International Niagara Board of Control

One Hundred Thirty Third Semi-Annual Progress Report

to the

International Joint Commission

Covering the Period March 1 through August 31, 2019

Executive Summary

The Niagara River and Lake Erie basin had record breaking conditions during this reporting period. Lake Erie began the reporting period with a March mean level 58 cm (22.8 inches) above its period-of-record (1918-2018) average level for the month. The level of Lake Erie was well above average throughout this reporting period, setting record high monthly mean values for May, June, July and August. The monthly mean level for June was the highest recorded since 1918. The August mean water level was 75 cm (29.5 inches) above average and 8 cm above its record high set in 1986 (Section 2).

The level of the Chippawa–Grass Island Pool (CGIP) is regulated under the International Niagara Board of Control's 1993 Directive. The Power Entities (Ontario Power Generation and the New York Power Authority) complied with the board's Directive at all times during the reporting period. Due to record high flows in the Niagara River during this reporting period tolerances of the Directive were suspended due to abnormally high flows for 14 days in May, 28 days in June, 30 days in July and 10 days in August. Even with the record high flows in the Niagara River the tolerances in place appear to be functioning well. The board will continue to monitor and assess performance as high flows continue (Section 3).

Gauges were operating at all times during this reporting period to provide flow measurements over Niagara Falls (Section 4).

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

During the reporting period, the Niagara River flow at Queenston averaged 7,578 m^3/s (267,610 cfs), which was 1,633 m^3/s (57,670 cfs) above the 1900-2018 average of 5,945 m^3/s (209,950 cfs). The June monthly mean flow of 8,059 m^3/s (284,600 cfs) set a new period-of-record high for the Niagara River at Queenston (Section 7).

Flow measurements are taken on a regular schedule to confirm the accuracy of the gauges used to determine the allocation of water from the Niagara River. No flow measurements were scheduled during this reporting period. The next scheduled flow measurements are for September 17 and 18, 2019 at the Ashland Avenue Gauge Rating Section, which is used to estimate the flow over Niagara Falls. Measurement are scheduled for 2021 at the Welland Canal and American Falls locations (Section 8).

Ontario Power Generation (OPG) and New York Power Authority (NYPA) continued ongoing upgrades to the their generating units for efficient use of water for power generation (Section 9).

The Lake Erie – Niagara River Ice Boom was operated by the Power Entities in accordance with conditions of International Joint Commission Order of Approval. Lake Erie had a heavy 2018/19 ice season. The Commission was informed on March 28, 2019 that ice cover on the eastern basin of Lake Erie was greater than 650 km^2 (250 mi^2), and that the ice boom would remain in place past April 1. Ice boom removal began on April 22, 2019 and all spans were removed by May 7, 2019 (Section 10).

Major General Mark R. Toy transferred out of his post during this reporting period. A replacement for MG Toy is expected to be named next reporting period (Section 13).

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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 was included. Data that was not available during the last reporting period may also be included in this report.

COVER: Horseshoe Falls June 7, 2019 during period of record high Niagara River flow. (Photo by Hafiz Ahmad, Environment and Climate Change Canada)

INTERNET SITES

International Joint Commission
English: https://ijc.org/en
French: https://ijc.org/fr

International Niagara Board of Control
English: https://www.ijc.org/en/nbc
French: https://www.ijc.org/fr/ccrn

Lake Erie-Niagara River Ice Boom
https://iceboom.nypa.gov/

INTERNATIONAL NIAGARA BOARD OF CONTROL

Cincinnati, Ohio
Burlington, Ontario

September 26, 2019

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 Third Semi-Annual Progress Report, covering the reporting period March 1, 2019 to August 31, 2019.

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

Lake Erie set new record high water levels for several months during this reporting period. The Lake Erie monthly mean levels for May through August were 8 cm, 10 cm, 10 cm and 8 cm higher respectively, than the previous records set in 1986. As a result, the Niagara River experienced record setting high flows during the reporting period.

The level of Lake Erie was above average throughout the reporting period. It began the reporting period with a March mean level of 58 cm (22.8 inches) above its 1918–2018 period-of-record, long-term average for the month. During its seasonal rise, Lake Erie's water level rose 48 cm (18.9 inches) from March to June, compared to its average rise of 27 cm (10.6 inches). Its decline in July of 1 cm was lower than the average decline of 2 cm. Lake Erie levels ended the reporting period with an August monthly mean water level of 75 cm (29.5 inches) above average. Recorded monthly water levels for the period March 2019 through August 2019 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 56.68 cm (22.3 inches) of precipitation during the period March through August 2019. This is about 15% above the 1900-2016 average for the period. Precipitation was above average for all months during the reporting period except for March 2019.

The monthly Lake Erie NBS for this reporting period are shown 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 typically greater than the water lost to evaporation. During the reporting period, the lake's NBS was above average for all months except August.

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. Every month during the reporting period (March-August) set a new seasonal Detroit River flow record high for the period of record going back to 1900 (Figure 5). As a result, inflow to Lake Erie via the Detroit River was approximately 27 percent above the long-term average from March through August 2019.

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 27 percent above average for the period March through August 2019. 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 monthly average flows at Buffalo were well above average ranging from 6,810 m^3/s (240,490 cfs) to 8,070 m^3/s (284,990 cfs) due to above average levels on Lake Erie (Figure 7). The highest flow in June (8,070 m^3/s) set a new record high flow for the river.

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 lake 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.

Due to relatively heavy ice conditions and record high flows in the Niagara River, tolerances of the Directive were suspended on numerous occasions during this reporting period. Tolerances were suspended a total of 12 times due to ice conditions (March 4-6,8,23-25, and April 26-30) and 82 times due to abnormally high flows (May 10, 11, 15, 16, 19-21, 23-26, 28, 30, 31; every day in June except June 8,9; every day in July except July 31, and August 6, 8-10,19, 21, 22, 28-30).

The significant increase in abnormally high flows for this reporting period was a result of the very high water levels in Lake Erie. The INWC reviewed operations of the CGIP over this reporting period and compared operations during the previous record high period, which occurred in 1986. The impacts of the high flows on the operation of the CGIP during this reporting period were found to be less than those in the high water levels in 1986. Of note, an ad hoc review team of the INWC was formed after the 1986 high flow period to review the 1973 Directive and determined that no changes where required to tolerances for the elevations of the CGIP in the 1973 Directive. The tolerances of the Directive in place for this reporting period are the same that were in use in 1986, and appear to continue to function well in high water periods. The INWC and board will continue to monitor and assess if abnormally high flows continue.

The Power Entities complied with the board's Directive at all times during the reporting period. Despite the record setting high flows in the Niagara River, the daily GIP only exceeded 0.46 m once on June 11, 2019 during the abnormally high flows when the Daily GIP Range was 0.50 m.

The accumulated deviation of the CGIP’s level from March 1, 1973 through August 31, 2019 was 0.21 metre-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.

