University of Windsor
Scholarship at UWindsor

International Joint Commission (IJC) Digital Archive

1988-10-01

Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin

International Joint Commission

Follow this and additional works at: http://scholar.uwindsor.ca/ijcarchive

Recommended Citation
International Joint Commission (1988). Interim Report on 1985-86 High Water Levels in the Great Lakes-St. Lawrence River Basin. *International Joint Commission (IJC) Digital Archive*. http://scholar.uwindsor.ca/ijcarchive/381

This IR is brought to you for free and open access by Scholarship at UWindsor. It has been accepted for inclusion in International Joint Commission (IJC) Digital Archive by an authorized administrator of Scholarship at UWindsor. For more information, please contact scholarship@uwindsor.ca.

00381

GLC ZZZZZ 657

Acq/Bib 2nd copy "In Process"

Interim Report on

1985-86 High Water Levels in the Great Lakes - St. Lawrence River Basin

October 1988

International Joint Commission
Commission mixte internationale

International Joint Commission

November 22, 1988

The Honorable George P. Shultz
Secretary of State
Department of State
2201 C St., NW
Washington, DC 20520

Dear Mr. Shultz:

I have the honor to transmit herewith the Interim Report of the International Joint Commission requested by the Governments of Canada and the United States in the August 1, 1986 Reference.

The report is also being sent to the Secretary of State for External Affairs of Canada by similar letter from the Secretary of the Canadian Section of the Commission.

Yours sincerely,

D LaRoche

David A. LaRoche
Secretary
United States Section

Enclosure

Table of Contents

I Background

Authority

On August 1, 1986, during a period of critically high water levels on most of the Great Lakes, the Governments of the United States and Canada requested by Reference to the International Joint Commission (Commission) an examination and report on methods of alleviating the adverse consequences of fluctuating water levels in the Great Lakes-St. Lawrence River Basin.

Purpose and Scope

The purpose of this report is to respond to that part of the Reference calling for: "...an interim report, focusing on measures to alleviate the present crisis, be submitted no later than one year from the date the Commission's study board actively begins its work." and, in a limited way, to the requirement to; "...propose and evaluate measures which governments could take, under crisis conditions, to alleviate problems created by high and low lake levels...". This report is submitted in a situation changed considerably from that prevailing at the time of the request as the extremely high lake levels of 1985 and 1986 have abated substantially.

The Task Force Investigation

Responses to the recent high water level crisis included the Reference from Governments to the IJC and implementation of numerous domestic emergency programs in the various jurisdictions. Some limited responses to modify the lake fluctuations, using available regulatory and diversion works, were also undertaken including: (a) the temporary storage of water on Lake Superior, (b) the implementation of Criterion (k) with respect to Lake Ontario regulation (both pursuant to existing IJC Orders of Approval), and (c) temporary storage of the Ogoki diversion by the Province of Ontario.

The Commission submitted an initial report to Governments by letters dated November 14 and December 10, 1986. Concurrently, the Commission decided to obtain additional technical information on all possible crisis measures, using a Task Force composed of IJC staff and specialists from both countries.

Within the one year study time frame established by the Commission, the Task Force identified measures which could be implemented within approximately one year or less to alleviate the crisis. The Commission determined that a satisfactory economic and social analyses could not be undertaken in the available time and should not be attempted. However, significant physical effects were to be identified and direct project costs estimated wherever possible.

Eight major tasks were identified and sub-groups established to develop detailed work plans and undertake the technical evaluations. Complete descriptions of the various measures, with their limitations and constraints, appear in the individual task reports that have been made available previously and are summarized in Appendix A. Following completion of the initial work assignment, the Task Force conducted several supplemental investigations that are described in Appendix B.

II Conclusions

1. The high lake level crisis, that began in late 1984 and continued until early 1987, obviously no longer exists.

2. Fluctuating lake levels are, for most observers, the tangible evidence of variations, primarily in precipitation (rainfall and snowfall) and secondarily in evaporation, that are created by unpredictable weather patterns. These relationships are illustrated by the 1984-88 rise and fall of the lakes and precipitation values shown in the following table:

Table 1

Precipitation 1/

19 Month Totals mm (inches)

	Superior Basin	Michigan-Huron Basin	Erie Basin	Ontario Basin
Nov. '84 - May '86	1310(51.6)	1550(61.0)	1560(61.4)	1510(59.4)
Avg. '66 - '86	1220(48.0)	1300(51.2)	1460(57.5)	1490(58.7)
Nov. '86 - May '88	1080(42.5)	1130(44.5)	1290(50.8)	1340(52.8)

1/ Sources: National Ocean Service and U.S. Army Corps of Engineers

3. It is impossible to predict the occurrence (when), the type (above or below average), the duration (length of time), or the intensity (how far above or below average), of a future trend in precipitation. Even when a trend is established (e.g., the current trend of below average precipitation), it is impossible to predict its duration or intensity. Short of a major scientific break- through that is not anticipated as of now, this lack of predictability will continue to be one of the most vexing issues concerning lake levels.

4. Under our present climatic conditions, it should be assumed that extreme lake levels will occur at irregular intervals and may occur at any point in time.

5. Previous studies by the IJC and others have identified various individual measures that are technically possible to reduce the effects of high water levels such as those that occurred during the recent crisis. Several of these measures have not been utilized at all or not utilized

to their full capabilities for various reasons. First, implementation of certain measures would reduce income or increase costs to various entities and no entity was eager to be the only one making that sacrifice. Second, the reduction in levels achieved by any one available measure was considered by some to be minor when compared to the larger impacts of nature in the form of supplies and the direction and intensity of winds. Third, there was concern regarding the absence of clear means and lead time to deal with any adverse effects. Fourth and of primary importance, each measure has both domestic and international implications and there was no agreement or common understanding among the various Governments and interests on what should be done.

6. The Task Force found that a combination of relatively low capital cost measures, utilizing primarily existing facilities and operated as part of a Great Lakes Basin emergency high water management plan, could be implemented within one year and could lower extreme high water levels. The Task Force also found that both structural and non-structural coastal zone management techniques can reduce the adverse effects of high water levels, and should be integrated appropriately into an emergency management plan.

7. The implementation of an emergency high-water or low-water management plan requires agreements between the Governments, and coordination among the various entities that have the operational responsibility for each individual component.

III Recommendations

In recognition of the recent high-level crisis, the abrupt reversal of precipitation and the findings of the Task Force, the Commission believes it is prudent to offer further advice and recommendations to Governments at this time.

Recommendation l.

Governments should initiate immediately broad but systematic discussions of their use of Great Lakes water, as called for in the Commission's January 1985 report on Great Lakes Diversions and Consumptive Uses.

In reiterating this advice, the Commission's intent is to initiate discussions on the broad and fundamental issues that bear directly or indirectly on measures Governments could take under low or high water crisis conditions. Our work under the 1986 Reference to date has revealed a number of issues, on which there are undoubtedly strongly held but differing views by Governments and interests, and which may significantly and perhaps profoundly affect our two countries and the preservation and utilization of the Basin.

