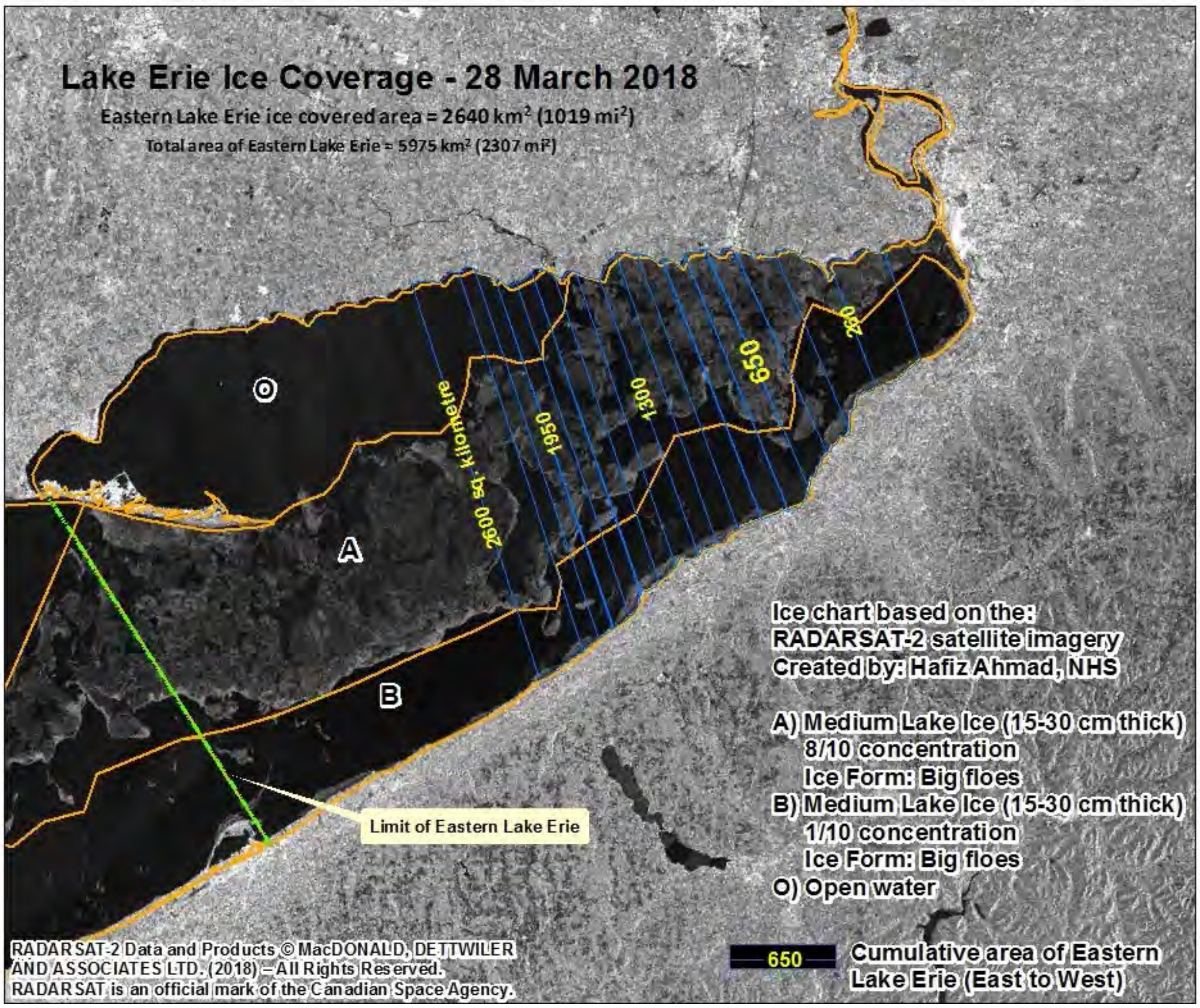
International Niagara Board of Control

One Hundred Thirty First Semi-Annual Progress Report

to the

International Joint Commission



Covering the Period March 29 through August 31, 2018

Executive Summary

Lake Erie began the reporting period with a March mean level 60 cm (23.6 inches) above its 1918–2017 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 46 cm (18.1 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 (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 the week of May 15, 2018 near the International Railway Bridge to evaluate the accuracy of the stage-discharge relationships used to measure the flow entering the Niagara River from Lake Erie. As well, measurements were also taken in the Welland Supply Canal above Weir 8 to verify the index-velocity rating used to determine flow through the Welland Canal. The next scheduled series of measurements are planned for September 2019 at the Ashland Avenue gauge rating section in the Lower Niagara River (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 G3, G7 and G9 during previous reporting periods. Unit G10 returned to service on June 9, 2017 and testing to establish a new unit rating table has been scheduled for January 2019 (Section 9).

Ice cover on the eastern basin of Lake Erie at the end of March 2018 was greater than 650 km^2 (250 mi^2) and the Commission was informed on March 27, 2018 that the opening of the Lake Erie – Niagara River Ice Boom would be delayed until after April 1. Ice boom removal began on April 10, 2018 and all spans were removed by April 19, 2018 (Section 10).

There were no changes or reappointments to the board membership during this reporting period. Changes to the board's working committee during the reporting period were: On June 29, 2018, Lieutenant Colonel (LTC) Jason A. Toth became the US Chair of the board's working committee succeeding LTC Adam J. Czekanski. Mr. Kurt Kornelsen, Ontario Power Generation succeeded Ms. Joan Frain on the Canadian Section of the working committee on May 23, 2018 (Section 13).

Table of Contents

List of Tables

List of Figures

Enclosures

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

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.

COVER: Lake Erie Ice Coverage on March 28, 2018 derived from RADARSAT-2 satellite imagery.
(Slide created by Hafiz Ahmad, Environment and Climate Change Canada)

INTERNET SITES

International Joint Commission
http://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.ny pa.gov

INTERNATIONAL NIAGARA BOARD OF CONTROL

Cincinnati, Ohio
Burlington, Ontario

September 19, 2018

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 (revised in 2017), 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 Thirty First Semi-Annual Progress Report, covering the reporting period March 29, 2018 to August 31, 2018.