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.

Regular Maintenance at INCW involved a major overhaul on Gate 5, which commenced on May 13, 2019 with an expected completion date of October 31, 2019. The minor overhaul of Gate 4 will be deferred to 2020 due to the late start on Gate 5 associated with ice floes. Gates 12, 13 and 14 were out of service on July 19, 2019 to retrieve Gate 13's ice shield. With this repair the Gate 13 operation restriction was lifted.

There are several on-going projects at the INCW. The public safety radar monitoring project is operational but enhancements continue to be made. A new radar project to monitor ice floes over the ice boom and along the Niagara River will commence in the fall of 2019. The bullnose rehabilitation project is currently mobilized with 8 piers currently being repaired and 8 more piers scheduled for repair in 2020. The control room and IT upgrades are in the execution phase with targeted completion in the 4th quarter of the 2019. The gate refurbishment project is expected to begin its execution phase in 2022.

4. Gauging Stations

The Fort Erie, Material Dock and Ashland Avenue gauges (as shown in Enclosure 1) are used to determine flows in the Niagara River, monitor the CGIP levels and monitor the flow over Niagara Falls. 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. 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 a period of 6.5 hours during a communications failure on 5 July 2019 at Fort Erie and Frenchman's Creek gauges. Frenchman's Creek also had a communication failure for 50.5 hours spanning May 11-13, 2019.

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. Due to the high flows in the Niagara River during this reporting period only April had night time flows below 2,832 m^3/s (100,000 cfs) while all other months (May-August) had both day time and night time values well above the day time minimum limit. The maximum Falls flow of 5,145 m^3/s (181,694 cfs) for the reporting period occurred on June 11, 2019 in the night time hours and the maximum day time flow of 4,612 m^3/s (162,871 cfs) occurred on April 13, 2019.

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 during this reporting period was taken on August 29, 2019) 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 2019, diversion for the SAB I and II plants averaged 1,670 m^3/s (58,980 cfs) and diversion to the Robert Moses Niagara Power Project averaged 2,425 m^3/s (85,640 cfs).

The average flow from Lake Erie to the Welland Canal for the period March through August 2019 was 172.6 m^3/s (6,110 cfs). Diversion from the canal to OPG's DeCew Falls Generating Stations averaged 123.2 m^3/s (4,340 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 2019, and departures from the 1900–2018 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 2019, the flow at Queenston averaged 7,578 m^3/s (267,610 cfs), which was 1,633 m^3/s (57,670 cfs) above the 1900-2018 average of 5,945 m^3/s (209,950 cfs) for the period. The monthly values ranged between 6,894 m^3/s (243,460 cfs) and 8,059 m^3/s (284,600 cfs). The monthly mean June Niagara River flow (8,059 m^3/s) at Queenston is the new highest flow on record for this month.

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. No measurements were taken 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 the week of May 15, 2018. The draft analysis and report are completed, technically reviewed and was distributed to the Niagara Working Committee on 27 Feb 2019 for review. No comments were received and the report is recommended final. 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 continued throughout the year by the USGS New York and ECCC. For the current period, continuous daily discharge data will be produced using the maintained stage-discharge relationship. A new vertical index velocity gauge was completed in November 2018 as a shore-mounted vertical system. In April 2019, the gauge was damaged. Access by divers to repair the gauge has not been possible due to the high water velocities in the river. Planning for repairs to the index velocity setup is underway. Continuous daily discharge data during non-ice affected periods will be published by ECCC (https://wateroffice.ec.gc.ca/report/real_time_e.html?stn=02HA013) and USGS (as contributed data).

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 measurements are scheduled for September 17 and 18, 2019. The following measurement series is scheduled for 2022.

The index velocity meter located at the outflow of the Niagara River into Lake Ontario continues to be measured to develop an accurate rating equation. Measurements were taken in August 2019, additional measurements are scheduled for September 2019.

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 well to the 1978 Rating Equation, with all measurements falling within 1% of the rating. The final report has been posted on the IJC SharePoint site. 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. The last set of verification measurements were made in May 2018 and a report is being prepared. The next set of measurements is planned for May 2021.

9. Power Plant Upgrades

OPG began a unit rehabilitation program in 2007 for its G3, G7, G9 and G10 Beck I units. All of the upgrades have been completed and new unit rating tables have been issued for G3, G7, and G9 during previous reporting periods. A Gibson Test on unit G10 was witnessed by members of the INWC on February 28, 2019 for development of a new rating table for that unit. A report detailing the results of the G10 Gibson Test and the new unit rating table will be completed by OPG and presented to the board. An overhaul of G2 at the DeCew Falls generating station began in November 2016 and was completed with the unit coming back online in August 2019. The Sir Adam Beck G5 unit is being overhauled between May 2019 to June 2020. Refurbishment of the Sir Adam Beck I power canal is planned for the 2020's. A limited time reduction in diversion capacity is planned to be completed by 2022 to replace gates and prepare for longer term rehabilitation. The main rehabilitation project and diversion reduction is planned to be executed in a flexible window between 2023 and 2028, to be timed to minimize the impact to the Ontario energy market. Front end engineering and design has begun on a project to re-establish SAB 1 as a 10-unit station by replacing G1 and G2 with new 60 Hz units. The new units will allow better use of water from the Pump Generating Station and improved peaking operations.

NYPA is continuing unit upgrades at the Lewiston Pump Generating Plant as part of its Life Extension Modernization (LEM) project. The LEM 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 eight months, and is currently targeted for completion by 2020. Unit PG4 was brought back into service in June 2019. PG3 is in outage mode for an eight month period starting June 30, 2019 while it is being replaced. This leaves two out of 12 units, PG1 and PG10, for anticipated completion by 2020. The Robert Moses Plant 'Next Generation Niagara' LEM has plans to upgrade the control boards at the end of 2020 with unit mechanical upgrades scheduled for 2023; the targeted completion of all 13 units is 2032. In

April 2019, NYPA completed the inspection of the twin intake conduits connecting the Hydro-plant forebay and the Niagara River, and intake gates and their housing structure.

10. Ice Conditions and Ice Boom Operation

Ice cover over Lake Erie started increasing during the second week of January and peaked at about 95% during the first week of March. It then began to steadily decline throughout the remainder of the 2018-19 ice season (Figure 11). Information on the installation of the Lake Erie-Niagara River Ice Boom for the 2018-19 ice season is provided in the 132nd semi-annual report.

Measurements of ice thickness at six standard site on the eastern end of Lake Erie were taken on March 13, 2019, the second set of measurements taken during the 2018/19 ice season. The first measurements were taken on February 22, 2019.

