International Niagara Board of Control

One Hundred Twenty Ninth Semi-Annual Progress Report

to the

International Joint Commission

Covering the Period March 3 through September 21, 2017

Executive Summary

Lake Erie began the reporting period with a March mean level 41 cm (16.1 inches) above its 1918–2016 period-of-record, long-term average level for the month. The level of Lake Erie remained above average on a monthly basis throughout the reporting period. The August mean water level was 45 cm (17.7 inches) above average (Section 2).

The level of the Chippawa–Grass Island Pool is regulated under the International Niagara Board of Control's 1993 Directive. The Power Entities (Ontario Power Generation and the New York Power Authority) were able to comply with the Board's Directive at all times during the reporting period. (Section 3).

Gauges were operating at all times during this reporting period to provide a flow measurement over the Falls. Plans for remediation work at the Ashland Avenue gauge were finalized during this reporting period and construction is planned for the fall of 2017. Preliminary investigation into finding alternate methods of estimating Falls flow was initiated in this reporting period. (Section 4).

Flow over Niagara Falls met or exceeded minimum Treaty requirements at all times during the reporting period (Section 5).

Flow measurements were taken May 8-12, 2017 to verify the American Falls rating equation. The next scheduled series of measurements are planned for 2018 in the Upper Niagara River and the Welland Canal (Section 8).

As part of OPG's SAB1 rehabilitation program, the upgrades of G3, G7, and G9 have been completed, with new unit rating tables issued for G7 and G9 during previous reporting periods. The new rating table for G3 was put into service March 8, 2017. Unit G10 returned to service on June 9, 2017 and testing to establish a new unit rating table has been scheduled for November/December 2017 (Section 9).

As with the previous winter, solid ice formation did not occur during the winter of 2016/2017. On February 28, 2017, the INWC decided to remove the ice boom and a media advisory was issued by the Board on March 6, 2017. Ice boom removal began by NYPA on March 6, 2017. All spans were moved to their summer storage facility by March 28, 2017, ending the 2016–2017 ice boom season (Section 10).

The Board held an outreach event with the public at the Erie County Fair from August 9-20, 2017 in the Niagara area (Section 12).

There were no changes or reappointments to the Board membership during this reporting period. The U.S. section member is currently vacant and efforts are being made to fill the position. (Section 13).

COVER: View of the INBC booth at the Erie County Fair.
(Photos by Frank Seglenieks and Aaron Thompson, Environment and Climate Change Canada)

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Note that only data available at the time of writing this report is included. Data that was not available during the last reporting period may also be included in this report.

<u>INTERNET SITES</u>

International Joint Commission
www.ijc.org

International Niagara Board of Control
English: ijc.org/en_/inbc
French: ijc.org/fr_/inbc

Lake Erie-Niagara River Ice Boom
www.iceboom.nypa.gov

INTERNATIONAL NIAGARA BOARD OF CONTROL

Cincinnati, Ohio
Burlington, Ontario

September 21, 2017

International Joint Commission
Washington, D.C.
Ottawa, Ontario

Commissioners:

1. General

The International Niagara Board of Control (Board) was established by the International Joint Commission (IJC) in 1953. The Board provides advice to the IJC on matters related to the IJC's responsibilities for water levels and flows in the Niagara River. The Board's main duties are 1) to ensure the operation of the Chippawa-Grass Island Pool (CGIP) upstream of Niagara Falls within the limits of the Board's 1993 Directive, and 2) to oversee the operation of the Lake Erie-Niagara River Ice Boom at the outlet of Lake Erie. The Board also collaborates with the International Niagara Committee (INC), a body created by the 1950 Niagara Diversion Treaty to determine the amount of water available for Niagara Falls and hydroelectric power generation.

The Board is required to submit written reports to the IJC at its semi-annual meetings in the spring and fall of each year. In accordance with this requirement, the Board herewith submits its One Hundred Twenty Ninth Semi-Annual Progress Report, covering the reporting period March 3, 2017 to September 21, 2017.

All elevations in this report are referenced to the International Great Lakes Datum 1985 (IGLD 1985). Values provided are expressed in metric units, with approximate customary units (in parentheses) for information purposes only. Monthly Lake Erie water levels are calculated from four gauges established by the Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data to provide the average level of the lake.

2. Basin Conditions

The level of Lake Erie was above average throughout the reporting period. It began the reporting period with a March mean level at 41 cm (16.1 inches) above its 1918–2016 period-of-record, long-term average level for the month. Lake Erie's water level went through its seasonal rise with its monthly average water level rising 35 cm (13.8 inches) from March to June, compared to its average rise of 26 cm (10.2 inches). Its decrease in July of 2 cm was close to the average decline of 1 cm. Lake Erie levels ended the reporting period with an August monthly mean water level 45 cm (17.7 inches) above average. Recorded monthly water levels for the period March 2017 through August 2017 are shown in Table 1 and depicted graphically in Figure 1. The following paragraphs provide more detail on the main factors that led to the water level changes observed on Lake Erie during the reporting period.

Lake Erie receives water from its local drainage basin and from the upstream lakes. The water supplied to a lake from its local drainage basin is referred to as its net basin supply (NBS). A lake's NBS is the sum of the amount of water the lake receives from precipitation falling directly on its surface and runoff (including snow melt) from its surrounding land area, minus the amount of water that evaporates from its surface. The sum of Lake Erie's NBS and the inflow from Lake Michigan–Huron via the St. Clair-Detroit Rivers system is its net total supply (NTS).

Precipitation is a major contributor to NBS, both directly on the lake and through runoff due to rain and snowmelt. Recent precipitation data and departures from the long-term average are shown in Table 2 and depicted graphically in Figure 2. The Lake Erie basin received approximately 53.7 cm (21.1 inches) of precipitation during the period March through August 2017. This is approximately 9 percent above the average for the period. Precipitation was above average during all months except for August.

The recent NBS to Lake Erie is shown relative to average on a monthly basis in Figure 3. A negative NBS value indicates that more water left the lake during the month, due to evaporation, than entered it through precipitation and runoff. On average, this is the case for Lake Erie from August to November. For the remainder of the year, average precipitation and runoff are greater than the water lost to evaporation. During the reporting period, the lake's NBS was above average for all months except August which received slightly below average NBS.

Inflow via the Detroit River is the major portion of Lake Erie's NTS, and is greatly influenced by the level of Lake Michigan–Huron. Continuing the trend of the past year and a half, the level of Lake Michigan-Huron was above average for the entire reporting period (Figure 4). This above average lake level caused the flow in the Detroit River to be above average for the entire reporting period, and in particular, during the month of March 2017 (Figure 5). As a result, inflow to Lake Erie via the Detroit River was approximately 15 percent above the long-term average from March through August 2017.

The inflow from Lake Michigan–Huron via the Detroit River combined with Lake Erie's NBS resulted in very wet conditions with a NTS for Lake Erie of approximately 16 percent above average for the period March through August 2017 (Figure 6). The NTS were above-average for all months this reporting period. The NTS to Lake Erie for this reporting period is depicted relative to the long-term average in Figure 6.

