniences of disrupted ferry service caused by navigation season extension. He related several specific instances where he experienced loss of professional service time. He stated that the island residents who have their income disrupted by the extended season should be reimbursed for losses and these costs should be considered.

c. Save Our Shores. - Mr. Joseph Haller, St. Marys River property owner, suggested that if an economic gain is to be realized by the region from winter navigation, compensation for losses should be made to the area residents. Mr. Haller asked that the Corps of Engineers take measures to protect the shores of the St. Marys River from ice damage, and that monetary compensation be provided where protection is not possible. Mr. Haller further requested Federal assistance to improve winter ferry service to the islands, and also requested that Edison Sault Electric Company not be permitted to increase electricity rates to consumers because of power losses due to extended season navigation.

d. Neebish Island Resident. - Ms. Helen B. McLeod objected to the opening of the West Neebish Channel after 1 January of each year unless a more thorough study is carried out and adequate ferry service is made available to island residents.

e. Poirier Marine, Inc. - Mr. D. W. Zimmerman, Chairman of the Board, stated that he agreed with the basic philosophy of extended season navigation on the basis of economic benefits. However, he questioned the costs accrued to the taxpayers and residents of shoreline properties as a result of extended season navigation. His major items of concern were shore erosion and damage and the difficulties to island residents due to inadequate ferry service. Mr. Zimmerman suggested that the responsible government organizations should purchase and operate their own ferries during periods of heavy ice. He also recommended further in-depth studies of environmental impacts on shorelines of the St. Marys and St. Clair Rivers and other areas before an extended season program is implemented.

f. Neebish Island Resident. - Mr. Walter Sanford expressed the opinion that ferries could not withstand the ice forces experienced in Neebish Channel. Mr. Sanford objected to extended season operation where it disrupts island-to-mainland transportation.

g. Great Lakes Commission and Great Lakes Task Force. - Mr. Leonard Goodsell, Executive Director and Secretary respectively, expressed his support of the statement by Mr. Robert Scott, President of the Great Lakes Commission, at the 7 January public meeting at Duluth, Minnesota. Mr. Goodsell reviewed the progress of the Demonstration Program to date and noted that the extension of the navigation season in the four upper Great Lakes meets the test of economic feasibility. He further noted such beneficial aspects as the low cost of water transportation, fuel economy, and the lesser demand for land transportation corridors and facilities. He urged that the Great Lakes-St. Lawrence Seaway System be operated as a single system along with the inland waterways system, the rail system, the truck-highway system and other transportation systems, and requested that the Interim Survey Report emphasize the need for the system-wide approach and a year-round navigation season.

h. Industrial Users of the Great Lakes and St. Lawrence Seaway. - Mr. Goodsell read a letter submitted by Mr. James M. Scovic, Chairman. Mr. Scovic expressed continued support of the extension of the winter navigation on the Great Lakes and St. Lawrence Seaway System. He also expressed support for increased water movement of goods as the most efficient method of transportation.

i. Paradise, Michigan, Resident. - Mr. William Wilson questioned the artificial target dates that have been set for season extension (31 January and 28 February). He expressed his opinion that vessel operation is dependent on weather and ice conditions. He expressed concern over shoreline erosion caused by extended season navigation. Mr. Wilson stated that the industries which benefit from the extended season should pay the associated costs.

j. Dr. Gale Gleason, a limnologist, questioned the procedures undertaken and results obtained in the Demonstration Program. Dr. Gleason criticized the Public Information Brochure, claiming it was inadequate, lacked documentation and concrete facts and was a poor representation of two and one-half years of study. Dr. Gleason questioned the cost figures of the alternatives presented by Colonel Hays and expressed concern over the benefits accrued to commercial carriers and the costs to the taxpayer. Dr. Gleason stated that the target dates for the extended season are artificial, and recommended that navigation on the Great Lakes be terminated as soon as the water attains a temperature of 32°F. He noted his concern over the availability of the Environmental Impact Statement and Interim Survey Report for public review.

k. Sugar Island Resident. - Mr. R. E. Curlis expressed concern for the school children and other residents who have to use the tugboat transportation provided by the Coast Guard when the regular car ferry is not operating. He stated the need for vehicular transport between Sugar Island and the mainland and for more frequent trips.

l. Sault Ste. Marie, Michigan, City Commission. - Mr. John Harrington, former Mayor of Sault Ste. Marie, recommended the implementation of a more physical program to alleviate the taxpayers' problems stated at the meeting.

m. ARCTEC, Inc. - Mr. Richard Voelker stated that commercial ice engineering laboratories are available to directly address some of the problems associated with extended season navigation. He presented a release to be included in the public record which outlined ARCTEC sercices.

5. Letters read into the public record in connection with the public meeting are summarized in the following paragraphs.

a. Conference of Great Lakes Congressmen. - A letter submitted by Congressman John A. Blatnik (D-Minn.), Chairman, expressed his full support and encouragement in extending the navigation season on the Great Lakes. Congressman Blatnik emphasized the value of shipping as the least expensive mode of transportation and also as the most economical from the standpoint of energy conservation. He stated that a 10-month assured season, which the program has already made a reality in the upper lakes, will improve our ability to attract trade, provide longer employment for crews and dockworkers throughout the lakes, and contribute to the nation's trade and energy conservation efforts.

b. Board of Chippewa County Commissioners and Board of Chippewa County Road Commissioners. - A statement submitted by Mr. R. T. Ronquist, Engineer-Superintendent, outlined the effects of winter navigation upon Sugar, Neebish, Lime and Drummond Islands, their residents and the associated island-to-mainland transportation. Mr. Ronquist objected to the extended navigation season in the St. Marys River on the grounds that it interferes with or disrupts the islanders' health and welfare, and accessibility to the mainland. He also questioned the wisdom of continuing efforts to operate during the winter on the upper Great Lakes in view of the critical fuel situation.

6. Additional statements submitted for the public record in connection with the public meeting are summarized in the following paragraphs.

a. Neebish Pioneers Association. - A letter submitted by Mr. Frank Fucik, Ecological Committee Chairman, commented on a draft environmental impact statement on Coast Guard icebreaking. Mr. Fucik stated that icebreaking in the St. Marys River in January and February exerted large forces on dock structures on the shoreline and allowed the formation of additional ice in the broken channel. He stated that movement of vessels in the channel caused water level fluctuations which damage shore structures which are frozen into the ice-cover. Mr. Fucik recommended that the costs of damages to private docks be included in the cost to the Government of maintaining an ice-free channel for 12 months of the year, or that some method of protecting the shore structures be implemented.

b. Edison Sault Electric Company (ESELCO). - A statement submitted by Mr. Robert C. Cline, Jr., Vice Chairman of the Board, and Mr. William R. Gregory, President, restated, with minor modifications, the written statement that was previously submitted at the first series of public meetings held at the Dirksen Building, Chicago, Illinois, on 24 May 1972. They outlined adverse effects on Edison Sault Electric Company hydropower generation resulting from extended season navigation. Major problems are: reduction of available head for power generation caused by partial ice jams or ice buildups and the frequent icing conditions at turbine intakes. In addition, ESELCO requested that the Winter Navigation Board, in its studies, develop procedures to eliminate the problems set forth in their statement, if the extension program is to be continued.

c. Northern Michigan Wilderness Coalition. - A letter submitted by Mr. Robert A. Hanson, Coordinator, expressed concern over navigation season extension and requested that possible environmental impacts be researched and an Environmental Impact Statement be prepared.

7. DISCUSSION

Following the presentation of formal statements, Colonel

Hays opened the meeting for a question and answer period. The majority of the questions raised by the attendees concerned the problem of shoreline damages, specifically whether property owners would be reimbursed for damages, whether damage costs would be included in the cost-benefit analysis and whether the extended season would be continued in future years.

Colonel Hays stated that the Interim Survey Report would include a recommendation to Congress as to how the problem of bank protection and shore structure protection should be handled. He stated that a study on this very problem was currently being done by the Corps of Engineers; however, the results of the study had not been completed. Colonel Hays also stated that it currently appears that sufficient funds may be available to carry on the Demonstration Program for one more year, and that a request for an additional 2-1/2 year extension is currently before the Congress for approval.

Other questions were concerned with the availability of Demonstration Program results and environmental impact assessments, whether costs of ferry improvements at Drummond Island and loss of power production due to loss of head caused by ice jams downstream would be included in the cost-benefit analysis, how many ships utilize the extended season, the merits of building more ships rather than extending the navigation season, whether foreign ships will utilize the extended season, the relationship of the energy situation to the extended navigation season, and the effect of increased shipping on the utilization of natural resources such as increased production of coal.

Colonel Hays stated that the Interim Survey Report together with an Environmental Impact Statement is currently being prepared and will be available to the public by 1 July 1974, if all goes according to schedule. Mr. Carl Argiroff, chairman of the Ice Management Work Group, stated that currently it has not been shown that problems at the Drummond Island ferry crossing are a result of the extended season program; however, data is being collected this winter to further evaluate the situation. The problem of power production is being addressed in the Interim Survey Report. Colonel Hays stated that as of 9 January 1974, 19 ships were still operating in the extended season of an estimated total of 400 in the fleet. Captain Gerald Brown of the U.S. Coast Guard and Vice Chairman of the Working Committee stated that even if the newer ships can carry more during the regular shipping season, the problem is amortizing the cost of the vessel over a 9-month period versus a 12-month period, and consequently shipping companies are looking towards an extended season. Mr. David C. N. Robb of the St. Lawrence Seaway Development Corporation and chairman of the Ice Control Work Group stated that the Seaway Corporation is extremely supportive of opening the entire Great Lakes-St. Lawrence Seaway System, including making provisions for foreign vessels into the St. Lawrence River; however, he also stated that the Interim Survey Report as it is presently structured does not contemplate recommending an extended season program on the Seaway at this time. Colonel Hays covered the question on the energy situation stating that recent studies have indicated that water commerce is the most efficient way to go from an energy utilization standpoint. He also stated that if industry should cut back production in the interest of energy conservation, then he would assume that shipping companies serving those industries would not ship as much.

8. CONCLUSION

Colonel Hays concluded by noting future actions concerning the program. He stated that an Interim Survey Report as now proposed would be submitted to Congress in July 1974, and that the knowledge gained through public meetings would be used in the future development of alternatives in the next few months. Digests of the public meetings and an Environmental Impact Statement would accompany the Interim Survey Report. He stated that at least one more set of public meetings would be held prior to submitting an Interim Survey Report to Congress.

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DIGEST OF PROCEEDINGS OF THE
SECOND SERIES OF PUBLIC MEETINGS CONCERNING
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ON THE GREAT LAKES AND ST. LAWRENCE SEAWAY

1. GENERAL

The third meeting of the second set of three public meetings was held on 11 January 1974, by the District Engineer, Detroit District, Corps of Engineers, in Room 514 of the Veterans Memorial Building, 151 West Jefferson Avenue, Detroit, Michigan. The meeting began at 10:00 A.M. and terminated at 2:00 P.M.. A total of 79 were present, representing various Federal and state agencies, business and conservation interests, et. al.

2. MEETING

The meeting was opened by Colonel James E. Hays, District Engineer, Detroit District, U.S. Army Corps of Engineers, acting in his capacity as the Chairman of the Winter Navigation Working Committee. Colonel Hays introduced the members of the Working Committee and stated that the purpose of the meeting was to present to the public, proposals to extend the navigation season on the upper four Great Lakes and to hear public views and suggestions for further work to be undertaken as a part of the Survey Study and Demonstration Program.

3. The meeting was held because the Congress of the United States directed the Corps of Engineers to further investigate and study the means for extending the navigation season on the Great Lakes and St. Lawrence Seaway. This study is pursuant to Section 107 of the 1970 River and Harbor Act, Public Law 91-611, approved 31 December 1970. The 1970 authorization consisted of three parts: a Survey Study and Demonstration Program to be conducted by the Corps of Engineers and an insurance study to be conducted by the Secretary of Commerce acting through the Maritime Administration. He stated that the Survey Study and Demonstration Program is an overall investigation to determine the engineering, economic, and environmental feasibility of an extended navigation season.

Colonel Hays presented the history of the study which led to the currently proposed Interim Survey Report. The report would address implementation of an extended navigation season on the upper four Great Lakes with a long-range objective of extending the navigation season in the entire Great Lakes-St. Lawrence Seaway System.

Colonel Hays discussed the problems attributable to extended season navigation, outlined the solutions being considered to address the problems, defined the alternative plans for the upper four Great Lakes and displayed the preliminary costs and benefits related to the alternative plans. He stated that initial analyses indicate that navigation season extension on the upper four Great Lakes is economically feasible.

4. Statements presented during the session are summarized in the following paragraphs.

a. Great Lakes Landowners Group. - Mr. Paul B. Rutledge, Chairman, expressed opposition to extended navigation because of ecological and environmental concerns, particularly with respect to damage to private properties adjoining the Great Lakes, attributable to the extended season navigation. He requested that the costs of repair of such damage be considered in the total economic feasibility of the proposed program. He recommended that a winter and spring assessment of shore damages be undertaken to differentiate between damages attributed to the extended season and those attributed to the natural spring breakup phenomena, and that affected property owners be reimbursed for damages. Mr. Rutledge submitted for the record a petition, expressing opposition, signed by 135 persons of the Landowners Group who reside along the St. Clair River. However, he stated that if the navigation season extension is of economic value to the Midwest regions, the landowners would support extension of the navigation season providing the Landowners get relief for damages incurred.

b. Michigan Department of Natural Resources. - Mr. Herbert Miller read a statement by Mr. A. Gene Gazlay, Director, reaffirming the position presented in the Michigan Department of Natural Resources statement in the first set of public hearings on 10 July 1972. Their position is that the State of Michigan has an obligation to assure maximum protection of the public's interest in the Great Lakes surrounding Michigan, and that mutual coordination between Federal and state interests on the navigation season extension program, together with thorough study, is a means to fulfilling that obligation. Mr. Gazlay recommended that the various demonstration projects be thoroughly researched, followed by a review of the environmental aspects, before the projects are implemented on an operational basis. He cited shoreline erosion and flooding, possible physical alterations to the connecting channels, and the effects of the proposed bubbler systems on fish behavior as areas in need of additional investigation. Mr. Gazlay expressed support of an extension of the Demonstration Program to permit further study. He requested full consideration of broad public interests and stated that the responsibility for protection or compensation must be dealt with adequately and fairly if extension of the navigation season is to become operational.

c. Sierra Club. - Mr. Irving Salmeen read a statement of Mr. Jonathan Ela, Midwest Representative of the Sierra Club. Mr. Ela stated that the Sierra Club is not opposed in principle to extended season navigation, but strongly resists premature implementation. Mr. Ela outlined potential adverse environmental impacts of techniques to extend the navigation season, of large scale shipping during the winter season, and on the future of the Great Lakes in general. Mr. Ela concluded that adequate and competent environmental analysis of winter navigation technology has not been undertaken, that hazards of winter vessel traffic have not been adequately studied and evaluated, that shipping on the Great Lakes has not been considered in a context of other economic, social and environmental interests, and that the economics of shipping as compared to other alternative forms of transportation and the question of public and general benefits as opposed to private and localized gain have not been publicly considered. Mr. Ela recommended that: the preparation of the Interim Survey Report be deferred, the Demonstration Program be extended 3 to 5 years with emphasis on environmental impacts throughout the entire system, and multiple uses of the Lakes be considered.

d. City of Buffalo, New York. - Mr. Richard O'Neil, Assistant Harbormaster of Buffalo Harbor, expressed concern about broken ice floating down from the upper Great Lakes and accumulating in the vicinity of the north entrance to Buffalo Harbor and at the ice boom located at the head of the Niagara River. He stated that the City of Buffalo should be taken into consideration in a navigation season extension program.

e.. University of Michigan. - Mr. Horst Nowacki, of an Investigation Team in the Department of Naval Architecture and Marine Engineering, outlined a technical and economic study sponsored by the Maritime Administration of the Department of Commerce, regarding Great Lakes winter navigation. Mr. Nowacki stated three areas of cost savings which their study had identified, namely, vessel transport costs accomplished by an increase in ship utilization from 8-1/2 to 10 months or more, fleet-wide transport costs achieved by making longer and better use of newer, more efficient ships and consequently retiring or utilizing the older ships less, and inventory costs achieved by reducing stockpiles. Mr. Nowacki concluded that, on the basis of their study, extended season navigation is economically attractive.

f. Mr. Elmer Treloar, interested citizen, stated that the season extension appears unrealistic. He mentioned problems of adverse weather and ice conditions, and stated that the shipping companies operating in the extended navigation season should assume full responsibility for damage they cause to shore properties and should also provide their own icebreakers.

g. Michigan Department of Agriculture. - Mr. Porter Barnett, transportation specialist, read a statement by Mr. B. Dale Ball, Director. Mr. Ball stated that the Great Lakes-St. Lawrence Seaway System should be fully developed as a transportation system to help the Midwest and Michigan farmers market their grains and other agricultural commodities. Due to the uncertainty of rail-car availability, Mr. Ball supported low fuel-consumption shipping to facilitate Midwest transportation of grains and processed foodstuffs to U.S. and subsequently foreign markets. Mr. Ball stated that in developing and expanding overseas markets, the Michigan Department of Agriculture is vitally interested in deepening the Saginaw River to St. Lawrence Seaway maximum channel depths in order to fully utilize the port of Bay County in Saginaw, Michigan, and to provide a more efficient and economic means of transporting Michigan's agricultural commodities.

h. Marine Engineers Beneficial Association. - Mr. Tom Conway, Assistant Vice President of the Lakes, presented a statement primarily concerned with human safety and survival. Mr. Conway stated that his organization supports the U.S. Coast Guard's long range investigation program on safety and survival; however, he expressed concern that efforts in the survival program were not proceeding fast enough. He expressed the need for the distribution of survival suits during this winter's extended season to provide some protection to the vessel crews; however, he claimed that the Coast Guard has opposed distribution of the suits because they are faulty. In conclusion, Mr. Conway stated that the men are willing to sail the extended season provided their needs are met.

i. Port Coordinator for Bay County, Michigan. - Mr. James McGowan stated he supports the implementation of extended season navigation on a year-round basis throughout the entire Great Lakes-St. Lawrence Seaway System. Mr. McGowan also expressed support of statements made at the meeting by the Industrial Users Group, Michigan Department of Agriculture and Michigan Department of Natural Resources.

5. Letters read into the public record in connection with the public meeting are summarized in the following paragraphs.

a. Industrial Users of the Great Lakes and St. Lawrence Seaway. - A letter submitted by Mr. James M. Scovic, Chairman, expressed continued support of the extension of the winter navigation on the Great Lakes and St. Lawrence Seaway System. He also expressed support for increased water movement of goods as the most efficient method of transportation.

b. Ogdensburg Bridge and Port Authority, Odgensburg, New York. - A letter submitted by Mr. Richard H. VanDerzee, Port Director, urged that studies consider the Great Lakes-St. Lawrence Seaway System in its entirety, rather than dividing the system up into the lower and upper lakes. He also recommended that the 1974 Demonstration Program include a detailed study of human factors.

c. Great Lakes Task Force. - A letter submitted by Mr. John A. Seefeldt, Chairman, stated that in addition to direct transportation savings, the environmental benefits to be derived from the use of water transportation and the lesser demand for land transportation corridors and facilities would result from greater use of the Great Lakes-St. Lawrence Seaway System. He recommended that an overall system outlook be preserved and that the entire Great Lakes-St. Lawrence Seaway System be coordinated with other modes of transportation. He also recommended that authorization be aimed at a year-round navigation season.

d. Michigan Department of Commerce. - A letter submitted by Mr. Richard K. Helmbrecht, Director, expressed concurrence in the strategy of giving priority considerations to intra-lake operation; however, he stated that the long-range objective must be international in scope and aimed at year-round operation. In support of extended season navigation, Mr. Helmbrecht indicated that his Department has requested funds from the State of Michigan to conduct a preliminary feasibility study on extended and year-round operation of the Saginaw River Port facility. He also expressed his pleasure that impacts of extended season navigation on the environment and on the life style of individuals living along the Great Lakes are given priority attention in the Interim Survey Report.

e. Power Authority of the State of New York. - A letter submitted by Mr. Robert Conner, Resident Manager, St. Lawrence Power Project, reiterated the position expressed by the Authority in the past, this position being that the Authority has no objections to an extended navigation season provided such can be accomplished without adversely affecting riparian interests or power production. He stated that the Authority has seen little evidence developed from the Demonstration Program thus far to support a conclusion that this objective can be met.

6. Additional statements submitted for the public record in connection with the public meeting are summarized in the following paragraphs.

a. Port of Cleveland, Ohio. - A telegram from Mr. Andrew C. Pubka, in behalf of the Port of Cleveland and the Mayor of the City of Cleveland, expressed support of year-round navigation on the Great Lakes.

b. Chicago Regional Port District. - A letter submitted by Mr. Maxim M. Cohen, General Manager, expressed the opinion that a navigation season extension of at least 10 months is desirable on the Great Lakes and St. Lawrence Seaway with an ultimate goal of year-round operation. He expressed the difficulty in soliciting tonnage because of the automatic expiration of the present 8-1/2 month season and noted the benefits of the extended season with respect to future investment programs and long range development regarding commodity transportation.

c. Michigan Elevator Exchange, Division of Farm Bureau Services, Inc., Lansing, Michigan. - A letter submitted by Mr. Donn Kunz, Manager, Grain Department, outlined the function of the Michigan Elevator Exchange, namely to market farm products, and gave a brief overview of present problems concerning the marketing of farm crops. He stated that in the fall of 1972 crops were unable to be moved out of the fields because of transportation difficulties, i.e. unavailability of railroad cars and trucks and the closing of the navigation season, and this alone cost the grain handlers an estimated $10 million. He pointed out the economic advantages attributed to extended season navigation by being able to move crops in late fall and stressed the need to extend the navigation season on the St. Lawrence Seaway. Mr. Kunz also stated that his organization is actively involved in efforts to have the Saqniaw River deepened to Seaway maximum depths.

d. Neebish Island Resident. - A letter submitted by Dr. Keats K. Vining, Jr., M.D. expressed his opinion that extended season navigation and icebreaking activities have, in part, contributed to damage of shore structures. He stated that the shoreline property owners should be provided assistance to cover damage they incur as a result of extended season navigation. Dr. Vining also requested assistance in developing new designs for shoreline structures for future use.

7. DISCUSSION

Following the presentation of formal statements, Colonel Hays opened the meeting for a question and answer period. The majority of questions dealt with safety and survival equipment, particularly survival suits. Several of the attendees were concerned about the merits of survival suits, why survival suits had not been distributed to vessels operating during the extended season, and what survival systems are available or are being developed.

Commander Robert Cook of the U.S. Coast Guard and chairman of the Ice Navigation Work Group explained that the current survival suits have inherent defects such as inadequate floatation and faulty zippers and that they do not provide a sufficient amount of protection. In addition to the inherent defects, he explained that the suits must be worn with life preservers and without lengthy and proper training in the use of the suits, the Coast Guard maintains that they are presently inadequate for use.

In answer to the question regarding the development of survival systems, Commander Cook described three survival systems which the Coast Guard are currently developing, namely, an enclosed rubber-type life raft, an enclosed metal capsule, and an air inflatable chute used for exit from a vessel.

A question was raised regarding how much ice floe would result from icebreaking in the upper lakes that might end up in the lower lakes. Mr. Guenther Frankenstein, chairman of the Ice Engineering Work Group, stated that there are two studies ongoing to answer this question. Mr. Carl Argiroff, chairman of the Ice Management Work Group, further stated that plans of improvements in the upper Great Lakes involve techniques to stabilize the ice-cover and consequently minimize ice floe.

Additional questions dealt with Canadian involvement in the extended season program and cost sharing, and the methods used in computing benefits derived from an extended navigation season. Colonel Hays explained that Canadian coordination is made through two Canadian observers, one on the Winter Navigation Board and the other on the Winter Navigation Working Committee. He stated that the Canadian Government is vitally interested in the extended season program; however, as far as costs and benefits, the Corps of Engineers can only address those costs and benefits in support of U.S. commerce at this time.

Mr. Mike DiGiovanni, chairman of the Economic Evaluation Work Group, stated the benefits displayed at the meeting are primary benefits and are principally transportation savings, stockpiling savings, and savings incurred by more efficient use of the vessel fleet. These savings, at first, go to the industrial users; however, they are ultimately passed on to the consumer. He also stated that a study is being conducted to determine the secondary benefits of an extended navigation season such as those benefits related to the products, income, employment and possible industrial relocation effects.

One additional comment was made by RADM E. H. Thiele (USCG-retired), Marine Consultant for The Cleveland Stevedore Company, noting that winter navigation has been under study since before World War II and that the major problem is effectively controlling the ice to minimize ice floe that may disrupt shore properties. He noted that safety and survival problems on the Great Lakes are not new and are no worse than in many other cold weather areas of the world.

8. CONCLUSION

Colonel Hays concluded by noting future actions concerning the program. He stated that an Interim Survey Report as now proposed would be submitted to Congress in July 1974, and that the knowledge gained through public meetings would be used in the further development of alternatives in the next few months. Digests of the public meetings and an Environmental Impact Statement would accompany the Interim Survey Report. He stated that at least one more set of public meetings would be held prior to submitting an Interim Survey Report to Congress.

DEPARTMENT OF THE ARMY
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DIGEST OF PROCEEDINGS OF PUBLIC HEARINGS CONCERNING THE EXTENSION OF THE NAVIGATION SEASON ON THE GREAT LAKES

1. GENERAL

Public Hearings were held at Paulucci Hall, Duluth, Minnesota, 18 February; Lake Superior State College, Sault Ste. Marie, 19 February; and Veterans Memorial Building, 20 February. All meetings began at 1:00 p.m. local time.

2. MEETING

Duluth - The meeting was opened by Colonel James E. Hays, Detroit District Engineer. The purpose of the hearing was to solicit comment from interested parties and the general public on the interim feasibility report prepared by the Winter Navigation Board. The feasibility report weighs several alternatives for extension of the shipping season beyond the normal mid-December closing to January 31st or February 28th or year around.

3. Colonel Hays discussed the background using a slide presentation to familiarize attendees with the substance of the program.

4. Statements presented during the session are summarized in the following paragraphs.

a. Duluth, Minnesota - 18 February: At the meeting, with 40 people in attendance, favorable response came from representatives of Duluth and Northeastern Minnesota industry and governmental units, with some negative response from environmental and lake vessel crews.

(1) Colonel James E. Hays, District Engineer, Detroit, stated that extending the season to January 31st on the four lakes would entail average annual costs of $5 million. The average annual benefits are measured at $15.9 million, resulting in a benefit-cost ratio of 3.1 to 1.

(2) The Mayors of Duluth, Virginia, Hibbing, Mountain Iron and Chisholm and the Duluth Area Chamber of Commerce, the Virginia Chamber of Commerce and the Mountain Iron Civic Association favored extending the shipping season. All indicated the proposal is important to the area's economy and continued stable growth.

(3) Thomas Burke, Executive Director of the Seaway Port Authority of Duluth, said the Federal Government must "expand its commitment" to the winter navigation program if it is to be beneficial to both domestic and international shippers. "Air bubblers" will be needed to keep channels and loading berths free of ice.

(4) F. J. Habic, Duluth Missabe & Iron Range Railway Co. Dock Superintendent, testified that the DM&IR ore docks in Two Harbors were used during the 1974-75 season for loading vessels year round although dock facilities "were not originally designed to operate in extreme cold weather conditions." The planned $35 million investment in DM&IR new dock facilities in Two Harbors is intended to make them as fully operational as possible all year. Citing impressive growth of the Minnesota taconite industry, DM&IR is shipping 14.7 million tons of pellets annually; the volume will increase to more than 27 million tons by 1978, and possibly to 40 million tons in the 1980's.

(5) General Manager C. H. Grindy of the Hallett Dock Co., Duluth, urged the Corps to make every effort to overcome the negative aspects of an extended season and move forward as quickly as possible to implement it.

(6) Mr. Maxwell Oie, Chairman of the Duluth Area Chamber of Commerce's Waterways Committee, stated that the plan would enhance employment opportunities and serve as an effective tool in enticing new or expanding industries to locate in Minnesota. He termed it a partial solution to the energy problem and testified it would stimulate the construction of larger and more efficient ships, which would diminish the possibility of air pollution by less efficient modes of transportation. Mr. Oie also advocated more flexibility in an extension program and asked the Board to consider continuing beyond January 31st when weather conditions permit.

(7) Mr. Alden Lind, Duluth, representing the Save Lake Superior Association, commented that the proposal made as much sense as trying to grow corn in the Arctic. The benefit cost ratio, he stated, did not consider such factors as damage to the environment or the total supply of resources the earth has on it. Mr. Lind said the lack of safety measures for men and ships, the lack of concern for energy, the unknown effects of operation of bubbler systems and the added hazards of transporting toxic materials during the winter months is typical of the sort of arrogance man displays toward his natural environment.

(8) J.A. Renner, Duluth, a Third Engineer on lake vessels, stated that sailors deplore winter sailing conditions. He also commented that the companies will make out at the expense of the taxpayers.

(9) Mr. Milton Pelletier, President of the Minnesota Conservation Federaltion commented that the longer season prospects for Great Lakes sailors are pretty grim. While he also stressed environmental concerns he urged consideration of the human element. He said we should be planning how to utilize people of our area, not how we can utilize dollars.

b. Sault Ste. Marie, Michigan - 19 February: At the Sault Ste. Marie meeting local residents, students, environmentalists, and people concerned about their tax dollars voiced a great deal of opposition to the program. There were 150 people in attendance.

(1) A statement, in part, by Congressman Ruppe follows:

"... the human/people needs must be addressed and quantified as to type, quantity, and cost of the provisions or equipment essential to their interests and their interests alone. The responsibility for securing this equipment lies solely with the Winter Navigation Board.

"Winter navigation does present an opportunity to help bring the Great Lakes into competition with the nation's other three seacoasts. But in so doing, we must solve the problems it causes for those who live along the shores of these majestic water resources."

(2) A statement, in part, by Lieutenant Governor James Damman on behalf of Governor William G. Milliken follows:

"A Committee has been formed by Governor Milliken of Michigan and the Committee has subsequently developed a Michigan Policy on Winter Navigation which was accepted by Governor Milliken.

"This Policy statement is as follows:

"It is the Policy of the State of Michigan to support the concept of a winter navigation season on the Great Lakes. This support is predicated on the following propositions:

"That future programs regarding winter navigation on the Great Lakes include the participation of State government in their development and operational planning. That State participation must include specifically the determination of routes and operationsl procedures to assure the special problem areas are adequately considered.

"That no extension of winter navigation on the St. Clair River, Lake St. Clair, Detroit River portion of the system be developed without a thorough investigation of potential problem areas including flooding, ice damage and oil spills, as well as the establishment or contingency plans to handle unforseen situations.

"That the directly attributable primary and secondary costs, such as ferry operations, shore damages, etc., of winter navigation be included and funded as part of the relevent Federal Agencies Operative Budget.

"That a winter navigation program include appropriate evaluation procedures to assure that social, economic and environmental impacts are monitored on a continuing basis.

"That a favorable overall benefit to cost ratio will be maintained, including the design of program elements to minimize adverse social, economic and environmental impacts, as well as optimizing efficient energy use considerations. Michigan also supports a study to be conducted to evaluate the extension of the navigation season on the St. Lawrence Seaway.

"To assure that the principles set forth in this policy are achieved, future winter navigation programs must include the full participation of the affected states. To achieve this objective we recommend that a permanent Winter Navigation Board be established including the appropriate Federal agencies, the industry and the appointed representatives of each of the states in whose waters winter navigation activities are conducted. The role of the Board would include specifically the adoption of routes and operational procedures.

"A mechanism must be established to provide for the resolution of claims in an equitable manner to assure that there is a process short of litigation to resolve payment for legitimate damages. We recognize the basic conflict between the inter-state commerce clause and the rights of riparian owners but we also believe the government has a responsibility to assure equity in its dealings with its citizens. The development of this mechanism should be a first priority of the proposed Winter Navigation Board.

"In closing, Michigan is prepared to work with the Federal government to achieve the long held goal of winter navigation on the Great Lakes. As a State, we wish to support this effort, but our support will only be given if we assured that our citizens and our shores are protected."

(3) Dr. Gale Gleason, Professor of the Lake Superior College, stated that the following additional items should be completed before the Feasibility Report is submitted: The St. Marys River vessel speeds should be better regulated by the U.S.C.G. because of shore erosion and dock damage, including sedimentation; revision of the U.S.C.G. Marine Inspection Program concerning vessel design, power, etc.; and review of safety and survival equipment on vessels.

(4) Wayne Zimmerman, Extended Season Coordinator for Chippewa County, discussed and proposed shoreline damage protection program to include necessary engineering permits and riprap with no cost to public. He pointed out the island transportation problems in the St. Marys River at Drummond Island. The Eastern Upper Penninsula Transportation Authority is taking action to resolve these problems. For a year round program West Neebish Channel would be kept open which would cause problems for the Neebish Island Ferry. Due to Winter Navigation Board efforts which included placement of the ice boom, only minor Sugar Island Ferry service interruptions were experienced this year. However, future programs will require more money and possible construction of a bridge.

(5) Mr. Leap expressed concern over the Federal Government's subsidizing private corporations through winter navigation efforts.

(6) Michelle Gunnery, Student, stated concern that winter navigation was contributing to the acceleration of resources exhaustion.

(7) Mr. Goldhamer, Peoples Bicentennial Commission, read declaration of that Commission which stated the Group's opposition to winter nav.

(8) Mr. Tom Burnett asked about the Environmental Impact Statement. It was responded that one was completed and would be filed with the report. He further pointed out that a complete environmental evaluation is needed.

(9) Mr. William Gregory, President, Edison Sault Electric Company, is concerned with the loss of kwh which could be caused by ice jams. However, it is hard to separate ice jams that are the result of winter navigation or ice jams caused by natural forces. He also pointed out the increased cost of replacing lost energy and that contracts with the Government did not contemplate winter navigation.

(10) P. Black, Student, Lake Superior State College, opposed winter navigation citing the high cost of implementing the program, high tax dollars, and inconvenience to Sugar Islanders.

(11) M. Willis, Resident, Sugar Island, would like to see U.S. Steel Company pay the cost of winter navigation.

(12) Mr. W. Tubman, Hydro Plant Operator, Corps of Engineers, is opposed to winter navigation due to the fact that the area is suffering losses in power and erosion to the St. Marys shoreline, plus inconvenience to Sugar Islanders.

(13) S. Colt, Resident of St. Ignace, commented that the Government should not subsidize private industry.

(14) J. Ingold, representing the Sault Ste. Marie area school system, commented that the children must be considered first in any program where they have to be transported from Island to Mainland.

(15) M. Burton is opposed to winter navigation because of the power costs and the Islanders inconvenience. Cited that he wants to know who would benefit from winter navigation. He did not foresee any new jobs coming to the Upper Penninsula because of the program. Wanted to know who is paying for the bridge and lock expansion if they become necessary.

(16) Mr. Wilson, resident, Whitefish Bay, thought more boats should be using the locks and also charge them a toll for the use of the locks.

(17) Mr. W. Palmer, Resident, Sugar Island, protests winter navigation because fishing is disturbed. He also wondered why representatives of U.S. Steel and Lake Carriers' Association were not present.

(18) Mr. C. McClouth, Resident, Neebish Island, stated that winter navigation would create problems.

c. Detroit, Michigan - 20 February: There were 40 people in attendance at the Detroit meeting held at the Veterans Memorial Building, and there was mixed reaction as to support and opposition to the Winter Navigation Program.

(1) Mr. Porter Barnett, Transportation Specialist with the Michigan Department of Agriculture, Lansing, Michigan, supported the Winter Navigation Season and said that their records will bear out the particular points they made at the hearing of the meeting held on 11 January 1974. He said that they would like to reiterate their concern about extension of the Navigation Season and its importance to the agriculture and economy of the State of Michigan. The State of Michigan is faced with serious transportation problems, not only with water support, but we also see transportation problems in other modes such as airports, rail networks, and highway systems to some extent. The Michigan Department of Agriculture is deeply concerned in getting food stuffs to overseas destinations and to the market place. The Department of Agriculture and Industry depends heavily

upon efficient and economical modes of transportation to do this job for us and for the industry itself. With this in mind, we see that the State of Michigan needs a balanced transportation system in that all modes of transportation are considered. There are certain commodities in the agricultural sector that lend itself to ocean transportation. Waterborne transportation and other modes at this particular time have been able to furnish the requirement and means for the agricultural industry in the State of Michigan. So, in essence, the Michigan State Department of Agriculture is in favor of Winter Navigation.

(2) Mr. Ray Trombley from the Lake St. Clair Advisory Committee, said that he has looked at the economic benefits and agrees with many of them but that one of the things that should be more closely looked at was the environmental consequences of Winter Navigation. He also was concerned about crew safety, particularly the sailors who sail the Great Lakes during the winter months. He also said that he had indications from property owners, particularly on the St. Clair River in the Lake St. Clair area, of property damage caused by the breakup of ice as a result of the Winter Navigation Program. In summation, he felt that the program was not impossible, that it could be accomplished, but that all of these areas had to be closely looked at.

(3) Mr. John Chasca of the Lake Erie Cleanup Committee and President of the Monroe Gun Club, did not have a prepared statement, but he expressed many of the same thoughts of Mr. Ray Trombley and said that Mr. Trombley's statements had covered pretty much what he had wanted to say. He was concerned with crew safety as was Mr. Trombley and also cited numerous reports of property damage in Lake Erie, Lake St. Clair, and in the Lake Michigan area.

(4) Mr. Stuart C. Minton, an employee of the Great Lakes ships for the last 28 years--23 years as a licensed deck officer--and he's past President of the Port Huron Lodge of the International Shipmasters Association, said he had served for the last eight years, 1968 to 1975, as Chairman of Navigation Legislative Committee of the Grand Lodge of the International Shipmasters Association. He said, "I appear here today to request again that certain questions regarding our safety and welfare be given highest priority in any consideration of further extension of the Winter Navigation Study. I reiterate my letter addressed to your body on 20 June 1972 prior to a hearing. This letter was shunted from your body to the U.S. Coast Guard who eight months later deigned to answer." He continued, "I believe that points one and two of my letter, vessel inspection and cold effect on steel, still need more consideration. With regard to point number three (life saving equipment), I state to you that we still sail these waters with davit-launched open lifeboats and life rafts which proved so useless in the recent disaster of 10 November 1975. After five years of this Winter Navigation Study, not one successful solution to this problem has been forthcoming." He believes that additional icebreakers

are still essential. He would also like to see more and better aids to navigation, aids to replace buoys, license hearings, and full and competent crews.

(5) Mr. F.E. Helborn, a design engineer, addressing himself to the safety aspects on the extended Navigation Season, has sailors, crews, and ship vessels that are sailing on the Great Lakes. He said that, "We cannot justify a 'Fitzgerald' as a result of Winter Navigation as November has always been a difficult Navigation Season, but what we are looking at here is the lack of a form of interested small groups of citizens and their input and being able to represent ideas on different types of safety equipment that could be allocated to use. At the present time the U.S. Coast Guard is responsible for proving all types of rescue and lifesaving equipment." He went on to say that he's working on the design of a fiberglass boat that would alleviate some of the hazards to winter sailing. He also wanted to set up a meeting, if there is a possibility of setting up a meeting, so all the people who have ideas on safety and how best to address the safety of crews could be heard, and he would like the Corps of Engineers and the U.S. Coast Guard available in order to reach some sort of solution.

(6) Mr. James R. Friesema, Chair of the Detroit-Wayne County Port Commission, said, "I am the Chairman of the Detroit-Wayne County Port Commission, and the Port Commission has supported and continues to support the efforts of the Corps of Engineers to extend the length of the Navigation Season on the St. Lawrence Seaway and the Great Lakes." He further commented that he would like to commend the Winter Navigation Board for its past efforts and offer the Commission's services in any appropriate manner to assist in the future efforts to bring this long-held dream of year-round navigation to fruition.

(7) Mr. Joseph Grzelak, indicated that the benefit-cost ratio did really not address itself to the environmental but only to the ongoing economic situations. He felt that the cost of Winter Navigation would be much higher if all the environmental aspects were taken into consideration. He also wanted compensation for property owners along the lower portion of the system, and he feels that the general public is due the same compensation that he feels that big industry is getting. This could be applied through various insurance programs and other ways and means of compensation.

(8) Mr. Karl Richards stated his big objective: the cost to the taxpayers. He wondered why the steel companies don't pay for all the subsidies since they are the ones directly benefiting. He said that U.S. Steel, the biggest benefactor of the Winter Navigation Season, realize most of the economic gain and that last year they had a fleet of 38 to 39 boats 13 or 14 of which were not used during the summer season because they were in eight or nine carriers in the wintertime and that they didn't need to run the boats in the summer-time or spring because of the increased tonnage. He said the U.S. Steel was the only one running in the winter season.

(9) Mr. Charles Keller, representing Neebish Island Pioneer Association, said that he had spent quite a bit of time trying to get some support and help from various organizations involved in Winter Navigation and that he has had no results. In the last two winters alone, he said, he has sustained dock damage in the neighborhood of $20,000 to dock facility at Johnson Point on Neebish Island in the St. Marys River, and he said no help whatsoever came from the Corps of Engineers. "I have a dock that has withstood the last two winters, but I expect it to go out this spring." He said that he has letters from the Corps of Engineers that admit that the direct cause of the damage done to the dock structure on the St. Marys River is the result of Winter Navigation. He said he has not received a response from the Corps of Engineers or any other agency regarding his particular problem on the St. Marys River. He said that until some compensation is afforded to the property owners along the St. Marys River they would continue to oppose Winter Navigation.

(10) Mr. George P. Graff, Michigan State Chamber of Commerce, stated that the State Chamber of Commerce is in support of Winter Navigation; that the Winter Navigation Demonstration Program has proven the feasibility of extending the season on the Great Lakes, and that the task-force system has worked well and should address itself to keeping individual harbors open during the winter sailing periods.

d. Cleveland, Ohio - 23 February: There were 27 people in attendance at the meeting with mixed reaction as to support and opposition to the Winter Navigation Program.

(1) The first statement was a letter read by Colonel James E. Hays, testimony of the Honorable Charles A. Vanik, United States Representive, Congressman from Ohio, on the Great Lakes Shipping Season. Congressman Vanik's letter follows in part:

"The cost of extending the shipping season appears to be well within the ratio benefits, more than three times the cost. According to the interim report, the 18.7 million dollar benefits resulting from a season extension accrued in two areas, transportation savings both an increase deficiency of the shipping fleet and the lower rates compared to winter land transport a combined total of 8 million dollars, and savings from reduced stock piling requirements by industries depending on ship transportation.

"However, I am concerned about the effects the extended season will have on shore erosion which has developed into a major problem. As you well know, Lake Erie, particularly the southern shore of Lake Erie and even more particularly the high bluff shores of my Congressional District east of Cleveland, has suffered staggering losses due to high water erosion. We cannot stand one more inch of water in Lake Erie. Lake Huron and Lake St. Clair residents feel exactly the same way. My support for an extension of the shipping season is contingent upon continued efforts to limit lake levels.

"I would strongly oppose extension of the shipping season if it means any increase in lower lake levels. I support an extension in the shipping season to determine the effect on lake shore erosion. It may be that the development and maintenance of channels through the ice in winter months will accelerate run off of lake waters to lower levels. It is my hope that the extension of the shipping season could have a two-fold effect: continued commercial economic benefits, and lower lake levels to prevent the crushing burden of erosion."

(2) The second statement was a letter read by Colonel James E. Hays, Colonel, District Engineer, Detroit District. "This is a statement on behalf of the Port of Milwaukee Maritime Counsil. The suspension of Commercial vessel activities in the Great Lakes during the winter months results in the under-utilization of public and private investment in locks, channels, vessels, docks, and loading/unloading facilities. Additionally, port related labor is under-utilized to the extent that many workers must turn to public welfare or unemployment compensation or must be put to work during the winter months at less productive jobs than the ones for which they are trained. Milwaukee Port annually sees 2,000 port and port related workers that must be diverted to less productive jobs or must seek public assistance. Commerce and industry depending on the Great Lakes for the receipt and shipment of goods must stockpile raw materials or resort to more costly over land transport when the Great Lakes are closed to navigation.

"We urge the U. S. Army Corps of Engineers and the U. S. Congress to extend the funds necessary to continue the experiment of lengthening the Great Lakes shipping season. Of course the actual implementation of such a plan will be most desirable. We believe that the economics of the shipping season extension make sense and will have an over-all positive impact on jobs and income and on the continued viability of the Port of Milwaukee and Great Lakes shipping."

(3) Statement made by Captain H. E. MacDermid of the International Ship Master's Association, President of the Lake Pilot Association. Captain MacDermid stated that at a recent meeting in Toledo the International Ship Master's Association voted unanimously to oppose extending the shipping season on the Great Lakes, primarily because they felt that the safety factor of the human element and the welfare of the crews had not been adequately addressed thus far in winter navigation studies.

(4) Statement made by Vice Admiral Paul E. Trimble, U. S. Coast Guard, Retired, President of Lake Carriers' Association. Admiral Trimble statement follows in part:

"Why should there be public interest in extending the navigation season on the lakes? Is there really a public benefit in greater utilization of the $550 million investment in Great Lakes channels, locks, and harbor improvements and approximately $400 million in the Seaway? Those are huge dollar outlays to contemplate but for comparison consider that improvements in the Arkansas River opening barge service to Tulsa in 1971 cost 1.2 million. The carriers estimated 13 million net tons of cargo annually. Then consider that over 200 million net tons water born freight moves through the Great Lakes annually during the 8-1/2 month navigation season. By comparison, that $550 million public investment in the Great Lakes looks like a real bargain even though it is dollars from earlier years.

"The voluminous data accumulated to date in the preliminary survey report reflect a favorable cost benefit picture for extension even for a ten month season. Benefits of $18.7 million compared to average annual costs of $5 million to the industry served by lake shipping and ultimately the consumer savings come from reduced stockpiling and better utilization of ships. This translates into lower capital investment, maintenance and carrying charges.

"Lake shipping iron ore, coal, grain, limestone, petroleum products, cement, sand, etc, is a vital link in the steel industry as is energy production and distribution, food processing and the construction industry. The Great Lake region is 14% of the country's population and produces about 50% of the nation's steel. Its industry out-put is as large as the European common market or the Soviet Union.

"To maintain the steel production levels forecasted for our national economy in the 80's and beyond, a timely and adequate raw materials supply is a necessity. As one looks at the statistics, think in terms of jobs lost in our country. The balance of payments deficit for steel alone for 1974 was $3.0 billion and estimated to be $3.4 billion for 1975. Not only is lake shipping the cheapest transportation mode between upper and lower lake points but water transportation is a very efficient user of our scarce energy resources and has the least environmental impact.

"The lake shipping industry is gratified with the progress that has been made to date in the congressionally authorized multi-year study and demonstration program to extend the Great Lakes navigation season.

"There is also progress in identifying and clarifying environmental impact that is attributable to winter navigation, especially in the St. Marys and St. Clair Rivers area.

"There is progress, albeit slow, and ship-board crew survival system research being conducted by the Coast Guard.

"Now that the Loran-C electronic aids to navigation system has been adopted nationally and in Canada there will be fall-out benefits for the lakes region, better all weather position-keeping, and reduce delays from poor visibility.

"Specially designed buoys for use in ice conditions were tested in the past several years by the Coast Guard but these so called "ice buoys" do not at present show much promise.

"Well into the ninth year of industry, efforts to extend, the navigation season and the fifth year of the congressionally authorized demonstration project, the planning is vague as to size and design of the most cost-effective replacement vessels needed for the Coast Guard Great Lakes responsibilities. Authorization, funding and construction obviously can not commence until that decision is made.

"We have recommended such vessels as replacement for the obsolescent Great Lakes fleet of 110 foot multi-purpose harbor vessels now operated by the Coast Guard with personnel allowances of twenty men each.

"Continuing progress in the marine weather field is noted, especially the real-time-all-weather ice observation being obtained by a side-looking radar equipted Coast Guard plane in cooperation with NASA.

"I compliment the Winter Navigation Board on its decision to try out an ice boom this winter below the locks the Soo to restrict ice build-up in the Little Rapids Cut and Sugar Island ferry landing. Experience this winter and subsequent years for the actual navigation through the boom should provide invaluable data and transferability to design booms for use in simular situations in the St. Lawrence River. Reviewing Lake Saline experience since the start of this effort, the following accomplishments were largely accomplished with existing public facilities except for temporary deployment of a polar ice breaker through the lakes and the ice boom installed at the Soo in December and the accomplishments referred to are a record of Lake Saline through the Locks from 1967 to 1976. In view of this experience, the insignificant impact on our environment and the fact that no additional public investment is required I urge that the interim report posed navigation on selected areas of the upper four lakes until January 31st or as long as weather conditions permit.

"In summary I urge that efforts continue promptly and decisively to seek acceptance in winter navigation on the Great Lakes as national policy. Authorization of the interim reports plus the recommendations modify the recommended above to January 31st or as long as weather conditions permit. Stepped up action by the Coast Guard and ice breaking vessel replacement for the lakes announcement of a supply and establishment of priorities for its accomplishment and action by the National Oceanic and Atmospheric Administration on a marine weather and ice forecast and research center for the lakes. Longer use of lake shipping to reduce transportation cost is clearly in the national interest and support of our economy, it will help keep our domestic steel industry healthy and will affect thousands of jobs in link of the chain from producer to consumer. A longer shipping season will also contribute toward a favorable foreign trade balance and assist in energy utilization and conservation."

(5) Statement from the Sierra Club, letter follows in part:

"Our organization has a long history in involvement with this project; we have been represented on the environmental evaluation work shop and have expressed our concerns about the environmental ramifications of the project on numerous occasions. We find ourselves distressed to discover, however, that many of the concerns which we have articulated from the beginning appear to have fallen on deaf ears. From the beginning project fundings for environmental studies has been seriously inadequate, this continues to be the case and as a result, although this demonstration project has continued for a number of years, necessary environmental studies have not been made. Base line data has not been collected from a wide enough range from areas over a long enough period of time to develop the necessary back ground information. Without this back-ground information legitmate analysis of environmental impact can not be made.

"The Sierra Club has stated in the past that we wish to read it right here that we are not opposed to the concept of winter navigation on the Great Lakes, however, we do believe that proper environmental research and evaluation must proceed any commitment to expend public funds on the development of the winter navigation program. The club seriously questions the current proposal that separate authorization be sought for certain segments of the navigation season extension. It has been contended that the limited plans proposed for early authorization is self contained and that it is economically and environmentally justifiable in itself, we question this conclusion.

"An adequate and competent analysis of winter navigation technology must be completed. Hazards of winter vessels traffic must be adequately studied and evaluated, this must include an accurate assessment of vessels safety and a through analysis of both the structural and institutional means by which vessels can safely be improved. Currently a large proportion of the Great Lakes fleet is composed of elderly battle scarred vessels, these were constructed before the time specific steel strength standards were required for vessels shellplating. Few if any of the Great Lakes vessels meet the American Bureau of Shipping Standards of horse power and haul design for operating even in light ice conditions, nor do they meet the standards for strength and framing rudder and steering assemblies and shell thickness. How is the public going to be insured that only vessels which are equipped for heavy ice conditions are permitted to use the lakes during the winter season?

"Such a study must also include a thorough assessment of the hazards from spills, chemical and petrolem products. They must delineate the environmental damage to be expected from spills of these various products as well as the effectiveness of an available clean-up techniques.

"In addition to the above an inter-modal transportation study must be made to determine what the other transportation alternatives are and what effects extended winter navigation will have on these other modes.

"The Great Lakes are the most valuable natural resource of the upper midwest region, currently they are multiple use bodies of water and shipping is but one historic and legitimate use. The Sierra Club is not opposed in principle to the extension to the navigation season, however, we believe that any extentsive expansion of the shipping on the lakes must be viewed in the context which considers other competing economic social and environmental requirements, no resource can accommodate optimally all potential users."

(6) Statement from Wayne S. Nichols, Chief of the Ohio Division of Water, Department of Natural Resources, his statement reads in part:

"The Department of Natural Resources has reviewed the draft Interim Feasibility Study on the Great Lakes-St. Lawrence Seaway Navigation Season Extension and we concur with the selection of alternative plan three which involves the extension of navigation season to as much as a twelve month or year around operation. The direct and indirect benefits to the State of Ohio are of high order or magnitude. An extended season will make less costly water transportation available for more of the year, will reduce the need for bulk stock-pile accumulation, and will permit more efficient use of the Great Lakes fleet. We will cooperate in every way possible for the achievement of the objectives of the program.

"The interim report shows that winter navigation is feasible and part of the system, this will be presented to Congress, but we suggest that a recommendation be included for a continuation of the study and the remaining portion of the system so that ultimately sufficient information is available to support unequivocal decisions. An intrical part of the Great Lakes-St. Lawrence Seaway navigation system is the harbors. The importance of the inter-relation between the harbors and navigation system cannot be ignored. We would encourage continued study of the harbors.

"The Ohio Department of Natural Resources is concerned with the protection and conservation of the natural resources of the State. Oil spills in winter could be a serious problem. While the draft of an environmental impact statement deals with the hazards of oil spills and recognizes the potential acceleration to shore erosion and shore structures resulting from ice movement. There still remains a need for more intense research in this area. We encourage and will support the Corps efforts in requesting further authorization for such activity."

(7) Statement of letter submitted from the Cleveland-Cliffs Iron Company, Cleveland, Ohio 44115 - Reads in part as follows:

"Request for Congressional authorization of the extension of the navigation season on the upper four Great Lakes as outlined in your Interim Report has the support of the Cleveland-Cliffs Iron Company, We are also interested in keeping the Ports of Escanaba and Marquette open for extended season service in the Upper Peninsula so that iron ore may be shipped. Vessel movement in and out of Escanaba and Marquette during the winter navigation season is most important to the steel and mining industry if capacity movement of iron ore tonnage from the Upper Peninsula of Michigan is to be accomplished. The UP iron ore production and ship facilities will reach capacity. The increased number of shipping days is one means to move the additional tonnages. Escanaba is presently the only Port that can load UP ores and ships with a beam width over 75 feet. Escanaba is a preferred winter port when ice conditions in the St. Marys River become difficult.

"Cliffs indorses your proposal to improve selected harbors with bubbler systems. Bubbler systems are yet to be proven in open water ways where currents, deep water and moving ice introduce changing conditions. The Escanaba extension concept would add data to that which has already been accumulated. Advantages to the Escanaba plan are (1) potential to relieve ice breakers for other duties to reduce ice breaking costs (2) reduce ice breaking costs (3) provide simple long range ice elimination capability (4) establish guidelines for other harbor installations (5) establish guidelines for private ownership of bubblers in Federal waterways and (6) study environmental effects if any. Letter signed by Richard P. Eide, Manager Marine Department, Cleveland-Cliffs."

(8) Letter to Colonel Hays from the Greater Cleveland Growth Association Follows in part:

"I am sure you are aware that the Greater Cleveland Growth Association supports the extension of the navigation season on the Great Lakes and the St. Lawrence Seaway system. The Board of Directors of the Association adopted a policy supporting this extension many years ago. We feel much as your report indicates that the justification for the navigation season extension is as strong or stronger today than in the past. The resulting positive economic impact will greatly benefit the Greater Cleveland area as well as other communities located on the Great Lakes.

"Although our ultimate objective is to achieve a twelve month shipping season we urge you to submit an interim report to obtain necessary Congressional authorization and funding for the existing, proven and operational measures which have been recommended. Sincerely, Frederick B. Unger, Vice President, Greater Cleveland Growth Association."

(9) Statement from Thomas J. Readon, Department of Public Works, Harbor Master, City of Buffalo, Buffalo, New York. Mr. Readon recommends that a total system concept be approached rather than the upper lakes or the lower lakes, he also recommends that the results of an existing study on Lake Erie and Niagara River Ice Boom Study be incorporated into the interim report.

APPENDIX IV

ST. LAWRENCE RIVER SYSTEM PLAN FOR ALL-YEAR NAVIGATION

ARCTEC, Incorporated
for SLSDC

SAINT LAWRENCE SEAWAY
SYSTEM PLAN FOR ALL-YEAR NAVIGATION

SUMMARY REPORT

July 1975

Prepared For

U. S. Department of Transportation
Saint Lawrence Seaway Development Corporation
800 Independence Avenue, S. W.
Washington, D. C. 20591

By

ARCTEC, Incorporated
9104 Red Branch Road
Columbia, Maryland 21045

PREFACE

This study was undertaken as part of the Great Lakes-St. Lawrence Seaway Navigation Season Extension Demonstration Program. It was funded in part by this Season Extension Program and in part by the St. Lawrence Seaway Development Corporation. The Ice Control Work Group of the Season Extension Program provided technical management, guidance and review throughout the study.

A number of organizations provided necessary information for the study and their assistance is acknowledged as follows. Data on benefits to be derived from extended season ship operation were provided by the North Central Division, U.S. Army Corps of Engineers. Much basic data from which the ice, channel and lock models were derived and verified were provided by the St. Lawrence Seaway Authority and the St. Lawrence Seaway Development Corporation. The Power Authority of the State of New York provided additional data on ice conditions, and on water levels and ice boom maintenance and construction costs.

Many individuals, too numerous to mention by name here, were responsible for the successful completion of the study, but their assistance is gratefully acknowledged. One individual, however, is deserving of mention, for without his guidance and dedication to the project, the study would not have reached its successful conclusion. This individual is Mr. David C. N. Robb, Director of Comprehensive Planning for the

St. Lawrence Seaway Development Corporation and Chairman of the aforementioned Ice Control Work Group. His assistance in this study is gratefully acknowledged.

The study is presented in five (5) volumes as follows:

(1) Volume I, SUMMARY REPORT - Contains the essential points of the study. It describes the approach taken and major results and provides recommendations for future action. It is intended to serve as an executive summary and therefore stands complete by itself.

(2) Volume II, APPENDIX A, MATHEMATICAL FUNCTIONS AND DETAILED METHODOLOGY - Contains the detailed development of all mathematical models used in the Seaway simulation, the data base used by these models and, where pertinent, verification of the models.

(3) Volume III, APPENDIX B, SEAWAY SIMULATION - Describes the computer program developed to simulate winter operation of the Seaway. It contains program descriptions, listings, flow charts and describes input and output data.

(4) Volume IV, APPENDIX C, ENVIRONMENTAL EVALUATION-Presents the results of a brief analysis of the environmental impact of each measure proposed to remove the constraints to navigation identified in the study.

(5) Volume V, APPENDIX D, ECONOMICS - Describes the engineering calculations and cost estimates associated with each measure proposed to remove a constraint to navigation, the cost estimates associated with each system plan alternative, and the methodology and results of the benefit/cost analysis.

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I. INTRODUCTION

The purpose of this report is to present the results and findings of a study of the problems associated with winter navigation of the Saint Lawrence River between Montreal, Quebec, and Lake Ontario (hereinafter called the Seaway). The objective of the study was to develop a systems plan for all-year navigation by identifying in time and space the obstacles to winter navigation and then assigning priorities to their removal on a cost effective basis.

The navigation season in the Seaway is presently closed for roughly a 15 week period, commencing approximately 15 December with the formation of ice on the river. The river is closed to ship traffic for two primary reasons. First, ice in the river presents a major obstacle to ship movement and hence could prevent ship passage. Second, two major hydro-electric generating stations exist in this portion of the river, and some believe that ship traffic will prevent the formation of a stable ice cover in critical reaches of the river, which could then lead to reductions in the river discharge with attendant disruptions to levels and flows and loss of power at these stations.

Closing of the navigation season greatly reduces the potential cargo handling capacity of the river. For example, if the navigation season were extended to all-year operations, this could represent a 41 percent increase in potential cargo handling capacity over the present

37 week navigation season. Since the present system is approaching capacity, extension of the navigation season in order to provide additional capacity is potentially an extremely cost-effective alternative.

Closing of the navigation season also affects, in several ways, the rates charged to transport cargo. First, cargo which must be shipped year round is diverted to more expensive forms of transportation, resulting eventually in higher costs to the consumer. Second, cargo which can be stockpiled must bear an additional charge to cover the cost of stockpiling. Third, ships which are not employed over the winter season do not generate revenues for the owners and thus force them to charge higher rates. The potential, therefore, exists for substantial benefits from extended season operations, and it appeared reasonable to conduct a study to determine if the benefits derived would exceed the costs of extending the navigation season.

The best system plan for extending the navigation season was not obvious at the beginning of this study. Nor was it obvious that the benefits which might accrue from extending the navigation season would necessarily exceed the costs associated with making extended season operations possible. It was therefore decided that the study should look at season extension on a week-by-week basis. For each week of extension a complete system plan would be developed which would assure extended season operations. Associated with each of these plans would be a cost to implement the plan and a performance factor representing the system's ability to handle available traffic. This information would in turn be combined with traffic forecast and projected benefits to determine the worth (benefits less costs) associated with each week of season extension. The best system plan would then be defined as the one with the greatest worth. In general, this was the approach taken in the conduct of the study. The remaining sections of this report will elaborate on the details, results and conclusions.

II. APPROACH

2.1 Overview

The problems and factors which restricted navigation in the St. Lawrence River were identified in this study and concepts were developed to remove these restrictions on a cost effective basis. The approach taken was to develop a mathematical simulation of the operation of the Seaway and use its predictions of ship-seaway interactions to identify the obstacles to all-year navigation. After the obstacles were identified, system plans were prepared which removed these obstacles, and associated costs and performance of each system plan were estimated. This information was then used in conjunction with benefits data provided outside of this study to conduct a benefit-cost analysis of each system plan.

2.2 Mathematical Simulation

The simulation prepared for this study had as its principal function the prediction of ship transit times and the hydraulic behavior of the river during extended season operations. Ship transit times were used to identify obstacles to winter operations by noting when transit times became excessive or infinite and then determining what factors caused this to occur. Information on the hydraulic behavior of the river was used in a go, no-go manner. That is, simulated ship movement through the Seaway was not allowed to cause a disruption of the hydraulic integrity of the river anywhere along its length. Any hydraulic impediment identified was removed, whether or not it had any effect on ship transit time.

The simulation consisted of four principal mathematical models:

(1) Seaway Transit Model - This model processed the ships through the Seaway using information concerning weather, ice conditions, amount of ship traffic in the Seaway and administrative or investment decisions;

(2) Weather Model - This model was prepared from historical data and was used to compute at any given time and any given level of winter severity, such things as wind speed and direction, visibility and temperature;

(3) Ice Conditions Model - This model predicted the ice conditions along the Seaway as a function of ship traffic and weather conditions;

(4) Hydraulics Model - This model predicted river levels and flow conditions in certain critical areas along the river as a function of ice conditions and ship traffic.

These mathematical models were computerized in order to allow many case studies to be performed quickly and economically. These computer programs are contained in Appendix B.

In order to identify the obstacles to all-year navigation in space the Seaway was divided into sixty (60) subreaches on the basis of navigational, hydraulic, glaciological and initial investment characteristics. In addition, ships which transit the Seaway were divided into four (4) classes and each class was evaluated as to extended season performance.

2.3 Alternate System Plans

After the constraints to navigation were identified for each sub-reach as a function of weather severity and ship class, a total of forty-five (45) system plans were prepared; three (3) levels for each of the fifteen (15) weeks available for extending the season. The three levels for a given season extension date consisted of a low cost, low capacity level, a medium cost, medium capacity level, and a high cost, high capacity level. Cost estimates and performance estimates were then prepared for each plan. The performance estimates were formulated in terms of expected transit times and available capacity of the Seaway. These variables were later used to determine how many of the available benefits a given plan was able to capture.

The cost estimate prepared for each alternate system plan was compiled from separate cost estimates prepared for each element required by the system plan. The elemental cost estimates were based on readily available cost estimating factors in the majority of cases and not on detailed engineering designs of the element structures.

2.4 Benefit/Cost Analysis

The procedure used to conduct this analysis consisted of first determining the time phased distribution of the life cycle costs and benefits associated with each system plan. The present value of each of these time series was then computed using a given discount rate.

The difference between the net present value of the benefits and the net present value of the costs was called the net present worth of the system, and the system with the greatest net present worth was selected as the best system plan.

The time phased distribution of the life cycle costs was determined directly as part of the engineering studies which accompanied the formulation of the alternate system plans. The time phased distribution of the benefits was less straightforward and was handled in the following manner. First, the capacity of the alternate system plan under investigation was determined. That is, the capability of the slowest lock to process ships through the Seaway was used to compute the total number of transits the Seaway could accommodate in the time associated with the system plan. Next, available transits were determined from the benefits data provided for this study, taking into account the ship transit times associated with the alternate system plan under investigation. Available transits were then compared with the Seaway capacity calculations and the lesser of the two formed the actual transits. These actual transits were then converted into benefit dollars using a conversion factor obtained from the benefits data supplied for this study.

A sensitivity analysis was also conducted to determine the effect on net present worth to variations in system plan costs, system plan operating life, discount rate and winter severity.

2.5 Environmental Evaluation

The study concluded with a brief analysis of the environmental impact of the various concepts proposed for removing the constraints to navigation. Existing literature on the effect of winter navigation and proposed ice control measures was reviewed and this information was then supplemented with information obtained from conversations with power authorities and other persons concerned with the St. Lawrence River Valley environment.

III. OPERATIONAL CRITERIA

3.1 Overview

In order to proceed with the development of the simulation of the Seaway, it was necessary to prepare a set of rules which would model the human decision making process and to make certain assumptions which would facilitate the mathematical modelling of physical phenomena. This section of the report will provide a summary of the rules and assumptions adopted for this study. Derivations of all mathematical functions used in the simulation are presented in Appendix A, and details of the simulation program are presented in Appendix B.

3.2 General Assumptions

The simulation developed for this study pertained only to that portion of the Seaway between Montreal, Quebec, and Tibbetts Point at Lake Ontario. Ship arrivals at these two points were provided to the simulation as input data, and it was assumed that the condition of the remainder of the system had no effect on the portion of the Seaway under study.

3.3 Channel Transiting Rules and Assumptions

Ships were advanced through the Seaway from one designated anchorage or lock wall to another. This closely follows the procedures used by the Seaway traffic controllers. Anchorage to anchorage processing does not mean that ships actually go to anchor. Rather, it means that the ship is allowed to proceed and not go to anchor only if certain conditions are met. These conditions are as follows:

1. visibility must be greater than one-half mile,
2. wind velocity must be less than a designated value for the ship class in question,
3. the next anchorage or lock wall cannot be full,
4. another ship cannot be blocking the channel ahead, and
5. the ship must be able to make the next anchorage before nightfall if lighted navigational aids have been removed.

If a ship were allowed to proceed, it would proceed at a speed of advance equal to the minimum of the following speeds:

1. maximum speed capability of ship considering the sum of resistances due to ice, open water, and winds,
2. maximum speed which would permit ship to stop in half the visibility,
3. maximum speed permitted by either SLSDC or SLSA rules,
4. speed of the ship ahead if passing is *not* permitted in a particular subreach .

No ships were delayed because a bridge or ice boom was not open.

A ship had no influence on its locking priority.

Ships could not operate during nighttime once lighted aids had been pulled. When twilight occurred, all ships were required to anchor at designated anchorages.

3.4 Lock Transiting Rules and Assumptions

Ships were "locked through" so as to make as efficient use of the lock as possible. The most efficient operation is to continually alternate between locking a downbound ship and an upbound ship.

A lock would "turnback" to lock through consecutive upbound (or downbound) ships as long as the next upbound (or downbound) ship arrived ten minutes before the next downbound (upbound) ship.

The entrance time and exit time for a ship were a function of its length, beam, and whether the ship was an inland or ocean going ship.

A ship would *not* be locked through if any of the following conditions occurred in any subreach between the lock and the next anchorage or lock wall:

1. visibility less than one-half mile
2. wind velocity greater than the designated wind restrictions
3. next anchorage or lock wall full
4. another ship blocking the channel
5. ETA at next anchorage was after nightfall if lighted aids had been pulled.

The amount of ice pushed into the lock was a function of the amount of ice in the upstream throat and the beam of the ship. The need for an ice lockage was determined by summing the length of ship and length of ice pushed into the lock and comparing to the usable length of the lock.

No ice lockages were required for upbound ships.

Tandem lockages were permitted as long as the sum of the ship lengths plus that of the ice pushed in was forty-five feet less than the usable length of the lock.

Iroquois (Lock No. 7) is not equipped with filling culverts or valves because of the very small lift (usually 0.5 feet). A walk-through procedure is used where a vessel passing through will not be required to secure in the lock but will proceed under its own power at a low speed. The lockage, therefore, consists of a smooth continuous movement through the lock. Investigation of the transit times through Iroquois Lock indicated that,regardless of the ship type, size, or direction, the transit time is approximately twenty minutes. Tandem lockages are not allowed at this lock.

3.5 River Hydraulics Assumptions

Detailed assumptions concerning the modelling of the effects of ice and ships in the Seaway on the river hydraulics are contained in Appendices A and B. One basic assumption or constraint, however, is worthy of mention at this time. It was assumed throughout the study that the hydraulic integrity of the river would not be disturbed by any improvement or by ship passage. This assumption was necessary to insure that no loss of discharge capacity would occur above and beyond that which normally occurs in the winter.

IV. RESULTS

4.1 Overview

This section of the report presents the major results obtained from the simulation and a summary of the alternatives considered for extending the navigation season. Detailed analysis of the constraints identified and costs associated with each of the alternatives considered are presented in Appendix D.

4.2 Constraint Identification and Analysis

4.2.1 Constraints to Extended Season Navigation

A constraint to navigation may be defined as any procedure or physical impediment which causes the transit time of a ship to increase to unacceptable values. The simulation identified the following major constraints:

1. closure of existing ice booms;
2. removal of lighted aids to navigation;
3. accumulation of ice at existing locks;
4. formation of ice jams in certain critical subreaches with ice thicknesses so great that they prevented ship passage;
5. growth of ice in navigation channels due to ship traffic which accumulated to such proportions that ships were severely slowed or got stuck; and
6. decreased visibility caused by river fog.