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 National Oceanic and Atmospheric Administration and the Canadian Ice Service (Figure 12) was used to estimate the ice cover on the eastern basin of Lake Erie form March to April. At the end of March 2019 the eastern basin of Lake Erie was covered an area ice of about 1800 km^2 (700 mi^2). The Commission was informed on March 28, 2019 that the opening of the ice boom would be delayed until after April 1, 2019. A fixed wing survey flight, which took place on April 17, 2019, determined that the amount of ice remaining in the eastern basin of Lake Erie was 746 km^2 (288 mi^2).

Based on the ice flight, the INWC held a conference call on April 18, 2019. It was brought to the attention of the INWC that warm temperatures were forecasted for the next few days, therefore, ice cover is estimated to be below 650 km^2 (250 mi^2) by the start of the following week. Considering the ice flight findings, weather forecast, and the absence of ice buildup in the Maid-of-the-Mist Pool below Niagara Falls, a media advisory was released the same day (April 18, 2019) stating that the Lake Erie Niagara River Ice Boom removal would commence April 22, 2019. The New York Power Authority crew opened, removed and placed all 22 spans of the Ice Boom behind the Buffalo Harbor breakwall from April 22 to May 7, 2019.

All ice boom buoy barrels were removed between May 8, 2019 and May 13, 2019. The 152 metre (500 foot) long ice boom spans were towed from the breakwall up the Buffalo River to the Katherine Street storage facility and put into dry storage between May 14, 2019 and May 20, 2019.

Both the United States and Canadian Coast Guards, along with the Commission, were informed that the ice boom operations were complete for the 2018-19 ice season.

11. Other Issues

All issues were covered within sections of this report for this reporting period.

12. Meeting with the Public

A board exhibit with U.S. INWC members available to answer questions was set up at the Paddles Up Niagara event on July 27, 2019 at Beaver Island State Park on Grand Island, New York. About 200 participants attend the event. A WebEx is planned for October 8, 2019 to provide information on board activities to the public and provide an opportunity for members of the public to ask questions to the board members.

13. Membership of the Board and the Working Committee

Major General Mark R. Toy transferred out of his post during this reporting period. A replacement is being sought for the US Co-Chair.

14. Attendance at Board Meetings

The board met once during this reporting period. The meeting was held on September 26, 2019 at the Canadian Centre for Inland Waters, Burlington, Ontario Canada. Mr. Aaron Thompson, Canadian Section Chair and Mr. Stephen Durrett, U.S. Alternate Section Chair, were present in Burlington. Canadian board member, Ms. Jennifer Keyes, and U.S. board member Mr. David Capka attended via WebEx.

The next board meeting is scheduled for March 2020 in Ann Arbor, Michigan, United States.

Original signed by	*Original signed by*
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Mr. Aaron F. Thompson Chair, Canadian Section	Mr. Stephen G. Durrett Chair, United States Section
Original signed by	*Original signed by*
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Ms. Jennifer L. Keyes Member, Canadian Section	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* 2019	Average 1918-2018	Departure	Recorded* 2019	Average 1918-2018	Departure
March	174.66	174.08	0.58	573.03	571.13	1.90
April	174.83	174.23	0.60	573.59	571.62	1.97
May	175.05	174.31	0.74	574.31	571.88	2.43
June	175.14	174.35	0.79	574.61	572.01	2.60
July	175.13	174.33	0.80	574.57	571.95	2.62
August	175.02	174.27	0.75	574.21	571.75	2.46

* Provisional

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

	Centimetres			Inches			
Month	Recorded* 2018	Average 1900-2016	Departure	Recorded* 2018	Average 1900-2016	Departure	Departure (in percent)
March	6.99	7.00	-0.01	2.75	2.76	-0.01	00
April	11.18	8.10	3.08	4.40	3.19	1.21	38
May	9.65	8.60	1.05	3.80	3.39	0.41	12
June	11.00	8.80	2.10	4.33	3.46	0.87	25
July	9.45	8.60	0.75	3.72	3.39	0.33	10
August	8.41	8.20	0.21	3.31	3.23	0.08	02

* Provisional

Table 3: Monthly Niagara River flows at Queenston.

	Cubic Metres per Second			Cubic Feet per Second		
Month	Recorded 2019	Average 1900-2018	Departure	Recorded 2019	Average 1900-2018	Departure
March	6894	5666	1228	243,460	200,090	43,370
April	7167	5922	1245	253,100	209,130	43,970
May	7893	6116	1777	278,740	215,980	62,760
June	8059	6091	1968	284,600	215,100	69,500
July	7851	5998	1853	277,260	211,820	65,440
August	7602	5878	1724	268,460	207,580	60,880
Average	7578	5945	1633	267,610	209,950	57,660

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	2019	7893	278,740	1934	4530	159,980
June	2019	8059	284,600	1934	4470	157,860
July	2019	7851	277,260	1934	4360	153,970
August	2019	7602	268,460	1934	4370	154,330

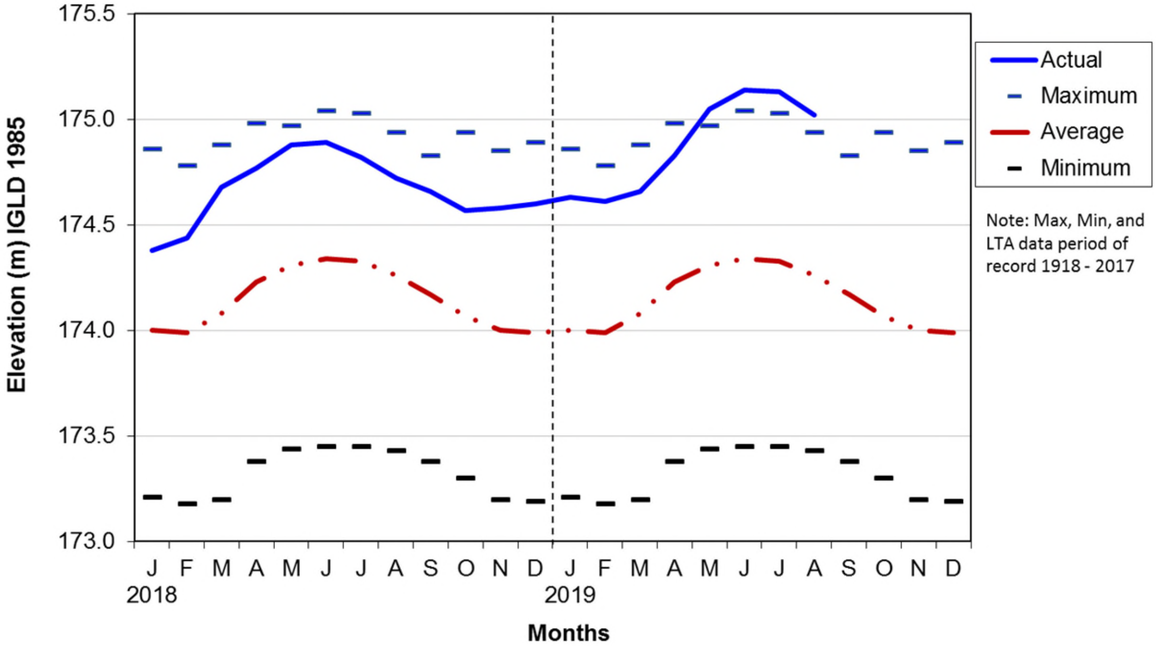


Figure 1: Lake Erie mean monthly and long-term maximum, minimum and average water levels.

