Appendix to the Progress Reports
to the
International Joint Commission
by the

International Lake Ontario - St. Lawrence River Board

Covering the periods after
January 2017

APPENDIX OBJECTIVE

The objective of this appendix is to provide the background material that was previously presented in the semi-annual reports of the former International St. Lawrence River Board of Control to the International Joint Commission (IJC). Providing the material in this manner allows the semi-annual report to focus on the issues and conditions of the reporting period, and the interested reader to refer to this appendix for the background information.

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1 HYDROLOGICAL CONDITIONS

1.1... LAKE ONTARIO BASIN - NET BASIN SUPPLY

Lake Ontario is the furthest downstream of the five Great Lakes. It receives the outflow of lakes Superior, Michigan, Huron and Erie (Figure A-1). Historically, on average 85 percent of the water received by Lake Ontario comes from the upstream Great Lakes. Lake Ontario outflows are controlled at a location about 160 kilometres (100 miles) from the lake (Figure A-2), with almost all of the water going through the Moses-Saunders powerhouse. Prior to construction of the powerhouse and navigation locks (Figure A-3), the flow out of Lake Ontario was naturally controlled by a set of rapids that began about 110 kilometres (70 miles) downstream of the Lake, downstream of the towns of Ogdensburg, New York and Prescott, Ontario.

Water supply to Lake Ontario is composed of four main factors (Figure A-4): inflow from Lake Erie through the Niagara River and Welland Canal diversion, precipitation on the surface of the lake, runoff from streams and groundwater flowing into the lake, and evaporation of water from the lake. In addition, water for consumptive use is taken from the lake.

In the semi-annual progress reports, supplies to Lake Ontario are reported in terms of net basin supplies and net total supplies. The definitions of these terms are as follows:

> The net basin supply is the aggregate of the amount of precipitation over the lake, runoff to the lake, including groundwater, and evaporation and consumptive uses from the lake. Precipitation and runoff are estimated by measurements but it is not possible to accurately measure evaporation and consumptive uses. Therefore, the net basin supply is estimated as the difference between the lake's outflow down the St. Lawrence River and inflow from Lake Erie, plus any change in storage within the lake itself as a result of a rise or fall in the lake's level. . An indicator of the amount of spring runoff that may be expected is obtained by monitoring the snow pack in the basin.
>
> The net total supply is obtained by adding to the net basin supply the inflows from Lake Erie through the Niagara River and Welland Canal. The Niagara River flow is computed using a stage-discharge relationship for the Niagara River below Niagara Falls and adding the flow through the hydropower turbines located along the Niagara River.

A summary of the mean supplies to Lake Ontario for each month in the reporting period is provided in tabular and graphical form as referenced in the text of Section 1. This information

includes the inflow from Lake Erie, net basin supply and total supplies, along with some statistical data to assist in understanding how they compare historically.

Also shown graphically are the long-term average monthly net basin supplies and supplies for the previous two years. The horizontal bars above and below the plots are the recorded maximum and minimum long-term monthly net basin supplies for the period of record since 1900.

1.2... PRECIPITATION

Monthly precipitation amounts for the Lake Ontario and Great Lakes basins for each reporting period of the semi-annual reports are provided in a table referenced in Section 1 of the report.

The snow-pack (included in the precipitation values) on the Lake Ontario basin affects spring runoff supplies when the snow melts. owever, because of the often lower volume than the volume of inflow from Lake Erie, limited snow-pack data and lack of skill in predicting melt conditions, the volumes of snowmelt runoff are difficult to quantify and correlate to spring water levels in Lake Ontario and the St. Lawrence River. . The contribution of snowmelt to the spring freshet of the Ottawa River is better quantified.

1.3... SUPPLIES FROM LAKE ERIE

On average, the majority of water entering Lake Ontario comes from Lake Erie through the Niagara River and the Welland Canal. . A Table referenced in Section 1 of the report gives the monthly average inflows from Lake Erie, the exceedance probability and the percent of the long-term average based on recorded supplies from Lake Erie since 1900.