4.2.2 Closure of Ice Booms

The installation of the power authorities' ice booms presents the first major impediment in time to ships transiting the Seaway. Existing ice booms were designed to retain and stabilize an ice cover upstream of these booms. Their use has proven effective in preventing the formation of ice jams which could cause disruption of the river discharge; however, they were not designed to allow ship transits while simultaneously retaining and stabilizing the ice cover. In order to allow navigation to proceed in the simulation, it was assumed that these ice booms would be replaced with ice control structures which would allow ship passage. Such ice control structures will be discussed later.

4.2.3 Removal of Lighted Aids to Navigation

The second major impediment in time to ships transiting the Seaway is the removal of floating lighted aids to navigation. These navigational aids are pulled by the navigation authorities to prevent loss or damage by ice. When they are pulled, ship operations are restricted to daylight operations only. This action greatly increases the time required to transit the Seaway and severely reduces the capacity of the Seaway because ships are forced to go to anchor and locks remain idle for long periods of time. The situation is further aggravated by the fact that the number of daylight hours is least during the winter months. The effect on transit time and Seaway capacity of removing lighted navigational aids was studied by assuming these structures would be replaced with ice resistant structures, and/or by an all-weather electronic navigation system, to be discussed later.

4.2.4 Accumulation of Ice at Locks

The third major impediment in time to ships transiting the Seaway is the presence of ice at existing locks. Ice accumulation at locks severely affects the capacity of the Seaway, but does not have a major influence on Seaway transit time. This is because the locks, being the slowest processing element in the system, determine the capacity of the Seaway; however, since there are only seven locks in the system, the time a ship spends in the locks is only a small proportion of the total transit time even when lockage time is greatly increased. The effect on transit time and Seaway capacity was studied by assuming various alternatives for removing the lock ice accumulation, to be discussed later.

4.2.5 Formation of Ice Jams

The fourth major impediment in time to ships transiting the Seaway is the formation of ice jams in certain critical reaches. The formation of ice jams was found to have a catastrophic, go/no go effect on ships. That is, once the jams formed, ships would get stuck and cause the subreach in which they formed to become the constraining reach in the system. It was found that ice jams formed very quickly, and within a matter of a day or two the ice thickness became so great that ships could not navigate the reach in which they occurred. In order to allow navigation to proceed in the simulation, it was assumed that these ice jams could be controlled by various ice control measures that will be described later.

4.2.6 Growth of Ice in Navigation Channels

The fifth major impediment in time to ships transiting the Seaway is the increased growth of ice in the navigation channel in certain subreaches. This phenomenon occurs in subreaches of low river currents and is caused by ships breaking the insulating layer of ice and exposing water to freezing temperatures after each passage. The water near the surface freezes rapidly and hence adds to the accumulation of ice already in the ship channel. It was found that the ice would accumulate to such proportions that ships would be severely slowed and even halted unless means were provided to remove some of this ice from the ship channel. A special craft to perform this function will be discussed later.

4.2.7 Decreased Visibility

Although fog is not a major impediment to ships transiting the Seaway, the simulation indicated that extended season navigation could be affected by fog caused by cold air over relatively warm water. This problem would be particularly acute in subreaches where a stable ice cover would not form, such as the critical or ice jam reaches. Fog increases Seaway transit time and decreases Seaway capacity. Concepts to partially remove this impediment are discussed below.

4.3 Concepts for Season Extension

4.3.1 Navigational Aids

Three alternatives were developed to remove the impediments to navigation caused by removal of lighted navigational aids and river fog.

The first alternative simply consisted of leaving the floating aids in place and accepting any losses which might occur due to ice. Such an alternative is only workable for short (one or two weeks) season extensions because, as the winter progresses,the ice could eventually destroy the utility of any floating aid.

The second alternative considered consisted of replacing the floating aids with permanent fixed structures capable of withstanding the forces caused by ice. A system of these aids was prepared following discussions with the Seaway pilots. Cost estimates for this system of fixed, lighted aids is given in Appendix D.

The third alternative considered consisted of the fixed, lighted aids just discussed plus a high accuracy radiolocation system for low visibility navigation. The radiolocation system could consist of several shore based transmitters strategically located along the Seaway and receivers on each ship in the Seaway. To keep the cost of the system to a minimum, the pilots could carry the receivers (which are portable) from ship to ship. A cost estimate for this alternative is given in Appendix D.

4.3.2 Ice Control Structures

Several types of ice control structures now exist in the Seaway. Of these, the least costly and most flexible structures are ice booms. Several variations of this basic structure were investigated for use in the various critical reaches of the river.

4.3.2.1 Ice Boom Gates: One way to provide a means of transiting ice booms is to install a gate in the boom. The gate may take the form of an opening in the boom with a movable section that is opened and closed for each ship transit, or an opening in the boom without a movable section. In the latter case, it is assumed that the opening is sufficiently small to allow ice to naturally arch across the opening.

Since the opening in the boom causes an unbalance in the forces in the cross stream cables, a means must be provided to anchor the free ends of the boom and still provide a clear opening for the ships.

4.3.2.2 Strengthening Existing Booms: Existing ice booms were not intended to withstand the additional forces which might be transmitted to the boom by downbound ships. In addition, some of the existing booms have floating members which are somewhat unstable under load and can therefore easily trip and allow the ice cover to pass over or under the boom. In such cases, the boom may have to be strengthened or replaced with a more stable, heavy duty ice boom.

4.3.3.3 Additional Booms: In several subreaches, new ice booms will be required to retain and stabilize the ice cover. Some of these booms will be used in conjunction with thermal effluent systems. In these instances the booms will be used to retain ice in the critical flow subreaches in order to prevent formation of frazil ice. These booms would not extend into the navigation channel, however. Instead, thermal effluent would be piped along the bottom of the navigation channel and the discharge used to prevent formation of frazil ice in the channel.

4.3.3.4 Longitudinal Booms: Booms which run parallel to the navigation channel can be used to absorb the shear loads exerted on the ice cover by passing ships and hence prevent the ship from dislodging or breaking up the ice cover on either side of the navigation channel. This is particularly important in subreaches where the flow is at or near its critical velocity in terms of ice stability.

4.3.3.5 Boom Costs: The cost of the ice booms associated with any given system plan alternative is determined from the number of booms used in the system plan alternative and certain cost estimating factors associated with designing, constructing and operating the booms. Cost estimates for various booms used in the system plan alternatives are given in Appendix D.

4.3.3 Lock Improvements

Three levels of improvements were developed to remove the impediments to navigation caused by accumulations of ice at locks. The problems are described and costed in Appendix D. Only a brief description of the problems and concepts for their removal will be provided here.

Ice moving into the upstream throat of a lock causes increased lockage time, which may be divided into the following categories:

(1) increase due to having to scrape off the walls of locks ice which was put there by a preceding ship and which prevents another ship from entering the lock;

(2) increase due to an inability to fully open the gates because of ice caught in the mite-gate recesses, edges or contact blocks;

(3) increase due to ice pushed into the lock which prevents the ship from fully entering the lock; and

(4) increase due to failure of equipment, which renders the lock inoperable.

The three improvement levels considered were defined as follows:

(1) Level 1 - a slight extension of existing knowledge and procedures requiring a minimum expenditure of funds.

(2) Level 2 - expenditure of moderate amounts of time and funds. The methods and mechanisms could be substantial in scope and complexity with design and application experience obtained from trials and demonstration programs.

(3) Level 3 - expenditure of all reasonable efforts to insure maximum available operating time for each lock.

A summary of the improvements associated with each improvement level is given in Table 4.1.

TABLE 4.1

SUMMARY OF LOCK IMPROVEMENTS

IMPROVEMENT METHOD	IMPROVEMENT LEVEL 1	2	3
Backhoes and Guillotines	X		
Improved Air Bubblers	X		
Increased Preventive Maintenance	X		
Anti-icing Coatings and Steam Cleaning	X	X	
Flow Developers	X	X	
Hollow Rubber Seals with Heated Fluid		X	
Heaters and Local Enclosures		X	X
Ice Diversion Booms		X	X
Heating Lock Walls			X
Sector Gates			X
Heated Contact Blocks			X
Ice Diversion Channels with Ice Crusher and Weir Gate			X

4.3.4 Icebreaking

To prevent the formation of ice jams for a one or two week period, it is possible to use powerful icebreaking tugs stationed in the reaches where ice jamming is likely. The tugs would be used to break up ice jams and keep the ice moving downstream. Tugs could be leased for this purpose, and estimated leasing costs are given in Appendix D.

To insure a firm April 1 opening after the navigation season has been closed for one or more weeks will probably require the use of heavy duty icebreakers initially to break up the ice and then for escort purposes. It is envisioned that two heavy duty icebreakers employed for one week would be sufficient to insure a firm April 1 opening. Estimated cost of the services is given in Appendix D.

4.3.5 Channel Clearing

A special channel ice clearing craft was conceived to remove the impediments to navigation caused by growth of ice in the navigation channel. Two such craft would be required, and they would continuously work the Seaway from end to end, sweeping the channel and pushing the ice to either side. These craft are further discussed and costed in Appendix D.

4.3.6 Thermal Effluent

Three critical areas were identified where high flow velocities and subfreezing temperatures combine to cause unstable ice accumulations. The first area to become critical is the Beauharnois Canal. Here it is proposed that one of two concepts utilizing waste heat from a thermal power plant be employed to prevent the formation of frazil ice. The first concept would employ a 3,600 megawatt plant, which would be capable of maintaining the entire canal ice free. The second concept would employ a 1,200 megawatt plant, a diffuser system running along the bottom of the navigation channel, and a series of ice booms to maintain a stable ice cover everywhere in the canal except in the navigation channel. These concepts and their estimated costs are further described in Appendix D.

The next area to become critical is the area around Cornwall Island. Here it is proposed that a 1,450 megawatt plant be located at Massena Point. Two diffusers would be used. One would carry a small fraction of the effluent north of Cornwall Island to reduce ice formation in the rapids section near the Seaway Bridge. The other would inject effluent into the flow at Polly's Gut,where it will keep the channel clear of ice from Polly's Gut to Stonehouse Point. Ice booms would also be employed to maintain a stable ice cover outside of the navigation channel. This concept and its estimated costs are further described in Appendix D.

The third area to become critical is the area between Ogdensburg and Morrisburg. Here it is proposed to install two thermal power plants with the attendant diffusers and ice booms. One plant would be located at Chimney Point and would inject effluent into the flow at Galop Island. The other plant would be located near Iroquois in the vicinity of Toussaint Island. It would be equipped with twin diffusers which would inject a limited amount of heat into the lock approach while the remainder would be piped into the tailwater of the Iroquois control dam. These concepts and their estimated costs are further described in Appendix D.

4.3.7 Dredging

Another approach to removing the constraint to navigation caused by ice jams which could occur in the three critical reaches is to dredge wider and deeper channels. Wider and deeper channels mean greater cross sectional areas which, for a given river discharge, result in lower velocities. If the channels are dredged sufficiently, the velocities can be reduced below critical values and hence allow formation of stable ice covers.

The amount of river bed material to be removed is quite large, and hence its removal would be quite expensive. A complete environmental inventory of the river bed is not yet available, and therefore the costs and impacts associated with dredging cannot be completely determined. Based on available information, however, dredging is an attractive alternative to the thermal power plants and is further discussed in Appendix D.

4.3.8 Twinning Locks

Another constraint to extended season navigation is the fact that existing locks in the Seaway require approximately four (4) weeks of down time each year for maintenance purposes. Thus, extending the season to year-round operations would require an additional lock at each existing lock site. Twin locks would benefit the normal season traffic as well as the extended season traffic and significantly increase the capacity of the Seaway.

In preparing cost estimates for the new locks, it was assumed that only the cost of winterizing the new locks would be chargeable to extended season operations. The cost to winterize the new locks was assumed to be equal to the Level 3 lock improvements discussed previously.

4.4 System Plan Alternatives

The concepts for removing the constraints to navigation were combined into complete system plans for extending the navigation season. A total of forty-five (45) system plans were prepared; three (3) for each of the fifteen (15) weeks available for extending the season. The three levels for a given season extension date consisted of a low cost, low capacity level (A), a medium cost, medium capacity level (B), and a high cost, high capacity level (C). The elements associated with each level and each system plan are summarized in Tables 4.2 through 4.4. A description of each system plan and detailed cost estimates are given in Appendix D.

4.5 Economic Analysis

The base case results of this analysis are shown in Figure 4.1. This analysis assumed a 50 year system life, average weather conditions and a 6-7/8 percent discount rate. The results show the following:

TABLE 4.2

ST. LAWRENCE RIVER NAVIGATION SEASON EXTENSION
SYSTEM COMPONENTS FOR VARIOUS CLOSING DATES

LEVEL A - LOW COST, LOW CAPACITY PLAN

SYSTEM ELEMENTS	CLOSING DATES														
	Dec		Jan				Feb				March				
	22	29	5	12	19	26	2	9	16	23	2	9	16	23	30
I. NAVIGATION AIDS															
Level 1 - Fixed Aids		■	■												
Level 2 - Prans				■	■	■	■	■	■	■	■	■	■	■	■
II. VESSEL CAPABILITY CRITERIA		■	■	■	■	■	■	■	■	■	■	■	■	■	■
III. LOCK MODIFICATIONS															
Level 1 - Mechanical Scrapers	■	■	■												
Level 2 - Wall Coatings, Steam				■											
Level 3 - Heating Walls					■	■	■	■	■	■	■				
Level 4 - Waste Heat															
Twin Locks												■	■	■	■
IV. CHANNEL MAINTENANCE															
Icebreaking Tugs															
Beauharnois Canal		■	■	■											
Lake St. Louis															
Lake St. Francis					■	■	■	■	■	■	■	■	■	■	■
St. Regis Island															
Lake St. Lawrence					■	■	■	■	■	■	■	■	■	■	■
Ogden Island															
Above Ogdensburg															
Heavy Icebreakers (Spring)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Channel Clearing Devices															
V. ICE JAM AREAS															
Beauharnois Canal															
Entrance Boom Modification	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Improve Existing Booms		■	■	■											
Longitudinal Booms					■	■	■	■	■	■	■	■	■	■	■
Waste Heat															
St. Regis Island															
Boom System			■	■	■	■	■	■	■	■	■	■	■	■	■
Waste Heat					■	■	■	■	■	■	■	■	■	■	■
Dredging															
Ogden Island															
Boom System			■	■	■	■	■	■	■	■	■	■	■	■	■
Waste Heat				■	■	■	■	■	■	■	■	■	■	■	■
Dredging															
Galop Island															
Gate		■	■	■											
Boom System					■	■	■	■	■	■	■	■	■	■	■
Dredging															
Ogdensburg Prescott															
Gate		■	■	■											
Boom System Improvement					■	■	■	■	■	■	■	■	■	■	■

TABLE 4.3

ST. LAWRENCE RIVER NAVIGATION SEASON EXTENSION

SYSTEM COMPONENTS FOR VARIOUS CLOSING DATES

LEVEL B - MEDIUM COST, MEDIUM CAPACITY PLAN

SYSTEM ELEMENTS

I. NAVIGATION AIDS

Level 1 - Fixed Aids
Level 2 - Prans

II. VESSEL CAPABILITY CRITERIA

III. LOCK MODIFICATIONS

Level 1 - Mechanical Scrapers
Level 2 - Wall Coatings, Steam
Level 3 - Heating Walls
Level 4 - Waste Heat
Twin Locks

IV. CHANNEL MAINTENANCE

Icebreaking Tugs

Beauharnois Canal
Lake St. Louis
Lake St. Francis
St. Regis Island
Lake St. Lawrence
Ogden Island
Above Ogdensburg

Heavy Icebreakers (Spring)
Channel Clearing Devices

V. ICE JAM AREAS

Beauharnois Canal

Entrance Boom Modification
Improve Existing Booms
Longitudinal Booms
Waste Heat

St. Regis Island

Boom System
Waste Heat
Dredging

Ogden Island

Boom System
Waste Heat
Dredging

Galop Island

Gate
Boom System
Dredging

Ogdensburg Prescott

Gate
Boom System Improvement

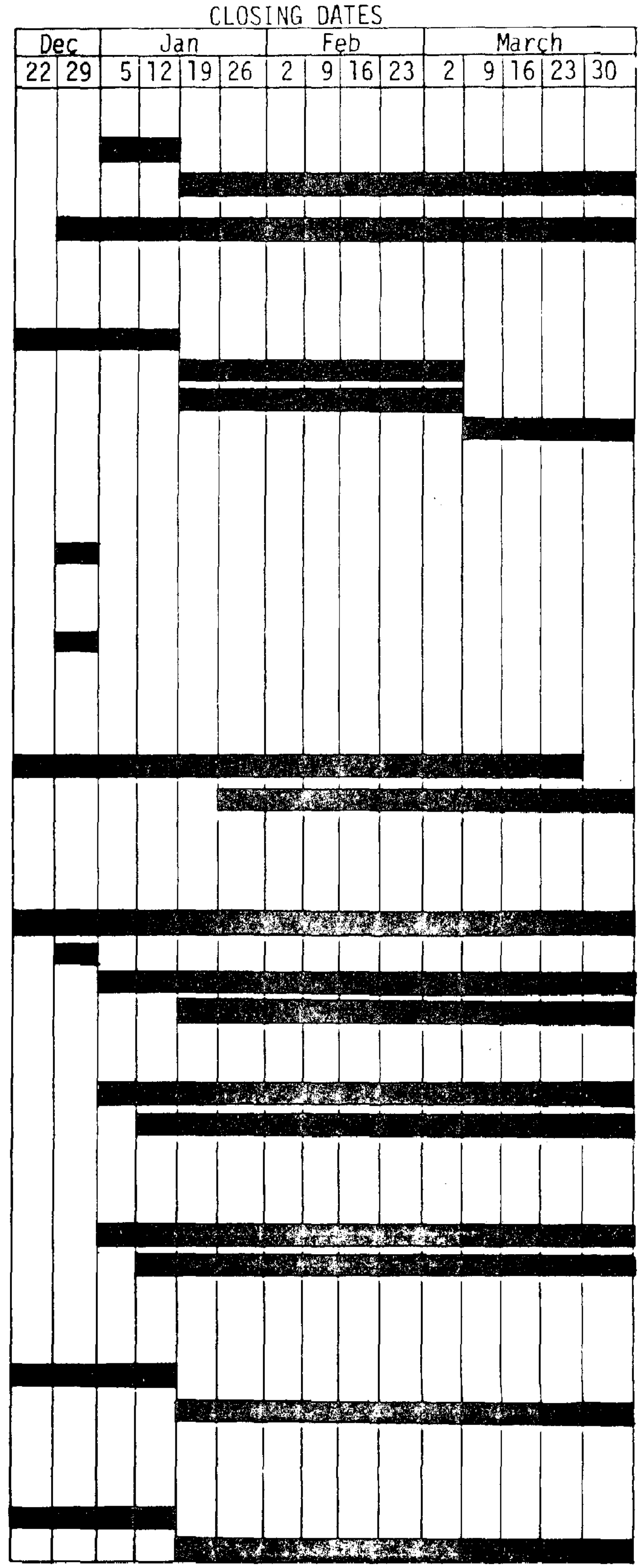


TABLE 4.4

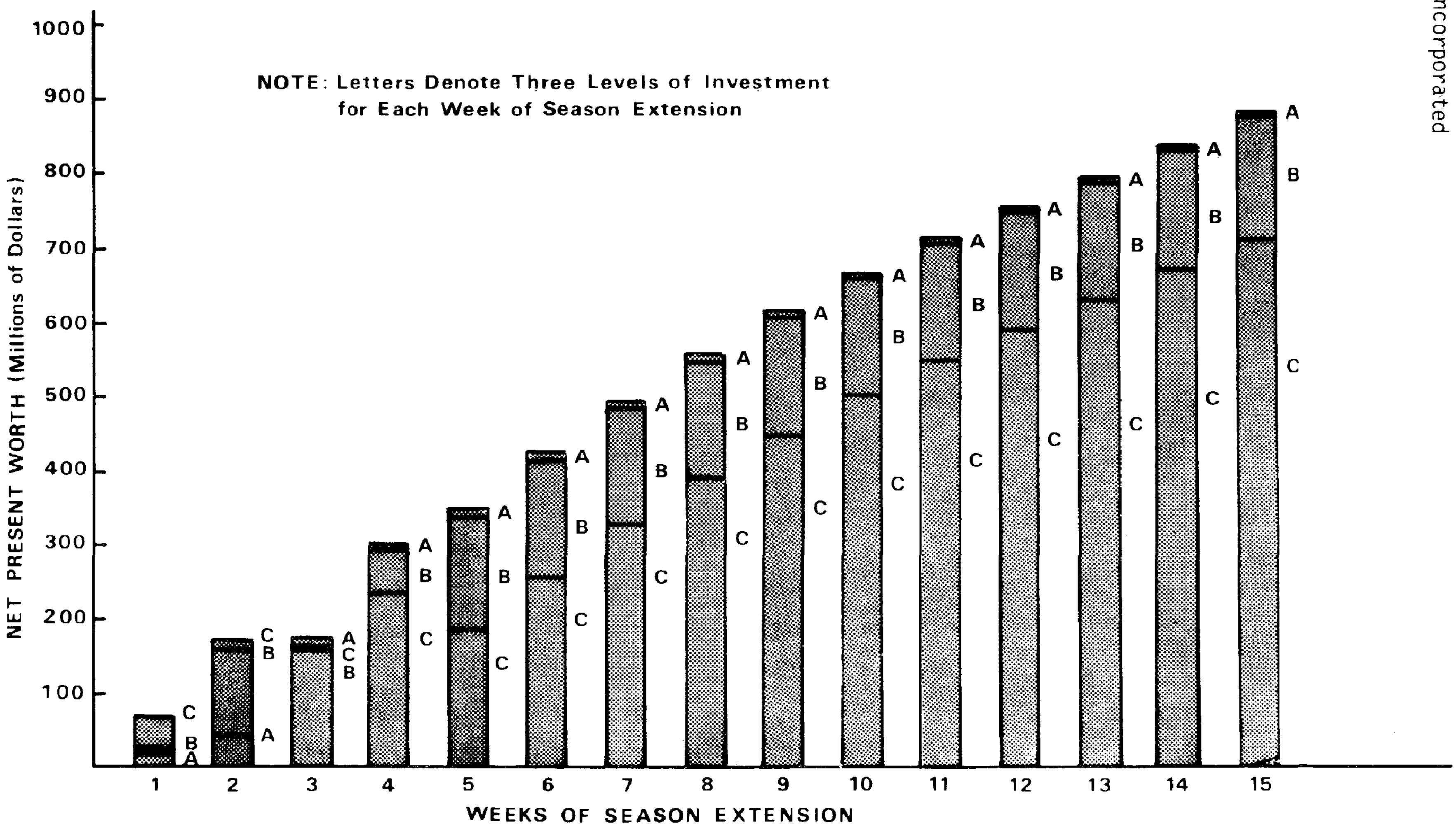
ST. LAWRENCE RIVER NAVIGATION SEASON EXTENSION
SYSTEM COMPONENTS FOR VARIOUS CLOSING DATES
LEVEL C - HIGH COST, HIGH CAPACITY PLAN

CLOSING DATES

SYSTEM ELEMENTS	Dec		Jan				Feb				March				
	22	29	5	12	19	26	2	9	16	23	2	9	16	23	30
I. NAVIGATION AIDS															
Level 1 - Fixed Aids	■														
Level 2 - Prans		■	■	■	■	■	■	■	■	■	■	■	■	■	■
II. VESSEL CAPABILITY CRITERIA		■	■	■	■	■	■	■	■	■	■	■	■	■	■
III. LOCK MODIFICATIONS															
Level 1 - Mechanical Scrapers															
Level 2 - Wall Coatings, Steam	■	■	■	■											
Level 3 - Heating Walls					■	■	■	■	■	■	■				
Level 4 - Waste Heat															
Twin Locks												■	■	■	■
IV. CHANNEL MAINTENANCE															
Icebreaking Tugs															
Beauharnois Canal		■	■	■	■	■	■	■	■	■	■	■	■	■	■
Lake St. Louis					■	■	■	■	■	■	■	■	■	■	■
Lake St. Francis					■										
St. Regis Island		■	■	■	■	■	■	■	■	■	■	■	■	■	■
Lake St. Lawrence					■										
Ogden Island	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Above Ogdensburg					■	■	■	■	■	■	■	■	■	■	■
Heavy Icebreakers (Spring)	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Channel Clearing Devices						■	■	■	■	■	■	■	■	■	■
V. ICE JAM AREAS															
Beauharnois Canal															
Entrance Boom Modification	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Improve Existing Booms		■													
Longitudinal Booms			■	■	■	■	■	■	■	■	■	■	■	■	■
Waste Heat															
St. Regis Island															
Boom System			■	■	■	■	■	■	■	■	■	■	■	■	■
Waste Heat															
Dredging			■	■	■	■	■	■	■	■	■	■	■	■	■
Ogden Island															
Boom System			■	■	■	■	■	■	■	■	■	■	■	■	■
Waste Heat															
Dredging			■	■	■	■	■	■	■	■	■	■	■	■	■
Galop Island															
Gate	■	■	■	■											
Boom System					■	■	■	■	■	■	■	■	■	■	■
Dredging					■	■	■	■	■	■	■	■	■	■	■
Ogdensburg Prescott															
Gate	■	■	■	■											
Boom System Improvement					■	■	■	■	■	■	■	■	■	■	■

Figure 4.1

NET PRESENT WORTH OF SYSTEM PLAN ALTERNATIVES USING BASE CASE ASSUMPTIONS



(1) all system plan alternatives have a positive net present worth;

(2) the net present worth of the system plans generally increases with the number of weeks of season extension; and

(3) the optimal system plan is associated with all-year navigation and has a net present worth of approximately $900 million and a benefit/cost ratio of 9.8.

A sensitivity analysis of various assumptions which were made in the base case analysis was also conducted. In no case did a benefit/cost ratio of less than 1.0 result. The sensitivity analysis gave the following results:

(1) Sensitivity to increased transportation cost due to winter operations - In the base case analysis this increase was variable and depended upon Seaway transit time. It averaged around 10 percent. When increased to a fixed 50 percent, the net present worth of the optimal system plan was reduced 52 percent.

(2) Sensitivity to system operating life - Decreasing the system life to 20 years reduces the net present worth of the optimal system plan by 32 percent.

(3) Sensitivity to system plan costs - Increasing the costs by 20 percent reduces the net present worth of the optimal system plan only 2 percent.

(4) Sensitivity to discount rate - Varying the discount rate plus or minus 2 percent changes the net present worth of the optimal system plan as follows: A 69 percent increase occurred in the case of a 2% decrease in discount rate and a 37 percent decrease occurred in the case of a 2% increase in the discount rate.

(5) Sensitivity to weather - Variations in winter severity have negligible effect on the net present worth of the optimal system plan.

The details of the benefit/cost analysis are contained in Appendix D (section D.5).

4.6 Environmental Evaluation

This analysis revealed no significant impact on the environment of any of the measures proposed to remove the constraints to navigation that were identified in this study, with one exception. That exception is the large scale dredging operations required to reduce the flow velocities in the critical reaches of the river. First, the dredging would cause localized (but temporary) disturbances to the river bottom which would place solids in suspension and which could in turn lead to local kills of marine life. Then the dredged material would have to be relocated, which, due to the volume of material involved, could cause damage to the shoreside environment.

V. CONCLUSIONS AND RECOMMENDATIONS

On the basis of a comprehensive analysis of the St. Lawrence River portion of the Seaway, specifically that portion between Cape Vincent, New York, on Lake Ontario and Montreal, Quebec, at the start of the Seaway, it is concluded that all periods of navigation season extension, from one week to a full 12-month season, are technically, economically and environmentally feasible. The analysis comprised examination in a rational, rigorous manner of the effects of weather, ice conditions, fleet mix and vessel characteristics, plus a wide range of potential system improvements, on vessel transit times and system throughput capacity.

Four major obstacles to winter navigation became apparent early in the analysis:

1. In order for vessels to move and to satisfy international requirements, the present winter levels and flows regime of the river must be maintained or improved.

2. Ice control systems in critical areas of the river must be improved to maintain a stable ice cover and allow vessel passage.

3. Locks must be winterized to reduce delays due to ice in lock throats and chambers, on lock walls and on operating machinery.

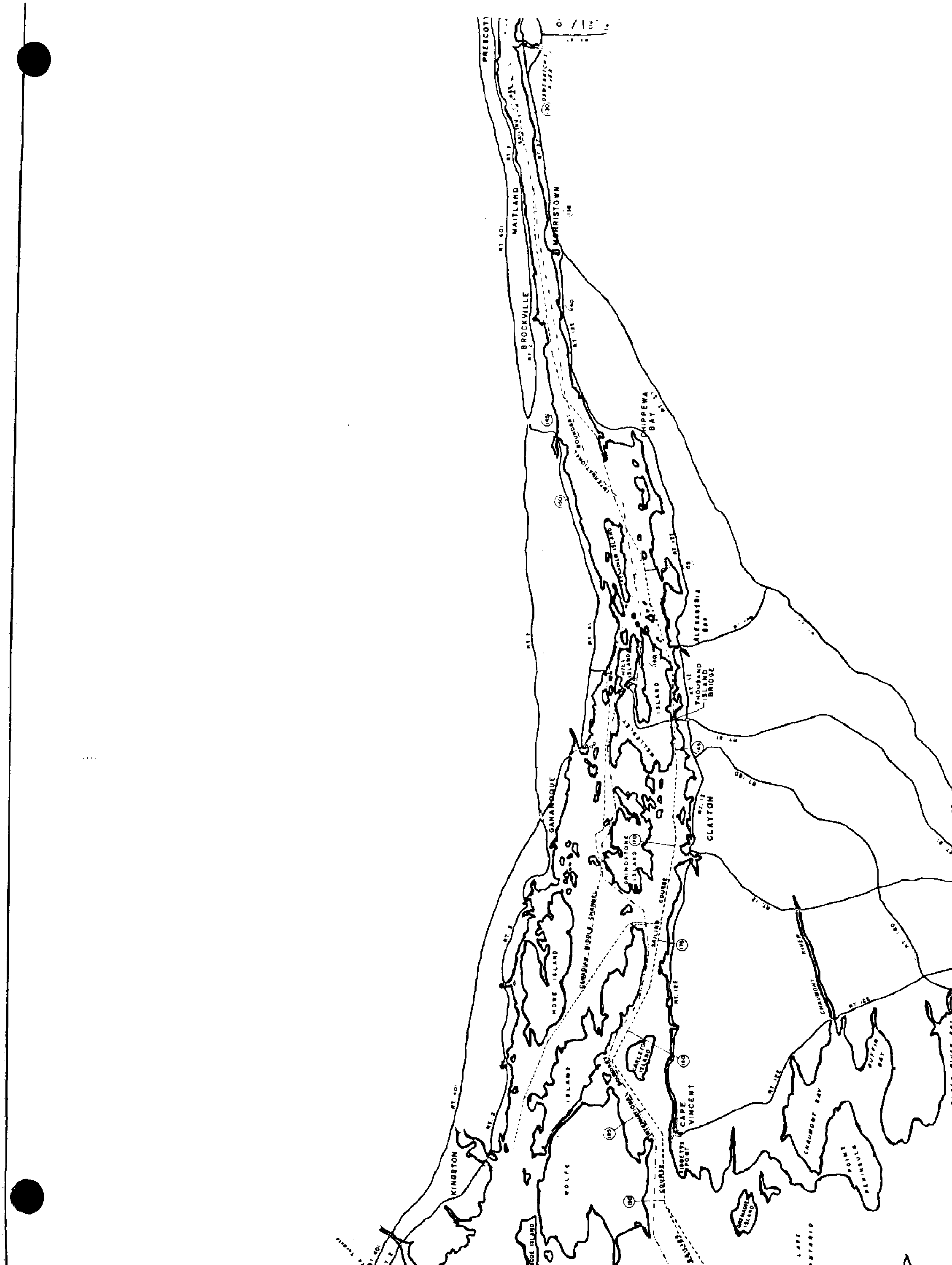
4. An all-weather navigation (positioning) system, vessel capability criteria (ability to operate in ice), and special devices for maintaining ice in channels at acceptable thicknesses will be required.

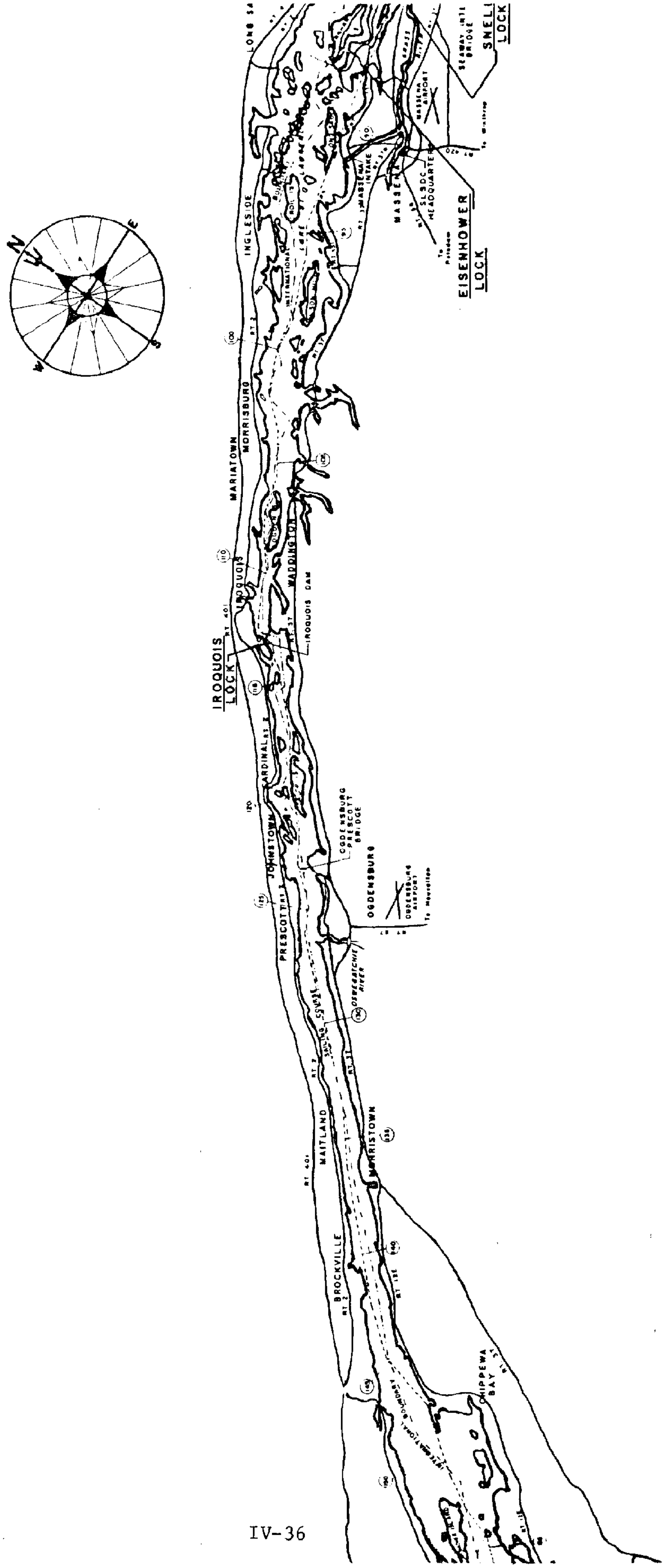
There is no single, simple answer to the question, "What is required to allow winter navigation on the Seaway?" Safe, environmentally sound, economically efficient winter navigation will require a combination of improvements to address the above constraints.

The economic analysis indicated that extending the navigation season to all year operations is the best alternative in terms of maximizing the net present worth of the project. However, the portion of the Seaway studied in this work is not under the exclusive control of the St. Lawrence Seaway Development Corporation, and hence the following recommendations presume consideration and active involvement of the other entities involved with control of the navigation and power projects in the Seaway. In this context, the following specific plan of action is recommended.

(1) Undertake immediately the implementation of System Plan Alternative 2A in order that available benefits are not lost during the time associated with implementing an all-year operations system plan. This plan provides for a firm April 1 opening and December 31 closing of the Seaway, and contains no elements which would be wasted when longer season extensions are attempted. A detailed PERT chart of the model testing, design, and full scale testing to be conducted in the two-year R & D phase associated with this plan should be prepared for purposes of discussion and scheduling.

(2) Undertake an additional study to determine the best approach to implementing an all-year operations system plan. This study indicated that System Plan Alternative 15A is the best system plan. However, it was judged best because of the assumptions that installation of thermal plants or dredging operations could each be accomplished within a nine (9) year period and that all locks in the Seaway could be twinned within the same period of time. If these assumptions are incorrect, then the best all-year operations plan may not be 15A. The recommended study should carefully ascertain the most probable start dates and construction times for installation of thermal power plants, dredging operations and lock twinning. These times should then be used to redistribute the costs associated with the three all-year operations system plans and the benefit/cost analysis should be repeated.


PRESCOTT
MAITLAND
MORRISTOWN
BROCKVILLE
CHIPPEWA BAY
ALEXANDRIA BAY
THOUSAND ISLAND BRIDGE
HILL ISLAND
WELLESLEY ISLAND
GANANOQUE
CLAYTON
GRINDSTONE ISLAND
HOWE ISLAND
SAILING COURSE
CARLETON ISLAND
CAPE VINCENT
TIBBETTS POINT
WOLFE ISLAND
KINGSTON
CHAUMONT RIVER
CHAUMONT BAY
POINT PENINSULA
LAKE ONTARIO
RT. 401
RT. 2
RT. 12
RT. 12E


SNELL LOCK
EISENHOWER LOCK
MASSENA
SLSDC HEADQUARTERS
MASSENA INTAKE
MASSENA AIRPORT
INGLESIDE
INTERNATIONAL
MORRISBURG
MARIATOWN
WADDINGTON
IROQUOIS
IROQUOIS DAM
IROQUOIS LOCK
CARDINAL
JOHNSTOWN
OGDENSBURG PRESCOTT BRIDGE
OGDENSBURG
OGDENSBURG AIRPORT
PRESCOTT
OSWEGATCHIE RIVER
MAITLAND
MORRISTOWN
BROCKVILLE
CHIPPEWA BAY
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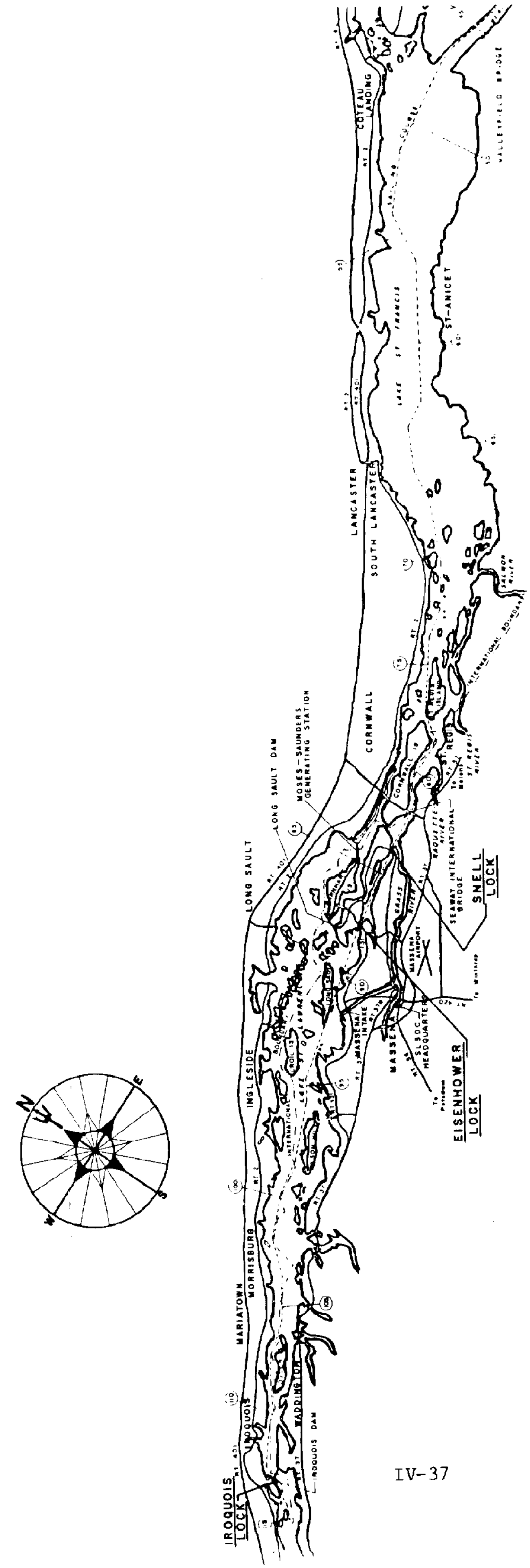
IROQUOIS LOCK
IROQUOIS
IROQUOIS DAM
WADDINGTON
MARIATOWN
MORRISBURG
INGLESIDE
LONG SAULT
LONG SAULT DAM
MOSES-SAUNDERS GENERATING STATION
EISENHOWER LOCK
SNELL LOCK
MASSENA
SLSDC HEADQUARTERS
MASSENA AIRPORT
SEAWAY INTERNATIONAL BRIDGE
CORNWALL
SOUTH LANCASTER
LANCASTER
LAKE ST FRANCIS
ST-ANICET
COTEAU LANDING
VALLEYFIELD BRIDGE
INTERNATIONAL BOUNDARY
SALMON RIVER
N
E
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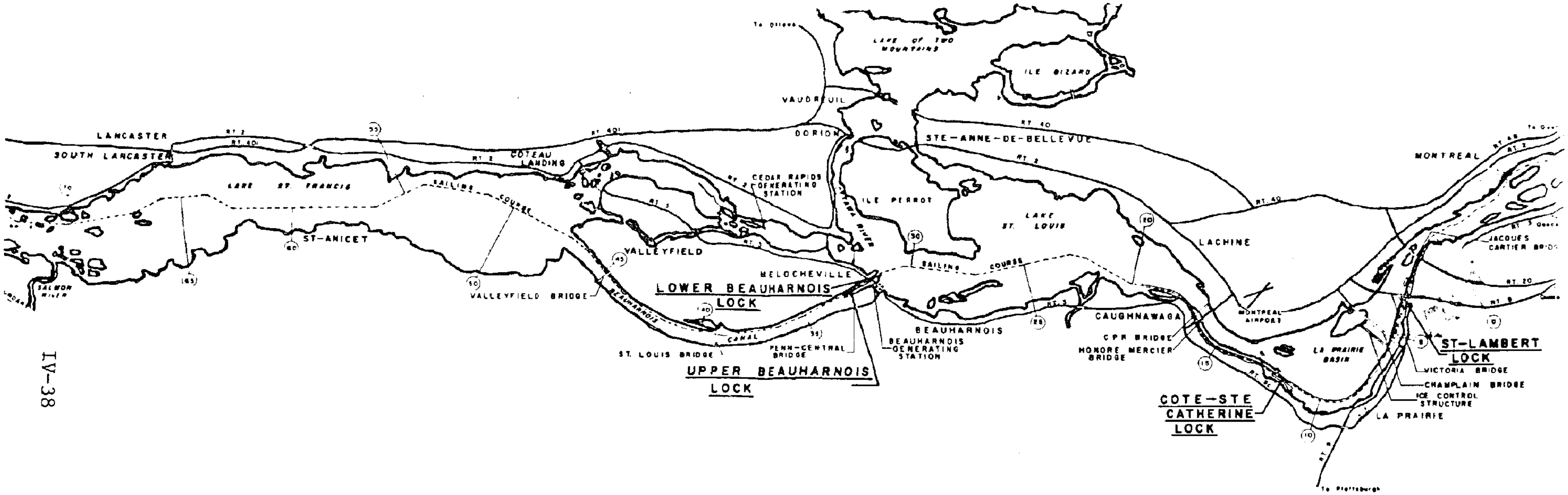

ST. LAWRENCE SEAWAY DEVELOPMENT CORPORATION

ST. LAWRENCE SEAWAY FROM MONTREAL, CANADA TO LAKE ONTARIO

OFFICE OF ENGINEERING JULY, 1970

SCALE OF STATUTE MILES

LEGEND

(10) INDICATES SEAWAY CHANNEL DISTANCES IN STATUTE MILES FROM MILE ZERO (0) WHICH IS THE INTERSECTION OF THE SEAWAY AND SHIP CHANNELS, IN MONTREAL HARBOUR

APPENDIX V

GREAT LAKES-ST. LAWRENCE SEAWAY

SYSTEM ECONOMICS

APPENDIX V

ECONOMICS OF NAVIGATION SEASON EXTENSION ON THE ENTIRE GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM

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APPENDIX V

ECONOMICS OF NAVIGATION SEASON EXTENSION ON THE ENTIRE GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM

INTRODUCTION

This section of the report discusses the economic aspects of navigation season extension on the Great Lakes-St. Lawrence Seaway System. Preliminary estimation of benefits is based on traffic projections over the selected 1980-2030 period of analysis. The reader should carefully note the qualifications with respect to forecasted tonnage levels and resulting benefits as discussed in various table footnotes of this appendix, as well as in appendices VI and VII. Forecasted tonnage and benefits, as well as costs, will be subject to further refinement of baseline data methodology.

METHODOLOGY

The economic justification of the alternative plans was determined by comparing equivalent average annual charges; i.e., interest, amortization, and operations and maintenance costs, with an estimate of the average transportation-related annual benefits that will accrue over the selected 1980-2030 period of analysis. The value given to benefits and costs at the time of their accrual was made comparable by conversion to an equivalent time basis using an interest rate of 6 1/8 percent, the current rate applicable to public projects.

REQUIREMENTS FOR NAVIGATION SEASON EXTENSION

The entire Great Lakes-St. Lawrence Seaway System was analyzed, on a preliminary basis, as to the problems and requirements considered necessary to extend the navigation season in the following areas: (1) five Great Lakes, (2) Great Lakes connecting channels including the Welland Canal, (3) locks in the St. Marys River, Welland Canal and St. Lawrence River, (4) harbors in the entire system, and (5) the St. Lawrence River. Figure 1 displays those requirements needed to extend the navigation season throughout the system. These requirements, which consist of operational elements, information collection dissemination, and remedial measures, are discussed in the following paragraphs.

OPERATIONAL ELEMENTS

The following enabling measures are considered to be necessary operational elements.

Icebreaking Assistance

Icebreaking assistance in lakes, connecting channels, and harbors by vessels with icebreaking capability was found to be an effective way of aiding ice navigation of commercial vessels. Icebreaking assistance, over and above service normally provided by Coast Guard vessels on the Great Lakes in winter (5-180 feet buoy tenders, 5-110 feet tugs, 1 medium-class icebreaker-MACKINAC), would be conducted by the following:

a. For season extension to 31 January - 3 new icebreaking tugs, 1 new medium-class icebreaker, and modernization of the Icebreaker MACKINAW.

b. For season extension beyond 31 January - all of the above, plus 4 more new icebreaking tugs.

In addition to this Coast Guard icebreaking assistance, this category includes use of a channel clearing craft in the St. Lawrence River to remove ice from the navigation channel.

FIGURE 1

NAVIGATION SEASON EXTENSION

TYPE AND LOCATION OF ACTIVITIES

NOTES

A specified ■ for an entire river or lake system implies that the activity is available anywhere in the lake or river system, including harbors.

The type and location of activities presently anticipated as a minimum requirement to allow an extension of the navigation season is shown on this table. This table displays those activities which have been identified to date.

	Operational Elements								Information Collection Disseminat				Remed. Meas.		
Location of Activity	Icebreaking Assistance	Ice Control Devices	Navigation Aids	Precise Navigation System	Air Bubbler Systems	Lock Modifications	Dredging	Mooring Improvements	Ice Navigation Center Services	Aerial Reconnaissance	Automated Vessel Reporting System	Water Level Gauges	Assistance to Ferry Transportation	Powerplant Protection	Shore Erosion and Shore Struc. Protect.
LAKE SUPERIOR	■		■						■	■	■				
Duluth-Superior Harbor					■										
Silver Bay Harbor					■										
Taconite Harbor					■										
Two Harbors					■										
Presque Isle Harbor					■										
ST. MARYS RIVER	■		■	■					■	■	■	■			■
Whitefish Bay			■		■										
Soo Locks						■									
Sault Ste. Marie, Michigan														■	
Little Rapids Cut		■													
Sugar Island													■		
Middle Neebish Channel		■			■										
Lime Island Turn					■										
Pipe Island Turn		■			■										
Lime Island													■		
LAKE MICHIGAN	■								■	■	■				
Milwaukee Harbor								■							
Green Bay Harbor			■		■										
Muskegon Harbor		■													
Ludington Harbor		■													
STRAITS of Mackinac	■		■						■	■	■				
St. Ignace Harbor							■	■							

FIGURE 1 (continued)

NAVIGATION SEASON EXTENSION

TYPE AND LOCATION OF ACTIVITIES

NOTES

O A similar system presently exists on Lake Ontario and the St. Lawrence River.

** Activities entirely within Canadian boundaries (Note: these activites are not reflected in cost estimates)

Location of Activity	Operational Elements								Information Collection Disseminat				Remed. Meas.		
	Icebreaking Assistance	Ice Control Devices	Navigation Aids	Precise Navigation System	Air Bubbler Systems	Lock Modifications	Dredging	Mooring Improvements	Ice Navigation Center Services	Aerial Reconnaissance	Automated Vessel Reporting System	Water Level Gauges	Assistance to Ferry Transportation	Powerplant Protection	Shore Erosion and Shore Struc. Protect.
LAKE HURON (incl. Saginaw Bay)	—		—	—					—	—	—				
Saginaw River		—													
ST. CLAIR-DETROIT RIVERS SYSTEM	—		—	—					—	—	—	—			—
Port Huron		—													
LAKE ERIE	—		—						—	—	—				
Ashtabula Harbor		—													
Buffalo Harbor		—													
Lorain Harbor		—													
Conneaut Harbor		—													
Cleveland									—						
WELLAND CANAL						—					O				
LAKE ONTARIO	—		—					—	—	—	O				
ST. LAWRENCE RIVER	—		—	—				—	—	—	O				
Iroquois Lock						—									
Snell Lock						—									
Eisenhower Lock						—									
** Beauharnois Lock						—									
** Cote Ste. Catherine Lock						—									
** St. Lambert Lock						—									
** Beauharnois Canal Area		—													
St. Regis Island Area		—					—								
Ogden Island Area		—					—								
Ogdensburg-Prescott/Galop Islan		—													

Ice Control Devices

Ice Control devices (i.e. floating log booms) to stabilize the ice-cover are effective means of managing ice. These devices, designed to permit navigation, would stabilize ice-covers and prevent subsequent ice jams downstream. Ice Control devices, for any of the three alternative periods of season extension, would be required in the St. Marys River, Lake Huron, and the following locations in the St. Lawrence River: the Beauharnois Canal entrance, the Beauharnois Canal itself, the St. Regis Island area, the Ogden Island area, Ogdensburg-Prescott and Galop Island. In addition, for season extension beyond 31 January, ice control devices would be required at Lake Nicolet, Pipe Island Turn, Muskegon Harbor, Ludington Harbor, Saginaw Harbor, Lorain Harbor, Ashtabula Harbor, Conneaut Harbor, and Buffalo Harbor.

Navigation Aids

Navigation aids include ice buoys and radar transponder beacons (RACONs). Ice buoys are being developed and tested under the Demonstration Program to withstand the rigorous ice environment, to maintain their position in ice, to be highly detectable by a ship's radar, to be readily detectable visually, and to be a valuable aid to a shipmaster in planning the approach to a turn in a channel. The RACON, which transmits a response to a ship's radar signal, enables large ranges of 8 to 16 miles and distinct code identification of shore targets so equipped. RACONs have been demonstrated and used in trial locations and found very effective.

Precise Navigation System

The precise navigation system under consideration would be a short-range electronic shipboard navigation aid to determine a ship's location, speed and attitude. The system would be used in harbors, bays and channels.

Air Bubbler Systems

Air bubblers in harbor channel areas, at docking and berthing areas, at tight turns in the connecting channels, and in lock facilities were considered for their ability to control ice formation and reduce ice thickness. Air bubblers were found to be an effective ice reducing means. Air bubblers would be necessary at the following locations: Middle Neebish Channel, Lime Island Turn, Pipe Island Turn, Whitefish Bay, Escanaba, Green Bay, Duluth-Superior Harbor, Presque Isle Harbor, Silver Bay, Taconite and Two Harbors.

Lock Modifications

Lock modifications would include safety boom and gate engine pit enclosures, vertical lock wall ice removal both manually and with the use of heat, air bubblers in gate recesses, modifying existing floating plants for winter lock maintenance, and twinning at existing locks. Lock modifications would be required for the locks at Sault Ste. Marie, the Welland Canal and the St. Lawrence River.

Dredging

Dredging improvements would be necessary in the St. Lawrence River to reduce velocities in high velocity reaches to allow formation of an ice cover with use of ice booms.

Mooring Improvements

Mooring improvements at St. Ignace, Milwaukee and on the St. Lawrence River would be undertaken to accommodate U.S. Coast Guard icebreaking vessels.

INFORMATION COLLECTION AND DISSEMINATION SYSTEMS

The following items were considered the most promising information collection and dissemination systems:

Ice Navigation Center

The Coast Guard Ice Navigation Center would be expanded to collect, monitor and disseminate ice, weather and shipping data as advisories and forecasts.

Aerial Ice Reconnaissance

Aerial Ice reconnaissance would be conducted throughout the entire system by Coast Guard medium-range aircraft equipped with appropriate sensors. One aircraft would be required for season extension to 31 January. For season extension beyond 31 January, two aircraft would be necessary.

Automated Vessel Reporting System

The Automated Vessel Reporting System would monitor vessel passage itineraries and other information to provide current up-to-date advisories as to vessel movement and the potential need for icebreaking assistance by the U.S. Coast Guard icebreaking fleet.

Water Level Gauges

Water level gauges to provide a warning system of rising water levels in the event of downstream ice jams would be required to advise shore residents and powerplant personnel of possible flooding. Water level gauges would be required in the St. Marys River and the St. Clair River.

REMEDIAL MEASURES

The following items were considered as possible actions to mitigate potentially adverse effects of extended season navigation:

Assistance to Ferry Transportation

Methods to allow island residents on the St. Marys to maintain transportation to the mainland during the winter months are under consideration. Plans would include closing the West Neebish Channel in the St. Marys River and providing bubbler-flusher units at the ferry docks. In addition, an airboat would be required for Lime Island residents. Assistance to ferries operating in the St. Clair River will be considered in subsequent interim reports.

Powerplant Protection

Flood protection is contemplated to the Edison Sault powerplant on the St. Marys River to minimize the risk of shutdown as a result of flooding caused by possible downstream ice jams.

Shore Erosion and Shore Structure Protection

Problems with shore erosion and shore structure damage along the connecting channels are recognized and are being evaluated with regards to winter navigation. Areas on the St. Marys River have been identified, as well as on the St. Clair River; however, further detailed evaluation is needed, to include the St. Lawrence River.

COSTS

For study purposes and evaluation three periods of season extension were considered: (1) 31 January , (2) 28 February, and (3) year-round.

A summary of costs is contained in Table 1. Costs are based on December 1975 prices. All cost estimates include engineering, design, and supervision and administration of construction based on similar cost relationships for recent projects.

The first costs for all the improvements shown in Table 1 include both initial capital costs and replacement costs. Replacement costs for each particular improvement were discounted back to present worth at 6 1/8% based on the useful life of the improvement. For example, if a certain improvement has a useful life of 10 years, then it was assumed that replacement costs would accrue in the 10th, 20th, 30th and 40th year of the 50-year project life. This stream of replacement costs was then discounted back to present worth and combined with initial capital costs to derive the total first cost of the improvement. Interest during construction was added to the total first cost to get total investment costs. Interest during construction was accrued to items of two or more years' construction time.

Estimates of annual costs were based on an economic life of 50 years. The estimated total average annual costs include interest, repayment of the principal (amortization), and operation and maintenance charges. Operation and maintenance for the Great Lakes-St. Lawrence Seaway System principally involves that of floating plants. Vessels, such as icebreakers and icebreaking tugs, demand constant upkeep and repair. Floating equipment, such as ice buoys, requires installation, removal and upkeep. Mechanical plants, including air bubblers, require servicing by operating personnel.

In deriving the annual costs, an assumption is made that United States costs comprise 50% of the total cost of facilities on the St. Lawrence River. It should be noted that this is an

TABLE 1

GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM
TOTAL ANNUAL COSTS OF NAVIGATION SEASON EXTENSION 1/
AT 6-1/8% INTEREST RATE
(WITHOUT LOCK TWINNING)

IMPROVEMENTS		Season Extension To: 31 January	28 February	Year-Round 2/
Ice Breaking Assistance		62,513,100	93,575,500	93,575,500
Ice Control Devices		15,683,400	38,666,800	38,666,800
Navigation Aids		1,885,100	1,896,700	1,896,700
Precise Navigation System		3,650,100	3,650,100	3,650,100
Air Bubbler Systems		6,611,400	6,611,400	6,611,400
Lock Modifications		12,798,100	12,798,100	12,798,100
Dredging		119,716,000	119,716,000	119,716,000
Mooring Improvements		428,300	629,000	629,000
Ice Navigation Center Services		306,400	306,400	306,400
Aerial Reconnaissance		8,516,800	17,033,600	17,033,600
Automated Vessel Reporting System		314,600	314,600	314,600
Water Level Gauges		175,300	175,300	175,300
Assistance to Ferry Transportation		90,800	99,100	117,400
Power Plant Protection		191,300	191,300	191,300
Shore Erosion and Shore Structure Protection		1,381,600	1,381,600	1,381,600
TOTAL FIRST COSTS:		234,262,300	297,045,500	297,063,800
INTEREST DURING CONSTRUCTION:		30,575,300	32,477,900	32,477,900
TOTAL INVESTMENT COSTS:		264,837,600	329,523,400	329,541,700
ANNUAL COSTS:	INTEREST	16,221,300	20,183,300	20,184,400
	AMORTIZATION	876,600	1,090,700	1,090,800
	OPERATION & MAINTENANCE	6,348,800	9,491,800	12,533,100
TOTAL ANNUAL COSTS		23,446,700	30,765,800	33,808,300

1/ Costs are for U. S. portion of the Great Lakes-St. Lawrence Seaway System. It is assumed that U. S. costs comprise 50% of the total cost of facilities on the St. Lawrence River.

2/ Reflects year-round season extension on the upper four Great Lakes only. For purposes of this analysis it was assumed that season extension beyond 28 February on the St. Lawrence Seaway would require twinning of the Welland and St. Lawrence River locks to permit lock maintenance. It should be noted that year-round navigation would be feasible without lock twinning if the U.S. and Canadian Governments are able to achieve year-round servicing of these locks.

NOTE: The costs shown on this table are total costs. The share of Federal and non-Federal costs have not been developed.

initial assumption and is not based on any negotiations between the American and Canadian governments.

BENEFITS

Substantial benefits would result from extending the navigation season to 31 January on the upper four Great Lakes. First, shippers of Great Lakes waterborne commerce will have the less costly water transportation alternative open to them for an extended period. This would result in transportation rate savings based on the differentials between Great Lakes winter waterborne rates and alternative overland rates.

The second major area of savings is in the more efficient utilization of the existing 1975 Great Lakes fleet mix under normal winter operations. Navigation season extension provides a greater annual return on the capital invested in ships. Even though variable costs such as fuel and labor may increase with winter navigation, these minor increases are more than offset by increasing the number of loaded trips to spread capital costs over. Thus, whereas transportation rate savings result from a new least cost alternative defined in terms of existing waterborne and rail rate structures, vessel utilization benefits result from efficiencies in using the current Great Lakes fleet, which lowers the annual freight rate for ships operating in the upper lakes.

Thirdly, users of bulk commodities such as iron ore and coal, which are transported on the Great Lakes during the 1 April to 15 December navigation season, stockpile resources for winter production needs in addition to contingency needs. Stockpiling savings which would result from a reliable winter supply include interest on capital invested in the stockpile inventory itself, real estate released for other more productive uses, and reduction of handling costs incurred in stockpile management.

The derivation of these primary, transportation-related benefits attributable to navigation season extension is discussed in the following paragraphs. Supplement A to this appendix addresses the secondary regional effects of navigation season extension on production, income and employment in the Great Lakes region.

GREAT LAKES-ST. LAWRENCE SEAWAY NAVIGATION SYSTEMS STUDY

The Great Lakes have long been associated with the production of transportation equipment and also service significant concentrations of petroleum refining and manufacturing of chemicals, paper and food products. As population and personal income in the United States and the world continues to grow, the demand for transportation of commodities increases. Record volumes of iron ore and grain have been experienced on the Great Lakes in the decade of the 1970's, and sharp increases in coal and general cargo are expected for the remainder of the 1970-1980 period. A growing demand exists for low-cost transportation capable of handling large volumes of bulk and manufactured products.

The completion of the 1,200-foot long by 110-foot wide Poe Lock in the St. Marys River in 1968 has further strengthened the economic advantage of high volume, low cost waterborne transportation on the Great Lakes. The construction of several bulk carriers 1,000-feet in length and 105-feet in beam has dramatically changed the direction of the future Great Lakes shipping fleet. Ship building activity has been renewed, and a period of accelerated change in the size of vessels which will operate in future years on the Great Lakes is just now emerging.

In light of the rapid changes being experienced on the Lakes, a Systems Study was undertaken to simulate the impact that future improvements to the Great Lakes-St. Lawrence Seaway would have on waterborne traffic. Preliminary outputs from this Great Lakes-St. Lawrence Seaway Navigation Systems Study have been utilized in developing waterborne and overland traffic projections for the Great Lakes study area, establishing required freight rates for operation on the Great Lakes during both the normal and winter seasons, and determining the effect that navigation season extension would have on projected Great Lakes traffic levels and associated transportation and stockpiling savings.

The traffic projections were furnished under contract by A. T. Kearney, Inc. This contract called for a baseline Great Lakes-St. Lawrence Seaway forecast to 2040, 120 in-depth interviews with shippers and transportation-related professionals, and a model showing the route-split between waterborne and overland commerce. The normal season transportation rates, which were developed by the Corps of Engineers in conjunction with a transportation consultant, reflect the differential between Great Lakes tributary area cargo and the least-cost overland or waterborne alternative. The winter rates were furnished under contract by Arctec, Inc., and show the impact that season extension has on both bulk and general cargo required freight rates. The A. T. Kearney shipper preference interviews established the sensitivity of shippers to an expansion of navigation service on the Great Lakes into the winter months.

Summaries of the A. T. Kearney Traffic Study and the Arctec Winter Rate Study are contained in Appendices VI and VII, respectively.

Existing and Projected Waterborne Traffic

The A. T. Kearney traffic projections show flows of cargo to and from foreign trade regions and the BEA (Bureau of Economic Analysis) Areas located in the 19 state Great Lake Economic Region.

(A map of this 19 state region is contained in Section B.) These total cargo flows were allocated to the Great Lakes-St. Lawrence Seaway and to the land alternative. The route-split model then examined these resulting flows for the sensitivity of shippers to navigation season extension to determine the traffic that would be diverted from the least-cost land alternative now used during the closed winter season.

The traffic projections for normal season operations (December 15 closing date), as well as for navigation season extension to 31 January, 28 February and year round are shown in Table 2. Extended season traffic was defined as including only that traffic which moved through the Soo Locks or the St. Lawrence Seaway after 15 December. Therefore, traffic resulting from current normal winter operations (i.e., intra-lake traffic and non-ice restricted inter-lake traffic) was excluded from the analysis. Likewise, traffic not suited for winter navigation was excluded from benefit calculations. For example, because limestone goes through a wash process, a drying treatment would have to be instituted before it would be feasible to transport limestone in the winter. The traffic projections included only the movements which involve U.S. ports as either origin, destination, or both legs of the movement. This would include transit from United States to United States, United States to Canada, Canada to United States, United States to Overseas, and Overseas to United States. Great Lakes-St. Lawrence Seaway traffic involving movements from Canada-Canada and Canada-Overseas are not included in the projections.

The traffic forecasts shown in Table 2 take account of the fact that the existing locks in the Great Lakes-St. Lawrence Seaway System will reach capacity sometime during the 1980-2030 period of analysis. Previous lock capacity simulation studies by North Central Division, Corps of Engineers for the Sabin Lock Study

TABLE 2
GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM TRAFFIC
FOR NORMAL SEASON AND EXTENDED SEASON PERIODS 1/
WITHOUT LOCK TWINNING 2/
1977 and 1980-2030
(1,000 Tons)

U.S. TRAFFIC

NORMAL SEASON	1977 3/	1980 3/	1990	2000	2010	2030
IRON ORE	79,000	83,300	102,500	102,500	102,500	102,500
COAL	15,000	15,900	20,150	20,150	20,150	20,150
GRAIN	13,900	14,800	18,050	18,050	18,050	18,050
GENERAL CARGO 5/	10,000	12,000	26,000	26,000	26,000	26,000
TOTAL	117,900	126,000	166,700	166,700	166,700	166,700
31 JANUARY	1977	1980	1990	2000	2010	2030
IRON ORE	80,000	84,300	103,500	121,000	121,000	121,000
COAL	15,900	16,300	20,500	23,500	23,500	23,500
GRAIN	13,950	15,500	19,900	25,300	25,300	25,300
GENERAL CARGO 5/	10,000	12,100	28,600	41,800	41,800	41,800
TOTAL	119,850	128,200	172,500	211,600	211,600	211,600
28 FEBRUARY	1977	1980	1990	2000	2010	2030
IRON ORE	80,000	84,300	103,500	121,000	121,000	121,000
COAL	16,000	16,500	20,900	23,900	23,900	23,900
GRAIN	14,000	15,500	20,400	26,000	26,000	26,000
GENERAL CARGO 5/	10,000	12,100	29,900	43,700	43,700	43,700
TOTAL	120,000	128,400	174,700	214,600	214,600	214,600
YEAR-ROUND 4/	1977	1980	1990	2000	2010	2030
IRON ORE	80,700	85,300	104,300	122,000	122,000	122,000
COAL	16,050	16,500	21,000	24,000	24,000	24,000
GRAIN	14,000	15,500	20,400	26,000	26,000	26,000
GENERAL CARGO 5/	10,000	12,100	29,900	43,700	43,700	43,700
TOTAL	120,750	129,400	175,600	215,700	215,700	215,700

1/ The traffic base was defined as including only that traffic which moved through the Soo Locks or St. Lawrence Seaway after 15 December. Traffic resulting from current normal winter operations (such as intra-lake movements of petroleum and other commodities, and non-ice restricted inter-lake traffic) was excluded from the analysis. Likewise, traffic not suited for winter navigation (such as limestone) was excluded. The traffic projections include only traffic which is either shipped or received at a U.S. harbor.

2/ Without lock twinning, for the normal season, it is estimated the Great Lakes-St. Lawrence Seaway System will reach capacity in the year 1990. With season extension, lock capacity problems are expected to be delayed until the year 2000. No traffic is shown above the point of capacity.

3/ Tonnage figures for 1977 and 1980 only reflect navigation season extension on the upper four Great Lakes. They do not reflect any season extension on the St. Lawrence Seaway, since the period from 1977 to 1990 is considered one of research and development to achieve significant season extension on the Seaway. By 1990 traffic will be extended on the Seaway to 31 January and 28 February.

4/ Reflects year-round season extension on the upper four Great Lakes only. For purposes of this analysis it was assumed that season extension beyond 28 February on the St. Lawrence Seaway would require twinning of the Welland and St. Lawrence River locks to permit lock maintenance.

5/ General cargo traffic affected by season extension includes prime containerized foods, chemicals, and fabricated metal products; potentially containerized food, chemicals, iron and steel products, electrical machinery and equipment, machinery except electrical, and motor vehicles and parts.

estimated the Welland Canal and Sault Ste. Marie locks reaching capacity sometime during the 1990's. An extension of the navigation season increases the capacity of lock facilities through utilization during the previously idle winter periods. With season extension, capacity problems at critical locks in the Great Lakes-St. Lawrence Seaway are not expected to occur until around the year 2000. Traffic above the point of capacity for the normal season, as well as for each of the alternative increments of season extension, was not included in Table 2, nor was it included in the benefit derivations shown in Table 3.

Phasing of the lock maintenance program at the Soo Locks at Sault Ste. Marie, Michigan/Ontario to permit year-round navigation on the upper four Great Lakes is currently considered feasible. The St. Lawrence Seaway Development Corporation of the U.S. and the St. Lawrence Seaway Authority of Canada are currently investigating the possibilities of phasing their lock maintenance programs on the Welland Canal and the St. Lawrence River over the entire year, rather than performing maintenance all at once during the winter, which is the current mode of operation. If the U.S. and Canadian Governments are able to develop such a lock maintenance program, year-round season extension on the entire Great Lakes-St. Lawrence Seaway System would be feasible without lock twinning. However, for purposes of this analysis it was assumed that season extension beyond 28 February on the St. Lawrence Seaway would require twinning of the Welland and St. Lawrence River locks to permit lock maintenance. Therefore, it was assumed in the traffic projections shown in Table 2 that year-round season extension is currently limited to the upper four Great Lakes only.