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 60 cm (23.6 inches) above its 1918–2017 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 21 cm (8.3 inches) from March to June, compared to its average rise of 26 cm (10.2 inches). Its decrease in July of 7 cm was much higher than the average decline of 1 cm. Lake Erie levels ended the reporting period with an August monthly mean water level 46 cm (18.1 inches) above average. Recorded monthly water levels for the period March 2018 through August 2018 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 48.6 cm (19.1 inches) of precipitation during the period March through August 2018. This is very close (only 1 percent below) to the 1900-2012 average for the period. Precipitation was above average for April, May, June and 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 for March and July.

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 couple of years, 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 2018 which was the highest March value in the record going back to 1900 (Figure 5). As a result, inflow to Lake Erie via the Detroit River was approximately 14.0 percent above the long-term average from March through August 2018.

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 2018. 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 (revised 2017). 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.

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, 2018 was 0.27 metre-months (0.89 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 14 & 17, April 6-8; and due to abnormal flows on April 4, 5, 16 & 17 and May 4 & 5, 2017.

There were no control dam gate outages, typically scheduled maintenance outages were deferred due to the INCW parking lot project.

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 as follows: Ashland Avenue intermittent outages from 9:04 Jul 3 to 13:00 July 4 and from 9:20 to 10:55 on Aug 2. Both events were communications issues between the gauge and NRCC.

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 reporting period, 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 September 1, 2018) 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 2018, diversion for the SAB I and II plants averaged 1,617 m^3/s (57,100 cfs) and diversion to the Robert Moses Niagara Power Project averaged 2,401 m^3/s (84,790 cfs).

The average flow from Lake Erie to the Welland Canal for the period March through August 2018 was 172.0 m^3/s (6,070 cfs). Diversion from the canal to OPG's DeCew Falls Generating Stations averaged 122.3 m^3/s (4,310 cfs) for the same period of time. Records of diversions for power generation covering the reporting period are shown in Figure 10.

The monthly average Niagara River flow at Queenston, Ontario, for the period of March through August 2018, and departures from the 1900–2017 long-term average are shown in Table 3. Maximum and minimum monthly average flows for the 1900–2018 period of record are shown in Table 4. During the period March through August 2018, the flow at Queenston averaged 7,172 m^3/s (253,280 cfs), which was 1,389 m^3/s (49,050 cfs) above the 1900-2017 average of 5,783 m^3/s (204,220 cfs) for the period. The monthly values ranged between 6,925 m^3/s (244,550 cfs) and 7,428 m^3/s (262,320 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. During the current reporting period measurements were taken in the Upper Niagara River at the International Railway Bridge and at the Welland Canal.

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 the week of May 15, 2018. Data processing and analysis are currently underway and a draft report will be complete by September 2018. The next measurements are scheduled for May 2021.

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. For the current period, continuous daily discharge data has been produced using the index-velocity rating for the site when index velocity data was available, and otherwise using the maintained stage-discharge relationship. The November 2017 collapse of a retaining wall upstream of the index velocity instrument has now rendered the index velocity rating as unusable. Planning for a new index velocity setup is underway. Continuous daily discharge data during non-ice affected periods will be published 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. The next measurement series is scheduled for September 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 and May 12, 2017 to verify the American Falls rating equation. Results show that the discharge measurements fit very close to the 1978 Rating Equation, with all measurements falling within 1% of the rating. The draft report has been internally reviewed and sent to the Niagara working committee for review. 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. The draft report is being reviewed. A similar series of verification measurements was completed in May 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. All of these upgrades have been completed, with new unit rating tables issued for G3, G7, and G9 during previous reporting periods. Testing of G10 to establish a new unit rating table has been delayed until January 2019. An overhaul of G2 at the DeCew Falls generating station began in November 2016. The work is taking longer than previously expected and will remain out of service until November 2018. There were also outages for routine and forced mechanical maintenance at DeCew Falls GS1 in late April and May 2018. A short notice outage of DeCew Falls GS1 was also taken in July to support electrical reconfiguration as part of the DeCew Falls GS2 overhaul. None of the DeCew Falls GS1 maintenance will result in changes to flow or efficiency.

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 PG9 is currently being rebuilt, scheduled for start-up in June 2018. This leaves 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

Ice cover of Lake Erie started increasing during the first week of January and peaked at about 95% in the first week of February. It then began to steadily decline throughout the remainder of the 2017-18 ice season (Figure 11). Information on the installation of the Lake Erie-Niagara River Ice Boom for the 2017-18 ice season is provided in the 130th semi-annual report.

A second helicopter flight, in the 2017-18 ice season, was taken on March 16, 2018 to measure ice thickness at six standard sites on the eastern end of Lake Erie. The first measurements were taken on February 16, 2018.

The current Order of Approval governing the operation of the ice boom requires that all floating sections of the boom be opened by the first day of April unless more than 650 square kilometres (250 square miles) of ice remain on eastern Lake Erie. Other factors such as the quality of ice, ice build-up in the river above/below the Falls or in the lower Niagara River, or prediction of unfavourable weather are also considered.

Satellite imagery from the end of March 2018 showed ice coverage in the eastern basin of Lake Erie to be greater than 650 km^2 (250 mi^2). The Commission was informed on March 27, 2018 that the opening of the ice boom would be delayed until after April 1, 2018. A fixed wing survey flight took place on April 3, 2018 which determined that the amount of ice remaining in the eastern basin of Lake Erie was 2111 km^2 (815 mi^2).

Using satellite imagery, on April 8, 2018 members on the INWC determined that 174 km^2 (67 mi^2) of ice remained in the eastern basin, satisfying the criteria to begin removal of the Lake Erie Niagara River Ice Boom. The following day a media advisory was released stating that the Lake Erie Niagara River Ice Boom removal would commence April 10, 2018. On April 10, 2018, ice boom crews began Phase 1 of the Lake Erie Niagara River Ice Boom removal, which is removal of the boom spans. This phase ended on April 19, 2018 when all spans had been removed and secured to the breakwall.

Phase 2 of the ice boom removal process is the removal of the buoy barrel. This began on April 23, 2018 and was completed on April 25, 2018 once the last of the buoy barrels were removed.