1.4... LAKE ONTARIO – NET TOTAL SUPPLY

The monthly net total supplies (NTS) to Lake Ontario for each reporting period of the semi-annual reports are provided in tabular form (Table 1) and graphical form (Figure 1) showing the long-term average monthly NTS for the period of record and the supplies for the current reporting period. Also shown, for comparison purposes, are the monthly NTS for the previous two years. The horizontal bars above and below the curves on the graph are the long-term monthly net total supplies maxima and minima for the period of record since 1900.

1.5... OTTAWA RIVER BASIN

The Ottawa River is a major tributary of the St Lawrence River joining just upstream of Montreal which contributes to the water level of Lake St Louis at Pointe Claire and points downstream in the St. Lawrence River. In the semi-annual reports which show the flows of the Ottawa River,

the figures show the previous two years for comparison and quarter monthly average, maxima and minima values since 1963.

2 REGULATORY OPERATIONS

The International Lake Ontario – St. Lawrence River Board (the Board) assures that the provisions of the Order of Approval of the International Joint Commission (IJC) relating to Lake Ontario-St. Lawrence River outflows and levels are met. Control of the outflows and levels of Lake Ontario follows a regulation plan that was designed to satisfy the criteria set out in the IJC's 8 December 2016 Order and other requirements that were established to balance the benefits of regulation among various interests. On 8 December 2016, the U.S. and Canadian governments requested the implementation of the current plan of regulation, Regulation Plan 2014, in 2017.

The updated order and plan replace the 1952 and 1956 Orders and Plan 1958-D. Plan 2014, when water supplies permit, continues to protect shoreline property and provides net economic benefits, but also includes measures to improve ecosystem health and diversity on Lake Ontario and the upper St. Lawrence River. The plan retains, essentially unchanged, the environmental conditions and coastal protections on the lower St. Lawrence River, below the Moses-Saunders Dam. . Allowing for more natural variations of water levels, the plan aims to foster the conditions needed to restore Lake Ontario and upper St. Lawrence River coastal wetlands and improve habitat for fish and wildlife. The plan will also frequently extend the Lake Ontario recreational boating season in the fall, better maintain system-wide levels for navigation and allow for a modest increase in hydropower production compared to the previous plan.

Plan 2014 sets weekly discharges for the St. Lawrence River through the flow control structures of the Moses-Saunders hydro-electric plant located at Cornwall-Massena, which are designed to handle a broader range of water supply situations than the previous release rules (Plan 1958-D). In most instances, it will be important to release flows as determined by the release rules in order to realize its expected benefits. Therefore, the Board anticipates fewer, more limited instances where flow releases would differ from those of the release rules than was the case with Plan 1958-D. . These differences are described as operational adjustments, as well as minor, major, and emergency deviations as described further below.

The outflow from Lake Ontario is computed at least weekly by following the procedures laid out in the IJC Supplementary Order of December 2016 for the Regulation Plan 2014. The computational

procedures include the following steps (the reader is referred to the website http://www.ijc.org/en_/islrbc/Orders_of_Approval for additional details and considerations):

- Calculation of a provisional flow based on present and forecast conditions in the system (e.g., recent supplies, current/computed levels, and forecast supplies);
- Checking the provisional outflow against operational limits designed to protect interests; and,
- Setting a final 'Plan' outflow.

The Plan outflow is then reviewed by the Board's regulation representatives and operations advisory group (OAG), and assessed in consideration of the current operational requirements of domestic water supply, navigation, power and other interests in the system and against the Board's current deviation strategy, when applicable. If all are in agreement, the regulation representatives, on behalf of the Board, direct the hydropower entities (who operate the structures that control the outflows) on what outflow to pass for the coming week. If not all OAG members and regulation representatives agree on the flow for the coming week, the Board is called upon to decide.

