US Army Corps
of Engineers
North Central Division

GREAT LAKES LEVELS

UPDATE LETTER NO. 75 1 OCTOBER 1991

LAKE ONTARIO REGULATION

Physical Characteristics of the System

The Great Lakes - St. Lawrence River system of lakes and connecting channels (Figure 1) is such that the Lake Ontario - St. Lawrence River portion receives the natural drainage of all of the other lakes in addition to its own net basin supply. An additional 1,800 cfs enters the system which is the net diversion of 5,000 cfs from the Albany River basin to Lake Superior (Long Lac-Ogoki Diversion) and 3,200 cfs from Lake Michigan through the Chicago Sanitary and Ship Canal (Chicago Diversion). The vast majority of upper lake supplies enters Lake Ontario through the Niagara River at an average rate of 202,000 cfs. The Welland Canal also provides about 9,400 cfs from Lake Erie. A major basin that affects the regulation of Lake Ontario is the Ottawa River which enters the St. Lawrence River at Montreal. The Ottawa River basin covers 56,500 square miles of area. The timing and magnitude of Lake Ontario outflows become constrained during the annual Ottawa River freshet which usually occurs during April through June.

Historic Perspective

Development of the upper St. Lawrence River for navigation and hydropower was proposed as early as 1825. However, the most significant events associated with development occurred in the early part of the 20th century. The International Waterways Commission was established in December 1903, by the governments of Canada and the United States to establish a guiding set of principles and resolve disputes in boundary waters.