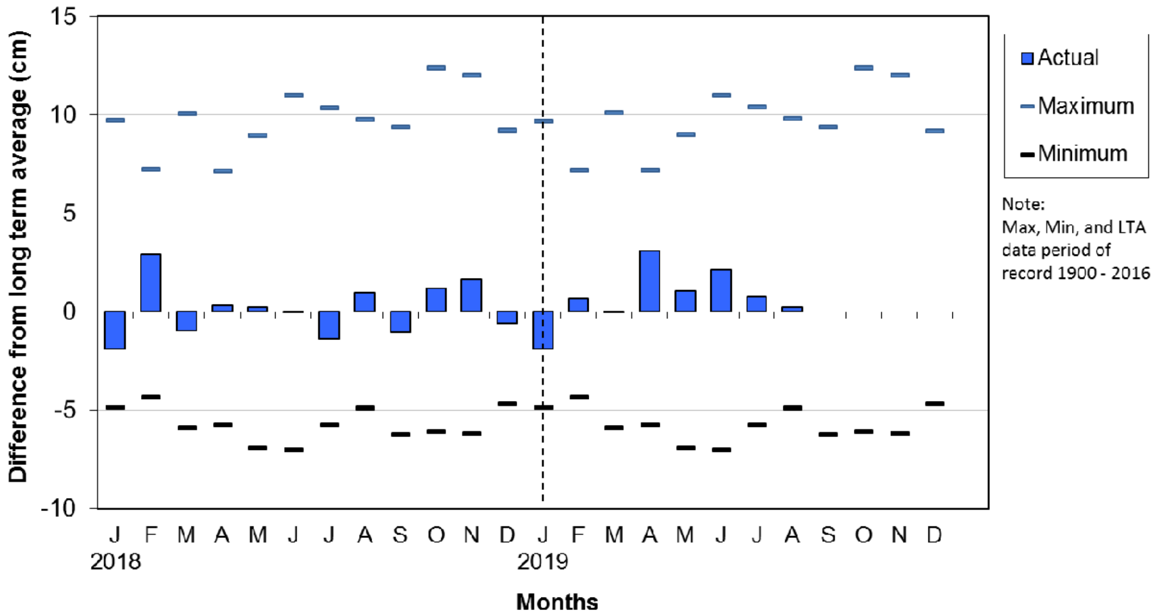


Figure 2: Monthly actual, maximum and minimum precipitation departures from the long-term average on Lake Erie basin.

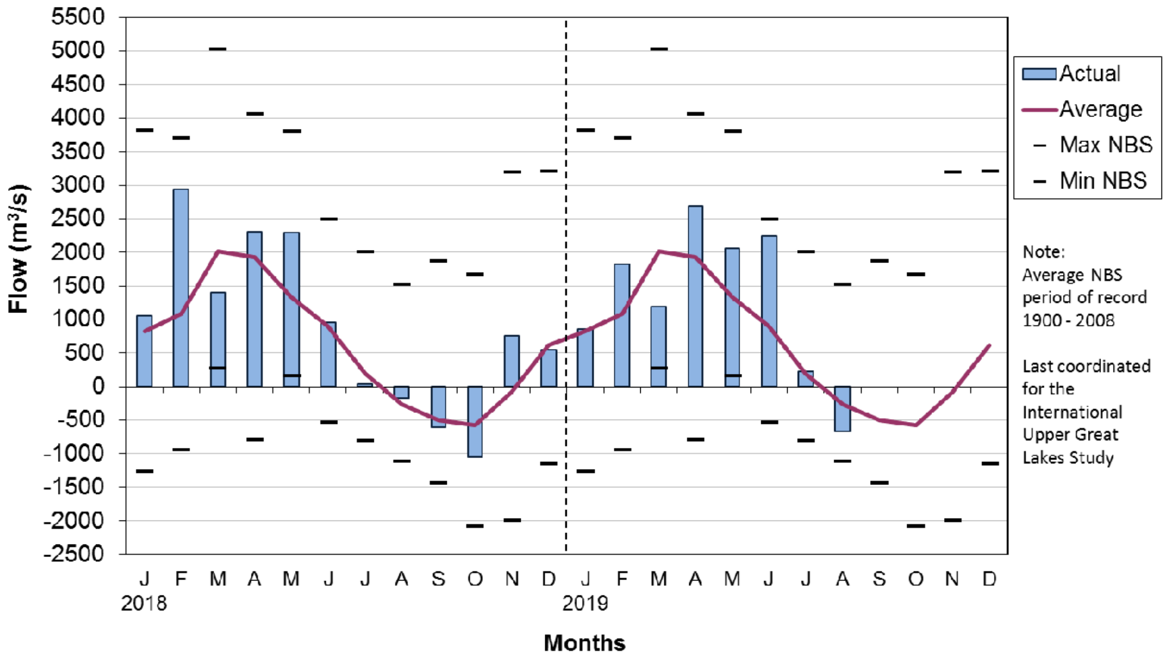


Figure 3: Monthly actual, maximum, minimum and average net basin supplies on Lake Erie basin.