For example:

- There are differences of opinion regarding the preference for structural versus non-structural solutions to high water levels.
- The recent Water Policy issued by the Federal Government in Canada encourages hydroelectric power development consistent with environmental protection. Consequently any potential action that would reduce hydropower generation, such as a diversion from the basin, may be viewed differently on the Canadian side of the basin than in the United States.
- A technical problem linked to policy matters is the uncertainty of forecasting future lake supplies and resulting levels. This particular uncertainty is compounded by the "greenhouse" potential. The lack of precision on this point becomes a policy issue because it contains the risk that any degree of protection provided from either extreme high or low levels will be exceeded or, conversely, never fully utilized. The amount of risk acceptable will, in all likelihood, vary significantly among decision makers.
- Federal/non-Federal cost-sharing has always been subject to debate and changes in policy. In the case of the Great Lakes, there is the added complexity of two sovereign nations with quite different divisions of powers with their provinces and states. In addition, the Commission anticipates that closely tied to possible cost sharing concerns will be issues of distribution of benefits, the impacts and distribution and redistribution of disbenefits, and the applicability of remedial, mitigation or compensatory measures.

Further, the Commission believes that these issues are so fundamental to the conduct of its ongoing, comprehensive study under the Reference, that consultations on both sides of the border regarding those differences and views should begin now and provision made for the results of these consultations to be taken into account in the actual study process itself.

Recommendation 2.

As part of their consultations on this report, Governments should develop coordinated, emergency management plans for both high and low water conditions, beginning with the information provided in our initial report (letters of November 14 and December 10, 1986) and the findings of the Task Force.

This recommendation responds to several important concerns.

First, the 1985-86 record high-water levels caused or contributed to extensive property damages and erosion in both the United States and Canada. In examining this crisis, the Task Force found a number of measures that are technically possible, using primarily existing facilities, to modify high water levels although some measures may have adverse effects. Such measures are summarized in Table l.

Second, given the complexity of the issues, Governments and interests involved, a considerable amount of time will be necessary following completion of the Commission's comprehensive study, to reach international and domestic agreements, obtain requisite funding, and implement any additional comprehensive measures aimed at alleviating the adverse effects of both high and low water levels. In the interim, the present trend in precipitation could reverse and high-water levels and attendant damages recur. Finding that greater relief from extreme high water levels could be achieved for certain interests with improved cooperation among the various affected interests acting in a system context, the Commission believes that Governments should begin at this time to prepare for and coordinate an interim emergency management response.

Table 2

Summary of Emergency Measures to Modify High Water Levels Technically Possible in One Year

	Normal Conditions	Emergency Conditions
Lake Superior Storage	Plan 1977	Plan 1977 with emergency discretions
Long Lac Diversion	1,400 cfs (40 cms)	0-800 cfs (0-23 cms)
Ogoki Diversion	4,200 cfs (119 cms)	0
Chicago Diversion	3,200 cfs (90 cms)	10,000 cfs (283 cms)
Welland Canal Diversion	9,200 cfs (260 cms)	10,000 cfs (283 cms)
Niagara River	Present outlet	Present outlet plus 1,300 cfs (36 cms) through Black Rock Lock.
Lake Ontario Outflow	Plan 1958-D with discretion	Plan 1958-D with discretion plus flood protection at Lake St. Peter.

This should be undertaken with the knowledge that any interim plan may need to be revised and modified as a result of the Commission's comprehensive study and other subsequent studies.

Third, given the present low precipitation trend, the consultations suggested above should also consider the possibility of a low water crisis so that Governments and institutions in both countries would be able to respond more quickly and effectively to such a situation.

Fourth, the consultations could contribute to the Commission's comprehensive study as discussed in Recommendation l above. For example, the selection of measures for a plan, whether in a crisis or in the general context of alleviating the adverse consequences of fluctuating levels, will involve reconciling competing interests. This reconciliation may be approached in a number of ways such as requiring all interests to share the burden of a crisis equally; giving certain interests special status; or allowing adverse effects to fall naturally where they may.

Recommendation 3.

All levels of government in Canada and the United States act to further discourage the construction of new, damage-prone buildings or facilities on the Great Lakes shoreline pending completion of the comprehensive study.

Given that the recurrence of high water levels is unavoidable, one method of reducing the potential for future damages is to restrict the use of land in the flood plain. Although this is a measure under investigation as part of the Commission's comprehensive study, the Commission believes that the interim implementation of this recommendation is appropriate so as not to preclude effective future Commission recommendations and Government action. If water levels continue to recede, development will normally continue to encroach upon the flood plain, thus increasing the potential severity of damages caused by future flooding. For those flood plains already developed, there is of course a more difficult question of protection versus prevention, which is being addressed as part of the comprehensive study. But for undeveloped areas, it should be ensured that this land, whether private or public, remains free of damage-prone structures.

Recommendation 4.

Governments enact measures necessary to insure that further encroachment does not occur in the connecting channels of the Great Lakes.

Technical studies have shown that various landfills have been placed in the connecting channels over time and that they have, depending on location, small but incremental effects on river flows and Great Lakes water levels. This issue of existing and future landfills in the Niagara River is of particular concern. The Task Force identified a number of obstructions in the Niagara River and estimated that the cumulative effect on Lake Erie water levels is significant. Because of the hydraulic characteristics of the Upper Niagara River, removal and/or modification of some of the existing obstructions, particularly those in the vicinity of the Peace Bridge, should also be considered.

Recommendation 5.

Governments continue the public information and technical activities emphasized during the recent high water crisis pending completion of the comprehensive study.

As Governments are well aware, there is considerable demand for information during periods of extreme water levels. The Commission continues to find significant groups of the public that have the need and desire to be better informed concerning the hydraulic, economic, social and biological features and interrelationships in the Basin. The recent high level crisis, and the strong responses by Governments and others in providing information and technical and financial assistance, has increased awareness of fluctuating lake levels and their consequences. But the Commission stresses that at least during the period of our comprehensive study, programs should be continuing in nature and not just at times of unusual conditions. Particular emphasis should be placed on those activities having a positive effect such as coastal zone hazard mapping. Such information must be "accessible", so that it is understandable by all interests and allows them to make full use of the information provided.

Appendix A

Summary, Great Lakes Water Levels Task Force To International Joint Commission

October 1987

SUMMARY

GREAT LAKES WATER LEVELS

TASK FORCE

TO

INTERNATIONAL JOINT COMMISSION

OCTOBER 1987

FORWARD

The Great Lakes Water Levels Task Force undertook a limited, emergency, flood control study. It did not include storm conditions or erosion control; nor were economic, social or environmental analyses undertaken. However it did identify crisis measures, address their technical feasibility, quantify hydrologic impacts and, where possible, indicate significant physical effects; all of which can provide an improved basis for decision making by Governments and the general public.

The Task Force was requested to examine every measure that could theoretically reduce extreme high water levels. No measure was excluded just because it might be trivial or impractical. In some cases, measures were taken to their physical limits in order to test their theoretical maximum effects. For example, the maximum physical flow through the Welland Canal of about 12,000 cfs (340 cms) was examined even though this flow requires the cessation of navigation.

The effects of any measure depends not only on its size but also on how it is used (when started and stopped and, where possible, its operation), and the water supplies with which it must attempt to cope.