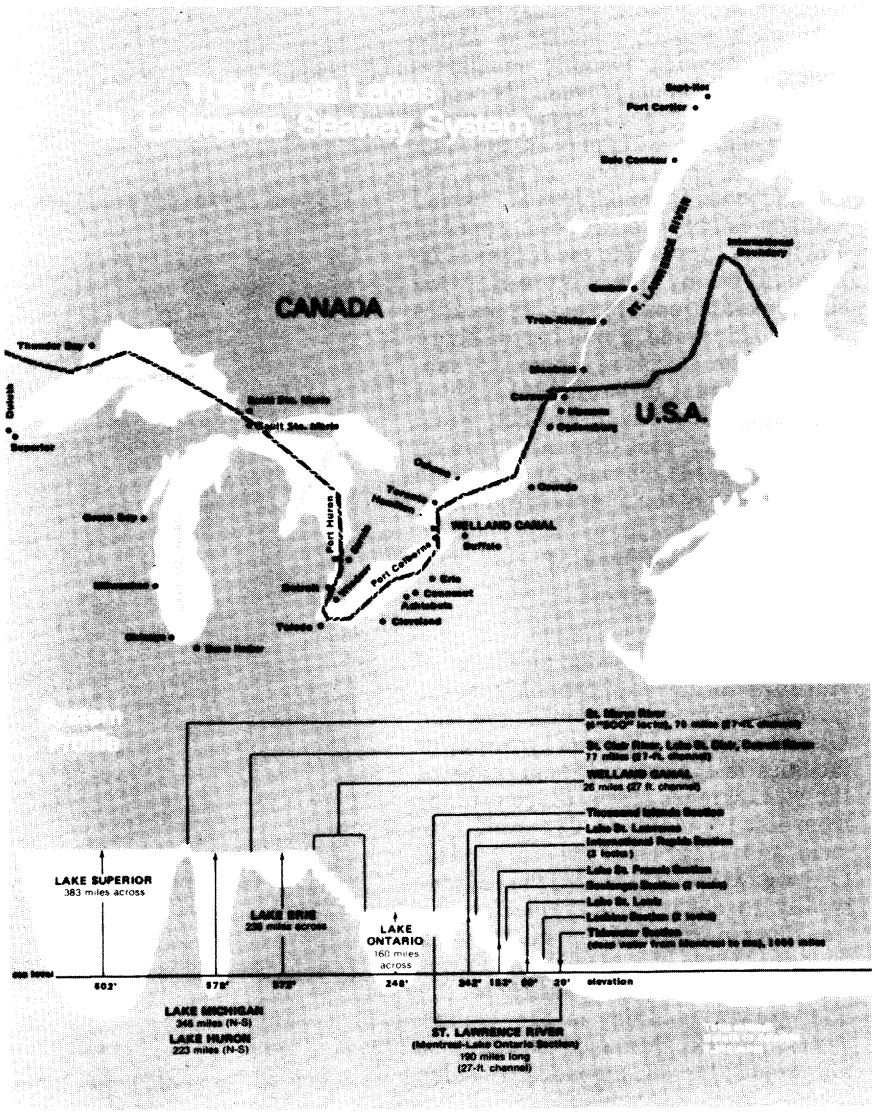

Figure 1. Great Lakes-St. Lawrence River and Schematic Profile

This recognition led directly to the Boundary Waters Treaty of 1909 between the United States and Great Britain. The present International Joint Commission (IJC) which guides the regulation of Lakes Superior and Ontario was established by this treaty.

The treaty specified that navigation "shall forever continue free and open for the purposes of commerce" and that the navigation laws of one country were to apply to citizens and vessels of the other. Although navigation was stressed, as population and industry expanded, interest in the development of electricity began to appear. The rapids of the river could facilitate this development. The dual purpose of a St. Lawrence River Seaway project was substantiated by a 1921 study by the U.S. Army Corps of Engineers and Department of Railways and Canals of Canada, under the auspices of the IJC. The study report, referred to as the Wooten-Bowden Report, concluded that navigation improvements would not be justified economically without developing the capability of the river for power generation. In 1924, the governments of the United States and Canada established the Joint Board of Engineers to examine the technical issues raised by the Wotten-Bowden recommendations. Reflecting decades of discussion and a number of board reports, the Corps of Engineers submitted a report in April 1942 entitled "St. Lawrence River Project, Final Report, 1942." This document formed the basis for the ultimate planning and construction of the seaway in the 1950s.

IJC Orders of Approval

In 1952, the IJC issued an Order of Approval for the applications from the governments of Canada and the United States to construct hydropower facilities in the international reach of the St. Lawrence River, which extends from Lake Ontario to Cornwall, Ontario and Massena, New York. The Order gave Ontario Hydro the responsibility to constuct and operate the Canadian portion of the hydropower facilities, while the New York Power Authority was made responsible for the hydropower facilities in the United States. In 1956, during construction of the project, the IJC amended its order