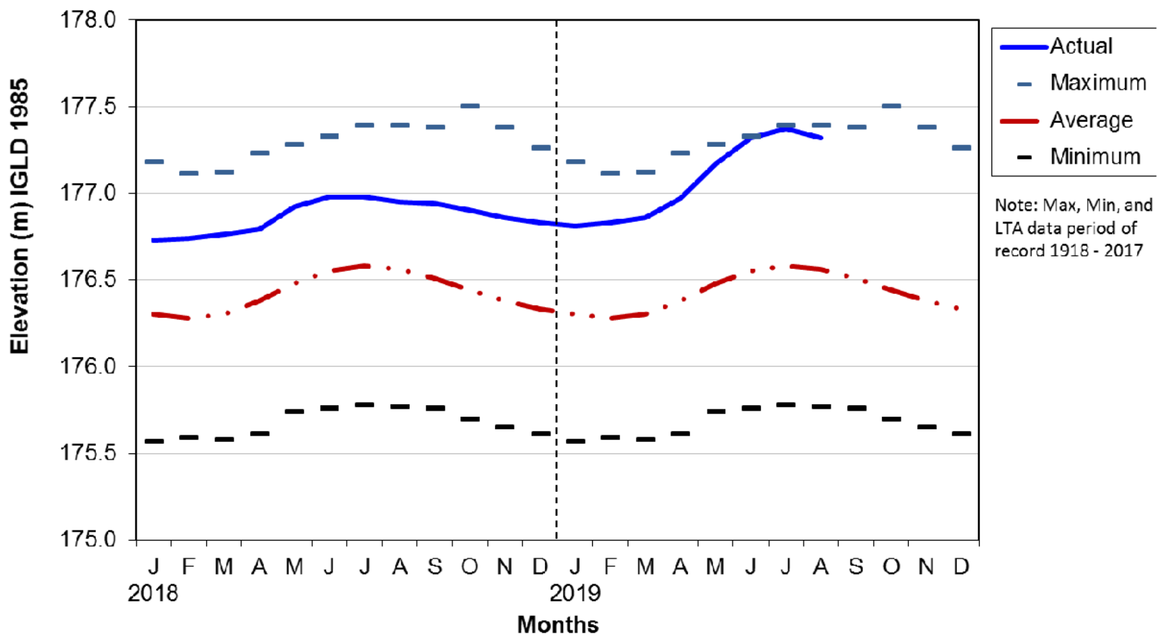


Figure 4: Lake Michigan-Huron mean monthly actual, maximum, minimum and average water levels.

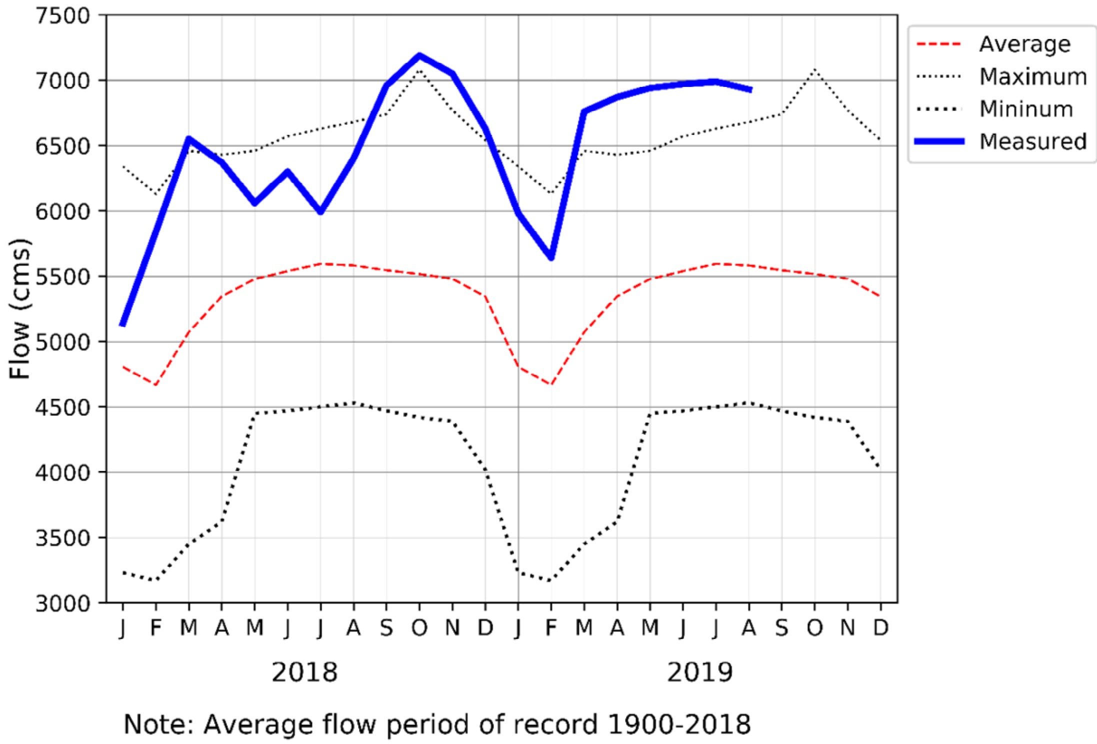


Figure 5: Detroit River mean monthly actual, maximum, minimum and average flows.

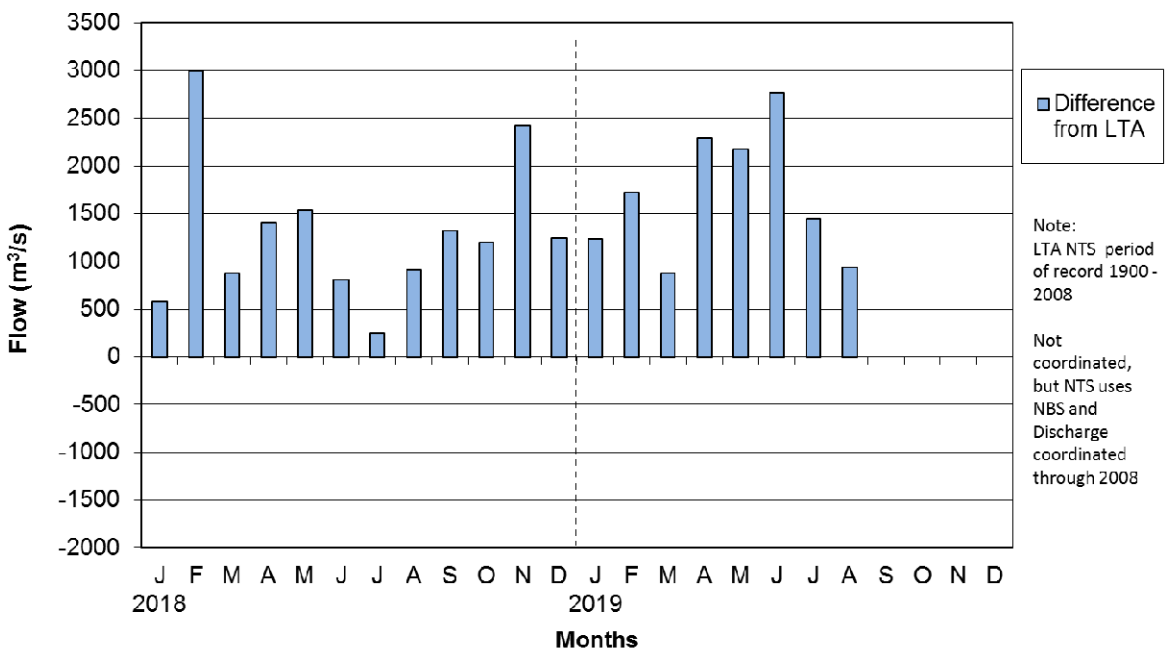


Figure 6: Lake Erie basin monthly net total supplies difference from the long term average.