Phase 3 of the Lake Erie-Niagara River Ice boom removal is placement of the ice boom spans into storage. This began on May 2, 2018 when ice boom crews towed four of the

152-metre (500-foot) long spans to the Katherine Street storage facility and pulled them onto shore. On May 10, 2018 crews completed Phase 3 of the ice boom removal process after all the spans had been towed to the storage facility.

All components were put into dry storage by May 10, 2018. Both the United States and Canadian Coast Guards, along with the Commission, were informed that the ice boom operations were complete for the 2017-18 ice season.

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 in conjunction with the Canadian Geophysical Union congress on June 10, 2018 at the Niagara Convention Centre in Niagara Falls, ON. This congress is held annually at various locations within Canada with typical attendance between 300-500 participants. As part of the conference, a public lecture was given by Canadian board co-chair Aaron Thompson highlighting the history of the region, the current governance structure, and the activities of the board. There was then a question period for the approximately 80 people in attendance. The session was recorded and is available on the board website.

13. Membership of the Board and the Working Committee

The membership of the Board remains unchanged from the last report. Changes to the board's working committee during the reporting period are:

On June 29, 2018, Lieutenant Colonel (LTC) Jason A. Toth became the US Chair of the board's working committee when he assumed duties as Commander of the Buffalo District of the US Army Corps of Engineers, succeeding LTC Adam J. Czekanski on completion of his assignment as Commander of the Buffalo District.

Mr. Kurt Kornelsen became a Canadian member of the working committee on May 23, 2018 upon recommendation by Ontario Power Generation, succeeding Ms. Joan Frain after her retirement from Ontario Power Generation.

14. Attendance at Board Meetings

The board did not meet during this reporting period. The previous meeting was held on March 28, 2018 at the Embassy Suites Hotel, Salon Meeting Room in Buffalo, NY. Mr. Stephen Durrett, U.S. Alternate Section Chair, Mr. Aaron Thompson, Canadian Section Chair, and Mr. David Capka, U.S. board member were present in Buffalo. Canadian board member, Ms. Jennifer Keyes, attended via WebEx.

The next board meeting is scheduled to be held on September 19, 2018 in Cornwall, ON.

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

Original Signed By

Mr. David Capka
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* 2018	Average 1918-2017	Departure	Recorded* 2018	Average 1918-2017	Departure
March	174.68	174.08	0.60	573.10	571.13	1.97
April	174.78	174.23	0.55	573.43	571.62	1.81
May	174.88	174.31	0.57	573.75	571.88	1.87
June	174.89	174.34	0.55	573.79	571.98	1.81
July	174.82	174.33	0.49	573.56	571.95	1.61
August	174.72	174.26	0.46	573.23	571.72	1.51

* Provisional

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

	Centimetres			Inches			
Month	Recorded* 2018	Average 1900-2012	Departure	Recorded* 2018	Average 1900-2012	Departure	Departure (in percent)
March	6.02	7.00	-0.98	2.37	2.76	-0.39	-14
April	8.46	8.10	0.36	3.33	3.19	0.14	4
May	8.81	8.60	0.21	3.47	3.39	0.08	2
June	8.86	8.80	0.06	3.49	3.46	0.03	1
July	7.29	8.60	-1.31	2.87	3.39	-0.52	-15
August	9.17	8.20	0.97	3.61	3.23	0.38	12

* Provisional

Table 3: Monthly Niagara River flows at Queenston.

	Cubic Metres per Second			Cubic Feet per Second		
Month	Recorded 2018	Average 1900-2017	Departure	Recorded 2018	Average 1900-2017	Departure
March	6999	5655	1344	247,170	199,700	47,470
April	7358	5910	1448	259,850	208,710	51,140
May	7428	6105	1323	262,320	215,600	46,720
June	7268	6081	1187	256,670	214,750	41,920
July	7054	5989	1065	249,110	211,500	37,610
August	6925	5869	1056	244,550	207,260	37,290
Average	7172	5935	1237	253,280	209,590	43,690

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

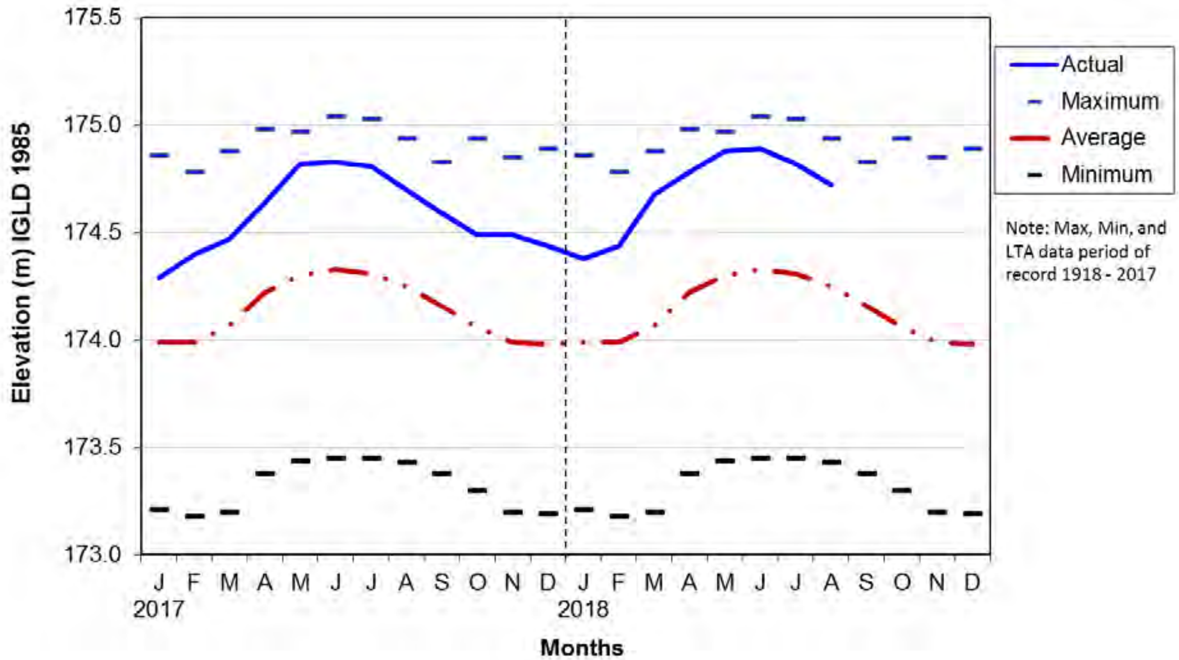


Figure 1: Lake Erie mean monthly and long-term maximum, minimum and average water levels.