The resulting benefits accruing to the U.S. from the traffic projections shown in Table 2 are estimated benefits based strictly on freight and stockpiling savings to the U.S. consumer/shipper. These benefits do not address the total direct or indirect national benefit derived by the U.S. and Canada from the existence of such traffic. The various commodities that are sensitive to navigation season extension are discussed in the following paragraphs:

a. Iron Ore. For mills in the Great Lakes hinterland area, the major U.S. sources of iron ore are the northern Minnesota, Michigan and Wisconsin areas. The consumption areas for these ores are concentrated on the southern shores of Lakes Michigan and Erie, and inland mills in Ohio and western Pennsylvania. Remaining iron ore requirements in the Great Lakes area are met by Canadian ore moving to mills in the eastern reaches of the lower lakes. Because of the compelling economic advantages of the Great Lakes route (including stockpiling cost) virtually all annual ore requirements for these origins-destinations move on the lakes in the season available. It is estimated that a year-round shipping season on the lakes would attract only 2 or 3% additional potential tonnage. This additional potential tonnage is typically tonnage that is railed on an emergency basis during the winter months, perhaps because first quarter steel production exceeds plans, or because storage of normal season vessel capacity is limited. This tonnage, if attracted to the Great Lakes System, would represent diversions from the rail mode. While navigation season extension would have a minimal impact in terms of attracting additional Great Lakes-St. Lawrence Seaway iron ore traffic, it would have a significant effect upon existing stockpiling patterns and domestic fleet size and mix. With the availability of a reliable winter supply, iron ore shipments would be redistributed over the entire 12-month season. This would greatly reduce stockpiling necessary to meet winter needs, as well as lower annual freight rates because of the more efficient utilization of the Great Lakes fleet.

b. Coal. The principal metalurgical coal producing regions are in the Ohio and Tennesse River Valleys. The majority of coal now moving on the lakes is for steaming purposes, moving to high-volume utility users with shore-side facilities. In general, a 12-month supply moves in the season available, with major stockpiles accumulated for the winter months. However, some utilities with older, smaller shore-side plants (primarily along the western shores of Lakes Michigan and Huron) have difficulty in obtaining and handling a complete winter stockpile and, consequently, must rail a limited amount of coal. Season extension would divert this tonnage from the rail mode, but the percentage tonnage increase relative to current total coal lakes shipments is minimal (about 5% for year-round). However, as was the case with iron ore, season extension would exert a substantial effect upon coal stockpiling patterns and domestic fleet utilization.

c. Grain. U.S. and Canadian cash grains are currently moving through the Great Lakes hinterland in a variety of ways. Canadian grains are consolidated at Thunder Bay on Lake Superior for shipment to eastern Canadian metropolitan areas and for export. Most of this grain tonnage is now shipped to eastern Canadian ports by lakers. Less than 5% of eastbound Canadian grains move by rail east of Thunder Bay. Grains produced in the U.S. grain belt that are appropriate for movement on the lakes are primarily export in nature. During the last 4 to 5 years, U.S. Great Lakes-St. Lawrence Seaway grain exports have been a tertiary route relative to (1) river barge to the Gulf of Mexico and (2) rail to Houston, Galveston, Norfolk, Baltimore, Philadelphia and other U.S. ports. These alternative routes have been more attractive than the Great Lakes-St. Lawrence Seaway because of relative increases in shipping costs on the lakes. Potential Great Lakes-St. Lawrence grain tonnage increases attributable to season extension are believed to be limited. The additional potential would come at the expense of some winter rail moves such as soybeans from Toledo to Norfolk and late harvested wheat from the upper Midwest to Houston, In summary, based on the additional shipping time made available with season extension, A. T. Kearney estimates that an additional 15 to 20 percent of the grains moving through the GL/SLS hinterland area would be made available to interact with rate and service factors in the route-split model if the Seaway were open for at least 11 1/2 months. It should be noted that this potential grain traffic could increase further with future tuning of the route-split model and further review of A. T. Kearney's base year grain flows.

d. General Cargo. The hypothesis that a year-round navigation season is a necessary condition for the Great Lakes-St. Lawrence Seaway to register significant gains in U.S. overseas general cargo trade was supported by A. T. Kearney's shipper preference interviews. The current lack of a full season is a liability to both liner operators and shippers: the carrier because of the need to find alternate winter trades for Great Lakes-fitted vessels; the shipper because of service discontinuity. There is considerable evidence to suggest that some general cargo shippers will pay a premium for service continuity to avoid having to find alternate routes for the winter months. It is estimated that the Great Lakes could attract an additional 30 percent of the total annual flow of prime containerized food, chemicals, and frabricated metal products if season extension is to at least 11 1/2 months. As far as imported iron and steel products are concerned, most foreign steel shippers indicate that all but about 10 percent of the annual Great Lakes area requirements are already shipped via the St. Lawrence Seaway. Therefore, the additional imported steel tonnage available with season extension is minimal. However, substantial stockpiling savings are applicable to this commodity. In many cases customers of imported steel products take delivery of a twelve-month supply during the eight-month seaway season. The service benefit of a season extension for shippers of capital equipment, consumer durables, and vehicles will be significant if the extension is to at least 11 1/2 months. The effect of such an extension would be to increase these commodities' potential tonnage available to the Great Lakes 100 percent. Season extension would do little to increase shipments of cargo not susceptible to containers, such as chemical fertilizers and pig iron.

Winter Rate Study

The purpose of the Winter Rate Study for the Great Lakes-St. Lawrence Seaway, conducted by Arctec, Inc., was to estimate the total transit time for ships navigating a technically feasible Great Lakes-St. Lawrence Seaway System (GL-SLS System) during the winter season and translate these total transit times into vessel operating costs and the associated required freight rates for the major commodity routes. For inland bulk cargo routes, annual required freight rates with season extension decreased for all routes and all commodities for the 1975 fleet and normal winter, with the greatest reduction (over 11%) occurring for all-year shipping of iron ore from Escanaba to Indiana Harbor. Whereas for inland bulk cargo routes the annual required freight rates decreased with season extension, the rate increased for overseas grain and general cargo routes with a maximum increase of seven percent for all-year shipping of grain and a three percent rise for all-year shipping of general cargo. As the fleet mix tends to larger, more powerful and economical ships, the required freight rates decrease even more for inland bulk cargo routes and increase less for overseas routes.

Shippers of bulk commodities would enjoy a savings in the annual cost of moving bulk commodities from an extension of the navigation season because the extra variable costs are more than offset by year-round use of the capital invested in vessels. However, annual required freight rates for overseas cargo increase with season extension because overseas vessels are assumed to have alternative employments during the winter. The users of the Great Lakes navigation season in the winter will optimize their shipment plans to obtain the lowest overall transportation costs. Therefore, all overseas shippers with negative savings on an annual basis because of higher annual rates associated with Great Lakes winter overseas movements will not use shipping lines that operate during the winter, but continue to use the Great Lakes during the normal season and the least cost alternative during the winter. It should be noted, however, that winter navigation will open additional operational options to overseas cargo shippers that would be subject to a laker annual required freight rate and not an overseas vessel annual required freight rate. These options include: 1) shifts in grain trade from direct overseas movements to laker movements on the St. Lawrence River and then transshipped overseas, and 2) general cargo laker feeder operations.

SUMMARY OF BENEFIT CALCULATION METHODOLOGY

The season-extension sensitive traffic is either redistributed from the normal season or diverted from an alternative mode. Stockpiling savings accrue to the tonnage that is redistributed (based on year-round production patterns) from the normal season. This tonnage was separated from the transportation savings tonnage and, accordingly, stockpiling benefits were calculated separately. The derivation of stockpiling benefits and transportation benefits are discussed in the following paragraphs.

Stockpiling Benefits

The extended navigation season is expected to materially change the annual stockpile pattern. A baseline safety stockpile is expected to remain at both the raw material source, the iron mines and pellet plants, as well as at the consumption point, the steel mills. At the pellet plants, the stockpile reaches a peak in April and is worked off gradually as shipments exceed production.

Pellets are produced on a year-round basis, while shipping is curtailed during the winter. At the steel mills the stockpile reaches a peak in December and is consumed (except for safety reserve of 60-day supply) until normal navigation resumes.

Capital cost occurs at both the Upper Lakes pellet plants producing ore throughout the closed winter navigation season, and also at the steel mills which are forced to gradually build up a stockpile to enable steel production throughout the winter when the Great Lakes are closed to navigation. Land is also required for the ground storage at both the pellet plants and steel mills. This real estate could be used for other purposes, particularly expansion at the older, congested steel mills on the lakes. Handling charges were claimed as a benefit only on inland shipments which require an extra loading or unloading unlike lakefront mills. The stockpiling savings were applied to most of the winter traffic of Upper Lakes ores. (The least costly alternative to shipping iron ore in the extended season is to stockpile and ship during the normal season.) For that traffic stockpiled, the shipper savings will include savings in interest costs, real estate rentals, and handling. A transportation savings, water vs. all rail, was applied to only a million tons now moving during the winter on unit trains, which is 1.3 percent of total iron ore shipments. In 1974, the Duluth Mesabi and Iron Range Railway Company shipped either directly or with connections of other railroads, 1.4 million tons to the steel producing centers in Illinois (0.4 million tons), Indiana (0.7 million tons), and Pennsylvania (0.3 million tons). The winter navigation program can replace some of these shipments, and shippers would save the differential in rail-laker shipment vs. all rail to the consuming center.

Transportation Benefits

The tonnage that is diverted from alternative modes with navigation season extension was compared to a logistics price file of Great Lakes transportation rates and least-cost alternative mode rates. The result was the transportation savings associated with season extension without the adjustment for winter rates. As discussed in the Winter Rate Study Section, winter navigation lowers the annual required freight rate for inland bulk cargo movements through more efficient capital utilization of the Great Lakes fleet. Normal season rates for the affected bulk commodity movements were adjusted to account for this winter rate effect.

The stockpiling and transportation savings associated with navigation season extension are summarized in Table 3.

ECONOMIC JUSTIFICATION

Table 4 shows a summary of the estimated benefits, the estimated costs and the ratio of benefits to costs for the three alternative proposals for navigation season extension on the entire Great Lakes-St. Lawrence Seaway System. These estimated benefits and costs will be continually updated throughout the course of the study as more refined information becomes available.

As can be evidenced from this table, all three alternative proposals are economically justified, with year-round season extension having the highest B/C ratio (5.9). However, as mentioned earlier, for purposes of this analysis it was assumed that year-round season extension would be limited to the upper four Great Lakes until such time as the Welland and St. Lawrence River locks are twinned to permit traffic during lock maintenance. The effect of lock twinning on navigation season extension is discussed in the following section of this appendix.

SENSITIVITY OF NAVIGATION SEASON EXTENSION TO LOCK TWINNING

Traffic and Benefits

In the preceding analysis, it was assumed that year-round season extension would be limited to the upper Great Lakes

TABLE 3

TOTAL BENEFITS TO GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM FROM NAVIGATION SEASON EXTENSION
WITHOUT LOCK TWINNING 1/
1977 AND 1980-2030

31 JANUARY	1977 2/	1980 2/	1990	2000	2010	2030
TONNAGE DIVERTED FROM ALTERNATIVE MODE (1,000 TONS)	1,950	2,200	5,800	7,800	7,800	7,800
NORMAL SEASON TONNAGE AFFECTED BY WINTER RATE SAVINGS (1,000 TONS)	36,970	39,884	73,928	94,437	94,437	94,437
TOTAL TRANSPORTATION BENEFITS ($1,000)	$15,000	$16,000	$38,800	$50,400	50,400	50,400
TONNAGE RELATED TO STOCKPILING SAVINGS (1,000 TONS)	9,132	9,765	12,972	16,037	16,037	16,037
TOTAL STOCKPILING BENEFITS ($1,000)	$23,884	$25,913	$39,062	$51,654	$51,654	$51,654
(CAPITAL)	($14,946)	($16,419)	($27,034)	($37,201)	($37,201)	($37,201
(REAL ESTATE)	($3,375)	($3,626)	($4,743)	($5,802)	($5,802)	($5,802
(HANDLING)	($5,563)	($5,868)	($7,285)	($8,651)	($8,651)	($8,651
GRAND TOTAL BENEFITS ($1,000)	$38,884	$41,913	$77,862	$102,054	$102,054	$102,054
28 FEBRUARY						
TONNAGE DIVERTED FROM ALTERNATIVE MODE ($1,000 TONS)	2,100	2,400	8,000	10,800	10,800	10,800
NORMAL SEASON TONNAGE AFFECTED BY WINTER RATE SAVINGS (1,000 TONS)	64,879	70,021	131,405	168,265	168,265	168,265
TOTAL TRANSPORTATION BENEFITS ($1,000)	$25,000	$27,000	$114,800	$161,000	161,000	161,000
TONNAGE RELATED TO STOCKPILING SAVINGS (1,000 TONS)	14,572	15,558	20,593	25,404	25,404	25,404
TOTAL STOCKPILING BENEFITS ($1,000)	$38,741	$42,058	$63,569	$84,164	$84,164	$84,164
(CAPITAL)	($25,781)	($28,274)	($46,053)	($63,080)	($63,080)	($63,080)
(REAL ESTATE)	($5,938)	($6,375)	($8,318)	($10,161)	($10,161)	($10,161)
(HANDLING)	($7,027)	($7,409)	($9,198)	($10,923)	($10,923)	($10,923)
GRAND TOTAL BENEFITS ($1,000)	$63,741	$69,058	$178,369	$245,164	$245,164	$245,164
YEAR-ROUND 3/						
TONNAGE DIVERTED FROM ALTERNATIVE MODE (1,000 TONS)	2,850	3,400	8,900	11,900	11,900	11,900
NORMAL SEASON TONNAGE AFFECTED BY WINTER RATE SAVINGS (1,000 TONS)	77,000	94,200	164,300	208,000	208,000	208,000
TOTAL TRANSPORTATION BENEFITS ($1,000)	28,000	$30,500	$119,000	166,700	166,700	166,700
TONNAGE RELATED TO STOCKPILING SAVINGS (1,000 TONS)	17,500	20,700	27,200	33,290	33,290	33,290
TOTAL STOCKPILING BENEFITS ($1,000)	$47,200	$57,300	$83,100	$107,600	$107,600	$107,600
(CAPITAL)	($29,200)	($36,500)	($56,600)	($75,000)	($75,000)	($75,000)
(REAL ESTATE	($7,600)	($9,000)	($11,650)	($14,000)	($14,000)	($14,000)
(HANDLING)	($10,400)	($11,800)	($14,850)	($18,000)	($18,000)	($18,000)
GRAND TOTAL BENEFITS ($1,000)	$75,200	$87,800	$202,700	$274,300	274,300	274,300

1/ Without lock twinning, for the normal season, it is estimated the Great Lakes-St. Lawrence Seaway System will reach capacity in the year 1990. With season extension, lock capacity problems are expected to be delayed until the year 2000. No traffic or benefits are claimed above the point of capacity.
2/ Benefit figures for 1977 and 1980 only reflect navigation season extension on the upper four Great Lakes. They do not reflect any season extension on the St. Lawrence Seaway, since the period from 1977 to 1990 is considered one of research and development to achieve significant *season extension on the Seaway. By 1990 traffic will be extended on the Seaway to 31 January and 28 February.*
3/ Reflects year-round season extension on the upper four Great Lakes only. For purposes of this analysis it was assumed that season extension beyond 28 February on the St. Lawrence Seaway would require twinning of the Welland and the St. Lawrence River locks to permit lock maintenance.

TABLE 4

GREAT LAKES - ST. LAWRENCE SEAWAY SYSTEM

TOTAL AND AVERAGE ANNUAL BENEFITS AND COSTS

OF NAVIGATION SEASON EXTENSION

WITHOUT LOCK TWINNING

(in $1,000)

	Season Extension to: 31 January	28 February	Year-Round 1/
BENEFITS			
Total Benefits			
1980	$41,913	$69,058	$87,800
2030	$102,054	$245,164	$274,300
Average Annual Benefits (@6-1/8%)	$78,100	$176,300	$200,900
COSTS			
Total Investment Costs	$264,838	$329,523	$329,542
Average Annual Costs (@6-1/8%)			
Interest & Amortization	$17,098	$21,274	$21,275
Operations & Maintenance	6,349	9,492	12,533
Total	$23,447	$30,766	$33,808
BENEFIT/COST RATIO	3.3	5.7	5.9

1/ Reflects year-round season extension on the upper four Great Lakes only. For purposes of this analysis it was assumed that season extension beyond 28 February on the St. Lawrence Seaway would require twinning of the Welland and St. Lawrence River locks to permit lock maintenance.

until the year 2000, when it is estimated the Welland and St. Lawrence River locks will be twinned in response to capacity constraints. In addition, it is estimated that the Poe Lock at Sault Ste. Marie will reach capacity shortly after the St. Lawrence River locks and will also be twinned. As a result of these lock twinnings, there would be additional traffic and benefits associated with season extension (for the period 2000-2030), as shown in Tables 5 and 6, respectively.

Costs

Because twinning of these locks does result in additional extended season benefits, a portion of the lock twinning costs has been attributed to the extended navigation season program, as shown in Table 7. Based on the ratio of extended season traffic to normal season traffic (including that traffic which would be redistributed from the normal season to the extended season as a result of stockpiling savings), it was estimated that 9%, 15% and 24% of total lock twinning costs would be attributable to navigation season extension to 31 January, 28 February and year-round, respectively. In addition, in deriving lock twinning costs, it was assumed that United States costs would comprise only 50% of the total cost of twinning the locks on the Welland Canal and St. Lawrence River. (It should be noted that this is an initial assumption and is not based on any negotiations between the American and Canadian Governments.)

Economic Justification

Table 8 summarizes the estimated benefits and costs of navigation season extension with twinning of the Poe Lock, the Welland Canal locks, and the St. Lawrence River locks. As can be evidenced from this table, the B/C ratios for all three alternative periods of season extension are higher with lock twinning than without lock twinning (Table 4).

TABLE 5
GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM TRAFFIC
FOR NORMAL SEASON AND EXTENDED SEASON PERIODS 1/
WITH LOCK TWINNING 2/
1977 AND 1980 - 2030
(1,000 TONS)

U.S. TRAFFIC

NORMAL SEASON	1977[3]	1980[3]	1990	2000	2010	2030
IRON ORE	79,000	83,300	102,500	119,800	142,200	194,000
COAL	15,000	15,900	20,150	23,000	26,100	30,550
GRAIN	13,900	14,800	18,050	23,000	29,000	41,000
GENERAL CARGO[5]	10,000	12,000	26,000	38,000	59,000	134,000
TOTAL	117,900	126,000	166,700	203,800	256,300	399,550
31 JANUARY	**1977**	**1980**	**1990**	**2000**	**2010**	**2030**
IRON ORE	80,000	84,300	103,500	121,000	143,600	196,000
COAL	15,900	16,300	20,500	23,500	26,600	31,200
GRAIN	13,950	15,500	19,900	25,300	31,900	45,100
GENERAL CARGO[5]	10,000	12,100	28,600	41,800	64,900	147,400
TOTAL	119,850	128,200	172,500	211,600	267,000	419,700
28 FEBRUARY	**1977**	**1980**	**1990**	**2000**	**2010**	**2030**
IRON ORE	80,000	84,300	103,500	121,000	143,600	196,000
COAL	16,000	16,500	20,900	23,900	27,200	31,800
GRAIN	14,000	15,500	20,400	26,000	32,800	46,350
GENERAL CARGO[5]	10,000	12,100	29,900	43,700	67,850	154,100
TOTAL	120,000	128,400	174,700	214,600	271,450	428,250
YEAR-ROUND[4]	**1977**	**1980**	**1990**	**2000**	**2010**	**2030**
IRON ORE	80,700	85,300	104,300	122,200	145,050	197,900
COAL	16,050	16,500	21,000	24,150	27,450	32,100
GRAIN	14,000	15,500	20,400	26,450	33,350	47,150
GENERAL CARGO[5]	10,000	12,100	29,900	47,500	73,750	167,500
TOTAL	120,750	129,400	175,600	220,300	279,600	444,650

1/ The traffic base was defined as including only that traffic which moved through the Soo Locks or St. Lawrence Seaway after 15 December. Traffic resulting from current normal winter operations (such as intra-lake movements of petroleum and other commodities, and non-ice restricted inter-lake traffic) was excluded from the analysis. Likewise, traffic not suited for winter navigation (such as limestone) was excluded. The traffic projections include only traffic which is either shipped or received at a U.S. Harbor.

2/ Tonnage figures shown in this table are based on the assumption that twinning of the Poe Lock, the Welland Canal locks and the St. Lawrence River locks will occur in the year 2000 in response to capacity constraints.

3/ Tonnage figures for 1977 and 1980 only reflect navigation season extension on the upper four Great Lakes, They do not reflect any season extension on the St. Lawrence Seaway, since the period from 1977 to 1990 is considered one of research and development to achieve significant season extension on the Seaway. By 1990 traffic will be extended on the Seaway to 31 January and 28 February.

4/ Reflects year-round season extension on the upper four Great Lakes only until the year 2000, when it is estimated the Welland and St. Lawrence River locks will be twinned in response to capacity constraints.

5/ General cargo traffic affected by season extension includes prime containerized foods, chemicals, and fabricated metal products; potentially containerized food, chemicals, iron and steel products, electrical machinery and equipment, machinery except electrical, and motor vehicles and parts.

TABLE 6

TOTAL BENEFITS TO GREAT LAKES - ST. LAWRENCE SEAWAY SYSTEM FROM NAVIGATION SEASON EXTENSION
WITH LOCK TWINNING 1/
1977 AND 1980 - 2030

31 JANUARY	1977 2/	1980 2/	1990	2000	2010	2030
TONNAGE DIVERTED FROM ALTERNATIVE MODE (1,000 TONS)	1,950	2,200	5,800	7,800	10,700	20,150
NORMAL SEASON TONNAGE AFFECTED BY WINTER RATE SAVINGS (1,000 TONS)	36,970	39,884	73,928	94,437	122,502	208,000
TOTAL TRANSPORTATION BENEFITS ($1,000)	$15,000	$16,000	$38,800	$50,400	$68,800	$129,300
TONNAGE RELATED TO STOCKPILING SAVINGS (1,000 TONS)	9,132	9,765	12,972	16,037	19,900	30,000
TOTAL STOCKPILING BENEFITS ($1,000)	$23,884	$25,913	$39,062	$51,654	$69,000	$116,000
(CAPITAL)	($14,946)	($16,419)	($27,034)	($37,201)	($51,000)	($89,000)
(REAL ESTATE)	($3,375)	($3,626)	($4,743)	($5,802)	($7,000)	($11,000)
(HANDLING)	($5,563)	($5,868)	($7,285)	($8,651)	($11,000)	($16,000)
GRAND TOTAL BENEFITS ($1,000)	$38,884	$41,913	$77,862	$102,054	$137,800	$245,300
28 FEBRUARY						
TONNAGE DIVERTED FROM ALTERNATIVE MODE ($1,000 TONS)	2,100	2,400	8,000	10,800	15,150	28,700
NORMAL SEASON TONNAGE AFFECTED BY WINTER RATE SAVINGS (1,000 TONS)	64,879	70,021	131,405	168,265	218,800	372,000
TOTAL TRANSPORTATION BENEFITS ($1,000)	$25,000	$27,000	$114,800	$161,000	$231,000	$466,000
TONNAGE RELATED TO STOCKPILING SAVINGS (1,000 TONS)	14,572	15,558	20,593	25,404	31,600	47,700
TOTAL STOCKPILING BENEFITS ($1,000)	$38,741	$42,058	$63,569	$84,164	$116,000	$190,000
(CAPITAL)	($25,781)	($28,274)	($46,053)	($63,080)	($87,000)	($146,000)
(REAL ESTATE)	($5,938)	($6,375)	($8,318)	($10,161)	($15,000)	($23,000)
(HANDLING)	($7,027)	($7,409)	($9,198)	($10,923)	($14,000)	($21,000)
GRAND TOTAL BENEFITS ($1,000)	$63,741	$69,058	$178,369	$245,164	$347,000	$656,000
YEAR-ROUND 3/						
TONNAGE DIVERTED FROM ALTERNATIVE MODE (1,000 TONS)	2,850	3,400	8,900	16,500	23,300	45,100
NORMAL SEASON TONNAGE AFFECTED BY WINTER RATE SAVINGS (1,000 TONS)	77,000	94,200	164,300	244,799	318,815	520,000
TOTAL TRANSPORTATION BENEFITS ($1,000)	28,000	30,500	$119,000	$350,000	$500,000	$1,040,000
TONNAGE RELATED TO STOCKPILING SAVINGS (1,000 TONS)	17,500	20,700	27,200	37,395	46,842	58,500
TOTAL STOCKPILING BENEFITS ($1,000)	$47,200	$57,300	$83,100	$148,976	$201,930	$250,000
(CAPITAL)	($29,200)	($36,500)	($56,600)	($112,467)	($157,648)	($200,000)
(REAL ESTATE)	($7,600)	($9,000)	($11,650)	($16,612)	($20,545)	($23,000)
(HANDLING)	($10,400)	($11,800)	($14,850)	($19,897)	($23,737)	($27,000)
GRAND TOTAL BENEFITS ($1,000)	$75,200	$87,800	$202,700	$498,976	$701,930	$1,290,000

1/ Benefit figures shown in this table are based on the assumption that twinning of the Poe Lock, the Welland Canal locks and the St. Lawrence River locks will occur in the year 2000 in response to capacity constraints.

2/ Benefit figures for 1977 and 1980 only reflect navigation season extension on the upper four Great Lakes. They do not reflect any season extension on the St. Lawrence Seaway, since the period from 1977 to 1990 is considered one of research and development to achieve significant season extension on the Seaway. By 1990 traffic will be extended on the Seaway to 31 January and 28 February.

3/ Reflects year-round season extension on the upper four Great Lakes only until the year 2000, when it is estimated the Welland and St. Lawrence River locks will be twinned in response to capacity constraints.

TABLE 7

GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM
TOTAL ANNUAL COSTS OF NAVIGATION SEASON EXTENSION 1/
AT 6-1/8% INTEREST RATE
(WITH LOCK TWINNING)

IMPROVEMENTS	Season Extension To: 31 January	28 February	Year-Round 2/
Ice Breaking Assistance	62,513,100	93,575,500	93,575,500
Ice Control Devices	15,683,400	38,666,800	38,666,800
Navigation Aids	1,885,100	1,896,700	1,896,700
Precise Navigation System	3,650,100	3,650,100	3,650,100
Air Bubbler Systems	6,611,400	6,611,400	6,611,400
Lock Modifications	41,722,100 3/	56,242,300 3/	78,022,800 3/
Dredging	119,716,000	119,716,000	119,716,000
Mooring Improvements	428,300	629,000	629,000
Ice Navigation Center Services	306,400	306,400	306,400
Aerial Reconnaissance	8,516,800	17,033,600	17,033,600
Automated Vessel Reporting System	314,600	314,600	314,600
Water Level Gauges	175,300	175,300	175,300
Assistance to Ferry Transportation	90,800	99,100	117,400
Power Plant Protection	191,300	191,300	191,300
Shore Erosion and Shore Structure Protection	1,381,600	1,381,600	1,381,600
TOTAL FIRST COSTS:	263,186,300	340,489,700	362,288,500
INTEREST DURING CONSTRUCTION:	35,244,500	40,259,800	44,929,000
TOTAL INVESTMENT COSTS:	298,430,800	380,747,500	407,217,500
ANNUAL COSTS: INTEREST	18,278,900	23,320,800	24,942,100
AMORTIZATION	987,800	1,260,300	1,347,900
OPERATION & MAINTENANCE	6,473,100	9,716,800	13,022,400
TOTAL ANNUAL COSTS	25,739,800	34,297,900	39,312,400

1/ Costs are for U. S. portion of the Great Lakes-St. Lawrence Seaway System. It is assumed that U.S. costs comprise 50% of the total cost of facilities on the St. Lawrence River.

2/ Reflects year-round season extension on the upper four Great Lakes only until the year 2000, when it is estimated the Welland and St. Lawrence River Locks will be twinned in response to capacity constraints.

3/ Includes that portion of the cost of twinning the St. Lawrence River Locks, the Welland Canal Locks and the Poe Lock which is attributed to the Navigation Season Extension Program (estimated to be 9%, 15% and 24% of total lock twinning costs for season extension to 31 January, 28 February and year-round, respectively) based on the ratio of extended season traffic to normal season traffic.

NOTE: The costs shown on this table are total costs. The share of Federal and non-Federal costs have not been developed.

TABLE 8

GREAT LAKES - ST. LAWRENCE SEAWAY SYSTEM

TOTAL AND AVERAGE ANNUAL BENEFITS AND COSTS

OF NAVIGATION SEASON EXTENSION

WITH LOCK TWINNING

(in $1,000)

	Season Extension to:		
	31 January	28 February	Year-Round 1/
BENEFITS			
Total Benefits			
1980	$41,913	$69,058	$87,800
2030	$245,300	$656,000	$1,290,000
Average Annual Benefits (@6-1/8%)	$90,700	$212,500	$361,100
COSTS			
Total Investment Costs	$298,431	$380,748	$407,218
Average Annual Costs (@6-1/8%)			
Interest & Amortization	$19,267	$24,581	$26,290
Operations & Maintenance	6,473	9,717	13,022
Total	$25,740	$34,298	$39,312
BENEFIT/COST RATIO	3.5	6.2	9.2

1/ Reflects year-round season extension on the upper four Great Lakes only until the year 2000, when it is estimated the Welland and St. Lawrence River locks will be twinned in response to capacity constraints.

ENERGY

It is presently estimated that extension of the navigation season on the Great Lakes-St. Lawrence Seaway will have an additional beneficial result in terms of making maximum use of fuel in transporting the vast volumes of bulk commodities involved. In the normal season, a Great Lakes bulk carrier of the 50,000-ton class will operate in excess of 650 ton-miles per gallon of fuel. This compares to 300 ton-miles per gallon for pipelines, 200 ton-miles per gallon for rail, 58 ton-miles per gallon for trucks, and less than 4 ton-miles per gallon for air transport modes. The average for the oil-burning transport vessels is about 500 ton-miles per gallon of fuel. It should be noted, however, that with winter navigation the estimated ton-miles per gallon for waterborne vessels would be somewhat less due to increased trip time stemming from ice resistance. In addition, certain improvements associated with navigation season extension, such as additional Coast Guard support vessels and operation of air bubblers, will result in increased fuel consumption. Still, overall, preliminary data indicates that the order of magnitude of energy savings associated with winter waterborne movement vs. overland movement is so great as to offset any increased fuel usages associated with extended season operations. The impact of navigation season extension on energy use will be addressed in greater detail in subsequent Interim Reports as more energy data becomes available.

POSSIBLE NEGATIVE BENEFITS

Navigation season extension will divert future expected traffic away from the rail and trucking industries and Eastern and Gulf ports toward the Great Lakes-St. Lawrence Seaway System. This diverted tonnage, with and without twinning of the locks in the system, is shown in Tables 6 and 3, respectively. However, it should be noted that this transport mode shift has no effect on the project's overall B/C ratio, which only addresses net increases or decreases in the nation's overall Gross National Product or efficiency - not regional transfers of income between competing industries and geographic areas. Thus, this project's B/C ratio reflects net increases in transportation savings that accrue to the shipper from the use of the Great Lakes-St. Lawrence Seaway in the winter months vs. the next least cost transport alternative.

Concerns expressed regarding possible negative benefits of season extension on power production along the Great Lakes waterways and winter recreational use of lakes, harbors and channels have not yet been evaluated. They will be addressed in future Interim Reports.

APPENDIX V

ECONOMICS OF PLAN ALTERNATIVES

SUPPLEMENT A

SECONDARY REGIONAL IMPACTS

SUPPLEMENT A TO APPENDIX V

SECONDARY REGIONAL IMPACTS

Great Lakes-St. Lawrence Seaway Navigation Season Extension

Introduction

This supplement summarizes the results of Phase I of a proposed two-phase study, conducted by the Regional Economic Analysis Division (READ), Bureau of Economic Analysis, to evaluate the economic impact of general cargo movements and the further direct, indirect and induced economic effects on the 11-state study area[1/] as a consequence of extending the shipping season on the Great Lakes and the St. Lawrence Seaway. For the first-phase effort during FY 74, READ was to develop (1) a primary-impact, transport-sensitivity model, (2) a secondary economic impact model and (3) preliminary aggregate estimates of the total economic impact on the study area as a whole. These preliminary and aggregate estimates were to be refined and disaggregated during the second phase of the study to be completed in FY 76. In addition, during the latter phase inter-regional effects were to be specified, and transport cost estimates improved to take into consideration the changed relative costs of energy -- and, hopefully, those changes expected to stem from the differential energy intensiveness of freight transport modes -- on industrial location in the Great Lakes area.

1/ The study area is shown on Plate I-2, and it consists of these 11 states (approximately from east to west): Ohio, Michigan, Indiana, Illinois, Wisconsin, Minnesota, Iowa, Nebraska, South Dakota, North Dakota, and Wyoming.

Table 9

Projected Earnings, by State, With and Without the Season-Extension Program

	1980		1990		2000		2020	
	With	W/O	With	W/O	With	W/O	With	W/O
	(thousands of 1967 dollars)							
Ohio	46,216,257	46,131,585	63,590,067	63,486,024	88,363,299	88,232,761	156,650,319	156,452,393
Michigan	39,918,166	39,854,686	55,309,633	55,230,153	77,030,016	76,929,439	135,912,847	135,759,161
Indiana	21,731,973	21,700,683	30,618,059	30,577,374	43,207,083	43,154,014	78,442,375	78,357,520
Illinois	52,276,661	52,186,908	71,461,802	71,349,447	98,752,734	98,609,685	172,965,919	172,744,281
Wisconsin	17,018,980	16,984,421	23,022,686	22,981,262	31,642,209	31,590,854	55,035,450	54,958,601
Minnesota	15,694,615	15,672,549	22,246,856	22,214,846	31,371,479	31,327,277	56,172,804	56,097,383
Iowa	10,124,801	10,110,767	13,423,508	13,404,853	18,104,734	18,080,109	30,730,164	30,690,286
Nebraska	5,368,150	5,366,043	7,202,031	7,198,805	9,822,563	9,817,980	17,032,896	17,024,725
South Dakota	1,959,641	1,959,369	2,525,803	2,525,405	3,324,311	3,323,736	5,505,335	5,504,328
North Dakota	1,764,003	1,763,679	2,235,981	2,235,500	2,907,683	2,907,036	4,748,413	4,747,269
Wyoming	1,152,584	1,152,431	1,492,302	1,492,039	1,972,652	1,972,255	3,303,449	3,302,740
Study Area	213,265,242	212,883,121	293,179,989	292,695,708	406,565,539	405,945,146	716,606,380	715,638,687

Note: With columns do not add due to interregional effects that are indigenous to the study area.

Preliminary estimates of effects associated with general cargo movement

The industries most likely to be comparatively advantaged by extending the shipping season are, for the most part, those with which the study area is already well endowed. Of the more than thirty specific manufacturing industries identified by the primary-impact, transport-sensitivity model as being transport-oriented, three broad manufacturing industries, in particular, stand out as benefiting from the season extension: machinery (excl. electrical), primary metals, and electrical machinery. These plus other manufacturing industries, together with their direct, indirect, and induced effects on income received in the area, are expected to add more than 382 million constant 1967 dollars to labor earnings in the study area by 1980, assuming a 12-month shipping season. This increase in labor earnings rises to almost one billion 1967 dollars by the year 2020. Table 9 shows earnings projections for the study area as a whole and for each of the 11 states over the projected period, 1980-2020, with and without the assumption of an all-year shipping season. In terms of employment, an increase of approximately 42,000 jobs, on the average, can be attributed to the total impact on general cargo movement and its associated increase in industrial production in the study area.

The study area as a whole has been growing at a somewhat slower rate than the Nation in recent history. The season-extension program with respect to general cargo movements would offset part of this relative decline, particularly in manufacturing states in the study area -- Illinois, Ohio, Michigan, Indiana, Wisconsin, and Minnesota. However, even Iowa and, to a lesser extent, Nebraska show significant improvement in their expanding manufacturing bases.

APPENDIX VI

GREAT LAKES-ST. LAWRENCE SEAWAY

TRAFFIC FORECAST STUDY

U.S. ARMY CORPS OF ENGINEERS
NORTH CENTRAL DIVISION

GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC FORECAST STUDY

(Contract No. DACW23-75-C-0052)

SUMMARY REPORT

Prepared by:

A. T. Kearney, Inc.
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February, 1976

GREAT LAKES/ST. LAWRENCE SEAWAY
TRAFFIC FORECAST STUDY

SUMMARY REPORT

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I - INTRODUCTION

The purpose of this report is to summarize the Great Lakes/ St. Lawrence Seaway System (GL/SLS) Traffic Forecast Study conducted by A. T. Kearney, Inc. for the Corps of Engineers. This work effort is in support of the Corps' overall GL/SLS study plan. The study objectives were focused upon the development of analytical aids/data bases for the Corps to utilize in its analyses of alternative improvement programs. Consequently, the report is designed to describe the Kearney research effort, the results of that effort and interpretations relevant to use of the study results. The recommendations contained in this report deal only with the future use of the results of this study.

OBJECTIVES AND SCOPE OF THE STUDY

The primary objectives of this study are four in number:

1. Develop a series of 60 year forecasts of U.S. and Canadian traffic which potentially may flow via the Great Lakes/ St. Lawrence Seaway System. Estimated true origin and destination flows of this traffic were developed.

2. Conduct a survey of shippers and other shipping interests (both current and potential GL/SLS users) to determine their sensitivities to various service and cost factors as related to the determination of transport routings. The survey scope included only cargoes which are currently moving or could potentially be transported via the GL/SLS. (In addition, non-shipper GL/SLS

related parties such as carriers, port authorities, etc. were interviewed.)

3. Develop a comprehensive route split* computer model which utilizes the information developed in items 1 and 2 and which provides the capability of measuring changes in GL/SLS traffic flows under alternative conditions (e.g., navigation season extension).

4. Provide the study documentation required by the Corps for future use of the study results.

OVERVIEW OF STUDY APPROACH

Listed below are the primary study steps:

1. Derived estimates of U.S. and Canadian traffic which might potentially be shipped via the GL/SLS for the period 1980 through 2040. For each ten year interval, low, "most likely" and high forecasts were developed.

2. Conducted a shipper preference survey in order to determine shipper sensitivity to service and cost factors which affect shipper decisions regarding the choice of transportation routings for cargoes which do or could potentially move via the GL/SLS. Subsequent to the completion of this survey, developed quantitative "shipper reaction profiles" as primary inputs to the route split computer model.

* The terms "route split," "modal split," and "mode split" are used interchangeably herein.

3. Utilized Corps-provided rate data to construct a model-compatible logistics price file.

4. Designed, developed, programmed, and tested the route split computer model.

5. Prepared and delivered final report documentation to the Corps in the following forms:

(a) This summary report volume.

(b) A second volume main report which provided the detail necessary to support methods used in the conduct of the study. A copy of the main report table of contents is contained in Appendix A.

(c) A series of technical appendices which described specific forecast methodologies utilized in the development of various commodity forecasts and the results of Kearney's review of available modal choice/route split research literature. A listing of these Appendices is contained in Appendix B.

(d) A computer model user's manual.

(e) Computer tapes containing the route split model programs, files, etc. plus "hard copy" of the program listings.

ROUTE SPLIT MODAL CONCEPTS

Several concepts should be understood regarding the route split model and its development.

1. The model is designed to address the same factors that the shipper uses in his decision-making process regarding transportation routings. To implement this approach, in-depth

interviews were conducted with a carefully selected group of respondent shippers and other relevant organizations in order to develop measurements of these "real world" decision criteria.

2. A high degree of analytical versatility is built into the model in order to maximize its utility. The model is specifically designed to permit rapid response to various types of "what if" questions such as, "What changes in traffic flows will occur if the navigation season on the System were extended by one month from current levels?"

3. The model is designed in modular form in order to simplify updating of data inputs or other types of changes which might be desired in the future.

4. The model inputs were developed on the basis of potential System improvements relative to the alternate mode. The reason for this approach is that the study is focused on the analysis of potential improvement programs for the GL/SLS.

5. The model is designed to focus upon the question of transport routing. The approach employed is static in nature relative to the sourcing locations of various commodity flows. Thus, the model's "starting point" is an estimated true origin-destination <u>total potential</u> traffic forecast,* a portion of which

* The true origin of a shipment is defined as its production location while the true (or ultimate) destination of a shipment is defined as the location of consumption or use. "Total potential" or "potential" traffic are tonnage movements which currently are or potentially could be transported using the GL/SLS (or portions thereof). Only those movements which originate and/or terminate at a point(s) within the Great Lakes area (defined in Section II) were considered in the development of potential traffic projections.

is then allocated to the GL/SLS using the route split model and its inputs.

DATA BASE COMMENTS

The development of the forecast data involved detailed analyses and professional judgment in order to overcome data base deficiencies, commodity coding differences, time period differences between one data base and another, etc. The complexity of the effort may be judged in part by the fact that over 150,000 data entries are contained in the forecast file alone. The unavailability of certain data and the need to develop estimates of true origin-destination flows are factors which should be thoroughly understood by those using the results of this study. Detailed discussion of these factors is contained in the main report and the technical appendices.

The logistics price file, a Corps responsibility, was provided to Kearney in a semi-completed form for use in model development. In this manner, a working base format was provided to facilitate model development while a simultaneous effort was being conducted to develop the extensive rate information required for the logistics price file. The Corps is currently completing the rate information required to provide a complete logistics price file (which is essential for model use).

USE OF THE MODEL

It is important in use of the route split model and its outputs that there exists a clear understanding of the data bases involved and the characteristics of those data bases. In addition, the "what if" types of questions which are addressed through the use of the model need to be carefully analyzed with regard to the reasonability of the analysis conditions. The reasonability of results derived from each model run should also be reviewed. Note also that the model will be further "tuned" after the logistics price file has been completed by the Corps.

THRUST OF THIS PROJECT

Throughout the course of this project there has been a high degree of contact with parties having an interest in the GL/SLS (e.g., shipper survey respondents). Kearney noted that many individuals believed that one of the objectives of this project was to provide recommendations regarding which, if any, GL/SLS improvement programs should be undertaken. The latter belief reflects a misconception regarding the scope of this project. The purpose of this research effort was to provide certain analytical tools/ data bases for the Corps to utilize in its analyses of GL/SLS alternative improvement programs. Thus, the recommendations contained in this report focus only upon future route split model usage and related needs.

II - PROJECTIONS OF POTENTIAL GL/SLS MOVEMENTS

This section provides a summary of the methodology used to develop the traffic flow data base. The methodology was developed specifically to identify the total potential traffic which could be routed through the System and what portion of that total potential is currently routed through the System. The route split model uses the estimated total potential flow forecasts, and splits a portion of that potential (e.g., 0 to 100%) to the GL/SLS route based on service, cost, and institutional factors.

This section is sub-divided into the following major topics:

- Background
- Bulk Commodities Projection Methodology
- Bulk Commodity Projections
- General Cargo Projection Methodology
- General Cargo Projections
- Summary.

BACKGROUND

The choice of a transportation route is a highly specific decision which may include several transloadings, storage and warehousing sub-decisions. Transport data that is publicly available typically do not represent the total movement of the commodity from shipper to receiver. For instance, available rail data show movements from rail origin to rail destination, and waterborne data show only port-to-port movement. If an intermodal transshipment is made, there is no way to trace directly from available data sources that transshipment. This problem may even occur for intramodal transshipments, particularly in the case of grain.

Yet shipper routing decisions are based on true origin to true destination movement of the goods. Total costs and service are considered in the decision. Modal choice decisions are not made in isolation, but are made as a package. That package is the transport of goods to destinations when and where needed. Currently available transport data do not allow this analysis as a package. Consequently Kearney had to develop estimates of true origin destination movements to facilitate modelling GL/SLS related route split decision making.

Thirty-seven commodity groupings were used as the basis for the forecasts. Commodities are grouped into two major categories, bulk and general cargo for purposes of this summary report.

A Great Lakes hinterland was defined in the United States, which included 19 states, and portions of other states immediately surrounding the Great Lakes. U.S. movements which originate and/or terminate within this hinterland area were relevant to this study. Clearly, the opportunity for the GL/SLS to participate in traffic flows to/from hinterland areas can vary significantly from area to area, but it is reasonable to provide a broad geographic definition of the potential market. Origin and destination areas were defined differently depending on location and availability of data. In the United States, origin/destination areas are defined as Bureau of Economic Analysis Regions (BEARs) for all bulk commodities and as states for all general cargo commodities. This hinterland is graphically displayed in the map on the following page.

Ten Canadian regions were defined, eight of which corresponded to various segments of the GL/SLS. Eighteen overseas regions were also defined. These regions correspond to the regions used in earlier studies for the Maritime Administration. Of principal concern for the Great Lakes are the United Kingdom, Northern Europe, Mediterranean Europe, North Africa and Japan.

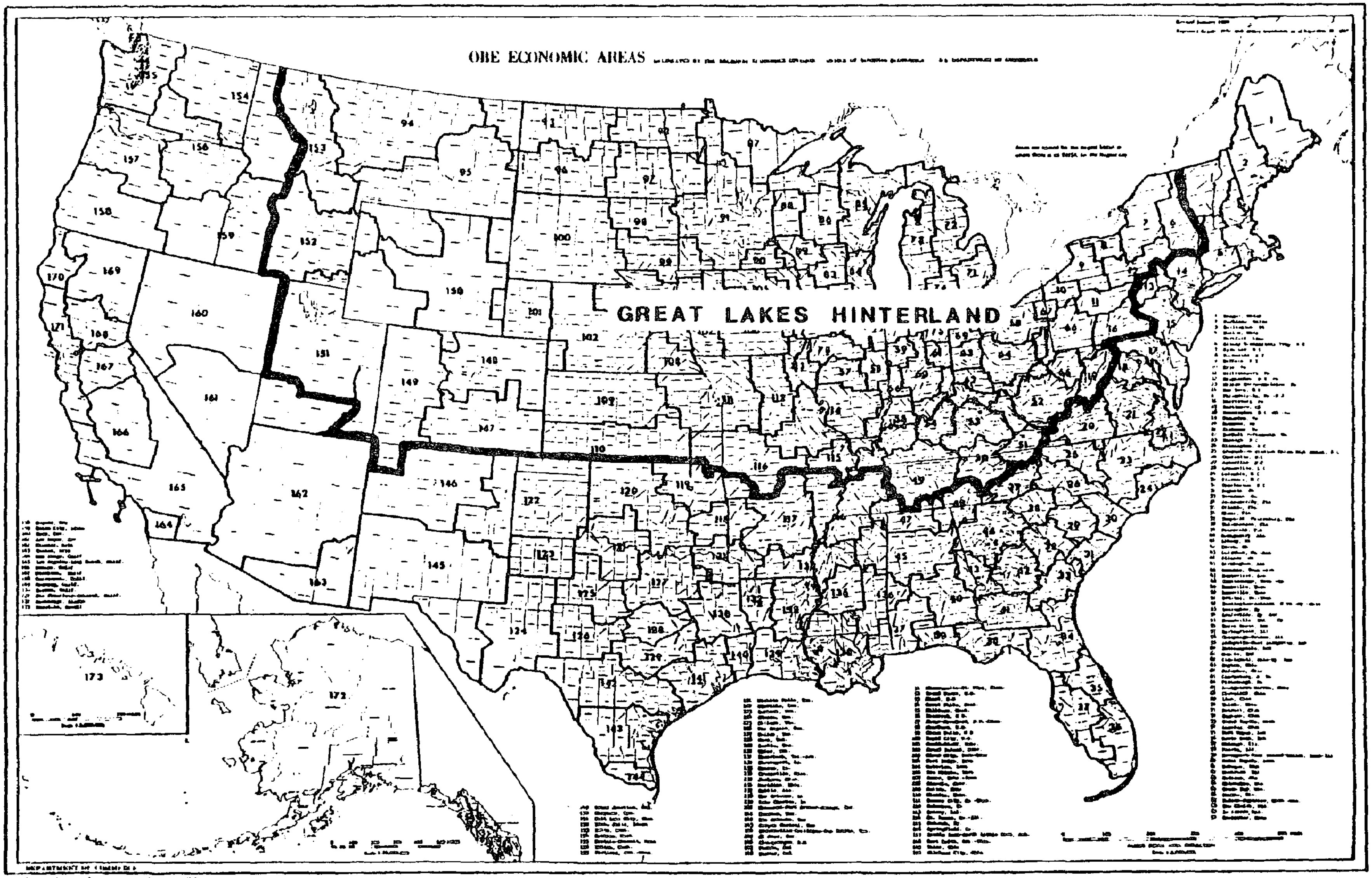
Thus, the term "movement" refers to a relatively detailed origin/destination/commodity flow that could potentially move on the GL/SLS. Approximately 6,000 individual movements potential to the GL/SLS were identified in the course of the study.

BULK COMMODITIES PROTECTION METHODOLOGY

The general methodology used to allocate potential movements to true origin and destination and to project these movements was substantially different for bulk commodities than for general cargo. The general methodology for bulk commodities will be discussed in this subsection. General cargo will be discussed later.

(a) Allocation Procedure

The general allocation procedure used to estimate true



Note: The hinterland area for purposes of general cargo includes only those nineteen states which are contained in their entirety in the area shown on this map.

origins and destinations of bulk movements and to identify potential GL/SLS movements not now on the GL/SLS relied upon the following 1972 transport data:

1. Waterborne movements via the GL/SLS by commodity provided by the Corps of Engineers on a BEAR to BEAR basis.

2. DOT 1% Waybill Sample providing rail movements.

3. Bureau of the Census Foreign Trade Statistics showing U.S. waterborne commerce by port, customs district and world trade area.

4. Canadian Shipping Statistics.

The allocation procedure to develop estimated true origin-destination flows is described in the main report.

The allocation procedures were performed manually. Although this was an arduous task, it ensured the reasonability of the movements contained in the data base. (Previous research studies that have attempted to identify true origin and destination flows using computerized allocation routines have not been successful.) The result of this procedure was a set of commodity movements by origin and destination regions for 1972, the base year of the study. These base year movements show total potential movements (expressed in tons by commodity groups) on the System and the GL/SLS percentage share (i.e., market share).

(b) Projection Procedure

Projections developed in this study were based in large part on existing projections of economic activity published by various agencies. The allocation and projection procedures vary somewhat by commodity. In general, domestic movements were tied closely to the OBERS Series E projections made jointly by the Bureau of Economic Analysis (Commerce) and the Economic Research Service (Agriculture). Growth rates of the demand industry in the destination BEAR were typically used to project growth.

Canadian growth rates were obtained from the Department of Energy, Mines and Resources, the Canadian Transport Commission and others and applied, as appropriate, to the base year movements. Projections of overseas movements (imports and exports) were generally derived from published U.S.D.A., Bureau of Mines and industry sources.

BULK COMMODITY PROJECTIONS

Exhibit II-1 is a summary of the forecasts of total potential movement of bulk commodities. As shown, in 1972, there were slightly over 300 million tons of GL/SLS potential bulk commodities flows. By 2040, this total is expected to increase to 1.2 billion tons. This represents an average annual growth rate of 2.1%.

U.S. domestic movements represent the single largest category of the total potential totalling 175 million tons in 1972 (or slightly less than 60%). This is heavily weighted by the iron ore volume.

In 1972, it is estimated that 75% of the potential tonnage of bulk commodities moved on the GL/SLS. Again this is heavily weighted by iron ore movements which were moved nearly 100% via the System. Also, due to the lack of Canadian rail data, all the estimated Canadian potential is now on the System. Removing these tonnages, it was found that the GL/SLS obtained only 53% of the potential bulk cargo tonnage available to it.

GENERAL CARGO PROJECTION METHODOLOGY

General cargo commodities were projected in an entirely different fashion from bulk commodities. The technique involved projecting total U.S. trade and utilizing an income elasticity approach to determine the mix of that trade by commodity and world trade area. In order to perform this analysis a computerized model was developed. University of Chicago Professor Stephen P. Magee, noted authority in the forecasting of foreign trade, guided and assisted in the development of the methodology and final results obtained.

No projections of U.S. domestic general cargo movements were made. These movements were not included in the data base because they are principally cross-lake rail ferry movements (a service that is expected to be discontinued), and because alternate route capabilities for the movement of domestic general cargo effectively preclude GL/SLS participation. (Approximately 4.5 million tons of U.S. domestic general cargo moved via the GL/SLS in 1972. This volume has subsequently decreased.)

Canadian domestic general cargo movements were based on the few package ships now operating in the Canadian trade. Potential was projected to grow at the rate of growth for the various Canadian industries, as appropriate.

(a) Projection Technique

In order to develop import/export projections of U.S. general cargo commodities potential to the GL/SLS, a total U.S. trade projection was first required. This projection was then allocated by commodity and world trade area based on an income elasticity approach.

Total trade projections were derived from Data Resources, Inc. projections (Summer-1975 Version) of merchandise trade made available to Kearney through the Corps of Engineers. In a separate effort, Kearney developed commodity trade projections based on a study performed for the Maritime Administration in 1973.* This study used an income elasticity approach by world trade area and commodity to project trade.

The income elasticity approach starts from current levels of trade by commodity and area. These Kearney obtained from the Bureau of Census foreign trade statistics. A relationship is then derived between the growth in real income and the tonnage growth

* Synergy, Inc. A Long Run Prediction of United States Seaborne Trade from 1972 to 1992, prepared for the Maritime Administration, Washington, D.C., June, 1973.

in trade by commodity and world trade area. Income herein is measured by real gross national product. This relationship measures the growth in imports from the U.S. (or foreign country) for a given commodity when a growth in income is experienced. The relationship is called an import income elasticity. For example, if the U.K. had an import income elasticity of +2.0 for U.S. manufactured goods, an increase in U.K. real income of 3.0% would result in an increase in U.K. imports from the U.S. of 6.0%. These income elasticities were developed in the study for the Maritime administration.

GNP projections to 2040 by world trade area were then developed from various published sources such as OECD, the U.N., and Herman Kahn at the Hudson Institute. In the final analysis the long-term projections used most closely resemble the estimates made by Herman Kahn while the shorter term (i.e., through 1990) most closely parallel those of Data Resources, Inc.

The elasticities and GNP projections were then applied to base year trade statistics and aggregated with the bulk forecasts to develop the total trade projection. This projection was then normalized against total trade projections adjusted for balance of trade contraints. The latter step is necessary in order to avoid projections which result in unrealistic regional trade imbalances.

(b) Allocation Technique

Once the total trade projections were made for general cargo, the traffic was allocated back to true origin and destination based on a joint agency study, Domestic and International Transportation of U.S. Foreign Trade: 1970. This study was composed of a sample of the true inland origins and destinations of 1970 U.S. foreign trade. Thus it was possible to calculate the share of the total U.S. trade that originated or was destined to each state in the Great Lakes hinterland and to calculate the share from each state that went via the GL/SLS. Allocations of hinterland trade were developed by commodity and world trade area and then applied to total U.S. projections. The results were then added to the data base of the computerized forecast file.

(c) Canadian Projection Technique

Canadian export/import general cargo movements are relatively minor. However, the same projection model was used to develop Canada - overseas trade projections. It was assumed that Canadian-related income elasticities were the same as those for the U.S. It was also assumed that the Canadian Great Lakes area would retain its current share of economic activity in Canada. Projections were thereby developed and incorporated in the forecast file.

GENERAL CARGO PROJECTIONS

The resulting general cargo projected movements that are potential to the GL/SLS are summarized in Exhibit II-2 and the table below.

Table II-2

Potential GL/SLS General Cargo Movements
(millions of short tons)

	U.S. Imports	U.S. Exports	All Other	Total
1972 base	15.0	9.2	5.4	29.6
1980	23.9	18.5	7.7	50.1
1990	63.7	35.9	13.9	113.5
2000	95.1	54.1	21.6	170.8
2010	143.1	94.5	32.7	270.3
2020	213.5	151.1	49.6	414.2
2030	316.8	240.3	75.2	632.3
2040	468.2	380.5	113.5	962.2

Source: A. T. Kearney, Inc.

As shown, U.S. imports of general cargo potential to the GL/SLS are expected to reach 468 million tons by 2040. Exports are expected to reach 380 million tons. These totals represent a 5.2% average annual percentage increase for imports and 5.6% for exports. Overall, the general cargo potential (including Canada) is expected to increase an average of 5.2% annually.

Iron and steel products represent the greatest potential on the import side, and food and kindred products represent the greatest potential on the export side. Other significant potential exists in imports of chemicals and food.

LOW AND HIGH PROJECTIONS

The previous discussion of forecast traffic flows focused only upon Kearney's "most likely" projections. In addition, high and low projection of each potential movement were also developed. These additional projections were provided to permit the Corps to conduct sensitivity analyses, to adjust forecast levels to account for changed assumptions, and to develop specific forecasts which could include a low, and high forecast range. Exhibits II-4 and II-5 provide summaries of the low and high projections.

The foregoing discussion of low and high projections is the only place in the report that these forecasts are described or utilized. All other discussions of forecasts, refer to the "most likely" projections since these are primary to the forecast effort and the ones which are expected to be utilized by the Corps in most instances.

SUMMARY

Total potential movements for all commodities are summarized in Exhibit II-3. Total potential in 1972 was 323 million short tons of which the Great Lakes obtained a 72% market share. This potential is expected to grow at an average annual rate of 2.8% to nearly 2.2 billion tons by 2040. U.S. domestic movements accounted for nearly 55% of the potential in 1972. (In some cases unavailability of competitive mode traffic data results in the understatement of total potential flow and an overstatement of GL/SLS market share.)

A summary by North American versus overseas segmented by bulk versus general cargo is shown in the table below.

Table II-2

Summary of Potential GL/SLS Movements
(millions of short tons)

World Area	Type of Cargo	1972 Tonnage	2040 Tonnage	Average Annual Growth Rate
North America (1)	Bulk	246.6	866.4	1.9%
	General	4.0	78.5	4.5
	Total	250.6	944.9	2.0%
Overseas	Bulk	55.5	343.1	2.7%
	General	25.6	883.7	5.3
	Total	80.1	1,226.8	4.1%
Total (2)	Bulk	302.1	1,209.5	2.1%
	General	29.6	962.2	5.2
	Total	331.7	2,171.7	2.8%

Notes: (1) North America includes U.S. domestic, Canada domestic and U.S./Canada trade.
(2) Totals vary slightly from Exhibits due to rounding.

Source: A. T. Kearney, Inc.

Overseas trade to/from North America is expected to grow at a faster rate than intra-North America movements. This is due principally to faster projected growth rates for foreign areas and the increased importance of general cargo flows.

EXHIBIT II-1

U.S. ARMY CORPS OF ENGINEERS

GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC FORECAST STUDY

MOST LIKELY FORECASTS OF TOTAL BULK COMMODITY MOVEMENTS
(Millions of Short Tons)

Type of Movement	1972 Base Year Potential Tonnage	1972 Base Year Percent GL/SLS	Forecasted Potential Movements 1980	1990	2000	2010	2020	2030	2040	Average Annual Growth Rate 1972-2040
U.S.A. to U.S.A.	175.3	81%	206.1	260.8	318.0	386.5	458.1	531.6	625.5	1.9%
U.S.A. to Canada	24.4	(2)	38.0	44.4	49.5	55.7	61.9	68.3	75.6	1.7
U.S.A. to Overseas	45.9	18	64.3	90.4	138.3	191.6	261.6	311.3	327.9	2.9
Canada to U.S.A.	18.5	(2)	23.9	26.3	31.1	34.6	41.9	49.5	58.6	1.7
Canada to Canada	28.4	(2)	41.8	53.8	67.0	77.0	86.3	96.0	106.7	2.0
Canada to Overseas	1.5	(2)	1.8	2.1	2.5	2.6	2.9	3.1	3.4	1.2
Overseas to U.S.A.	7.1	9	7.1	4.3	4.0	4.5	5.1	5.8	7.2	-
Overseas to Canada	1.0	(2)	1.5	2.1	2.8	3.3	3.7	4.2	4.6	2.3
Total(1)	302.1	75%	384.5	484.2	613.2	755.8	921.5	1,069.8	1,209.5	2.1

Notes: (1) Totals may vary slightly from computer printouts due to rounding.
(2) Due to the unavailability of competitive mode data for this trade route, the forecast file contains movement data only for the GL/SLS. Therefore, estimated 1972 base year GL/SLS market share for this trade route is shown in the file as 100%, although in fact this is not the case. In addition, estimates of potential tonnage are understated since flows via non-GL/SLS routings are not included. Also note that the total GL/SLS estimated 1972 base year market share is overstated and the total potential tonnage flows understated for the same reasons cited above.

Source: A. T. Kearney, Inc.

U.S. ARMY CORPS OF ENGINEERS

GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC FORECAST STUDY

MOST LIKELY FORECASTS OF GENERAL CARGO MOVEMENTS
(Millions of Short Tons)

Type of Movement	1972 Base Year Potential Tonnage	1972 Base Year Percent GL/SLS	Forecasted Potential Movements 1980	1990	2000	2010	2020	2030	2040	Average Annual Growth Rate 1972-2040
U.S.A. to U.S.A.	0	-	-	-	-	-	-	-	-	-
U.S.A. to Canada	0.7	82%	1.1	1.7	2.5	3.8	5.9	9.1	13.9	4.5%
U.S.A. to Overseas	9.2	17	18.5	35.9	54.1	94.5	151.1	240.3	380.5	5.6
Canada to U.S.A.	1.4	35	1.7	3.7	5.5	8.2	12.2	18.2	26.8	4.4
Canada to Canada	1.9	67	2.8	4.5	7.1	10.8	16.4	24.9	37.8	4.5
Canada to Overseas	0.6	(2)	0.9	1.6	2.6	4.0	6.2	9.5	14.6	4.8
Overseas to U.S.A.	15.0	39	23.9	63.7	95.1	143.1	213.5	316.8	468.2	5.2
Overseas to Canada	0.8	(2)	1.2	2.4	3.9	5.9	8.9	13.5	20.4	4.9
Total(1)	29.6	38%	50.1	113.5	170.8	270.3	414.2	632.3	962.2	5.2%

Notes: (1) Totals may vary slightly from computer printouts due to rounding.
(2) Due to the unavailability of competitive mode data for this trade route, the forecast file contains movement data only for the GL/SLS. Therefore, estimated 1972 base year GL/SLS market share for this trade route is shown in the file as 100%, although in fact this is not the case. In addition, estimates of potential tonnage are understated since flows via non-GL/SLS routings are not included. Also note that the total GL/SLS estimated 1972 base year market share is overstated and the total potential tonnage flows understated for the same reasons cited above.

Source: A. T. Kearney, Inc.

EXHIBIT II-2

U.S. ARMY CORPS OF ENGINEERS

GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC FORECAST STUDY

MOST LIKELY FORECASTS OF TOTAL MOVEMENTS
(Millions of Short Tons)

Type of Movement	1972 Base Year Potential Tonnage	1972 Base Year Percent GL/SLS	Forecasted Potential Movements 1980	1990	2000	2010	2020	2030	2040	Average Annual Growth Rate 1972-2040
U.S.A. to U.S.A.	175.3	81%	206.1	260.8	318.0	386.5	458.1	531.6	625.5	1.9%
U.S.A. to Canada	25.2	(2)	39.0	45.9	51.6	59.6	67.7	76.9	89.3	1.9
U.S.A. to Overseas	54.6	18	81.6	123.5	197.3	295.5	401.7	544.5	678.6	3.8
Canada to U.S.A.	20.0	(2)	25.5	29.9	36.5	43.0	54.1	67.9	85.9	2.2
Canada to Canada	30.2	(2)	44.5	58.4	73.8	87.5	103.2	120.6	144.2	2.3
Canada to Overseas	2.1	(2)	2.7	3.7	5.0	6.6	9.0	12.7	18.0	3.2
Overseas to U.S.A.	21.7	30	31.1	67.7	100.5	150.0	222.2	327.5	481.3	4.7
Overseas to Canada	1.8	(2)	2.6	4.5	6.7	9.2	12.6	17.6	25.0	3.9
Total (1)	323.5	72%	425.7	591.4	778.8	1,022.5	1,318.6	1,683.7	2,168.7	2.8%

Notes: (1) Totals may vary slightly from computer printouts due to rounding.
(2) Due to the unavailability of competitive mode data for this trade route, the forecast file contains movement data only for the GL/SLS. Therefore, estimated 1972 base year GL/SLS market share for this trade route is shown in the file as 100%, although in fact this is not the case. In addition, estimates of potential tonnage are understated since flows via non-GL/SLS routings are not included. Also note that the total GL/SLS estimated 1972 base year market share is overstated and the total potential tonnage flows understated for the same reasons cited above.

Source: A. T. Kearney, Inc.

U.S. ARMY CORPS OF ENGINEERS

GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC FORECAST STUDY

LOW FORECASTS OF TOTAL MOVEMENTS
(Millions of Short Tons)

Type of Movement	Potential Tonnage	Percent GL/SLS	Forecasted Potential Movements							Average Annual Growth Rate 1972-2040
			1980	1990	2000	2010	2020	2030	2040	
U.S.A. to U.S.A.	175.3	81%	190.9	223.6	256.3	288.8	326.6	369.7	401.8	1.2%
U.S.A. to Canada	25.2	(2)	32.3	38.7	43.1	49.5	56.4	64.4	74.5	1.6
U.S.A. to Overseas	54.6	18	68.0	98.4	148.0	194.3	279.5	339.5	456.0	3.2
Canada to U.S.A.	20.0	(2)	23.7	27.0	31.3	35.7	42.7	51.2	61.9	1.7
Canada to Canada	30.2	(2)	37.1	46.4	57.1	65.7	75.8	89.1	106.3	1.9
Canada to Overseas	2.1	(2)	2.4	3.3	4.3	5.5	7.4	10.3	14.6	2.9
Overseas to U.S.A.	21.7	30	29.2	57.7	85.1	122.3	174.7	248.1	351.4	4.2
Overseas to Canada	1.8	(2)	2.3	3.7	5.4	7.3	10.0	14.0	19.7	3.6
Total(1)	323.5	72%	385.9	498.8	630.6	769.1	973.1	1,186.3	1,486.2	2.3%

Notes: (1) Totals may vary slightly from computer printouts due to rounding.
(2) Due to the unavailability of competitive mode data for this trade route, the forecast file contains movement data only for the GL/SLS. Therefore, estimated 1972 base year GL/SLS market share for this trade route is shown in the file as 100%, although in fact this is not the case. In addition, estimates of potential tonnage are understated since flows via non-GL/SLS routings are not included. Also note that the total GL/SLS estimated 1972 base year market share is overstated and the total potential tonnage flows understated for the same reasons cited above.

Source: A. T. Kearney, Inc.

EXHIBIT II-4

U.S. ARMY CORPS OF ENGINEERS

GREAT LAKES/ST. LAWRENCE SEAWAY TRAFFIC FORECAST STUDY

HIGH FORECASTS OF TOTAL MOVEMENTS
(Millions of Short Tons)

Type of Movement	Potential Tonnage	Percent GL/SLS	Forecasted Potential Movements 1980	1990	2000	2010	2020	2030	2040	Average Annual Growth Rate 1972-2040
U.S.A. to U.S.A.	175.3	81%	216.5	296.3	382.0	487.4	603.8	740.9	898.9	2.4%
U.S.A. to Canada	25.2	(2)	46.3	57.0	65.9	79.3	97.1	119.4	151.0	2.7
U.S.A. to Overseas	54.6	18	81.3	137.4	253.6	397.2	617.6	864.5	1,151.4	4.6
Canada to U.S.A.	20.0	(2)	27.3	32.5	41.4	49.4	65.8	85.0	112.0	2.6
Canada to Canada	30.2	(2)	47.4	63.7	82.5	98.8	119.3	143.1	175.4	2.6
Canada to Overseas	2.1	(2)	2.8	4.1	5.6	7.5	10.3	14.5	20.7	3.4
Overseas to U.S.A.	21.7	30	35.1	72.9	116.0	179.6	276.3	422.3	644.7	5.1
Overseas to Canada	1.8	(2)	2.9	5.1	7.8	10.7	14.8	20.6	29.3	4.2
Total(1)	323.5	72%	459.6	669.0	954.8	1,309.9	1,805.0	2,410.3	3,183.4	3.4%

Notes: (1) Totals may vary slightly from computer printouts due to rounding.
(2) Due to the unavailability of competitive mode data for this trade route, the forecast file contains movement data only for the GL/SLS. Therefore, estimated 1972 base year GL/SLS market share for this trade route is shown in the file as 100%, although in fact this is not the case. In addition, estimates of potential tonnage are understated since flows via non-GL/SLS routings are not included. Also note that the total GL/SLS estimated 1972 base year market share is overstated and the total potential tonnage flows understated for the same reasons cited above.

Source: A. T. Kearney, Inc.

EXHIBIT II-5

III - SERVICE-RELATED ROUTE SPLIT CRITERIA

INTRODUCTION

This section provides a summary of the service-related factors and the role they serve in the route split model. This material is presented in four parts as follows.

- Role of Service Criteria
- Shipper Preference Survey
- Service Controls (Computer Model "Switches").
- Summary

ROLE OF SERVICE CRITERIA

The route split model has been designed to approach the mode/route choice problem in a "real world" manner. The route split model utilizes qualitative shipper route choice criteria as well as rate data in determining the appropriate mode/route split. Both components, cost and service, are interactive in the model, but as inputs retain their distinct identities. The model concepts utilized are designed to overcome the major shortcomings of many previous modal split modelling approaches, most of which are deficient in the treatment of service-related shipper decision criteria and the relationship of these criteria to costs.

The service component, or the service-related route criteria, represent in many cases the more qualitative, subjective factors (relative to cost) which influence shipper decisions. This service component is composed of two basic elements: Institutional constraints and service factors.

(a) Institutional Constraints

Institutional constraints are such that they tend to predetermine routes for shippers. Examples of these types of constraints include facilities and handling capabilities, fleet ownership, supply contracts, certain corporate policies and regulatory considerations. In the short-term many of these constraints may be considered fixed. However, over the sixty-year period being treated by the model, the majority may be treated as variable.

The effect of the application of these constraints on a given origin/destination traffic flow is to reserve a portion of the total flow for that mode/route which is favored by the constraint. Institutional constraints can be applied to reserve flows for either the GL/SLS route (e.g., receivers of bulk commodities who have only water-side storage and handling facilities) or the alternate route (e.g., long-term supply contract calling for delivery of the commodity at a coastal port on suppliers' vessels), or both.

(b) Service Factors

Service-related factors often predispose shippers to route commodities in a given manner. However, unlike institutional constraints, service factors are not long-term in nature. Service factors are in many cases intrinsic to a given route, variable in the short-term, and controlled directly by organizations external to the shipper (e.g., steamship companies, port authorities, etc.). Examples of service factors include service continuity (year-round availability), transit time, sailing frequency, schedule reliability, loss and damage experience, containerization, land feeder service, shipping infrastructure, and transloading efficiency. In the model, service factors are always evaluated for the GL/SLS route relative to the GL/SLS alternate route.