Lake Erie discharges water to Lake Ontario through the Niagara River and the Welland Canal. The portion of the Lake Erie outflow that is diverted through the Welland Canal is relatively small (between approximately three and five percent of the total Lake Erie outflow) and is used for navigation purposes through the canal and for the generation of electricity at Ontario Power Generation's (OPG's) DeCew Falls hydroelectric plants. Most of the outflow from Lake Erie occurs through the Niagara River and depends on the level of the lake at its outlet. Generally speaking, above-average lake levels result in above-average outflow, and below-average lake levels lead to below-average outflow. Flow in the river is also influenced by winter ice and summer aquatic plant growth in the river, both of which can decrease the flow. Prevailing winds can also cause variations in lake outflow with strong westerly winds raising the level of the lake at the east end resulting in increased outflow and easterly winds having the opposite effect. Throughout the reporting period, Niagara River outflows were well above average with average monthly flows ranging from 6,605 m^3/s to almost 7,359 m^3/s due to above average levels on Lake Erie (Figure 7).

While it is impossible to accurately predict future supplies to the lakes, using historical supplies and the current levels of the lakes, it is possible to estimate future water levels based on past lake levels (1918-present). The six-month water level forecast prepared at the beginning of September by the U.S. Army Corps of Engineers (USACE) and Environment and Climate Change Canada (ECCC) indicates that if average water supply conditions are experienced, the level of Lake Erie would remain above average throughout the fall and early winter.

3. Operation and Maintenance of the International Niagara Control Works

The water level in the Chippawa-Grass Island Pool (CGIP) is regulated in accordance with the Board's 1993 Directive. The Directive requires that the Power Entities – Ontario Power Generation (OPG) and the New York Power Authority (NYPA) – operate the International Niagara Control Works (INCW) to ensure the maintenance of an operational long-term average CGIP level of 171.16 m (561.55 feet) to reduce the adverse effects of high or low water levels in the CGIP. The Directive also establishes tolerances for the CGIP's level as measured at the Material Dock gauge.

Gate 3 of the INCW was out of service, for a major overhaul, from March 29 to July 25, 2017. Gate 15 was taken out of service for a major overhaul on August 11, 2017 and is expected to be unavailable until December 15, 2017.

The Power Entities complied with the Board's Directive at all times during the reporting period.

The accumulated deviation of the CGIP's level from March 1, 1973 through August 31, 2017 was 0.36 metre-months (1.18 foot-months) above the long-term operational average elevation. The accumulated deviation was within the maximum permissible accumulated deviation of ±0.91 metre-months (±3.0 foot-months) for this reporting period.

During the reporting period, tolerances for regulation of the CGIP were suspended due to ice on March 13, 14 and 15; due to abnormal flows on May 2 & 3, June 25 & 26 and August 5 & 6, 2017; and due to a sanctioned US falls flow test, by the USACE, on May 10, 2017.

The locations of the water level gauges on the Niagara River are shown in Enclosure 1. Recorded daily maximum and minimum Material Dock water levels covering the reporting period are shown in Figure 8.

4. Gauging Stations

The gauges used to determine flows in the Niagara River, monitor the CGIP levels and the flow over Niagara Falls are the Fort Erie, Material Dock and Ashland Avenue gauges as shown in Enclosure 1. The Buffalo, Slater's Point, and U. S. National Oceanic and Atmospheric Administration (NOAA) Ashland Avenue gauges are used as alternatives in the event of primary gauge failure. The Slater's Point and Material Dock gauges are owned and operated by the Power Entities. Both NOAA and the Power Entities own and operate water level gauges at the Ashland Avenue location. All gauges required for the operation of the INCW were in service during this reporting period, except for the water level gauge at Slater's Point which was unavailable due to maintenance from June 21 – July 6. The above mentioned backup gauges were used so that no gaps in gauge data occurred.

Design for remediation work at the Ashland Avenue Gauge, which is used to determine flow over the Falls for purposes of the 1950 Niagara Diversion Treaty, has been completed during this reporting period. This design involves extending the existing pipe from the gauge house a further 2 m (6 feet) into the river channel and placement of gabion stone mattresses to stabilize the shoreline band and support the inlet pipe extension. It also proposes putting an elbow at the end of the pipe extending downstream to prevent sediment deposition from upstream. This final design is anticipated to mitigate against infilling of the gauge inlet by providing more natural scouring of river bed material away from the inlet. The current configuration of the pipe requires regular maintenance to keep the end of the pipe sediment free.

The project is scheduled to commence construction beginning November 2017 during the lower Falls flow period, under an underwater construction and diving term agreement with a NYPA contractor. All work is expected to be completed within 30 days and it is anticipated that readings from the Ashland Avenue gauge will not be affected during the construction period.

Efforts to find a viable backup to the Ashland Avenue site remain ongoing. An initial investigation using hourly flow data from the power plants and level gauges above the falls was used to calculate the flow at Ashland Avenue. However, when this method was compared to actual measurements, it was seen that this simple method could not reproduce the measured flows at Ashland Avenue with sufficient accuracy. This indicates that in order for this approach to be useful for a temporary replacement for the Ashland Avenue gauge additional information would be necessary. Further investigation of a number of alternatives will be necessary to devise a method of hourly flow calculation in case of a large scale failure of the Ashland Avenue gauge.

5. Flow over Niagara Falls

The Niagara Diversion Treaty of 1950 sets minimum limits on the flow of water over Niagara Falls. During the tourist season (April-October) day time hours, the required minimum Niagara Falls flow is 2,832 cubic metres per second (m^3/s) (100,000 cubic feet per second (cfs)). At night and at all times during the non-tourist season months (November-March), the required minimum Falls flow is 1,416 m^3/s (50,000 cfs). The appropriate operation of the INCW, in conjunction with power diversion operations, maintains sufficient flow over the Falls to meet the requirements of the 1950 Niagara Diversion Treaty. Falls flow met or exceeded minimum Treaty requirements at all times during the reporting period. The recorded daily average flow over Niagara Falls, covering the period March through August 2017, is shown in Figure 9.

6. Falls Recession

The Board monitors the Horseshoe Falls for changes in its crestline. Crestline changes may result in a broken curtain of water which could change the scenic value of the Falls. Changes in the crestline could also form a notch which could signal a period of rapid Falls recession that has not been seen in more than a century. A review of the Falls crest imagery (most recent image found at time of writing the report was taken on August 26, 2017) showed no evidence of notable change in the crestline of the Falls during this reporting period.

7. Diversions and Flow at Queenston

Diversion of water from the Niagara River for power purposes is governed by the terms and conditions of the 1950 Niagara Diversion Treaty. The Treaty prohibits the diversion of Niagara River water that would reduce the flow over Niagara Falls for scenic purposes to below the amounts specified previously in Section 5 of this report.

The hydroelectric power plants, OPG's Sir Adam Beck (SAB) I and II in Canada and NYPA's Robert Moses Niagara Power Project in the United States, withdraw water from the CGIP upstream of Niagara Falls and discharge it into the Lower Niagara River at Queenston, ON and Lewiston, NY, respectively. During the period of March through August 2017, diversion for the SAB I and II plants averaged 1,476 m^3/s (52,120 cfs) and diversion to the Robert Moses Niagara Power Project averaged 2,327 m^3/s (82,180 cfs).