The Task Force chose several different water supply conditions to test the various emergency measures within each Task. In Task 8, Systemic Effects, all measures were subjected to the same water supplies, i.e., the actual high supplies of 1985 and 1986 followed by three years of average supplies. Also, each measure was assumed to be in place and its operation was begun immediately, since it was known that two years of high supplies were coming.

In the real world, no one knows what future supplies will occur. Consequently, it is unlikely that all measures would or should be initiated at the same time and the effects reported herein likely overstate what could be achieved in reality. Conversely, it is possible future supplies may be even more severe than the extreme supplies used in the Task Force analyses, in which case the effects may be understated.

It is important to recognize that the Task Force reports and summary do not include a discussion of the many positive effects that would result from reducing extreme high lake levels. These effects would include but are not limited to: reduced flooding, erosion and pumping costs; improved storm drainage, sewage treatment plant operation and recreational opportunities; possible environmental protection; and they would occur along the entire shoreline of every lake. However, there is not sufficient information available to make even qualitative estimates of these effects, and the resources required for such an effort were beyond the scope of the Task Force. Similarly, no attempt was made to quantify those interests that can better utilize high levels. On the other hand, the measures themselves are more site specific, several have been studied previously, and qualitative estimates of physical impacts were possible in almost all cases. These have been included. Consequently, the Task Force could not report equally on all significant physical effects.

INTRODUCTION

Authority

On August 1, 1986 the Governments of Canada and the United States, in response to record high water level conditions occurring in the Great Lakes, referred the problem of fluctuating Great Lakes water levels to the International Joint Commission for examination and report. As part of this effort, the Governments asked for an interim report focusing on measures to alleviate the high water level crisis existing at that time. To obtain the additional information for its consideration of an interim report, the Commission decided in September 1986 to use a Task Force approach with membership composed of IJC staff and specialists from both countries. This document is a summary of the investigations and findings of the Task Force.

Background

The Great Lakes and their connecting waterways make up the largest freshwater system in the world. Great Lakes water levels are a dynamic phenomenom; fluctuations in lake levels may occur short term, seasonally or long term. The total water supplies are the dominant cause of these fluctuations. Because of their vast surface area and restrictive connecting channels, it is usually possible for the system to cope with typical water supply variations in any given year with a normal range of levels of one to two feet (0.3 to 0.6 m). While nature plays the predominant role in these fluctuations, the influence of human impacts becomes more of a concern when water levels are either at the extreme high or low part of their cycle.

During 1985 and 1986 monthly water levels on all of the Great Lakes, except Lake Ontario, were in most cases the highest in this century. Predictions for continued high water levels, including Lake Ontario, were not encouraging. There was considerable shoreline flooding, erosion and associated coastal zone problems, with resulting public demands for Government action. It could be said that only the unusually small number of severe storms kept damages lower than anticipated.

An initial IJC response to the Reference was submitted to Governments by letters dated November 14, and December 10, 1986. In that report the Commission outlined; actions it had taken, actions recommended be taken by Governments, and measures to lower water levels which were technically feasible utilizing existing facilities which might be implemented immediately. At that time, water levels were extremely high throughout the Basin and the Commission had initiated additional investigations through the Task Force approach.

Fortunately, as of the date of this Summary, the water level crisis has eased. Lakes Superior and Ontario are slightly below their long term averages. Lakes Michigan, Huron, and Erie, while still above their long term means by one to one and a half feet (0.3 to 0.5 m), are approximately one foot (0.3 m) below their record 1986 levels. This change has occurred because of record <u>low</u> supplies to the Lakes between late 1986 and mid-1987; the exact opposite of what occurred in 1985 and 1986.

<u>Purpose and Scope</u>

The purpose of the Task Force investigation was to provide the Commission with technical information on possible "crisis" action measures. Because in late 1986 no one could predict when the crisis conditions would end, it was decided that all possible measures should be considered which:

1) could possibly be taken to alleviate problems created by current (ie - 1986) high lake levels;
2) could be examined within the one year; and
3) could be implemented within approximately one year or less after reporting to Governments.

The Commission decided that a detailed, conventional benefit/cost analysis should not be undertaken for this effort. However significant physical effects were to be identified and direct project costs estimated wherever possible.

A preliminary scoping of potential measures and tasks was drafted in September, and reviewed and finalized in December 1986. Eight major tasks were identified and staffed to develop detailed work plans and undertake the technical evaluations of potential measures within each task. Measures initially reviewed, and eliminated from detailed examination due to lack of effectiveness or the one year timeframe requirement, included:

- Black Rock Lock modifications
- Trent Canal diversion
- weather modification
- consumptive use modification
- off-stream storage
- groundwater recharge
- other emergency high water level actions (e.g. Great Salt Lake pumping).

Hydrologic impacts (water levels and outflows) of the various measures consisted of comparing the "no action" (or a basis-of-comparison) scenario with scenarios assuming certain emergency measures in effect. Complete descriptions of the various measures, together with their limitations and constraints, appear in the individual task reports.

Membership

The Task Force was deliberately structured at the outset to make efficient use of limited resources (time, personnel and finances) and to integrate the seperate tasks. Murray Clamen and Don Parsons, Commission engineering advisors, served as co-chairs of the Task Force, provided on-going direction, and prepared this Summary report. The combined Task Force membership is listed in Table 1. In most instances members were assisted by personnel in their agencies.

TABLE 1

TASK FORCE MEMBERSHIP

Canada		U.S.	
Doug Brown Inland Waters/Lands Environment Canada	Member Task 7	Jayson Chung Wisconsin Coastal Management Program	Member Tasks 1, 7
Andre Carpentier Ministe de l'Environment Quebec	Member Tasks 2, 7	Richard Bartz Ohio Dept. of Natural Resources	Member Task 7
Doug Cuthbert Inland Waters/Lands Environment Canada	Member Task 1	Thomas Bruns Indiana Dept. of Natural Resources	Member Task 7
Reg Golding Aids & Waterways Branch Transport Canada	Co-Chair Tasks 5, 6 Member Tasks 2, 3, 8	William Daley N.Y. State Dept. of Environ- mental Conservation	Member Tasks 2,3,4,7
Charles Lawrie Aids & Waterways Branch Transport Canada (retired April 1987)	Member Tasks 2, 5, 6	Benjamin DeCooke Consultant	Member Tasks 1, 2, 5, and 6
Maurice Lewis Water Management Branch Ontario Ministry of Natural Resources	Co-chair Task 7 Member 1, 2, 8	Tony Eberhardt Buffalo District U.S. Army Corps of Engineers	Co-Chair Tasks 2, 4 Member Task 8
Gerry MacMillan Inland Waters/Lands Environment Canada	Co-Chair Task 3 Member Task 8	Bill Erdle Buffalo District U.S. Army Corps of Engineers (retired April 1987)	Member Tasks 2, 3, 4
Mac Odell Ontario Ministry of Natural Resources	Member Task 3	Neil Fulton Illinois Dept of Transportation	Member Tasks 3, 7