The effect of the application of service factors is to identify a portion (0-100%) of the total origin/destination flow for which the GL/SLS cannot effectively compete (assuming certain conditions such as an eight month season, etc.). Thus, service reserves are developed for the GL/SLS alternate route. Implicitly then, the GL/SLS routes are, in a service sense, considered equal or less attractive than the alternate. This is the proper orientation since the ultimate purpose of the is to test and evaluate GL/SLS improvement opportunities.

The extent to which shippers are sensitive to service factors varies, in the first degree, by specific commodity or commodity group. Within commodity groups, shippers react in response to unique sets of circumstances such as market position, economic conditions, competitive posture, etc. These sensitivities are developed more fully in a following section.

SHIPPER PREFERENCE SURVEY

Integral to the development of the route split model was the determination of the relative importance of cost, service and other factors (and the nature of their dependency on certain conditional events) in the decision to route traffic via the GL/SLS versus other possible routes. An extensive, in-depth interview program was conducted to identify these modal choice factors and their relative sensitivities as perceived by shippers in making GL/SLS-related routing decisions. As a prerequisite to the design of this interview program, a review of relevant published research was performed to ensure that the findings of prior work could be integrated to the greatest advantage.

(a) Survey Objectives

The purpose of the shipper preference survey was to determine the relative importance of various cost and service-related factors vis a vis the shipper's routing decision. Specific survey objectives included:

1. To identify the various cost and service factors that most often combine to form the set of criteria shippers apply when making commodity routing decisions.

2. To determine the importance of the service factors;

   (a) as a group relative to cost (however defined by the shipper) and

   (b) individually relative to one another (a rank-ordering).

3. To determine the shipper's propensity to trade service for cost savings (and vice versa).

4. To determine the competitive position (as perceived by the shipper) of the GL/SLS route relative to the GL/SLS route alternate (overall and for each identified routing criterion).

5. To determine the nature of shipper sensitivity to various levels of improvement in the GL/SLS service criteria (as might be affected by various alternative improvement programs) and generally how that sensitivity may change over time.

6. To identify and determine the impact of current institutional constraints which work to predetermine cargo routings.

7. To identify trends in transportation technology, industry structure, regulatory climate, etc., which could structurally alter routing criteria in the future.

(b) Survey Sample Selection

The Corps specified that approximately 120 interviews were to be conducted with about 20% (or more) to be completed in foreign locations (outside the U.S. and Canada). The survey sample was designed as shown in the table on the following page.

Table III-1

GL/SLS Survey Sample Categories

Category	Approximate Number
U.S. GL/SLS Shippers and Shipper Organizations	40
Canadian GL/SLS Shippers and Shipper Organizations	10
Foreign Export/Import Agents & Shippers	20
U.S. Steamship Companies	5
Foreign Flag Steamship Companies	10
Traffic Managers & Personnel (Other modes)	15
U.S. and State Government Officials(1)	15
Transportation-Related Professionals	5
Total	120

Note: (1) Includes U.S. & Canadian Port Authorities.

Source: Corps of Engineers.

Sample selection criteria were developed jointly with the Corps for each survey category.

(c) Survey Methodology

Interview appointments were made in advance by telephone. The objectives of the telephone contact included:

1. Identify key individuals within the shipper organization responsible for major commodity routing decisions.

2. Inform potential interviewees about the contract and its potential long- and short-term value to the organization.

3. Determine the organization's interview potential and value.

(a) Do they have O/D/C's with potential for the GL/SLS?

(b) Are the real or potential tonnages significant (e.g., 100,000 tons for bulk; 1,000 tons for general cargo)?

(c) Will they cooperate?

4. If appropriate, gain interview commitment including firm appointment.

5. Provide advance notice of information required during interview.

The telephone call and appointment were confirmed by letter which also included a letter of introduction by the Corps. The Corps letter introduced the study, legitimized Kearney's role, and guaranteed individual interviewee anonymity and data confidentiality.

A shipper preference interview discussion guide was prepared by Kearney and reviewed by the Corps. Discussion guide development, and interviewee selection were enhanced by the "feedback" obtained at the Corps-sponsored May 7, 1975 Shipping Conference in Detroit and the results of a large Corps mail questionnaire program conducted in the summer of 1975. The interviews were conducted in an open-ended fashion with much interviewer-interviewee interaction. Non-shipper interviews provided an excellent opportunity to test shipper perceptions of certain GL/SLS advantages and disadvantages with individuals whose perspective is structurally different.

(d) Survey Respondents

Over 120 in-depths interviews were completed. Nineteen interviews were conducted in Europe; 11 in Japan. Typically, shipper/receiver respondents were at the corporate-level (with multiplant exposure), general traffic managers, and/or distributions vice-presidents. In the case of import/export agents and carriers, the respondents were most often presidents, managing directors, or vice-presidents. Over 85% of the interviews were conducted on a personal basis; the remaining by telephone. (Subsequently, approximately 25 additional telephone interviews were conducted with Corps-selected respondents.)

The results of the interview effort served as input to the development of the model service controls (switches) and the specific settings of those controls.

SERVICE CONTROLS (SWITCHES)

Route split service controls in the route split model are a series of switches each having various positions or settings. There are service switches provided which permit analysis of the traffic related effects of varying degrees of navigation season extension, service reliability, shipment time and availability of containerized services. These service switches (given a specific setting) selectively affect the service reserve functions resulting in relatively higher (or lower) fractional allocations of the cost-sensitive traffic volume for which the GL/SLS can compete with the alternate route on the basis of rates (as contained in the logistics price file).

For purposes of the model, the shipper sensitivity to a given service improvement on a given origin/destination (as effected through the service control switches), is measured by the increase in annual tonnage that could, from a service standpoint, be available to the GL/SLS as a result of that improvement. This potential tonnage increase would still have to be "tested" in the logistics price file to determine the extent to which the GL/SLS is economically competitive. Thus, shipper reaction profiles are a quantitative indication of the shipper's sensitivity to the service implications of a given service-related switch.

The results of the shipper preference survey indicated that the following factors are among the most often considered in making routing decisions:

1. Total cost of transportation, including implicitly or explicitly, the time value of goods-in-transit.

2. Service continuity including consideration of year-round availability, service loyalty, reputation and past dealings.

3. Sailing frequency.

4. Total transit time.

5. Service reliability.

6. Availability of special services such as container services (most often cited), "roll on-roll off" services, heavy-lift capability, etc.

7. Port operation considerations such as congestion avoidance, efficiency, degree of special service accommodation, etc.

Although these routing criteria are common to most shippers, the emphasis placed on the individual elements (or rank-ordering) varies for each shipper or shipper group.

Based on the survey findings noted above, route split model service switches were defined for:

1. Service continuity (length of season).

2. Shipment time, including combined effects of sailing frequency and transit time.

3. Service reliability (both schedule and handling).

4. Degree of containerization (and all that it implies).

A complete discussion of these switches is contained in the main report. Further discussion of them also appears in the next section of this report.

SUMMARY

As described in this section, the shipper preference survey resulted in the development of shipper reaction profiles. These profiles are the quantitative representation of the value shippers place on various service factors in determining transportation routings. Thus, the shipper reaction profiles represent a key input to the route split model as described in the next section.

IV - THE CARGO FLOW ROUTE SPLIT MODEL

This section contains an abbreviated summary of the route split model and some of the concepts utilized in its development. A computer model user's manual which provides detailed information regarding model use has been provided to the Corps under separate cover.

MODEL OVERVIEW

The GL/SLS route split model accepts origin/destination potential trade flow input data pertinent to the GL/SLS hinterland area and various domestic, Canadian and world trade areas. The model then allocates, where appropriate, a portion to the GL/SLS using a largely empirical modal choice procedure. The model has three principal segments (modules).

1. Forecast Processor. The purpose of this module is to take existing basic forecast data and selectively modify or combine elements to produce a specific forecast (in ten year intervals 1980-2040) of interest.

2. Route Split Module. The basic purpose of this module is to develop a fractional allocation of the specific forecast traffic flows for the GL/SLS. The estimates of traffic flow allocation depend on relative service and rate factors between GL/SLS routes and alternate mode routes.

3. Output Processor. This module provides edit capability regarding the output of the route split module in order to suppress unwanted detail and to aggregate results in the

manner desired for each model run.

Exhibit IV-1 graphically depicts the route split model while Exhibit IV-2 provides a description of route split module operation.

BASIC
CONCEPTS

The route split model is designed to approach the mode choice problem in a "real world" manner. Recognizing that past modal split approaches using a linear programming least cost solution have had serious shortcomings, the GL/SLS route split model utilizes qualitative shipper modal choice criteria as well as rate data in determining the appropriate mode/route split.

The basic concept is to split shipper decision criteria into three major components: institutional, service, and rate. In the real world these components are interactive, yet maintain their distinct identities. The route split model provides for this interaction.

The first component - institutional factors include: long-term supply contracts, corporate policy to maintain alternate transport routes, long-term facilities commitments, etc. These factors tend to have an overriding effect on a portion (0-100%) of total traffic. The identified portion is then reserved for that transport mode/route that is favored by the institutional constraints. This process is represented schematically on the following page.

Illustration of Institutional
Reserved Traffic

GL/SLS Reserved (Due to institutional factors)	Alternate Mode/Route Reserved (Due to institutional factors)	Institutional Residual or Unreserved Traffic (Sensitive to rate/service factors)

The total box represents the total flow of a particular commodity from a specific origin to a specific destination in a given year. A portion of that total traffic may be reserved for GL/SLS carriers for institutional reasons (e.g., a certain portion of receivers have only water facilities). Likewise, a portion of that total traffic may be reserved for alternate mode carriers (e.g., waterborne carriage may not be available in winter, but the shipper desires the commodity to be moved during the winter). These types of factors often have an overriding effect on the modal split. Rate factors do not enter the decision-making process directly. However, the institutional factors also have cost implications. These are fed into the rate functions described later.

That traffic which is "unreserved" due to institutional factors is split based on the remaining two factors - service and rates. Service factors include speed, flexibility, reliability and availability of service. Only a portion of the unreserved traffic or institutional residual may be available to the GL/SLS because of deficiencies in these service factors relative to alternate routes. Attainment of certain service levels may be deemed sufficiently important so as to preclude competition on a cost basis, (e.g., shipment time of certain general cargo items to an overseas destination may be unacceptably long via the GL/SLS under the assumptions used in a particular model run).

In the model, the levels of service available on the GL/SLS may be varied using switch settings. Estimates of the responses of shippers to these various service levels are contained in the the shipper reaction profiles. This information is used to reduce the institutional residual or unreserved traffic by a factor, leaving a portion that is susceptible to rate factors (contained in the logistics price file).

The service/price split is illustrated schematically below:

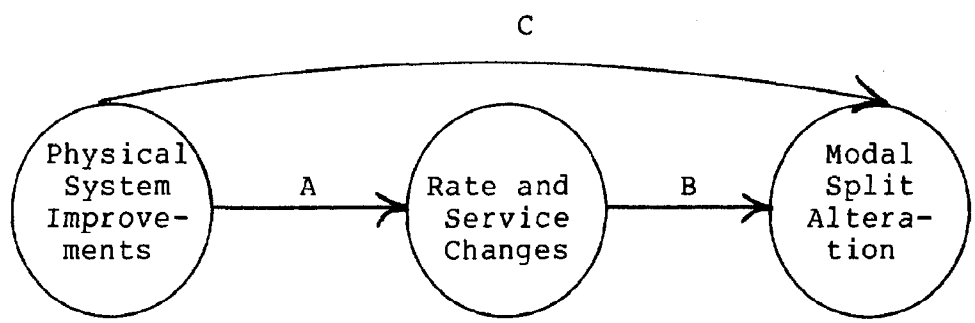
Illustration of Service/Rate Split

Not Available to GL/SLS System Because of Service Factors	Rate Sensitive-Allocated to GL/SLS System on Rate Basis	Rate Sensitive-Allocated to Alternate Routes on Rate Basis

The total box represents the institutional residual or unreserved flow. A portion of this is not available to the GL/SLS because of service limitations. The remainder of the flow is available to the GL/SLS, but is subject to rate competition. Because rates are distributed over a range, rather than being a single number, the allocation of traffic is not on an all or nothing basis. Thus, for a given commodity origin and destination flow some of the rate-sensitive traffic may split to the GL/SLS and some to the alternate route depending upon the rate relationship involved.

Both the service and rate factors may be modified as various GL/SLS service levels are altered in the model ("switch" concept). As a service improvement is "switched on" in the model, the appropriate service and cost factors are modified and the modal split is altered.

The model is designed to permit analysis of traffic flow changes due to GL/SLS improvements. Basically, the link from System improvement to modal/route split is a two step process, as shown graphically below:



The method of converting physical System improvements to modal split changes (Step C) is such that few shippers would be able to make this link, and thus provide this input to the model. Shippers could, however, make the link between rate and service factors and modal split changes (Step B). Therefore, physical System improvements and associated rate and service factors are only indirectly reflected in the model. The determination of the rate and service impact of physical improvements must be made external to the model (Step A).

As an example, one of the potential improvements is in availability of service. As the switch controlling this in the model is activated (i.e., availability is increased or season length is extended), both service and rate relationships are affected. That portion of traffic not available to the GL/SLS and, say, reserved for rail due to non-availability of water transport during certain portions of the year, will diminish and move to the cost susceptible portion of unreserved traffic. Concurrently, the rate function for water transport may shift to reflect operating cost changes associated with winter operations. A new route split would then be determined in the subsequent model run.

As shown in Exhibit IV-2, there are actually seven "switches" provided in the route split model. The first four are primarily service-related while the latter three are cost-related:

1. Navigation season length* expressed in whole months; 8-12 month settings.

(*) A Corps study conducted by ARCTEC resulted in estimated water rate changes attributable to season extension. These rate changes may be reflected in the model through use of the season extension switch.

2. Shipment time - expressed in days relative to alternate route shipment time.

3. Service reliability - expressed as percent relative to alternate route.

4. Containerization - expressed as degree of availability relative to alternate route.

5. GL/SLS technology - permits parametric adjustment of GL/SLS rates contained in the logistics price file.

6. Alternate route technology - permits parametric adjustment of alternate route rates contained in the logistics price file.

7. Tolls/users charges - permits the addition of GL/SLS tolls/user charges to the logistics price file.

SUMMARY

As described in this section, the route split model permits determination of the GL/SLS traffic volume variations attributable to various service and cost-related changes. In all cases, these changes are evaluated within the model relative to alternate route transport options available to the shipper.

GL/SLS TRAFFIC FORECAST STUDY
ROUTE SPLIT MODEL
SCHEMATIC

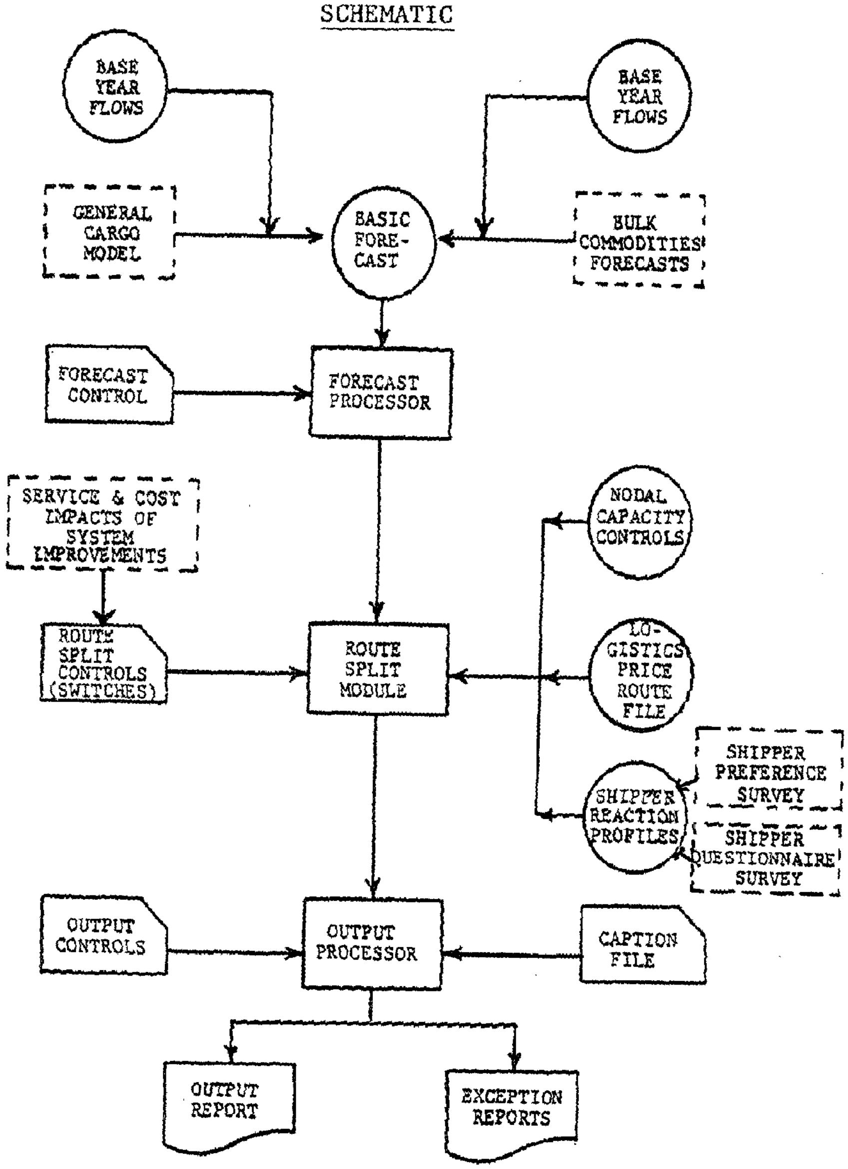
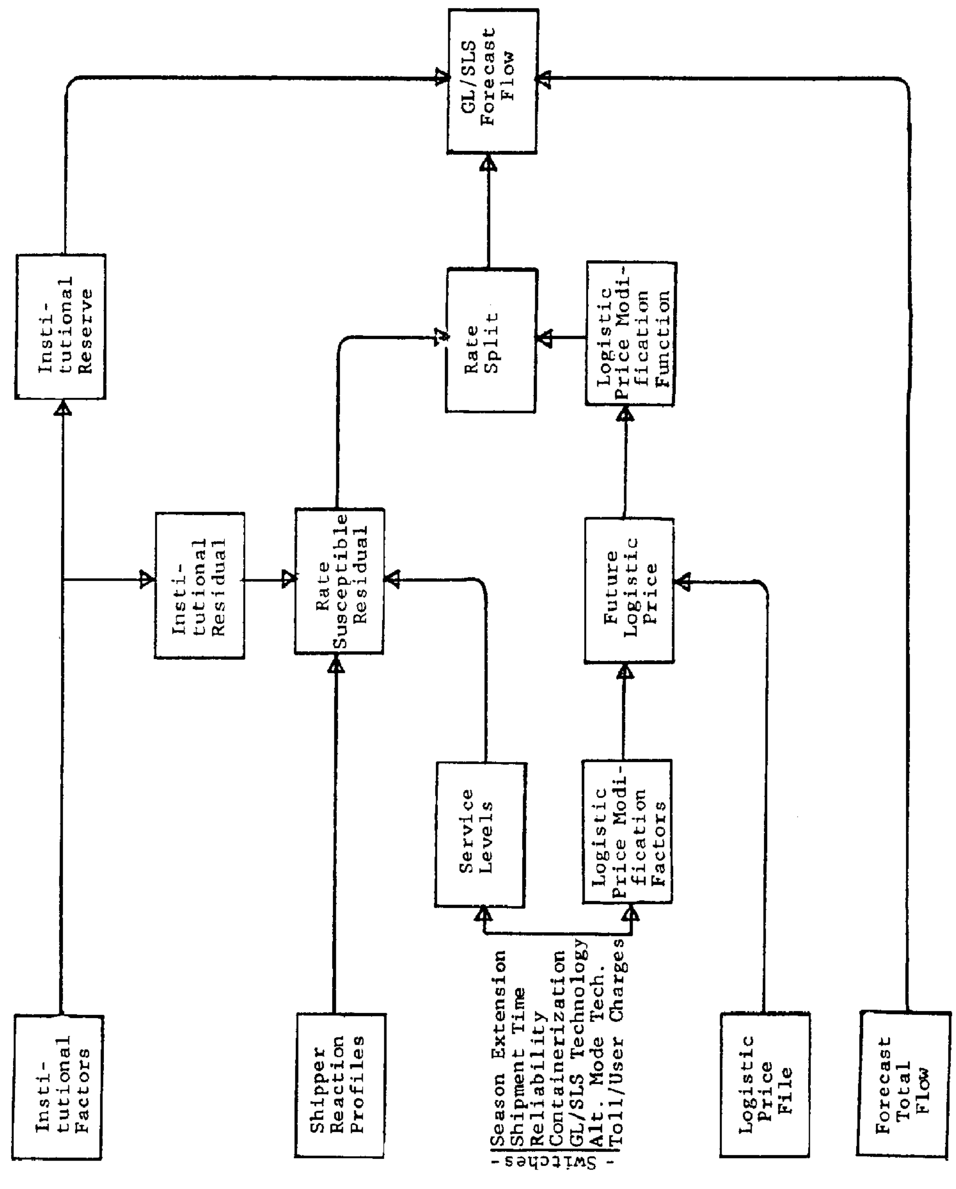


EXHIBIT IV-2

GL/SLS TRAFFIC FORECAST STUDY

ROUTE SPLIT MODULE SCHEMATIC



V - INTERIM FINDINGS

This report section is organized in the following fashion:

- Substantial Growth in Potential GL/SLS Tonnage Is Forecast.
- Opportunities Exist for Improvement for GL/SLS Market Share.
- Route Split Model "Tuning".
- Summary of Findings.

SUBSTANTIAL GROWTH IN POTENTIAL GL/SLS TONNAGE IS FORECAST

The table shown below provides a summary of the forecasts ("most likely") of potential GL/SLS traffic flows.

Forecasts of Potential GL/SLS System Traffic Flows

Summary of Projected Tonnage Growth 1972-2040

	Total Potential 1972	Total Potential 2040	Average Annual Growth Rate 1972-2040
	(Millions of Short Tons)		
Iron Ore	98	303	1.7%
Agricultural Products	68	384	2.6
Limestone	34	92	1.5
Coal	62	238	2.0
All Other Bulk Commodities	42	196	2.4
All Bulk Commodities	304	1,213	2.1
All General Cargo	29	979	5.2
All Commodities	333	2,192	2.8

Source: A. T. Kearney, Inc.

This table reveals that significant growth is expected and that this growth does not take place uniformly across all commodities. In addition, the relative importance of general cargo traffic will increase dramatically between now and 2040. The increased relative importance of general cargo traffic has significant implications for the GL/SLS since shipper routing decisions for general cargo commodities are far more sensitive to service-related factors than are bulk commodities.

OPPORTUNITIES EXIST FOR IMPROVEMENT IN GL/SLS MARKET SHARE

Listed in the table below are the estimated GL/SLS market-shares for selected aggregated commodity categories for the year 1972.

GL/SLS Estimated 1972 Market Shares
(Percent of Total Estimated GL/SLS Potential Tons Routed Via the System)

	GL/SLS Estimated Market Share (1)
Agricultural Products (U.S. - Overseas)	17%
Agricultural Products (Total)	42
Coal (U.S. - U.S.)	57
Coal (Total)	69
General Cargo (U.S. - Overseas)	17
General Cargo (Total)	38
All Commodities (Total)	72

Note: Estimated market shares are artifically inflated in some instances due to unavailability of certain alternate route traffic data such as US-Canada and Canadian rail flows.

Source: A. T. Kearney, Inc.

It is clear from this table that there exist significant volumes of potential GL/SLS traffic flows which currently are not moving via the System. In fact, within the aggregated commodity category projected with the greatest growth (general cargo), the current GL/SLS market share clearly indicates the opportunity for the development of significant added tonnage on the System with only relatively small improvements in market share.

There are also commodities which are highly sensitive to transport costs for which the GL/SLS currently has relatively low market shares. Most significant of these are the agricultural products, which are highly sensitive to changes in relative transportation costs.

Thus, there is a wide spectrum of consideration regarding alternatives for improving GL/SLS market participation. The realization of these opportunities may be a formidable challenge. The quantification of shipper-required System changes needed to capitalize on these opportunities is contained in the route split model shipper reaction profiles. (These profiles were developed based upon the results of the shipper preference survey as discussed in Section III.)

ROUTE SPLIT MODEL "TUNING"

Kearney has reviewed and "tuned" model operations where possible. However, one of the features of a model is to "default" to the base year GL/SLS market share if the logistics price file does not contain the necessary rate information for a particular origin/destination/commodity movement.

The logistics price file provided to Kearney and utilized in the "tuning" effort represented a "test file" designed to establish a basis for formatting and interaction of inputs. As such, the rate records provided were not representative across commodity and origin/destination elements. Therefore, it is impossible to impute from this logistics price file sample what may be expected to occur on the entire GL/SLS (using the model) once the comprehensive logistics price file is developed.

Kearney's recommendation that a further model "tuning" and review effort be undertaken after the Corps has had the opportunity to develop the necessary additional logistics price file information has been accepted. In addition, it would be desirable to audit the logistics price file data to determine that the rate information (developed primarily from published tariffs) contained in that file does represent what shippers are actually paying.

SUMMARY OF FINDINGS

Projections of future GL/SLS suspectible traffic flows indicate significant growth will occur. Current GL/SLS shares of potential traffic are relatively low in many instances. Thus, opportunities exist for significant System tonnage increases.

However, realization of these opportunities will not occur easily. Although current model input parameters have been tested to the extent possible, further model "tuning" is planned by the Corps subsequent to the development of a comprehensive logistics price file.

VI - FUTURE USE OF THE ROUTE SPLIT MODEL

The purpose of this section is to summarize a number of aspects related to the future development and use of the GL/SLS route split model. It is organized as follows:

- Future Use of the Model
- Origin-Destination Traffic Flow Data
- Logistics Price Data
- The Model as a Basis for Other Applications
- Summary.

FUTURE USE OF THE MODEL

The diverse data bases utilized and the unavailability of certain data add a number of nuances to one's understanding of the model and the results obtained in using it. By its very nature, the model is a relatively sophisticated tool. It also represents a significant Corps investment. To ensure maximum "leveraging" of this investment, Kearney believes that the Corps should formally commit its resources to ensure full utility, understanding and effective use of the model through the years. A formal assignment of responsibility and commitment of resources would provide an internal focal point from which to control model use and encourage its further development (discussed later herein).

ORIGIN-DESTINATION DATA

There currently exists almost no true origin-destination traffic flow data. Thus, the origin-destination traffic flow data base developed for this project is more properly labeled an "estimated" origin-destination traffic data base. Furthermore, there are significant gaps in data such as the lack of any U.S.-Canada rail flow data and the fact that the Canadian government would not divulge (in a form meaningful for this study), Canadian rail traffic flows potential to the GL/SLS.

It should also be recognized that some improvements in currently available data are planned and other further improvements are certainly possible in the future. An excellent example of an improvement which will shortly be available is the 1975 "Purple Book" sample of true U.S. origin-destination locations for overseas general cargo movements. Given the rapid development of containerization in the 1970-1975 period, together with other changed factors, one may expect to see traffic pattern changes as well as changes in the true U.S. origin-destinations origin-destinations for general cargo flows since 1970. When the 1975 results become available, Kearney believes the Corps should analyze them carefully relative to the 1970 "Purple Book"* data to determine the magnitude of change involved. This analysis is expected to

(*) Domestic and International Transportation of U.S. Foreign Trade: 1970.

reveal the desirability of updating the data base to account for changed overseas general cargo sourcing patterns.

LOGISTICS PRICE DATA

The logistics price file provided to Kearney is currently being expanded by the Corps. However, Kearney believes that such rate data is both expensive and extremely "perishable" in nature. Actual published rates change frequently over time, generally require manual look-up, and typically vary significantly based on shipment size/profile assumptions.

For the above cited reasons, among others, Kearney recommends that the Corps consider the development of a rate calculator model which would be designed to be readily updatable in terms of changes in rate levels and changes in shipment profiles. While the initial expense of creating such a model may be significant, its long-term utility would far exceed that of a current "tariff based" logistics price file, which as is a highly perishable investment. In addition, many shippers' transportation cost factors are not properly reflected in published tariffs (e.g., steel companies which own and operate their own ore carriers). Furthermore, a rate calculator model could have incorporated in it the capability of analyzing the sensitivity of transportation cost factors to various assumptions with regard to shipment profiles, rate structure, etc. A logistics price file derived from published rates does not provide this type of analytical flexibility. (There is concern by some parties that legal constraints may require the exclusive use of published rates. The legal aspects of this question should be part of any feasibility analysis pertinent to this recommendation.)

SHIPPER PREFERENCE DATA

This project called for the development of shipper reaction profiles based upon the results of approximately 120 shipper interviews. It is clear that expansion of those interviews within specific commodity or other categories may permit further refinement of shipper reaction profiles developed. In addition, specific important areas may be explored in depth and the results of those explorations incorporated in shipper reaction profiles. Thus, refinements of the reaction profiles currently in the model are certainly possible given a broader input base. However, for the relatively near term, Kearney assigns a lower priority to this need than it does to the need to upgrade data bases related to the logistics price file and the origin-destination flows. Although the shipper reaction profiles are not viewed as being highly perishable, it should be recognized that changes in shipper attitudes may occur over time and some checks of these reaction profiles at periodic intervals (e.g., several years from now) would be prudent.

THE MODEL AS A BASIS FOR OTHER APPLICATIONS

During the course of the study, numerous discussions were held with the Corps of Engineers, St. Lawrence Seaway Development Corporation, the St. Lawrence Seaway Authority and other GL/SLS interested parties. In these discussions, various questions were raised with regard to the capability of the route split model in addressing specific types of questions. Almost without exception, all of the System-related traffic effects analysis capabilities desired are included in the route split model.

Thus, as it is presently designed, the model is capable of addressing System-wide and certain System segment changes. Not incorporated in the model at the present time are GL/SLS segments such as port/harbor facilities and the effect of possible changes in those elements on traffic flows. However, given some model alteration and additional data, it would be possible to apply the System-oriented GL/SLS route split model to regional port traffic studies.

Consequently, Kearney believes that the Corps should be alert and fully aware of the versatility of the model as provided. This utility is such that other applications not provided for in this work effort may be feasible and economically attractive to the Corps using as a base the route split model as it now exists. The modular approach taken in the development of this model makes such "add on" applications all the more feasible.

SUMMARY

The route split model provides a significant improvement in analytical capabilities designed to determine traffic effects of alternative GL/SLS improvement programs. Full benefits of the model are more likely to be derived if a formal resource commitment is made to the use, maintenance and upgrading of the model over time. Finally, Kearney believes an awareness should be maintained of the feasibility and desirability of upgrading the model and utilizing it as a basis for other applications as appropriate. This approach, will provide for maximum "leveraging" of the investment the Corps has made in the development of the GL/SLS route split model.

APPENDIX VII

GREAT LAKES-ST. LAWRENCE SEAWAY

WINTER RATE STUDY

Final Report 00246C-3

FINAL REPORT
WINTER RATE STUDY FOR GREAT LAKES-ST. LAWRENCE SEAWAY SYSTEM

VOLUME I OF II

CONTRACT NUMBER DACW23-75-C-0043

16 DECEMBER 1975

Submitted To

North Central Division
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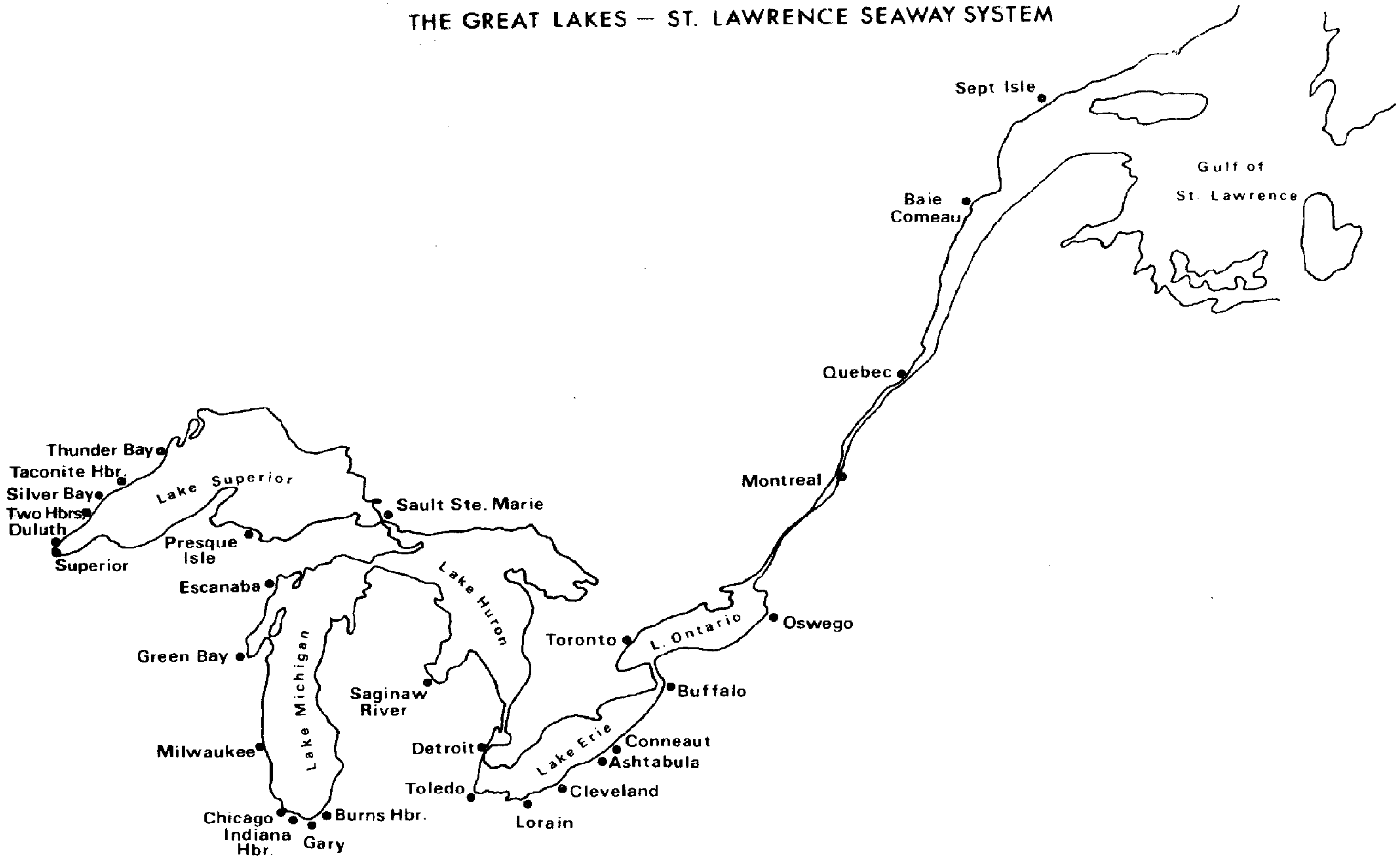
THE GREAT LAKES — ST. LAWRENCE SEAWAY SYSTEM



ACKNOWLEDGEMENT

The authors wish to thank Mr. Robert M. McIntyre of the North Central Division of the U.S. Army Corps of Engineers for his cooperation and assistance during the course of this study. The authors also wish to thank all of the individuals who gave of their time to talk with us and provide us with needed information.

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I. SUMMARY

The purpose of this report is to present the results of the WINTER RATE STUDY for The Great Lakes-St. Lawrence Seaway System (GL-SLS System). The objectives of this study were:

(1) to estimate the total transit time for ships navigating a technically feasible GL-SLS System during the winter season and translate these total transit times into vessel operating costs and the associated annual required freight rates for major commodity routes,

and (2) to estimate the effect on these annual required freight rates of:

- Improvement Levels
- Length of the Navigation Season
- Winter Severity
- Vessel Fleet Mix
- Improvement Levels

To accomplish these objectives, a computer model of the GL-SLS System was developed to simulate the movement of ships and cargo within the system, and to and from overseas ports. In simulating these movements, the model incorporates the interactions between ships and the system and between the ships themselves, such as:

- Increased transit, lockage and port times due to the presence of ice
- Port and lock limitations and constraints
- Draft limitations
- Speed limits
- Daylight only navigation
- Queues forming, expanding and diminishing at lock and port facilities
- Ships getting stuck and having to wait for icebreaker assistance

The model compiles statistics for each class of ship operating on each route and, at the conclusion, converts these statistics, along with vessel data, into vessel operating costs and the associated annual required freight rates for each route.

From the results presented in this report the following summarized conclusions were drawn:

(1) From the standpoint of annual required freight rates and operating costs per ton, extended season navigation, even all-year navigation, is commercially viable.

(2) For laker bulk cargo routes, annual required freight rates decrease with season extension for all routes and all commodities for the 1975 fleet and normal winter with the greatest reduction (over 11%) occurring for all-year shipping of iron ore from Escanaba to Indiana Harbor. The annual operating costs per ton tends to increase with season extension with the largest increase of 13% occurring for all-year shipping of iron ore from Sept Iles to Cleveland.

(3) Whereas for laker bulk cargo routes the annual required freight rates decrease with season extension, the annual rates increase with season extension for overseas grain and general cargo routes with a maximum increase of 7% for all-year shipping of grain and a 3% increase for all-year shipping of general cargo.

(4) As one would expect, a mild winter causes annual required freight rates for laker bulk routes to decrease a greater amount than those for a normal winter, and a severe winter causes the annual rates to decrease a smaller amount. It should be noted that for a severe winter, the annual rates for many laker routes decrease to a minimum annual rate for an optimum season extension period, and then begin to increase as season extension continues. For overseas routes, the annual rates increase to a lesser degree for mild winters and increase to a greater degree for severe winters.

(5) As the fleet mix tends to larger, more powerful and economical ships, the annual required freight rates decrease even more for laker bulk cargo routes and increase less for overseas routes.

(6) The effect of improvement levels is the same as the effect of fleet mix. In general, the greater

the improvement level, the larger the decrease in the annual required freight rates for laker bulk routes and the smaller the increase for overseas routes. The magnitude depends to a large degree on the route itself and whether or not it includes areas where improvements are being considered.

(7) The ships which benefit the most from season extension are the larger, more powerful and economical ships. They get stuck less, have less chance of damage, have faster speeds of advance, and can transport more cargo.

Based on the knowledge we have gained during the course of this WINTER RATE STUDY, we recommend the following:

(1) The overall Great Lakes-St. Lawrence Seaway System Model planned for Phase III, which includes the SIMULATION MODEL described in this report, should be developed in order to investigate the role of, and the demand for, GL-SLS shipping services in moving cargo. In developing this model, general cargo should be treated in the same manner as bulk cargo.

(2) Because the model simulates the interaction between ships and the system and between the ships themselves, it should be used as a tool to investigate various requirements and operating procedural changes, such as icebreaker requirements and ship requirements.

(3) The SIMULATION should be kept current by revising input data files and changing the basic rules and assumptions as required. Unless the SIMULATION is periodically upgraded, it will lose its credibility as a planning tool.

(4) The SIMULATION should be documented in detail so that it can be used by other government agencies and by private and public organizations thereby eliminating needless duplication of effort.

II. INTRODUCTION

The purpose of this report is to present the results of the WINTER RATE STUDY for the Great Lakes-St. Lawrence Seaway System (GL-SLS System). The objectives of this study were:

(1) to estimate the total transit time for ships navigating a technically feasible GL-SLS System during the winter season and translate these total transit times into vessel operating costs and the associated annual required freight rates for the major commodity routes listed in Table 1,

and

(2) to estimate the effect on annual required freight rates of:

- Length of the Navigation Season
- Winter Severity
- Vessel Fleet Mix
- Improvement Levels.

This study is only one part (Phase II, Part B) of a total program referred to as THE GREAT LAKES - ST. LAWRENCE SEAWAY NAVIGATION SYSTEM STUDY, which is comprised of the following phases:

PHASE I: Traffic Forecast Study

A. Preliminary Traffic Forecast, 1980-2040
B. Shipper Preference Study
C. Development of a CARGO FLOW MODEL

PHASE II: Rate and Cost Study

A. Normal Season
B. Extended Season

PHASE III: System Interrelationship Study

A. System Capacity
B. System Optimization

TABLE 1.

TRADE ROUTES

Route No.	Port of Origin	Port of Destination
Iron Ore		
1	Escanaba	Cleveland
2	Escanaba	Trenton Channel
3	Escanaba	Indiana Harbor
4	Presque Isle	Cleveland
5	Superior	Cleveland
6	Superior	Ashtabula
7	Superior	Buffalo
8	Superior	Detroit
9	Superior	Indiana Harbor
10	Duluth	Lorain
11	Duluth	Cleveland
12	Duluth	Conneaut
13	Duluth	Gary
14	Duluth	Calumet Harbor
15	Two Harbors	Conneaut
16	Two Harbors	Gary
17	Two Harbors	Calumet Harbor
18	Silver Bay	Toledo
19	Silver Bay	Cleveland
20	Taconite	Buffalo
21	Taconite	Burns Harbor
22	Taconite	Indiana Harbor
23	Thunder Bay	Indiana Harbor
24	Sept Iles	Cleveland
25	Sept Iles	Calumet Harbor
Coal		
26	Toledo	Rouge River
27	Toledo	Detroit
28	Toledo	Green Bay
29	Toledo	Sault Ste. Marie (Ont.)
30	Calumet	Duluth

TABLE 1. (CONTINUED)

Route No.	Port of Origin	Port of Destination
Grain (Lakers)		
31	Duluth	Baie Comeau
32	Chicago	Baie Comeau
33	Toledo	Baie Comeau
34	Thunder Bay	Baie Comeau
Grain (Salty)		
35	Duluth & Baie Comeau	Overseas
36	Chicago & Baie Comeau	Overseas
Iron-Steel		
37	Overseas	Chicago
38	Overseas	Cleveland

General Cargo (to and from Overseas)

Route No.	Ports of Call Within System
39	Montreal - Cleveland - Detroit - Montreal
40	Montreal - Detroit - Chicago - Montreal
41	Montreal - Detroit - Duluth - Montreal
42	Montreal - Toronto - Cleveland - Saginaw - Milwaukee - Montreal
43	Montreal - Detroit - Green Bay - Duluth - Cleveland - Montreal

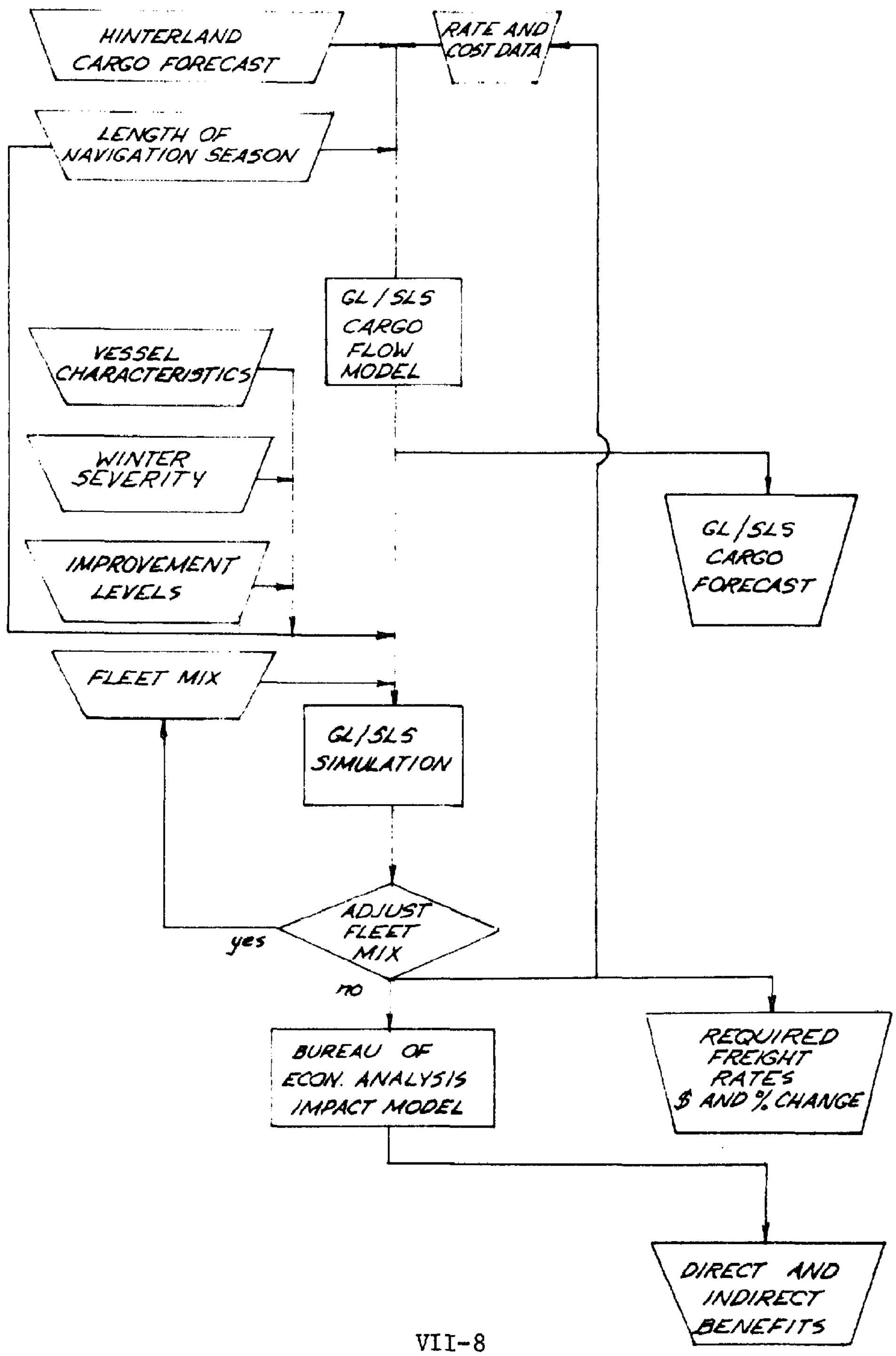
In Phase I, the primary objective is to develop a method of estimating future traffic suitable for waterborne movement in the GL-SLS System. This phase consists of a Preliminary Traffic Forecast of U.S. and Canadian general cargo, grain, and mineral bulk commodities for the years 1980-2040, followed by a Shipper Preference Survey and Development of a CARGO FLOW MODEL. Phase II of the total program consists of a Rate and Cost Study for both normal and extended season operations. The extended season portion of this phase is the subject of this report.

Using the results of Phases I and II, an overall computer model of the GL-SLS System will be developed in Phase III to study the system's capacity and to evaluate the potential benefits of proposed improvements. A conceptual flow diagram [1]* depicting the model is given in Figure 1. The GL-SLS SIMULATION contained in Figure 1 corresponds to the model described in this report. As seen from the flow diagram, the CARGO FLOW MODEL converts the hinterland cargo forecast information, length of the navigation season and initial rate and cost data into cargo forecast data. This cargo forecast data, in the form of cargo origin and destination data, along with the length of the navigation season, fleet mix, vessel characteristics, winter severity and improvement levels, is entered into the GL-SLS SIMULATION which models the movement of ships and cargo through the system and to and from overseas ports. The SIMULATION computes statistics for each class of ship operating on each route and converts these statistics into annual vessel operating costs and the associated annual required freight rates for each route. In simulating the movement of ships and cargo, the model incorporates the interactions between ships and the system as well as the interaction between the ships themselves:

- Increased transit, lockage and port times due to presence of ice
- Port and lock limitations and constraints
- Draft limitations
- Speed limits
- Daylight only navigation
- Queues forming, expanding and diminishing at lock and port facilities
- Ships getting stuck and having to wait for icebreaker assistance

*Numbers in brackets indicate References listed in Section IX.

FIGURE 1.
CONCEPTUAL BLOCK DIAGRAM FOR TOTAL PROGRAM



If, after running the simulation, the tonnage of cargo transported does not balance the cargo forecast, that is, if too much or not enough cargo has been transported, the size of the fleet should be adjusted appropriately to achieve a reasonable balance and the simulation rerun. Once a reasonable balance has been obtained, the annual required freight rates and annual vessel operating costs are fed back into the CARGO FLOW MODEL and the cycle is repeated until an overall balance is achieved. The final results are then entered into the IMPACT MODEL of the Bureau of Economic Analysis (BEA) to determine the direct and indirect benefits. The model can thus provide a tool to identify problem areas or bottlenecks to extended season navigation and, in turn, to evaluate the potential benefits derived by proposed solutions.

The model, as seen from the flow diagram, is an iterative one in which the output from the CARGO FLOW MODEL is required as input to the SIMULATION and vice versa. The program can therefore be thought of as a spiral in which several iterations are required to achieve a final solution. Where the spiral is entered is relatively unimportant as long as reasonable initial input data is available and a sufficient number of iterations are performed. The SIMULATION for this project was developed along the lines described above for inclusion into the total program, however a modified simulation was run to obtain a first estimate of the effect of winter navigation on annual required freight rates and annual vessel operating costs for use in Phase I and for input into the CARGO FLOW MODEL as initial rate and cost data. This modification consisted of altering the ship processing routine from one of routing ships based on cargo demand to one of routing ships along designated routes similar to the procedure used in the University of Michigan Model [2] and specifying the fleet mix on each route. While the simulation model described in this report is the GL-SLS SIMULATION contained in Figure 1, the results presented are based on computer runs using the modified simulation. A more detailed discussion of the modified simulation is given in Section VI.

In developing the GL-SLS System SIMULATION, the system had to be first described. As stated in the objectives of the study, a technically feasible GL-SLS System was to be considered. Thus, from the outset of the study, obstacles which would in themselves eliminate winter navigation such as the ice booms and ice jams in the St. Lawrence Seaway were assumed to be removed or solved.

III. REACH SELECTION

The first step in developing the simulation was to represent the GL-SLS Navigation System as a series of reaches, as shown in Figures 2 and 3 and listed in Table 2. Also in Figures 2 and 3, ten (10) icebreaker operating regions are shown. Specific icebreakers are assigned to each of these regions and can assist only ships becoming stuck in their region. Three types of reaches were defined: port reaches, lock reaches and channel reaches. For port and lock reaches, boundaries were chosen to correspond to the entrance and exit points of the facility, while boundaries for adjacent channel reaches were chosen to correspond to points where trade routes either joined or separated or where characteristics of the system changed significantly.

Once selected, every reach was described by a series of attributes. Port reaches, which were defined as any facility where ships moving over specified trade routes could either load or unload cargo, were described by:

- Maximum Allowable Ship Draft
- Maximum Allowable Ship Class
- Port Turnaround Time

and, for each type of cargo, by:

- Stockpile Level
- Number of Docks
- Cargo Arrival (Usage) Rate
- Cargo Loading (Unloading) Rate
- Dock Restrictions (Self Unloaders Only)

where the port turnaround time is the time for a ship to move to and from the docks excluding time spend in a queue waiting for a dock to become available. Data for each port was obtained primarily from Reference 3 and from discussions with ship operators and port officials. Data on cargo arrival (usage) rates for each port is input data generated by the CARGO FLOW MODEL to be developed in Phase I of the total program. It should be noted that the stockpile level indicated above is not an input variable but rather an internal one used in routing ships and cargo from port to port in the simulation as a measure of the amount of cargo available for shipping or for usage, depending on whether the port is a cargo supply port or a cargo demand port, respectively. The actual input data describing

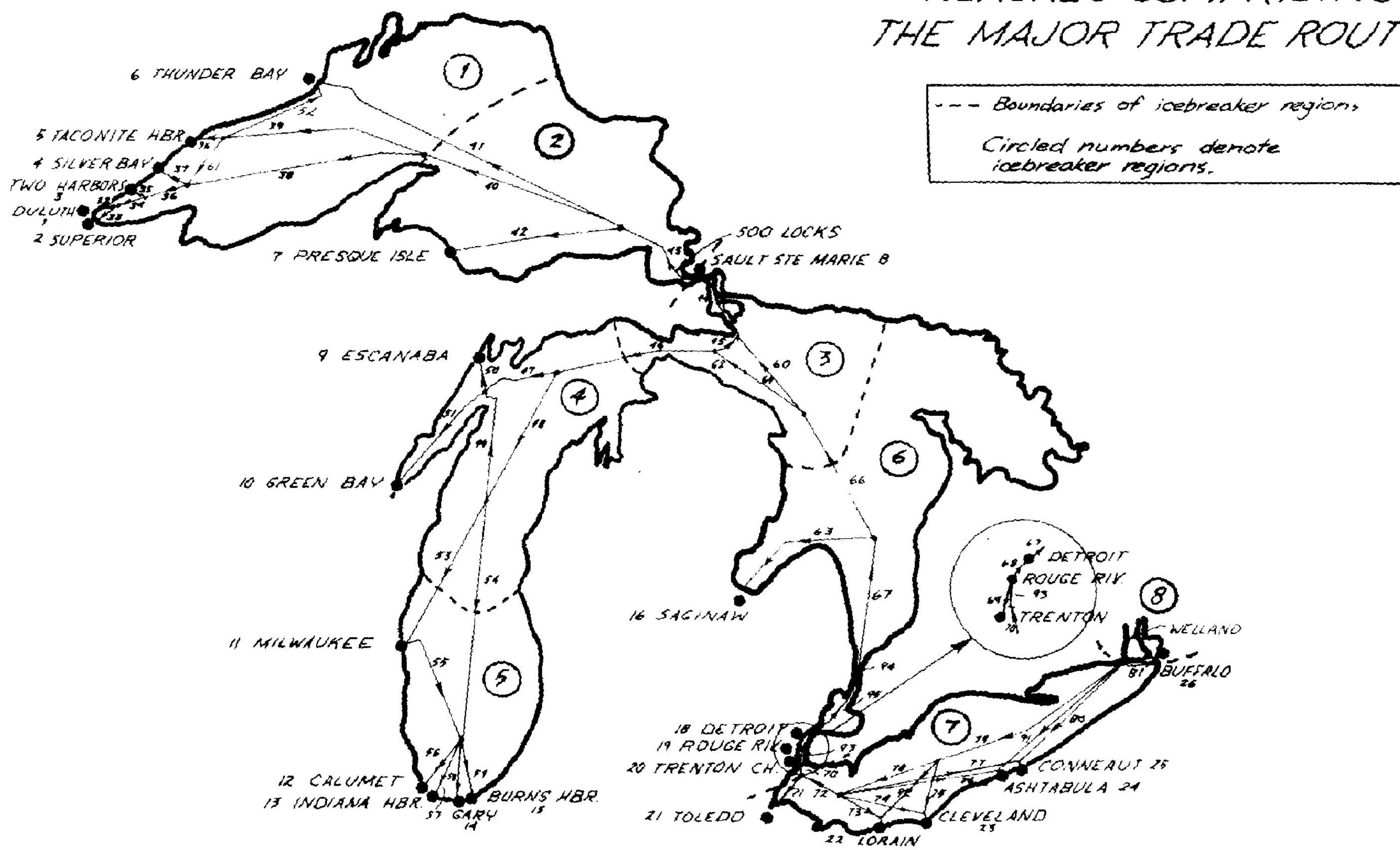


FIGURE 2
REACHES COMPRISING
THE MAJOR TRADE ROUTES

FIGURE 3

REACHES COMPRISING
THE MAJOR TRADE ROUTES

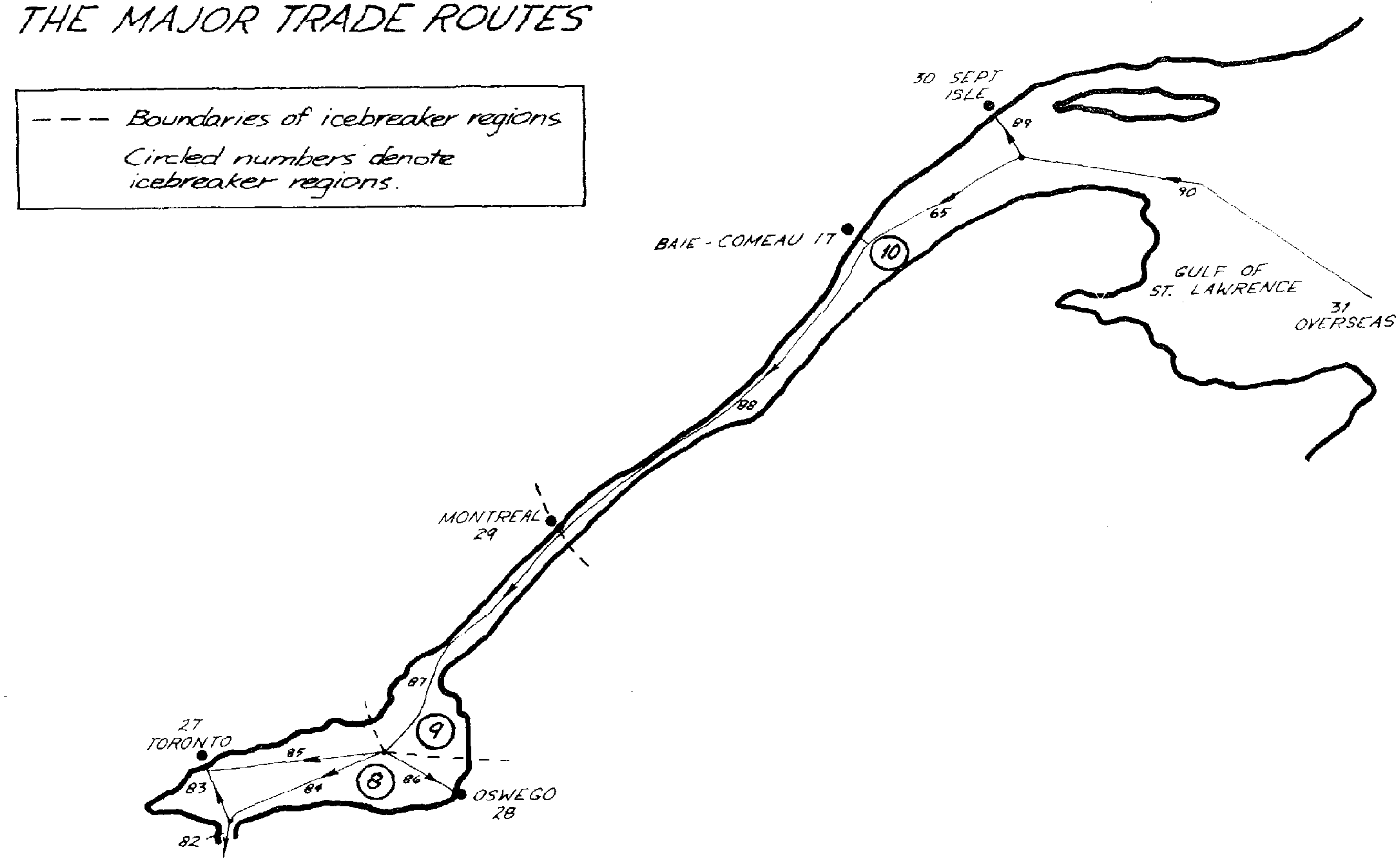


TABLE 2.

LIST OF REACHES

PORT REACHES

Reach No.	Port
1	Duluth
2	Superior
3	Two Harbors
4	Silver Bay
5	Taconite Harbor
6	Thunder Bay
7	Presque Isle
8	Sault Ste. Marie
9	Escanaba
10	Green Bay
11	Milwaukee
12	Calumet
13	Indiana Harbor
14	Gary
15	Burns Harbor
16	Saginaw
17	Baie Comeau
18	Detroit
19	Rouge River
20	Trenton Channel
21	Toledo
22	Lorain
23	Cleveland

TABLE 2. (CONTINUED)

Reach No.	Port
24	Ashtabula
25	Conneaut
26	Buffalo
27	Toronto
28	Oswego
29	Montreal
30	Sept Iles
31	Overseas

CHANNEL AND LOCK REACHES

Reach No.	"Upstream" Boundary	"Downstream" Boundary
32	approx. 10 miles east of Two Harbors	Duluth
33	upstream end of reach 32	Superior
34	upstream end of reach 32	approx. 4 miles southeast of Knife River
35	upstream end of reach 32	Two Harbors
36	approx. 12 miles north of Devil's Island	upstream end of reach 32
37	upstream end of reach 36	Silver Bay
38	approx. 12 miles north-east of Manitou Island	upstream end of reach 36
39	upstream end of reach 38	approx. 18 miles east-northeast of Taconite Harbor

TABLE 2. (CONTINUED)

Reach No.	"Upstream" Boundary	"Downstream" Boundary
40	Whitefish Point	upstream end of reach 38
41	upstream end of reach 40	Thunder Bay
42	upstream end of reach 40	Presque Isle
43	Point Iroquois	upstream end of reach 40
44	De Tour Reef	Sault Ste. Marie
45	2 miles north of Bois Blanc Lt.	upstream end of reach 44
46	Mackinac Bridge	approx. 10 miles northwest of Boulder Reef
47	downstream end of reach 46	approx. 4 miles west of Washington Island
48	downstream end of reach 46	approx. 30 miles east of Manitowoc
49	downstream end of reach 48	downstream end of reach 47
50	downstream end of reach 47	Escanaba
51	downstream end of reach 47	Green Bay
52	downstream end of reach 39	Thunder Bay
53	downstream end of reach 48	Milwaukee
54	downstream end of reach 48	approx. 30 miles east of Highland Park

TABLE 2. (CONTINUED)

Reach No.	"Upstream" Boundary	"Downstream" Boundary
55	downstream end of reach 54	Milwaukee
56	downstream end of reach 54	Calumet
57	downstream end of reach 54	Indiana Harbor
58	downstream end of reach 54	Gary Harbor
59	downstream end of reach 54	Burns Harbor
60	approx. 22 miles east of Presque Isle Harbor	De Tour Reef Lt.
61	downstream end of reach 39	Thunder Bay
62	approx. 20 miles north of Calcite	Mackinac Island
63	approx. 34 miles east of Au Sable Pt.	Saginaw
64	upstream end of reach 60	upstream end of reach 62
65	approx. 30 miles south of Sept Iles	Baie Comeau
66	upstream end of reach 63	upstream end of reach 60
67	Fort Gratiot Lt.	upstream end of reach 63
68	Rouge River	Detroit
69	Rouge River	Trenton
70	approx. 9 miles north-west of Middle Sister Island Lt.	Rouge River

TABLE 2. (CONTINUED)

Reach No.	"Upstream" Boundary	"Downstream" Boundary
71	upstream end of reach 70	Toledo
72	Pelee Passage	upstream end of reach 70
73	upstream end of reach 72	Lorain
74	upstream end of reach 72	Cleveland
75	approx. 35 miles south-east of Pte. aux Pins	Cleveland
76	upstream end of reach 72	Ashtabula
77	upstream end of reach 72	Conneaut
78	upstream end of reach 75	upstream end of reach 72
79	entrance to Welland Canal	upstream end of reach 75
80	upstream end of reach 74	Conneaut
81	upstream end of reach 74	Buffalo
82	upstream end of reach 74	entrance of Welland Canal
83	Port Weller	Toronto
84	7 miles south of Pt. Petre Lt.	upstream end of reach 83
85	upstream end of reach 84	Toronto
86	upstream end of reach 84	Oswego

TABLE 2. (CONTINUED)

Reach No.	"Upstream" Boundary	"Downstream" Boundary
87	Montreal	upstream end of reach 84
88	Baie Comeau	Montreal
89	30 miles south of Sept Iles	Sept Iles
90	overseas	upstream end of reach 89
91	upstream end of reach 74	Ashtabula
92	upstream end of reach 75	Lorain
93	entrance to Detroit River	Rouge River
94	Squirrel Island	Port Huron
95	Detroit	upstream end of reach 94
96	downstream end of reach 39	Taconite Harbor

each of these ports is contained in data file RCHIN1 listed in Appendix E of Volume II.

Lock reaches, which were defined as any reach containing a single lock or a system of locks such as the Welland Canal or St. Lawrence Seaway, were described by the following attributes:

- Ice Conditions
- Maximum Allowable Ship Draft
- Maximum Allowable Ship Class
- Imposed Speed Limit
- Beginning of Daylight Only Navigation
- End of Daylight Only Navigation
- Number of Locks
- Lock Turnback Time

The remaining reaches comprising the lakes and rivers were defined as channel reaches and described by:

- Ice Conditions
- Maximum Allowable Ship Draft
- Maximum Allowable Ship Class
- Imposed Speed Limits
- Beginning of Daylight Only Navigation
- End of Daylight Only Navigation

In describing the ice conditions, every channel and lock reach was divided into five (5) sections corresponding to the existence of different ice conditions along the length of the reach. Each section, except the middle one (section 3), was described by its length and the existing broken ice thickness in the ship navigation channel. The middle section was reserved for open water and only its length was denoted. The elimination of any section was achieved by equating its length to zero. For example, a totally open water reach has the length of section 3 equal to the total length of the reach while the lengths of the other sections equal zero. Ice conditions for each reach were prepared for every two week time period for representative winters of different severities: mild, normal and severe. These ice conditions are in terms of broken ice thickness existing in ship channels and should not be confused with typical sheet ice thicknesses. The ice thicknesses are based on average conditions but variations of over fifty percent can be expected at select locations. A normal ice year was determined by an analysis of temperature data and ice coverage as presented in References [4] through [11]. These information sources also provided an indication of what typical mild and severe ice years might be. It should be noted that broken ice thickness is greatest in the restricted waterways where ice tends to jam. It should also be noted that in some cases our best judgement was required and was based on the knowledge gained from References [12] through [16]. More specifically, year-round operation on the Great Lakes has been accomplished only once and hence limited data exists on actual thicknesses that ships experience. Nevertheless, by inspecting ship voyage logs and knowing the speed of advance for certain lengths of the voyage, we could reliably estimate broken ice channel thickness where reasonable approximations of bulk carrier performance in broken ice fields exist. In those areas where extended season shipping does not currently exist, approximations were made based on representative ice conditions at similar longitudes and the general prevailing wind direction. This latter factor influences ice conditions in such ports as Buffalo to a much greater extent than air temperature alone and has been incorporated into the ice conditions. In all cases it was assumed that the volume of traffic during the winter season would prohibit the broken ice from refreezing to a depth greater than three inches, which should not significantly influence ship resistance. It was also assumed that the U.S. Coast Guard would continue its current policy of maintaining broken ice channels and keeping the channel width equal to at least twice the largest ship's beam to prevent ice plugs from forming.

Ice conditions, along with the other attributes for each channel and lock reach, are tabulated in Appendix E of Volume II for mild, normal, and severe winters for every two week season extension period. Ice maps for a normal winter are also contained in Appendix E of Volume II.

IV. SHIP CLASSES AND FLEET MIX

Ships which transit the GL-SLS System were divided into four major types:

- LAKER BULK VESSELS
- OCEAN-GOING BULK VESSELS
- OCEAN-GOING GENERAL CARGO VESSELS
- ICEBREAKERS

These major ship types were further divided into classes to distinguish between different vessel sizes using the following standard Corps of Engineers Classification based on the length of the ship:

CORPS OF ENGINEERS VESSEL CLASSIFICATION BY LENGTH

CLASS	VESSEL LENGTH (feet)
1	Under 400
2	400 - 499
3	500 - 549
4	550 - 599
5	600 - 649
6	650 - 699
7	700 - 730
8	731 - 849
9	850 - 949
10	950 - 1000

For icebreakers, two classes were formed corresponding to a typical icebreaker and an icebreaking tug. The following vessel characteristics for each class are given in Tables 3 through 6:

CHARACTERISTIC	DESCRIPTION
Length	Overall length of ship (feet)
Beam	Maximum width of ship at the waterline (feet)
Horsepower	Maximum shaft horsepower generated by engines (hp)
Engine Type	Type of propulsion system

CHARACTERISTIC - Cont.	DESCRIPTION - Cont.
V_{design}	Maximum speed capability of the ship in open water (mph)
Locking Time - SLS	Time required for ship to lock through one lock at the St. Lawrence Seaway excluding delays (minutes)
Locking Time - WELLAND	Time required for ship to lock through one lock at the Welland Canal excluding delays (minutes)
Locking Time - SOO	Time required for ship to lock through a lock at Sault Ste. Marie excluding delays (minutes)
Midsummer Draft	Draft to which a vessel can load amid-ships during the designated Midsummer Season (feet)
Winter Draft	Draft to which a vessel can load amid-ships during the designated Winter Season (feet)
Long Tons/Inch Immersion	Long tons required to increase draft of vessel one inch (long tons per inch)
Self-Unloading Rate	Rate at which cargo can be unloaded by on-board unloading devices (long tons per hour)
MS Iron Ore	Maximum iron ore capacity required to achieve Midsummer Draft (long tons)
MS Coal	Maximum coal capacity (long tons)
MS Grain	Maximum grain capacity (long tons)
MS General Cargo	Maximum general cargo capacity required to achieve Midsummer Draft (long tons)

CHARACTERISTIC - Cont.	DESCRIPTION - Cont.
Ice Class	Rating as to the ice condition the ship can proceed through: IA: Extremely severe ice conditions IB: Severe ice conditions IC: Mild ice conditions II: Light ice conditions
Number of Crew	Number of working personnel aboard vessel
Total Sale Price	Estimated current sale price of vessel
Cubic Number	Product of the vessel's length, beam and depth divided by 100 (ft^3)
Gross Registered Tonnage	Cubic feet of interior space divided by 100
Capital Recovery Factor	Factor by which the initial investment is multiplied in order to find the annual cost of capital recovery

These vessel characteristics were obtained by selecting representative ships for each class and gathering data for each from Reference [3] and from discussions with owners. Once the data was gathered, certain characteristics were adjusted to more accurately reflect ships operating in specific trades. For example, lakers operating in the grain and coal trade generally have deeper cargo compartments than the usual iron ore ship because of the lower cargo density (lbs per cubic foot) of grain and coal compared to iron ore. These ships thus require more cubic volume capacity per ton of grain or coal than per ton of iron ore. To reflect this condition, the maximum grain and coal capacities indicated for laker bulk vessels were defined as 90% of the maximum iron ore capacities.