The average flow from Lake Erie to the Welland Canal for the period March through August 2017 was 151.3 m^3/s (5,330 cfs). Diversion from the canal to OPG's DeCew Falls Generating Stations averaged 102.0 m^3/s (3,600 cfs) for the same period of time. Records of diversions for power generation covering the period March through August 2017 are shown in Figure 10.

The monthly average Niagara River flow at Queenston, Ontario, for the period of March through August 2017, and departures from the 1900–2016 long-term average are shown in Table 3. Maximum and minimum monthly average flows for the 1900–2015 period of record are shown in Table 4. During the period March through August 2017, the flow at Queenston averaged 7,041 m^3/s (248,650 cfs), which was 1,115 m^3/s (39,380 cfs) above the 1900-2016 average of 5,926 m^3/s (209,270 cfs) for the period. The monthly values ranged between 6,605 m^3/s (233,250 cfs) and 7,359 m^3/s (259,880 cfs).

8. Flow Measurements in the Niagara River and Welland Canal

Discharge measurements are regularly scheduled in the Niagara River and Welland Canal as part of a program to verify the gauge ratings used to determine flow in these channels for water management purposes. Measurements are obtained through joint efforts of the USACE and ECCC. Measurement programs require boats, equipment and personnel from both agencies to ensure safety, quality assurance checks between equipment and methods, and bi-national acceptance of the data collected. The USACE and ECCC continue efforts to standardize measurement equipment and techniques. Historically, measurements were made at several locations as described below. Measurements were taken at the American Falls Channel section during the current reporting period.

Upper Niagara River: Regularly scheduled measurements are taken near the International Railway Bridge, located in the upper Niagara River, on a three-year cycle to provide information for evaluating stage-discharge relationships for flow entering the Niagara River from Lake Erie. The regularly scheduled discharge measurements near the

International Railway Bridge were taken in May 2015. The next measurements are scheduled for 2018.

ECCC continues to monitor continuous water levels from a gauge at a proposed International Gauging Station located near the International Railway Bridge discharge measurement section. Flow measurements continue throughout the year by the USGS New York and ECCC. ECCC will be using continuous acoustic velocity meter data to produce flows once the index-velocity ratings are approved (expected in fall 2017) Continuous daily discharge data during non-ice affected periods will be published for previous years by ECCC and USGS (as contributed data) through their respective web sites.

Lower Niagara River: The Ashland Avenue gauge rating (AAGR) is used to determine the flow over Niagara Falls for purposes of the 1950 Niagara Diversion Treaty. Discharge measurements are made on a three-year cycle at the AAGR section, located just upstream of the OPG and NYPA hydroelectric generating stations at Queenston–Lewiston, to verify the 2009 Ashland Avenue gauge rating of the outflow from the Maid-of-the-Mist Pool below the Falls. A suite of discharge measurements ranging between 1,902 m^3/s and 3,526 m^3/s were obtained between May 24 and May 27, 2016. Due to above average river flows and power system conditions experienced in both Ontario and New York at the time, the lowest targeted flow of 1,416 m^3/s could not be provided for measurement. The results of the discharge measurements have been analyzed and documented in a report prepared by the Great Lakes Hydraulics and Hydrology Office, USACE, Detroit District and Hydrometric Operations Ontario, Meteorological Service of Canada Monitoring and Data Services Directorate, ECCC. The 2016 discharge measurements were all within five percent of the flows computed using the 2009 Ashland Avenue rating equation and also consistent with previous acoustic Doppler current profiler (ADCP) measurements made at the section since 2001 verifying the accuracy of the current falls flow measurement. The next measurement series is scheduled for 2019.

In addition to the measurements at the AAGR section, measurements of total flow in the Niagara River are periodically made downstream of the OPG and NYPA hydroelectric generating stations at Queenston–Lewiston during run-of-river conditions. This section is located approximately 1.6 kilometers (1 mile) upstream of the Stella Niagara section, where conventional measurements have been made. Each measurement of total flow is compared to the sum of the outflow from the Maid-of-the-Mist Pool (flow over Niagara Falls) and the discharges from the hydroelectric generating stations to verify these measurements. The results are compared to turbine ratings and the summation of flow calculations to validate flow measurements being used for Treaty purposes. Brief summaries of these measurements are included in the report "Discharge Measurements on the Niagara River near the Cableway Section, 2013/2014: For Verification of the Ashland Avenue Gauge Rating For the Maid-of-the-Mist Pool Outflow, August 2015".

American Falls Channel: Discharge measurements are made in the American Falls Channel on a five-year cycle to verify the rating equation used to determine the amount of flow in the American Falls channel and to demonstrate that a dependable and adequate flow of water is maintained over the American Falls and in the vicinity of Three Sisters Islands as required by the IJC Directive to the Board. Measurements are made using a section in the upper reach of the American Falls channel near the American Falls Gauge site. As scheduled, measurements were taken between May 8-12, 2017 to verify the American Falls rating equation. Results are currently being analyzed and a draft report is expected to be released for review and comment in the fall of 2017. Following the five-year cycle, the next scheduled measurements at this location are scheduled for May 2022.

Welland Canal: Discharge measurements are made on a three-year cycle in the Welland Supply Canal above Weir 8 to verify the index-velocity rating used to determine flow through the Welland Canal. Measurements were made in the Welland Supply Canal in May 2012 to re-set the measurement interval. Off-schedule measurements and field work in 2013 provided baseline validation data for a second, duplicate, acoustic Doppler velocity meter (ADVM) system, together with confirming the validity of the 2007-2012 index velocity rating at the original site. A series of measurements were obtained in the Welland Supply Canal in May 2015 to verify the discharge equations for both ADVM systems. Results from this measurement series are still under review. The next measurement series will take place in 2018.

9. Power Plant Upgrades

OPG began a unit rehabilitation program in 2007 for a number of its Beck I units— G3, G7, G9 and G10. The upgrades of G3, G7, and G9 have been completed, with new unit rating tables issued for G7 and G9 during previous reporting periods. The new rating table for G3 was put into service March 8, 2017. Beck unit G10 went out of service on September 13, 2015 for rehabilitation (new runner and generator rewind) and returned to service on June 9, 2017. Testing of the unit to establish a new unit rating table has been scheduled for November/December 2017. An overhaul of G2 at the DeCew Falls generating station began in November 2016. The unit is expected to remain out of service until February 2018.

NYPA is continuing unit upgrades at the Lewiston Pump Generating Plant as part of its Life Extension Modernization (LEM) project. The Life Extension Modernization project for the Lewiston Pump Generation Plant began in the year 2012, which serves to upgrade all 12 pump-turbine units with digital controls and replacement/refurbished mechanical parts and equipment. It was developed as an 8-10 year program with unit upgrades and re-starts every 8 months, and is currently targeted for completion by the year 2020. Unit PG8 is being prepared for start-up by end of September 2017, and Unit PG9 is beginning tear down in November 2017. This will leave 4 of 12 units remaining for anticipated completion by 2020. NYPA is also presently in the process of developing an underwater inspection plan for the twin intake conduits connecting the Hydro-plant fore bay and the Niagara River.