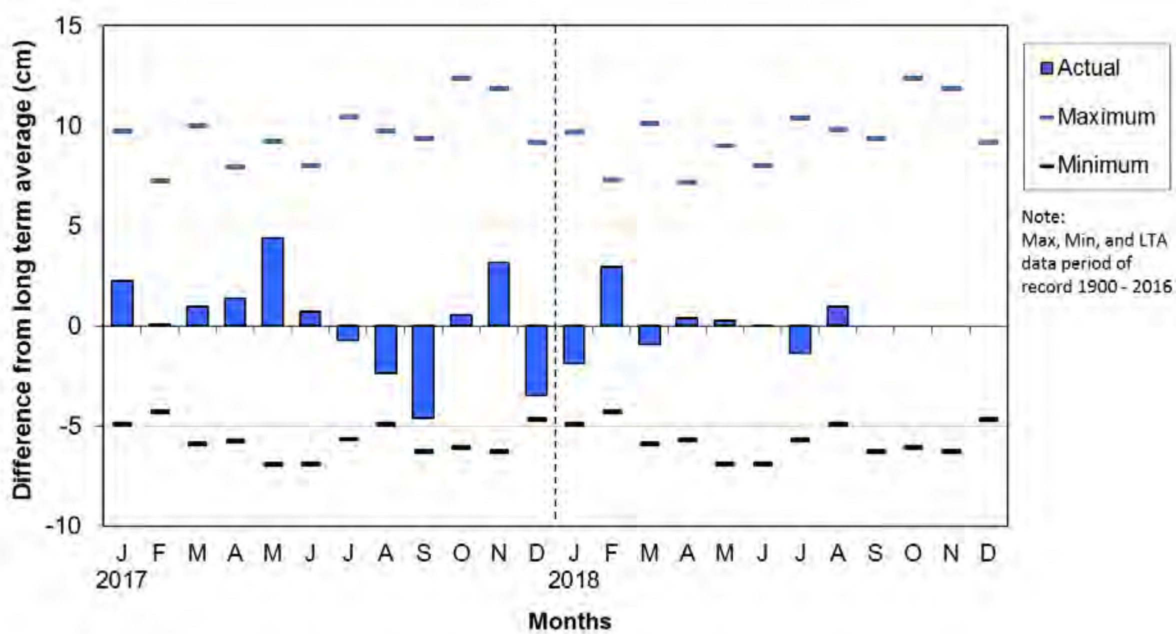


Figure 2: Monthly actual, maximum and minimum precipitation departures from the long-term average on Lake Erie basin.

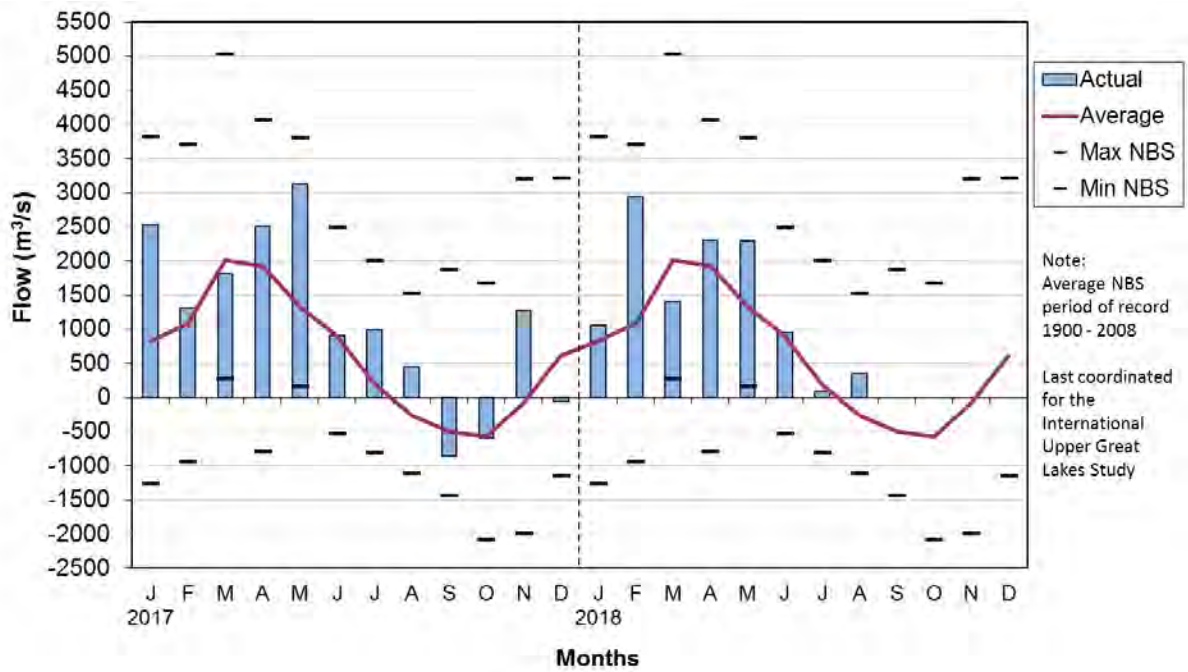


Figure 3: Monthly actual, maximum, minimum and average net basin supplies on Lake Erie basin.