A major difference between Plan 2014 and the previous plan is the incorporation of operational adjustments to the flows for ice management, downstream flooding balance, and to maintain adequate levels in the Seaway. . Previously these adjustments would have been considered deviations and would have required compensating over- or under-discharges to pay back the deviations. . Under Plan 2014, the adjustments become plan-specified flows.
The Directive on Operational Adjustments, Deviations and Extreme Conditions also considers the three cases below when the Board may set outflows other than those specified in the Plan.

1. To respond to short-term needs on the St. Lawrence River, the Commission will allow the Board to make minor discretionary deviations from the approved regulation plan, which have no appreciable effect on Lake Ontario levels. Minor deviations are made to provide beneficial effects or relief from adverse effects to an interest, when this can be done without appreciable adverse effects to other interests and is consistent with the requirements of the Order of Approval. Unlike flow adjustments made to maintain the intent of the plan, minor deviations from the plan require accounting and flow restoration.

Minor deviations, while not necessarily limited to only these situations, could include those to address contingencies such as:

- short-term flow capacity limitations due to hydropower unit maintenance;
- assistance to commercial vessels on the river due to unanticipated low water levels;
- assistance, when appropriate, with recreational boat haul-out on Lake St. Lawrence or Lake St. Louis at the beginning or at the end of the boating season; and,
- unexpected ice problems on the St. Lawrence River downstream of Montreal.

These deviations will affect levels on Lake St. Lawrence and the St. Lawrence River downstream to Montreal, but due to the relatively small volume of water involved, such deviations would have a very minor effect on Lake Ontario levels and the river upstream of Cardinal, ON.

2. Major deviations are significant departures from the approved regulation plan that are made in response to extreme high or low levels of Lake Ontario in accordance with criterion H14 of the revised Order of Approval and are expected to significantly alter the level of Lake Ontario compared to the level that would occur by following the approved regulation plan. Although the approved regulation plan was developed to perform under a wide range of hydrological conditions and with the experience gained in five decades of regulation operations, extreme high or low Lake Ontario water levels could require major deviations from the plan. . As the extreme event ends, the Board shall develop for Commission approval a strategy to return to plan flows and recommendations as to whether or not equivalent offsetting deviations from the plan flow should be made, as appropriate on a case-by-case basis.

3. Emergency situations are considered to be those that threaten the physical integrity of the water management system and that may lead to a loss of the ability to control the flows in the system, or unusual life-threatening situations. Examples could include the failure of a lock gate, flooding of the hydropower control works, failure of a spillway gate, dike failure, a regional power outage, or other such active or imminent incidents. Such incidents arise only on extremely rare occasions. . The Board will determine the need to make subsequent equivalent offsetting deviations from the plan flow, as appropriate, on a case-by-case basis.

2.1....REGULATION OVERVIEW

Each semi-annual report describes the outflow strategies of the Board in response to the water supply conditions of that reporting period. . Tables referenced in Section 2 of the semi-annual

reports show in tabular form the outflow changes, including operational adjustments and minor deviations, and comparisons with pre-project water levels and flows. . The technical staff of the Board have computed weekly what the water level of Lake Ontario and subsequent outflow would have been according to the natural water level – outflow relationship since regulation began. . This water level and flow are the preproject level and outflow. . A figure referenced in Section 2 of the semi-annual reports shows graphically the daily outflow from Lake Ontario in comparison to the previous two years, the long-term average and the monthly maxima and minima since 1900. . Also a figure compares the actual daily outflows to the weekly plan specified outflows and preproject flows and the daily long-term average since 1900. . This figure also compares monthly outflow maxima and minima since 1900.