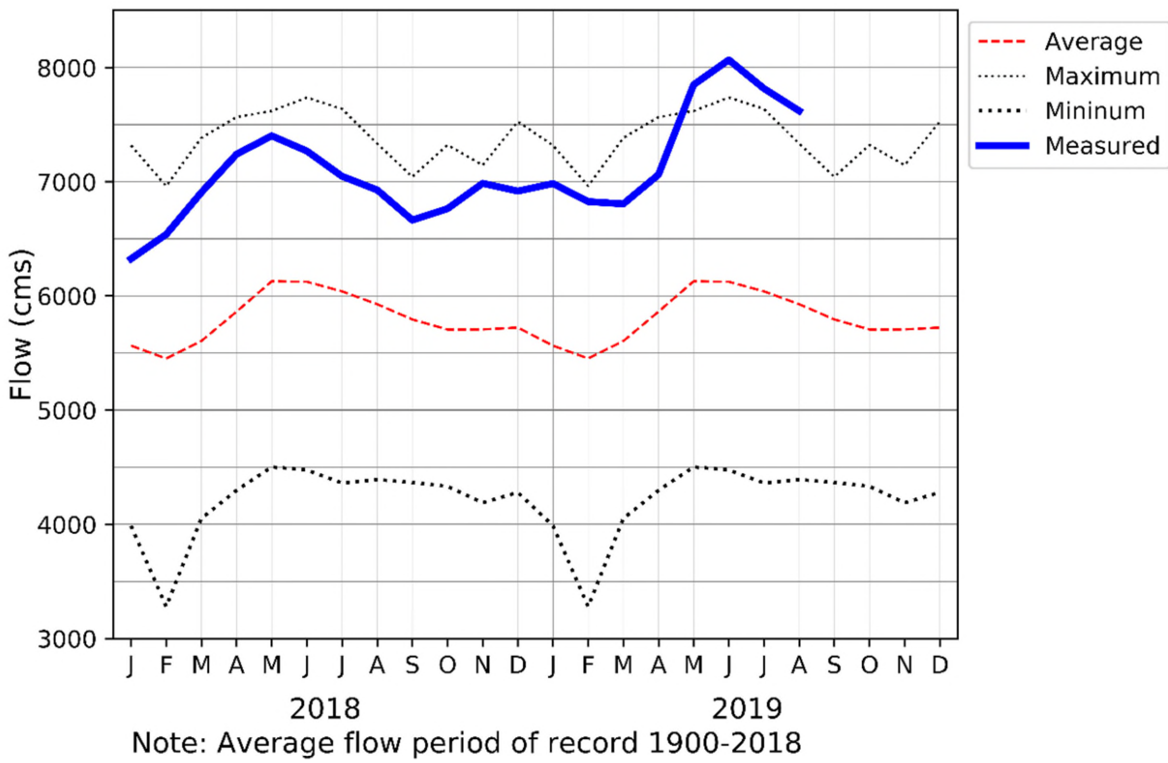


Figure 7: Niagara River mean monthly actual and average flows at Buffalo, New York.

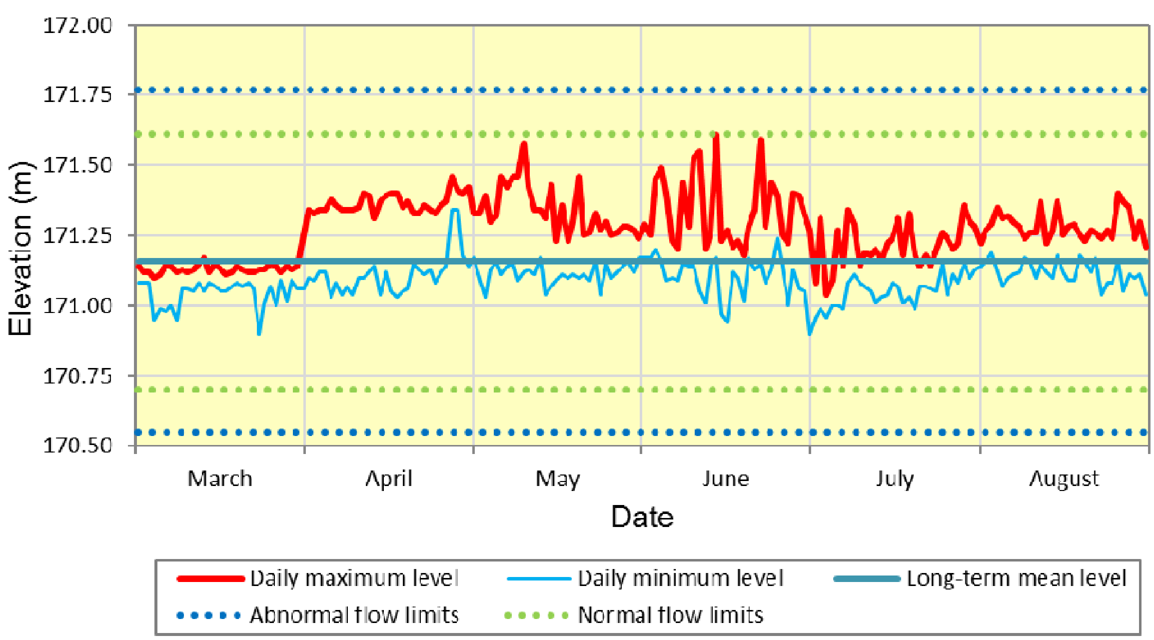
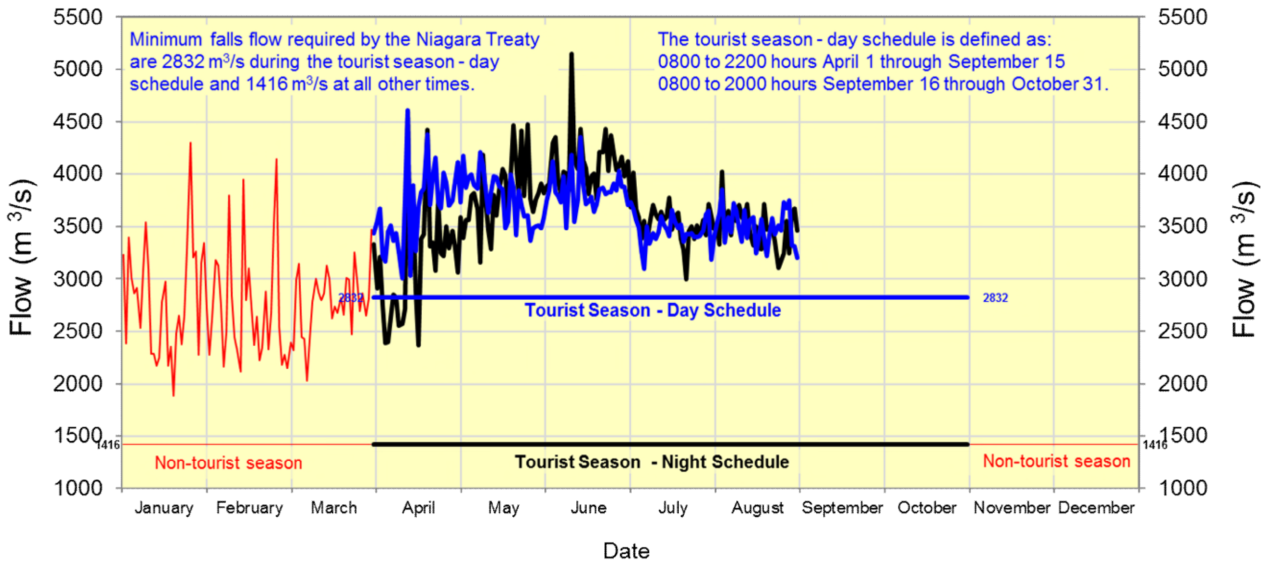
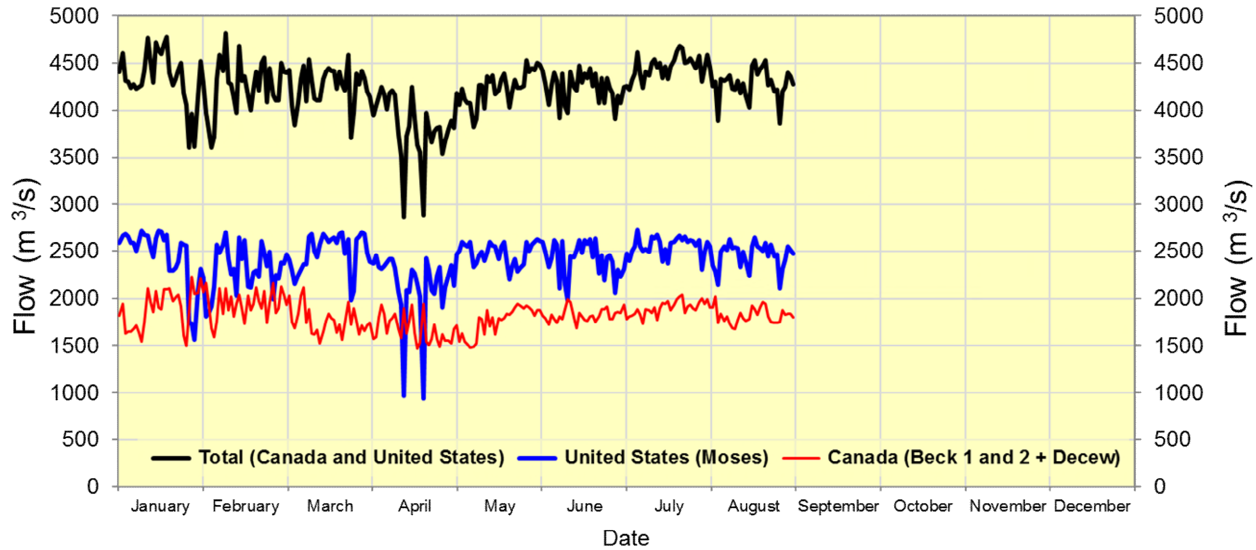