It was recognized that certain ship characteristics could not be defined for each class, with the expectation of representing the entire class of ships in the fleet. In particular, for any one class there are numerous self-unloaders as well as straight-deckers. A similar condition exists for ships equipped with bow thrusters. While the list of examples could be extended to the point where practically every ship would be

TABLE 3 .

LAKER BULK VESSEL CHARACTERISTICS

CHARACTERISTICS	SHIP CLASS 5	6	7	8	10
Length (feet)	640	699	730	767	1,000
Beam (feet)	67	70	75	70	105
Horsepower	4,000	7,700	8,800	7,000	14,000
Engine Type	Steam Turbine	Steam Turbine	Steam Turbine	Steam Turbine	Diesel
V design	14.5	16.5	16.5	16.5	18.0
Locking Time SLS (minutes)	37	39	41	41	59
Locking Time WELLAND (minutes)	36	37	39	40	43
Locking Time SOO (minutes)	56	57	55	66	87
Midsummer Draft (feet)	24.6	26.3	27.9	26.2	28.6
Winter Draft (feet)	22.0	24.5	26.0	24.5	28.6
Long Tons/Inch Immersion	996	1,206	1,452	1,404	2,542
Self-Unloading Rate (long tons/hr.)	0	0	0	0	8,500
MS Iron Ore (long tons)	18,150	22,400	27,600	26,500	57,500
MS Coal (long tons)	16,340	20,160	24,840	23,850	51,750
MS Grain (long tons)	16,340	20,160	24,840	23,850	51,750
Ice Class	II	IC	II	II	IC
Number of Crew	27	32	32	38	21
Total Sale Price (10^6)	6.97	12.15	17.29	17.28	33.60
Cubic Number	15,526	18,817	21,710	22,008	50,946
Gross Registered Tons	10,291	10,317	13,390	15,483	24,199
Capital Recovery Factor	0.157	0.139	0.134	0.139	0.131

TABLE 4 .

OCEAN GOING BULK VESSEL CHARACTERISTICS

CHARACTERISTICS	SHIP CLASS			
	4	5	6	7
Length (feet)	566	635	681	709
Beam (feet)	72	75	75	75
Horsepower	9,000	9,600	11,500	12,800
Engine Type	Diesel	Diesel	Diesel	Diesel
V design	19.0	17.3	18.4	17.3
Locking Time SLS (minutes)	33	37	39	41
Locking Time WELLAND (minutes)	35	36	37	39
Locking Time SOO (minutes)	56	56	57	55
Midsummer Draft (feet)	31.0	33.4	35.1	36.0
Winter Draft (feet)	31.0	33.4	35.1	36.0
Long Tons/Inch Immersion	1,118	904	1,266	1,291
MS Grain (long tons)	19,650	27,560	33,150	35,700
Ice Class	IB	IC	IC	IB
Number of Crew	30	30	30	30
Total Sale Price (10^6)	2.38	7.20	10.27	11.31
Cubic Number	13,510	17,148	19,312	20,671
Gross Registered Tonnage	14,468	12,100	19,644	21,288
Capital Recovery Factor	0.33	0.20	0.17	0.17

TABLE 5 .

OCEAN GOING GENERAL CARGO CHARACTERISTICS

CHARACTERISTICS	SHIP CLASS 1	2	3
Length (feet)	397	477	528
Beam (feet)	55	64	75
Horsepower	5,400	10,000	18,400
Engine Type	Diesel	Diesel	Diesel
V design (mph)	18.4	19.6	23.6
Locking Time SLS (minutes)	30	31	32
Locking Time WELLAND (minutes)	31	32	34
Locking Time SOO (minutes)	42	48	54
Midsummer Draft (feet)	25.3	28.6	31.5
Winter Draft (feet)	25.3	28.6	31.5
Long Tons/Inch Immersion	700	713	661
MS General (long tons)	6,250	12,780	12,030
Ice Class	IA	IA	IA
Number of Crew	30	30	30
Total Sale Price (10^6)	5.310	5.525	8.670
Cubic Number	5,523	8,908	12,473
Gross Registered Tons	5,419	9,003	10,846
Capital Recovery Factor	0.17	0.17	0.16

TABLE 6 .

ICEBREAKER CHARACTERISTICS

CHARACTERISTICS	CLASS 1	CLASS 2
Length (feet)	280	105
Beam (feet)	70	45
Horsepower	10,000	1,000
V design (mph)	16	14
Locking Time SLS(minutes)	25	20
Locking Time WELLAND (minutes)	25	20
Locking Time SOO (minutes)	40	40

treated as a unique class, it was felt these two were of particular importance since many docks in the system can service only self-unloaders and ships equipped with bow thrusters require a minimum of towing services. Therefore, each ship in the total fleet can be designated whether or not she is a self-unloader and whether or not she is equipped with bow thrusters. Thus, individual ships and not an entire class of ships can be restricted from delivering cargo to ports which service only self-unloaders.

Another major concern in describing the ship classes was whether or not laker bulk cargo ships should be restricted to single cargo trade, such as iron ore only, or be allowed to carry any bulk cargo, since both conditions exist in practice. For example, numerous ships are dedicated entirely or almost entirely to transporting iron ore from the head of the lakes to the lower lakes while other ships transport grain to Baie Comeau and then iron ore from Sept Iles to the lower lakes. Similar examples can be given for coal. To accommodate both conditions, each individual ship in the fleet can be assigned to transport a single cargo or as many as desired.

To calculate the annual required freight rates, a capital recovery factor and an investment level must be defined for each vessel class. Since this information was not readily available to us, the decision was made to treat each vessel class on a replacement basis; that is, to treat each vessel class as if it were bought today at today's prices. The total sale price or investment was defined as the current depreciated value of the cost of a new ship assuming straight line depreciation over its life. Laker vessels were assumed to have a 50-year, life while for ocean-going ships, a 20-year life was assumed due to the effect of the salt water environment. Data on the estimated cost of a new ship in each class was provided by the Corps of Engineers. The capital recovery factor was then established based on the remaining expected life of the ship, a 10% yield and a 48% tax rate similar to that used in the University of Michigan Model [2].

Using these ship classes as a basis, fleet mixes, given in Tables 7 and 8, were established for the years 1975, 1980, and 1995 from data provided by the Corps of Engineers and the St. Lawrence Seaway Development Corporation. The percentage split was obtained by using the projected cargo tonnage split

TABLE 7.

LAKER FLEET MIX (% OF SHIPS)

YEAR	SHIP CLASSES					
	5	6	7	8	10	TOTAL
1975						
Iron Ore	59	4	26	8	3	100%
Coal	69	4	23	4	-	100%
Grain*	38	31	31	-	-	100%
1980						
Iron Ore	38	2	20	27	13	100%
Coal	50	4	21	12	13	100%
Grain*	35	25	40	-	-	100%
1995						
Iron Ore	25	2	18	32	23	100%
Coal	44	4	20	12	20	100%
Grain*	25	15	50	4	6	100%

* Ships carrying grain from the lakes and iron ore from Sept Iles.

TABLE 8.

OCEAN-GOING FLEET MIX (% OF SHIPS IN FLEET)

YEAR	SHIP CLASSES							
	1	2	3	4	5	6	7	TOTAL
1975								
Bulk	-	-	-	39	23	14	24	100%
General Cargo	21	52	27	-	-	-	-	100%
1980								
Bulk	-	-	-	31	19	19	31	100%
General Cargo	13	45	42	-	-	-	-	100%
1995								
Bulk	-	-	-	17	11	33	39	100%
General Cargo	7	23	70	-	-	-	-	100%

reported in Reference 17. The fleet projection for 1995 was made assuming the locks in both the St. Lawrence Seaway and the Welland Canal would permit 1,000 foot vessels, similar to the POE Lock at the SOO.

In discussing individual ship classes, an important measure of performance is their ice transiting capability or icebreaking performance. Numerous measures of icebreaking performance have been proposed in the past. Two of the more frequently encountered measures are thickness of sheet ice which can be broken in either a continuous or ramming mode of operation, and penetration distance after impact during ramming. These measures are not very meaningful in terms of cargo ships, whose primary purpose is to move cargo from one point to another and not to break ice per se. Therefore, a much more meaningful measure of icebreaking or ice navigability is the speed a ship can attain through a given ice field. In Figures 4 through 7, the maximum speed of advance versus broken ice thickness is given for each cargo ship class. The method used in producing these figures is described in Appendix A of Volume II. From plots such as these, the ice navigability of each ship class can easily be established. For example, the maximum ice thickness a class 5 laker bulk cargo ship can proceed in is approximately 57 inches while, for a class 10 laker bulk cargo ship, the maximum ice thickness is 76 inches.

FIGURE 4.

SPEED OF ADVANCE VERSUS BROKEN ICE THICKNESS FOR LAKER BULK VESSELS

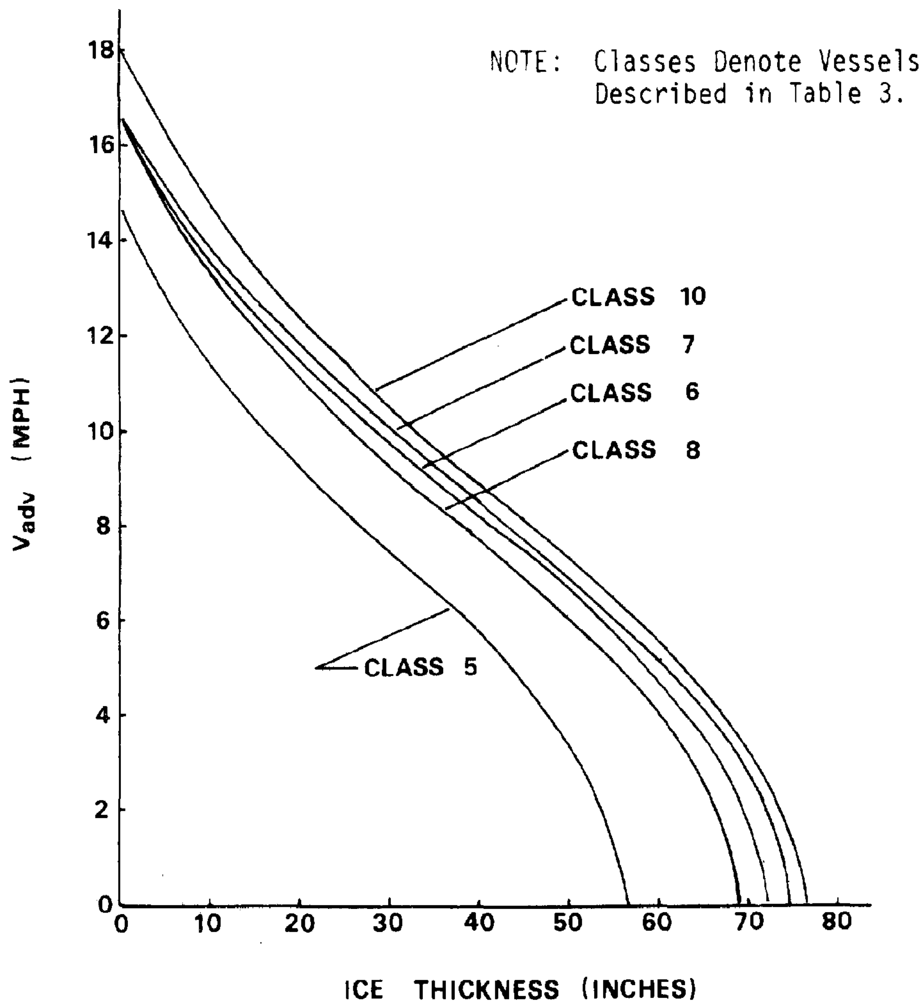


FIGURE 5.

SPEED OF ADVANCE VERSUS BROKEN ICE THICKNESS FOR OCEAN-GOING BULK VESSELS

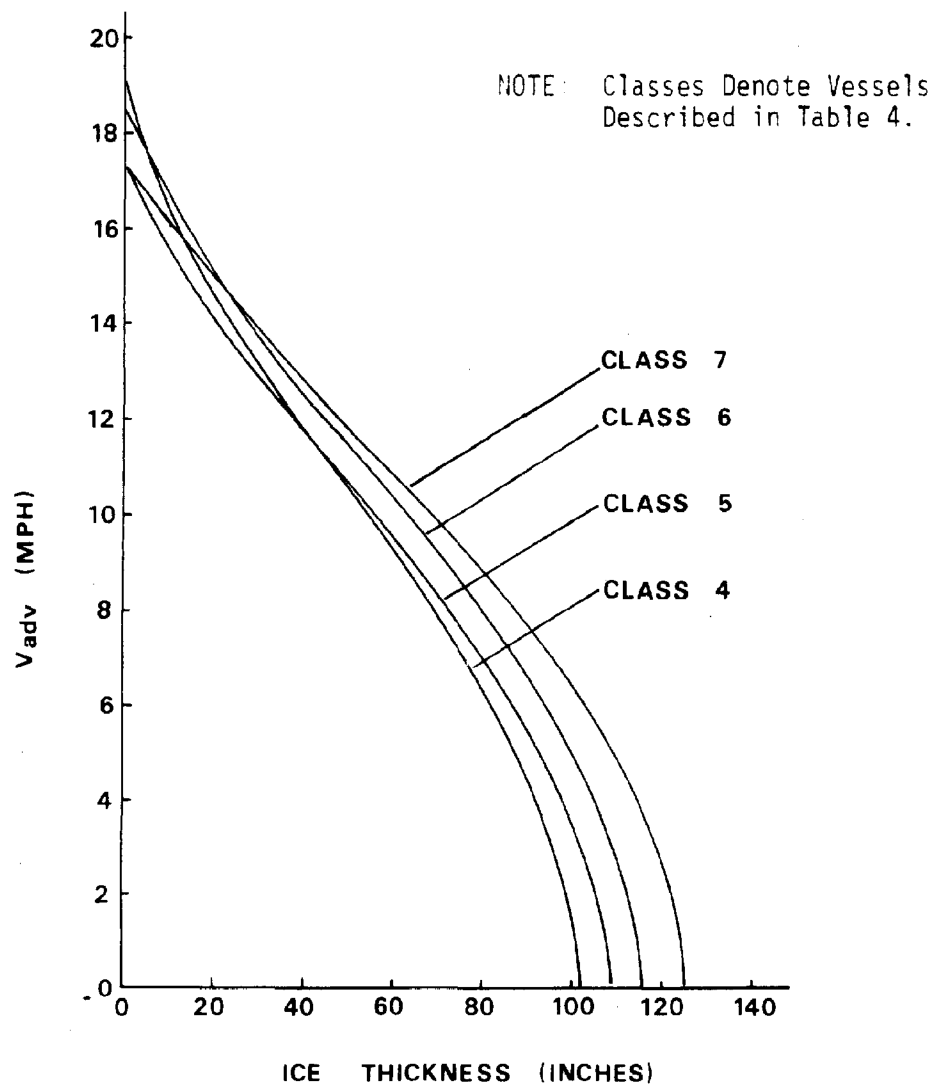


FIGURE 6.

SPEED OF ADVANCE VERSUS BROKEN ICE THICKNESS FOR OCEAN-GOING GENERAL CARGO VESSELS

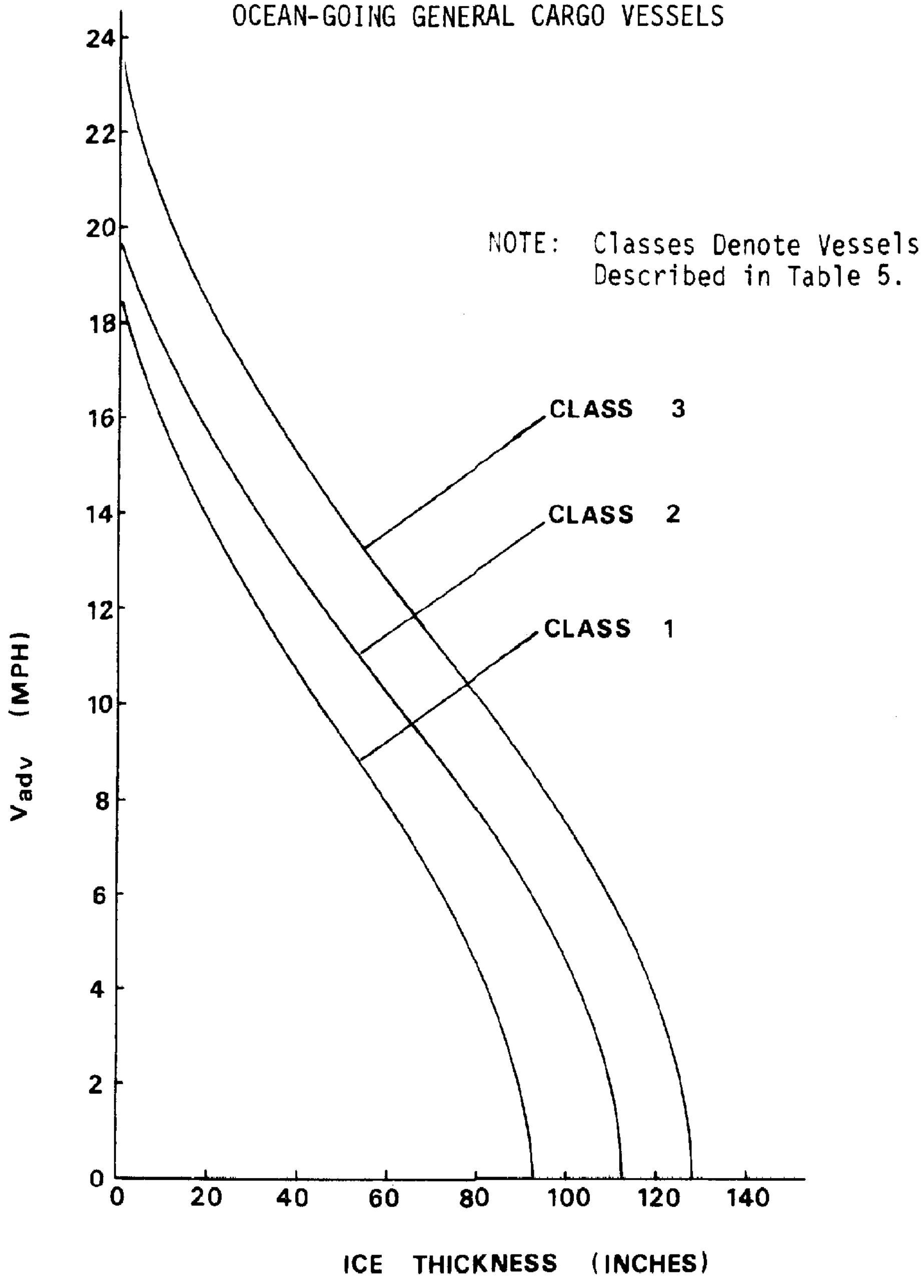
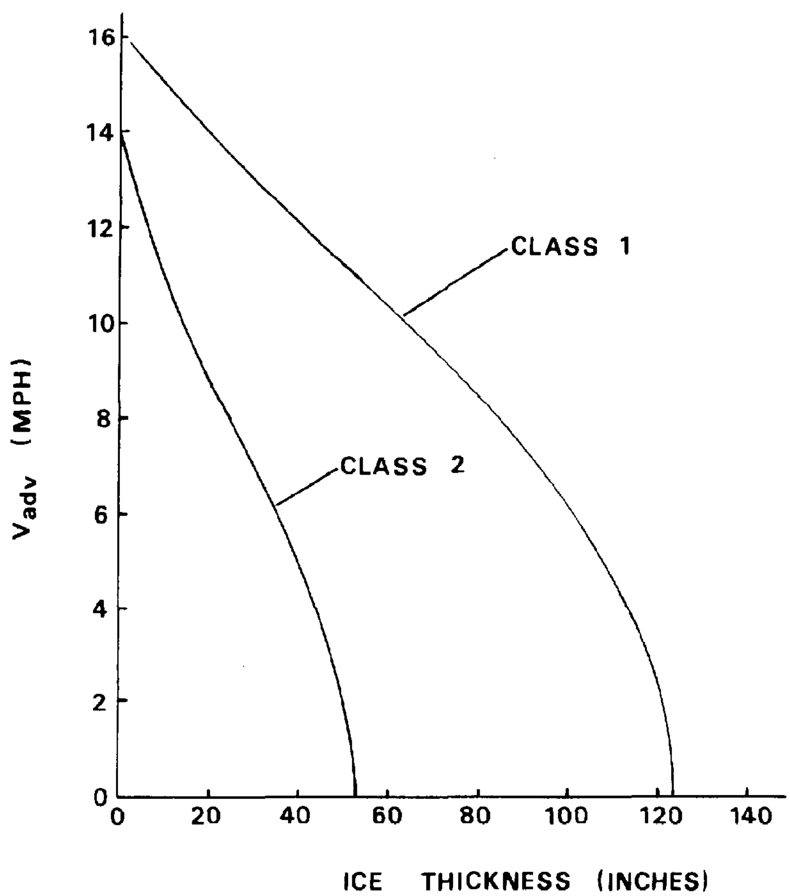


FIGURE 7.

SPEED OF ADVANCE VERSUS BROKEN ICE THICKNESS FOR ICEBREAKERS

NOTE: Classes Denote Vessels Described in Table 6.



V. SIMULATION DESCRIPTION

OVERVIEW

As indicated in the INTRODUCTION, the purpose of the model is to simulate the movement of ships and cargo during the winter season within the GL-SLS System and to and from overseas ports. During the running of the simulation, statistics are compiled for each class of ship operating on each route. These statistics, along with vessel data, are converted into annual vessel operating costs and the annual required freight rates for each route. In simulating the movement of ships and cargo, the model incorporates both the interactions between ships and the system and the interactions between the ships themselves, such as:

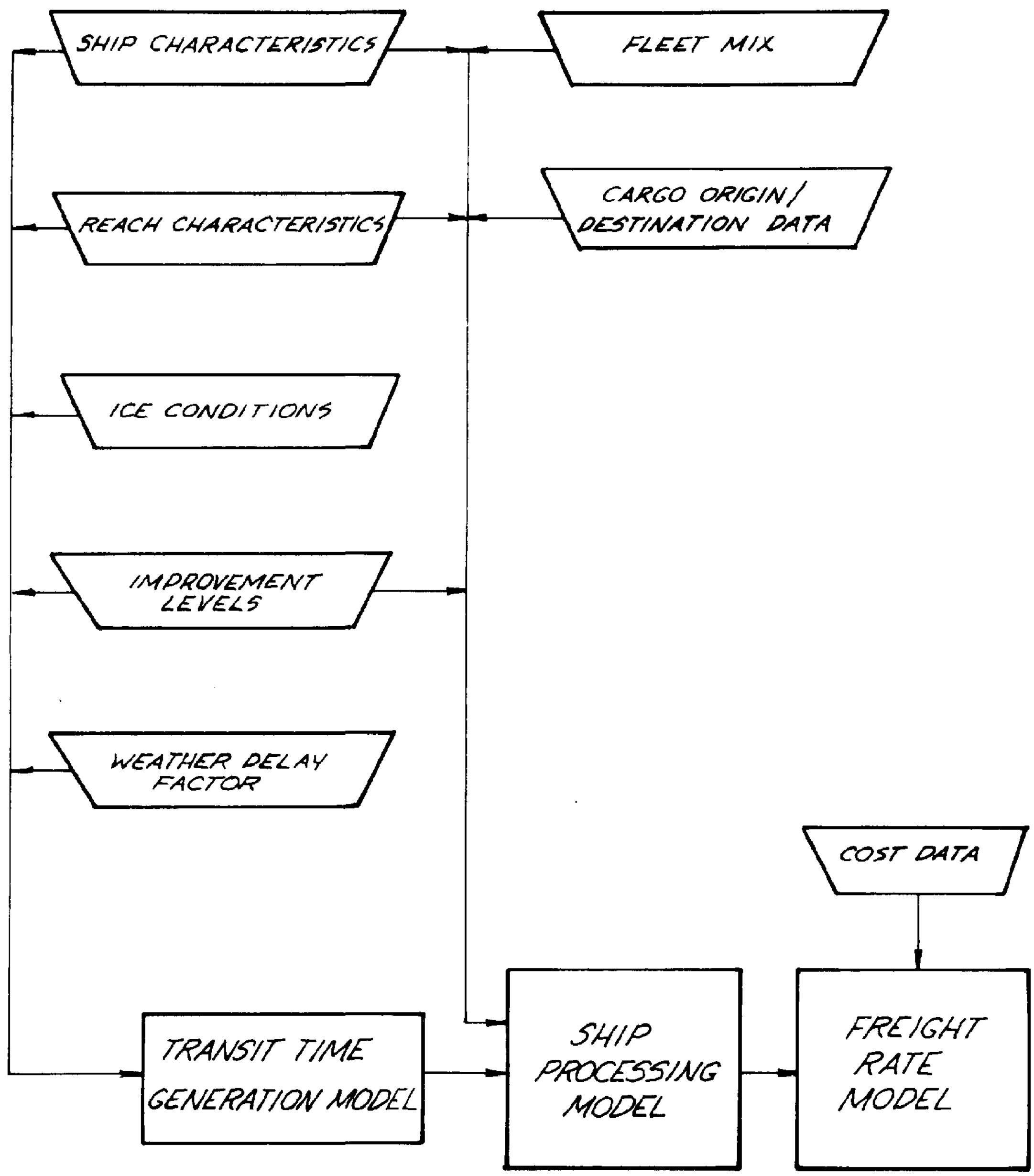
- Increased transit, lockage and port times due to presence of ice
- Port and lock limitations and constraints
- Draft limitations
- Speed limits
- Daylight only navigation
- Queues forming, expanding and diminishing at lock and port facilities
- Ships getting stuck and having to wait for icebreaker assistance

In order to develop a computer simulation which has sufficient detail to yield reasonable results, while requiring a minimum of computer time, the total simulation model was divided into the following individual models:

- TRANSIT TIME GENERATION MODEL
- SHIP PROCESSING MODEL
- FREIGHT RATE MODEL

The relationship of these three models to one another and to the input data is illustrated by the block diagram shown in Figure 8. By dividing the total simulation model in this manner, repetitive calculations, such as determining the transit time for a given reach, need only be performed once and stored in a data file for use every time the ship traverses the reach rather than repeating the calculation each time.

FIGURE 8.
SIMULATION BLOCK DIAGRAM



The purpose of the TRANSIT TIME GENERATION MODEL is to:

(1) Convert ship characteristics, reach characteristics, ice conditions, improvement levels and a weather delay factor into transit times required for each class of ship to traverse each channel and lock reach for every two-week season extension period.

(2) Generate an increased service time factor based on ice conditions for each port and lock facility for every two-week season extension period.

(3) Determine the maximum ship class and maximum allowable ship draft permitted to move from each port to every other port.

(4) Assemble the data in an appropriate format required by the SHIP PROCESSING MODEL.

In addition, the TRANSIT TIME GENERATION MODEL also indicates in which reaches a particular class of ship will become stuck. Delay times due to the ship becoming stuck and having to wait for icebreaker assistance are not determined in this model but in the SHIP PROCESSING MODEL since these delays are related to the level and availability of icebreaker support. Similarly, delay times due to ships waiting in queues for a port or lock facility to become available are also determined in the SHIP PROCESSING MODEL. Improvements to the system, such as bubbler systems and ice booms, are introduced into the model by reducing the corresponding ice thickness in the appropriate reach. By reducing the thickness, the resistance the ship must overcome is reduced, enabling the ship to increase its speed of advance and thereby decrease its transit time in the reach. A more detailed description, including the logic, method of analysis, and conceptual flow diagrams for the TRANSIT TIME GENERATION MODEL, is given in Appendix A of Volume II.

The SHIP PROCESSING MODEL uses the output from the TRANSIT TIME GENERATION MODEL, cargo origin and destination data, fleet mix, ship and reach characteristics and improvement levels to simulate the movement of ships and cargo while compiling the following statistics for each vessel class on every route for every two-week season extension period:

- Tons of cargo transported
- Time underway with cargo
- Time stopped with cargo
- Total number of trips
- Number of trips made by ships equipped with bow thrusters
- Number of trips made by self-unloaders
- Time underway during empty backhaul
- Time stopped during empty backhaul
- Number of trips through the Seaway with cargo
- Number of trips through the Seaway without cargo
- Number of trips through the Welland with cargo
- Number of trips through the Welland without cargo

It should be noted that the time spent during an empty backhaul is assigned to the vessel's next route. The simulation runs from November 1st through the entire winter navigation season to April 15th. The first two-week period (November 1st to 15th) is used to achieve a steady state condition in the system, and the following month (November 16th to December 15th) is used to gather statistics for the system to be representative of the normal navigation season. In representing the entire normal navigation season, weighted averages of both weather delay factors and seasonal ship draft variations are used. Starting with December 15th, a new set of the above listed statistics is compiled for each class of ship on each route for every subsequent two-week period.

In the Marine industry, there are two procedures used in routing ships and cargo from port to port. Ocean-going ships carrying general cargo follow preassigned itineraries; i.e., they visit specified ports of call following a prearranged time schedule. Ocean-going ships carrying bulk cargo also follow preassigned itineraries but their time schedules are not rigid as with general cargo. Laker bulk carriers, on the other hand, generally do not follow preassigned itineraries but are routed to optimize the system; i.e., operators try to maximize the cargo tonnage shipped per unit cost within the constraints imposed by the demands of their customers. To achieve this, operators try to minimize their empty backhauls. The model attempts to simulate this philosophy by routing ships and cargo from port to port based primarily on fulfilling the demand for cargo while striving to minimize the empty backhauls.

In processing ships from port to port, queues at ports and locks are allowed to form, expand and diminish as necessary. If the demand exceeds the capacity, a queue will form and grow indefinitely as long as the demand is greater than the capacity. The time spent in a queue waiting to be serviced is allocated to the route the ship is transiting. Similarly, when a ship becomes stuck and requires icebreaker assistance, the ship's waiting time is allocated to its current route. If the queue is large or if an icebreaker is currently not available, the waiting will be that much longer. The progress of ships as they transport cargo from port to port can be followed during the running of the simulation model by means of a VESSEL LOG RECORD, which indicates the status of each ship as it moves from port to port. Details of the logic, along with conceptual flow diagrams for the SHIP PROCESSING MODEL, are given in Appendix B in Volume II.

The statistics compiled for each class of ship on each route in the SHIP PROCESSING MODEL, along with vessel cost data, are converted by the FREIGHT RATE MODEL into vessel operating costs and required freight rates. The procedure used is similar to that used in the University of Michigan Model [2]. The annual required freight rate (RFR_{ij}) for the ith class of ship on the jth route is expressed by:

$$RFR_{ij}(\$/\text{long ton}) = \frac{CRF_i \cdot I_i + OC_{ij}}{T_{ij}} \qquad (1)$$

where CRF_i = Prorated capital recovery factor for the ith ship class

I_i = Investment level of the ith ship class

OC_{ij} = Total annual operating expenses of the ith ship class on the jth route

T_{ij} = Total annual tonnage of cargo transported by the ith ship class on the jth route

The annual operating expenses include the cost of:

- Fuel
- Wages and Benefits
- Subsistence and Supplies
- Protection and Indemnity Insurance
- Hull and Machinery Insurance
- Maintenance and Repair
- Towing
- Winter Lay-up
- Overhead
- Tolls

Since any individual ship will not operate on a single trade route for the entire navigation season, a prorated capital recovery factor (*CRF*) must be used instead of the annual one. For laker bulk carriers, which lay-up after the navigation season, the prorated capital recovery factor is given by:

$$CRF_i = CRF_i \text{annual} \cdot \left(\frac{\text{total time on } j\text{th route}}{\text{total time in navigation season}} \right) \quad (2)$$

For ocean-going vessels, which do not lay-up after the navigation season but operate elsewhere, the prorated capital recovery factor is given by:

$$CRF_i = CRF_i \text{annual} \cdot \left(\frac{\text{total time on } j\text{th route (minutes)}}{525{,}600} \right) \quad (3)$$

where 525,600 is the number of minutes in a year.

Once individual freight rates for each class of ship have been calculated for the jth route, the freight rate for the entire fleet of ships transporting cargo on the route is obtained by averaging the individual RFR_{ij} weighted on a tonnage basis, i.e.:

$$RFR_j = \frac{\sum_{i=1}^{N} RFR_{ij} \cdot T_{ij}}{\sum_{i=1}^{N} T_{ij}} \quad (4)$$

where RFR_j is the annual required freight rate for the jth route. The above procedure is repeated for every route and every two-week season extension increment.

In addition to freight rates, the FREIGHT RATE MODEL also calculates the annual operating cost per hour and annual operating cost per long ton of cargo for each vessel class. The details of the FREIGHT RATE MODEL, including the logic, method of analysis and conceptual flow diagrams, are given in Appendix C in Volume II.

RULES AND ASSUMPTIONS

In developing the simulation, the following major rules and assumptions were made:

Ships:

(1) All ships in the fleet are represented by specific ship classes.

(2) All ships will attempt to maintain their maximum capable speed at all times except where speed limits exist.

(3) A ship's maximum speed capability is determined by analyzing the ship's thrust capability versus its resistance characteristics.

(4) No accidents involving ships are assumed to occur in the system and no time delays due to accidents will be considered.

(5) Ship delays due to bad weather are accounted for by increasing the ship transit time by a weather delay factor based on historical data.

(6) All ships will observe winter draft restrictions during extended season operations.

(7) All lakers are assumed to lay-up at the end of the navigation season, while all ocean-going ships are assumed to operate elsewhere.

(8) All ships are treated on an equal basis.

(9) All ships will operate only during daylight hours in areas where nighttime navigation is prohibited.

(10) A ship is assumed to be stuck if its maximum capable speed of advance is less than 4 mph.

(11) Once stuck, a ship will call on an icebreaker for assistance and wait until the icebreaker arrives at the ship's location.

(12) If an icebreaker is not available and a ship becomes stuck, the ship must wait until one becomes available.

Icebreakers:

(1) Icebreakers, when called upon to free a ship, will escort that ship at 4 mph to the first reach where the ship can proceed without becoming stuck again.

(2) Icebreakers are assigned to specific regions and can assist only ships becoming stuck in that region.

(3) An icebreaker will not go beyond a lock reach into different regions.

(4) Icebreaker assistance is based on a first come-first served basis.

(5) Icebreakers will assist only one ship at a time.

Traffic Controller:

(1) Lakers are routed to fulfill the demand for cargo while attempting to minimize empty backhauls.

(2) Ocean-going ships follow preassigned itineraries.

(3) Ocean-going ships carrying general cargo spend two days in each port of call in the GL-SLS System and five days in the overseas port.

(4) Ships are routed only to ports which can accomodate them.

(5) Ships are not routed to ports requiring transit through a lock not able to accomodate the ship.

(6) Ships are allowed to carry only permissible cargo.

Channel Reaches:

(1) Ships are not permitted to exceed a speed limit if it exists in a particular reach.

(2) Passing is permitted in all reaches.

(3) Night operation is permitted except in areas where restricted.

Lock Reaches:

(1) Night operations are permitted except where restricted.

(2) Ships will be locked through in a manner which maximizes the lock's utilization.

(3) If queues exist on both sides of the lock, the lock will alternate in processing upbound and downbound ships.

(4) Ships are processed out of each queue on a first come-first served basis.

(5) If a queue exists on one side of the lock and the time of the arrival of a ship at the other side of the lock is less than the turnback time of the lock, the lock will wait to process the arriving ship. Otherwise, it will turn back to process the next ship in the queue.

(6) Only one ship at a time is locked through.

(7) Locking times are assumed to increase equally for all classes of ships at the rate of one percent for each inch of ice existing in the reach.

Port Reaches:

(1) Port facilities are assumed to operate 24 hours a day.

(2) Ships are loaded (unloaded) on a first come-first served basis.

(3) Ships are loaded with only one type of cargo at a time.

(4) Stockpiles are assumed to exist at all ports of origin and all ships are loaded to capacity or to some draft limitation with the exception of general cargo ships.

(5) Stockpiles are assumed to exist at all ports of destination and all ships are unloaded completely with the exception of general cargo ships.

(6) General cargo ships are loaded and unloaded using the given percent of capacity defined as input.

(7) The port turnaround times are assumed to increase equally for all classes of ships at the rate of one percent for each inch of ice in the next downbound reach.

(8) Ocean-going ships carrying grain stop in Baie Comeau to top-off before proceeding overseas.

Ice Conditions:

(1) Winter navigation is assumed to exist on a sufficient level to cause ice conditions in the navigation channel to correspond to a broken ice channel of twice the largest ship's beam.

(2) For each simulated extended season increment of two weeks, the ice conditions are assumed to be constant and equal to the conditions existing in the middle of the time period.

(3) Each channel reach and lock reach is divided into five sections corresponding to the existence of different ice conditions, with the middle section reserved for open water.

VALIDATION

As with any computer simulation, the results obtained are only as good as the basic input data and basic rules and assumptions. We earnestly tried to make the simulation represent the Great Lakes-St. Lawrence Seaway System as realistically as possible. In doing this, we used the knowledge we have gained as a result of the SPAN Study, ice-model testing of ships in our towing basin, full scale test programs on the Great Lakes and conversations with ship operators, port officials, and personnel at Coast Guard, MARAD, U.S. Army Corps of Engineers, and St. Lawrence Seaway Development Corporation. We also used available results and information from the work performed by the University of Michigan for MARAD and by Pennsylvania State University for the U.S. Army Corps of Engineers. We tried to include as much detail as possible in the simulation while keeping in mind the overall objective of developing a simulation for the entire GL-SLS System to be used as a planning tool to identify problem areas and bottlenecks to extended season navigation, and to evaluate the potential benefits of proposed solutions or improvements.

The real test of how realistically the simulation represents the Great Lakes-St. Lawrence Seaway System is through validation. The degree to which the simulation is validated is a direct measure of its credibility. We believe the validation presented in Appendix D in Volume II shows that the simulation accurately represents the GL-SLS System from the standpoint of the movement of ships and also from the standpoint of ship economics.

VI. RESULTS

As discussed in the INTRODUCTION, a modified simulation was run to obtain an estimate of the effect of winter navigation on vessel operating costs and annual required freight rates for use in Phase I and for input as initial cost and rate data into the CARGO FLOW MODEL. This simulation consisted of modifying the SIMULATION described in Section V in the following respects:

(1) SHIP ROUTING: Ships were assumed to operate on a single route for the entire navigation season. An appropriate empty backhaul port was selected for each laker bulk route. For overseas grain and general cargo routes, both Rotterdam and Japan were designated as the overseas port in order to evaluate the effect of distance from the GL-SLS System on the results.

(2) FLEET MIX: The mix of ship classes comprising the fleet operating on each route was specified.

(3) ICEBREAKER ASSISTANCE: If a ship became stuck, a two hour waiting time for icebreaker assistance was assumed. The ship was then escorted by the icebreaker at 4 mph to the next reach on the route where the ship could proceed without assistance.

With these changes incorporated, the modified simulation program was run for all the routes listed in Table 1 for a normal winter using the 1975 fleet mix indicated in Tables 7 and 8. Of these routes, representative ones were then selected to determine the effect of winter severity, fleet mix and improvement levels. Each computer run consisted of nine sets of output data for each route corresponding to data for the normal season followed by data for every two week season extension period. Each set of output data comprised the following information for each class of ship transporting cargo on the particular route:

- Loading Time per Trip
- Loading Port Turnaround Time per Trip
- Transit Time per Trip
- Locking Time per Trip
- Unloading Time per Trip
- Unloading Port Turnaround Time per Trip

- Total Round Trip Time
- Tonnage Transported per Trip
- Number of Trips per Season Extension Period
- Total Tonnage Transported during Season Extension Period
- Annual Time Underway
- Annual Time Not Underway
- Annual Number of Trips
- Annual Tonnage Transported
- Number of Trips During Normal Season
- Annual Crew Cost
- Annual Cost of Maintenance and Repair
- Annual Cost of Stores and Supplies
- Annual Cost of Insurance
- Annual Cost for Overhead
- Annual Cost of Towing
- Annual Cost of Winter Lay-Up
- Annual Cost of Fuel
- Annual Cost of Tolls
- Total Annual Operating Cost
- Annual Required Freight Rate
- Index of Required Freight Rate
- Annual Operating Cost per Ton of Cargo Transported
- Annual Operating Cost per Hour

This information for each class of ship was then combined to obtain similar information for the entire fleet transporting cargo on the route. The results of the computer runs have been divided into two categories: fleet results and individual ship class results. The results for each of these categories are presented separately in the following subsections. Discussion of these results, along with conclusions are presented in the next section.

FLEET RESULTS

The annual required freight rates and operating costs per long ton of cargo for all the routes listed in Table 1 for the normal winter using the 1975 fleet mixes indicated in Tables 7 and 8 are tabulated for monthly season extension increments in the following tables at the end of this section:

Table	Contents
9	Annual Required Freight Rates for Laker Bulk Cargo Routes
10	Annual Operating Cost Per Ton for Laker Bulk Cargo Routes
11	Annual Required Freight Rates for Overseas Grain Routes
12	Annual Operating Cost Per Ton for Overseas Grain Routes
13	Annual Required Freight Rates for Overseas General Cargo Routes
14	Annual Operating Cost Per Ton for Overseas General Cargo Routes

Included in each of these tables are index values using an 8 month navigation season as a basis. It should be noted that in Tables 13 and 14 for the overseas general cargo routes, ships are assumed to be filled to 100% of their cargo tonnage capacity. In the real world these ships will generally carry less for several reasons. First, due to the type of general cargo and its density, a ship can be totally filled from the standpoint of its volume capacity but not its tonnage capacity. Secondly, due to the frequency and availability of ships, and the requirements of the preassigned itinerary and schedule, sufficient cargo may not be available to fill general cargo ships to their cargo tonnage capacity. The approximate effect on general cargo freight rates for ships operating at less than capacity is illustrated in Figure 9.

To investigate the effect of winter severity, fleet mix and improvement levels on the required freight rates, the following computer runs were made:

Winter Severity	Fleet Mix	Improvement Level
Mild, Normal, Severe	1975	None
Normal	1975, 1980, 1995	None
Normal	1975	None, 25%, 50%, 75%

for twenty (20) representative routes listed in Table 15. While all routes could have been investigated, these twenty routes provide a good cross-section upon which to make comparisons and evaluate the effect of these variables on the GL-SLS System. The results of these computer runs are presented in graphical form in Figures 10 through 29.

In investigating the effect of improvements, the approach was taken to reduce the ice thickness in accordance with the level of the improvement in the following areas:

TABLE 9

ANNUAL REQUIRED FREIGHT RATES FOR LAKER BULK CARRIERS
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months)				
					8	9	10	11	12
1	Escanaba	Cleveland	Cleveland	Iron Ore	3.22* (1.00)**	3.05 (.948)	2.97 (.922)	2.97 (.921)	2.95 (.915)
2	Escanaba	Trenton Channel	Trenton Channel	Iron Ore	3.03 (1.00)	2.86 (.945)	2.78 (.918)	2.76 (.912)	2.74 (.905)
3	Escanaba	Indiana Harbor	Indiana Harbor	Iron Ore	1.85 (1.00)	1.75 (.945)	1.69 (.915)	1.66 (.899)	1.64 (.886)
4	Presque Isle	Cleveland	Cleveland	Iron Ore	3.47 (1.00)	3.28 (.946)	3.19 (.920)	3.18 (.916)	3.15 (.908)
5	Superior	Cleveland	Cleveland	Iron Ore	4.36 (1.00)	4.13 (.947)	4.02 (.922)	4.00 (.919)	3.98 (.914)
6	Superior	Ashtabula	Ashtabula	Iron Ore	4.43 (1.00)	4.20 (.947)	4.08 (.922)	4.07 (.918)	4.05 (.913)
7	Superior	Buffalo	Buffalo	Iron Ore	5.03 (1.00)	4.76 (.947)	4.64 (.923)	4.62 (.919)	4.60 (.915)
8	Superior	Detroit	Detroit	Iron Ore	3.74 (1.00)	3.54 (.946)	3.44 (.921)	3.42 (.916)	3.41 (.912)

* Annual required freight rate in $/long ton
**Index of required freight rate (8 Month Navigation Season = 1.00)

TABLE 9. (CONT'D)

ANNUAL REQUIRED FREIGHT RATES FOR LAKER BULK CARRIERS
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months) 8	9	10	11	12
9	Superior	Indiana Harbor	Indiana Harbor	Iron Ore	4.11 (1.00)	3.89 (.948)	3.79 (.924)	3.79 (.922)	3.78 (.920)
10	Duluth	Lorain	Lorain	Iron Ore	4.25 (1.00)	4.03 (.948)	3.92 (.924)	3.91 (.920)	3.89 (.916)
11	Duluth	Cleveland	Cleveland	Iron Ore	4.34 (1.00)	4.11 (.947)	4.00 (.923)	3.99 (.919)	3.97 (.915)
12	Duluth	Conneaut	Conneaut	Iron Ore	4.29 (1.00)	4.07 (.949)	3.97 (.925)	3.96 (.922)	3.94 (.919)
13	Duluth	Gary	Gary	Iron Ore	3.89 (1.00)	3.70 (.949)	3.61 (.926)	3.60 (.926)	3.60 (.924)
14	Duluth	Calumet	Calumet	Iron Ore	4.12 (1.00)	3.91 (.948)	3.81 (.925)	3.80 (.923)	3.80 (.921)
15	Two Harbors	Conneaut	Conneaut	Iron Ore	4.20 (1.00)	3.98 (.948)	3.88 (.923)	3.86 (.920)	3.84 (.915)
16	Two Harbors	Gary	Gary	Iron Ore	3.80 (1.00)	3.60 (.948)	3.51 (.924)	3.51 (.923)	3.50 (.920)
17	Two Harbors	Calumet	Calumet	Iron Ore	4.03 (1.00)	3.82 (.948)	3.72 (.923)	3.71 (.920)	3.69 (.917)

TABLE 9. (CONT'D)

ANNUAL REQUIRED FREIGHT RATES FOR LAKER BULK CARRIERS
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months)				
					8	9	10	11	12
18	Silver Bay	Toledo	Toledo	Iron Ore	4.02 (1.00)	3.81 (.947)	3.70 (.921)	3.68 (.915)	3.66 (.909)
19	Silver Bay	Cleveland	Cleveland	Iron Ore	4.11 (1.00)	3.89 (.947)	3.79 (.920)	3.76 (.915)	3.74 (.909)
20	Taconite Harbor	Buffalo	Buffalo	Iron Ore	4.79 (1.00)	4.54 (.947)	4.41 (.921)	4.39 (.916)	4.35 (.909)
21	Taconite Harbor	Burns Harbor	Burns Harbor	Iron Ore	3.74 (1.00)	3.55 (.948)	3.46 (.923)	3.45 (.920)	3.43 (.915)
22	Taconite Harbor	Indiana Harbor	Indiana Harbor	Iron Ore	3.87 (1.00)	3.66 (.947)	3.56 (.922)	3.55 (.918)	3.53 (.913)
23	Thunder Bay	Indiana Harbor	Indiana Harbor	Iron Ore	3.52 (1.00)	3.34 (.948)	3.25 (.924)	3.24 (.921)	3.23 (.916)
24	Toledo	Rouge River	Rouge River	Coal	1.05 (1.00)	0.99 (.943)	0.96 (.918)	0.96 (.910)	0.94 (.898)
25	Toledo	Detroit	Detroit	Coal	0.97 (1.00)	0.97 (.945)	0.89 (.921)	0.89 (.915)	0.88 (.904)
26	Toledo	Green Bay	Toledo	Coal	2.16 (1.00)	2.04 (.944)	1.98 (.919)	1.97 (.914)	1.96 (.907)
27	Toledo	Sault Ste. Marie	Toledo	Coal	1.76 (1.00)	1.66 (.942)	1.61 (.914)	1.59 (.906)	1.58 (.896)

TABLE 9. (CONT'D)

ANNUAL REQUIRED FREIGHT RATES FOR LAKER BULK CARRIERS
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months)				
					8	9	10	11	12
28	Calumet	Duluth	Calumet	Coal	2.80 (1.00)	2.63 (.942)	2.55 (.913)	2.54 (.907)	2.52 (.901)
29	Duluth	Baie Comeau	Cleveland	Grain	8.42 (1.00)	8.03 (.953)	7.93 (.941)	7.95 (.944)	7.90 (.937)
30	Sept Iles	Cleveland	Baie Comeau	Iron Ore	3.74 (1.00)	3.61 (.966)	3.62 (.969)	3.67 (.982)	3.65 (.978)
31	Calumet	Baie Comeau	Calumet	Grain	6.38 (1.00)	6.09 (.955)	6.03 (.946)	6.06 (.950)	6.01 (.942)
32	Sept Iles	Calumet	Baie Comeau	Iron Ore	5.27 (1.00)	5.07 (.962)	5.05 (.959)	5.10 (.968)	5.07 (.963)
33	Toledo	Baie Comeau	Cleveland	Grain	5.16 (1.00)	4.94 (.957)	4.92 (.952)	4.46 (.960)	4.91 (.951)
34	Thunder Bay	Baie Comeau	Cleveland	Grain	7.78 (1.00)	7.43 (.954)	7.34 (.943)	7.37 (.946)	7.30 (.938)

TABLE 10

ANNUAL OPERATING COSTS PER TON FOR LAKER BULK ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months) 8	9	10	11	12
1	Escanaba	Cleveland	Cleveland	Iron Ore	1.66* (1.00)**	1.65 (.992)	1.69 (1.02)	1.76 (1.06)	1.83 (1.10)
2	Escanaba	Trenton Channel	Trenton Channel	Iron Ore	1.53 (1.00)	1.52 (.990)	1.55 (1.01)	1.62 (1.06)	1.67 (1.09)
3	Escanaba	Indiana Harbor	Indiana Harbor	Iron Ore	0.94 (1.00)	0.93 (.991)	0.94 (1.00)	0.97 (1.03)	1.00 (1.06)
4	Presque Isle	Cleveland	Cleveland	Iron Ore	1.79 (1.00)	1.77 (.990)	1.81 (1.01)	1.89 (1.06)	1.95 (1.09)
5	Superior	Cleveland	Cleveland	Iron Ore	2.26 (1.00)	2.24 (.991)	2.29 (1.01)	2.39 (1.06)	2.48 (1.10)
6	Superior	Ashtabula	Ashtabula	Iron Ore	2.31 (1.00)	2.29 (.990)	2.34 (1.01)	2.43 (1.05)	2.52 (1.09)
7	Superior	Buffalo	Buffalo	Iron Ore	2.62 (1.00)	2.60 (.991)	2.65 (1.01)	2.77 (1.06)	2.87 (1.10)
8	Superior	Detroit	Detroit	Iron Ore	1.95 (1.00)	1.93 (.990)	1.97 (1.01)	2.05 (1.05)	2.13 (1.09)
9	Superior	Indiana Harbor	Indiana Harbor	Iron Ore	2.13 (1.00)	2.12 (.992)	2.17 (1.02)	2.26 (1.06)	2.35 (1.10)

* Annual operating cost per ton in $/long ton
** Index of operating cost per ton (8 Month Navigation Season = 1.00)

TABLE 10. (CONT'D)

ANNUAL OPERATING COSTS PER TON FOR LAKER BULK ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months) 8	9	10	11	12
10	Duluth	Lorain	Lorain	Iron Ore	2.22 (1.00)	2.20 (.991)	2.25 (1.01)	2.34 (1.05)	2.43 (1.09)
11	Duluth	Cleveland	Cleveland	Iron Ore	2.26 (1.00)	2.24 (.991)	2.29 (1.01)	2.38 (1.05)	2.47 (1.09)
12	Duluth	Conneaut	Conneaut	Iron Ore	2.25 (1.00)	2.24 (.992)	2.29 (1.02)	2.38 (1.06)	2.47 (1.10)
13	Duluth	Gary	Gary	Iron Ore	2.04 (1.00)	2.03 (.997)	2.08 (1.02)	2.17 (1.06)	2.26 (1.11)
14	Duluth	Calumet	Calumet	Iron Ore	2.15 (1.00)	2.13 (.992)	2.18 (1.01)	2.28 (1.06)	2.37 (1.10)
15	Two Harbors	Conneaut	Conneaut	Iron Ore	2.20 (1.00)	2.19 (.991)	2.23 (1.01)	2.33 (1.06)	2.41 (1.10)
16	Two Harbors	Gary	Gary	Iron Ore	1.99 (1.00)	1.98 (.992)	2.02 (1.02)	2.11 (1.06)	2.19 (1.10)
17	Two Harbors	Calumet	Calumet	Iron Ore	2.10 (1.00)	2.08 (.991)	2.13 (1.01)	2.22 (1.06)	2.31 (1.10)
18	Silver Bay	Toledo	Toledo	Iron Ore	2.09 (1.00)	2.07 (.990)	2.11 (1.01)	2.20 (1.05)	2.28 (1.09)

TABLE 10. (CONT'D)

ANNUAL OPERATING COSTS PER TON FOR LAKER BULK ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months) 8	9	10	11	12
19	Silver Bay	Cleveland	Cleveland	Iron Ore	2.14 (1.00)	2.12 (.991)	2.16 (1.01)	2.25 (1.05)	2.33 (1.09)
20	Taconite Harbor	Buffalo	Buffalo	Iron Ore	2.50 (1.00)	2.48 (.991)	2.52 (1.01)	2.63 (1.05)	2.72 (1.09)
21	Taconite Harbor	Burns Harbor	Burns Harbor	Iron Ore	1.96 (1.00)	1.95 (.992)	1.99 (1.02)	2.07 (1.06)	2.15 (1.10)
22	Taconite Harbor	Indiana Harbor	Indiana Harbor	Iron Ore	2.01 (1.00)	2.00 (.992)	2.04 (1.01)	2.13 (1.06)	2.20 (1.09)
23	Thunder Bay	Indiana Harbor	Indiana Harbor	Iron Ore	1.83 (1.00)	1.82 (.992)	1.86 (1.02)	1.94 (1.06)	2.01 (1.10)
24	Toledo	Rouge River	Rouge River	Coal	0.56 (1.00)	0.55 (.986)	0.56 (1.01)	0.58 (1.04)	0.60 (1.07)
25	Toledo	Detroit	Detroit	Coal	0.52 (1.00)	0.52 (.988)	0.53 (1.01)	0.55 (1.05)	0.56 (1.08)
26	Toledo	Green Bay	Toledo	Coal	1.14 (1.00)	1.12 (.987)	1.14 (1.01)	1.19 (1.05)	1.23 (1.08)

TABLE 10. (CONT'D)
ANNUAL OPERATING COSTS PER TON FOR LAKER BULK ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	Port of Origin	Port of Destination	Empty Backhaul Port	Cargo	Length of Navigation Season (months)				
					8	9	10	11	12
27	Toledo	Sault St. Marie	Toledo	Coal	0.94 (1.00)	0.93 (.984)	0.94 (1.00)	0.98 (1.04)	1.01 (1.07)
28	Calumet	Duluth	Calumet	Coal	1.47 (1.00)	1.45 (.984)	1.47 (1.00)	1.53 (1.04)	1.58 (1.08)
29	Duluth	Baie Comeau	Cleveland	Grain	4.65 (1.00)	4.62 (.995)	4.77 (1.03)	4.98 (1.07)	5.13 (1.10)
30	Sept Iles	Cleveland	Baie Comeau	Iron Ore	2.19 (1.00)	2.20 (1.01)	2.29 (1.05)	2.41 (1.10)	2.47 (1.13)
31	Calumet	Baie Comeau	Calumet	Grain	3.53 (1.00)	3.52 (.997)	3.64 (1.03)	3.81 (1.08)	3.92 (1.11)
32	Sept Iles	Calumet	Baie Comeau	Iron Ore	3.03 (1.00)	3.03 (1.00)	3.15 (1.04)	3.29 (1.09)	3.39 (1.12)
33	Toledo	Baie Comeau	Cleveland	Grain	2.89 (1.00)	2.88 (.998)	2.99 (1.04)	3.14 (1.09)	3.22 (1.12)
34	Thunder Bay	Baie Comeau	Cleveland	Grain	4.31 (1.00)	4.29 (.995)	4.43 (1.03)	4.63 (1.07)	4.76 (1.10)

TABLE 11

ANNUAL REQUIRED FREIGHT RATE OVERSEAS GRAIN ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Loading Ports	Empty Backhaul Port	Length of Navigation Season (months) 8	9	10	11	12
1	Rotterdam	Duluth Baie Comeau	Gulf of St. Lawrence	16.67* (1.00)**	16.72 (1.00)	16.98 (1.02)	17.31 (1.04)	17.56 (1.05)
2	Rotterdam	Calumet Baie Comeau	Calumet	7.88 (1.00)	7.90 (1.00)	8.03 (1.02)	8.20 (1.04)	8.32 (1.06)
3	Rotterdam	Duluth Baie Comeau	Cleveland	9.12 (1.00)	9.15 (1.00)	9.29 (1.02)	9.49 (1.04)	9.63 (1.06)
1	Japan	Duluth Baie Comeau	Gulf of St. Lawrence	27.03 (1.00)	27.08 (1.00)	27.45 (1.02)	27.90 (1.03)	28.28 (1.05)
2	Japan	Calumet Baie Comeau	Calumet	18.24 (1.00)	18.27 (1.00)	18.50 (1.02)	18.79 (1.03)	19.03 (1.04)
3	Japan	Duluth Baie Comeau	Cleveland	19.48 (1.00)	19.51 (1.00)	19.76 (1.02)	20.07 (1.03)	20.34 (1.04)

*Annual required freight rate in $/long ton
**Index of required freight rate (8 Month Navigation Season = 1.00)

TABLE 12

ANNUAL OPERATING COSTS PER TON FOR OVERSEAS GRAIN ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Loading Ports	Empty Backhaul Port	Length of Navigation Season (months) 8	9	10	11	12
1	Rotterdam	Duluth, Baie Comeau	Gulf of St. Lawrence	12.11* (1.00)**	12.14 (1.00)	12.36 (1.02)	12.65 (1.05)	12.88 (1.06)
2	Rotterdam	Calumet, Baie Comeau	Calumet	5.71 (1.00)	5.73 (1.00)	5.84 (1.02)	5.98 (1.05)	6.09 (1.07)
3	Rotterdam	Duluth, Baie Comeau	Cleveland	6.62 (1.00)	6.64 (1.00)	6.77 (1.02)	6.93 (1.05)	7.06 (1.07)
1	Japan	Duluth, Baie Comeau	Gulf of St. Lawrence	19.62 (1.00)	19.65 (1.00)	19.97 (1.02)	20.37 (1.04)	20.73 (1.06)
2	Japan	Calumet, Baie Comeau	Calumet	13.23 (1.00)	13.24 (1.00)	13.45 (1.02)	13.70 (1.04)	13.94 (1.05)
3	Japan	Duluth, Baie Comeau	Cleveland	14.14 (1.00)	14.15 (1.00)	14.38 (1.02)	14.65 (1.04)	14.91) (1.05)

* Annual operating costs per ton in $/long ton

** Index of operating cost per ton (8 Months Navigation Season = 1.00)

TABLE 13

ANNUAL REQUIRED FREIGHT RATES FOR OVERSEAS GENERAL CARGO ROUTES

(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Ports of Call in System	Length of Navigation Season (months)				
			8	9	10	11	12
1	Rotterdam	Montreal, Cleveland, Detroit, Montreal	20.46* (1.00)**	20.55 (1.00)	20.74 (1.01)	20.96 (1.02)	21.07 (1.03)
2	Rotterdam	Montreal, Detroit, Calumet, Montreal	22.21 (1.00)	22.31 (1.00)	22.50 (1.01)	22.75 (1.02)	22.87 (1.03)
3	Rotterdam	Montreal, Detroit, Duluth, Montreal	22.59 (1.00)	22.68 (1.00)	22.88 (1.01)	23.13 (1.02)	23.26 (1.03)
4	Rotterdam	Montreal, Toronto, Cleveland, Saginaw, Milwaukee, Montreal	24.07 (1.00)	24.17 (1.00)	24.38 (1.01)	24.65 (1.02)	24.78 (1.03)

* Annual required freight rate in $/long ton

** Index of required freight rate (8 Months Navigation Season = 1.00)

TABLE 13. (CONT'D)

ANNUAL REQUIRED FREIGHT RATES FOR OVERSEAS GENERAL CARGO ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Ports of Call in System	Length of Navigation Season (months)				
			8	9	10	11	12
5	Rotterdam	Montreal, Detroit, Green Bay, Duluth, Cleveland, Montreal	24.82 (1.00)	24.93 (1.00)	25.15 (1.01)	25.43 (1.02)	25.58 (1.03)
6	Japan	Montreal, Cleveland, Detroit, Montreal	41.76 (1.00)	41.88 (1.00)	42.11 (1.01)	42.40 (1.02)	42.56 (1.02)
7	Japan	Montreal, Detroit, Calumet, Montreal	43.52 (1.00)	43.63 (1.00)	43.88 (1.01)	44.18 (1.02)	44.36 (1.02)
8	Japan	Montreal, Detroit, Duluth, Montreal	43.89 (1.00)	44.01 (1.00)	44.26 (1.01)	44.57 (1.02)	44.75 (1.02)

TABLE 13. (CONTINUED)

ANNUAL REQUIRED FREIGHT RATES FOR OVERSEAS GENERAL CARGO ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Ports of Call in System	Length of Navigation Season (months) 8	9	10	11	12
9	Japan	Montreal, Toronto, Cleveland, Saginaw, Milwaukee, Montreal	45.37 (1.00)	45.50 (1.00)	45.76 (1.01)	46.08 (1.02)	46.27 (1.02)
10	Japan	Montreal, Detroit, Green Bay, Duluth, Cleveland, Montreal	46.12 (1.00)	46.25 (1.00)	46.53 (1.01)	46.87 (1.02)	47.07 (1.02)

TABLE 14

ANNUAL OPERATING COSTS PER TON FOR OVERSEAS GENERAL CARGO ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Ports of Call in System	Length of Navigation Season (months) 8	9	10	11	12
1	Rotterdam	Montreal, Cleveland, Detroit, Montreal	15.41* (1.00)**	15.49 (1.01)	15.64 (1.01)	15.82 (1.03)	15.91 (1.03)
2	Rotterdam	Montreal, Detroit, Calumet, Montreal	16.78 (1.00)	16.85 (1.00)	17.01 (1.01)	17.21 (1.03)	17.31 (1.03)
3	Rotterdam	Montreal, Detroit, Duluth, Montreal	17.06 (1.00)	17.14 (1.00)	17.30 (1.01)	17.50 (1.03)	17.61 (1.03)
4	Rotterdam	Montreal, Toronto, Cleveland, Saginaw, Milwaukee, Montreal	18.02 (1.00)	18.11 (1.00)	18.28 (1.01)	18.50 (1.03)	18.61 (1.03)

* Annual operating costs per ton in $/long ton

** Index of operating costs per ton (8 Month Navigation Season = 1.00)

TABLE 14. (CONT'D)

ANNUAL OPERATING COSTS PER TON FOR OVERSEAS GENERAL CARGO ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Ports of Call in System	Length of Navigation Season (months) 8	9	10	11	12
5	Rotterdam	Montreal, Detroit, Green Bay, Duluth, Cleveland, Montreal	18.60 (1.00)	18.69 (1.00)	18.87 (1.01)	19.10 (1.03)	19.23 (1.03)
6	Japan	Montreal, Cleveland, Detroit, Montreal	31.95 (1.00)	32.04 (1.00)	32.23 (1.01)	32.47 (1.02)	32.60 (1.02)
7	Japan	Montreal, Detroit, Calumet, Montreal	33.32 (1.00)	33.40 (1.00)	33.61 (1.01)	33.85 (1.02)	34.00 (1.02)
8	Japan	Montreal, Detroit, Duluth, Montreal	33.60 (1.00)	33.69 (1.00)	33.90 (1.01)	34.15 (1.02)	34.31 (1.02)

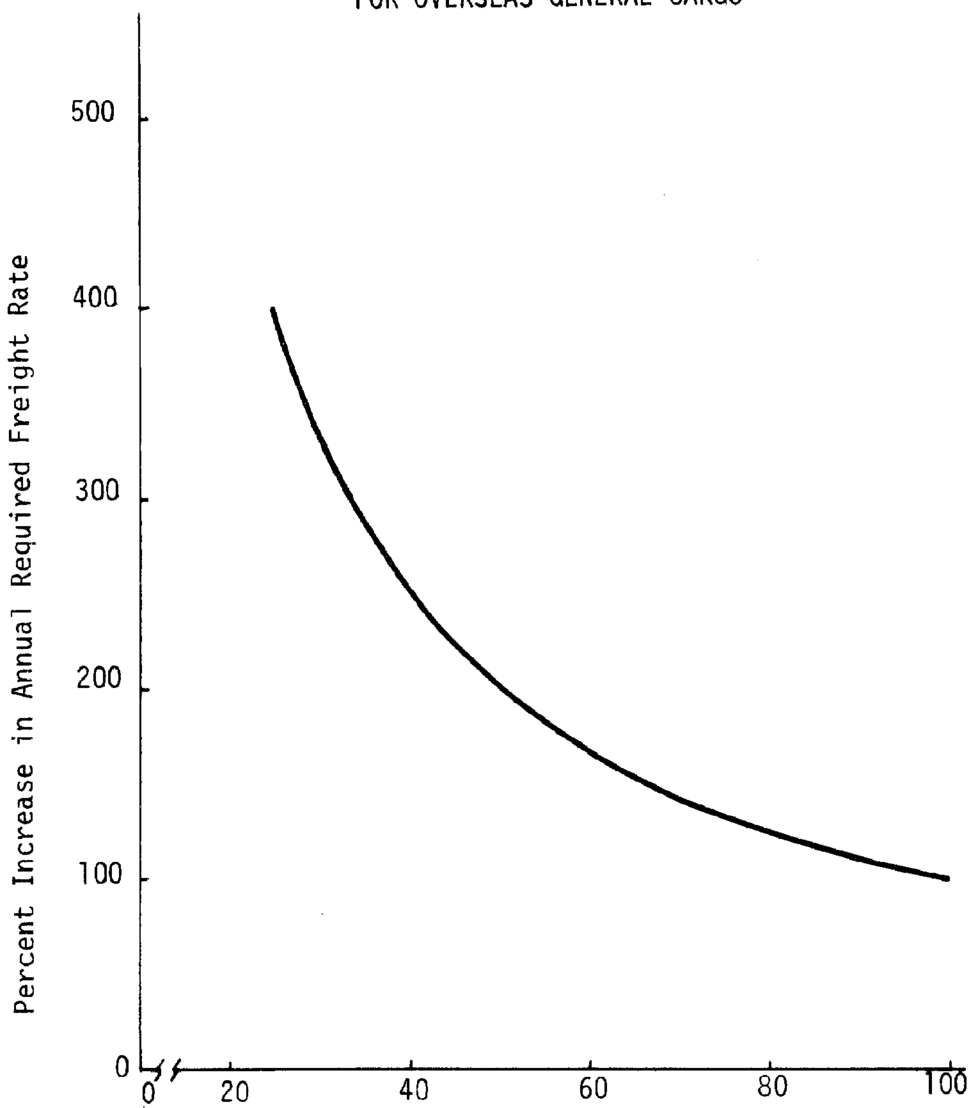
TABLE 14. (CONT'D)

ANNUAL OPERATING COSTS PER TON FOR OVERSEAS GENERAL CARGO ROUTES
(1975 FLEET, NORMAL WINTER)

Route Number	World Area	Ports of Call in System	Length of Navigation Season (months)				
			8	9	10	11	12
9	Japan	Montreal, Toronto, Cleveland, Saginaw, Milwaukee Montreal	34.56 (1.00)	34.66 (1.00)	34.87 (1.01)	35.14 (1.02)	35.30 (1.02)
10	Japan	Montreal, Detroit, Green Bay, Duluth, Cleveland, Montreal	34.14 (1.00)	35.24 (1.00)	35.47 (1.01)	35.74 (1.02)	35.92 (1.02)

FIGURE 9

EFFECT OF PER CENT CAPACITY ON ANNUAL REQUIRED FREIGHT RATES FOR OVERSEAS GENERAL CARGO



Percent Capacity = $\frac{\text{Total Annual Tonnage}}{\text{Ship's Capacity*Number of Trips/Yr.}}$

TABLE 15

REPRESENTATIVE ROUTES USED TO
INVESTIGATE THE EFFECT OF WINTER SEVERITY, FLEET MIX
AND IMPROVEMENTS ON REQUIRED FREIGHT RATES

Figure No.	Cargo	Port of Origin	Port of Destination
6	Iron Ore	Two Harbors	Gary
7	Iron Ore	Two Harbors	Conneaut
8	Iron Ore	Sept Isle	Cleveland
9	Iron Ore	Escanaba	Indiana Harbor
10	Iron Ore	Escanaba	Cleveland
11	Coal	Calumet	Duluth
12	Coal	Toledo	Detroit
13	Grain	Toledo	Baie-Comeau
14	Grain	Duluth	Baie-Comeau
15	Grain	Calumet	Baie-Comeau
16	Grain	Calumet	Rotterdam
17	Grain	Duluth	Rotterdam
18	Grain	Duluth	Japan
19	Grain	Calumet	Japan
20	General Cargo	Cleveland	Rotterdam
21	General Cargo	Calumet	Rotterdam
22	General Cargo	Duluth	Rotterdam
23	General Cargo	Cleveland	Japan
24	General Cargo	Calumet	Japan
25	General Cargo	Duluth	Japan