2.2... DEVIATIONS FROM REGULATION PLAN 2014

When undertaking any of the above three defined exceptions to Plan 2014 flows, In order to be responsive to changing conditions and the needs of various interests, the Board holds teleconferences to review conditions in the Great Lakes-St. Lawrence River system and develop deviation strategies to respond to conditions and ensure that the Board is able to offer assistance to interests in times of critical need. The deviations are designed to enhance the benefits provided by Regulation Plan 2014 while not causing appreciable adverse effects to any interest. The Board members are provided an assessment of conditions at the beginning of each month. The conditions and regulation outcomes are reported to the IJC semi-annually and are published on the Board's Website: https://ijc.org/en/loslrb/library/reports or during exceptional circumstances when time is critical, directly in media releases, which are also posted on its website: https://ijc.org/en/loslrb/news/releases..

Figures referenced in Section 2 of each semi-annual report show the daily Lake Ontario outflows during the reporting period, and the Lake Ontario actual daily and weekly computed Plan 2014 and preproject condition levels (that is, the levels that would have occurred had regulation not been undertaken) during the reporting period. The operational adjustments and the Board's deviations from Plan 2014, if any, during the reporting period are summarized in tabular form as referenced in this section. Daily water levels of Lake Ontario and of the St. Lawrence River in selected reaches are also described in the semi-annual reports in Section 2 where it may reference tables and figures.

This section of the semi-annual reports for the winter season also describes ice management. The hydropower entities install a series of ice booms each winter in the international section of the river to aid in the formation and stabilization of the ice cover. Hydro Quebec also installs a series of ice booms in the Beauharnois Canal each year. The Board does not direct the installation or removal of any of these booms. Installation and removal of the booms is coordinated between the hydropower entities and the St. Lawrence Seaway. The booms are normally removed as the ice deteriorates locally. The “I” limits within Plan 2014 are designed to manage flows to promote the formation of a stable ice cover in both the Beauharnois Canal and the upper St. Lawrence River. . Given the unpredictability of ice formation conditions within the week, operational adjustments in Plan 2014 are often required for ice management, as lower flows assist in the formation of a stable ice cover, and sometimes higher flows are required to manage the development of the ice cover.

2.3... WATER LEVELS THROUGHOUT THE SYSTEM

The effects of inflow conditions moderated by regulation plans and the Board’s deviation strategies on the daily water levels on Lake Ontario for the previous two years and the current year to date are shown in a figure in Section 2 of each of the semi-annual reports, compared to the long-term average starting in 1918. As a means of informing the IJC on the impacts of regulation activities on levels and outflows, the Board provides the IJC with a comparison of Lake Ontario’s actual monthly levels and outflows to those that would have been obtained under preproject conditions. A summary of this comparison for the reporting period is provided in a table referenced in this section of the report. The referenced figure provides a comparison of the daily levels to long-term average, and the levels of the previous two years.

Figures show the daily water levels graphically for selected reaches of interest in the St. Lawrence River are also referenced in this section. .

- The period of record for Lake St. Lawrence at Long Sault begins in 1960 after the construction of the Seaway and the Moses-Saunders Dam created the lake. The lake acts as a forebay to the Moses-Saunders Dam. Often its water levels decline when high outflows pass through the power plant and rise when low outflows are passed.
- The regulation of Lake Ontario outflows has a limited effect on the levels of Lake St. Francis, as the lake level is regulated by hydropower plant operations at Beauharnois and Les Cèdres, Québec. The historic range of monthly mean levels on Lake St. Francis since completion of the Moses-Saunders project is about one-fifth that of Lake St.

Lawrence. The period of record for the water level gauge on this lake at Summerstown is from 1960, after the construction of the Moses-Saunders power plant.

- Water levels measured on Lake St. Louis at Point Claire, in contrast, are influenced by the discharges from both the St. Lawrence and Ottawa Rivers, and are subject to much greater fluctuations. . The period of record for this water level gauge is also from 1960 as the LaSalle outlet was affected by the construction of the Seaway through the south shore canal.
- Water level fluctuations in Montreal Harbour are influenced by the discharges from the St. Lawrence and Ottawa rivers, winds, the tide, and in winter, by downstream ice conditions. The period of record for this water level gauge begins in 1967. . Water level data prior to 1967 are not used to compute the averages or extremes as the St. Lawrence River channel near and below Montreal was altered by river modifications in 1967.