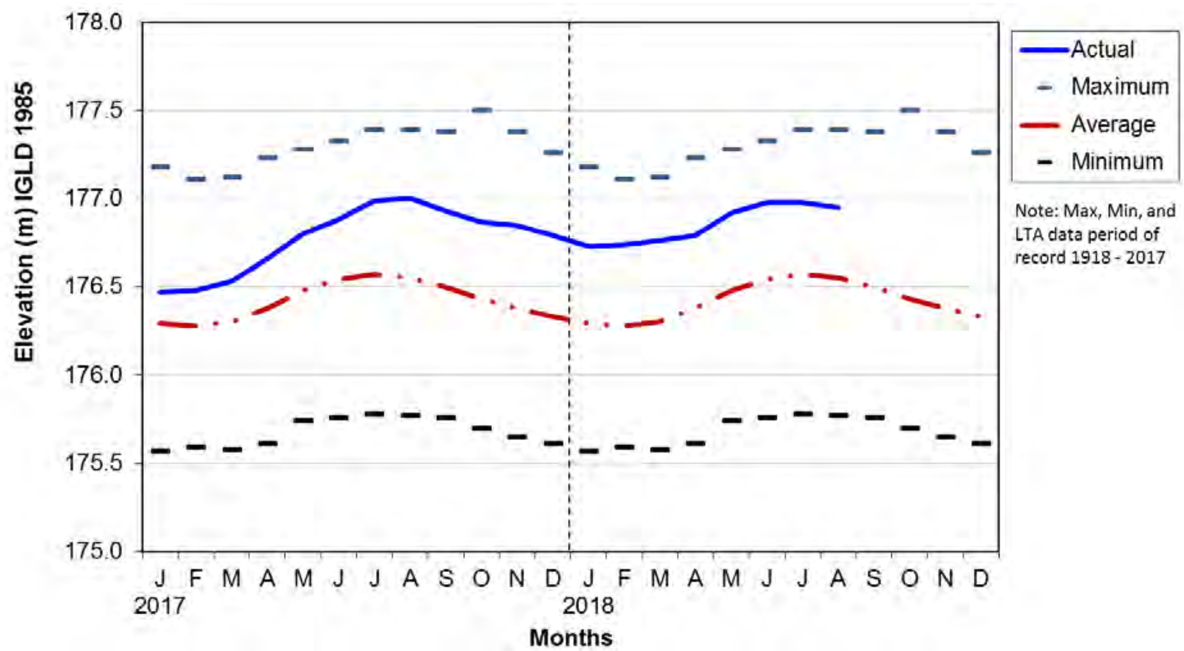


Figure 4: Lake Michigan-Huron mean monthly actual, maximum, minimum and average water levels.

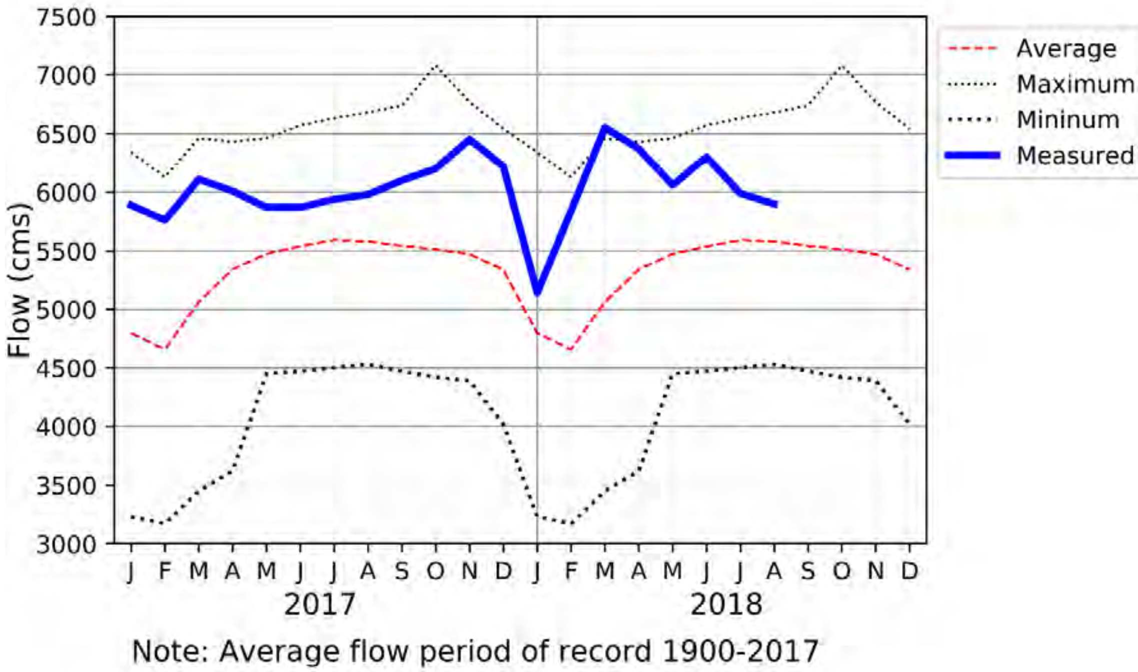


Figure 5: Detroit River mean monthly actual, maximum, minimum and average flows.

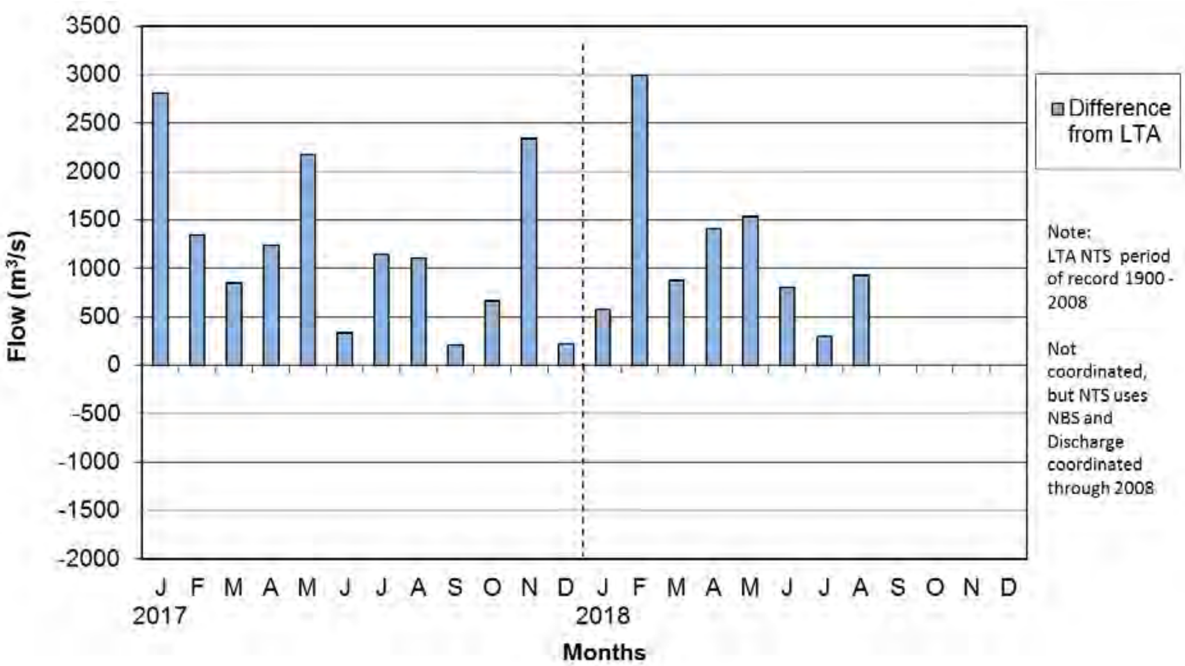


Figure 6: Lake Erie basin monthly net total supplies difference from the long term average.