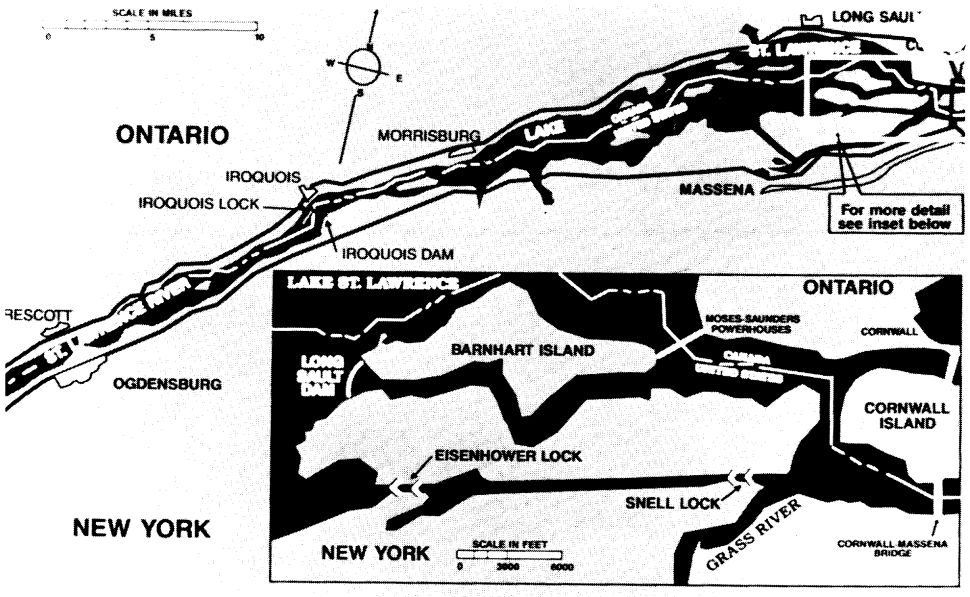

Figure 2. Upper St. Lawrence River Project Area

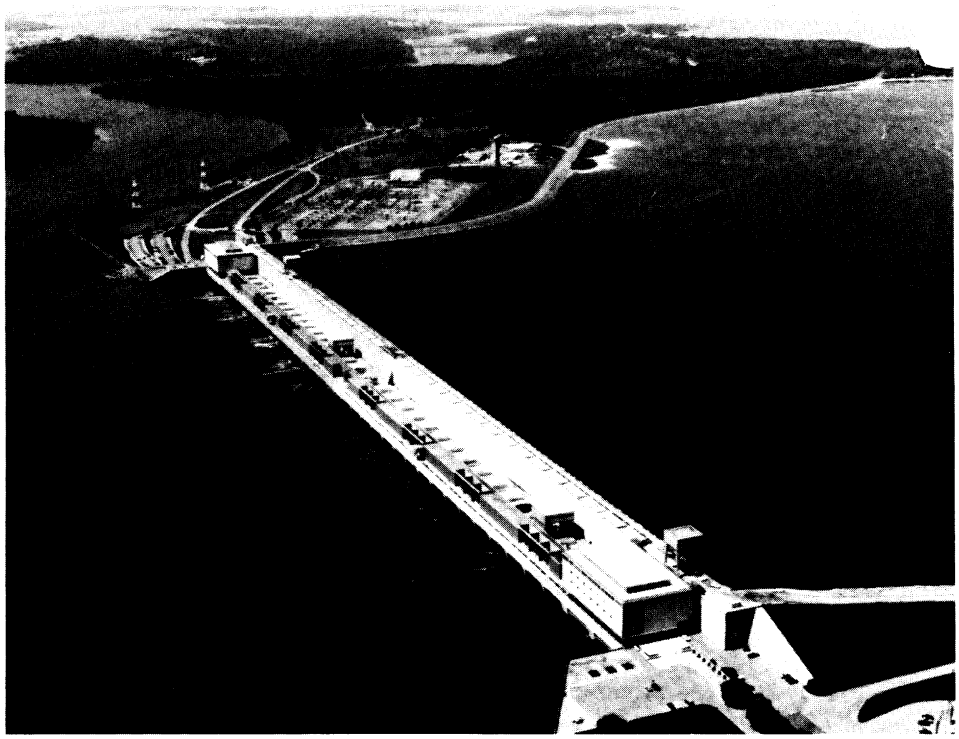

Figure 3. Moses-Saunders Power Dam

to include regulation criteria designed to reduce the range of levels experienced on Lake Ontario, facilitate navigation in the St. Lawrence River, and provide protection for riparian and other interests downstream in the Province of Quebec.

In addition, the order established the International St. Lawrence River Board of Control to ensure compliance with the provisions of the orders by the operators of these works. Upon completion of the project in 1960, the St. Lawrence River Board assumed its duties and is still the operating board today for the regulation of Lake Ontario outflows. Its present eight members are from the Corps of Engineers, Transport Canada, Environment Canada, and five other state, provincial, and local agencies. One of the primary conditions in the IJC Order was that Lake Ontario be regulated within a target range of 242.8 to 246.8 feet. Recognizing that future water supplies to Lake Ontario would at times be higher or lower than those experienced in the past, the IJC included an emergency provision, i.e., Criterion (k). It specifies that, in the event that supplies exceed supplies of the past, the works in the international rapids section should be operated to provide all possible relief to the riparian owners upstream and downstream. However, in the event that supplies less than the supplies of the past occur, the works should be operated to provide all possible relief to navigation and power interests. This criterion has been followed on several occasions to deal with extreme water supplies to Lake Ontario.