10. Ice Conditions and Ice Boom Operation

The winter of 2016-2017 was one of the warmest on record, with above average temperatures for all months except for March 2017. As with the previous winter, solid ice formation did not occur. On February 28, 2017, given the limited ice cover, the above average forecasted temperatures, and the limited potential for significant new ice buildup in the eastern part of Lake Erie and in the Niagara River, the INWC decided to remove the ice boom. A media advisory was issued by the Board on March 6, 2017 and ice boom removal began by NYPA on March 6, 2017. All spans of the ice boom were removed from Lake Erie and tied off to the Buffalo breakwall by March 13, 2017. All spans were moved to the Katherine Street storage facility by March 28, 2017, ending the 2016–2017 ice boom season.

In response to public concern on the timing of ice boom removal and INWC efforts to monitor Lake Erie ice cover, regular updates were provided on the Board's website at ijc.org/en_/inbc/ice_boom.

11. Other Issues

All issues were covered in the other sections of this report for this reporting period.

12. Meeting with the Public

In accordance with the Commission's requirements, the Board held an outreach event with the public at the Erie County Fair from August 9-20, 2017. This fair is held annually in the Buffalo area in mid-August. This is a different approach than used in the past and it led to many more interactions with the public than the most recent public meetings.

A booth developed jointly by the INWC and USACE Buffalo District was on display during the entire Erie County Fair. The booth was manned by Board representatives when resources allowed, while during times when representatives were not present there was an opportunity for the public to read over the display and to leave questions for the Board in a question box. The interaction with the public was seen as a success with an estimated 432 members of the public stopping and interacting with Board representatives at the exhibit during the staffed times. No questions were left for the Board when the booth was unmanned, however information from Erie County Fair officials indicated that a significant number of the public entered and read the display when it was unmanned. An after action review was undertaken by the INWC with help from the USACE Buffalo District staff. The summary report from this review will be used in planning future events.

13. Membership of the Board and the Working Committee

There were no changes or reappointments to the Board membership during this reporting period. Currently the U.S. section Board member is vacant and efforts are being made to find a replacement.

14. Attendance at Board Meetings

The Board met once during this reporting period. The meeting was held on September 21, 2017 at the Ontario Power Generation Office, Sir Adam Beck Plant, Queenston, Ontario. Mr. Aaron Thompson, Canadian Section Chair and Mr. Stephen Durrett, U.S. Alternate Section Chair were present in Queenston.

Original Signed By

Mr. AARON F. THOMPSON
Chair, Canadian Section

Original Signed By

BG MARK R. TOY
Chair, United States Section

Original Signed By

Ms. JENNIFER L. KEYES
Member, Canadian Section

Vacant

Member, United States Section

Table 1: Monthly average Lake Erie water levels based on a network of four water level gauges and the International Great Lakes Datum (1985).

	Metres			Feet		
Month	Recorded* 2017	Average 1918-2016	Departure	Recorded* 2017	Average 1918-2016	Departure
March	174.48	174.07	0.41	572.44	571.00	1.44
April	174.64	174.22	0.42	572.97	571.59	1.38
May	174.82	174.30	0.52	573.56	571.85	1.71
June	174.83	174.33	0.50	573.59	571.95	1.64
July	174.81	174.32	0.49	573.52	571.92	1.60
August	174.70	174.25	0.45	573.16	571.69	1.47

* Provisional

Table 2: Monthly average precipitation on the Lake Erie basin.

	Centimetres			Inches			
Month	Recorded* 2017	Average 1900-2016	Departure	Recorded* 2017	Average 1900-2016	Departure	Departure (in percent)
March	7.95	7.00	0.95	3.13	2.76	0.37	13
April	9.50	8.10	1.40	3.74	3.19	0.55	17
May	12.95	8.60	4.35	5.10	3.39	1.71	50
June	9.60	8.80	0.80	3.78	3.46	0.32	9
July	7.95	8.60	-0.65	3.13	3.39	-0.26	-8
August	5.74	8.20	-2.46	2.26	3.23	-0.97	-30

* Provisional

Table 3: Monthly Niagara River flows at Queenston.

	Cubic Metres per Second			Cubic Feet per Second		
Month	Recorded 2017	Average 1900-2016	Departure	Recorded 2017	Average 1900-2016	Departure
March	6605	5647	958	233,250	199,420	33,830
April	6978	5901	1077	246,430	208,390	38,040
May	7359	6094	1265	259,880	215,210	44,670
June	7200	6072	1128	254,270	214,430	39,840
July	7170	5979	1191	253,210	211,150	42,060
August	6933	5860	1073	244,840	206,940	37,900
Average	7041	5926	1115	248,650	209,270	39,380

Table 4: Monthly maximum and minimum Niagara River flows at Queenston.

	Maximum Flows			Minimum Flows		
Month	Year	m^3/s	ft^3/s	Year	m^3/s	ft^3/s
March	1986	7320	258,500	1934	4130	145,850
April	1974	7550	266,630	1935	4380	154,680
May	1974	7560	266,980	1934	4530	159,980
June	1986	7610	268,740	1934	4470	157,860
July	1986	7510	265,210	1934	4360	153,970
August	1986	7190	253,910	1934	4370	154,330

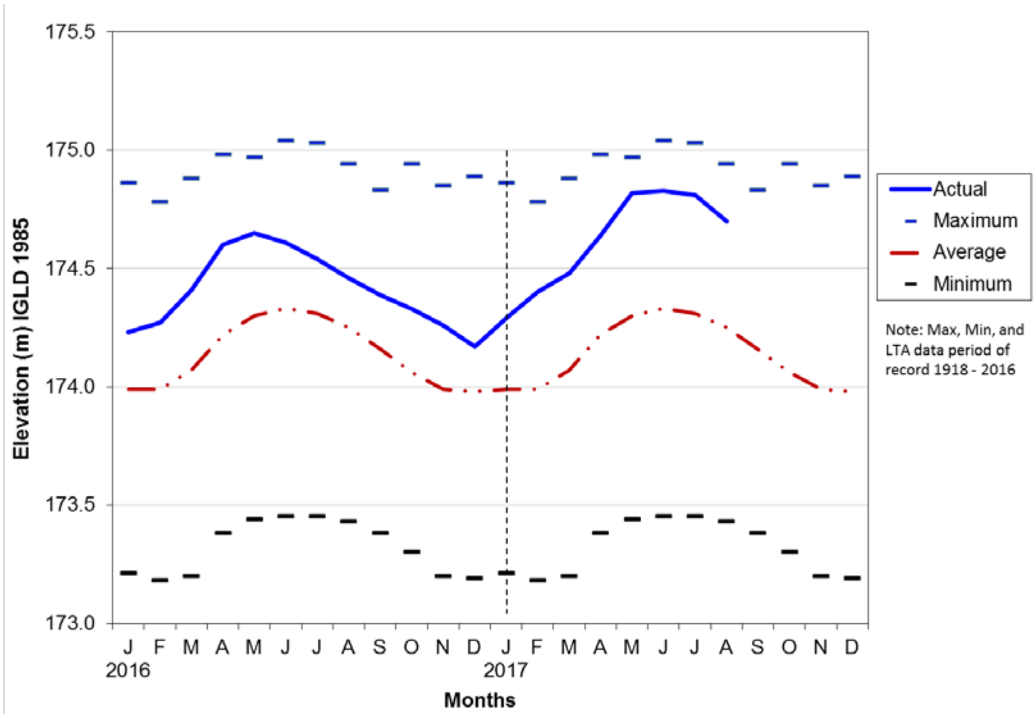


Figure 1: Lake Erie mean monthly and long-term maximum, minimum and average water levels.