Canada		U.S.	
Dave Smith Inland Waters/Lands Environment Canada	Co-chair Tasks 1, 2 Member Tasks 5, 8	Ronald Harnack Minnesota Dept. of Natural Resources	Co-chair Task 7 Member Tasks 1, 8
Dave Strelchuck Ontario Ministry of Natural Resources	Member Task 4	Joseph Hoffman Pennsylvania Dept. of Environmental Resources	Member Task 7
Brian Tait Fisheries and Oceans Canada	Member Task 1	Don Leonard North Central Div. U.S. Army Corps of Engineers	Co-chair Task 3 Member Task 8
Peter Yee Inland Waters/Lands Environment Canada	Co-chair Task 4 Member Tasks 3, 8	Thomas Martin Michigan Dept. of Natural Resources	Member Tasks 1, 5, 7
		Frank Quinn Great Lakes Environmental Research Laboratory, National Ocean and Atmospheric Administration	Member Tasks 1, 4, 5
		Ogbazghi (Obie) Sium Minnesota Dept. of Natural Resources	Member Tasks 1, 7
		Ronald Wilshaw Detroit District U.S. Army Corps of Engineers	Co-chair Tasks 1, 5, 6 Member Task 8

POTENTIAL MEASURES AND FINDINGS

The Task Force met on several occasions to organize the various tasks and develop detailed work statements, including personnel and schedules. Table 2 lists the eight tasks and indicates the focus of investigation and objectives for each.

Task 1 - Lake Superior Storage

The work of this task was divided into two areas. The first part addressed the technical feasibility of increasing the storage on Lake Superior above 602 feet (183.5 m) and the associated physical impacts; the second phase reviewed historic information on lake levels, datum planes and outflow relationships to identify the maximum historic Lake Superior water level.

An evaluation of the stability of the regulatory works and structures located in the St. Marys River at Sault Ste. Marie, Ontario/Michigan was carried out to determine if the works could accommodate an increased water level. While the different structures would be over-topped at various stages, it appears that all the structures can accommodate a water level of about 602.8 feet (183.7 m) measured at the compensating works, resulting in a level of 603.0 feet (183.8 m) on Lake Superior. No further raising of the Lake Superior water level is possible without considerable stability analysis to identify any necessary modifications. Any storing of water would require making departures from Plan 1977, the current Lake Superior regulation plan.

The computations showed that it is technically possible to increase the level of Lake Superior to 603.0 feet (183.8 m). This action would increase the level of Lake Superior between one and one and a half feet (0.3 to 0.5 m) above that which would occur had the action not been taken. Downstream water levels would be reduced, depending on the water supply situation, between 0.67 ft. to 1.02 ft. (20 to 30 cm) for Lakes Michigan-Huron, and between 0.30 ft. and 0.57 ft. (9 to 16 cm) for Lake Erie. The above analysis did not include a procedure to maintain or release the stored water.

Around Lake Superior, the adverse effects on public and private facilities, and shore erosion were predicted to be severe. The environmental evaluation was very broad and not conclusive and mitigation measures could not be addressed within available resources.

TABLE 2

THE TASK FORCE

Task	Focus	Objectives
1	Lake Superior Storage	To determine if it is technically possible to raise Lake Superior above 602.0 feet (182.5 m), and identify the significant physical impacts both on Lake Superior and downstream, and any mitigation measures that may be required. To examine historic Lake Superior water levels.
2	Lake Ontario/ St. Lawrence River	To determine if it is technically possible to lower Lake Ontario levels by removing or modifying some of the existing constraints on Lake Ontario outflows and identify the significant physical impacts.
3	Diversions Management	To determine if it is technically possible to lower lake levels through changes in existing diversion rates and identify the significant physical impacts. The diversions were the Welland Canal, the Long Lac and Ogoki diversions, the Chicago diversion, and the New York State Barge Canal.
4	Niagara River	To determine if it is technically possible to increase Lake Erie outflows by various measures and identify the significant physical impacts. The measures involved the Black Rock Lock, the Chippawa-Grass Island Pool, channel excavation at the head of the Niagara River, and removing or modifying obstructions in the Niagara River and a Squaw Island diversion.
5	St. Clair/ Detroit Rivers	To determine if it is technically possible to modify flows in the St. Clair and Detroit Rivers and identify the significant physical impacts.

6	Ice Management	To determine if it is technically possible to improve flows under the ice cover in the connecting channels and identify the significant physical impacts.
7	Inventory of Emergency Measures and Shoreline Management Activities	To assemble available information on coastal emergency activities including; measures, public information, forecasting, mapping and damage resulting from the present crisis.
8	Systemic Effects	To evaluate the systemic effect of various combinations of emergency measures examined by the other tasks.

The review of historic water level data showed that high levels occurred on Lake Superior in 1869 and 1876. The task found that the maximum historic level on Lake Superior likely occurred in August 1876. When converted to the present Great Lakes datum, IGLD (1955), using the procedure presently accepted by the Commission, this level becomes 602.31 feet (183.6 m).

Task 2 - Lake Ontario/St. Lawrence River

This task evaluated the technical feasibility of lowering Lake Ontario levels by removing or modifying some of the existing constraints on Lake Ontario outflows, the objective being to increase outflows thereby lowering Lake Ontario water levels during crisis conditions.

Four constraints were identified for detailed study:

(i) agricultural land on the shoreline of Lake St. Peter (Quebec);
(ii) residential, commercial and industrial lands surrounding Lake St. Louis (Quebec);
(iii) navigation depth requirements in the International Rapids Section of the St. Lawrence River; and
(iv) maximum outflows during the navigation season.

(i) Adverse impacts on cropland surrounding Lake St. Peter occur at levels in excess of 16.7 ft. (5.1 m) (IGLD 1955) at the Sorel water level gauge during the growing season from late May to the end of October. Computations showed that flooding of these agricultural lands during 1986 could have decreased Lake Ontario's level 0.62 ft. (19 cm) with this amount being reduced to 0.33 ft. (10 cm) by the end of the navigation season in December. A number of ways to mitigate these impacts were described including construction of dykes, dredging of the St. Lawrence River, purchasing flood easements, or compensating farmers for damages. The first three probably could not be implemented quickly.

(ii) Adverse impacts to residential, industrial and commercial facilities occur around Lake St. Louis at levels in excess of 72.25 ft. (22 m). To remove this constraint requires protecting these lands and structures around Lake St. Louis by major dredging and/or dyking. Since such measures could not be completed within one year, it was determined that the Lake St. Louis outflow constraint would remain.

(iii) Navigation depths in the International Rapids Section of the St. Lawrence River are provided for in the Commission's Orders of Approval concerning Lake Ontario regulation through a minimum water surface profile. However operating experience since the Seaway was opened has shown that vessels require a slightly different profile with river levels above the minimum profile in part of the River (called alert depths) to provide acceptable depths and velocities for safe operation. In this task, it was assumed that the commonly accepted alert depths used by the navigation entities could be reduced by six inches (15 cm) to permit slightly higher Lake Ontario outflows. Another scenario with levels reduced to the minimum profile was also examined. Depending on the supplies, the reduction of Lake Ontario levels resulting from the modification of this constraint ranged from 0.15 ft. to 0.27 ft. (5 to 8 cm) by the end of the navigation season. Peak levels in the year of implementation were unaffected in all cases, but could be reduced slightly the following year.