2.4... IROQUOIS DAM OPERATIONS

The Board approves the gate settings at the Iroquois Dam operated by the power entities under the conditions of the Flow Regulation paragraph of the IJC's Directive dated 8 December 2016. The gates of the dam can be lowered partially into the water to assist in ice formation and to reduce the level of Lake St. Lawrence when there are low outflows. Boaters must use the Iroquois lock to bypass the dam when the dam gates are in use.

2.5... LONG SAULT DAM OPERATIONS

The spillway for the Moses-Saunders Dam is located at the south-west edge of Barnhart Island, NY (Figure A-3). . The New York Power Authority operates the 30 spillway gates of the Long Sault Dam which release discharge into an ecologically sensitive south channel of the St. Lawrence River. . They open as many gates as necessary to meet the Board's outflow requirements when the desired outflow is in excess of the turbine capacity of the dam, whether the excess is due to high specified outflows or turbine maintenance at either the Canadian or American side of the Moses-Saunders power plant. The semi-annual report mentions the duration the power entities opened any gates and the reason.

2.6... RAISIN RIVER DIVERSION

The Raisin River diversion from the St. Lawrence River is located at the village of Long Sault, ON. It is operated by the Raisin Region Conservation Authority to augment flow in the upper reaches of this small river, as necessary. The purpose of this diversion is to augment low

summer flows in the Raisin River and to improve the environment for fish and wildlife, as well as recreational uses. The semi-annual report mentions the duration and flow rate of the diversion.

2.7... ST. LAWRENCE SEAWAY REPORT

The St. Lawrence Seaway operates autonomously from the Board. Each semi-annual report records the first or last ship of the recording period, as well as any significant Seaway operations or initiatives over the past six months.

2.8... HYDROPOWER PEAKING AND PONDING

By letter dated 13 October 1983, the IJC authorized OPG and NYPA to continue to carry out peaking and ponding operations at the St. Lawrence Project. Peaking refers to the common hydro-electric practice of lowering water flows through a hydro-power plant during hours of low electrical demand, typically at night, so that flows may be increased during hours of high demand, while still keeping the total daily flow the same as though a constant flow had passed through the turbines during the 24 hours. Ponding is the practice of lowering flows through a hydro-power plant on days of low demand, typically weekends, so that flows may be increased on days of high demand, while still keeping the total weekly flow the same as though a constant flow had passed through the turbines during the seven days.

The conditions governing peaking and ponding operations were specified in Addendum No. 3 to the Operational Guides for Regulation Plan 1958-D. On 4 November 2016, the IJC renewed the approval for a 5-year period, dated 1 December 2016 to 30 November 2021, continuing under the operation of Plan 2014.

The semi-annual reports record updates to the authorization and peaking and ponding activities which occurred during the reporting period.

3 BOARD ACTIVITIES

3.1... BOARD MEETINGS & CONFERENCE CALLS

The Board, as mentioned in the previous section, oversees the operations of the hydropower project in the international reach of the St. Lawrence River in accordance with the IJC's 8 December 2016 Order of Approval and Directives. The Board, primarily through the offices of the regulation representatives, monitors conditions throughout the Lake Ontario-St. Lawrence River and Ottawa River systems. The regulation representatives provide the Board with weekly regulation data, monthly reviews of hydrological conditions, weekly water level and outflow outlooks and advise the Board on deviation strategy options and their potential impacts on water

levels and interests throughout the system, when required. During extreme events, the regulation representatives may provide this information daily. The Board's operations advisory group (OAG) holds weekly teleconferences to apprise the regulation representatives of operational requirements and constraints. The committee on river gauging monitors the power entities' program for operation and maintenance of the gauging system required for Board operations, and reports to the Board annually.