FIGURE 10

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

IRON ORE FROM TWO HARBORS TO GARY

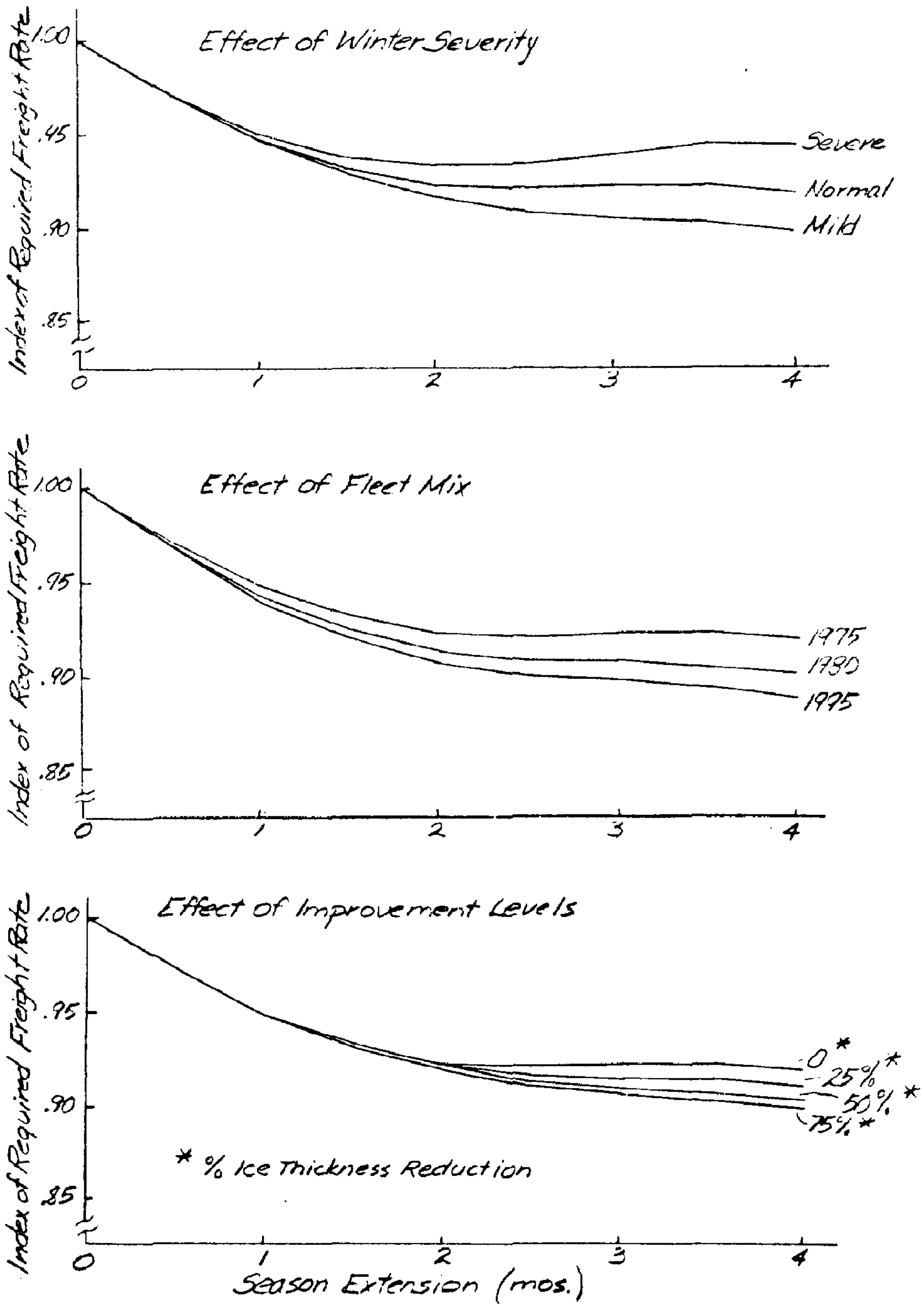


FIGURE 11

INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
IRON ORE FROM TWO HARBORS TO CONNEAUT

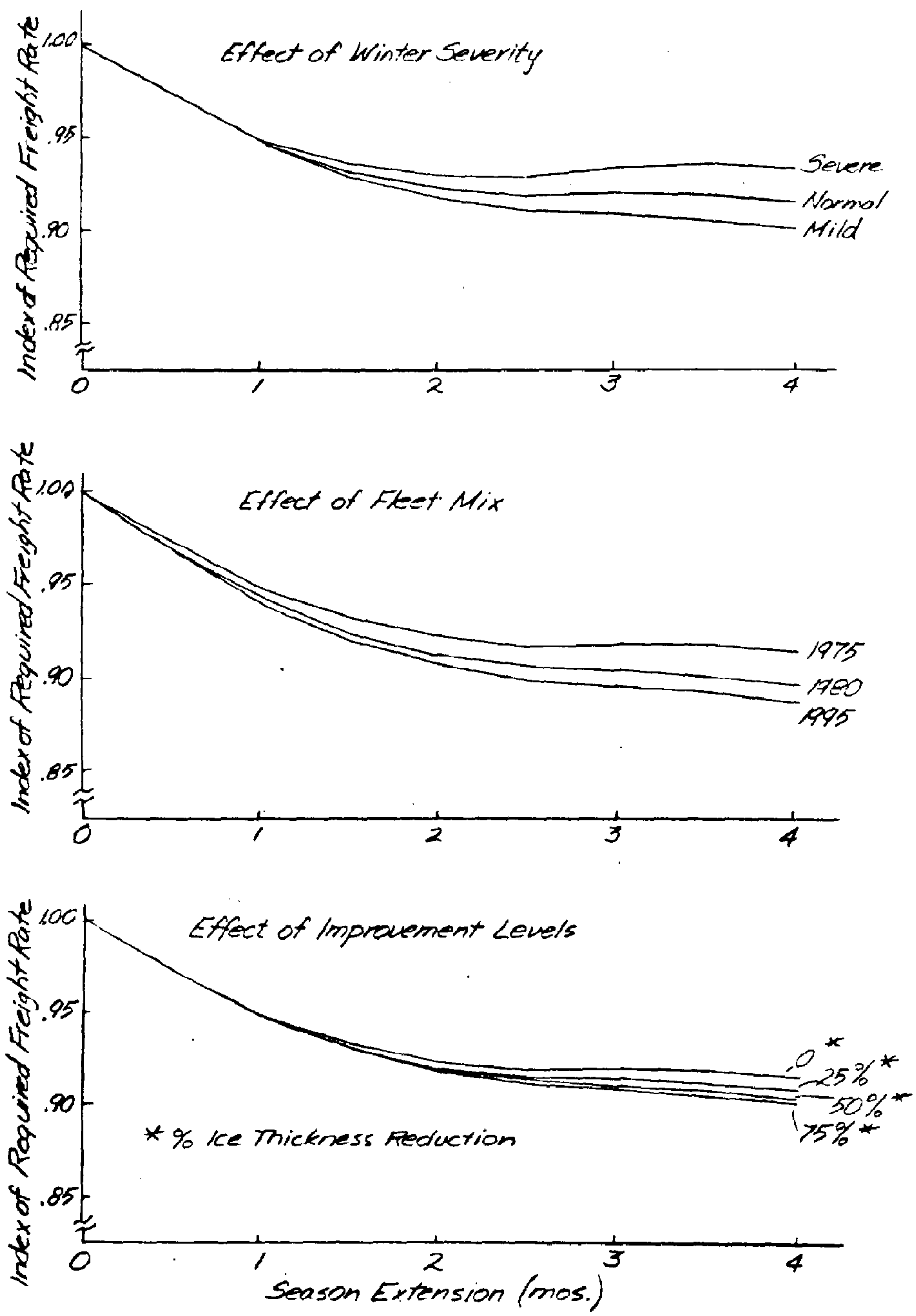


FIGURE 12
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
IRON ORE FROM SEPT ISLE TO CLEVELAND

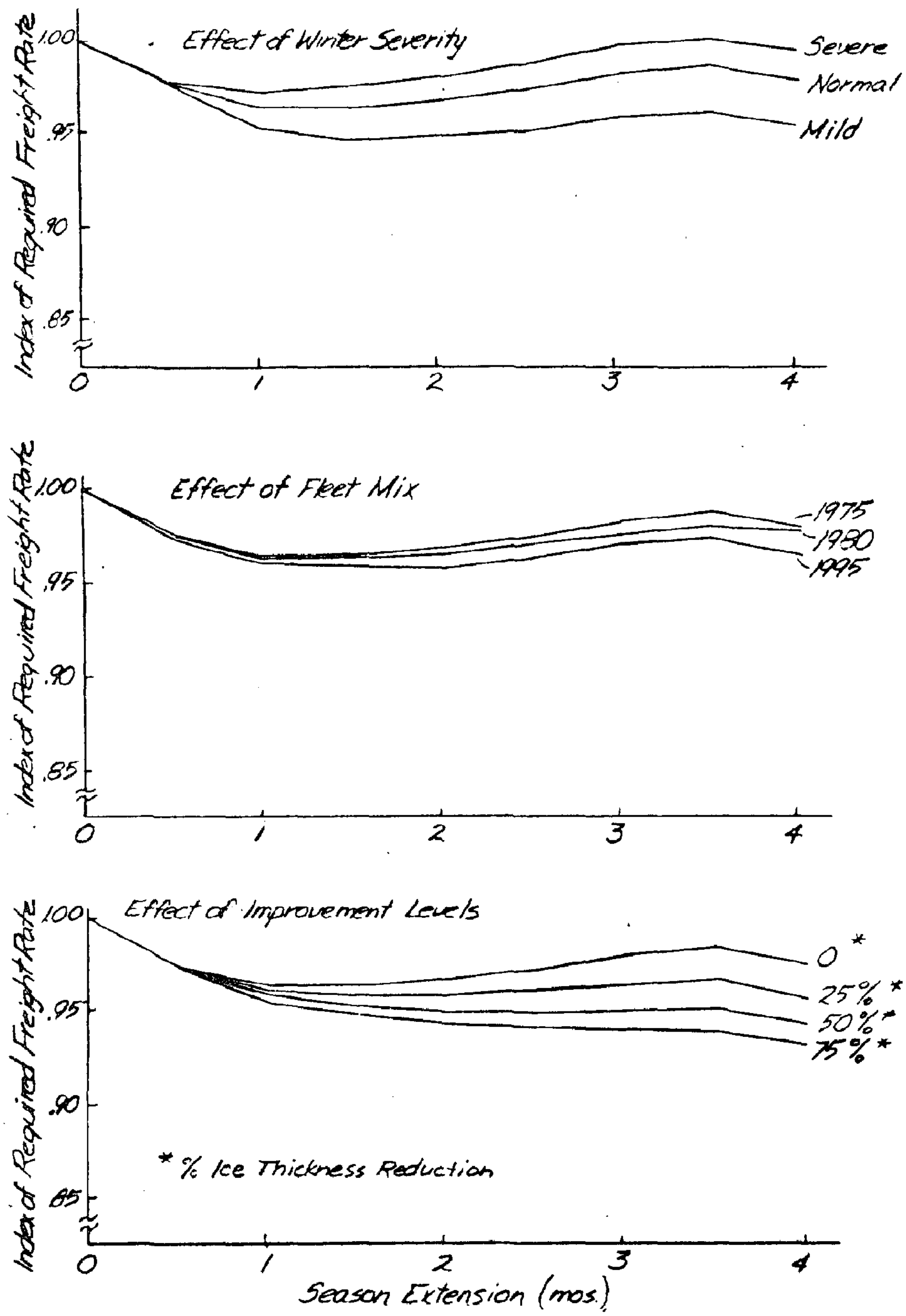


FIGURE 13

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

IRON ORE FROM ESCANABA TO INDIANA HBR.

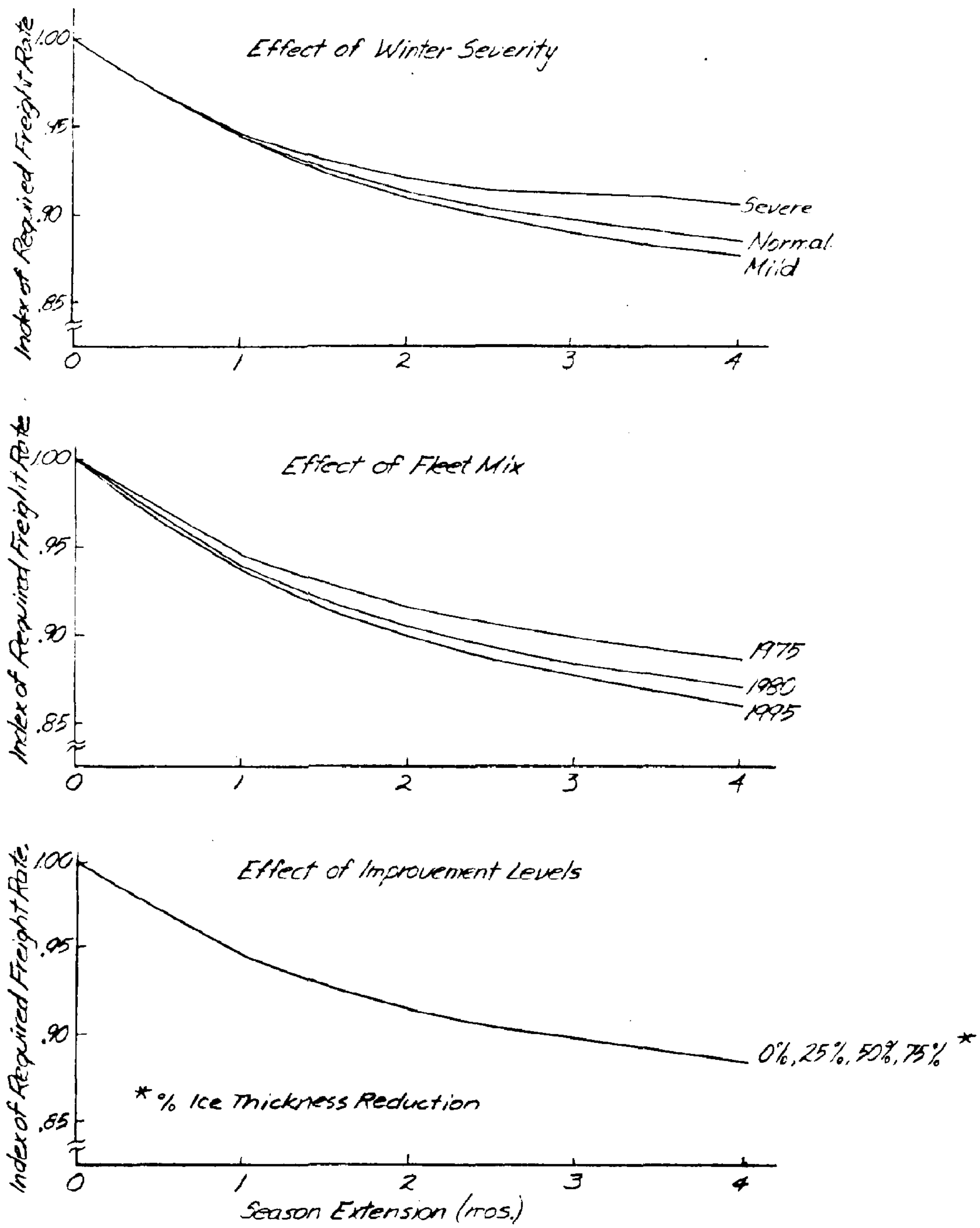


FIGURE 14
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
IRON ORE FROM ESCANABA TO CLEVELAND

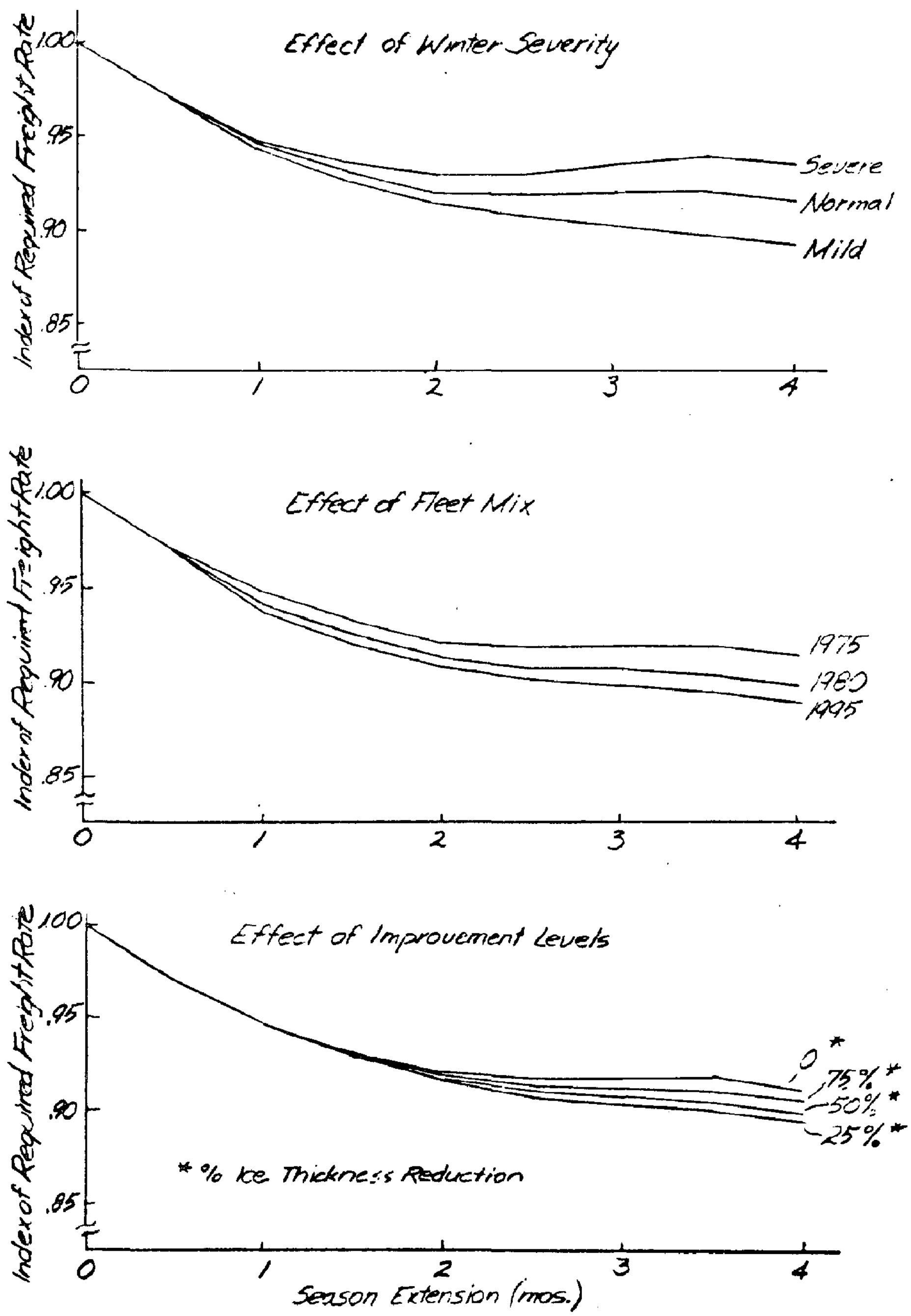


FIGURE 15

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

COAL FROM CALUMET TO DULUTH

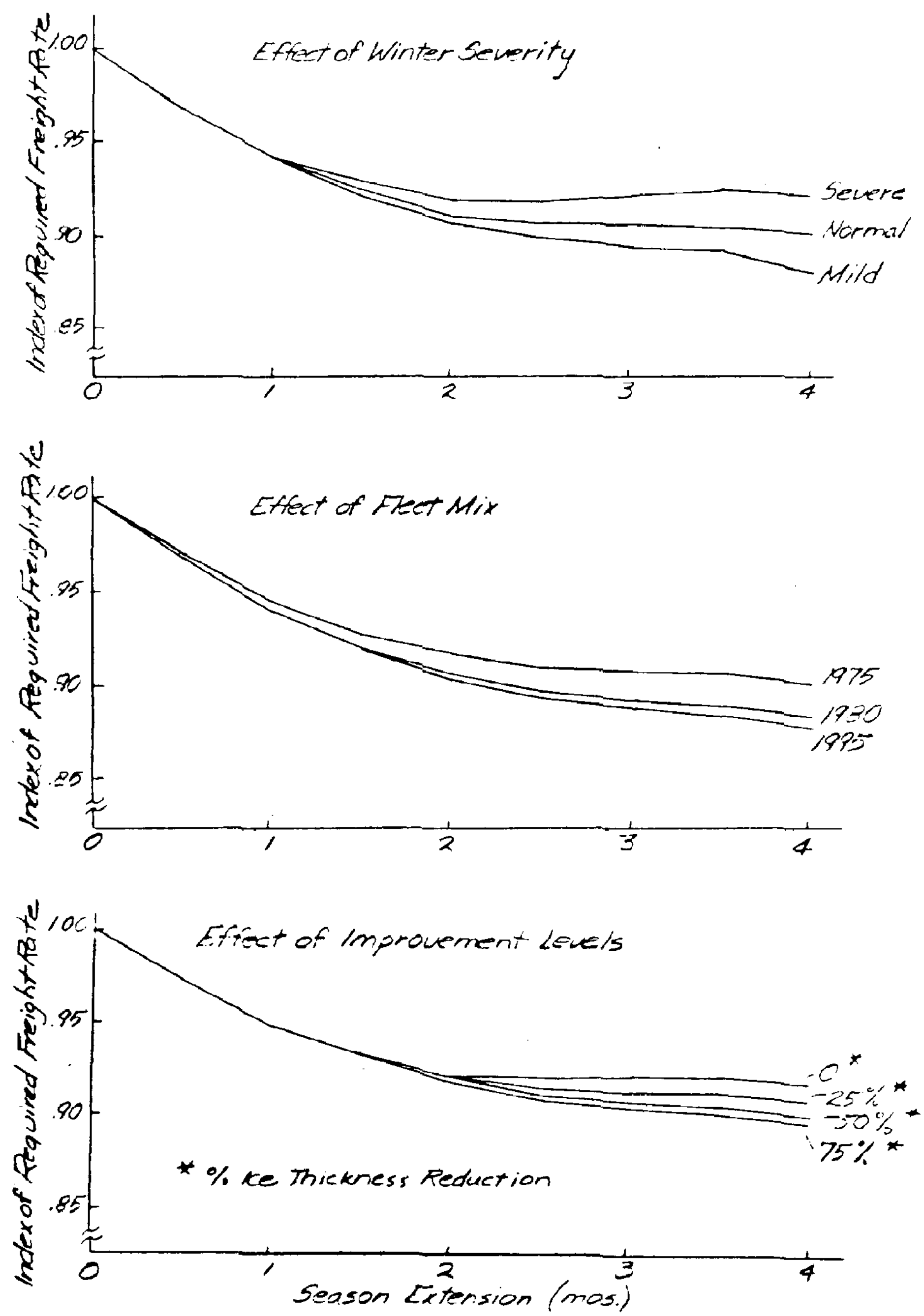


FIGURE 16

INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
COAL FROM TOLEDO TO DETROIT

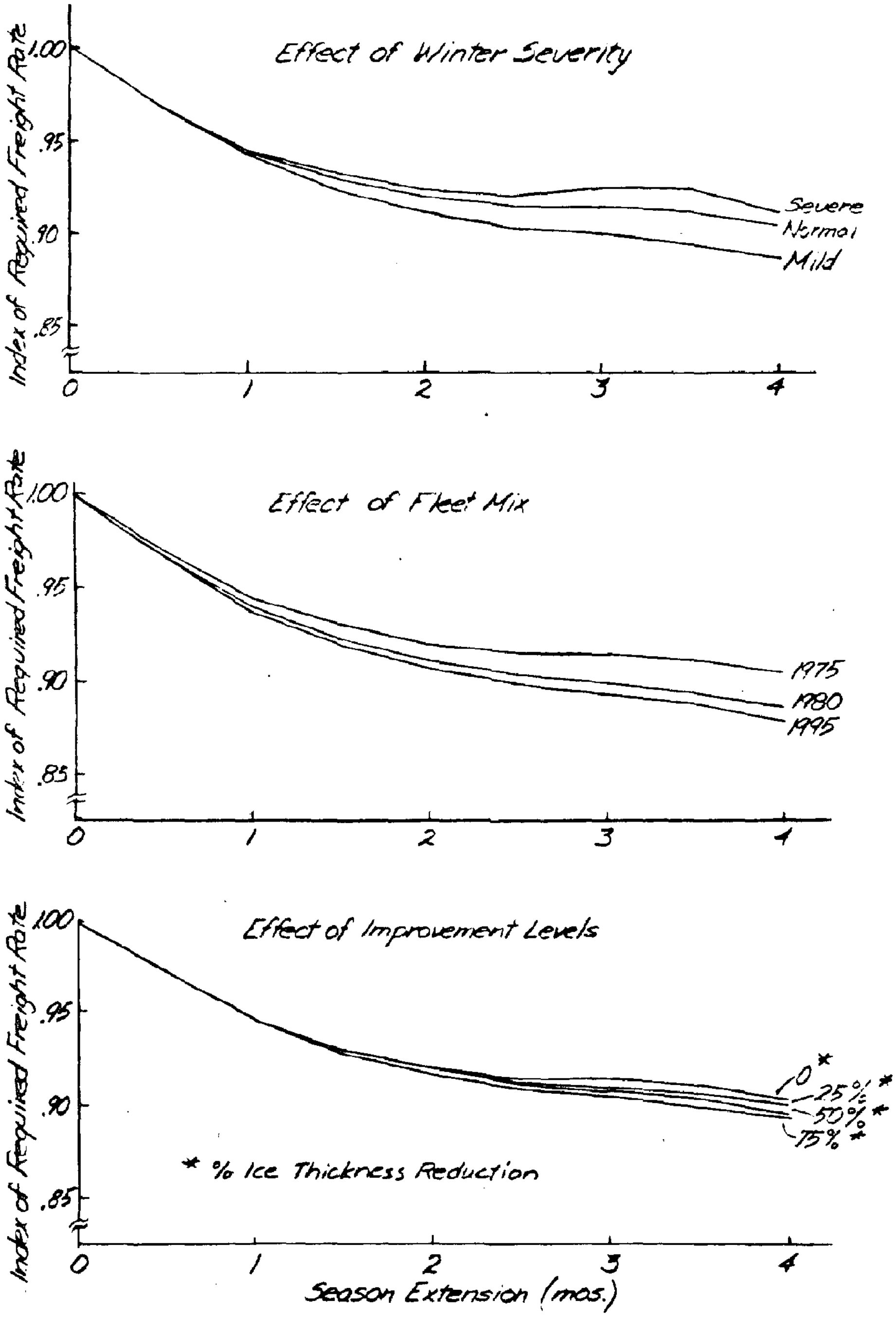


FIGURE 17

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

GRAIN FROM TOLEDO TO BAIE-COMEAU

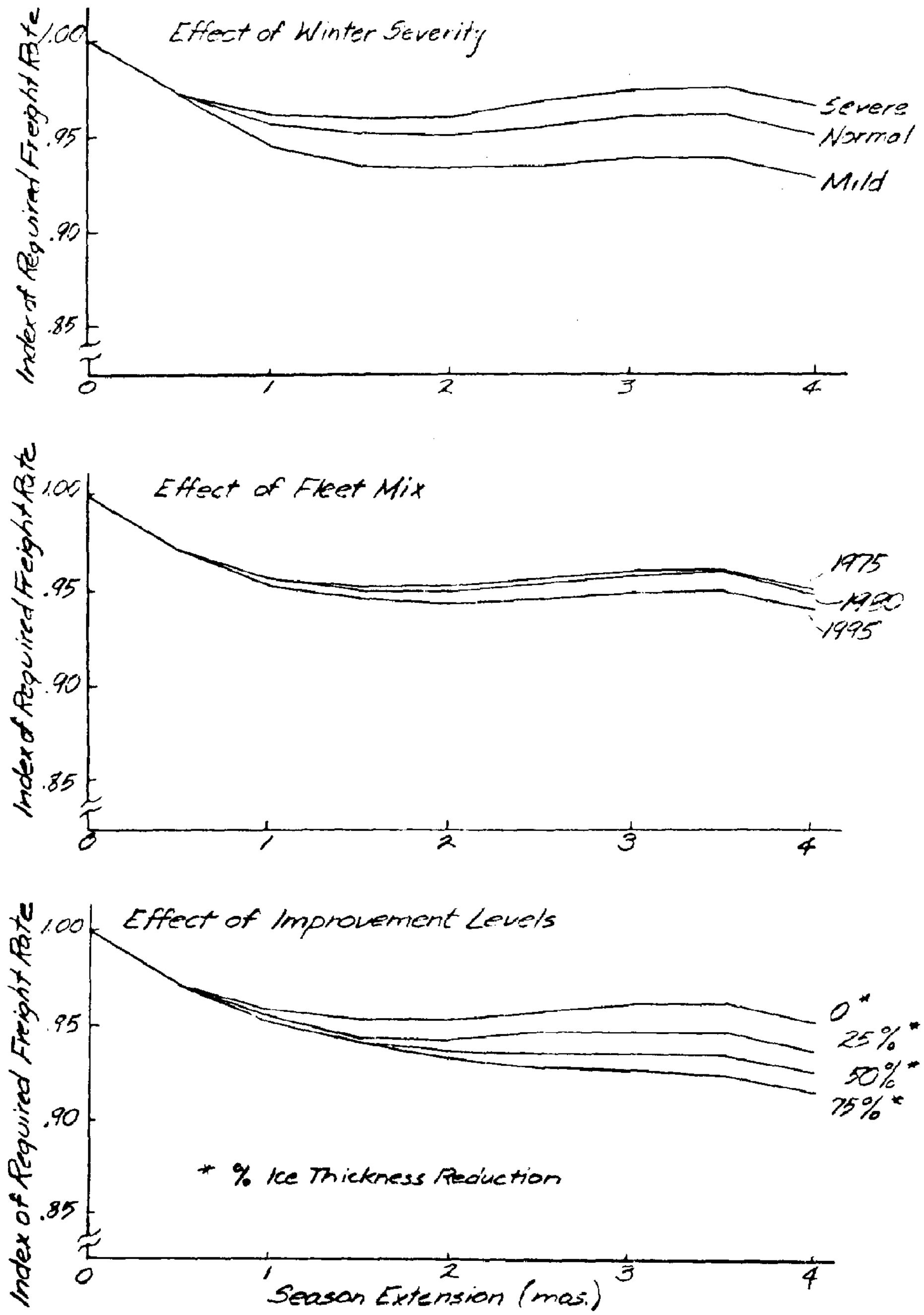


FIGURE 18
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GRAIN FROM DULUTH TO BAIE-COMEAU

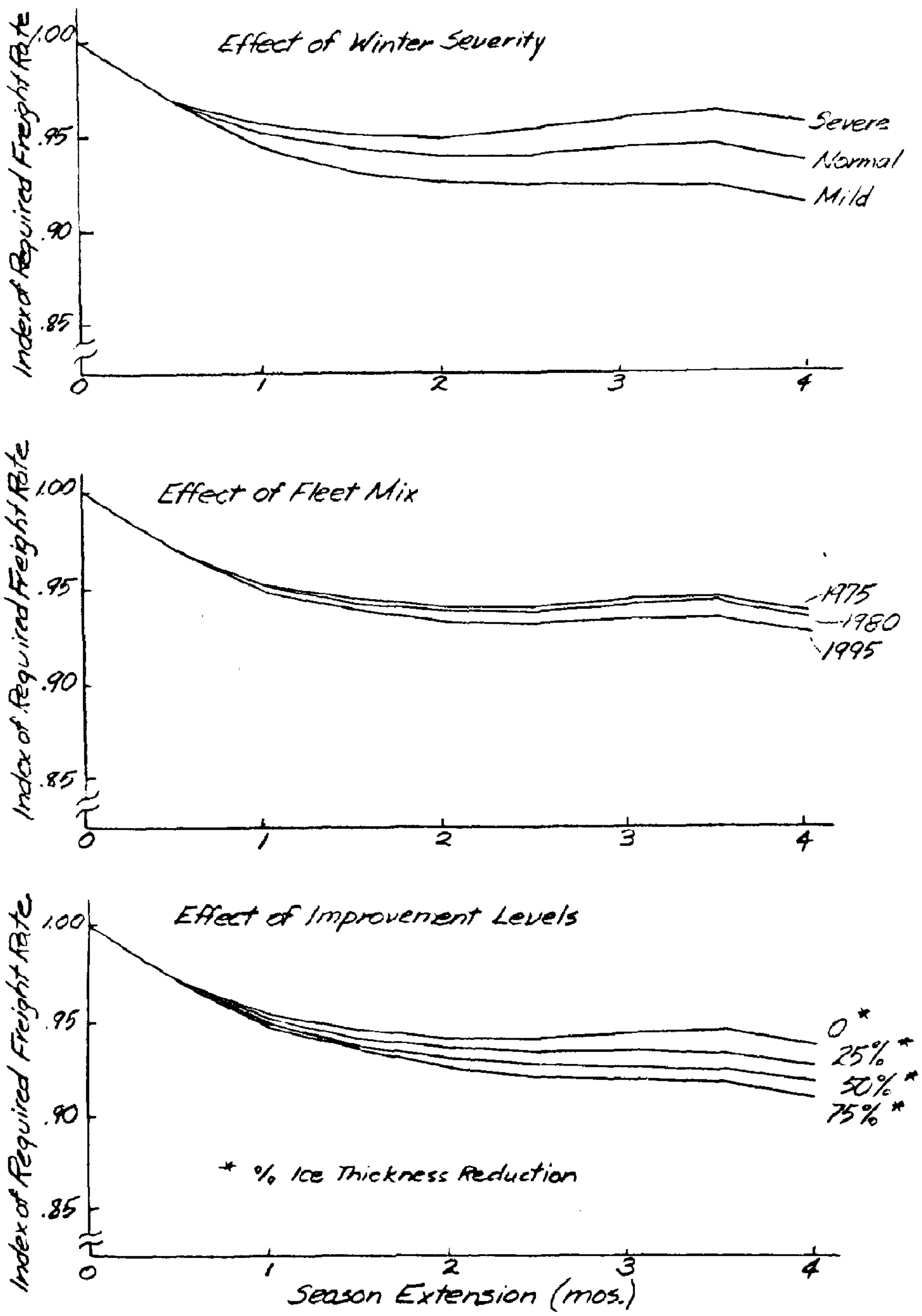


FIGURE 19
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GRAIN FROM CALUMET TO BAIE-COMEAU

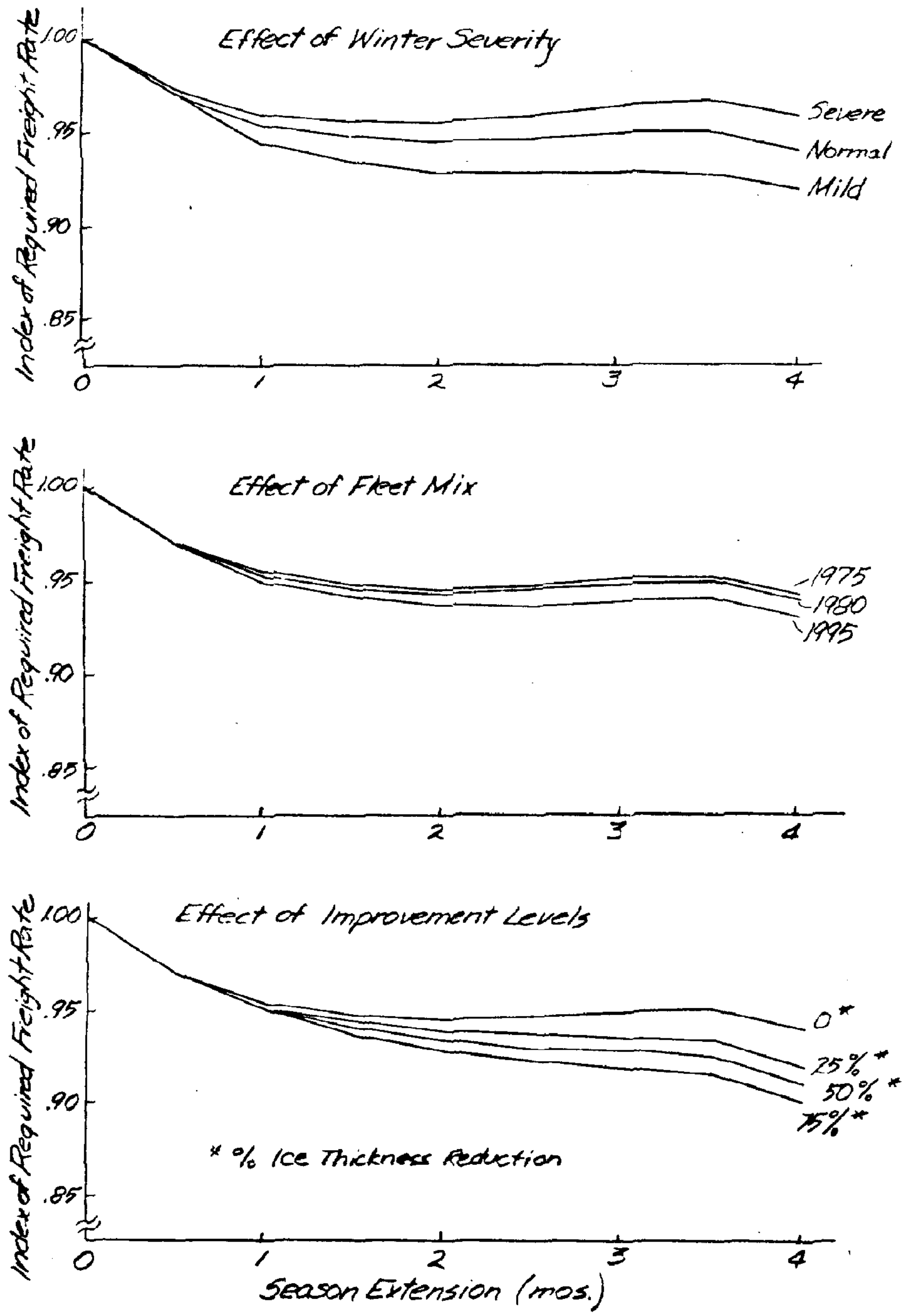


FIGURE 20

INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GRAIN FROM CALUMET TO ROTTERDAM

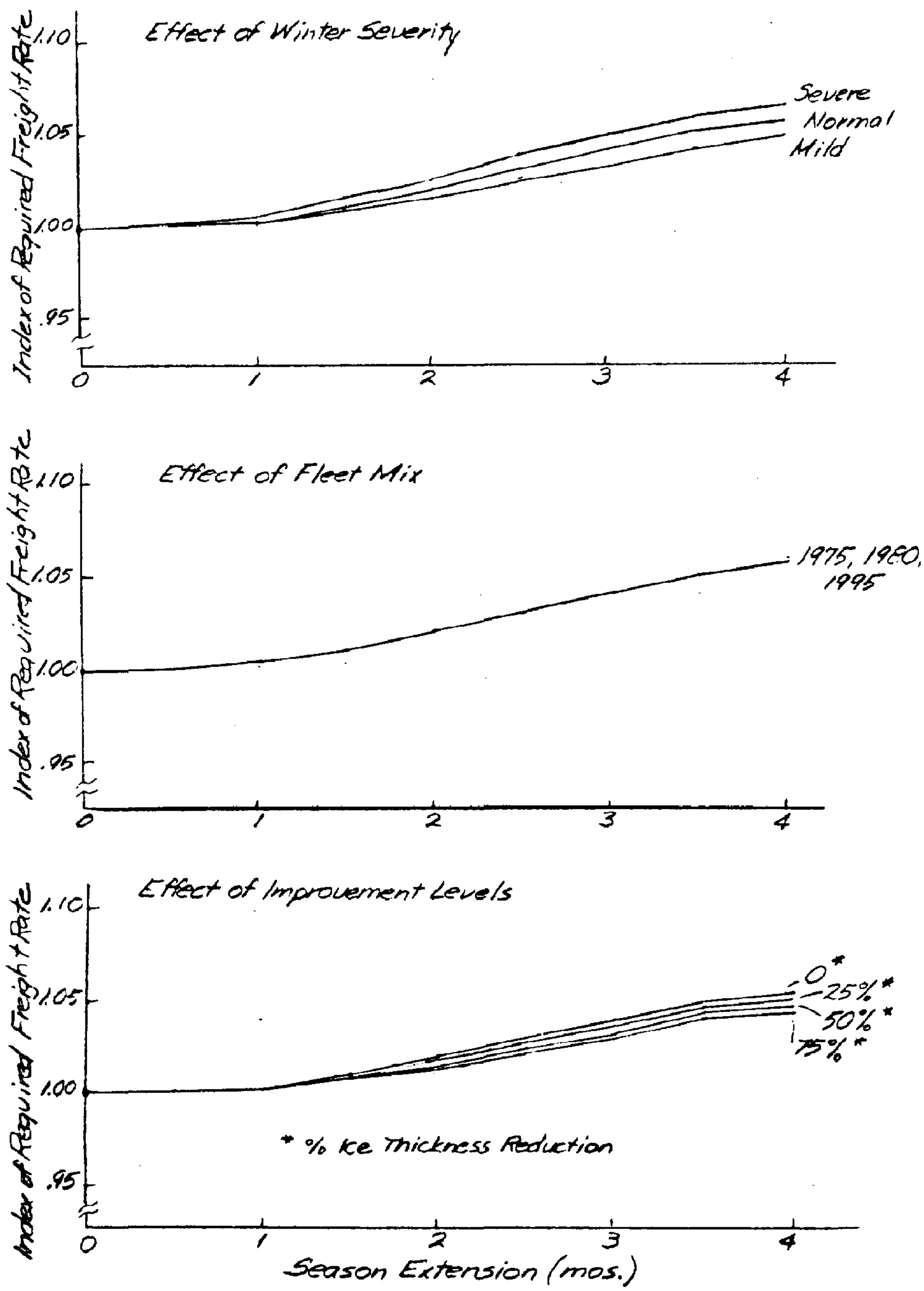


FIGURE 21

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

GRAIN FROM DULUTH TO ROTTERDAM

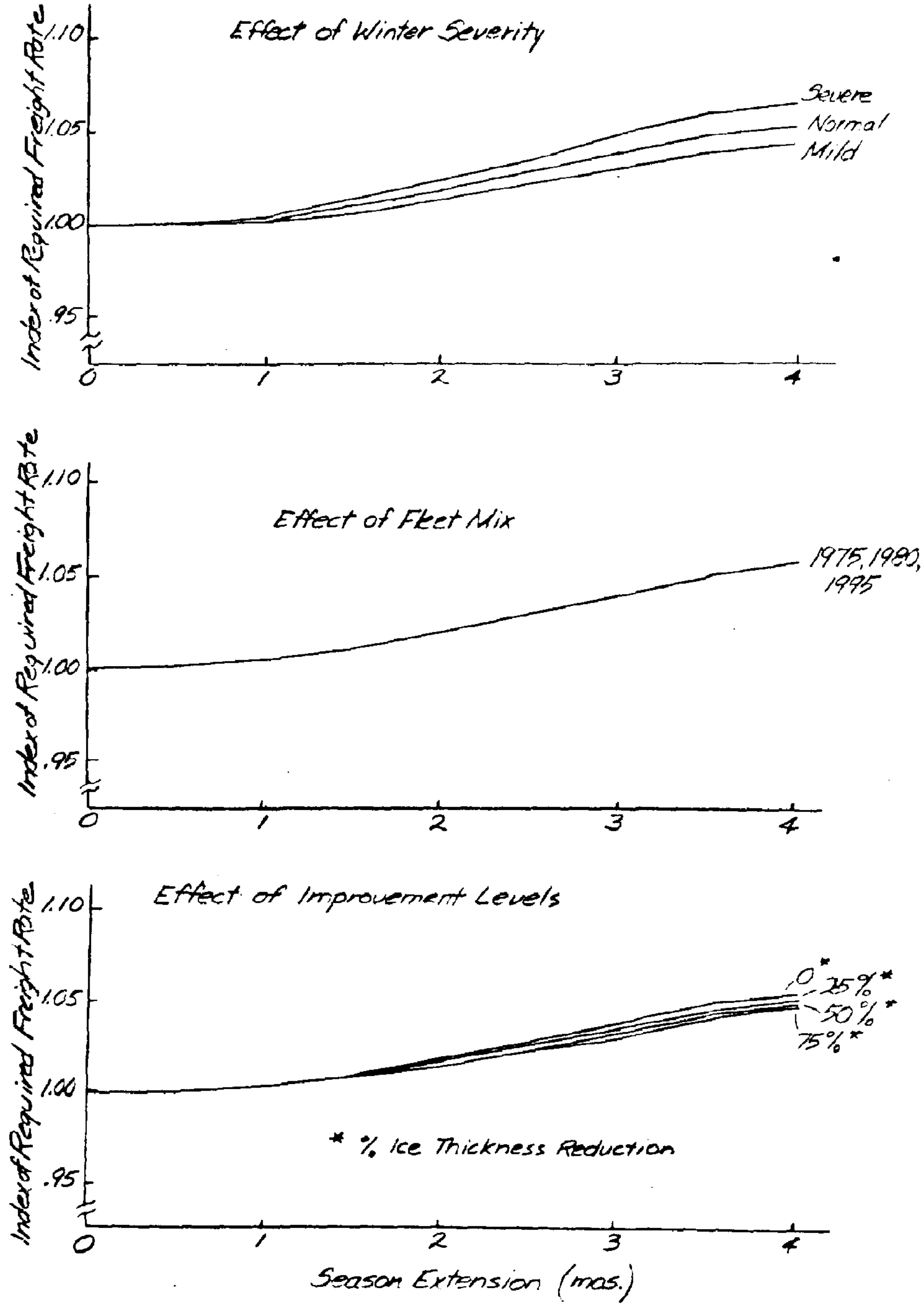


FIGURE 22
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GRAIN FROM DULUTH TO JAPAN

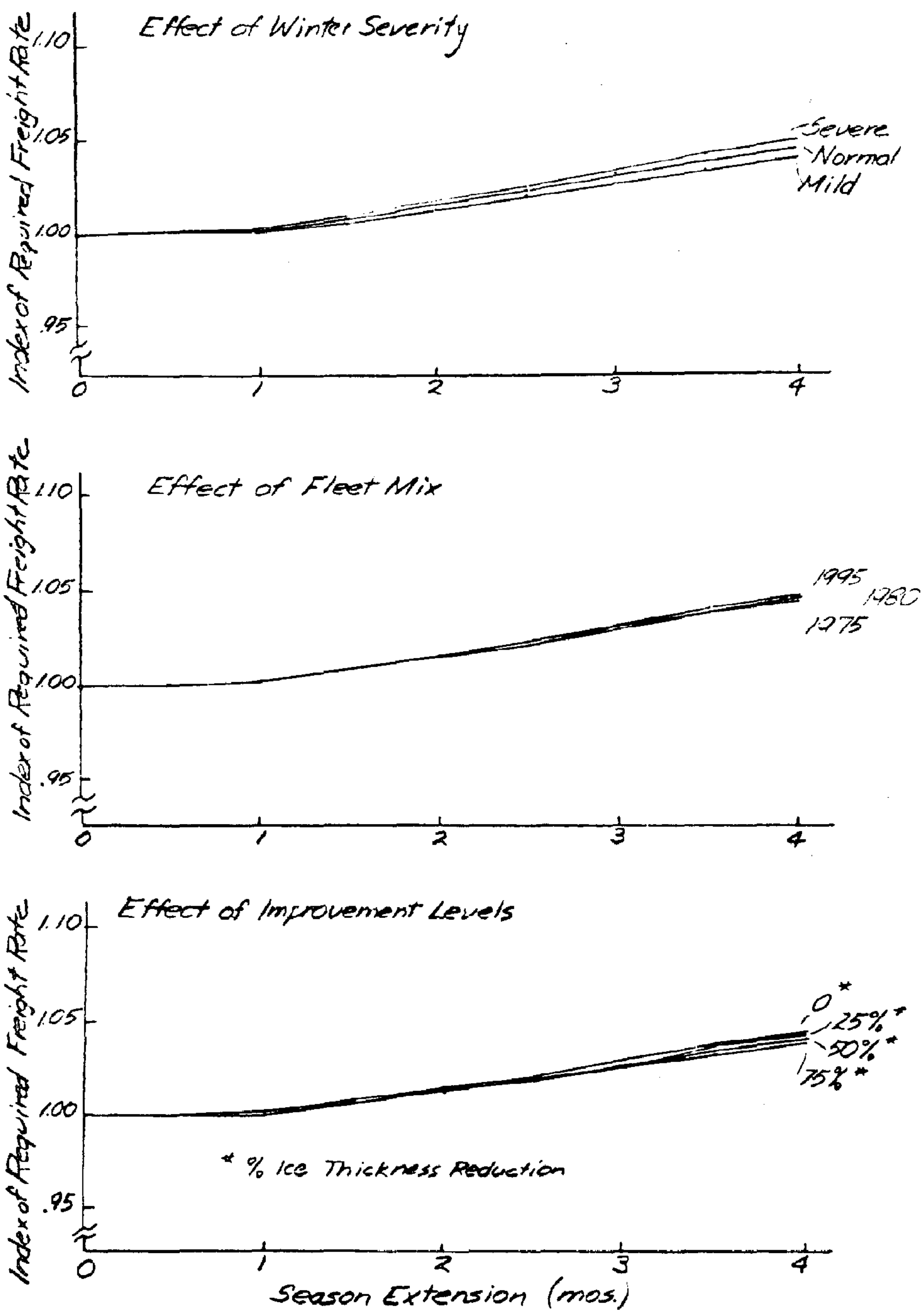


FIGURE 23

INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GRAIN FROM CALUMET TO JAPAN

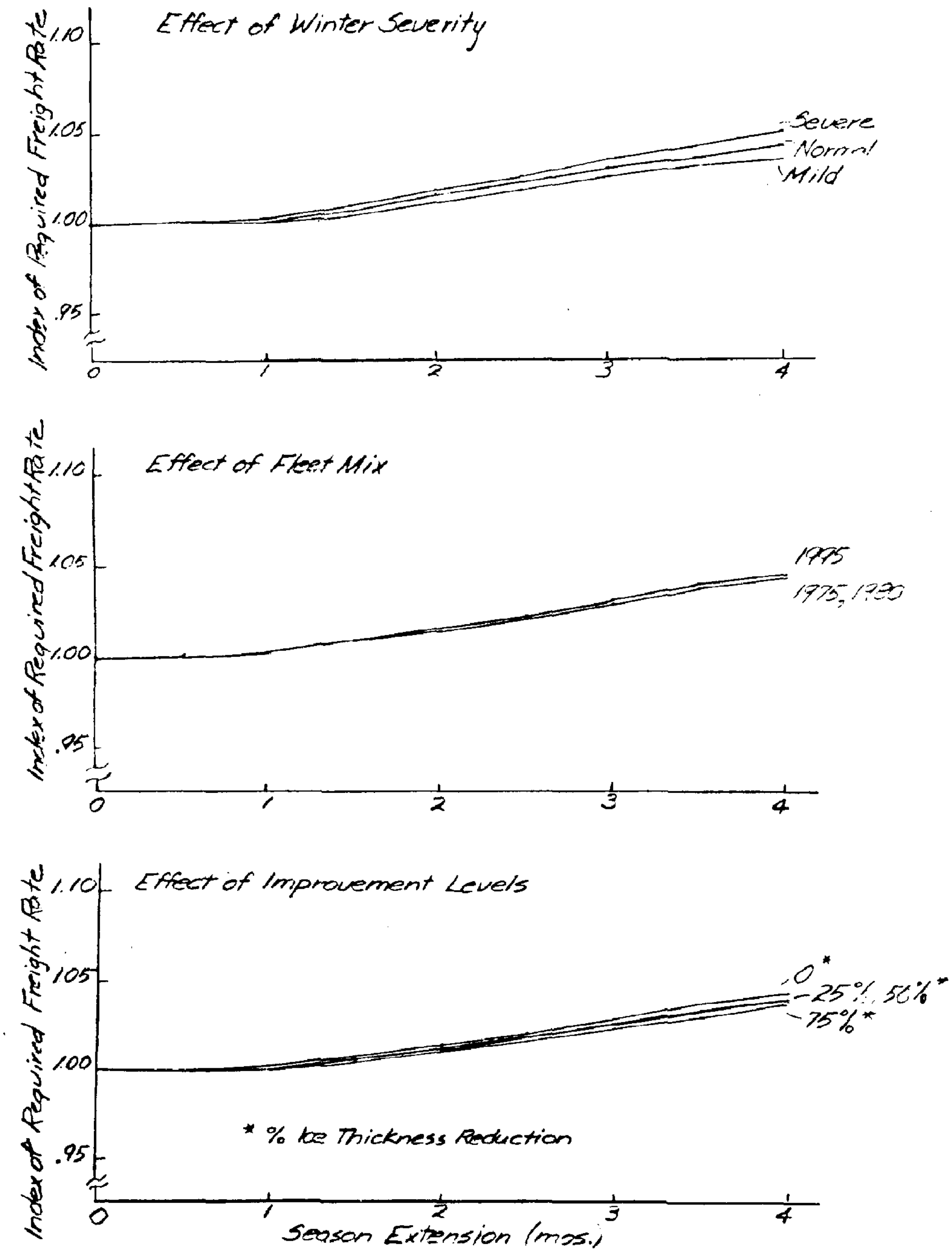


FIGURE 24
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GENERAL CARGO FROM CLEVELAND TO ROTTERDAM

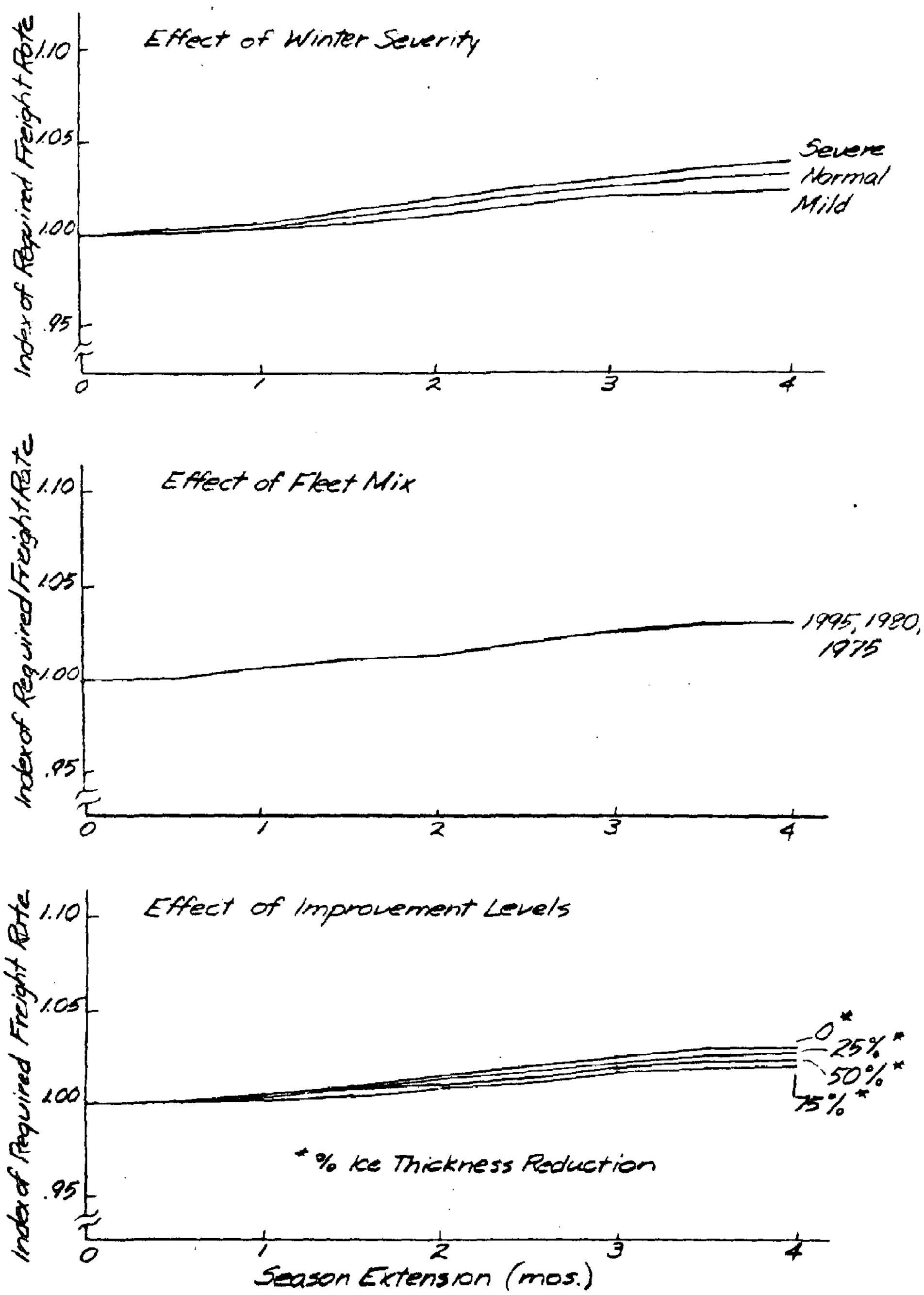


FIGURE 25

INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GENERAL CARGO FROM CALUMET TO ROTTERDAM

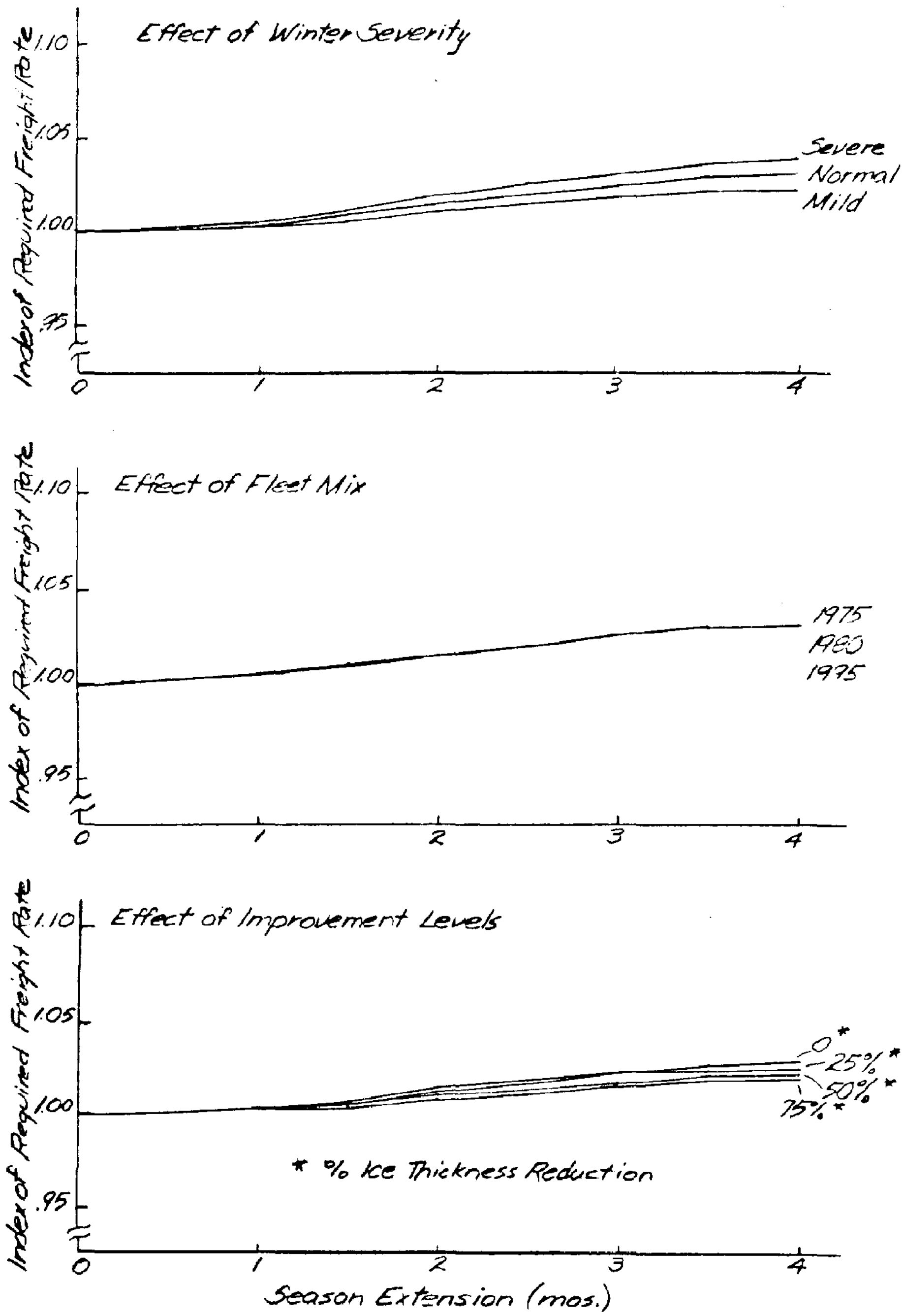


FIGURE 26

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

GENERAL CARGO FROM DULUTH TO ROTTERDAM

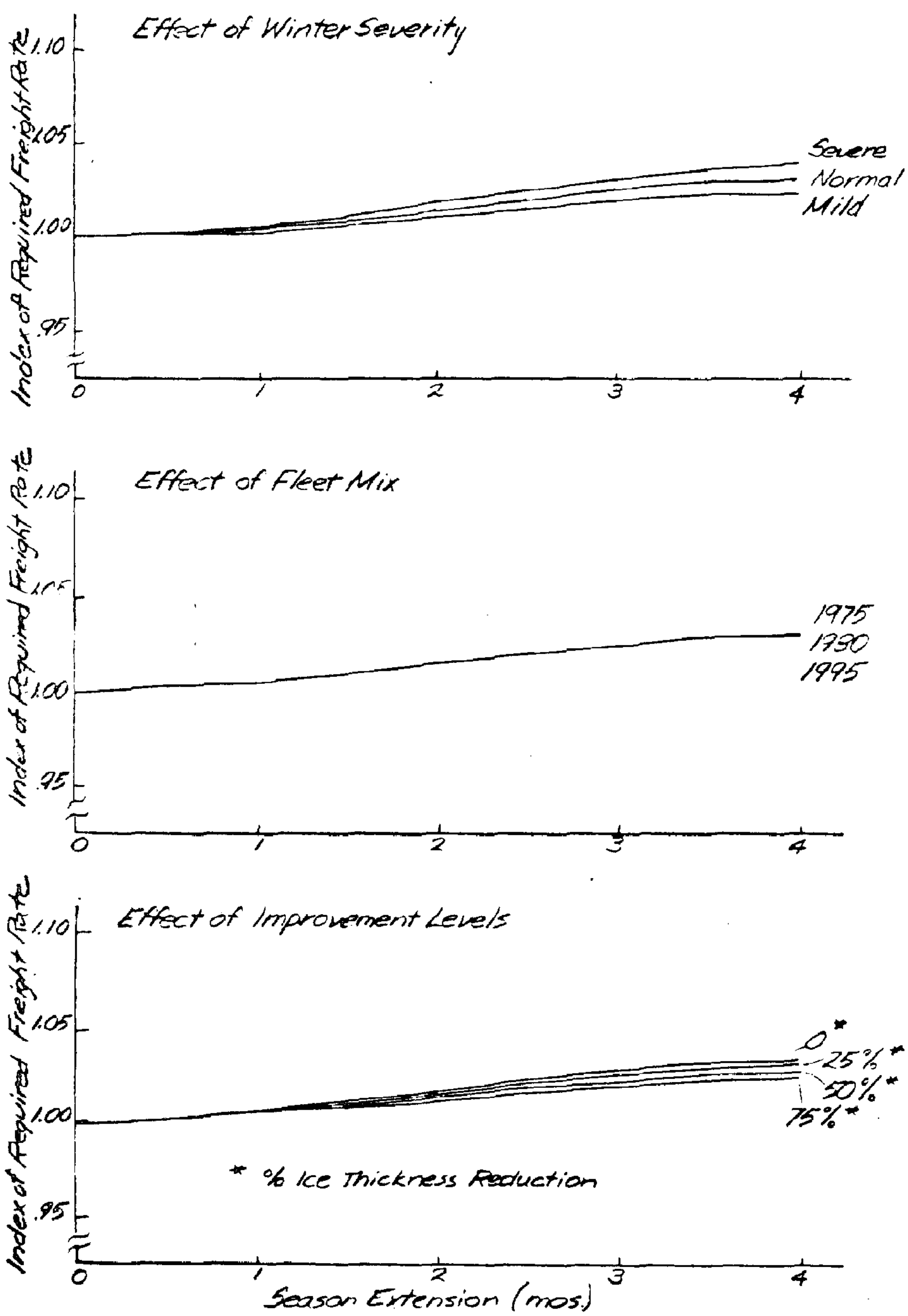


FIGURE 27
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GENERAL CARGO FROM CLEVELAND TO JAPAN

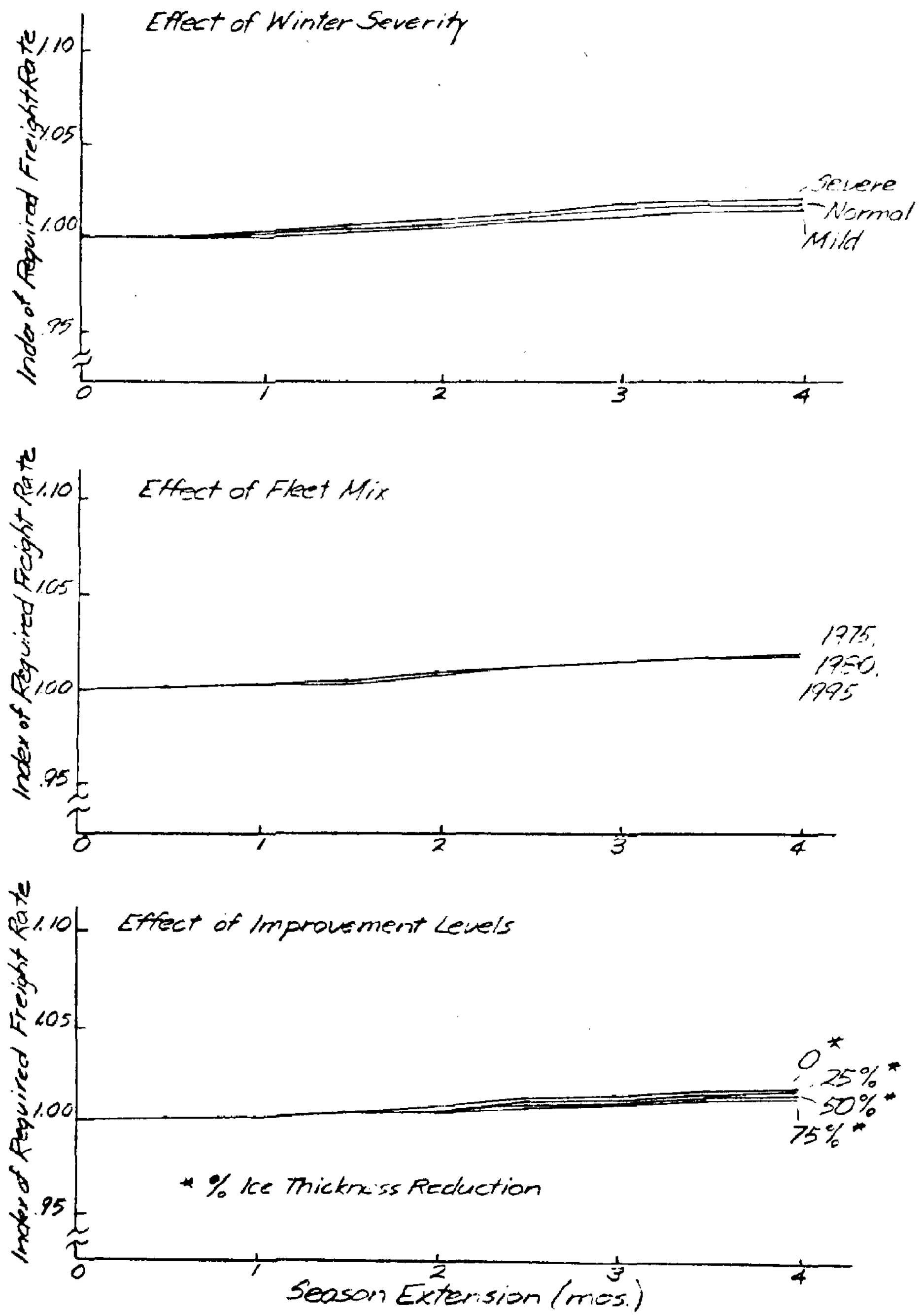


FIGURE 28
INDEX OF REQUIRED FREIGHT RATE
vs.
SEASON EXTENSION
GENERAL CARGO FROM CALUMET TO JAPAN

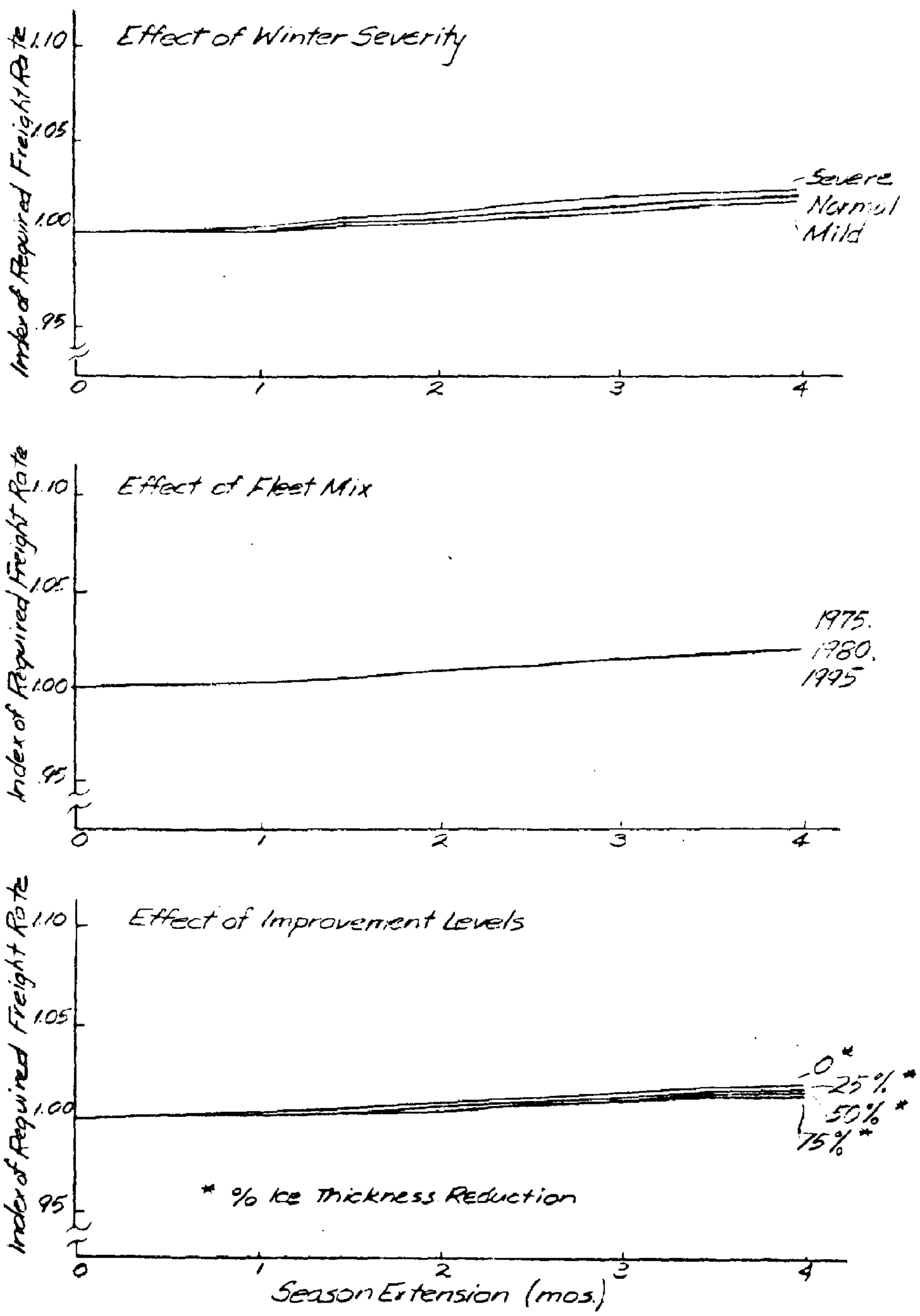


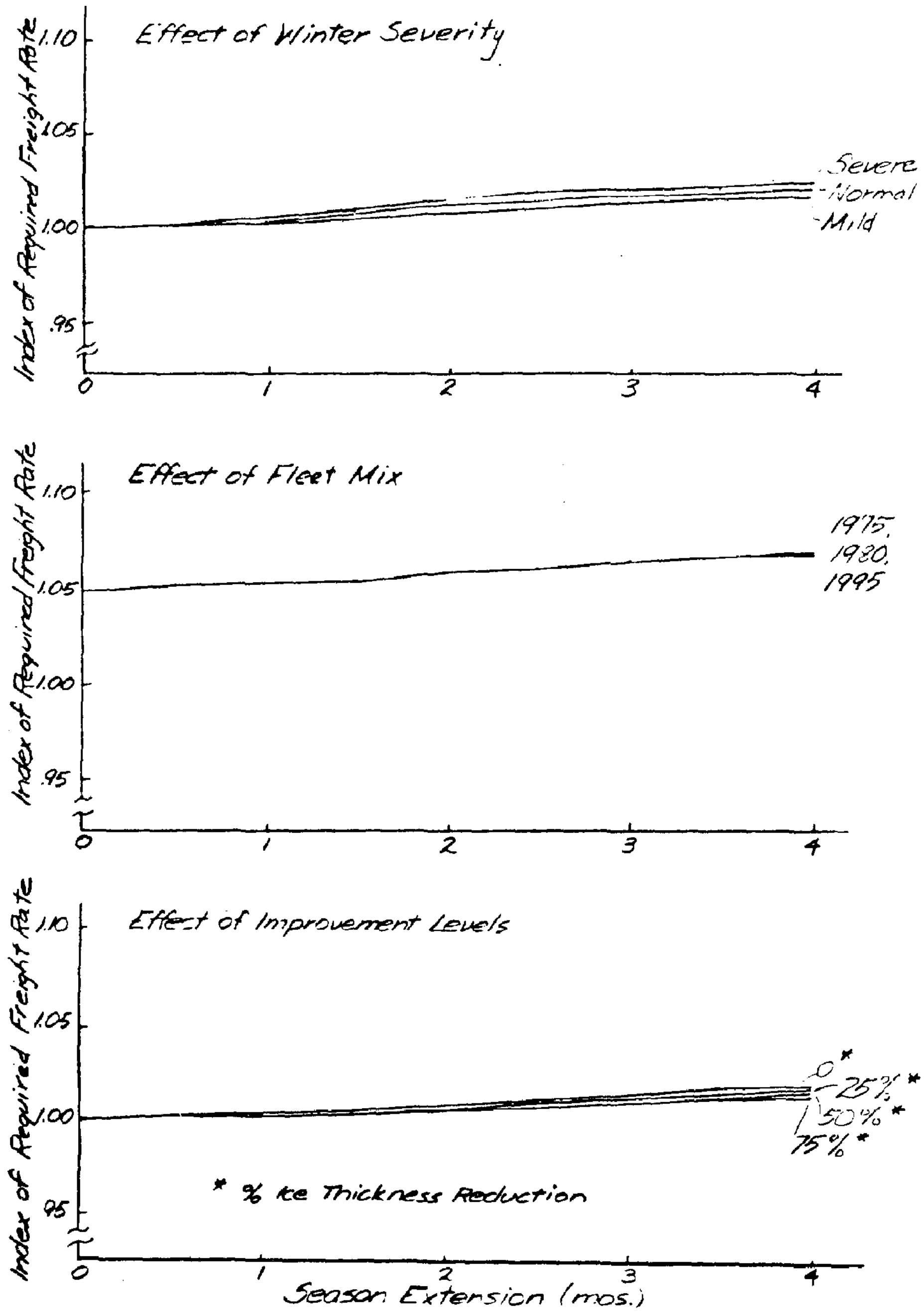
FIGURE 29

INDEX OF REQUIRED FREIGHT RATE

vs.