(iv) During construction of the St. Lawrence Seaway, channel enlargements were carried out to provide a maximum mean velocity of four feet per second (1.2 meters per second) in the navigation channels, which translates into a maximum Lake Ontario outflow of 310,000 cfs (8,780 cms). In practice, navigation has been able to operate with maximum outflows up to 340,000 cfs (9,630 cms) and velocities above four feet per second (1.2 meters per second) during high water conditions on Lake Ontario. As a result, this task investigated two increases in maximum outflows to 350,000 cfs (9,910 cms) and 360,000 cfs (10,200 cms). Results were similar in both cases; Lake Ontario would be reduced in the range of 0.09 ft. to 0.32 ft. (3 to 10 cm) during mid-summer, depending on supplies. By the end of the navigation season this would have been reduced to between zero and 0.10 ft. (3 cm). Peak levels were unaffected by the flow increases.

If the above alert depth and maximum outflow constraints were not respected, shipping interests could suffer significant adverse impacts. It is simply not known whether vessels could safely navigate sections of the river having higher velocity flows and cross currents. Impacts to navigation would be difficult to mitigate. Other possible impacts due to increased flows and/or higher water levels would be: increased erosion of streambanks; disruption and potential loss of wildlife habitat and vegetation; decreased efficiency of storm drainage and sewage treatment facilities; and slight reductions in beach width and hydropower generation.

<u>Task 3 - Diversions Management</u>

Starting from the Commission's 1985 report on this subject, this task re-evaluated certain diversion management actions that could be taken to moderate supplies and lower water levels. The diversions were the Long Lac, Ogoki, Chicago, Welland Canal, and New York State Barge Canal.

The Long Lac and Ogoki diversions, bringing an average annual flow of about 5,600 cfs (159 cms) into Lake Superior, can both be closed completely. Two scenarios were simulated; one representing a complete stoppage of both diversions, while the other scenario assumed the Ogoki diversion was closed with 800 cfs (23cms) remaining in the Long Lac diversion to sustain the pulp mill at Terrace Bay to avoid major adverse impact to the town. Depending on the supplies and the regulation scenario, the ultimate effect, reached in about two years, would be to reduce Lakes Michigan-Huron between 0.16 ft. to 0.23 ft. (5 to 7 cm), and Lake Erie between 0.12 ft. and 0.15 ft. (4 to 5 cm).

Physical impacts of altering these two diversions will occur in both the Great Lakes and Hudson Bay drainage basins from reductions in flows along the diversion routes and increases in flows within the natural drainage area. Shutdown of the diversions causes reduction of electrical energy production in the Ontario Hydro system with some additional reduction at U.S. and Quebec hydro stations. Complete stoppage of the Long Lac diversion itself would prevent normal log driving operations, resulting in closure of the Terrace Bay pulp mill and the direct loss of approximately 2,500 jobs in the area as well as impact on the livelihood of approximately 7,500 people indirectly throughout a wider area. There would be a direct adverse impact on the fishing and recreation industries of the area; certain fish spawning and wildlife habitat areas would be disrupted and there would be increased hazards to boaters on the rivers. Flood flows could affect Indian Reserve No. 65 at the confluence of the Ogoki and Albany Rivers.

The three components of the Chicago diversion presently withdraw and divert a maximum of 3,200 cfs (90 cms) from Lake Michigan, as decreed by the U.S. Supreme Court. This task examined the possibility of increasing the diversion rate to a maximum annual diversion of 10,000 cfs (283 cms), a potential maximum indicated in previous studies. Computer simulations of lake levels with the diversion at the above two rates indicate that levels on Lakes Michigan-Huron and Erie could ultimately be reduced by 0.21 ft. (6 cm) and 0.14 ft. (4 cm), respectively, within about two years.

Significant physical impacts to navigation, as well as interests that could be flooded along the Illinois waterway, are associated with a diversion increase to 10,000 cfs (283 cms). An operating plan would need to be developed if flow increases were contemplated as an emergency measure.

The existing maximum annual diversion rate through the Welland Canal is about 9,200 cfs (260 cms). However flows in 1985 and 1986 declined to an annual average of 7,900 cfs (224 cms) due to repairs of a lock wall that failed in 1985 and the beginning of a major seven-year canal rehabilitation program. It has been estimated that the theoretical maximum flow through the canal is 11,000 cfs (310 cms) with maximum water use by all sectors. If a water level crisis of such proportions existed that the canal was utilized solely to lower Lake Erie and upstream water levels, all navigation could be stopped and flows could possibly reach 12,000 cfs (340 cms). Computer simulations comparing lake levels with this latter extreme flow and the normal 9,200 cfs (260 cms) maximum showed that Lakes Michigan-Huron would be reduced by 0.03 ft. (1 cm) and Lake Erie by 0.11 ft. (3 cm) after about two years.

Theoretical maximum flows of 12,000 cfs (340 cms) through the Welland Canal would have several significant physical impacts. There would be complete cessation of navigation between Lake Ontario and the upper Great Lakes for the entire period affecting the economies of both countries. In the canal itself, there is a risk of erosion and bank slumping at any flows in excess of 9,000 cfs (255 cms). The maximum flow would also cause flooding around the pondage basins and over the docks; and increase bank stabilization and dredging maintenance.

This task also investigated the New York State Barge Canal. The relatively small unregulated flow, estimated at 700 cfs (20 cms), is withdrawn from the Niagara River considerably downstream from the natural outlet of Lake Erie. Also, the Canal is virtually at capacity without extensive modifications. Consequently, this diversion has virtually no effect on the levels of the Great Lakes and the Niagara River and cannot be used as a practical means to lower water levels in an emergency.

Task 4 - Niagara River

This task investigated the following measures in the Niagara River to increase Lake Erie outflows:

(i) increased flows through the Black Rock Lock;
(ii) modified operation of the Chippawa-Grass Island Pool Control Structure;
(iii) removal or modification of flow obstructions;

(iv) channel excavation at the head of the Niagara River; and

(v) construction of a diversion through Squaw Island.

(i) Analysis of the Black Rock Lock and its operation shows that the existing lock culverts and butterfly valves in the lock gates can be operated to discharge 300 cfs and 1,000 cfs (8 cms and 28 cms) respectively with no structural modifications. The 1,300 cfs (36 cms) flow increase in the Niagara River translates into a maximum lowering impact on Lake Erie of about 0.06 ft. (2 cm) within one year. Aside from possible interruptions to recreational boaters, no significant adverse physical impacts are predicted.

(ii) Mathematical modelling and actual field measurements taken in June 1987 suggest there could be some increase in flow in the Niagara River if the existing control structure in the Chippawa-Grass Island Pool were operated to maintain a slightly lower level when compared with the present operating procedure. The amount of Pool lowering is dependent upon several factors; in particular extended periods of Pool lowering during the winter would not be feasible because the risk of ice grounding and jams in the Niagara River would be high. Based on the analysis of existing data, it was assumed that the Pool level could be maintained at a target level of 560 feet (170.7m), one foot (0.3m) below the present operating range. It was further assumed that this would translate into a Niagara River flow increase of about 3,000 cfs (85 cms) which corresponds to an estimated lowering impact on Lake Erie of about 0.13 ft (4 cm) after about one year.