The Board typically reviews conditions in the basin on a monthly basis and may determine if deviations from the plan are needed through meetings, conference calls, telephone and e-mail. Should conditions warrant , the Board can (and has) met more often. Board members in attendance at these meetings and teleconferences are noted in a table referenced in Section 3.

3.2... BOARD AND COMMITTEE MEMBERSHIP CHANGES

Each semi-annual report records any changes to membership of the Board, its regulation representatives, secretaries, gauging committee, and operations advisory group.

3.3... COMMUNICATIONS, OUTREACH AND ENGAGEMENT

A significant mandate of the 2016 Order of Approval is for the Board to communicate water conditions to the stakeholders and conduct public outreach on its regulation activities. The Board members and associates present on topics related to the Board when invited, post regularly on its Facebook page, https://www.facebook.com/InternationalLakeOntarioStLawrenceRiverBoard, and add photos to its Flickr page, https://www.flickr.com/photos/ijc_islrbc as well as providing regulation data, learning modules and FAQs on its website: https://ijc.org/en/loslrb. The Communications Committee, individual Board members and the secretaries actively engage in outreach, information exchange and liaison with stakeholders throughout the Lake Ontario-St. Lawrence River system. Board members and staff respond to inquiries and requests for interviews from the media and general public concerning water level conditions and the Board's operations. The semi-annual reports to the IJC reference appendices in this Section and describe activities in detail related to public stakeholder outreach.

The Board's experience demonstrates that communications with those affected by water levels and flows have become ever more important to the Board and IJC. Therefore, effective public and stakeholder communications remains a key focus of the Board. Each semi-annual report summarizes the Board's communications activities during the reporting period. To lead this effort, the Board has a standing committee (the Communications Committee), consisting of

three Board members, the Board secretaries, the regulation representatives, Great Lakes-St. Lawrence River Adaptive Management leaders, and advisors of the IJC.

3.4... GAUGING COMMITTEE

The Board granted authority under the 2016 Supplementary Orders of Approval for Regulation of Lake Ontario, specifically Conditions G and J, to its St. Lawrence Committee on River Gauging to ensure that water level measurements in the international section of the St. Lawrence River are complete, readily available, accurate, and properly archived. The Gauging Committee inspects the computational methods employed at each of the eight outflow structures. Additionally, the Committee oversees an annual field inspection of 16 water level gauges used by the Board to monitor river conditions, including the water levels and flows related to the operation of structures and forebay elevations. The Gauging Committee also conducts annual audits of water level data collected and archived by the power entities. The Gauging Committee prepares an annual report to the Board outlining the activities undertaken by the Committee.

The committee members are representatives from the U.S. regulation representative office (U.S. Co-chair), Ontario Power Generation (Canadian Co-chair), the New York Power Authority and the Canadian regulation representative office. Committee associates perform annual inspections of the water level gaging network.

The Committee thus ensures the accuracy of flow and water level estimates. This includes annual inspections of the computational methods used at each of the eight outflow structures as well as auditing the power entities' data processing. The committee is charged with providing the Board with an annual report on the inspection results and computed outflows. Each semi-annual report records the status of the Gauging Committee annual reports and any recent issues or scheduled activities.

4 ADAPTIVE MANAGEMENT COMMITTEE

The Great Lakes - St. Lawrence River Adaptive Management (GLAM) Committee of technical experts, was established by the IJC to in 2015 to consider adaptive management methods under the authority of the three IJC Boards in the Great Lakes. The committee continually evaluates regulation plans, verifying the predictions and models of past studies, in order to implement their science-based recommendations and develop new ones. Detailed reports of GLAM activities can be found on the GLAM Committee's website.