Figure 8: Daily maximum and minimum water levels at Material Dock gauge (March through August 2019).



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 2019 (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 2019).

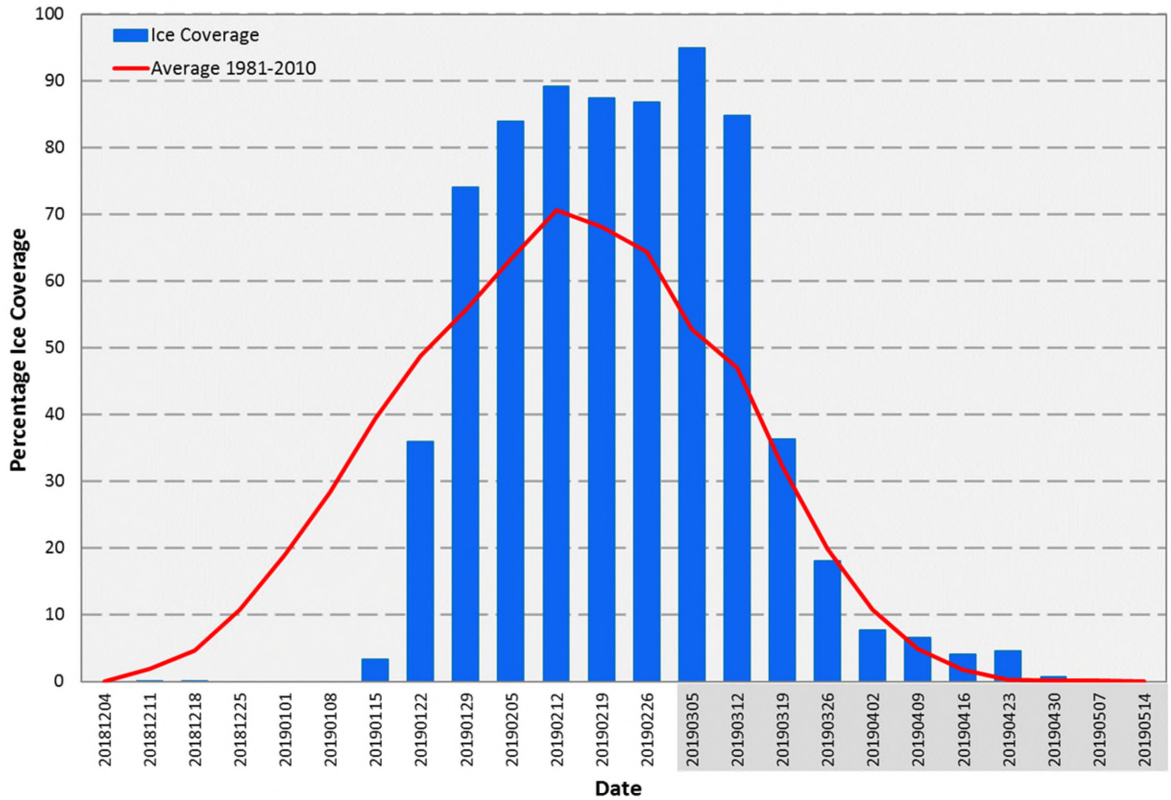


Figure 11: Weeky ice coverage for Lake Erie during the 2018-19 ice season.