Lowering of the Pool level could affect the power diversion and/or generation at Niagara power plants. Extended periods of low levels in the Pool could also adversely affect local riparian interests who operate water intakes and/or boating facilities in the area. A detailed operating plan would be required if this measure were to be utilized in an emergency situation.

(iii) The task identified a number of obstructions in the Niagara River and estimated the impact on Lake Erie levels of removing or modifying them. Taken together, these obstructions have a significant effect on Lake Erie levels. Because of the hydraulic characteristics of the upper Niagara River, shoreline modifications and/or removal of obstructions in the vicinity of the Peace Bridge would have the greatest impact on Lake Erie water levels. Possible impacts ranged from a reduction of 0.01 ft. (0.3 cm) for removal of the old Buffalo water intake structure to a reduction of about 0.4 ft. (12 cm) for complete removal of the Bird Island Pier.

Removal or modification of these obstructions will cause varying types and degrees of physical impacts. For example, removing or replacing the Peace Bridge or the International Railway Bridge, at considerable expense, would cause major traffic disruptions; removal of the old water intake structure is not expected to cause problems but removal would be difficult and costly since it would take place in fast-moving water.

(iv & v) Dredging of the Niagara River in the vicinity of the Peace Bridge and constructing a Squaw Island diversion channel and control structure were also investigated. Flow increases of about 10,000 cfs (283 cms) each would result if either of these measures were undertaken. Maximum Lake Erie water levels would be reduced 0.4 ft. (12 cm) while Lake Ontario would rise by about 0.2 ft. (6 cm) for either of these measures.

There is a potential for significant adverse impacts if either of these projects were undertaken. The Squaw Island diversion would need to consider possible toxic contaminant migration, erosion of Strawberry Island and cultural (prehistoric) resources. The dredging proposal would need to address rock disposal, fishery resources and contamination in the Niagara River. Because the investigation showed that construction required at least two years, neither possibility was considered practical as an emergency measure.

<u>Task 5 - St. Clair/Detroit Rivers</u>

The work of this task was divided into three areas: the first area reviewed historic information to determine the effect of the dredging and compensating works that have been placed in the St. Clair/Detroit Rivers; the second area looked at lowering Lakes Michigan-Huron by removing the compensating works which have been placed over time in the Detroit River; conversely, the third area looked at lowering Lake Erie by placing additional works in the St. Clair River to offset the effect of dredging in that river.

The task documents the various dredging projects in the St. Clair/Detroit River system since 1876. The estimated net effect of all dredging and compensating works placed to date in the St. Clair River is a lowering of Lakes Michigan-Huron between approximately 1.2 to 1.6 ft. (0.4 to 0.5 m). The effect of such works in the Detroit River on Lakes Michigan-Huron and St. Clair is negligible.

Removal of the compensating dykes in the Detroit River would lower Lakes Michigan-Huron by about 0.15 ft. (5 cm) and Lake St. Clair by 0.10 ft. (3 cm). However the timeframe to accomplish this action would extend well beyond one year. Such removal would restrict navigation in the river during construction and may reduce navigation draft throughout the system. There could be significant environmental impacts both during the construction phase and in the long-term.

Studies indicated it is technically possible to place sills in the St. Clair River to offset the lowering of Lakes Michigan-Huron caused by navigation dredging projects, and in turn decrease inflows to Lake Erie. Such a project could raise Lakes Michigan-Huron by 0.6 ft.(18 cm), have adverse impacts to shoreline interests on those lakes, create transitory but overall negative environmental impacts and have only a transitory lowering of Lake Erie water levels. A staged construction period could take from three to ten years to complete.

<u>Task 6 - Ice Management</u>

This task investigated the technical feasibility of improving flows under the ice covers in the connecting channels. The review included an examination of the ice formation and dissipation forces in the Great Lakes connecting channels and the St. Lawrence River, current ice management structures such as ice booms, and measures to improve flow conditions during the ice season. Winter navigation and documentation of the severe 1984 ice jam in the St. Clair River were also reviewed.

The task noted that the present use of ice booms in the St. Marys, Niagara and St. Lawrence Rivers has increased winter outflows, reduced ice jamming and/or improved local conditions. The task found that placement of an ice boom in the St. Clair River should help prevent jams caused by the flow of Lake Huron ice into the channel. Using a simplistic assumption that such a measure would totally eliminate the present average ice retardation in the river, there would be a calculated maximum lowering effect on Lake Superior of 0.09 ft. (3 cm) and on Lakes Michigan-Huron of 0.12 ft. (4 cm) while the average level of Lake Erie would rise by 0.05 ft. (2 cm). The reduction or elimination of ice jams would be of considerably more significance.

<u>Summary of Hydrologic Impacts</u>

Tables 3a and 3b summarize the measures investigated by tasks 1 through 6 and present a sample of hydrologic impacts. These tables should be used with caution because the impacts cannot be added and represent a theoretical range which can vary considerably depending upon supplies and other conditions.

Task 7 - Inventory of Emergency Measures and Shoreline Management Activities

This task was one of data gathering and no lake level or flow management actions were intended. Listed below are the shoreline management activities and initiatives where each individual jurisdiction was asked to provide information. The inventories included both existing policies, programs and activities and items being planned for implementation in the near future:

- o Emergency Measures
- o Education/Public Information
- o Storm Warning/Forecasting
- o Hazard Mapping
- o Analysis of Storm Frequency, Duration and Direction
- o Estimated Damages
- o Public and Private Facilities/Environmentally Sensitive Areas
- o Land Use Management Policies and Programs.

The availability and reliability of data and information varied widely and each jurisdiction did not provide information on all the inventories. Pending completion of this task, a Supplement may be issued.

Task 8 - Systemic Effects

This task, made up of the co-chairs of the first seven tasks, evaluated the hydrologic impacts of various combinations of emergency measures examined by the other tasks. The evaluation compared Great Lakes water levels and outflows under a no-action (basis-of-comparison) scenario with three different scenarios summarized in Tables 4a and 4b.

Scenario 1 is a supply control scenario with no direct implementation costs; Scenario 2 builds on the first scenario and adds additional measures that could be implemented quickly with little capital outlay; Scenario 3 is a theoretical maximum effect, requiring significant expenditure and time.

A five-year study period was selected starting with the actual lake levels of July 1987. Although the extreme high water levels of 1985-86 had declined, significantly high water levels were still occurring on the middle Great Lakes. This time span was considered to be sufficiently long enough to identify the effectiveness of the maximum impact of the emergency measures and to allow for the possibility of high supplies recurring . During the first two years, the study assumed supplies to be the record high supplies that occurred during the period August 1985 to July 1986. For the next three years, the study assumed average supplies.

Table 5a and 5b summarize the changes in lake levels produced by each of the three scenarios. Tables and graphic plots of monthly water levels for each Lake, each scenario, and the base case, are presented in the report of this task.