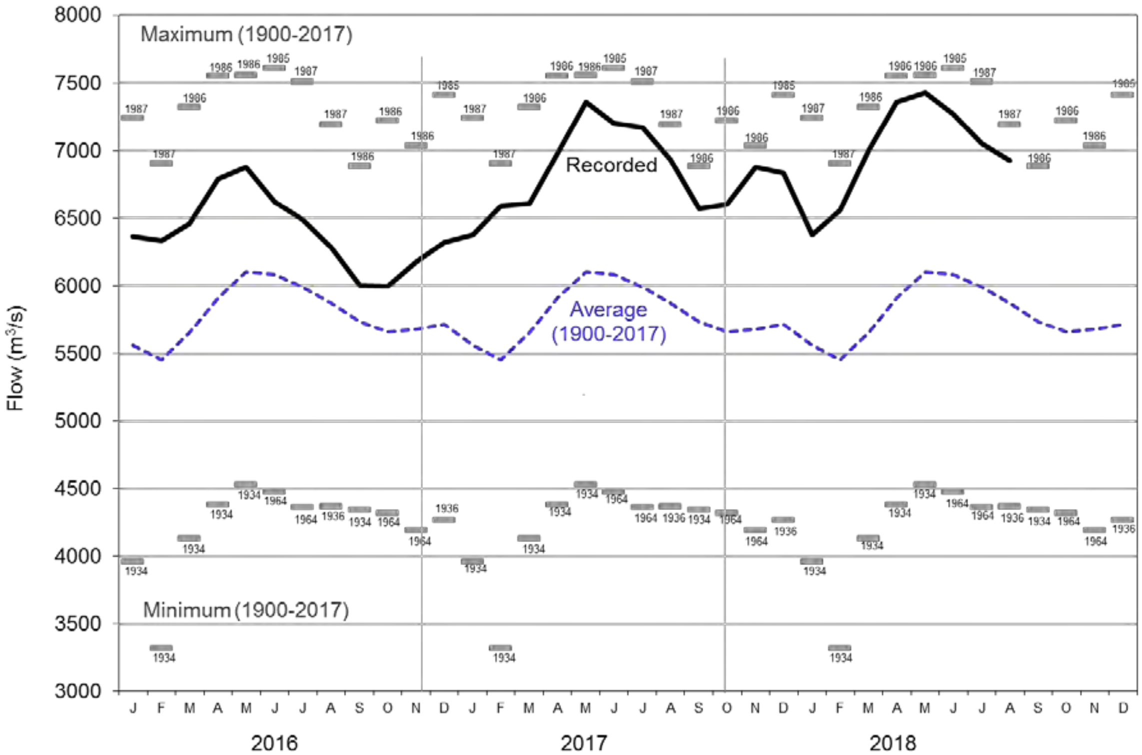


Figure 7: Niagara River mean monthly actual and average flows at Queenston, Ontario.