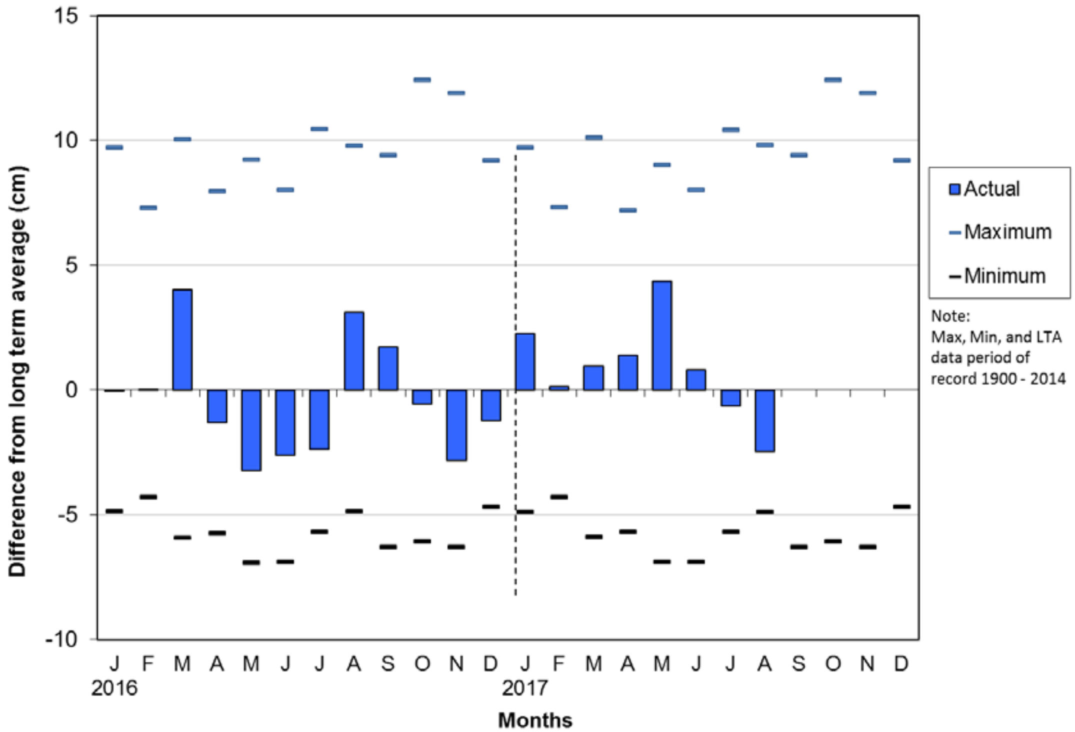


Figure 2: Monthly actual, maximum and minimum precipitation departures from the long-term average on Lake Erie basin.

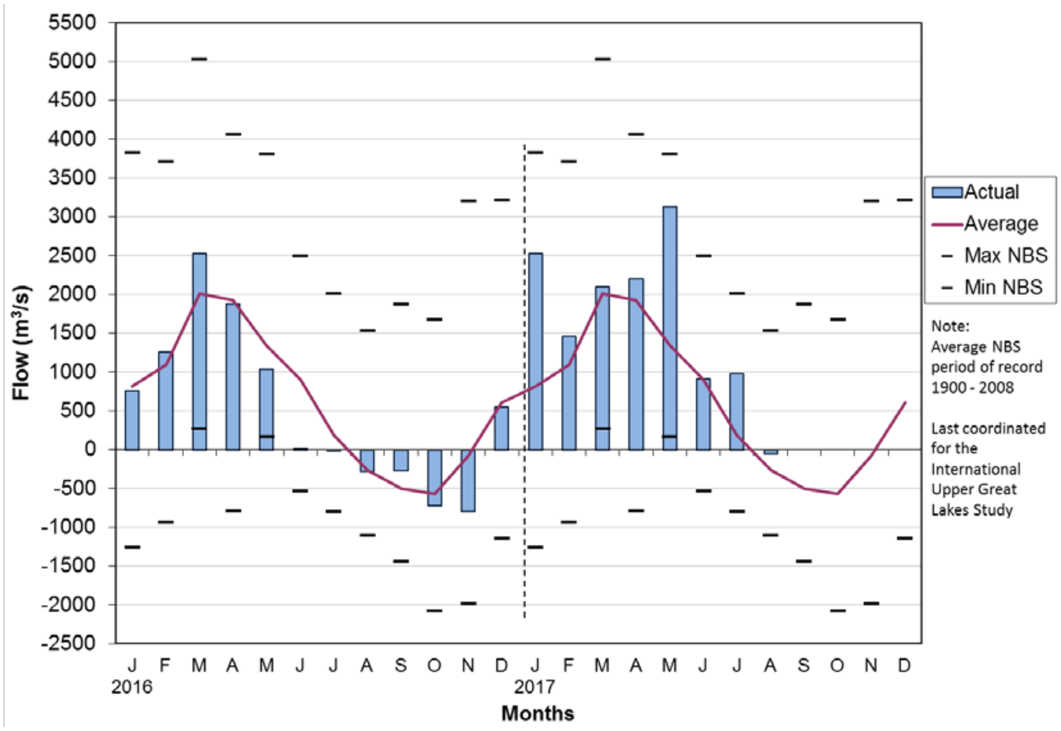


Figure 3: Monthly actual, maximum, minimum and average net basin supplies on Lake Erie basin.