Regulatory Facilities

The outflows of Lake Ontario have been regulated since 1960, following completion of the St. Lawrence Seaway and Power Project. The project required extensive river deepening and construction of navigation locks. The Moses-Saunders Power Dam that crosses the St. Lawrence River between Cornwall, Ontario, and Massena, New York, is the principal regulatory structure (Figures 2 and 3). A second dam (Figure 4), located near Long Sault, Ontario, acts as a spillway when outflows from Lake Ontario are larger than the capacity of the power dam. A third structure at Iroquois, Ontario, can also be used to regulate the flow of water, but is used principally to assist in the formation of a stable ice

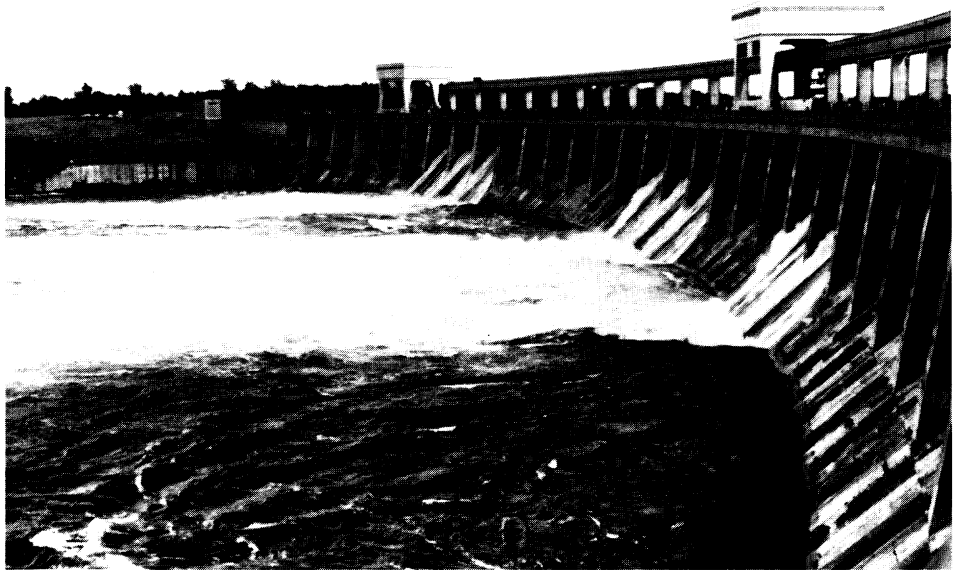

Figure 4. Long Sault Dam

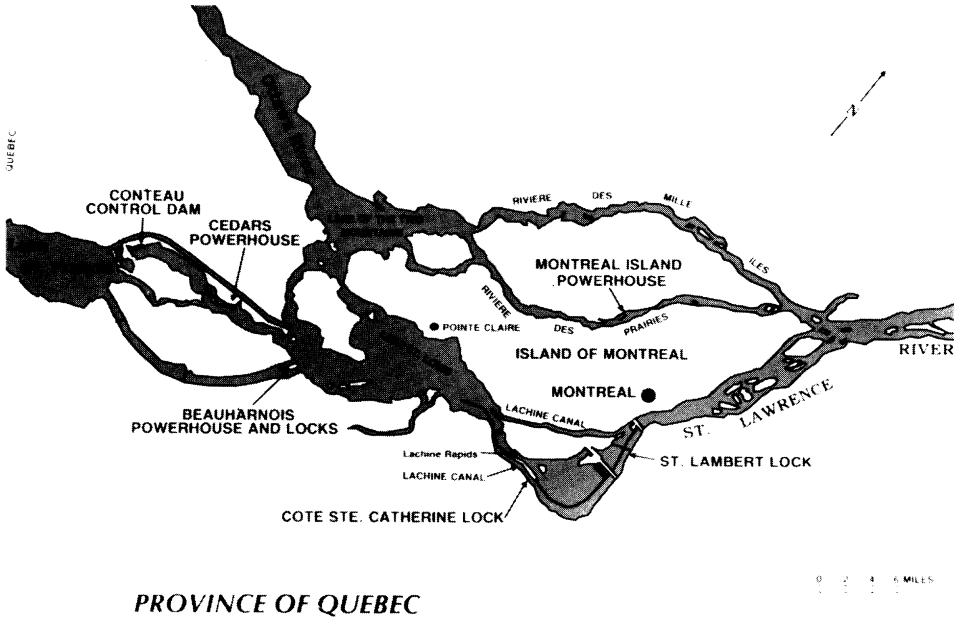

Figure 5. Lower St. Lawrence River

Table 1
Great Lakes Hydrology[1]