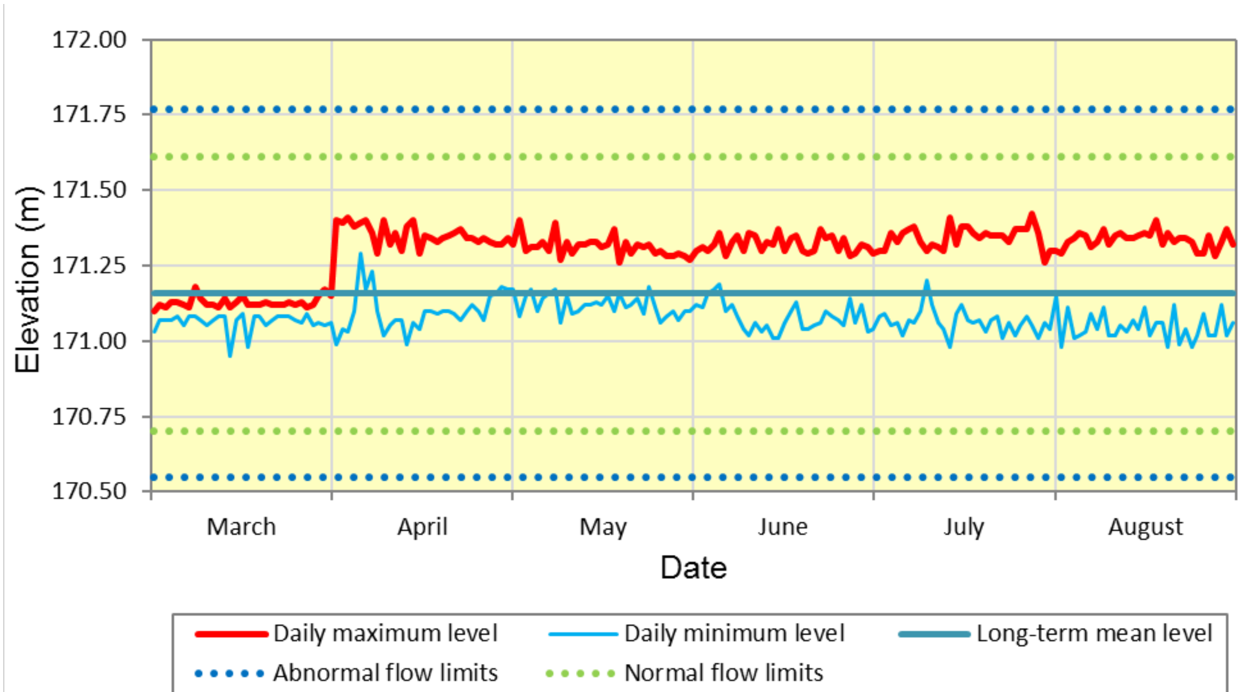
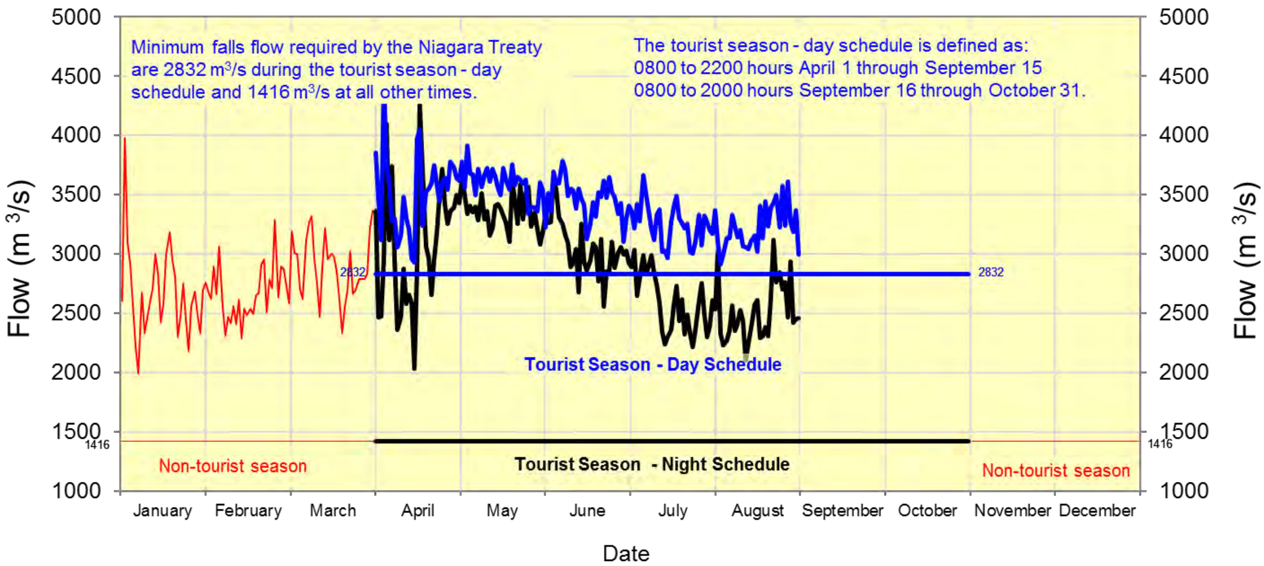
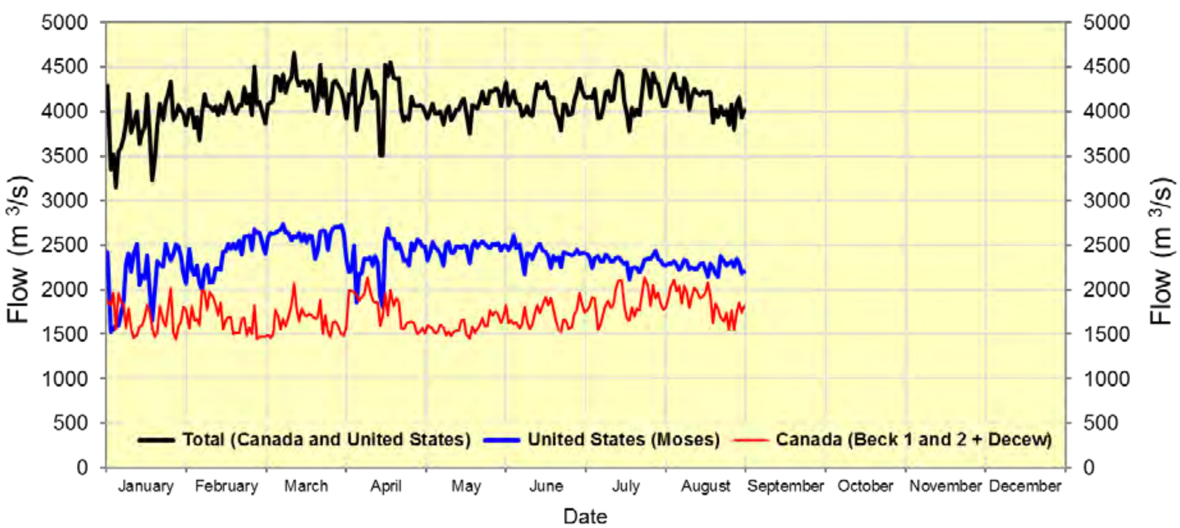


Figure 8: Daily maximum and minimum water levels at Material Dock gauge (March through August 2017).



Note: Flow over Niagara Falls is defined as the flow at Ashland Avenue gauge

Figure 9: Daily flow over Niagara Falls from January through August 2018 (flow at Ashland Avenue in m^3/s).



Note: For purposes of the Niagara Treaty, the Canadian diversion includes water diverted from the Niagara River and water diverted through the Welland ship canal for power purposes

Figure 10: Daily diversion of Niagara River water for power purposes (January through August 2018).