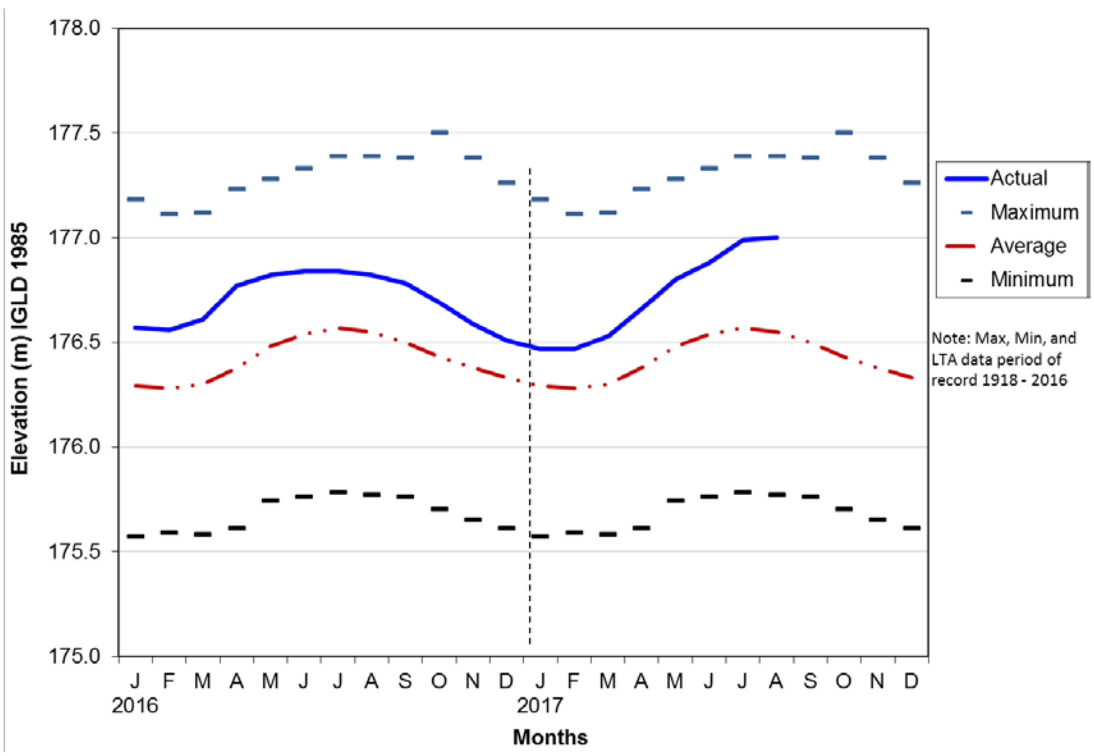


Figure 4: Lake Michigan-Huron mean monthly actual, maximum, minmum and average water levels.

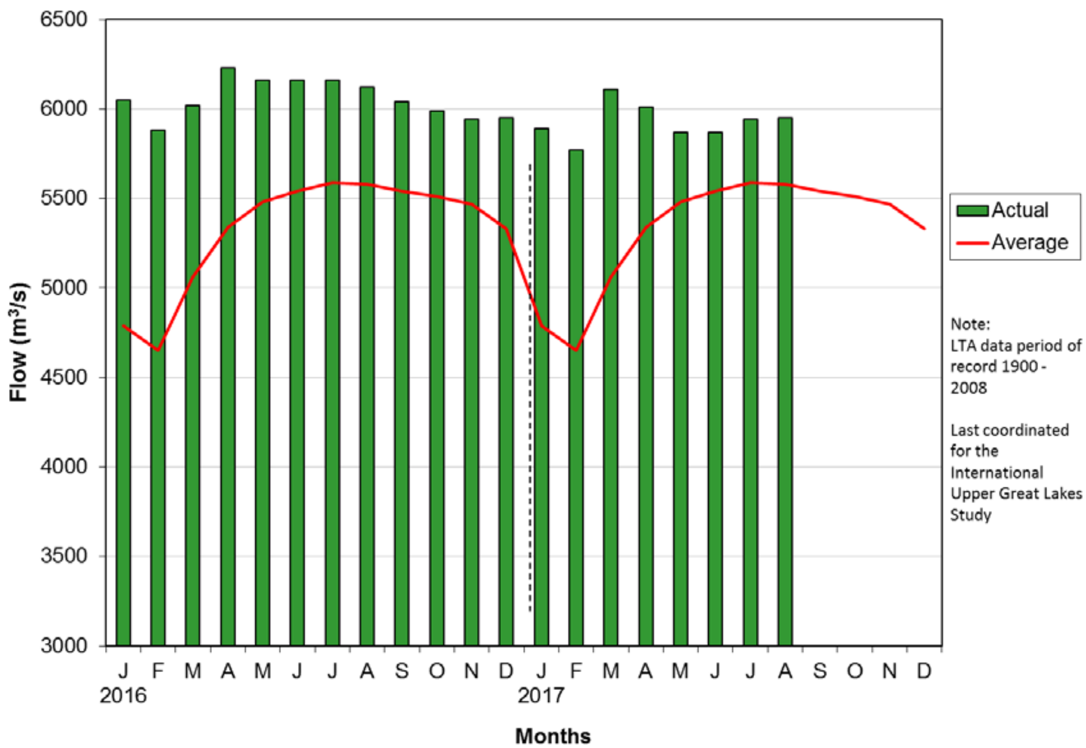


Figure 5: Detroit River mean monthly actual and average flows.

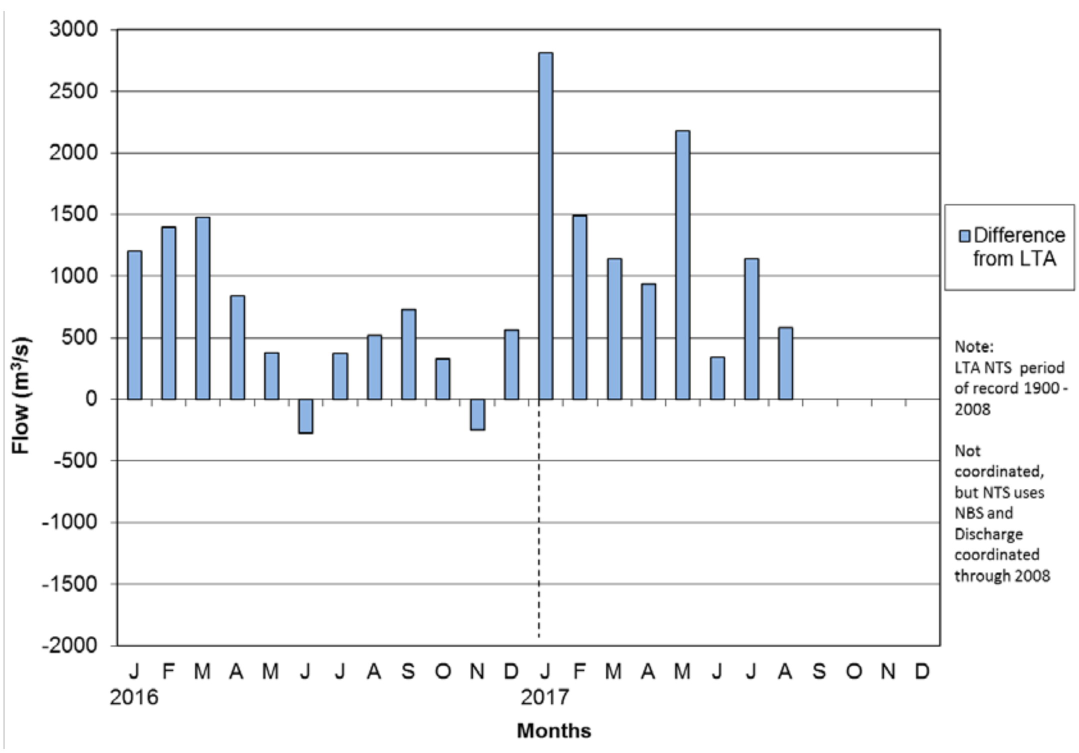


Figure 6: Lake Erie basin monthly net total supplies difference from the long term average.