PRECIPITATION								
BASIN	SEPTEMBER				YEAR-TO-DATE			
	1991*	AVERAGE**	DIFF.	% OF AVERAGE	1991*	AVERAGE**	DIFF.	% OF AVERAGE
Superior	4.8	3.5	1.3	137	25.2	23.0	2.2	110
Michigan-Huron	2.6	3.5	-0.9	74	23.8	24.0	-0.2	99
Erie	2.0	3.1	-1.1	65	23.0	26.7	-3.7	86
Ontario	2.4	3.2	-0.8	75	25.2	26.0	-0.8	97
Great Lakes	3.1	3.4	-0.3	91	24.2	24.3	-0.1	100

LAKE	SEPTEMBER WATER SUPPLIES***		SEPTEMBER OUTFLOW[3]	
	CFS[2]	AVERAGE[4]	CFS[2]	AVERAGE[4]
Superior	36,000	73,000	68,000	84,000
Michigan-Huron	-115,000***	31,000	186,000[5]	194,000
Erie	-79,000***	-18,000***	201,000[5]	203,000
Ontario	16,000	5,000	253,000	247,000

* Estimated (inches) ** 1900-89 Average (inches)
*** Negative water supply denotes evaporation from lake exceeded runoff from local basin.

1 Values (excluding averages) are based on preliminary computations.
2 Cubic Feet Per Second 3 Does not include diversions 4 1900-89 Average (cfs)
5 Reflects effects of ice/weed retardation in the connecting channels.

For Great Lakes basin technical assistance or information, please contact one of the following Corps of Engineers District Offices:

For NY, PA , and OH:
Colonel John W. Morris
Cdr, Buffalo District
U.S. Army Corps
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1776 Niagara Street
Buffalo, NY 14207-3199
(716) 879-4200

For IL and IN:
LTC Randall R. Inouye
Cdr, Chicago District
U.S. Army Corps
of Engineers
River Center Bldg (6th Flr)
111 N. Canal Street
Chicago, IL 60606
(312) 353-6400

For MI, MN, and WI:
Colonel Richard Kanda
Cdr, Detroit District
U.S. Army Corps
of Engineers
P.O. Box 1027
Detroit, MI 48231-1027
(313) 226-6440 or 6441

cover in the winter, as well as to prevent water levels from rising too high in Lake St. Lawrence which is upstream of the power dam.

The navigation locks in the Canadian portion of the St. Lawrence Seaway are operated by the St. Lawrence Seaway Authority (Figure 5). Locks in the United States are operated by the St. Lawrence Seaway Development Corporation. Similar to the lock facilities on the St. Mary's River, operations of these facilities are federally controlled and not under the supervision of the IJC. Other hydropower and navigation facilities exist downstream of the power dam, in the Province of Quebec.

Lake Ontario Regulation Plans and their Operations

Three plans have been used to regulate the outflows of Lake Ontario. All of these plans were designed to meet the objectives specified in the 1952 Order and the 1956 Supplementary Order of Approval. Plan 1958-D, the present regulation plan, has a family of operating curves for different trends in the water supply conditions for Lake Ontario. If the water supplies to the lake are high, for example, the curve with a higher supply indicator will be used to determine the outflows and vice versa. This was designed to maintain the levels on Lake Ontario within the target range of 242.8 to 246.8 feet.

Plan 1958-D also specifies a number of flow limitations. For example, monthly minimum permissible flows are specified to ensure adequate flows for hydropower production. Also, other limitations are designed to ensure adequate depths in the St. Lawrence River for navigation.