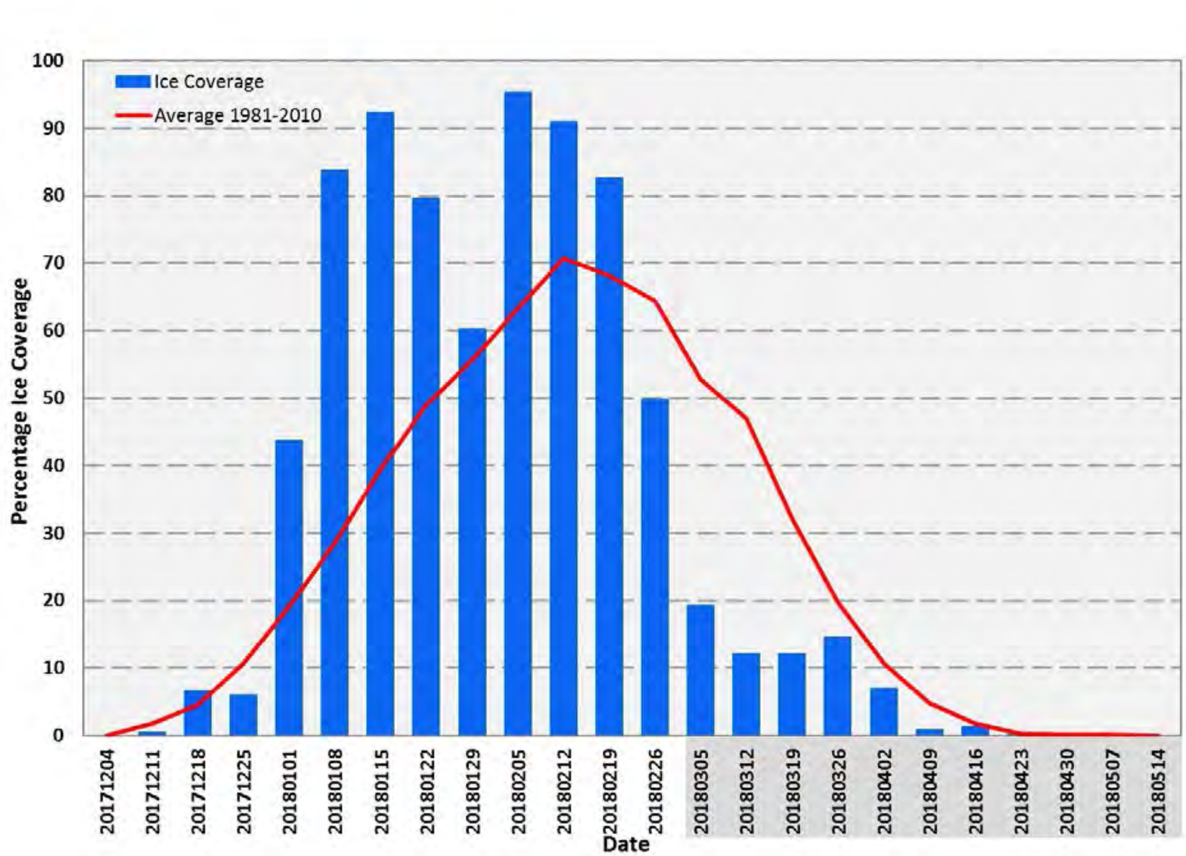
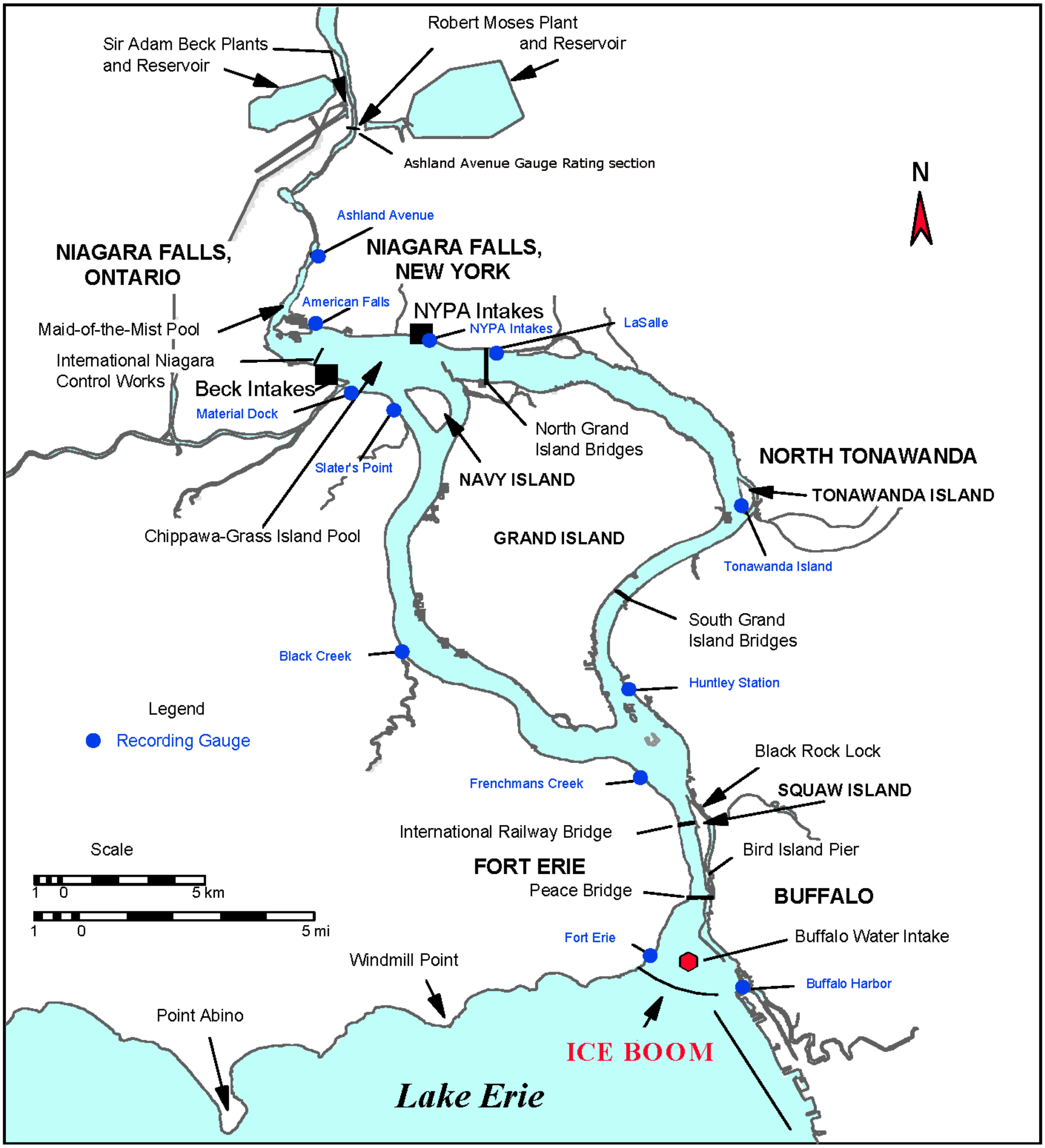


Figure 11: Weeky ice coverage for Lake Erie during the 2017-18 ice season.



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