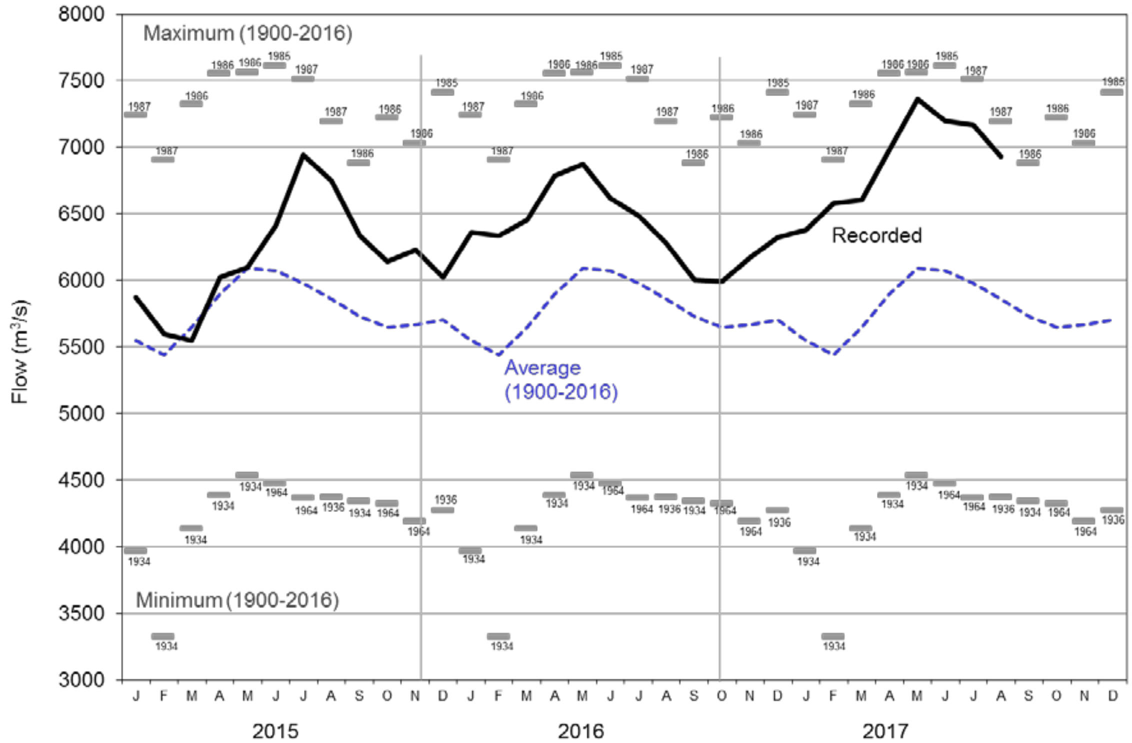


Figure 7: Niagara River mean monthly actual and average flows at Queenston, Ontario.

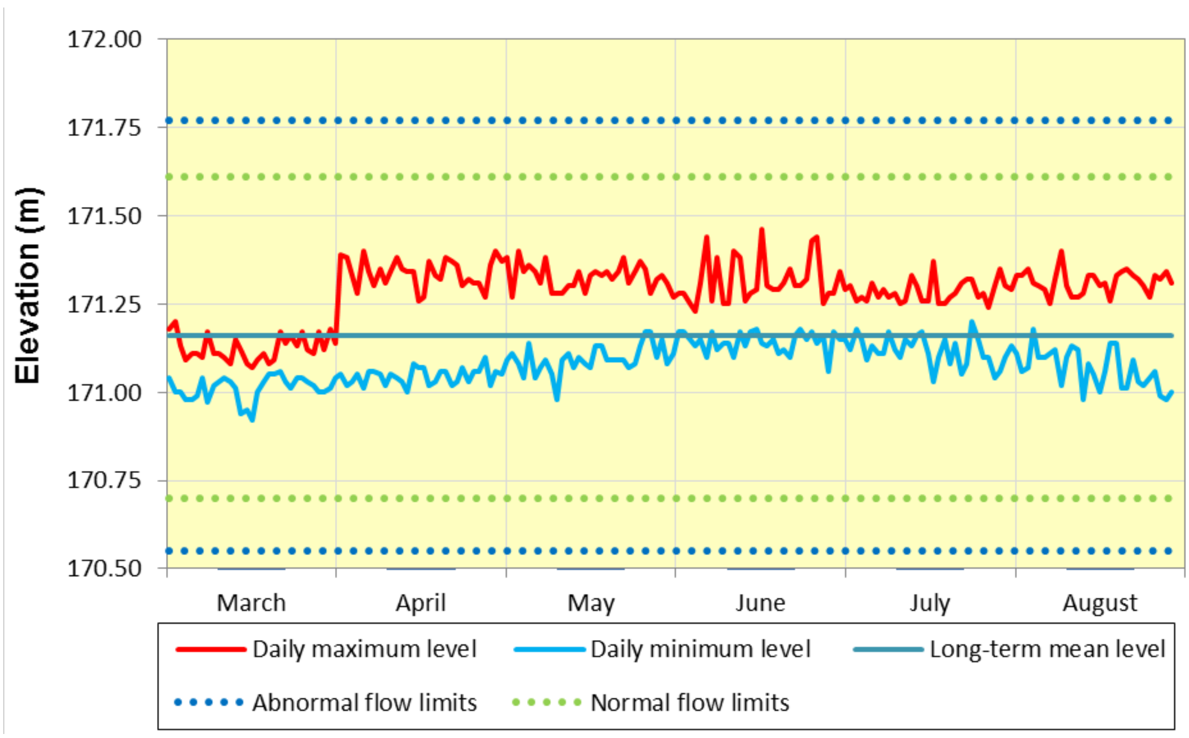


Figure 8: Daily maximum and minimum water levels at Material Dock gauge (March through August 2017).

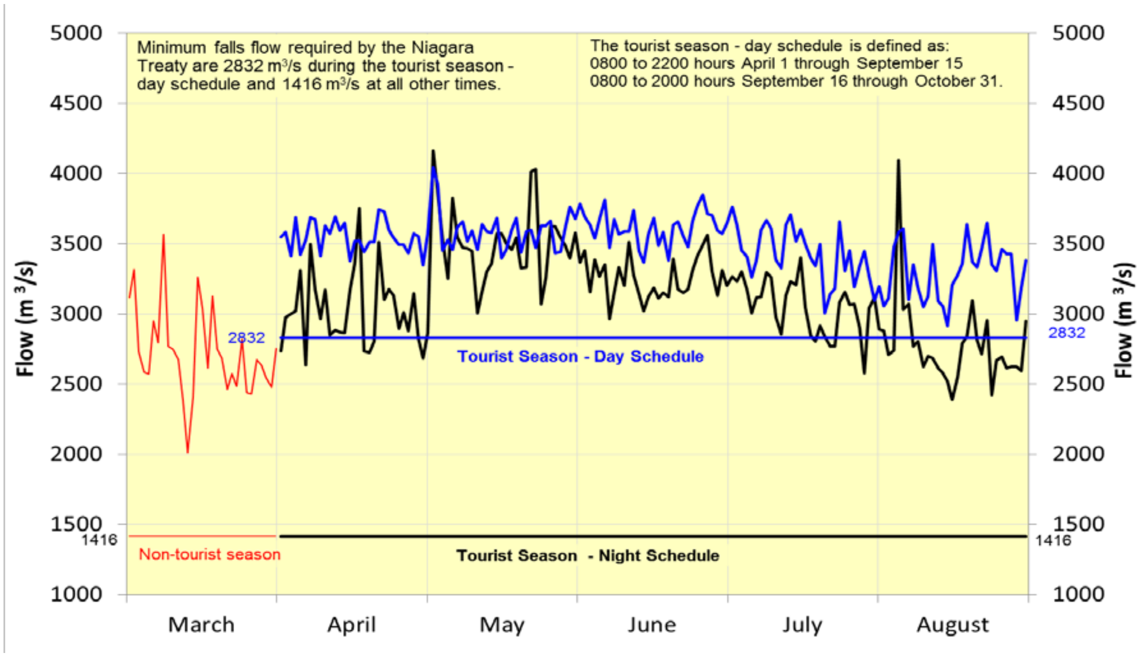


Figure 9: Daily flow over Niagara Falls from March through August 2017 (flow at Ashland Avenue in m^3/s).