Lake Ontario's outflow is adjusted weekly by the St. Lawrence River Board according to Regulation Plan 1958-D. During winter operations, ice becomes an important factor in regulating Lake Ontario outflows. For a short period at the beginning of the winter, outflows from Lake Ontario are often temporarily reduced to assist in the formation of a stable ice cover at the outlet of Lake St. Francis (at the Beauharnois-Des Cedres hydropower complex upstream of Montreal) and in the international rapids section of the St. Lawrence River upstream of Cornwall, Ontario, and Massena, New York. Ice booms are also located at several sites in the river to help this process. A breakup of the ice cover can cause an ice jam and result in severe

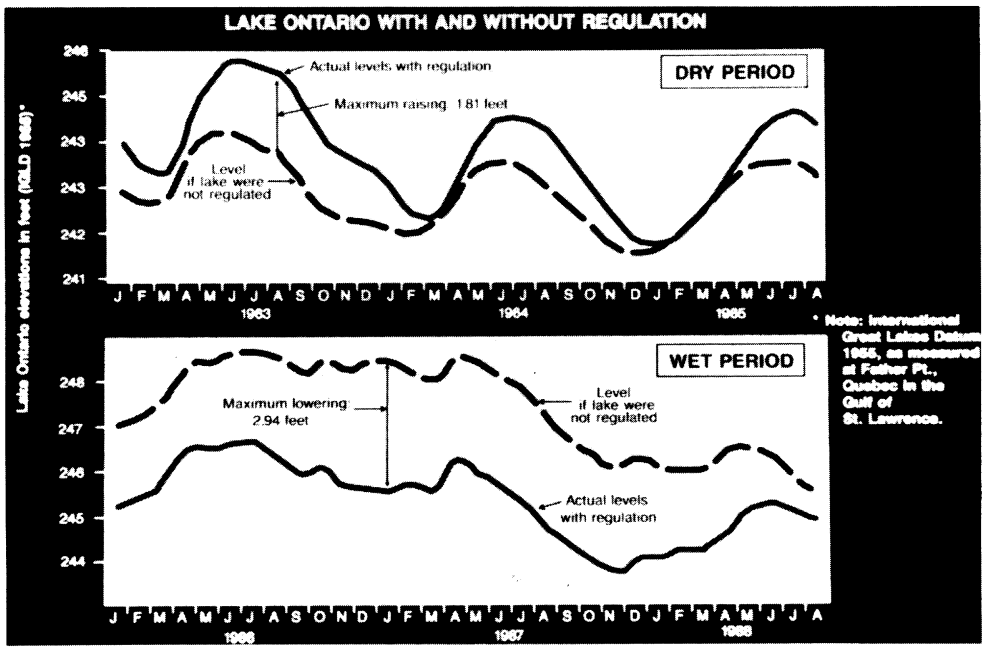


Figure 6. Example of Lake Ontario Regulation Benefits

difficulties in flow regulation and hydropower production. After a stable ice cover is formed, flows in the river are gradually increased to offset any temporary flow reductions.

Operational experience has shown that flooding in the Montreal area by spring runoff from the Ottawa River (a major tributary to the St. Lawrence River) can be reduced by temporary reductions in Lake Ontario outflows. These reductions are later offset following the freshet.

Experience in Lake Ontario Regulation

Lake Ontario regulation does not ensure full control of the levels of the lake, because the major factors affecting the water supply to the Great Lakes, i.e., over-lake precipitation, evaporation, and runoff cannot be controlled, nor can they be accurately predicted over the long term. Further, the fluctuation of Lake Ontario levels cannot affect the upstream lakes due to the presence of Niagara Falls. Nonetheless, since 1960, Lake Ontario regulation has had positive impacts.

During the extreme low water period of the mid-1960s, Lake Ontario levels were maintained slightly higher than they otherwise would have been without regulation (Figure 6). In the early and mid-1970s, when water supplies were critically high, water levels were held to more than a foot below pre-project levels. Despite this action and because of unusually high water supplies, Lake Ontario water levels reached 247.9 feet, well above the 246.8 feet prescribed in the IJC's Order of Approval.

In the winter of 1986-87, the IJC increased Lake Ontario's outflows above those prescribed by Plan 1958-D. This action prevented Lake Ontario from rising to extreme high levels, in spite of continued extreme high inflows to the lake from the upper Great Lakes. The very mild weather and favorable ice conditions in the St. Lawrence River that winter helped to make these high flows possible. During that time, water level conditions in the Montreal area and downstream were monitored closely so as to not aggravate the existing high water conditions.