TABLE 3a
SUMMARY OF EMERGENCY MEASURES
TASKS 1 THROUGH 6

TASK	MEASURE	TECHNICALLY POSSIBLE IN ONE YEAR Y/N	TYPICAL HYDROLOGIC EFFECTS (FEET) SUPERIOR	MICHIGAN/ HURON	ERIE	ONTARIO
Lake Superior Storage	Up to 603 ft.	Y	+1.0 to +1.5	-0.67 to -1.02	-0.30 to -0.57	--
	Greater than 603 ft.	N				
Lake Ontario Regulation	Lake St. Peter	Y	--	--	--	-0.62
	Lake St. Louis	N	--	--	--	--
	Alert Depth					
	Alert Minus 6 in.	Y	--	--	--	-.15 to -.27
	Min. Profile	Y	--	--	--	-.13 to +.38
	Maximum Outflow	Y	--	--	--	-.09 to -.32
Diversions Management	Ogoki/Long Lac shutoff	Y	--	-0.23	-0.15	--
	Chicago 10,000 cfs	Y	--	-0.21	-0.14	--
	Welland 12,000 cfs	Y	--	-0.03	-0.11	--
	NYSB Canal	N	--	--	--	--

TABLE 3a (CONTINUED)

TASK	MEASURE	TECHNICALLY POSSIBLE IN ONE YEAR Y/N	SUPERIOR	MICHIGAN/ HURON	ERIE	ONTARIO
Niagara River	Squaw I. diversion	N	0	-0.16	-0.42	+0.19
	Channel excavation	N	0	-0.16	-0.42	+0.19
	CGIP	Y	negligible		-0.13	negligible
	Black Rock Lock	Y	negligible		-0.06	negligible
	Obstructions					
	Ice Boom	N	--	--	--	--
	Bird I. Pier-breach	N	--	--	-0.12	--
	-remove	N	--	--	-0.40	--
	Mather Park	N	--	--	-0.07	--
	Buffalo Water Intake Structure	N	--	--	-0.01	--
	Peace Bridge	N	--	--	-0.11	--
	Nicholl's Marine	Y	--	--	-0.06	--
	Buffalo S.T.P. Bulkhead	N		negligible		
	Int'l R.R. Bridge	N	--	--	-0.07	--
	Utvich Fill	N	--	--	-0.01	--
St. Clair/ Detroit Rivers	Remove dykes Detroit River	N	--	-0.15	+ temporary	+ temporary
	Install sills St. Clair River	N	+0.2 1/	+0.59	- temporary	- temporary
Ice Management	St. Clair River Ice Boom	N	-0.09	-0.12	+0.05	--

1/ Estimated subsequent to Task 5 report.

TABLE 3b
SUMMARY OF EMERGENCY MEASUESs
TASKS 1 THROUGH 6

TASK	MEASURE	TECHNICALLY POSSIBLE IN ONE YEAR Y/N	TYPICAL HYDROLOGIC EFFECTS (CENTIMETRES) SUPERIOR	MICHIGAN/ HURON	ERIE	ONTARIO
Lake Superior Storage	Up to 183.8m	Y	+30 to +45	-20 to -30	-9 to -17	--
	Greater than 183.8m	N				
Lake Ontario Regulation	Lake St. Peter	Y	--	--	--	-19
	Lake St. Louis	N	--	--	--	--
	Alert Depth					
	Alert Minus 15cm	Y	--	--	--	-5 to -8
	Min. Profile	Y	--	--	--	-4 to +12
	Maximum Outflow	Y	--	--	--	-3 to -10
Diversions Management	Ogoki/Long Lac shutoff	Y	--	-7	-5	--
	Chicago 283 cms	Y	--	-6	-4	--
	Welland 340 cms	Y	--	-1	-3	--
	NYSB Canal	N	--	--	--	--

TABLE 3b (CONTINUED)

TASK	MEASURE	TECHNICALLY POSSIBLE IN ONE YEAR Y/N	SUPERIOR	MICHIGAN/ HURON	ERIE	ONTARIO
Niagara River	Squaw I. diversion	N	0	-5	-13	+6
	Channel excavation	N	0	-5	-13	+6
	CGIP	Y	negligible		-4	negligible
	Black Rock Lock	Y	negligible		-2	negligible
	Obstructions					
	Ice Boom	N	--	--	--	--
	Bird I. Pier-breach	N	--	--	-4	--
	-remove	N	--	--	-12	--
	Mather Park	N	--	--	-2	--
	Buffalo Water Intake Structure	N	--	--	-0.3	--
	Peace Bridge	N	--	--	-3	--
	Nicholl's Marine	Y	--	--	-2	--
	Buffalo S.T.P. Bulkhead	N		negligible		
	Int'l R.R. Bridge	N	--	--	-2	--
	Utvich Fill	N	--	--	-0.3	--
St. Clair/ Detroit Rivers	Remove dykes Detroit River	N	--	-5	+ temporary	+ temporary
	Install sills St. Clair River	N	+7 1/	18	- temporary	- temporary
Ice Management	St. Clair River Ice Boom	N	-3	4	2	--

1/ Estimated subsequent to Task 5 report.

TABLE 4a
SYSTEMIC SCENARIOS (CMS AND FEET)

	Base Case	Scenario 1	Scenario 2	Scenario 3
Long Lac/Ogoki	5,600	0	0	0
Lake Superior Outflow	Plan 1977	Plan 1977	Storage range from	602.3 to 603.0
Chicago Diversion	3,200	10,000	10,000	10,000
St. Clair - Detroit R.	present outlet	present outlet	present outlet	50% reduction in ice retardation(3) 10,000 cfs increase in Det. River (4)
Welland Canal Diversion	9,200	9,200	11,000	11,000
Niagara River	present outlet	present outlet	4,300 increase(1)	8,000 increase(2)
Lake Ontario	Plan 1958-D with discretion (it was not necessary to modify any constraints)			

(1) due to the use of the Black Rock Lock (1300 cfs) and CGIP lowering (3000 cfs)
(2) due to the additional 3700 cfs increase by removing selected obstructions
(3) due to placement of an ice boom at the head of the St. Clair River
(4) due to removal of compensating dykes in the Detroit River

TABLE 4b

SYSTEMIC SCENARIOS (CMS AND METRES)

	Base Case	Scenario 1	Scenario 2	Scenario 3
Long Lac/Ogoki	159	0	0	0
Lake Superior Outflow	Plan 1977	Plan 1977	Storage range from	183.6 to 183.8
Chicago Diversion	90	283	283	283
St. Clair - Detroit R.	present outlet	present outlet	present outlet	50% reduction in ice retardation(3) 283 cms increase in Det. River (4)
Welland Canal Diversion	260	260	310	310
Niagara River	present outlet	present outlet	120 increase(1)	224 increase (2)
Lake Ontario	Plan 1958-D with discretion (it was not necessary to modify any constraints)			

(1) due to the use of the Black Rock Lock (36 cms) and CGIP lowering (84 cms)

(2) due to the additional 104 cms increase by removing selected obstructions

(3) due to placement of an ice boom at the head of the St. Clair River

(4) due to removal of compensating dykes in the Detroit River

TABLE 5a

SUMMARY OF SYSTEMIC IMPACTS (FEET)
AFTER YEARS INDICATED

	Scenario 1		Scenario 2		Scenario 3	
	2 years	5 years	2 years	5 years	2 years	5 years
Lake Superior	-0.3	-0.2	+1.3	+2.1	+1.3	+2.1
Lakes Mich-Huron	-0.3	-0.7	-1.1	-1.3	-1.2	-1.5
Lake Erie	-0.2	-0.4	-0.9	-1.1	-1.0	-1.2
Lake Ontario1/	-0.4	-0.2	-1.3	-0.4	-1.0	-0.2

Note: Positive values indicate levels raised and negative values indicate levels lowered.