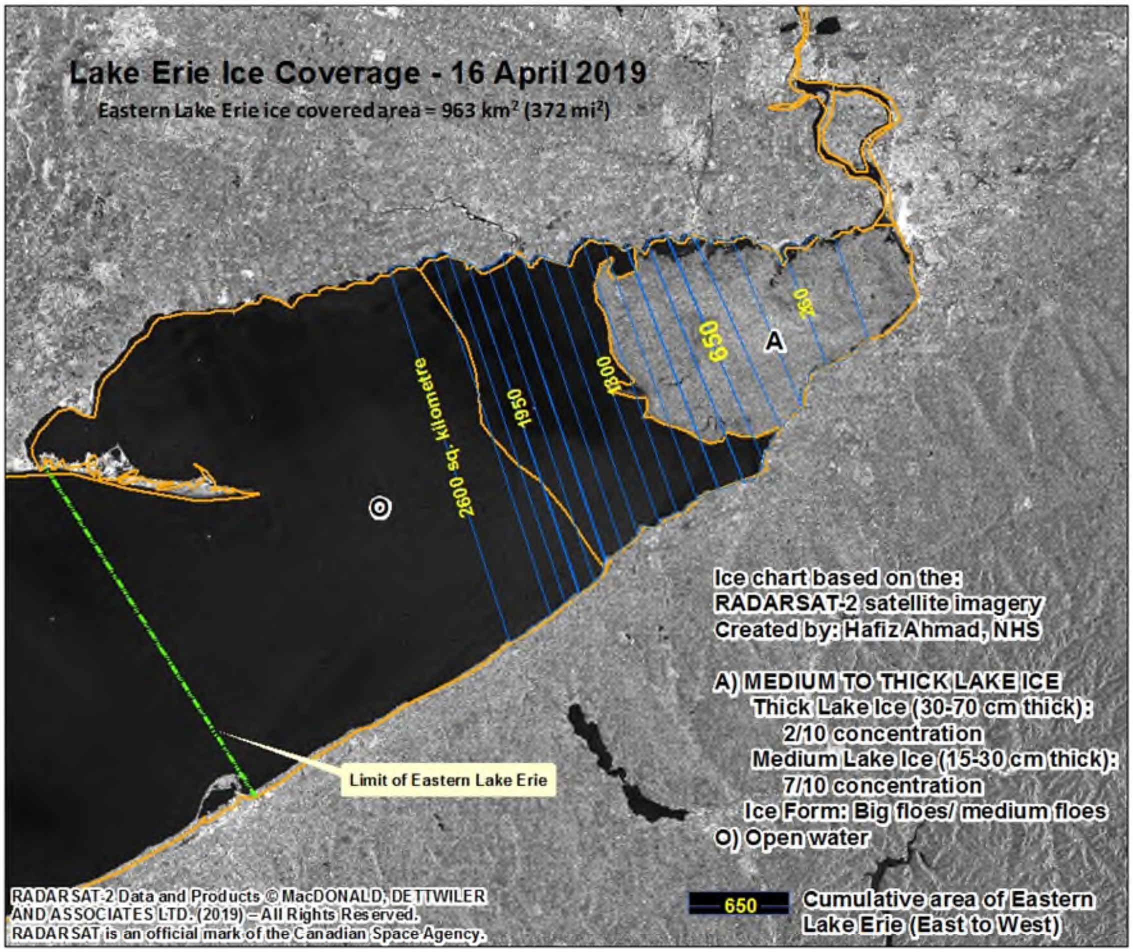
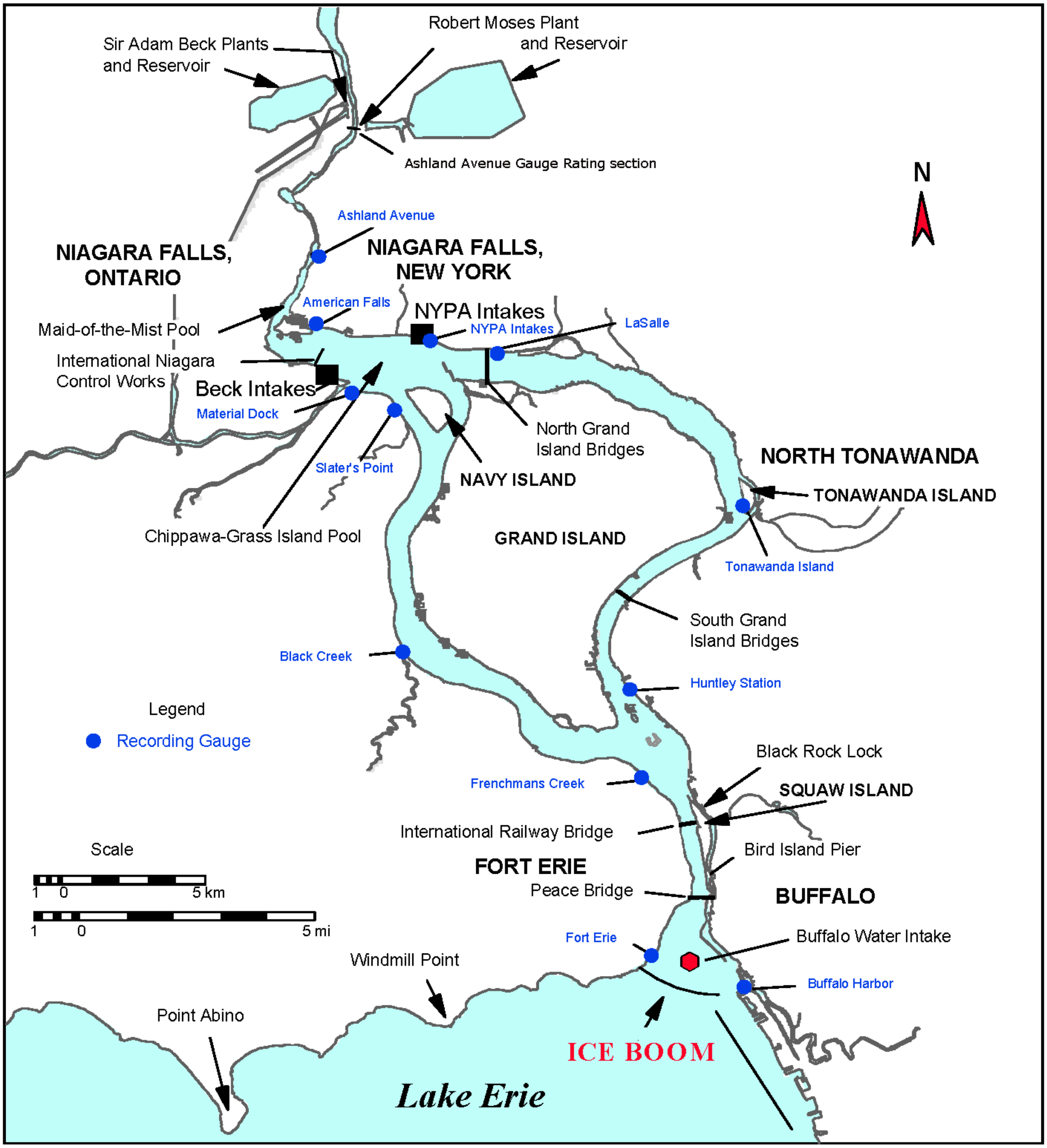


Figure 12: Satellite image from Canadian Ice Service used to estimate ice cover on Lake Erie.



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