High flows in the St. Lawrence River have been made possible with the completion of the Seaway and Power Project, but high flows also increase cross currents and water velocity, which in turn can make navigation difficult. At times, these conditions temporarily halt ship traffic.

In the spring of 1989, the board reduced Lake Ontario's outflows, because of a concern that its levels had fallen significantly below its seasonal long-term average. There was also the concern about low levels in the international section of the river. The flow reduction was carried out during the Ottawa River spring runoff, so as to not adversely affect downstream interests. An unexpected heavy spring rainfall, combined with the reduced outflows,

caused the level of Lake Ontario to rise sharply, and thus enabled a return to plan flows earlier than anticipated.

During December 21, 1990 through April 5, 1991, the board increased the Lake Ontario outflows above the Plan flows in response to high water supplies. The board also took prompt action to underdischarge during April 6 through May 3, 1991 to protect the downstream interests in the vicinity of Montreal at the time of Ottawa River freshet. Throughout the summer, the board modified the outflows with the intent of maintaining adequate depths for the recreation boaters.

As a result of conditions which occurred during the summer of 1987 on Lake Ontario and St. Lawrence River, further studies to improve Lake Ontario regulation have been undertaken. The inclusion of interests not specifically considered in the development of Plan 1958-D are being evaluated, including recreational boating and environmental concerns. These investigations are now included as a part of the ongoing efforts of the IJC's Levels Reference Study Board. A future Update Letter will provide an article on the Plan 1958-D improvement studies.

Based on the comparison of preproject and actual levels of Lake Ontario, it can be concluded that regulation of the lake has provided benefits to riparians along the shoreline of the lake, as well as the the river by compressing the range of water level fluctuations. It has also assisted hydropower production and dependable navigation.

IJC Board's Public Involvement

The International Niagara Board of Control held its meeting with the public on September 12, 1991, in Fort Erie, Ontario. The meeting was attended by 30 members from the public and local and federal agencies from the U.S. and Canada. The IJC Commissioners, R. Welch and R. Goodwin, also attended this meeting. Following brief presentations by the board, there were questions and discussions by the public which covered a wide spectrum of issues related to the Great Lakes and Niagara River.

The International Lake Superior Board of Control held an open house in Sault St. Marie, Ontario. The open house was held between 7-10 p.m. and was attended by 40 members of the public, as well as some representatives of local, state, and federal agencies from the U.S. and Canada. The board members and its associates discussed issues and concerns of the public in an informal atmosphere. The public viewed the excellent display boards provided by the Detroit District, U.S. Army Corps of Engineers and Environment Canada. The public also received several brochures related to the regulation of Lake Superior and Great Lakes in general.

Brigadier General Patin dedicated a large permanent display at the U.S. Army Corps of Engineers' Soo Visitors Center, located at the Soo Locks on September 17, 1991. This display portrays and depicts the Corps' support of IJC activities.

The three IJC boards plan to hold their next series of public meetings in the United States. The dates and meeting places will be announced in future Update Letters.

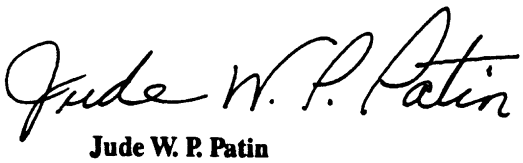
Hydrological Atlas

The Ohio Department of Natural Resources has released a new publication entitled "Hydrological Atlas for Ohio." This atlas shows the average annual precipitation, temperature, streamflow, and maps indicating the variations of hydrologic elements. The atlas cost is $6.54, including tax and postage. It can be ordered from the following:

ODNR Publication Center
4383 Fountain Square Drive
Building B-1
Columbus, Ohio 43224-1362

IJC Levels Reference Study

The Levels Reference Study Board will report on its activities to the IJC on October 24, 1991. A workshop on initial screening of measures will be conducted by the Working Committee (Principles, Measures Evaluation, Integration, and Implementation) in Ottawa, Ontario, on October 23, 1991.



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