1/ Changes in levels shown for all Lakes except Ontario are essentially the maximum change for that Lake. The maximum changes on Ontario are:

Scenario 1: - 0.7 ft. (after 3 years)
Scenario 2: - 1.7 ft. (after 2 years)
Scenario 3: - 1.3 ft. (after 3 years)

TABLE 5b

SUMMARY OF SYSTEMIC IMPACTS (CENTIMETRES) AFTER YEARS INDICATED

	Scenario 1		Scenario 2		Scenario 3	
	2 years	5 years	2 years	5 years	2 years	5 years
Lake Superior	-9	-6	+40	+64	+40	+64
Lakes Mich-Huron	-9	-21	-34	-40	-37	-46
Lake Erie	-6	-12	-27	-34	-30	-37
Lake Ontario 1/	-12	-6	-40	-12	-30	-6

Note: Positive values indicate levels raised and negative values indicate levels lowered.

1/ Changes in levels shown for all Lakes except Ontario are essentially the maximum change for that Lake. The maximum changes on Ontario are:

Scenario 1: - 21 cm (after 3 years)
Scenario 2: - 52 cm (after 2 years)
Scenario 3: - 40 cm (after 3 years)

Appendix B
Supplemental Investigations

After the Task Force completed its primary work in October 1987, the Commission initiated several supplemental investigations which are described below.

By letter of October 13, 1987 the Commission requested its International Niagara Board of Control to conduct a field test on the operation of the Chippawa-Grass Island Pool (CGIP) Control Structure to evaluate the possible effect of the structure on Lake Erie water levels. A report summarizing the results of the field test, conducted in December 1987, was submitted to the Commission in May 1988. The report indicates that although some problems occurred during the test period, considerable data was collected using the acoustic velocity meter (AVM) already in place in the Niagara River for demonstration purposes. The Board concluded that the data collected in the test were much more reliable than those of earlier tests. However, as with the tests conducted by the Board in May 1974 and June 1987, the December 1987 test encountered a similar problem of constantly changing water levels in eastern Lake Erie. These occurrences made it extremely difficult to measure the very small differences in Niagara River flows that are theoretically possible by changing Pool levels. The Board's analysis of the data did not identify any measurable effect on Lake Erie outflows due to changes in the CGIP level. Accordingly, the Board recommended that no further tests be carried out in the CGIP and upper Niagara River until better proven technologies in flow measurement exist.

By letter of October 13, 1987 the Commission requested the U.S. Army Corps of Engineers to test the Corps' Black Rock Lock at Buffalo, New York. Water was to be discharged through the lock by opening butterfly valves in the lock miter gates and simultaneously opening the lock filling and emptying systems. This combination was previously tested in 1987 for about 24 hours. However, the further test of one month was required to determine whether the lock could be operated for a longer period of time, and also to receive advice on maximizing availability of such operations with regard to winter conditions, maintenance or other limiting factors. The test was initiated in July and completed in August, 1988 with no reported adverse effects.

Further review and consultation regarding the Long Lac and Ogoki Diversions indicate that potential adverse effects on environmental and certain economic and recreational interests as indicated under Task 3 and the Task Force Summary may be overstated.

As the Task Force was completing its work, it was suggested that the Black Rock Lock could be modified quickly to achieve a design outflow capacity of about 12,000 to 15,000 cfs (340 to 425 cms). Although further investigation of this concept is being undertaken as part of the Commission's comprehensive study, results to date indicate that incremental control of flows through the lock could be achieved by a set of stackable, steel stoplogs installed and removed as necessary by a permanent stiff-legged derrick at a first cost of about $3.5 million (1988 U.S. dollars) with a maximum design flow of 15,000 cfs (425 cms). Further investigation is underway regarding navigation requirements and potential environmental impacts. However, recent maintenance investigations have revealed significant voids behind the lock walls. Consequently, the lock cannot be considered structurally sufficient for these large flows until after rehabilitation is completed in 1989.

The Task Force investigated several contraints that limit outflows from Lake Ontario. One of these is the threat of flooding of agricultural lands immediately adjacent to Lake St. Peter in Quebec during the growing season. Recently, the Commission has been informed that private conservation organizations, land owners and the Provincial Government have entered into negotiations with a view to purchasing some flood-prone land for duck habitat and protecting other land by dyking. It is expected that the outcome of these negotiations will be important and could affect the regulation of Lake Ontario, particularly during high water conditions. The Commission along with with its International St. Lawrence River Board of Control will be monitoring developments as part of its ongoing responsibilities under our Orders of Approval.

The Task Force estimated that the theoretical maximum flow through the Welland Canal is 11,000 cfs (311 cms) with maximum water use by all sectors. However, at any flow substantially in excess of approximately 9,000 cfs (255 cms), there is a risk of erosion and bank slumping in the canal itself. Further discussions with St. Lawrence Seaway officials indicated that the maximum allowable flow may be 10,000 cfs (283 cms).

The Task Force inventoried readily available damage estimates due to high lake levels during 1985-1987, and estimated some damages if levels increase beyond those experienced previously. Subsequent to the Task Force completing its work on this matter, the following reports were released which provided additional shore-damage related information for Lake Superior:

(1) Environment Canada

"Lake Superior Canadian Commercial and Industrial Shore Property Survey"; Christian Stewart, Burlington, Ontario, February 1988;
52 pp.

(2) Ontario Ministry of Natural Resource and Environment Canada

"Report on Lake Superior Shore Property Damage Economic Evaluation and Social Impact Assessment"; Marshall, Macklin, Monaghan Limited; Don Mills, Ontario, 1988.

(3) Wisconsin Department of Administration

"Governor's Task Force on High Great Lakes Water Levels Final Report"; December 1987, 17 pp.

Finally, the Task Force evaluated the systemic effects of various combinations of emergency measures. Further computations, using a different combination of measures than those originally selected by the Task Force, were undertaken. Table 3 summarizes the maximum impacts of this scenario on the lakes for the period of time indicated.

Table 3

Systemic Impacts Feet (Centimetres)
After Years Indicated 1/

	1 year	2 years	5 years
Lake Superior	+0.7 (21)	+0.6 (18)	+1.4 (43)
Lakes Mich-Huron	- 0.7 (21)	- 0.6 (18)	- 1.1 (34)
Lake Erie	- 0.4 (12)	- 0.5 (15)	- 0.8 (24)
Lake Ontario	- 0.4 (12)	- 1.0 (30)	- 0.5 (15)

Note: Positive values indicate levels raised and negative values indicate levels lowered.

1/ This additional scenario assumed the same supplies and time period as Task 8 in the Task Force investigation. The specific combination of measures is:

Long Lac/Ogoki Diversion	‘	800 cfs (23 cms)
Chicago Diversion	‘	10,000 cfs (283 cms)
Welland Canal	‘	10,000 cfs (283 cms)
Black Rock Lock	‘	1,300 cfs (36 cms)
Lake Superior	‘	Emergency discretion to 602.3 feet (183.6 m)