Since the Board seeks to continually evaluate regulation plan performance over time with regard to a broad range of environmental and economic indicators, the semi-annual reports describe the efforts, activities and conclusions of any GLAM Committee studies related to Lake Ontario and the St. Lawrence River system.

5 ABBREVIATIONS AND TERMS USED IN THE REPORT

actual (data)	the actual recorded value
avg	average
Board	International Lake Ontario - St. Lawrence River Board (unless otherwise specified)
cfs	cubic feet per second
cm	centimetre(s)
cms	cubic metres per second
computed level, outflow	the level or outflow computed by Regulation Plan 2014
deviation (outflow)	a Lake Ontario outflow different from the Plan 2014 outflow
exceedance probability	the percent of time that the value was exceeded in the past
ft	foot/feet
GLAM `	Great Lakes-St. Lawrence River Adaptive Management Committee
IGLD	International Great Lakes Datum
IJC	International Joint Commission
ILO-SLRB	International Lake Ontario - St. Lawrence River Board
in	inch(es)
lake	Lake Ontario (unless otherwise specified)
level	water level
LTA	long-term average
m	metres
m^3/s	cubic metres per second
mm	millimetres
NYPA	New York Power Authority
OAG	the Board's operations advisory group
operational adjustment	an outflow change to meet the applicable limit of Plan 2014 under changing within-the-week hydrologic or ice conditions
OPG	Ontario Power Generation
Peaking	variations in the hourly flows over the course of a day
Plan	Regulation Plan 2014
Ponding	variation in the day-to-day flows over the course of a week

preproject	the levels and outflows that would have occurred had the project not been constructed and regulation not been undertaken
regulation	management of flows in the Lake Ontario-St. Lawrence River system by physical control of outflows from Lake Ontario
Regulation Plan 2014	current plan of regulation for Lake Ontario
Seaway	the St. Lawrence Seaway (commercial navigation corporations or project)
Study Board	International Lake Ontario-St. Lawrence River Study Board
supply	quantity of water received
tcfs	thousand cubic feet per second