SEASON EXTENSION

GENERAL CARGO FROM DULUTH TO JAPAN



- Harbors
- Locks
- St. Lawrence Seaway
- Welland Canal
- St. Clair River, Lake St. Clair and Detroit River System
- Straits of Mackinac
- Whitefish Bay and St. Mary's River System

For a 50% improvement level, the ice thickness in all reaches comprising the above areas was reduced by 50%, and similarly for a 75% improvement level, the ice thickness was reduced by 75%. It should be noted that an 0% improvement level corresponds to a technically feasible system. Thus, obstacles which would in themselves eliminate winter navigation such as the ice booms and ice jams in the St. Lawrence Seaway are assumed to be solved.

INDIVIDUAL SHIP CLASS RESULTS

Data for individual ship classes operating on a typical laker bulk route, an overseas grain route and an overseas general cargo route are presented in Tables 16 through 18 for the normal navigation season of 8 months. Summarized data for navigation seasons of 9, 10, 11 and 12 months are presented in Tables 19 through 21 for each individual ship class.

VARIABLE REQUIRED FREIGHT RATES

All of the data presented so far has dealt with annual required freight rates, that is, rates which would have to be charged during the extended season, as well as during the normal season. The question naturally arises as to the effect on the rates if they were allowed to vary. To determine this effect representative routes were selected and a comparison was made between annual rates and variable rates. The variable required freight rates were obtained by:

$$RFF_{SE} \text{ (\$/long ton)} = \frac{\dfrac{(RFR_8 \cdot Tons_8 - OC_8)}{12} \cdot \Delta \text{ Season} + \Delta\, OC}{\Delta \text{ Tons}}$$

for lakers and by:

$$RFR_{SE}\ (\$/\text{long ton}) = \frac{\dfrac{(RFR_8 \cdot Tons_8 - OC_8)}{8} \cdot \Delta\ \text{Season} + \Delta\ OC}{\Delta\ \text{Tons}}$$

for ocean-going vessels where

RFR_{SE} = Required freight rate for current period

RFR_8 = Annual required freight rate for normal season operation only

$Tons_S$ = Tonnage transported during normal season operation

OC_8 = Annual vessel operating cost during normal season operation only

Δ Season = Length of time of current period

$\Delta\ OC$ = Vessel operating costs during current period

$\Delta\ Tons$ = Tonnage transported during current period

The results of the comparison are presented in Tables 22 through 24.

TABLE 16.

INDIVIDUAL SHIP CLASS DATA FOR
IRON ORE FROM TWO HARBORS TO GARY*

	Laker Ship Classes				
	5	6	7	8	10
Total Time Underway (min.)	3.230E 05	3.143E 05	3.088E 05	3.082E 05	2.899E 05
Total Time Waiting (min.)	2.977E 04	3.848E 04	4.399E 04	4.455E 04	6.286E 04
Total Number of Trips	4.115E 01	4.445E 01	4.367E 01	4.359E 01	4.394E 01
Annual Tonnage (long tons)	7.149E 05	9.508E 05	1.116E 06	1.104E 06	2.316E 06
Trips in Normal Season	4.115E 01	4.445E 01	4.367E 01	4.359E 01	4.394E 01
Crew Cost ($)	6.190E 05	7.080E 05	7.080E 05	6.368E 05	5.123E 05
M & R Cost ($)	6.609E 04	8.303E 04	9.117E 04	8.713E 04	2.374E 05
Stores and Supplies ($)	1.686E 04	2.106E 04	2.279E 04	2.120E 04	3.545E 04
Insurance Cost ($)	1.008E 05	1.639E 05	2.259E 05	2.253E 05	4.231E 05
Overhead Cost ($)	1.281E 05	1.343E 05	1.397E 05	1.403E 05	1.945E 05
Towing Cost ($)	1.059E 04	4.404E 04	4.842E 04	1.404E 04	2.768E 04
Lay-Up Cost ($)	1.125E 05	1.125E 05	1.125E 05	1.125E 05	1.125E 05
Fuel Cost ($)	4.879E 05	7.684E 05	8.449E 05	7.041E 05	1.549E 06
Tolls ($)	0.000E-01	0.000E-01	0.000E-01	0.000E-01	0.000E-01
Annual Operating Cost ($)	1.542E 06	2.035E 06	2.193E 06	1.941E 06	3.092E 06
RFR ($/long ton)	3.687E 00	3.917E 00	4.043E 00	3.934E 00	3.235E 00
Index of RFR	1.000E 00	1.000E 00	1.000E 00	1.000E 00	1.000E 00
Operating Cost/Long Ton	2.157E 00	2.141E 00	1.966E 00	1.758E 00	1.335E 00
Operating Costs/Hour	2.622E 02	3.461E 02	3.730E 02	3.302E 02	5.258E 02

* Normal Winter with No Improvements.

TABLE 17.

INDIVIDUAL SHIP CLASS DATA FOR
GRAIN FROM DULUTH TO ROTTERDAM*

	Ocean Going Ship Classes			
	4	5	6	7
Total Time Underway (min.)	3.194E 05	3.095E 05	3.024E 05	3.017E 05
Total Time Waiting (min.)	3.341E 04	4.332E 04	5.040E 04	5.113E 04
Total Number of Trips	1.429E 01	1.283E 01	1.316E 01	1.248E 01
Annual Tonnage (long tons)	2.808E 05	3.536E 05	4.361E 05	4.456E 05
Trips in Normal Season	1.429E 01	1.283E 01	1.316E 01	1.248E 01
Crew Cost ($)	6.724E 05	6.724E 05	6.724E 05	6.724E 05
M & R Cost ($)	8.606E 04	9.540E 04	1.054E 05	1.117E 05
Stores and Supplies ($)	1.699E 04	1.917E 04	2.047E 04	2.128E 04
Insurance Cost ($)	4.588E 04	1.041E 05	1.411E 05	1.538E 05
Overhead Cost ($)	1.243E 05	1.312E 05	1.352E 05	1.378E 05
Towing Cost ($)	1.179E 04	1.237E 04	1.361E 04	1.344E 04
Lay-Up Cost ($)	0.000E-01	0.000E-01	0.000E-01	0.000E-01
Fuel Cost ($)	1.093E 06	1.135E 06	1.315E 06	1.448E 06
Tolls ($)	1.061E 05	1.340E 05	1.446E 05	1.444E 05
Annual Operating Cost ($)	2.157E 06	2.303E 06	2.547E 06	2.702E 06
RFR ($/long ton)	9.548E 00	9.228E 00	8.510E 00	8.941E 00
Index of RFR	1.000E 00	1.000E 00	1.000E 00	1.000E 00
Operating Cost/Long Ton	7.683E 00	6.513E 00	5.841E 00	6.065E 00
Operating Costs/Hour	3.668E 02	3.917E 02	4.332E 02	4.596E 02

* Normal Winter with No Improvements.

TABLE 18.

INDIVIDUAL SHIP CLASS DATA FOR
GENERAL CARGO FROM DULUTH TO ROTTERDAM*

	Ocean Going Ship Classes 1	2	3
Total Time Underway (min.)	1.984E 05	1.935E 05	1.796E 05
Total Time Waiting (min.)	1.544E 05	1.593E 05	1.732E 05
Total Number of Trips	5.475E 00	5.639E 00	6.120E 00
Annual Tonnage (long tons)	6.844E 04	1.441E 05	1.472E 05
Trips in Normal Season	5.475E 00	5.639E 00	6.120E 00
Crew Cost ($)	6.724E 05	6.724E 05	6.724E 05
M & R Cost ($)	5.421E 04	7.877E 04	1.104E 05
Stores and Supplies ($)	1.219E 04	1.422E 04	1.636E 04
Insurance Cost ($)	8.024E 04	8.316E 04	1.213E 05
Overhead Cost ($)	1.094E 05	1.157E 05	1.224E 05
Towing Cost ($)	1.937E 04	2.789E 04	3.926E 04
Lay-Up Cost ($)	0.000E-01	0.000E-01	0.000E-01
Fuel Cost ($)	4.833E 05	8.173E 05	1.341E 06
Tolls ($)	1.602E 05	3.167E 05	3.175E 05
Annual Operating Cost ($)	1.591E 06	2.126E 06	2.740E 06
RFR ($/long ton)	3.204E 01	1.910E 01	2.499E 01
Index of RFR	1.000E 00	1.000E 00	1.000E 00
Operating Cost/Long Ton	2.325E 01	1.475E 01	1.861E 01
Operating Costs/Hour	2.706E 02	3.616E 02	4.660E 02

* Normal Winter with No Improvements.

TABLE 19

INDIVIDUAL SHIP CLASS RESULTS FOR
IRON ORE FROM TWO HARBORS TO GARY*

SHIP CLASSES	Length of Navigation Season (Months) 8	9	10	11	12
CLASS 5					
Number of Round Trips	1.00**	1.12	1.22	1.30	1.39
Annual Tonnage	1.00	1.10	1.20	1.27	1.35
Annual Operating Cost	1.00	1.10	1.22	1.35	1.49
Annual Required Freight Rate	1.00	0.96	0.94	0.95	0.95
Annual Operating Cost per Ton	1.00	0.99	1.01	1.06	1.10
Annual Operating Cost per hour	1.00	0.98	0.98	0.99	1.00
CLASS 6					
Number of Round Trips	1.00	1.12	1.23	1.32	1.42
Annual Tonnage	1.00	1.11	1.22	1.30	1.40
Annual Operating Cost	1.00	1.10	1.23	1.36	1.50
Annual Required Freight Rate	1.00	0.95	0.92	0.92	0.91
Annual Operating Cost per Ton	1.00	1.00	1.01	1.05	1.07
Annual Operating Cost per hour	1.00	0.98	0.99	1.00	1.01
CLASS 7					
Number of Round Trips	1.00	1.12	1.23	1.33	1.43
Annual Tonnage	1.00	1.11	1.22	1.32	1.41
Annual Operating Cost	1.00	1.11	1.25	1.40	1.40
Annual Required Freight Rate	1.00	0.94	0.92	0.91	0.90
Annual Operating Cost per Ton	1.00	0.99	1.02	1.06	1.11
Annual Operating Cost per hour	1.00	0.99	1.00	1.02	1.05
CLASS 8					
Number of Round Trips	1.00	1.12	1.23	1.32	1.42
Annual Tonnage	1.00	1.11	1.22	1.30	1.40
Annual Operating Cost	1.00	1.10	1.24	1.40	1.58
Annual Required Freight Rate	1.00	0.94	0.91	0.90	0.90
Annual Operating Cost per Ton	1.00	0.99	1.02	1.07	1.13
Annual Operating Cost per hour	1.00	0.98	1.00	1.02	1.06

*Normal winter with no improvements

**8 Month Navigation Season = 1.00

TABLE 19 Continued

INDIVIDUAL SHIP CLASS RESULTS FOR
IRON ORE FROM TWO HARBORS TO GARY *

SHIP CLASSES	Length of Navigation Season (Months) 8	9	10	11	12
CLASS 10					
Number of Round Trips	1.00**	1.12	1.23	1.33	1.43
Annual Tonnage	1.00	1.12	1.23	1.33	1.44
Annual Operating Cost	1.00	1.11	1.25	1.41	1.58
Annual Required Freight Rate	1.00	0.93	0.89	0.88	0.86
Annual Operating Cost per Ton	1.00	0.99	1.01	1.05	1.10
Annual Operating Cost per hour	1.00	0.99	1.00	1.03	1.06

*Normal winter with no improvements

**8 Month Navigation Season = 1.00

TABLE 20

INDIVIDUAL SHIP CLASS RESULTS FOR
GRAIN FROM DULUTH TO ROTTERDAM*

SHIP CLASSES	Length of Navigation Season (Months) 8	9	10	11	12
CLASS 4					
Number of Round Trips	1.00**	1.12	1.23	1.34	1.45
Annual Tonnage	1.00	1.12	1.23	1.33	1.45
Annual Operating Cost	1.00	1.12	1.25	1.39	1.53
Annual Required Freight Rate	1.00	1.00	1.02	1.04	1.05
Annual Operating Cost per Ton	1.00	1.00	1.02	1.04	1.06
Annual Operating Cost per Hour	1.00	1.00	1.01	1.02	1.03
CLASS 5					
Number of Round Trips	1.00	1.12	1.23	1.34	1.46
Annual Tonnage	1.00	1.12	1.23	1.34	1.46
Annual Operating Cost	1.00	1.13	1.27	1.42	1.58
Annual Required Freight Rate	1.00	1.00	1.02	1.05	1.07
Annual Operating Cost per Ton	1.00	1.00	1.03	1.06	1.08
Annual Operating Cost per Hour	1.00	1.00	1.02	1.03	1.06
CLASS 6					
Number of Round Trips	1.00	1.12	1.23	1.34	1.46
Annual Tonnage	1.00	1.12	1.24	1.34	1.46
Annual Operating Cost	1.00	1.12	1.26	1.42	1.58
Annual Required Freight Rate	1.00	1.00	1.02	1.05	1.07
Annual Operating Cost per Ton	1.00	1.00	1.03	1.06	1.09
Annual Operating Cost per Hour	1.00	1.00	1.02	1.04	1.06
CLASS 7					
Number of Round Trips	1.00	1.12	1.24	1.35	1.47
Annual Tonnage	1.00	1.12	1.24	1.35	1.46
Annual Operating Cost	1.00	1.12	1.26	1.41	1.56
Annual Required Freight Rate	1.00	1.00	1.02	1.03	1.05
Annual Operating Cost per Ton	1.00	1.00	1.02	1.04	1.06
Annual Operating Cost per Hour	1.00	1.00	1.01	1.03	1.04

*Normal winter with no improvements.

**8 Month Navigation Season = 1.00

TABLE 21

INDIVIDUAL SHIP CLASS RESULTS FOR
GENERAL CARGO TO ROTTERDAM*

	Length of Navigation Season (Months)				
SHIP CLASSES	8	9	10	11	12
CLASS 1					
Number of Round Trips	1.00**	1.12	1.23	1.34	1.46
Annual Tonnage	1.00	1.13	1.24	1.35	1.47
Annual Operating Cost	1.00	1.13	1.26	1.39	1.52
Annual Required Freight Rate	1.00	1.01	1.02	1.03	1.04
Annual Operating Cost per Ton	1.00	1.01	1.02	1.04	1.05
Annual Operating Cost per Hour	1.00	1.00	1.01	1.02	1.02
CLASS 2					
Number of Round Trips	1.00	1.12	1.24	1.35	1.47
Annual Tonnage	1.00	1.13	1.24	1.35	1.47
Annual Operating Cost	1.00	1.12	1.25	1.38	1.51
Annual Required Freight Rate	1.00	1.00	1.01	1.02	1.03
Annual Operating Cost per Ton	1.00	1.00	1.01	1.02	1.03
Annual Operating Cost per Hour	1.00	1.00	1.01	1.01	1.01
CLASS 3					
Number of Round Trips	1.00	1.12	1.24	1.35	1.47
Annual Tonnage	1.00	1.12	1.24	1.35	1.47
Annual Operating Cost	1.00	1.13	1.26	1.39	1.51
Annual Required Freight Rate	1.00	1.00	1.01	1.02	1.03
Annual Operating Cost per Ton	1.00	1.00	1.01	1.03	1.03
Annual Operating Cost per Hour	1.00	1.00	1.01	1.01	1.02

*Ports of Call in System: Montreal-Detroit-Duluth-Montreal
Normal winter with no improvements

**8 Month Navigation Season = 1.00

TABLE 22

VARIABLE REQUIRED FREIGHT RATES FOR LAKER BULK CARRIERS
(1975 FLEET, NORMAL WINTER)

Port of Origin	Port of Dest.	Empty Backhaul Port	Cargo	Annual* Rate	Normal Season Rate	Rate During Months of Extended Season 1	2	3	4
Two Harbors	Gary	Gary	Iron Ore	3.50**	3.13	3.14	3.92	5.09	4.96
Two Harbors	Conneaut	Conneaut	Iron Ore	3.84	3.53	4.56	4.92	6.28	5.91
Sept. Iles	Cleveland	Baie Comeau	Iron Ore	3.65	3.22	3.65	5.63	6.86	4.89
Escanaba	Indiana Harbor	Indiana Harbor	Iron Ore	1.64	1.01	1.52	1.82	2.02	2.05
Escanaba	Cleveland	Cleveland	Iron Ore	2.95	2.70	2.69	3.41	4.38	4.09
Calumet	Duluth	Calumet	Coal	2.52	2.35	2.21	2.73	3.51	3.44
Toledo	Detroit	Detroit	Coal	0.88	0.82	0.78	1.01	1.20	1.11
Toledo	Baie Comeau	Cleveland	Grain	4.91	4.88	5.19	7.77	9.28	6.94
Duluth	Baie Comeau	Cleveland	Grain	7.90	7.17	7.28	10.27	12.55	10.43
Calumet	Baie Comeau	Calumet	Grain	6.01	5.43	5.63	8.14	9.75	7.73

* 12 Month Navigation Season

** Required Freight Rates ($/long ton)

TABLE 23.

VARIABLE REQUIRED FREIGHT RATES FOR OCEAN-GOING GRAIN CARRIER
(1975 FLEET, NORMAL WINTER)

World Area	Loading Ports	Empty Backhaul Port	Annual* Rate	Normal Season Rate	Rate During Months of Extended Season 1	2	3	4
Rotterdam	Duluth Baie Comeau	Gulf of St. Lawrence	17.56**	16.67	17.12	19.56	21.07	20.52
Rotterdam	Calumet Bae Comeau	Calumet	8.32	7.88	8.10	9.32	10.11	9.69
Japan	Duluth Baie Comeau	Gulf of St. Lawrence	28.28	27.03	27.41	30.91	32.82	32.79
Japan	Calumet Baie Comeau	Calumet	19.03	18.24	18.61	20.66	21.84	21.83

* 8 Month Navigation Season

** Required Freight Rates ($/long ton)

TABLE 24.

VARIABLE REQUIRED FREIGHT RATES FOR OCEAN-GOING GENERAL CARGO CARRIER

World Area	Ports of Call in System	Annual * Rate	Normal Season Rate	Rate During Months of Extended Season 1	2	3	4
Rotterdam	Montreal, Cleveland, Detroit, Montreal	21.07 **	20.46	21.40	22.54	23.47	22.27
Rotterdam	Montreal, Detroit, Calumet, Montreal	22.87	22.21	23.14	24.37	25.44	24.23
Rotterdam	Montreal, Detroit, Duluth, Montreal	23.26	22.59	23.54	24.66	26.04	24.67
Japan	Montreal, Cleveland, Detroit, Montreal	42.56	41.76	42.85	44.09	45.39	44.56

*12 Month Navigation Season

**Required Freight Rates ($/long ton)

TABLE 24. (CONTINUED)

VARIABLE REQUIRED FREIGHT RATES FOR OCEAN-GOING GENERAL CARGO CARRIER

World Area	Ports of Call in System	Annual* Rate	Normal Season Rate	Rate During Months of Extended Season 1	2	3	4
Japan	Montreal, Detroit, Calumet Montreal	44.36 **	43.52	44.65	46.21	47.40	46.21
Japan	Montreal, Detroit, Duluth, Montreal	44.75	43.89	44.91	46.65	47.86	46.69

* 12 Month Navigation Season

** Required Freight Rates ($/long ton)

VII. CONCLUSIONS

In analyzing the results presented in the previous section, certain considerations must be kept in mind. As with any computer simulation, the results obtained are only as good as the basic input data and basic rules and assumptions, which are given in Appendix E of Volume II and Section V respectively. One must also keep in mind factors other than those considered in the study which influence the potential benefit of season extension. First of all, for extended season navigation to become commonplace, the demand must exist for winter shipping services; that is, there must be a need along with economic justification. Secondly, the feasibility of transporting each particular cargo must be considered. For example, limestone goes through a wash process causing it to have a high moisture content. A drying process would therefore have to be instituted before transporting limestone during winter would be feasible. Thirdly, one must consider the advantages of shipping during the winter season resulting from lower stockpiling costs, increased annual season capacity, less diversion of cargo to more expensive modes of transportation and so on. Also, a smaller fleet comprised of the larger, more economical and efficient ships obtained by phasing out smaller, less economical ships could transport the same annual tonnage as the present fleet. In addition, one must also consider the needs for repair and maintenance, not only of ships but also of lock and port facilities. With these considerations in mind the following conclusions were drawn as a result of this study:

OVERALL

From the standpoint of annual required freight rates and annual operating costs per ton, extended season navigation, even all-year navigation, is commercially viable. As one would expect, the magnitude of the benefit varies from route to route with the greatest benefit occurring for routes with the mildest ice conditions and the least benefit occuring for routes with the most severe ice conditions.

LAKER BULK CARGO ROUTES

For laker bulk cargo routes, extended season navigation was found to be economically beneficial with the annual required freight rates decreasing for all routes and all bulk commodities for the 1975 fleet and a normal winter. The average reduction in rates was approximately 8% with the greatest reduction of over 11% occurring for all-year shipping of iron ore from Escanaba to Indiana Harbor. As one would expect, the reduction was a direct function of the ice conditions. The milder the ice conditions along a particular route, the greater the reduction. Conversely, for routes having severe ice conditions, the reduction is not as great and, in fact, may exhibit an optimum season extension period for which the rates are a minimum. The range of the decrease in annual required freight rates is shown in Table 25. The primary reason for this decrease in freight rates is that lakers employed over the winter season can generate revenues for their owners, thereby enabling lower rates to be charged while still recovering their investment.

While the annual required freight rate decreases with season extension, the operating costs per ton of cargo tend to increase as shown in Table 25. The largest increase, of approximately 13%, occurred for all-year shipping of iron ore from Sept Iles to Cleveland. The smallest increase of 6% for all-year navigation occurred for iron ore from Escanaba to Indiana Harbor. The reason operating costs per ton tend to increase with season extension is that while certain costs, such as lay-up costs, decrease with season extension; other costs, such as maintenance, repairs, and insurance, increase. In addition since transit times increase with season extension, less cargo can be transported during any given time period. It should be noted that the annual operating costs per ton tend to decrease slightly with initial extended season operations and then begin to increase.

OVERSEAS GRAIN AND GENERAL CARGO ROUTES

Whereas for laker bulk cargo routes the annual required freight rates decreased with season extension, the rates increased for overseas grain and general cargo routes as shown in Tables 26 and 27 with a maximum increase of 7% for all-year shipping of grain and a 3% increase for all-year shipping of general cargo. The reason for this increase is again related to the ability of ships to generate revenues for their owners. Instead of laying-up for the winter as laker ships do, ocean-going ships operate elsewhere in the world during the winter

TABLE 25

SUMMARY OF RESULTS FOR LAKER BULK CARGO ROUTES

Range of the Index of Annual Required Freight Rates*

Type of Cargo	Length of Navigation Season (months)				
	8	9	10	11	12
Iron Ore	1.00	.945-.966	.915-.969	.899-.982	.886-.978
Coal	1.00	.942-.945	.913-.921	.906-.915	.896-.907
Grain	1.00	.953-.957	.941-.952	.944-.960	.937-.951

Range of the Index of Annual Operating Cost Per Ton*

Type of Cargo	Length of Navigation Season (months)				
	8	9	10	11	12
Iron Ore	1.00	.990-1.01	1.00-1.05	1.03-1.10	1.06-1.13
Coal	1.00	.984-.988	1.00-1.01	1.04-1.05	1.07-1.08
Grain	1.00	.995-1.00	1.03-1.04	1.07-1.09	1.10-1.12

* 8 Month Navigation Season = 1.00

TABLE 26

SUMMARY OF RESULTS FOR OVERSEAS GRAIN ROUTES

Range of the Index of Annual Required Freight Rates*

World Area	Length of Navigation Season (months)				
	8	9	10	11	12
Rotterdam	1.00	1.00	1.02	1.04	1.05-1.06
Japan	1.00	1.00	1.02	1.03	1.04-1.05

Range of the Index of Annual Operating Cost Per Ton

World Area	Length of Navigation Season (months)				
	8	9	10	11	12
Rotterdam	1.00	1.00	1.02	1.05	1.06-1.07
Japan	1.00	1.00	1.02	1.04	1.05-1.06

* 8 Month Navigation Season = 1.00

TABLE 27.

SUMMARY OF RESULTS FOR OVERSEAS GENERAL CARGO ROUTES

Range of the Index of Annual Required Freight Rates*

World Area	Length of Navigation Season (months)				
	8	9	10	11	12
Rotterdam	1.00	1.00-1.01	1.01-1.02	1.02-1.03	1.03
Japan	1.00	1.00	1.01	1.02	1.02

Range of the Index of Annual Operating Costs Per Ton*

World Area	Length of Navigation Season (months)				
	8	9	10	11	12
Rotterdam	1.00	1.00-1.01	1.01-1.02	1.03	1.03
Japan	1.01	1.00	1.01	1.02	1.02

* 8 Month Navigation Season = 1.00

season generating revenues for their owners. Thus, if ocean-going ships operate in the GL-SLS System during extended season, both the annual vessel operating costs and the portion of the investment which must be recovered increases proportionally with the length of the navigation season. These increases coupled with the increased transit time in the system cause the annual required freight rates to increase. In the same manner,the annual operating cost per ton also increases with season extension as shown in Tables 26 and 27.

Distance to the overseas port from the GL-SLS System has a small influence on both the index of annual required freight rate and index of annual vessel operating cost per ton of only 1% for all-year navigation. It is interesting to note that the closer the overseas port is to the system, the larger the percentage increase with season extension since the percentage of time the ships spends in the GL-SLS System to the total voyage time increases.

EFFECT OF WINTER SEVERITY ON ANNUAL REQUIRED FREIGHT RATE

As one would expect, a mild winter causes annual required freight rates for laker bulk routes to decrease a greater amount than those for a normal winter, and a severe winter causes the rates to decrease a smaller amount. It should be noted that for a severe winter, the rates for many laker routes decrease to a minimum annual rate for an optimum season extension peroid, and then begin to increase as season extension continues. For overseas routes, the rates increase to a lesser degree for mild winters and increase to a greater degree for severe winters. These results are tabulated in Table 28.

EFFECT OF FLEET MIX ON ANNUAL REQUIRED FREIGHT RATES

As the fleet mix tends to larger, more powerful and economical ships, the annual required freight rates decrease even more for laker bulk cargo routes and increase less for overseas routes. These results are tabulated in Table 29.

EFFECT OF IMPROVEMENT LEVELS ON ANNUAL REQUIRED FREIGHT RATES

The effect of improvement levels is the same as the effect of fleet mix. In general the greater the improvement level, the larger the decrease in the annual required freight rates for laker bulk routes and the smaller the increase for overseas routes. The magnitude depends to a large degree on the

TABLE 28.

EFFECT OF WINTER SEVERITY ON REQUIRED FREIGHT RATES

(RANGE OF THE INDEX OF REQUIRED FREIGHT RATES)

Routes	Length of Navigation Season (months)				
	8	9	10	11	12
Laker Iron Ore	1.00 *	.944-.972**	.911-.979	.890-.997	.877-.994
Laker Coal	1.00	.942-.945	.909-.924	.879-.925	.882-.923
Laker Grain	1.00	.945-.957	.926-.961	.925-.974	.915-.966
Overseas Grain	1.00	1.010-1.005	1.015-1.024	1.026-1.048	1.039-1.065
Overseas General Cargo	1.00	1.002-1.006	1.007-1.018	1.012-1.030	1.016-1.036

* 8 month Navigation Season = 1.00
** Mild - severe

TABLE 29.

EFFECT OF FLEET MIX ON REQUIRED FREIGHT RATES
(RANGE OF THE INDEX OF REQUIRED FREIGHT RATES)

Routes	Length of Navigation Season (months)				
	8	9	10	11	12
Laker Iron Ore	1.00*	.935-.965**	.899-.968	.876-.982	.860-.977
Laker Coal	1.00	.937-.945	.917-.920	.893-.915	.987-.904
Laker Grain	1.00	.949-.957	.933-.953	.934-.960	.926-.951
Overseas Grain	1.00	1.002-1.003	1.015-1.020	1.030-1.041	1.044-1.057
Overseas General Cargo	1.00	1.003-1.005	1.008-1.014	1.015-1.025	1.018-1.029

**8 month Navigation Season = 1.00*
**1995 Fleet mix - 1975 Fleet mix

route itself and whether or not it includes an area where improvements are being considered. For example, while the improvement level has a significant effect on the rate of Sept Iles to Cleveland, it has a negligible effect for Escanaba to Indiana Harbor. For Sept Iles to Cleveland, a 75% improvement level caused the index of annual required freight rate to drop from 0.977 to 0.934 for all-year navigation or a 4.4% drop in annual freight rates.

The results of the effect of improvement levels are given in Table 30. It should also be noted that an added benefit of improvement levels is to reduce the need for ships to have icebreaker escorts,, reduce the chance of ship damage and aid in reducing insurance costs.

INDIVIDUAL SHIP CLASSES

The ships which benefit the most from season extension are the larger, more powerful and economical ships. They get stuck less, have less chance of damage, have faster speeds of advance, and can transport more cargo. In addition, they increase the system capacity measured in tons of cargo transported since fewer ships can transport the same tonnage of cargo as smaller ships do. For example, a class 5 laker vessel carrying ore from Two Harbors to Gary can make 41 trips during the normal season and 57 if it operated all-year, while a class 10 laker vessel can make 44 to 63 respectively or 6 additional trips during the year. In terms of cargo, a class 10 laker vessel can transport over 2 million more tons of ore than a class 5 vessel over the entire year.

VARIABLE REQUIRED FREIGHT RATES

By having freight rates vary through the navigation season, the rates for the normal season and the early winter months when ice does not present a major problem would be lower than the annual rates. Conversely during the later winter months, when ice does cause problems, the rates would be higher than the corresponding annual rates.

TABLE 30.

EFFECT OF IMPROVEMENT LEVELS ON REQUIRED FREIGHT RATES
(RANGE OF THE INDEX OF REQUIRED FREIGHT RATES)

Routes	Length of Navigation Season (months)				
	8	9	10	11	12
Laker Iron Ore	1.00 *	.945-.965**	.915-.968	.899-.982	.885-.977
Laker Coal	1.00	.945	.917-.920	.905-.915	.892-.904
Laker Grain	1.00	.950-.957	.927-.952	.919-.960	.901-.950
Overseas Grain	1.00	1.001-1.003	1.012-1.020	1.027-1.041	1.041-1.056
Overseas General Cargo	1.00	1.002-1.005	1.006-1.014	1.011-1.026	1.015-1.030

*8 Month Navigation Season = 1.00
**75% Ice Conditions Reduction - 0% Ice Conditions Production

VIII. RECOMMENDATIONS

Based on the knowledge we have gained during the course of this WINTER RATE STUDY, we recommend the following:

(1) The overall model planned for Phase III, which includes the SIMULATION MODEL described in this report, should be developed in order to investigate the role of, and the demand for, GL-SLS shipping services in moving cargo. The model should also be used to identify problem areas and bottlenecks to extended season navigation and to evaluate the potential benefit of proposed solutions and improvements and establish system capacities. In addition, sensitivity studies should be conducted to determine the primary variables which can influence or cause change in the GL-SLS System and to determine the magnitude of their impact.

(2) In developing this overall model, we recommend that general cargo be treated in the same manner as bulk cargo is treated in the simulation described in this report. General cargo should be separated by world areas and each should have a stockpile level, cargo arrival rate, cargo demand rate, and number of docks similar to bulk cargo at every port. In this way, the cargo arrival and demand rates along with the frequency of service will establish the tonnage general cargo ships can transport.

(3) Because of the capability of the model to simulate the interaction between ships and the system and between ships themselves, we recommend the model be used to investigate various requirements and operating procedural changes. For example, the model can be used by the Coast Guard as a tool to investigate their icebreaker requirements. The model could also be used in investigating ship requirements, such as the need for restricting ships with low power to beam ratios (shp/B) from extended season operations.

(4) The level of proposed improvements such as air bubblers and ice booms should be determined for each specified area. For example, if an air bubbler system is proposed for different areas, its size should be related to anticipated improvement in each particular area; that is, the reduction in ice thickness. Similarly, proposed improvements at ports and locks should be related to decreases in ice conditions or a decrease in service time at each facility.

(5) The simulation model should be kept current by revising input data files and changing the basic rules and assumptions as required. The simulation model should be updated as more data is obtained on ice conditions, ice navigability of ships, improved cost data, and the operation of ports, locks, and ships during extended season operations. Unless the simulation is periodically upgraded, it will lose its credibility as a planning tool.

(6) The simulation should be documented in detail so that it can be used by other government agencies and by private and public organizations, thereby eliminating needless duplication of effort.

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APPENDIX VIII

GREAT LAKES-ST. LAWRENCE SEAWAY

U.S. FISH & WILDLIFE REPORT

APPENDIX VIII

U.S. FISH & WILDLIFE SERVICE
REPORT ON THE INTERIM
FEASIBILITY STUDY,
MARCH 1976, GREAT LAKES -
ST. LAWRENCE SEAWAY
NAVIGATION SEASON EXTENSION

February 1976

*See Appendix II - Pertinent Correspondence for
transmittal letter of this report.

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1. INTRODUCTION

The present winter navigation extension program consisting of a demonstration program and a survey program came into being about 1971. The demonstration portion began in July, 1971 and is presently scheduled to end in June of 1976; however, it is possible that the demonstration program may be extended two years in order to further study needs for the area downstream of Lake Huron. The survey program began somewhat earlier and is presently scheduled to end in December, 1976.

1.1 AUTHORIZATION

This report evaluates the effects of your selected plan for operational winter navigation extension in the upper four Great Lakes and included connecting channels on the indigenous fish and wildlife resources and the utilization of the same. This report, based on the selected plan as presented in the Draft Interim Feasibility Study, Great Lakes - St. Lawrence Seaway Navigation Season Extension, is submitted for inclusion in future feasibility reports. It has been prepared under the authority and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) and the National Environmental Policy Act of 1969 (P.L. 91-190; 83 Stat. 852-856).

The Great Lakes - St. Lawrence Seaway Navigation Season Extension Demonstration Program was authorized by Federal Legislation, Sec. 107 of

Public Law 91-611 of the Rivers and Harbors Act of 1970 for the purpose of demonstrating the practicability of extending the navigation season on the Great Lakes - St. Lawrence Seaway. The particular function of the Fish and Wildlife Service in the winter navigation extension demonstration program has been to establish baseline data relative to the areas of the demonstration and evaluate the environmental effects of the program.

1.2 PURPOSE

The intent of the winter navigation extension program has been to demonstrate that the Great Lakes - St. Lawrence Seaway can be navigated beyond December 15, the time when most vessel transits end due to ice formation interfering with normal operations except, in the central portions of the major Great Lakes. Consequently, the areas primarily dealt with are the harbors, bays and connecting channels. Normally, only in the extreme western ends of Lake Superior and Lake Erie do significant ice covers form other than in the harbors, bays and connecting channels.

There are two basic approaches to moving vessels through the Great Lakes - St. Lawrence Seaway system during the period when ice formation and/or ice cover interferes with normal operation: (1) Involves modification of the ice formation or ice cover through which vessels must transit, and (2) involves modification of the vessel to cope with ice formation and/or ice cover. The best solution appears to be a combination of ice formation - ice cover and vessel modification. Ice cover can best be modified by ice breaking by ice breakers or other vessels suitably constructed. Other means of ice cover modification are bubblers, flow diversions, thermal ice suppression and ice stabilization structures. These measures during a normal winter may prove of marginal value alongside ice breaking. Modification of vessels involves hull strengthening to enable operation through ice formations without incurring structural damage.

The bottlenecks in the Great Lakes - St. Lawrence River system which necessitate implementation of the above measures occur in the several harbors, St. Marys River, Soo Locks, Straits of Mackinac, St. Clair River, Lake St. Clair, Detroit River, Western Lake Erie, Welland Canal and St. Lawrence River. The St. Marys River and St. Lawrence River will probably require ice stabilization structures to facilitate ship transit. The rest can be generally transitted with the use of ice suppression methods and/or ice breaking.

Presently a Draft Interim Feasibility Study, Great Lakes - St. Lawrence Seaway Navigation Season Extension has been prepared by the Detroit District, Corps of Engineers which essentially addresses a selected plan to extend the present navigation season on the upper four Great Lakes and included connecting channels. The time frame of this extension has been defined as December 15 through January 31. The selected plan contains only methods which have been demonstrated as feasible. Consequently we can make observations about the selected plan. Concern remains, however, regarding future operational items. These might include channel modification, lock modification or new locks, and the use of untested methods of ice suppression. We presume that, if need for these arise, they will be submitted to the same scrutiny as the present measures.

2. AREA DESCRIPTION

The upper four Great Lakes are comprised of Lakes Superior, Michigan, Huron and Erie and their connecting channels; the St. Marys River, the Straits of Mackinac, and the St. Clair River - Lake St. Clair - Detroit River. These lakes and their tributaries drain an area of approximately 263,720 square miles and have a combined water surface area of 87,340 square miles as shown in Table 1. This area constitutes better than half of the St. Lawrence River Basin.

The United States portion of the above figures is 107,030 square miles for drainage area and 57,142 for water surface area. In the selected plan presented in the Interim Feasibility Study it is indicated that twenty-one harbors will be utilized during the operational extension of the shipping season to January 31.

2.1 PHYSICAL DESCRIPTION OF HARBORS

2.1.1 Taconite Harbor, Minnesota, Lake Superior

This is a private harbor maintained by the Erie Mining Company. The area inside the basin is about 3/4 mile long by 1/4 mile wide and is inclosed by breakwaters, Gull and Bear Islands and the mainland near the mouth of the Two Island River. There are rubblemound breakwaters on the southwest and northeast sides, an ore dock on the mainland side, and an entrance about 400 feet wide. The depth of the entrance channel is between 27 and 29 feet with a basin depth of about 50 feet. Iron ore pellets are shipped, and coal, steel and fuel oil received.

TABLE 2

DESCRIPTIVE DATA ON THE UPPER FOUR GREAT LAKES

DESCRIPTION	LAKE SUPERIOR	LAKE MICHIGAN	LAKE HURON	LAKE ST. CLAIR	LAKE ERIE	TOTALS
Low Water Datum (LWD) Elevation in feet IGLD (1955)	600.0	576.8	576.8	571.7	568.6	
Dimensions in miles						
Length	350	307	206	26	241	
Breadth	160	118	183	24	57	
Shoreline including islands	2,980	1,660	3,180	169	856	8,845
Areas in Sq. Miles 1/						
Drainage Basin U.S.	37,500	67,900	25,300	2,370	23,600	156,670
Drainage Basin Canada	43,500	0	49,500	4,150	9,880	107,030
Total Basin Land & Water	81,000	67,900	74,800	6,520	33,500	263,720
Water Surface U.S.	20,600	22,300	9,100	162	4,980	57,142
Water Surface Canada	11,100	0	13,900	268	4,930	30,198
Total Water Surface	31,700	22,300	23,000	430	9,910	87,340
Volume of water in cu. miles 1/	2,935	1,180	849	1	116	5,081
Depths of water in feet 1/						
Average over lake	489	279	195	10	62	
Maximum observed	1,333	923	750	21 2/	210	
Outlet River or Channel	St. Marys River	Str.of Mackinac	St. Clair R.	Detroit River	Niagara River	
Length in miles	70	---	27	32	37	
Average Flow (1860-1970) CFS	75,000	52,000	187,300	190,000	201,900	
Monthly Elevations in feet 3/						
Minimum	598.23	575.35	575.35	569.86	567.49	
Average	600.39	578.70	578.70	573.09	570.41	
High	602.06	581.94	581.94	575.70	572.76	

1/ Lake level at Low Water Datum elevation. LWD is a reference elevation for nautical charts and projects.

2/ This is the Greatest natural depth for Lake St. Clair, a greater depth of 27.5 feet occurs in the center of the ship channel.

3/ Lake elevations are as recorded at Marquette (Lake Superior), Harbor Beach (Lake Michigan-Huron), Grosse Pointe Shore (Lake St. Clair) and Cleveland (Lake Erie). Recorded elevations are affected by man-made changes.

2.1.2 Silverbay Harbor, Minnesota, Lake Superior

This is a private harbor maintained by the Reserve Mining Company. The area inside the basin is about 3/4 mile long and 1/4 mile wide, with depths over most of the area of 30 feet. The basin is inclosed by rubblemound breakwaters, Pellet Island, and Beaver Island. This harbor contains a single loading dock. Iron ore pellets are shipped and coal, steel and fuel oil received.

2.1.3 Two Harbors (Agate Bay), Minnesota, Lake Superior

This is a public harbor at the City of Two Harbors, Minnesota and maintained by the United States both as a commercial harbor and a harbor of refuge. The harbor is a natural bay or indentation about 3/4 miles long by 1/2 mile wide with two breakwaters, one on either side of the entrance. The entrance is 100 feet wide. The depth in the harbor basin runs from 26 feet on the easterly side to 30 feet elsewhere. There are three active ore docks owned by the Duluth, Mesabi and Iron Range Railroad in addition to an inactive coal dock and merchandise wharf.. There are also commercial fishing docks along the easterly aspect of the basin. Iron ore is shipped from the active ore docks.

2.1.4 Presque Isle Harbor (Marquette Upper Harbor), Michigan, Lake Superior

This is a public harbor north of Marquette, Michigan and maintained by the United States as a commercial harbor. The state also maintains a small boat harbor with full facilities. The harbor basin is formed by an indentation in the coastline south of Presque Isle Pointe with a single breakwater on the north side. It is about 1½ miles long and ½ mile wide with controlling depths from 18 to 40 feet with a hard sand, gravel and boulder bottom. The harbor depth is maintained at 23 feet with an entrance channel depth of 30 feet. Harbor facilities consist of one ore dock and a merchandise and petroleum wharf owned by the Lake Superior and Ishpeming Railroad Company. Iron ore is shipped and petroleum products received.

2.1.5 Marquette Harbor (Lower Marquette Harbor), Michigan, Lake Superior

This is a public harbor maintained by the United States with 350 acres protected by the shoreline on the north and south and a breakwater to the east. This harbor basin has an available depth of 27 feet. One ore dock, two coal docks, two petroleum docks, and others in various states of repair are available. Iron ore is shipped and coal and petroleum received. This harbor is also used as a base for commercial fishing.

2.1.6 Milwaukee Harbor, Wisconsin, Lake Michigan

This is a public harbor with an outer basin of 1,100 acres protected by breakwaters on the north and south. The outer harbor is separated from the inner commercial harbor by a river entrance channel with parallel breakwaters. The inner harbor is comprised of 2.9 miles of the Milwaukee River, 1.9 miles of the Menominee River, and 1.84 miles of the Kinnickinnic River including the Municipal Mooring Basin. The Milwaukee River is joined by the Menominee River from the west and the Kinnickinnic River from the south just inside the entrance channel. The Municipal Mooring Basin is used primarily for the winter moorage of commercial vessels. Car ferries, auto ferries, petroleum tankers and commercial vessels purportedly ply year-round to Muskegon, Ludington, and various southern Lake Michigan ports. Additionallly a full range of services are available to small craft adjacent to the two small craft anchorage areas.

2.1.7 Calumet Harbor, Illinois, and Indiana, Lake Michigan

This is a public harbor located at the mouth of the Calumet River and is frequently used by many vessels during severe weather, for this reason it is also a very important harbor of refuge. The only facilities in this area sheltered by the breakwater are the private slips of U.S.Steel. It is used by commercial vessels throughout the year, particularly those entering the Calumet River. The available depth is 27 feet.

2.1.8 Calumet River, Illinois and Indiana, Lake Michigan

The primary purpose of this public waterway is to connect Calumet Harbor with Lake Calumet, a major port, and provide access to industry throughout its 7.7 mile length. Depths of 27 feet are available over about the first 6.5 miles.

2.1.9 Gary Harbor, Indiana, Lake Michigan

This is a private harbor developed and owned by the U.S. Steel Corporation. It is entirely artificial comprised of a 246 foot wide channel between parallel piers extending 2,000 feet north and 3,563 feet south from the former shoreline terminating in a turning basin 750 feet in diameter. Universal Atlas Cement Division and U.S. Steel Corporation have plants adjacent to this harbor. Of interest is the fact that this harbor is at the southern extremity of Lake Michigan.

2.1.10 Indiana Harbor, Indiana, Lake Michigan

This is an artificial harbor located at East Chicago, Indiana and comprised of breakwaters, an entrance channel, an outer harbor basin, and a canal entrance channel between areas of made land inclosed by piers and bulkheads built into the lake from the original shoreline occupied by Youngstown Sheet and Tube Company & Inland Steel Company. The Indiana Harbor Canal has branches extending toward Lake George and the Grand Calumet River. The main harbor has an available depth of at least 27 feet.

2.1.11 Burns Waterway Harbor, Indiana, Lake Michigan

This is an artificial public harbor under the control of the Indiana Port Commission. The harbor basin is comprised of an outer harbor of 93 acres with an available depth of 27 feet for the most part. The inner harbor is comprised of two arms divided by a breakwater. The eastern arm apparently abuts property of Midwest Steel Corporation and Bethlehem Steel Corporation. The Indiana Port Commission has established a public terminal and transfer facility on the central arm.

2.1.12 Muskegon Harbor, Michigan, Lake Michigan

This public harbor is formed by Muskegon Lake and an improved and protected entrance channel which connects it to Lake Michigan Muskegon Lake, with its westerly end less than a mile from Lake Michigan, is approximately four miles long and its width ranges from two miles at the westerly end to 5/8 miles near the middle. It reaches a maximum depth of 79 feet with most of the lake greater than 29 feet. A shoal extending south from the north shore, and a shoal border along the south shore, restrict the deep water to a width of about 2000 feet near mid-lake. There are many obstructions in the shallow parts of the lake. An available depth of at least 27 feet is maintained in the commercial vessel channels leading to and within the harbor. Facilities for a wide range of commerce are located along the south and east shores of the lake at Muskegon, Michigan. The U.S. Coast Guard also maintains a station adjacent to the entrance channel.

2.1.13 Ludington Harbor, Michigan, Lake Michigan

This public harbor is formed by Pere Marquette Lake and an improved and protected entrance channel which connects it to Lake Michigan at the north end. The lake is about two miles long, inclusive of the marsh at the southerly end and 1/4 mile wide. Depths to 45 feet exist with an available depth of at least 24 feet throughout the commercial vessel channels. The U.S. Coast Guard maintains a station adjacent to the entrance channel and facilities for small craft can be found along the north shore. Purportedly car ferries operate year-round from the ferry docks on the south side of the lake. There are also coal docks which handle coal and petroleum.

2.1.14 Saginaw River, Michigan, Lake Huron

The Saginaw River is a wide, slow flowing river that drains 6,222 square miles. It has an average flow of about 25,000 cubic feet per second and an average width of 670 feet. Its narrowest point, 365 feet, occurs 22 miles from the mouth. Its widest point, 1,700 feet, occurs 8.5 miles from the mouth.

The public harbor is formed by the first 18 miles of the Saginaw River. The Saginaw River is formed by the confluence of the Tittabawassee and Shiawassee Rivers. In the first 14 miles of the river an available depth of at least 22 feet is maintained by the United States. This depth gradually increases toward the mouth of the river where a 27 foot channel is maintained through Saginaw Bay to deep water in Lake Huron. Along the Saginaw River are facilities for receiving and shipping a large variety of materials such as coal, oil, stone, etc.. There are also numerous small craft facilities and a U.S. Coast Guard Station.

2.1.15 Detroit Harbor, Michigan, Lake Huron

The waterfront of Detroit, Michigan extends along practically the upper 13 miles of the Detroit River from the head of Fighting Island to Lake St. Clair. Below Belle Isle the bank is built up out to deep water and occupied by numerous industries and docks providing ample accomodations for various vessels. The Rouge River also constitutes an important branch channel to the harbor of Detroit, The U.S. Coast Guard maintains a station on Belle Isle.

2.1.16 Toledo Harbor, Ohio, Lake Erie

This public harbor is located at the western extremity of the lake and includes the lower seven miles of the Maumee River and the 18 mile long channel through Maumee Bay to deep water in Lake Erie. The channel through the bay is maintained at a least depth of 28 feet and includes a 39 acre widening near the mouth of the river. Depths of 20 to 28 feet are maintained in various portions of the river. The Maumee River through the City of Toledo has been extensively developed for commercial vessel traffic and offers facilities of all natures. A seaplane base, U.S. Coast Guard Station, and small craft facilities can also be found in the area.

2.1.17 Lorain Harbor, Ohio, Lake Erie

This public harbor is located at Lorain, Ohio and is comprised of an outer harbor, and the lower 3 miles of the Black River. In about the first 2 miles a least depth of 20 feet is maintained by the United States. Such facilities as dry docks and complete ship yards for vessels of all sizes are found here. Additionally a U.S. Coast Guard Station, coal docks, ore docks, and small craft basins are available at this harbor.

2.1.18 Cleveland Harbor, Ohio, Lake Erie

This harbor consists of both an outer and inner harbor made up of parts of the Cuyahoga River. A least depth of 23 feet is provided throughout the harbor area. The southwesterly waterfront is comprised of various commercial facilities, small craft moorages, an airport, and other public utilities. The East Harbor under the jurisdiction of the Cleveland-Cuyahoga Port Authority is comprised of several public piers. There are also ore docks operated by various private concerns to unload iron ore. Dry docks are also available at the U.S. Coast Guard station. This is an extremely heavily developed area.

2.1.19 Ashtabula Harbor, Ohio, Lake Erie

This is a public harbor comprised of an outer harbor, protected by breakwaters, and approximately the first 10,500 feet of the Ashtabula River. Two large slips give directly into the outer harbor and are within the protection of the breakwaters. Depths from 18 feet in the upper portion of the river to 28 feet in the outer harbor are maintained by the United States. Penn Central Company and Pinney Dock and Transport Company have developed docks and slips in the outer harbor on either side of the river. The river itself also offers additional commercial and small craft facilities as well as a U.S. Coast Guard Station.

2.1.20 Conneaut Harbor, Ohio, Lake Erie

This public harbor is comprised of an outer breakwater protected harbor, the lower 3000 feet of the Conneaut Creek, and a slip built by the Pittsburgh and Conneaut Dock Company. Presently an average depth of at least 27 feet is offered in most of the harbor area. Iron ore, coal, limestone and steel loading and/or unloading facilities are available. Also small craft facilities can be had.

2.1.21 Buffalo Harbor, New York, Lake Erie

This public harbor is located at the eastern end of Lake Erie, where it converges to an open and somewhat shallow bay 8 miles across north to south. The lake discharges into the Niagara River at the northeast corner of this bay. The Buffalo River meanders through the city from east to west and enters the lake near the head of the Niagara River. The outer harbor is about 4½ miles long and 1,600 feet wide inclosed by a system of breakwaters with depths of 23 to 30 feet. The inner harbor can be divided in two section; the Buffalo River and the Buffalo Ship Canal. The Buffalo River is about 150 to 300 foot wide and 5½ miles long with a depth of 22 feet. The Buffalo Ship Canal is an artificial waterway 125 feet wide and 1 mile long with a depth of 22 feet. Any of various commercial vessel facilities are available. Also a U.S. Coast Guard Station and small craft facilities are available at Buffalo, New York.

2.2 PHYSICAL DESCRIPTION OF CONNECTING CHANNELS

2.2.1 Whitefish Bay, Michigan, Lake Michigan

Whitefish Bay can be loosely described as that area comprised of the area bounded by Whitefish Point (northwest), Iroquois Point (southwest)

Gros Cap (southeast), and Copper Mines Point (northeast). Several lesser bays including Tahquamenon, Goulais and Batchawana are identified within this area. Since we are concerned primarily with the American sector, the important features are Iroquois and Tahquamenon Islands, a shoal with least depths of 2 feet from just north of the mouth of the Tahquamenon River to within a mile of the southern shore, and the fact that the 30 foot contour approaches to within about 1/2 mile of the shore between Pendils Creek and Dollar Bay Settlement. In the area of Whitefish Bay frequented by commercial vessels safe draft is available.

2.2.2 St. Marys River, Michigan

The St. Marys River connects Lake Superior to Lake Huron. The difference between the levels of the two lakes is about 20 feet, most of which occurs in the St. Marys Falls area at Sault Ste. Marie. The river begins at a point nominally defined as a line between Iroquois Point and Gros Cap flowing in a general southeasterly direction till it reaches Point De Tour which marks the confluence with Lake Huron. At Sault Ste. Marie the river passes over the rapids with control works at the upper end, through two hydroelectric power plants, and five navigation locks. Some water is also bypassed around the rapids via a power canal for yet another hydroelectric plant on the United States side. From the base of the rapids it is about two miles to where the river splits into two channels flowing either side of a series of islands. The total length of the river is about 70 miles bordered by several bays and wetlands of various types. The riverbed runs from mud to granite.

2.2.3 Straits of Mackinac, Michigan

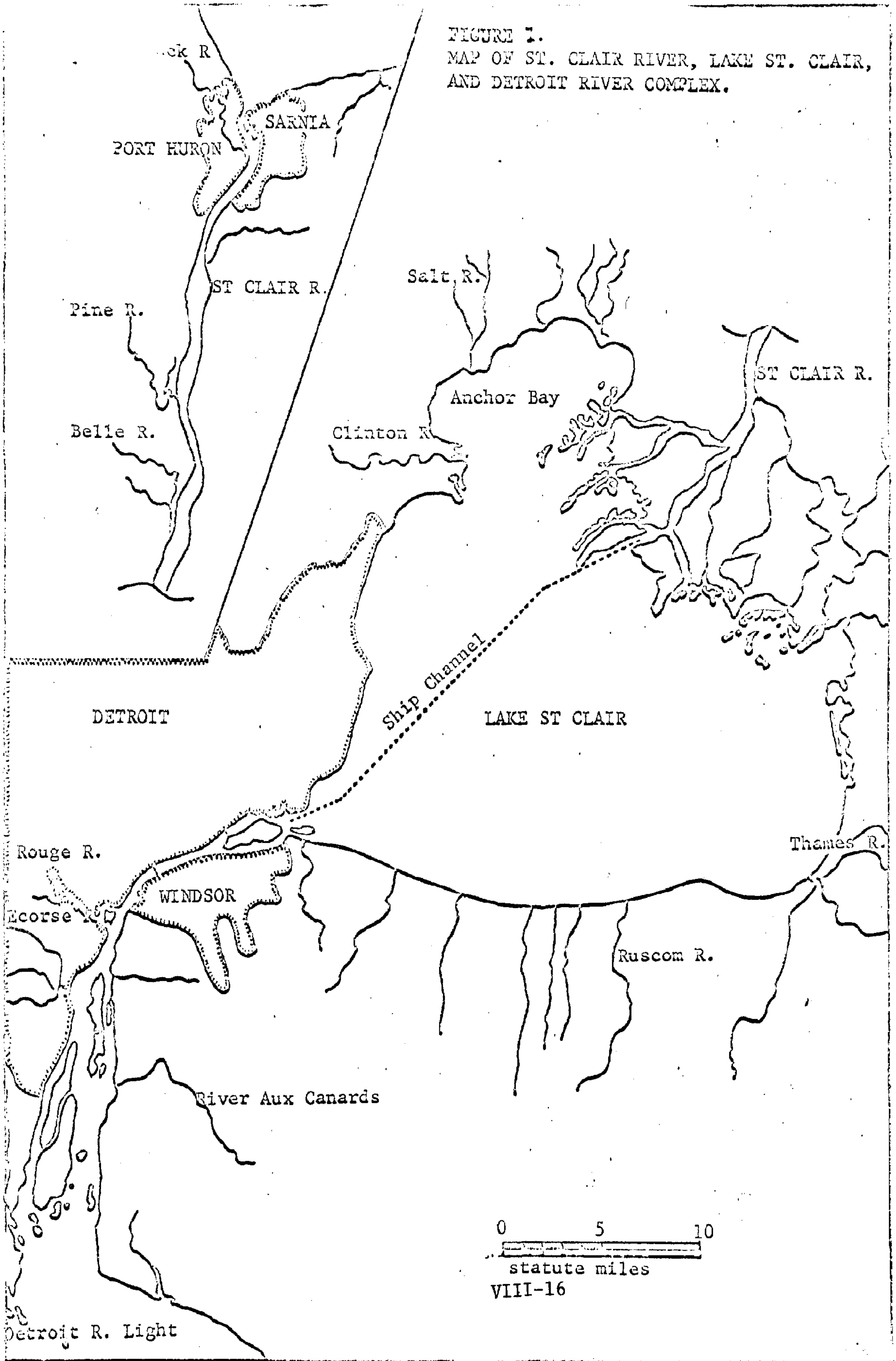
The Straits of Mackinac forms the outlet for Lake Michigan, or more correctly, a connection with Lake Huron. The straits are about 3.5 miles wide at their narrowest point between the upper and lower peninsulas of Michigan and four miles long. The water depth in the straits is greater than 220 feet, however, shallow water areas of 30 feet in depth are extensive along both shorelines and in several places extend nearly a mile into the straits.

2.2.4 St. Clair River - Lake St. Clair - Detroit River, Michigan

The connecting channel between Lake Huron and Lake Erie consists of three distinct bodies of water. These are the St. Clair River, Lake St. Clair, and the Detroit River.

The St. Clair River, which flows from Lake Huron to Lake St. Clair, carries the outflow from Lakes Huron, Michigan and Superior with the exception of that diverted at Chicago and to Lake Simcoe. The approximate length of the river is 39 miles. The upper river (Lake Huron to the Chenal Ecarte) and the lower river (Chenal Ecarte to Lake St. Clair) are 28 miles and 11 miles long respectively. The upper river contains two islands, Fawn (Woodtick) and Stag. It has a rapids section with a velocity of four miles per hour which extends from a point 1,000 feet north of the Blue Water Bridge to 300 feet south of the bridge at Port Huron, Michigan. The lower river (delta portion), where there are many branching channels, is commonly called the St. Clair Flats. It was formed when water velocity became reduced sufficiently to allow the silt load to settle. The St. Clair River has a velocity of about two miles per hour when it enters Lake St. Clair.

FIGURE 1.
MAP OF ST. CLAIR RIVER, LAKE ST. CLAIR, AND DETROIT RIVER COMPLEX.



The discharge of the St. Clair River into Lake St. Clair averages 174,000 to 187,000 cubic feet per second (cfs). The total average discharge is unevenly distributed among the several branches flowing through the delta. The main branches of the river and their average discharges are: North Channel with 99,200 cfs; South Channel with 78,500 cfs; Chenal Ecarte 93,000 cfs; and Chematogen Channel with 1,800 cfs. The North Channel has 2 branches--North Channel (61,800 cfs) and Middle Channel (37,400 cfs). The South Channel has 3 branches--Southeast Bend (33,600 cfs), St. Clair Cut-off (37,400 cfs), and Bassett Channel (7,500 cfs), with the flow through the lake proper tending to follow the ship channel. The Sydentiam River also contributes to the Chenal Ecarte (Draft No. 4, Regulation of the Great Lakes Water Levels, Appendix D - Fish, Wildlife and Recreation).

The banks of the river are clay and sand and usually quite steep. The American bank is more highly urbanized and industrialized than the Canadian with the exception of the area immediately around Sarnia, Ontario. The St. Clair River normally rises and falls an average of one foot in any given year, with occasional seiches of two feet caused by high winds. These changes usually occur in consonance with the lake level variations in Lake Huron.

Lake St. Clair is an expansive shallow basin comprised of low marshy shores and a flatly sloping bottom with a maximum natural depth of 21 feet. It is located at the approximate midpoint of the Great Lakes system.

Water enters the lake mainly through the St. Clair River delta. Several rivers and streams also flow into the lake from the surrounding watershed. A dredged ship channel bisects the lake and forms an important connecting link in the waterway between Lake Erie and Lake Huron. The American shoreline is highly urbanized. There are no large commercial or industrial establishments and no harbors other than marinas located along its shoreline.

The normal lake level varies from year to year. During each year the water level has a consistent seasonal rise and fall usually reaching the highest stages in the summer months and the lowest stages in the winter months. In the last five years, the range between the maximum monthly mean stages was between 2.87 feet and 4.53 feet above low water datum, and the range between the monthly minimum stages was 1.06 and 3.29 feet above low water datum. The greatest annual fluctuation has been 3.32 average feet and the least has been 0.88 average feet.

In addition to the seasonal variations in level, Lake St. Clair is affected by seiches caused by wind action or sudden changes in barometric pressure. The amplitude of these seiches may amount to a foot or more and the period may reach several hours. At times when the level is affected by winds of sufficient velocity to drive the surface water forward in greater volume than it can be carried back by the lower return currents, the water elevation is raised on the lee shore and lowered on the weather shore. This action is materially increased in the bays where the impelled water is concentrated in a restricted space, especially if the converging shores of the bay feature a gradually sloping inshore bottom. The latter condition is very pronounced at Anchor Bay.

Th[illegible]e important facts relative to Lake St. Clair follows:

1. Areas in square miles:

	United States	Canada	Total
Water surface of lake -	198	292	490
Entire drainage basin -	3,050	4,370	7,420

2. Monthly mean stage at St. Clair Shores since 1898 -
   Highest: 576.23 feet (IGLD) Lowest: 569.86 feet (IGLD)

3. Mean surface elevation over 76 year record (1898-1973) = 573.12 feet (IGLD).

4. Mean surface elevation is 5.59 feet below mean surface of Lake Huron.

5. Mean surface elevation is 2.70 feet above mean surface of Lake Erie.

6. Average annual rainfall during period of record = 34 inches.

7. Length of ship channel from outlet of South Channel of St. Clair River to Windmill Point Lighthouse = 18 1/2 miles.

The Detroit River is 32 miles long and extends from Windmill Point Light (at its confluence with Lake St. Clair) to the Detroit River Light (at its mouth in Lake Erie). The upper 13 miles, Lake St. Clair to the head of Fighting Island, has an unbroken cross section, except at its confluence with Lake St. Clair where it is divided by Peach Island and Belle Isle. The upper river is generally deep with an earth bottom and steep banks.

The lower river is broad and has many islands and shallow expanses. The banks have gentle slopes with the bottom consisting of earth and boulders. An exception occurs about six miles north of the south end of Bois Blanc Island where the bottom is typically boulders and bed-rock. To provide channels of suitable width and depth for deep draft commercial vessels extensive rock excavation and dredging has been accomplished. The current velocity of the river is slow, ranging from 1.4 miles per hour at Windmill Point and in the Fleming Channel to 1.9 miles per hour in the Livingstone and Amherstberg Channels. Each year the river rises and falls about two feet. Seiches of several feet, produced by high easterly or westerly winds, respectively raise or lower the water level at the west end of Lake Erie and similarly affect the level of the lower Detroit River. Such changes have been as much as 6 feet within 8 hours. The discharge of the Detroit River over the 74 years of record has averaged 180,900 cubic feet per second.

2.3 PHYSICAL DESCRIPTION OF OTHER ENVIRONMENTALLY SENSITIVE AREAS

2.3.1 Saginaw Bay, Michigan, Lake Huron

Saginaw Bay is a large indentation on the west shore of Lake Huron, 26 miles wide between Point Aux Barques on the east shore and AuSable Point on the west shore and 51 miles long. The bay narrows to a width of 13 miles between Point Lookout on the west shore and Sand Point on the east shore. A broad shoal at this constriction (between Charity Island and Sand Point) effectively divides the bay into an outer and inner zone. The bay encompassing 1,143 square miles is divided equally between the two zones. The outer zone is considerably deeper (depth, mean 48 feet; maximum 133 feet) than the inner zone (depth, mean 15 feet; maximum 46 feet) and contains about 70 percent of the total volume of the bay. The volume of water above the 18 foot depth contour is 32 percent for the outer zone and 80 percent for the inner zone.

The east shore of the outer zone is rocky, while the west shore has extensive sandy areas with some rock and clay occurring near Point Lookout. The shoal around Charity Island and most of the points in the outer zone are rocky. Tawas Point and Sand Point are sand spits.