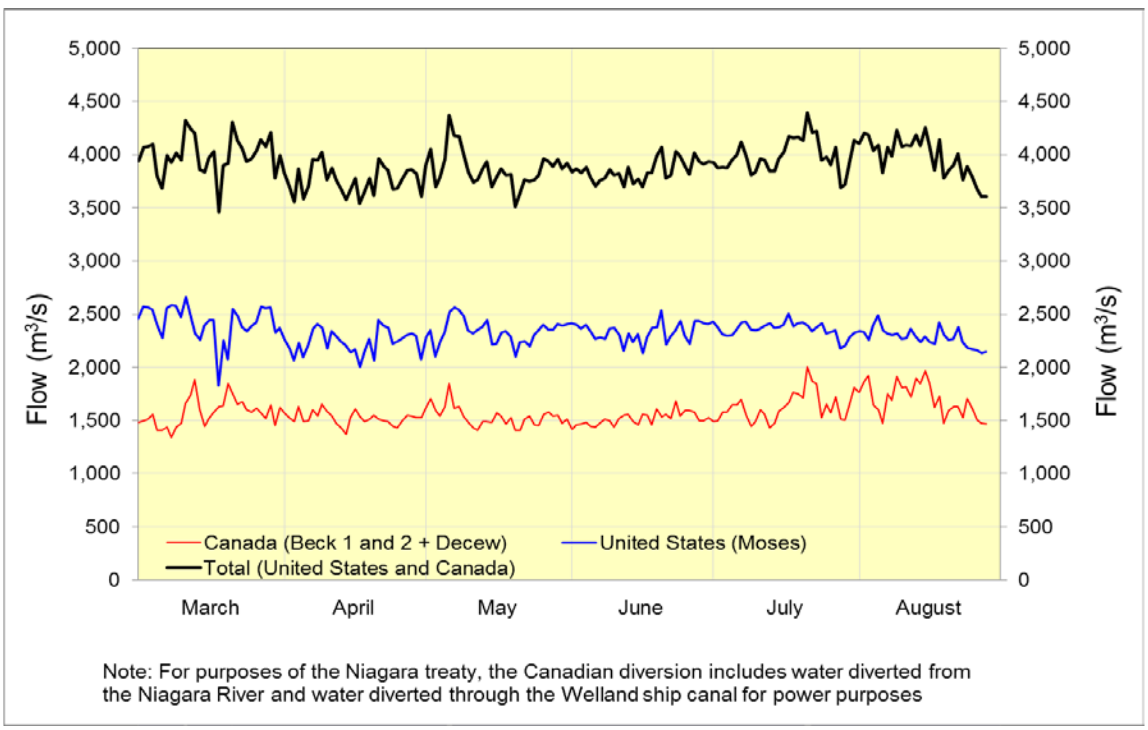
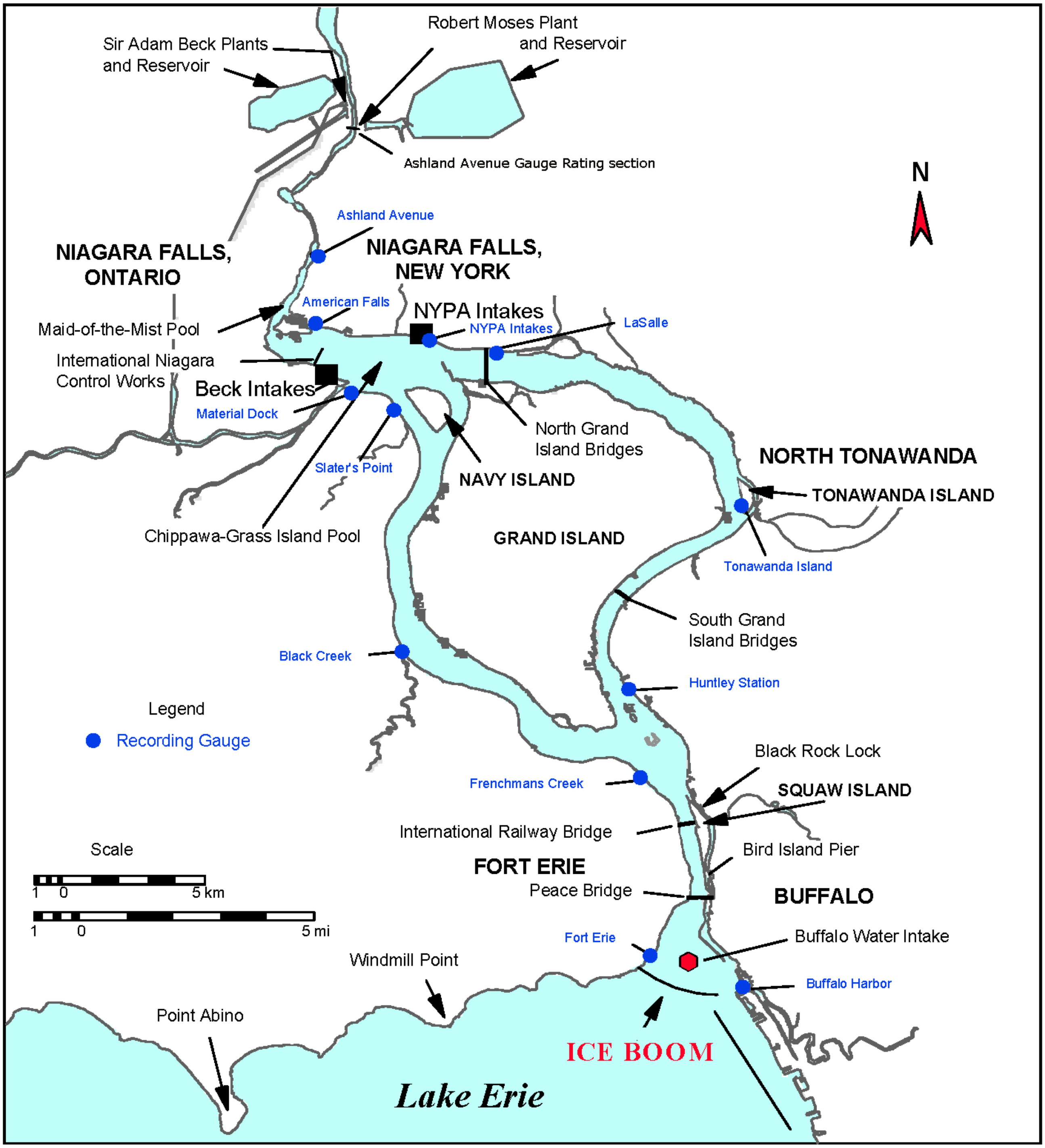


Figure 10: Daily diversion of Niagara River water for power purposes (March through August 2017).



Enclosure 1: Map of the upper Niagara River showing water level gauge locations.