Figure A-1. Great Lakes Drainage Basin - St. Lawrence River system

Figure A-2. Map of Lake Ontario-St. Lawrence River system

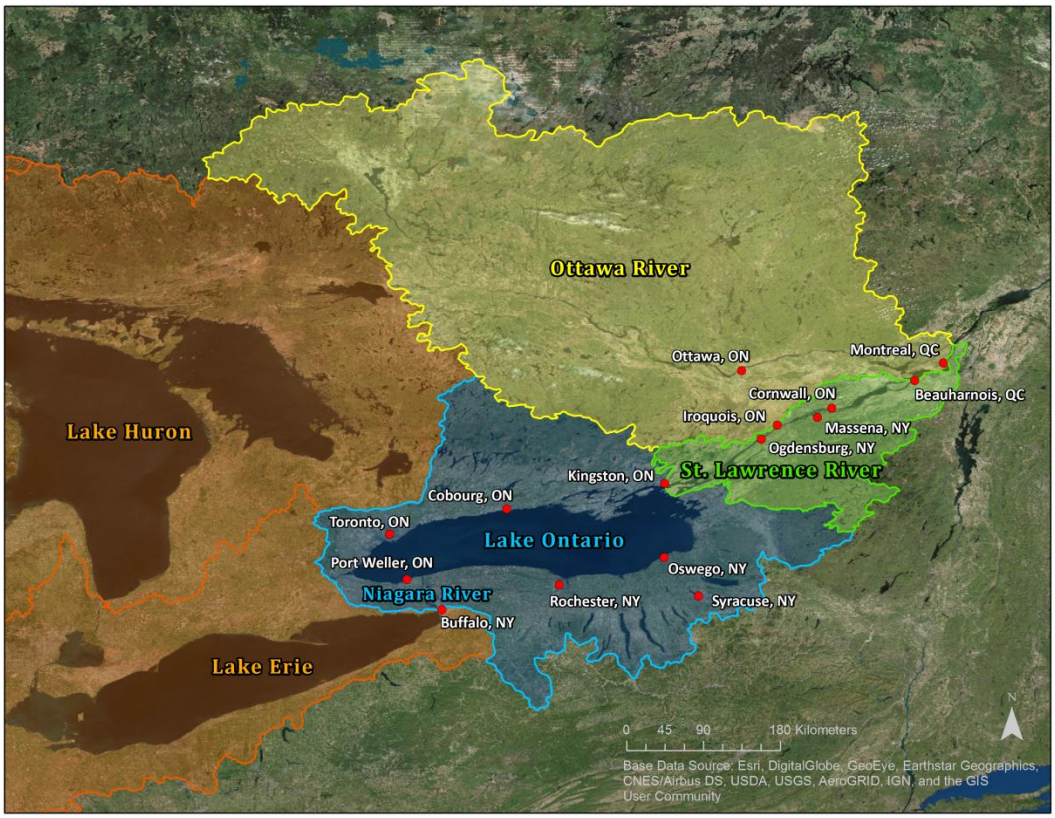

Figure A-3. Map of Upper St. Lawrence River control structures

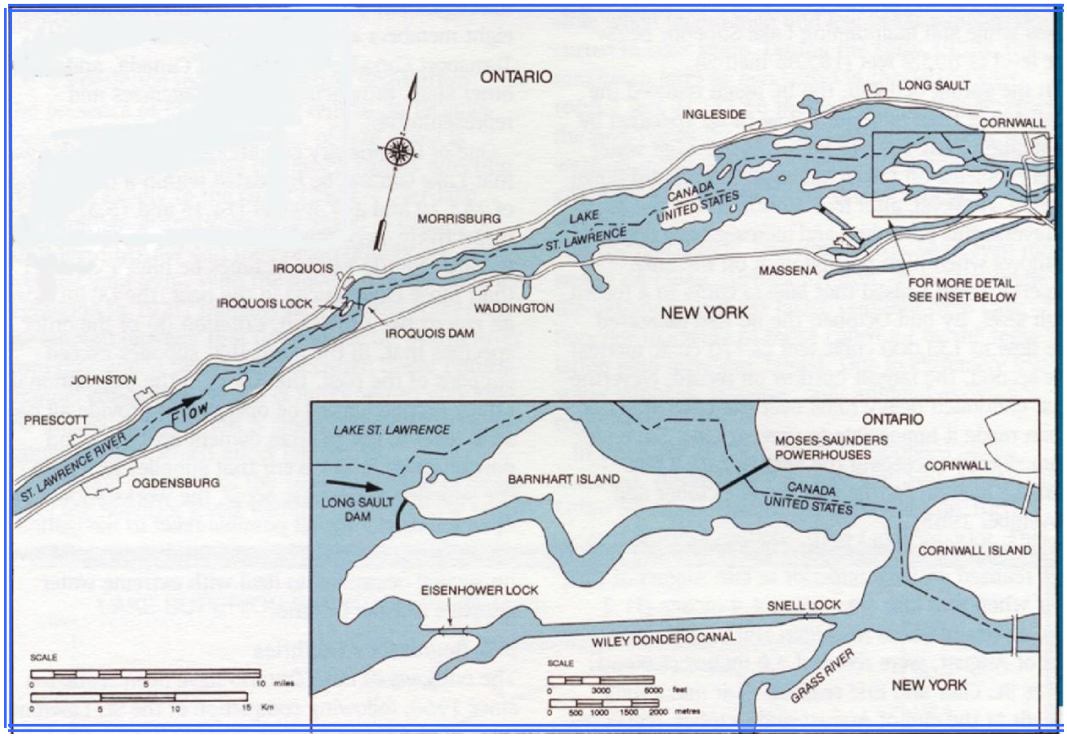

Figure A-3. Factors influencing level of Lake Ontario