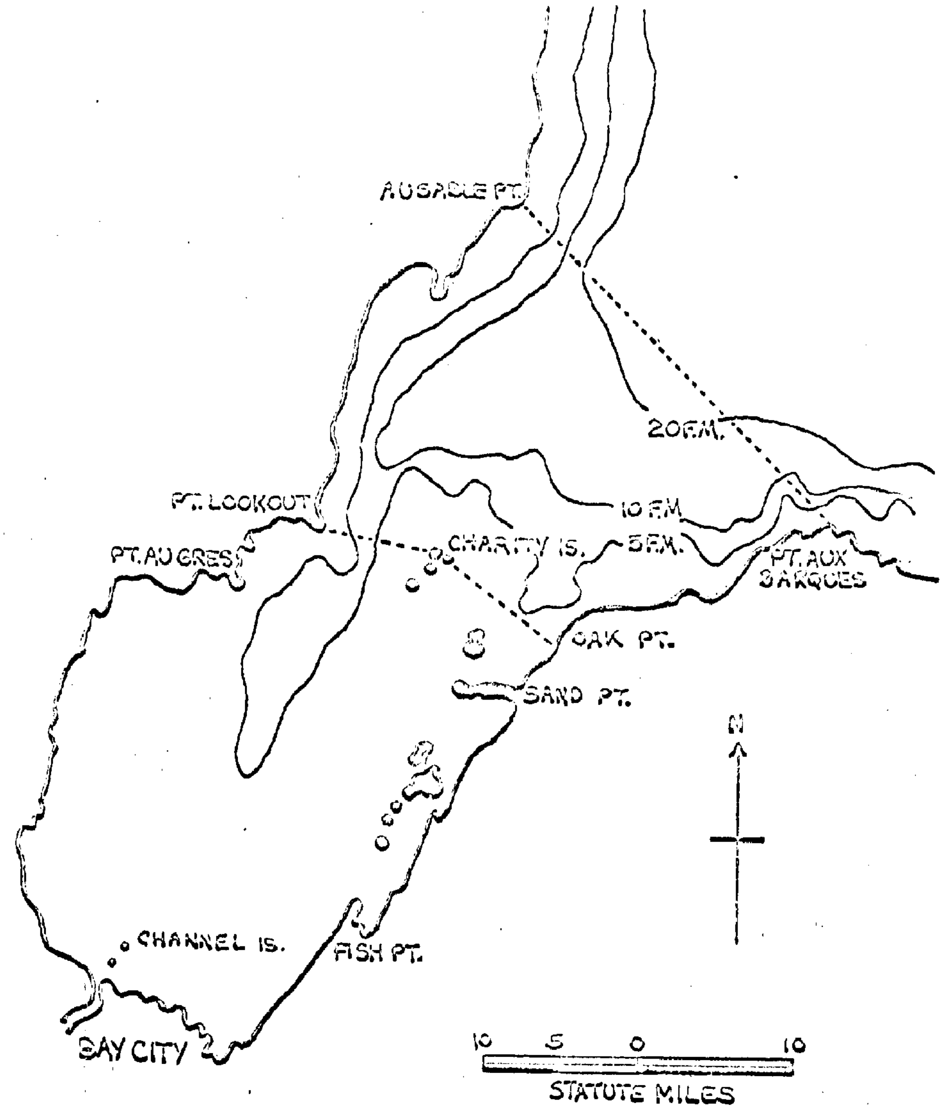


FIGURE 2.
MAP OF SAGINAW BAY SHOWING THE INNER AND OUTER ZONES AND MAJOR LANDMARKS. CONTOURS ARE IN FATHOMS.

The inner zone has extensive shallows. A broad sandy flat extends southward from Wildfowl Bay. Another irregular sandy flat extends from the Saginaw River along the west shore to Point AuGres. Several shallow spits off the mouths of small rivers extend over this flat perpendicular to the shore. The two large flats have extensive marshes near shore.

Corycon Reef is a sand and gravel bar lying between the shore southeast of the Saginaw River and the Charity Islands. Its ridge is about six feet below the surface and it is separated over most of its length from the sandy flats near shore by water more than 12 feet deep.

The bay has several islands, the most prominent of which is Charity Island. A group of marshy low-lying islands (North, Stony and Katechay) are located southwest of Sand Point. These islands are surrounded by marshy shallows for which there is no clear line of demarcation.

2.3.2 Western Basin Lake Erie, Michigan and Ohio, Lake Erie

The western basin extends eastward from the southern tip of Grosse Ile, Michigan, to a line connecting the tip of Pointe Pelee, Ontario, and the tip of Cedar Point, Ohio. Most of the islands (Bass Island group) lie in the eastern portion and are surrounded by shallow water. The western basin contains many shoals and islands with the deeper areas lying near the Canadian shore. The average depth is about 24 feet. The western basin encompasses 13 percent, 1,200 square miles, of the total lake surface area and five percent of its volume. Topographically, the western basin bottom is flat, except for the sharply rising islands and shoals in the central and eastern sectors. The flat bottom areas of Lake Erie are mud and clay while ridges and rising slopes are sand and gravel.

Within the United States, there are approximately 96 miles of shoreline on the lake proper and another 61 miles on Sandusky Bay. In addition to these two figures, there are several miles of shoreline around the perimeters of the various islands. A considerable portion of this shoreline is typically marshy.

Surface currents in western Lake Erie depend upon winds. There is a surface to bottom clockwise rotational movement of water in western Lake Erie, and a general, down-lake surface flow which increases in velocity as it nears the outlet at the eastern end. Temporary thermal stratification can occur in the western basin during prolonged quiet periods (Scholl, 1970), but it is usually precluded by wave action.

3. DESCRIPTION OF SELECTED PLAN

3.1 INTRODUCTION

The United States Corps of Engineers has deemed winter navigation season extension through January 31 on the upper four Great Lakes both economically and environmentally feasible. They further state that future economic and environmental studies may alter this finding.

The Interim Feasibility Study in Section E addresses the several enabling measures considered for implementation, which are existing, demonstrated and proven. Many are being presently utilized in a nearly operational fashion. The Demonstration Program provided the opportunity to develop, improve, and use these measures to demonstrate the feasibility of winter season extension.

3.2 ENABLING MEASURES

As presented in Section E of the Interim Feasibility Study, the enabling measures being considered for winter navigation season extension on the upper four Great Lakes through January 31 are:

1. Ice Breaking Assistance
2. Navigation Aids
3. Operation of Ice Navigation Center
4. Shore Unit and Aerial Ice Reconnaissance
5. Ice and Weather Forecast Operations
6. Ice and Water Data Collection

7. Monitoring Programs to Observe

   a. Ice Jams St. Marys River

   b. Ice Jams St. Clair River

   c. Natural Ice Bridge Formation at Port Huron, Michigan

8. Lock Operations at Sault Ste. Marie, Michigan

9. Operation of Lime Island Airboat, St. Marys River

10. Operation of Bubbler Flusher Unit, Sugar Island Ferry, St. Marys River

11. St. Marys Ice Boom at Little Rapids Cut

3.2.1 Ice Breaking Assistance

Ice breaking assistance will be supplied by the U.S. Coast Guard in the form of two icebreakers supported by ten others with icebreaking capability.

3.2.2 Navigation Aids

The U.S. Coast Guard will deploy winterized buoys and radar transponder beacons (RACONS) at selected sites throughout the upper four Great Lakes, primarily in the connecting channels.

3.2.3 Ice Navigation Center

This center will be responsible for the collection and dissemination of data; keeping abreast of commercial vessel itineraries; controlling the operation of U.S. Coast Guard ice reconnaissance; collection and dissemination of ice and weather information; and validation of and transmission to mariners of remote sensing imagery.

3.2.4 Shore Units and Aerial Reconnaissance

Thirty-seven U.S. Coast Guard shore units and three air stations will provide the principle source of data for operation of the Ice Navigation Center.

3.2.5 Ice and Weather Forecast Operations

These forecasts will be prepared by the Ice Navigation Center. These are an ice summary; ice and weather forecast and outlook; ice analysis charts; and wind and temperature forecast charts.

3.2.6 Ice and Water Data Collection

These will include weekly ice thickness measurements at 37 sites; monthly water measurements at selected sites; and bathythermograph measurements on Lake Superior. These measurements would be done by the Great Lakes Environmental Research Laboratory at Ann Arbor, Michigan.

3.2.7 Monitoring Programs to Observe

3.2.7.a Ice Jams in the St. Marys River

The U.S. Army Corps of Engineers will collect the required information.

3.2.7.b Ice Jams in the St. Clair River

The U.S. Army Corps of Engineers will collect the required information.

3.2.7.c Natural Ice Bridge Formation at Port Huron

The U.S. Army Corps of Engineers will collect the required information.

In all of the above three cases the resultant data will be forwarded to the Ice Navigation Center.

3.2.8 Lock Operation at Sault Ste. Marie, Michigan

According to the U.S. Army Corps of Engineers the Poe and MacArthur Locks can be operated during the proposed extension of December 15 to December 31 without any addition to existing physical plants. During the period of the extension January 1 to January 31 only the

Poe Lock would be required. Again no change in physical plant is sought at this time.

3.2.9 Operation of Lime Island Airboat, St. Marys River

This entails the operation of an air propelled boat sled tested during the Demonstration Program to provide transit between island and mainland when the vessel track is broken.

3.2.10 Operation of Bubbler-Flusher Unit, Sugar Island Ferry, St. Marys River

This entails the operation of a bubbler-flusher unit in the mainland ferry slip utilized to clear the slip of ice during docking operations. It has been tested during the Demonstration Program.

3.2.11 St. Marys Ice Boom Little Rapids Cut

This is an ice control device consisting of floating-log sections spanning the mouth of the Little Rapids Cut, above the normal ferry crossing lane, with an opening of 250 feet in the ship channel. This boom allows the ferry track to remain clear of ice while ice breaking operations and commercial vessel transits are underway.

3.3 ENABLING MEASURES AND THEIR EFFECTS ON THE FISH AND WILDLIFE RESOURCES

3.3.1 ENABLING MEASURES EFFECTING

The following enabling measures are considered to have some effect upon fish and wildlife resources:

1. Ice Breaking Assistance
2. Lock Operations at Sault Ste. Marie, Michigan
3. Operation of Lime Island Airboat, St. Marys River

4. Operation of Bubbler Flusher Unit, Sugar Island Ferry, St. Marys River

5. St. Marys Ice Boom at Little Rapids Cut

The potential or real effects of these enabling measures will be discussed under the respective area where effects are likely to be felt.

3.3.2 ENABLING MEASURES NON-EFFECTING

The balance of the measures briefly described in 3.2 are not considered to have any appreciable effect upon the fish and wildlife resources.

4. FISH AND WILDLIFE RESOURCES WITHOUT THE SELECTED PLAN

For the purpose of this discussion the several harbors, connecting channels, or other sensitive areas have been broken into a slightly different array dependent mainly on geographical position. Also instead of being broken into three groups they are presented in a single progressive listing, beginning at Taconite Harbor, Minnesota and ending at Buffalo, New York. Figures for the number of man days of sport ice fishing without the project in the areas described in this section, where they are impacted by the selected plan, are given in TABLE 2 on page 62.

4.1 Taconite Harbor, Silver Bay Harbor, and Two Harbors, Minnesota

The first two of the above are private harbors developed and maintained primarily for the processing of iron ore. Consequently, the noise of the processing plants and or loading operation would significantly limit the wildlife found in close proximity to the harbor. The last mentioned is at Two Harbors, Minnesota and in this case would inhibit wildlife due to the urban development surrounding the harbor. Shore-birds in particular and other avian species also frequent the area, mostly during the more clement portions of the year. Lake trout, steelhead, brown trout, coho, chinook, lake herring, smelt, chubs, perch, northern pike, walleye, suckers, alewife, carp, and the sea lamprey are likely to be found in any or all of the harbors dependent on water quality. None of the above harbors develop significant ice cover during the period of December 16 to January 31.

4.2 Presque Isle and Marquette Harbors, Michigan

Both of these are public harbors, the first north of Marquette, Michigan at the mouth of the Dead River and the other at the city itself. A new ore dock has just recently been completed at Presque Isle Harbor and similar facilities have existed at Marquette for sometime, thus, detracting from the suitability of the area for wildlife. Both harbors are frequented by lake trout, steelhead and recently coho which are the most sought after fish in the area. Whitefish, perch, smelt, suckers, and herring are also likely found in the area. Avians, particularly shorebirds, frequent the area. In 1970, 75,000 coho's and 50,006 chinooks were planted in the Dead River which flows into Presque Isle Harbor. During the period of the anticipated extension, December 16 to January 31, no significant ice cover developed in either of the two harbors, particularly the latter.

4.3 Whitefish Bay and St. Marys River, Michigan

The river and fringe of the bay constitute part of major migratory routes for waterfowl and receive heavy use in fall and spring. Moreover, the river when frozen over, provides a route for entry into Michigan's Upper Peninsula by terrestrial species such as the timber wolf, coyote, fox, bear, lynx, and martin. Some of these are at the southern extremity of their ranges. In addition to cross channel movement, there is the probable movement to and from islands.

The Critical Nesting and Migration Areas study indicates that the St. Marys River area is important to gulls and other shore birds and waterfowl for nesting.

Steelhead and walleye in the spring and whitefish in the fall migrate up the river to spawn. Lake trout and whitefish move into the bay with steelhead and herring. The varied habitat of the bay and river provide habitat for a wide variety of sport and commercial fish such as lake sturgeon, northern pike, round whitefish, lake herring, rainbow trout, white sucker, yellow perch, smelt, rock bass, and carp. The following comprehensive list of fish species and their relative abundance has been compiled from lamprey surveys conducted in the St. Marys River and its tributaries above Lake Munuscong, and fish surveys performed by the U.S. Fish and Wildlife Service in the St. Marys River.

SPECIES MOST COMMONLY TAKEN

Central mudminnow	Yellow perch
Northern creek chub	White sucker
Common shiner	Northern pike
Johnny darter	Walleye
Brook stickleback	Rock bass
Mottled sculpin	Brown bullhead

SPECIES OCCASIONALLY OR RARELY TAKEN

Brook trout	Round whitefish
Spottail shiner	Lake chub
Golden shiner	Longnose sucker
Alewife	Logperch
Rainbow smelt	Carp
Lake whitefish	Black crappie
Black bullhead	Iowa darter
Northern redhorse	Blacknose dace
Trout-perch	Longnose dace
Lake herring	Redbelly dace
Bluntnose minnow	Pearl dace
Burbot	Pumpkinseed sunfish

Thick beds of vegetation occur at depths of less than 25 feet in the river, especially in summer. The north channel no longer used by deep draft vessels has remained undredged for many years. At depths to 25 feet, thick beds of rooted vegetation cover most of the bottom, especially in summer. Species of Potamogeton comprise most of the rooted plants. In places of gentle or negligible flow, species of Myriophyllum and Isoetes and Eleocharis adicularis cover the bottom. Beds with varying proportions of Potamogeton richardsonii, P. praelongus, and P. zosteriformis are common. P. robbinsii is frequently abundant on the bottom of bays. P. strictifolius and other narrow-leaved species frequently present and in late summer and fall commonly break off and are found in floating mats. These vegetation beds afford shelter and food to fish, waterfowl and various zoobenthos such as snails, oliogochaetes and hydra. Occasionally sponges (Spongilla) are found attached to quillwort (Isoetes). Two species of clam (unionid an sphaeriid) and three species of snail (Amnicola, Campeloma and Lymnaea stagnalis) are common.

The low wet shores are bordered by emergent vegetation such as sedges (Eleocharis and Scipus), horsetail (Equisetum fluviatile), and willows (Salix). These emergent plants along the shoreline area provide habitat for many immature insects. Young fish, sculpins, crayfish, leeches (especially Haemopsis), wigglers and scuds are common inhabitants of the shallow water.

Unlike the areas previously discussed, various portions of Whitefish Bay and a considerable portion of the St. Marys River do develop substantial ice cover during the proposed extension. In conjunction with the ice cover which develops during a large percentage of the winters, both a sport fishery and commercial fishery have evolved. Sport fishing is conducted both with and without the use of darkhouses.

The commercial fishery consists of both gill netters (Chippewa Indians) and pound or trap netters, who fish their nets beneath a stable ice cover.

In Whitefish Bay there are two areas frequented by ice fishermen of both persuasions. The first is inside the shoal which runs roughly south from the north side of the mouth of the Tahquamenon River to a point about one mile north of the south shore. According to the Michigan Department of Natural Resources (MDNR) the area west of this shoal is frequented by as many as a hundred sport ice fishermen. About twenty commercial fishermen are also known to operate in this area southeast of Emerson, Michigan. In this area the major species sought are whitefish and perch. The ice cover in this area develops west of the shoal in mid-December most years.

The second area is off Pendil's Creek where in the past up to 1,000 ice fishermen seeking the lake trout have concentrated. Normally this strictly sport fishing takes place up to three or four miles offshore and is usually available only during the last week of January.

In the St. Marys River important sport and/or commercial fisheries exist in the following areas:

a. Between Iroquois Island and Round Island in the ship channel (Sport) and outside near shore (Commercial).

b. Waiska Bay (Sport)

c. Round Island to Sault Ste. Marie Michigan Water Intake in the ship channel or close to it (Sport)

d. Lake Munuscong including Rock Cut (Sport)

The sport ice fishing which takes place between Iroquois Island and Round Island is from portable dark houses with spears for Lake herring. The area according to MDNR is strictly within the ship channel where the herring travel in schools just below the ice. Only the adventurous participate in this fishery, and at best, the last two weeks in January.

In the area of the St. Marys River bounded by Iroquois Point, Gros Cap, Cedar Point, and Point Louise, several commercial ice fishermen will operate gill nets, ice conditions being favorable. Further, they will exploit whatever ice is available. Presently gill netting, and more importantly commercial fishing has been banned in this portion of the river. However, due to certain treaties with the Indians the exact status of this fishery is unknown. It is hoped it can be resolved in the near future to the benefit of all involved.

Between Round Island and the Sault Ste. Marie Water Intake, an extensive sport ice fishery, mostly from dark houses, exists for whatever valuable species pass by. The extent of this fishery is presently 400 men 3 days a week during the month of January. Reportedly, the fishery has been in the past immediately in the ship channel or on the very edge of it. With resolution of the problems in the area with the Chippewa Indians it is expected that this particular fishery will increase in importance, especially with the return of lake trout and whitefish.

The sport ice fisheries in Waiska Bay and Lake Munuscong are somewhat seasonal, or used when the other more lucrative types are not available. Lake Munuscong in particular supports a sport fishery numbering in the 1,000's in the spring for walleyes. Ice fishing also occurs at other scattered points along the St. Marys River, such as at the base of the Rock Cut. Where ice conditions permit the ice fishermen will fish in the ship channel.

The St. Marys River is a major migratory route for waterfowl and has heavy use, both spring and fall. The river, when frozen over, provides a route for entry into Michigan's Upper Peninsula by terrestrial species such as the timber wolf and Canadian lynx. The Critical Nesting and Migration Areas study indicates that the St. Marys River area is important for gull and other water bird nesting.

4.4 Milwaukee Harbor, Wisconsin

This is a public harbor, described as polluted, which receives heavy year round use by present commercial navigation. The harbor area is surrounded by a highly urbanized area and consequently of little value to wildlife other than avians. Chubs, lake trout, yellow perch and coho have been reported from the harbor area. The benthos is dominated by the pollution tolerant sludgeworms. Stable ice cover does not normally develop within the harbor proper.

4.5 Calumet River and Calumet, Gary, Indiana and Burns Waterway Harbors, Illinois and/or Indiana

Gary Harbor is the only known public facility in the above group which serve a wide variety of industries in a highly industrialized and urbanized area. Consequently, the habitat available to wildlife, especially mammals, is limited. The water quality in many of the above is greatly reduced and in fact the last two are artificial and serve the steel industry primarily. Both Illinois and Indiana reportedly are in the process of upgrading the fishery in the southern portion of Lake Michigan. According to contact with both the Illinois Department of Conservation and the Indiana Department of Natural Resources the fishing that occurs in these areas is limited, especially during the winter, and primarily for rough fish. Also, there is no significant ice formation within the period December 16 to January 31.

4.6 Muskegon Harbor, Michigan

Muskegon Harbor has degraded water quality caused in part by the effluent from paper mills and other industries on Lake Muskegon. Water quality improvement should improve the area's sport fishery. A list of sport fish found in Lake Muskegon follows:

lake sturgeon	channel catfish
coho salmon	smallmouth bass
chinook salmon	largemouth bass
rainbow trout	black crappie
brown trout	bluegill
brook trout	rock bass
lake trout	yellow perch
northern pike	sauger
muskellunge	walleye
rainbow smelt	white bass

Anadromous salmonids from Lake Michigan congregate in Lake Muskegon in the winter. Fall chinook salmon and spring steelhead and walleye spawning runs exist in the Musgegon River. Fishery biologists feel that the Muskegon River may be the spawning ground for most of the walleyes in the southeast Lake Michigan. Muskegon Lake supports a panfish population which in turn provides winter ice fishing use of the lake, in addition to fishing during other seasons. In recent years the Muskegon River has received plants of coho and chinook.

The commercial fishery within a twenty mile radius of Muskegon, Michigan produces over 150,000 pounds of chubs and deepwater ciscoes annually. Detailed information on commercial fish landings are contained in the Great Lakes Fishery Commission Technical Report No. 3, Commercial Fish Production in the Great Lakes from 1867-1968 and recent similar publications. Changes in the catch will reflect changes in species composition and abundance.

Muskegon Lake receives migratory waterfowl use. In addition, certain marshy areas of the lake support a muskrat population.

While there is no commercial fishing during the winter and in particular, during the period of ice cover which normally begins in the last week of December, an extensive sport ice fishery does exist in three locations in Lake Muskegon. These locations are out from the State Park, Sand Docks, and Conservation Club. 280, 630, 210 mandays are involved per week in the respective areas with yellow perch, bluegills, and northern pike the sought after species.

4.7 Ludington Harbor, Michigan

The water quality in Pere Marquette Lake is better than that found in Muskegon Lake; however, they both support much the same species of fish and wildlife with some exceptions. Anadromous salmonid runs occur in the fall and steelhead in the spring. The Pere Marquette River is a well known steelhead and trout stream and receives high fishing pressure. When ice cover permits, which is usually restricted to the last week in January or later, ice fishermen seek northern pike in the central portion of the harbor. Most fishing in winter occurs from the breakwaters.

4.8 Straits of Mackinac, Michigan

The straits are used by most fish found in either Lake Michigan or Lake Huron, particularly species such as whitefish, lake sturgeon, steelhead and anadromous salmonids.

Historically, the Indians had a lake trout, lake whitefish, and lake sturgeon fishery in the Straits area. Alewife, carp, lake trout, smelt, white sucker, lake whitefish and round whitefish are still important to the fishery in this area. Detailed information can be found in the Great Lakes Fishery Commission Technical Report No. 3, Commercial Fish Production in the Great Lakes 1867-1968 and similar recent publications. Changes in the catch reflect changes in species composition and abundance. The lake sturgeon population is presently greatly depressed.

The Straits of Mackinac is used by migratory waterfowl. The Critical Nesting and Migratory Areas study lists the shoreline west of Mackinaw City, Michigan, as a major concentration point in the spring for shorebirds, hawks, and songbirds.

The Straits of Mackinac forms the outlet for Lake Michigan as it flows into Lake Huron. The straits are approximately 3.5 miles wide at their narrowest point between the upper and lower peninsulas of Michigan, and four miles long. The water depth in the straits is greater than 220 feet; however, shallow water areas to 30 feet in depth are extensive along both shorelines and in several places extend nearly a mile into the Straits.

Presently ice fishing pressure is restricted to the bays along the south shore of Michigan's upper peninsula between St. Ignace and Detour.

4.9 Saginaw Bay and River, Michigan

Saginaw Bay which is entered by the Saginaw River at Bay City, Michigan, is an important "estuary" because of its high fish and wildlife habitat value. The bay is a spawning and nursery area for many of Lake Huron's fish species. A list of these fish species follows:

lake trout	pumpkinseed sunfish
brown trout	bluegill
rainbow trout	smallmouth bass
brook trout	largemouth bass
coho salmon	white crappie
chinook salmon	black crappie
northern pike	yellow perch
muskellunge	sauger
channel catfish	walleye
white bass	rainbow smelt
rock bass	lake sturgeon

A more complete list of the fish species present in Saginaw Bay, with some indication of their seasonal distribution, is given in the U.S. Fish and Wildlife Service Special Scientific Report, Fisheries No. 417. Since their survey was made, changes have occurred in both abundance and distribution of fish species, which has led to the fact that several abundant species are not being fully utilized, such as carp.

The introduction of coho and chinook salmon into the Saginaw Bay area has brought new interest in sport fishing, which previously had centered on smallmouth bass, northern pike, yellow perch, suckers, and rainbow smelt. The fishing season is year-round with a large ice fishery extending along both sides of the bay for yellow perch, channel catfish, and suckers. This ice fishery consists of about 4,000 man days on the west side of the bay from eleven locations and about 1,200 man days on the east side during the month of January.

Concerning commercial ice fishing activity, there are three active operators on the bay. The primary gear used is pound or trap nets, although one operator still fishes large mesh gill nets for carp.

The introduction of coho and chinook salmon into the Saginaw Bay area has brought new interest in sport fishing, which previously has centered on smallmouth bass, northern pike, yellow perch, suckers and rainbow smelt. The fishing season is year-round with a large ice fishery on the bay for yellow perch, channel catfish and suckers.

Sport fishing statistics collected on selected fish species by the Michigan Department of Natural Resources in 1970 indicate that the fishing pressure for Saginaw Bay was over 264,000 angler days. The total catch included:

coho salmon	7,280
steelhead	140
yellow perch	1,938,830
suckers (species not given)	126,780
rainbow smelt	1,800,100

There has been an increase in fishing pressure since 1970, but no figures have been compiled to demonstrate this other than observation.

The lower Lake Huron Basin and Saginaw Bay provide a vital link in the total support and protection of waterfowl, shorebirds, marshbirds, and passerine birds which frequent the North American continent. The bay is a nationally known waterfowl concentration area. It also supports numerous aquatic and terrestrial furbearers, upland game, and white-tailed deer.

An extensive waterfowl habitat complex exists in Saginaw Bay, from Point AuGres to Bay City, and north to Sand Point. Its border of excellent emergent vegetation and prime submerged plant beds provides feeding, resting, nesting and nursery habitat for transient and breeding ducks. Waterfowl species include the following:

black duck	ringneck	Canada goose
mallard	lesser scaup	American merganser
blue-winged teal	greater scaup	red-breasted merganser
green-winged teal	redhead	coot
wood duck	canvasback	whistling swan
baldpate	goldeneye	loon
pintail	bufflehead	grebe
gadwall	blue goose	
ruddy duck	snow goose	

From the air, large numbers of ducks have been sighted in the open water areas of Wigwam, Wildfowl, and Sebawaing Bays, with some "rafts" containing as many as one-quarter million birds during migration periods. Blue and snow geese have been sighted in large groups, ranging from 20,000 to 25,000.

Substantial waterfowl breeding occurs throughout the Saginaw Bay area. Many of the basin's streams and marshlands are frequented by mallards, black ducks and teal. Inland areas also provide nesting habitat for a sizeable population of Canada geese. Farm pond construction in the area along with an excellent food supply furnished by the area farms are encouraging larger numbers of breeding waterfowl to remain in the Saginaw Bay area. Very few waterfowl winter in Saginaw Bay. Open water is limited to the mouth of the Saginaw River and in the area of Consumers Power's effluent outfall.

An estimated 30 species of waterfowl and marsh birds are available to hunters during the period of October to December. Additionally, over 200 species non-game water oriented and passerine birds can be observed throughout the year by bird watchers.

Based on duck stamp sales in the surrounding counties, an average of 7,000 waterfowl hunters annually use the bay area. Many hunters travel great distances for the area's famous hunting. However, in recent years, hunter activity appears to be decreasing. Hunting is allowed on most of the following state game and wildlife areas. It also occurs on portions of other state recreation areas in the bay area.

NAME OF PROJECT	
Tobico Marsh State Game Area	1,829 acres
Fish Point Wildlife Area	3,076 acres
Nayanquing Point Wildlife Area	1,003 acres
Quanicassee Bay Wildlife Area	217 acres
Wigwam Bay Wildlife Area	136 acres
Wildfowl Bay Wildlife Area	1,542 acres
Total area	7,803 acres

The lowlands and marshes bordering Saginaw Bay support muskrat and mink in the wetter areas and raccoon, weasel, skunk, opossum and fox in the drier areas. Since 1964, high water levels have favored muskrat production. Burrowing muskrats, however, cause damage to dikes and retaining walls in the Saginaw Bay area and tributary streams. This has resulted in costly and time consuming repairs on public and private properties. Extended trapping seasons during this period have increased the harvest and exercised a control on the population. Mink appear to be decreasing. This decline is evident in the harvest. The number of mink trappers have been constant throughout the bay region, but the annual harvest has been steadily dropping since 1964. Smaller numbers of other fur species such as skunk, opossum, fox, raccoon and weasel are trapped in the Bay area. Recent increases in prices of long haired furs have stimulated interest in trapping. The Saginaw Bay drainage supports populations of cottontail rabbit, gray squirrel, fox squirrel, grouse, pheasant, and white-tailed deer. These provide hunting opportunities for thousands of Michigan sportsmen.

The following threatened and endangered species pass through the Saginaw region: Arctic and American peregrine falcon (duck hawks), bald eagle, and osprey.

Following is a partial list of reptiles and amphibia occurring in the Saginaw Bay drainage. They fill ecological niches in the natural resources of Michigan.

REPTILES		AMPHIBIANS	
snappling turtle	garter snake	American toad	bull frog
painted turtle	hognose snake	spring peeper	wood frog
blanding turtle	ringneck snake	tree frog	mud puppy
softshell turtle	green snake	cricket frog	blue-spotted salamander
red-bellied snake	blue racer	pickerel frog	spotted salamander
brown snake	rat snake	chorus frog	red-backed salamander
water snake	king snake	leopard frog	
		green frog	

4.10 St. Clair River - Lake St. Clair - Detroit River, Michigan including Detroit Harbor, Michigan

The vegetation, fish, and wildlife of this widely diversified reach of the St. Lawrence Basin are a very important natural resource base.

The aquatic vegetation in the upper St. Clair River is restricted to the area outside the ship channel. In the lower reach, delta, of the river rooted aquatics are prominent. Particularly in the lower half of the delta, the various pondweeds, especially Scirpus acutus and Chara sp., occur in abundance. The following is a listing of the common species:

Wild celery	Vallisneria americana
Common elodea	Elodea canadensis
Flexible naiad	Najas flexilis
Coontail	Ceratophyllum demersum
Muskgrass	Chara sp.
Hardstem bullrush	Scirpus acutus
Common threesquare bullrush	Scirpus americanus
Redhead Grass	Potamogeton perfoliatus
Floating pondweed	Potamogeton natans
Leafy pondweed	Potamogeton foliosus
Sago pondweed	Potamogeton pectinatus

The aquatic vegetation of Lake St. Clair is arranged in a series of zones proceeding from the true shoreline to the deepest parts of the lake, with the exception of the ship channel. These four zones are as follows: 1) the littoral zone which includes depths to eight feet is typified by pickerelweed (Pontederia cordata), burread (Sparganium sp.) near shore and bullrush (Scirpus sps.) in the deeper portions; 2) a mixing zone between the littoral and the Potamogetonetum where an intergradation occurs; 3) the Potamogetonetum occupies depths to 23 feet where redhead grass (Potamogeton perfoliatus) predominates; and 4) the open water beyond the 23 foot contour where microscopic plants are found and the bottom is covered by muskgrass (Chara sp.) and flexible naiad (Najas flexilis). For a complete listing of the 158 aquatic plant species and a discussion of this zonation see The Plants of Lake St. Clair by A.J. Pieters.

The aquatic vegetation of the Detroit River falls into two somewhat distinct groups; one for the upper reach of the river from samples taken in the vicinity of Belle Isle, and the other for the lower reach of the river in the vicinity of Grosse Ile. The following lists apply to the respective areas.

UPPER RIVER

Wild celery	(Vallisneria americana)
Common elodea	(Elodea canadensis)
Flexible naiad	(Najas flexilis)
Common bladderwort	(Utricularia vulgaris)
Coontail	(Ceratophyllum demersum)
Water milfoil	(Myriophyllum sp.)
Sago pondweed	(Potamogeton pectinatus)
Flatstem pondweed	(Potamogeton zosteriformis)
Slender pondweed	(Potamogeton pusillus)
Longleaf pondweed	(Potamogeton nodosus)
Variable pondweed	(Potamogeton gramineus)
Redhead grass	(Potamogeton perfoliatus)

LOWER RIVER

Wild celery	(Vallisneria americana)
Common elodea	(Elodea canadensis)
Flexible naiad	(Najas flexilis)
Common bladderwort	(Utricularia vulgaris)
Coontail	(Ceratophyllum demersum)
Water milfoil	(Myriophyllum sp.)
Horned pondweed	(Zannichellia palustris)
Muskgrass	(Chara sp. and Tolypella sp.)
Stubby-Wapato	(Sagittaria Sp.)
Water-Stargrass	(Heteranthera dubia)
Sago Pondweed	(Potamogeton pectinatus)
Flatstem pondweed	(Potamogeton zosteriformis)
Slender pondweed	(Potamogeton pusillus)
Longleaf pondweed	(Potamogeton nodosus)
Variable pondweed	(Potamogeton gramineus)
Redhead grass	(Potamogeton perfoliatus)
Curly pondweed	(Potamogeton crispus)

The following table indicates the invertebrates which are indigenous to the St. Clair River, Lake St. Clair, and the Detroit River respectively.

	ST. CLAIR R.	LK. ST. CLAIR	DETROIT R.
Cnidaria (Hydra)		x	
Platyhelminthes	x	x	x
Nematoda	x	x	
Mollusca			
Gastropoda	x	x	x
Pelecypoda			
Sphaeriidae	x	x	x
Unionidae		x	
Annelida			
Hirudinea	x	x	x
Oligochaeta	x	x	x
Polychaeta		x	x
Arthropoda			
Arachnida		x	x
Crustacea			
Cladocera	x		
Amphipoda	x	x	x
Decapoda	x	x	x
Ostracoda		x	
Isopoda	x	x	
Insecta			
Diptera	x	x	x
Hemiptera		x	
Trichoptera	x	x	
Ephemeroptera	x	x	x
Plecoptera	x		
Odonata	x		

The invertebrate population of the St. Clair River is found mainly outside of the shipping channel, except in the lower portion where it extends completely across the river bottom, particularly downstream of the islands where the current slackens. In Lake St. Clair the indigenous population is comprised of snails (Gastropoda), fingernail clams (Spaheriidae), aquatic earthworms (Oligochaeta), seed shrimps (Ostracoda) and chironomids (Diptera). In the Detroit River the composition changes to snails, fingernail clams and leeches (Hirudinea).

Until mercury was discovered to be a major contaminant of fish in the St. Clair River - Lake St. Clair - Detroit River complex, a large, increasing sport fishery and stable commercial fishery in Ontario waters existed. As a result of mercury contamination, the commercial fishery has been at a standstill since March of 1970. There is also a commercial baitfish industry in the Ontario waters.

Although sport fishing was greatly curtailed in the latter part of 1970, it returned to near normal levels in 1971. According to the Fish, Wildlife and Recreation Appendixes of the Fourth Draft of the Regulation of Great Lakes Water Levels Study by the International Joint Commission, a creel census in Michigan waters of Lake St. Clair placed the effort at 0.6 million man days and the harvest at 2.4 and 7.9 million fish for 1966 and 1967. It can be presumed that the figures for Ontario waters would be comparable.

The North Channel of the St. Clair Delta area is a major spawning area for sturgeon, while the shallow bays and adjacent marshes, such as Anchor Bay, Goose Bay, Bug Muscamoot Bay, St. Anne's Bay and Mitchell's Bay provide spawning and nursery area for largemouth bass, smallmouth bass, muskellunge, northern pike, panfish and carp. The Thames River is the spawning area for the majority of walleye caught in the Lake St. Clair area and nearby Lakes Erie and Huron. Major movements of walleye and other species between Lake Erie and Lake St. Clair occur via the Detroit River.

Ice fishing is an important winter activity in the area, being confined mainly to the larger bays such as Anchor Bay and Mitchell's Bay, United States and Canada respectively. However, it is not limited to these areas, and ice conditions permitting will expand to other areas. The major areas within the United States are in Anchor Bay, North Channel near Harsen's Island, and along the St. Clair Shores area. That which occurs along St. Clair Shores ammounts to 60 man days during the last two weeks of January, ice condition permitting.

The following is a list of fish species found in the area:

Fish Species	St. Clair River	St. Clair River Delta	Lake St. Clair	Detroit River
Walleye	X	X	X	X
Smallmouth bass	X	X	X	X
Largemouth bass			X	
Yellow perch	X	X	X	X
Rock bass	X	X	X	X
Northern pike	X	X	X	X
Muskellunge			X	
White bass	X	X	X	X
Crappie			X	
Channel catfish	X		X	
Sauger	X	X		X
Common sucker	X	X	X	X
Brown bullhead	X		X	
Freshwater drum	X		X	X
Carp			X	X
Mooneye		X		
Redhorse	X	X	X	X
Bluegill			X	
Pumpkinseed			X	X
Bowfin			X	
Longnose gar			X	
Alewife			X	
Smelt			X	
Silver chub			X	
Emerald shiner			X	
Spottail shiner			X	
Stone cat			X	
Furious madtom			X	
Trout-perch			X	

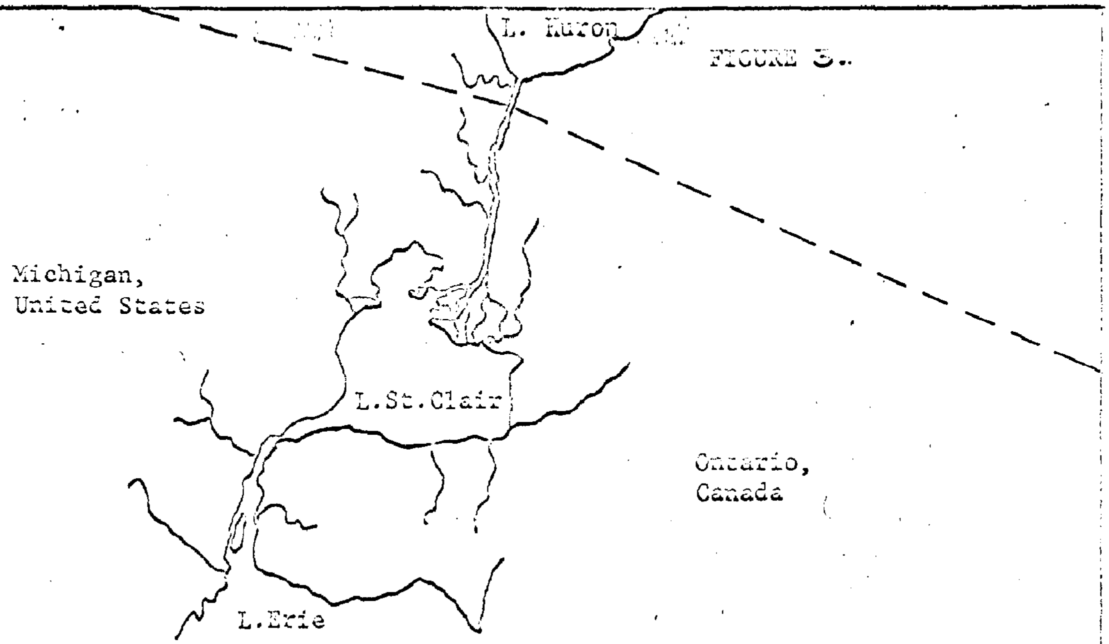
This area is used by many species of reptiles and amphibians in addition to valuable fur bearing mammals such as mink and muskrat. Fox, coyote, raccoon and deer are also frequent inhabitants of the area, especially on the Canadian side, and particularly in the delta area at the confluence of the St. Clair River and Lake St. Clair.

The whole area is extensively used by various aquatic avians such as sandpipers, herons, bitterns, tern, snipes, gulls, swans, geese and ducks. Most of these are found in the near shore area, along the beach, on rocks of the quiet bays and in the rivers rather than in the open portions of Lake St. Clair. However, extensive beds of submerged aquatic vegetation, both in Lake St. Clair and the Detroit River are intensively used by waterfowl, expecially ducks and coots. The following is a list of waterfowl common to the area:

Ducks:	Black	Gadwall
	Mallard	Pintail
	Shoveller	Blue-winged teal
	Green-winged teal	Scoter
	Bufflehead	Canvasback
	Baldpate	Goldeneye
	Redhead	Ruddy
	Lesser scaup	
Others:	Coot	American merganser
	Canada geese	Whistling swan

In addition to the aquatic avians, the area is used by several species of non-water avians. The following figures demonstrate that the area is a crossroads for some of the major flyways.

FIGURE 3.



MOBILE BAY CORRIDOR

Baldpate	Green-winged teal
Pintails	Mallards
Gadwalls	Blacks

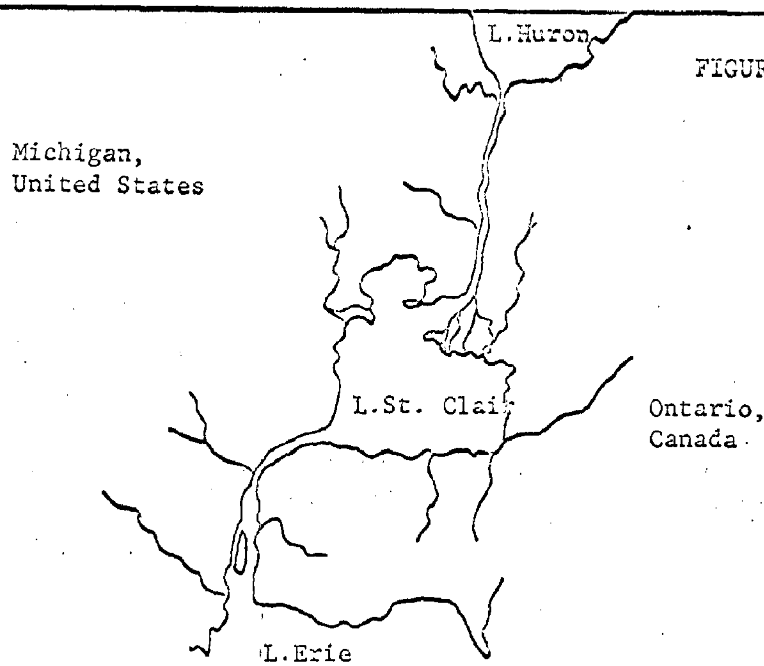
(Whole area is part of)

CHESAPEAKE BAY CORRIDOR

Mallards	Lesser scaup
Baldpate	Redheads
Pintails	Canvasbacks

(Area below dotted line)

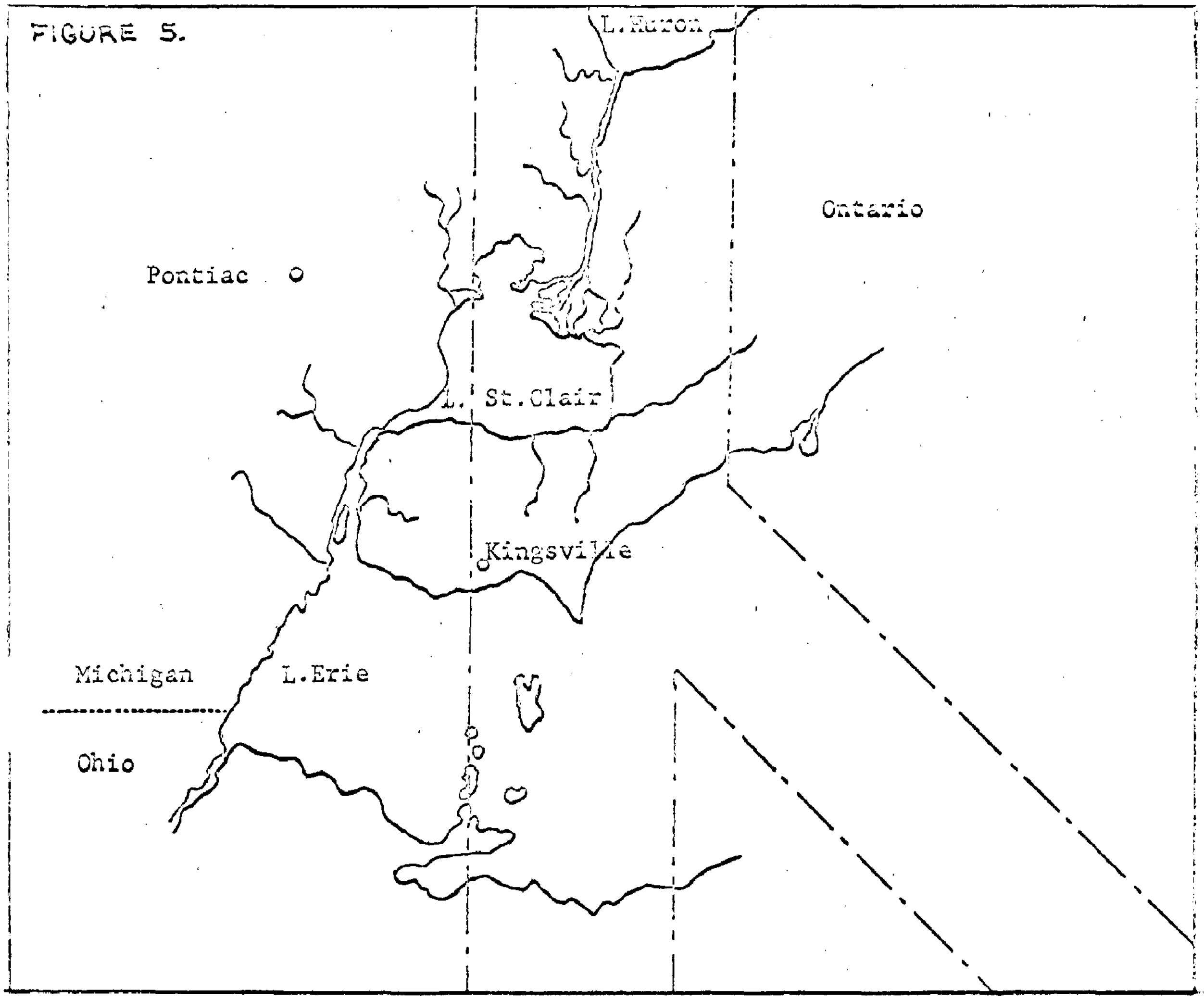
FIGURE 4.



SOUTHERN MICHIGAN CORRIDOR
Lesser scaup
Redheads
(Whole area part of)

CENTRAL OHIO CORRIDOR
Redheads
Lesser scaup
(Whole area part of)

FIGURE 5.



GOOSE CORRIDOR - This corridor is used mostly by Canada Geese and extends southward from James Bay across the west end of Manitoulin Island and down Lake Huron to a refuge near Pontiac, Michigan, and the Jack Miner Bird Sanctuary near Kingsville, Ontario. At this point the corridor divides.

4.11 Western Basin of Lake Erie Including Toledo Harbor, Ohio

This public harbor located at the western extremity of Lake Erie is flushed by the Maumee River. The western basin is fed by many streams and rivers and contains several islands. Species of fish which are found in the western basin likely frequent Toledo Harbor, water quality permitting.

The many islands and several shoals of the western basin are invaluable spawning habitat for the several indigenous species of fish. The western basin provides a valuable commercial fishery and an accessible sport fishery.

Detailed information can be obtained from the Great Lakes Fishery Commission Technical Report No. 3, Fish Production for the Great Lakes 1867 - 1968 and similar recent publications. Catfish, perch, freshwater drum, smallmouth bass, white bass and walleye form the base of the present day commercial fishery in the western basin of Lake Erie. Of these, the sheephead is the predominant species and least exploited. During the winter ice fishing takes place on the west side of Bass Island and several other sites along the mainland to the south and in Sandusky Bay. The species primarily sought is the yellow perch.

Diatoms comprise 75 percent of the phytoplankton in Lake Erie and copepods make up the bulk of the zooplankton; protozoans and rotifers are also numerous. Major benthic organisms of the western basin are oligochaeta, tendipedidae, sphaeriidae, and gastropoda. Filamentous green algae, Cladophora, is an increasing nuisance in western Lake Erie while Ulothrix is an extremely abundant green algae. Blue-green algaes, indicators of pollution, are comprised largely of Aphanizomenon and Microcystis. They occur in massive blooms during August in the western basin (Scholl, 1970).

The western portion of the Western Basin of Lake Erie is in the Mississippi Flyway and receives heavy waterfowl use in the fall and spring for migration, feeding and resting purposes. Large numbers of waterfowl stay as long as the water in the area remains free of ice. There are also several mammals indigenous to the Bass Island group which use the winter ice for migratory purposes.

4.12 Lorain, Cleveland, Ashtabula and Conneaut Harbors, Ohio

All of the above are found along the United States shore of the central basin of Lake Erie. These harbors are at or in the mouth of the Black River, the Cuyahoga River, the Ashtabula River, and Conneaut Creek respectively. All of these with the exception of the Cuyahoga support spring spawning runs of suckers. Yellow perch, freshwater drum, carp and catfish often frequent these streams, water quality permitting. Anadromous salmonids (steelhead, chinook and coho) are maintained through annual planting of parr on Conneaut Creek. Returns have been realized since 1968. Walleye and northern pike are also infrequently taken. In the Cuyahoga River, bottom sediments of the lower reaches of the river cannot even support the most pollution tolerant benthic organisms and fish life is almost non-existant. It can be assumed that shorebirds, such as gulls, waterfowl and other avians frequent the areas. All of these harbors are at the center of highly urbanized areas. Even though ice cover does develop during the latest part of the proposed extension, little or no ice fishing activity is conducted within the limits of these harbors according to the Ohio Department of Natural Resources.

4.13 Buffalo Harbor, New York

This public harbor is located at the eastern extremity of Lake Erie, at the heart of the highly urbanized and industrialized city of Buffalo, New York. Consequently other than avians the wildlife is virtually nil. Fish likely to be found in the Niagra River may include those found in Lake Erie proper, but probably are restricted to yellow perch, muskellunge, rock bass, black crappie, sunfish, and bullhead. Their is little sport fishery in the area and virtually no commercial fishery. A small sport ice fishery exists in a local yacht basin adjacent to the river proper, and ice conditions permitting, the adventurous will cross the breakwater to take large yellow perch.

4.14 Rare and Endangered Species of the Upper Four Great Lakes

The following is a list of the endangered fauna found within the reach of the St. Lawrence River Basin.

1. Longjaw cisco, Coregonus alpenae (Ill., Ind., Mi., N.Y., Oh., Penn., Wi.)
2. Blue pike, Stizostedion vitreum glaucum (Mi., N.Y., Oh., Penn.)
3. Eastern timber wolf, Canis lupus lycaon (Mi., Mn.)
4. Indiana bat, Myotis sodalis (Ill., Ind., N.Y., Oh., Penn.)
5. Kirtland's warbler, Dendroica kirtlandii (Mi.)
6. American peregrine falcon, Falco peregrinus anatum (transient)
7. Artic peregrine falcon, Falco peregrinus tundrius (transient)

At present the Lake Sturgeon, *Acipenser fulvescens* has been recommended for placement on the official review list of threatened species.

5. FISH AND WILDLIFE RESOURCES WITH THE SELECTED PLAN

Our short-term observations have led to the determination that certain impacts may be expected as a result of implementation of the selected plan. Two of these concerns, the impact upon sport and commercial ice fishing and cross channel migration of mammals, are related to ice breaking. The last two concerns, oil spills in the presence of ice cover and shoreline erosion in the connecting channels, are related to increased vessel movement during the period when commercial navigation has been non-existent.

5.1 IMPACT UPON SPORT AND/OR COMMERCIAL ICE FISHING

The table, TABLE 2 page 62, which accompanies this section was referred to in the previous section and sets forth man-days of sport ice fishing without the project, with the project, and the percent of likely impact. The figures in this table were derived in the following fashion. The total fishing licenses for a state using the base year of 1970 was divided by the OBERS Series E population figure for the base year, resulting in a figure for licenses per capita. This figure was multiplied by the OBERS Series E population figure projected for the desired year to result in a projected license sales figure. Estimates of use of the various areas were obtained from the respective state natural resource departments, as well as an estimate of the time when ice was first utilized for ice fishing. The number of persons ice fishing, the number of days during the week when they were ice fishing, and the number of weeks between December 15 and January 31 were noted and based on this, a figure for sport ice fishing man-days derived with 1970 as the base year. Two assumptions were then made:

1) license sales per capita would remain constant over the life of the project, and 2) the ratio of sport ice fishermen to total fishermen would remain constant through the life of the project. The following comparison was developed: ice fishing man days use base year is to license sales base year as projected sport ice fishing man days use is to projected license sales. In other words, the projected increase in sport ice fishing corresponds to the increase in license sales. Further, degree of impact upon sport ice fishing was derived from observations made during the Demonstration Program by Fish and Wildlife Service personnel and contact with the respective state department of natural resources. This table allows a comparison of sport ice fishing with and without the project and should be referred to while reading the following discussion of impact on sport ice fishing.

It should further be noted that these figures do not take into consideration the impact as a result of the time required for stable ice cover to form once the January 31 date arrives. It is very possible that the period of impact may extend one or more weeks into the month of February and possibly longer.

5.1.1 Whitefish Bay, St. Marys River, Michigan

The fishery base in this area as previously described is extremely good and much sought after. There are four areas where impact upon the sport ice fishery will be felt with the implementation of the selected plan, the first two which are located in Whitefish Bay and the last two in that portion of the St. Marys River above the Soo Locks.

The Emerson area is that west of the shoal extending south from the Tahquamenon River. Purportedly ice breaking in the ship channel to the east causes the broken ice to be blown into this area and turned on end, sometimes to the point of going to the bottom. Consequently the degree of impact attributed to season extension has been estimated as 10% to 100% depending on the nature of the winter and ice conditions. 100 or more persons ice fish in this area usually on the weekend. Also, approximately 20 commercial fishermen operate in the area, upon whom the impact is probably of the same degree.

The Pendil's Creek area is that area immediately north of the Pendil's Creek. In 1967 only about 50 persons regularly used the area on a daily basis, however in 1969 about 1000 persons frequented the area on a daily basis. The degree of impact was estimated to be considerably less, about 0% to 20%, as opposed to that of Emerson, however the cause of the impact was given as much the same.

The Iroquois area takes in the reach of the ship channel between Iroquois Island and Round Island. Admittedly it is very small only 20 persons, 3 days of 1 week but with the advent of the selected plan it will be obliterated.

At the present time in this area, but closer to shore and likely unaffected by season extension, a gill net ice fishery is carried on by the local band of Chippewa Indians.

The Round Island area takes in the reach between Round Island and the Sault Ste. Marie water intake crib. This is the most heavily used area on the river with the exception of Lake Munuscong where the ice fishing occurs later in the year as a general rule. The sport ice fishery consists of about 400 persons on the weekend at the present time. The MDNR district fishery biologist believes that if the gill net problems in the area can be resolved, and the local stocks improved or allowed to recover this will become a very important sport fishery in 20 years and the numbers of participants willrise accordingly. The projections presented in this report have not taken this increase into consideration. Purportedly all of the sport ice fishing in this reach historically took place in the ship channel. In our computations we have allowed for some digression and estimated the degree of impact at 75%. According to the MDNR it would be greater.

In any event with implementation of season extension to January 31 the sport and commercial ice fishery in the above areas will be impacted to a large degree if not totally lost.

5.1.2 Muskegon Harbor, Michigan

The only ice fishing done at Lake Muskegon is of the sport variety for such species as yellow perch, bluegill, and northern pike. This is a well established sport ice fishery and occurs in three principle locations; south of the State Park, north of the Sand Docks, and south of the Conservation Club. Respectively on any given day the following number of persons can be found; 90, 30 and 40. It has been mentioned before that ice sets in the last week of December, but is worth reiterating. The estimate of degree of impact is probably conservative at the figure of 60%. In any event all three areas will probably be affected with implementation of season extension.

5.1.3 Ludington Harbor, Michigan

At this harbor formed by Lake Pere Marquette the number of sport ice fishermen is small, 30 persons on any given day, for only the last week of the proposed extension. Here again the estimated degree of impact at 50% is probably conservative.

5.1.4 Saginaw Bay, Michigan

In this particular situation the winter operation of the commercial ice fishermen is likely to be impacted more than that of the sport ice fishermen. The impact upon sport ice fishermen will occur to those individuals using the Bay City State Park as an access site and then the degree of impact is estimated at 10%. On the other hand, the commercial ice fishermen will be impacted at the least by 50% and in the event of stable ice cover development will lose the ability to cross the bay on the ice as they have in the past, due to the broken ice of the vessel track in the ship channel.

5.1.5 Lake St. Clair, Michigan

Here again the number of sport ice fishermen effected by the proposed extension likely will be limited to those who fish along the extreme southwestern shore where the ship channel passes close to the land. However, with stable ice cover this sport fishery will be lost. It is also possible that the more important sport ice fisheries in the AnchorBay area and the St. Clair Flats may be effected should other than ice breaking be utilized in this reach of the system.

5.1.6 Buffalo Harbor, New York

This particular area, specifically the portion of the harbor directly across a local yacht basin breakwater, is precarious at best. According to the New York State Department of Environmental Conservation only five persons take advantage of it during the last week of January. The reason they persist is that large yellow perch are the reward of the adventurous. This will be lost entirely with season extension.

5.2 IMPACT UPON CROSS CHANNEL MIGRATION BY MAMMALS

The larger mammals, in particular wolves, caribou and lynx are known to move across ice cover, especially if the distance is not great. In particular, according to the national park service this is the method by which Isle Royale in Lake Superior was colonized.

5.2.1 St. Marys River, Michigan

The St. Marys River separates the sparsely populated portions of the Province of Ontario, Canada and the upper peninsula of Michigan over the greater portion of its length of about 70 miles. In this area the wolf and lynx are at the southern extremity of their respective normal ranges, however since they are known to move across an ice cover there is no reason to believe they should not utilize the frozen surface of the St. Marys River. They may choose to cross from mainland to mainland or to any of the islands. Other mammals such as deer, coyotes and fox also probably make use of a stable ice cover for movement. While it is known that animals move across an ice cover, the amount of this movement is not precisely known. Much of the area is no longer prime habitat due to the influence of man's developmental activities.

TABLE 1

PROJECTED IMPACT UPON WINTER SPORT ICE FISHING SHOULD A WINTER NAVIGATION EXTENSION OCCUR BETWEEN DEC. 15 AND JAN. 31

Site	Without or With the Project	1970 * Base Year	1980 *	1990 *	2000 *	2020 *	Degree of Impact	Weeks of Ice Fishing
EMERSON	Without	258	283	309	329	372	10-100%	6
	With		28-283	31-309	33-329	37-372		
PENDILS	Without	225	247	270	288	326	0-20%	1
	With		0-49	0-54	0-58	0-65		
IROQUOIS	Without	17	19	21	23	25	100%	2
	With		19	21	23	25		
ROUND IS.	Without	686	754	823	878	994	75%	4
	With		566	617	659	746		
MUSKEGON	Without	4480	4921	5377	5729	6488	60%	4
	With		2953	3226	3437	3893		
LUDINGTON	Without	210	231	252	270	305	50%	1
	With		116	126	135	153		
SAGINAW	Without	100	110	120	129	145	10%	4
	With		11	12	13	15		
ST. CLAIR	Without	60	66	72	77	87	0-50%	2
	With		0-33	0-36	0-39	0-44		
MICHIGAN TOTALS	Without	6096	6697	7317	7800	8829		
	With		3693-4030	4033-4401	4300-4693	4869-5313		
BUFFALO	Without	35	37	40	43	48	100%	1
	With		37	40	43	48		
NEW YORK TOTALS	Without	35	37	40	43	48		
	With		37	40	43	48		

*All figures are given in man days of ice fishing use.

5.2.2 St. Clair River, Michigan

In this area the lower end of the river known as the St. Clair Flats presents similar possibilities to those discussed for the St. Marys River, but on a very limited scale. However, movement of the coyote and some of the smaller mammals still may take place, especially between the scattered islands found in this area.

5.3 IMPACT FROM OIL SPILLS IN PRESENCE OF AN ICE COVER

The problem of an oil spill in the presence of an ice cover has been addressed by the Demonstration Program, especially by the report prepared by Commander Mason et. al. on this subject. This report adequately describes the serious shortcomings associated with dealing with an oil spill in the presence of an ice cover. Also, in light of the several public reports on the effect of oil on fish and wildlife which have appeared in print in recent years, the fact that accidental oil spills constitute a serious threat to the vegetation, benthos, fish and wildlife of the upper four Great Lakes hardly needs to be belabored. At present the location of a single Oil Strike Force Base is given as being at Cleveland, Ohio under the auspices of the U.S. Coast Guard. It should also be pointed out that this particular concern is pointed out by the Army Corps of Engineers as a "risk associated with winter navigation extension". We hasten to point out that it is a very grave risk with very serious consequences since once oil has been spilled in the presence of an ice cover, its recovery is difficult at best.

5.4 IMPACT FROM SHORELINE EROSION

Shoreline erosion as a result of commercial navigation during the season extension is probably minor at best according to the Draft Report on Effect of Winter Navigation on Erosion of Shoreline and Structure Damages Along St. Marys River, Michigan by the Army Corps of Engineers. This is substantially supported by findings of the study on Turbulence Effects on Shallow Water Sediments and Organisms presently being completed by the Great Lakes Fishery Laboratory, Ann Arbor, Michigan. Consequently, concern that shoreline wetlands and other habitats might be damaged as a result of season extension commercial vessel transit appears to be unsupported. It would appear that what little shoreline erosion occurs is indistinguishable from that which occurs during the natural spring melt and breakup where melting begins at the shoreline, which is responsible for the greater amount of the damage to the shoreline. Obviously the areas where this impact may play a role is in the connecting channels, more specifically the St. Marys River and the St. Clair River, and then primarily from the rapid transit of ice breakers in the process of breaking ice.

5.5 IMPACT FROM BUBBLER-FLUSHERS AND/OR BUBBLERS

Under the selected plan only a bubbler-flusher unit at the mainland dock of the Sugar Island Ferry is mentioned. The intention is to keep the ferry slip open by action of a bubbler unit along the wall and below the surface and to flush the slip of ice just before the ferry docks with a large burst. The bubbler-flusher operator on the basis of discharging oxygen into the water to create a current and prevent ice formation in the first case. In the second a larger more forceful current is induced.

A bubbler on the other hand creates a current at greater depths which draws the somewhat warmer water toward the colder surface water inducing a retardation of or a reduction in the ice cover. In both bubblers and bubbler-flushers the only actions are a very slight rise in the water temperature, much less than one degree celcius, and an increase in the level of dissolved oxygen. The change in the dissolved oxygen level may be either small, the St. Marys River or large, in a polluted harbor.

In the event that bubblers are installed in a polluted harbor, polluted to the extent that passage of desired species is blocked, the bubbler may become an enhancement feature. The path of dissolved oxygen may create a pathway through the otherwise blocked river mouth to upstream spawning areas. It should also be pointed out that this may allow the sea lamprey equal access to otherwise untenable spawning areas. This in turn would negate the enhancement feature of allowing desirable species of fish to pass.

6. FISH AND WILDLIFE PLAN NEEDS

Certain needs have arisen as a result of the close scrutiny of the various aspects of the selected plan. All of these aspects have been investigated during the Demonstration Program in some depth. Additionally, investigations and observations have been made by the U.S. Fish and Wildlife Service of many of the aspects. In the discussion in Section 3 the following operational aspects of the selected plan were listed as effecting the environment:

1. Ice Breaking Assistance
2. Lock Operations at Sault Ste. Marie, Michigan
3. Operation of Lime Island Airboat, St. Marys River
4. Operation of Bubbler Flusher Unit, Sugar Island Ferry, St. Marys River
5. St. Marys Ice Boom at Little Rapids Cut

Obviously ice breaking assistance exhibits the greatest potential for adverse impact upon the fish and wildlife resources of the upper four Great Lakes and upon the utilization of the same. Lock operations and the operation of the Lime Island airboat as presently proposed will have little or no effect upon fish or wildlife resources. Operation of the Sugar Island Ferry bubbler-flusher may actually enhance the environment within the ferry slip. The St. Marys ice boom at the Little Rapids Cut merely returns the cut to the condition present before the winter navigation season extension demonstration was instituted.

6.1 NEEDS RESULTING FROM IMPACTS OF THE SELECTED PLAN

6.1.1 Upon Ice Fish Activity

The degree of impact upon sport ice fishing activity has been summarized in TABLE 2 and the impact upon commercial ice fishing activity addressed in Section 5.1. As a result, a certain amount of sport and commercial ice fishing activity will be lost in Whitefish Bay, the St. Marys River, Muskegon Lake, Pere Marquette Lake, Saginaw Bay, Lake St. Clair, and Buffalo Harbor with the extension of commercial navigation through January 31. At present, there are no visible means of compensating for these losses. However, TABLE 2, Projected Impact Upon Winter-Sport Ice Fishing Should a Winter Navigation Extension Occur Between December 16 and January 31, very clearly shows that nearly half of the total impact is felt by Muskegon Lake during the month of January. Consequently, it is recommended that commercial navigation into Muskegon Harbor past the time of ice cover be discouraged because of the heavy use by sport ice fishermen. Also, for the safety of both sport and commercial ice fishermen in all areas, we recommend that in the ship channels where the ice cover has been broken by ice breaking or retarded or reduced by bubbler-flusher or bubbler operation, the vessel track be plainly marked, warning ice fishermen of the unsafe condition.

6.1.2 Upon Cross Channel Migration

Under the constraints of the proposed navigation season extension, December 16 to January 31, the impact, as discussed in Section 5.2, is considered to be minor. It is minor by virtue of the fact that the period after January 31 should provide adequate time for migration.

6.1.3 From Oil Spills in the Presence of Ice Cover

This particular concern, discussed in Section 5.3, is a major concern considering the recognized difficulty of recovery in the presence of an ice cover. Presently, an Oil Spill Strike Group is stationed at Cleveland, Ohio. Consequently, since speed in reaching the site of an accidental oil spill is important, especially during periods of ice cover, it is recommended that one of the following alternative recommendations be implemented.

The first recommendation is to limit movement of oil tankers to ice free portions of the upper four Great Lakes once substantial ice cover has developed, and especially from movement through or within the connecting channels. The other recommendation is to establish several strategically placed oil strike groups. These locations might include Duluth, Minnesota; Milwaukee, Wisconsin; and Sault Ste. Marie, Michigan in addition to the present base at Cleveland, Ohio.

6.1.4 From Shoreline Erosion

In Section 5.4 it was stated that concern over shoreline erosion is basically unsupported. Regardless, during spring break up, or any time when the ice becomes separated at the shoreline, ice movement in the shore zone will occur more readily on a raising water level. Consequently, during winter navigation season extension the water levels should be held as constant as possible. Also, in the future, should shoreline erosion attributable to season extension be identified, suitable means to protect the shoreline should be taken.

6.1.5 From bubbler-flushers and/or bubblers

Previous discussion has established that bubbler-flushers and bubblers often cause a reduction or retardation in an otherwise stable ice cover. Consequently, such areas so affected should be clearly marked. It is also possible that bubbler installation may open polluted harbors to fish transit; which would otherwise be blocked due to the degree of pollution. Therefore, it is recommended that this aspect be studied further to determine what the cost of associated increased lamprey control will be, since these costs should be borne by the project.

6.2 RESULTING FROM FUTURE IMPROVEMENTS OF THE SELECTED PLAN

We also have concern about operational items or improvements to items of the selected plan that may become apparent later. These would include but not be limited to channel modifications, lock modification, new locks, and the use of untested methods of ice suppression such as the thermal ice suppression unit in the final stages of testing this winter. We understand that such items, if proposed for implementation, would be submitted to the same scrutiny as the present measures.

7. CONCLUSIONS

The U.S. Fish and Wildlife Service has studied the various aspects of extending the navigation season that have been investigated during the Demonstration Program. All aspects being considered for navigation season extension from December 15 to January 31 under the selected plan are those which have been demonstrated. Concern remains also for operational items or improvements to implemented items of the selected plan which may be suggested in the future. However, it is assumed that opportunity to scrutinize these measures will be provided. Therefore, under the operational plan presented in the selected plan, the time frame of navigation season extension (December 15 to January 31, only) and within the area described (the upper four Great Lakes), we believe season extension to be environmentally feasible. Our short-term observations and studies during the Demonstration Program indicate that the proposed operation would not significantly effect the valuable fish and wildlife populations or habitats. Also the utilization of these resources will not be significantly effected with the possible exception of Muskegon Lake. However, it cannot be determined at this time what long term effects, if any, may occur.

8. RECOMMENDATIONS

As a result, the U.S. Fish and Wildlife Service makes the following recommendations:

8.1 It is recommended that commercial vessel traffic (navigation season extension) be terminated in Muskegon Harbor when ice formation begins.

8.2 It is recommended that vessel tracks (ship channels) containing broken, retarded or reduced ice cover be plainly marked warning of the unsafe conditions in areas where sport or commercial ice-fishing activity has been indicated.

8.3.1 It is recommended that movement of oil tankers during the navigation season extension be limited to the ice free portions of the upper four Great Lakes and especially from movement through or within the connecting channels.

8.3.2 An alternative recommendation to 8.3.1 would be to establish several strategic oil strike force locations, such as Duluth, Minnesota; Milwaukee, Wisconsin; and Sault Ste. Marie, Michigan in addition to the present base at Cleveland, Ohio.

8.4 It is recommended that water levels be held as constant as possible during the period of winter navigation extension.

8.5. It is recommended that should areas of shoreline erosion attributable to winter navigation extension be identified, suitable shore protective measures be undertaken.

8.6 It is recommended that needs for further lamprey control resulting from bubbler installation, should they be used, be determined.

It is hoped that these recommendations will improve the selected plan.

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