International Niagara Board of Control

One Hundred Thirty-Second Semi-Annual Progress Report

to the

International Joint Commission

Covering the Period September 1, 2018 through February 28, 2019.

Executive Summary

The level of Lake Erie was above average throughout the reporting period. It began the reporting period with a September mean level at 49 cm (19.3 in) above its 1918–2017 period-of-record, long-term average level for the month. From September 2018 to February 2019 the lake level fell 5 cm (1.9 in). This is 12 cm (4.7 in) less than the average decline of 17 cm (6.7 in) for this period. From September to October, water levels declined 9 cm (3.5 in), similar to the long-term average decline of 10 cm (3.9 in) for this period. Water levels remained relatively constant from October to December, steadily increasing by 2 cm (0.8 in). From December to February, lake levels rose another 2 cm (0.8 in) ending the reporting period with a February monthly mean water level 62 cm (24.4 in) 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).

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).

OPG began an overhaul of G2 at the DeCew Falls generating station in November 2016. The work is taking longer than previously expected and will remain out of service until March 2019. The Sir Adam Beck G5 unit will be overhauled in May 2019 to June 2020. In

2021 to 2023 there will be an extended outage for refurbishment of the Sir Adam Back I power canal.   NYPA is continuing unit upgrades at the Lewiston Pump Generating Plant as part of its Life Extension Modernization (LEM) project. Also, the Robert Moses Plant LEM has scheduled control boards to be upgraded in 2020 with unit mechanical upgrades scheduled for 2023. (Section 9).

Installation of the ice boom was initiated on December 13 with placement of spans of the boom starting from the Canadian side. Some adverse weather conditions were encountered on December 17, but the Ice Boom Marine Crew was able to complete the boom installation on 18 December, 2018. Ice cover on Lake Erie was approximately 93% on February 28, 2019 or approximately 24,000 km^2 (9,300 square miles). (Section 10).

COVER: View of the Horseshoe Falls.
(Photo by Hafiz Ahmad, Environment and Climate Change Canada)

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.

INTERNET SITES

International Joint Commission
https://www.ijc.org/en

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
www.iceboom.nypa.gov

INTERNATIONAL NIAGARA BOARD OF CONTROL

Cincinnati, Ohio March 1, 2019
Burlington, Ontario

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 Thirty-second Semi-Annual Progress Report, covering the reporting period September 1, 2018 to February 28, 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

The level of Lake Erie was above average throughout the reporting period. It began the reporting period with a September mean level at 49 cm (19.3 in) above its 1918–2017 period-of-record, long-term average level for the month. From September 2018 to February 2019 the lake level fell 5 cm (1.9 in). This is 12 cm (4.7 in) less than the average decline of 17 cm (6.7 in) for this period. From September to October, water levels declined 9 cm (3.5 in), similar to the long-term average decline of 10 cm (3.9 in) for this period. Water levels remained relatively constant from October to December, steadily increasing by 2 cm (0.8 in). From December to February, lake levels rose another 2 cm (0.8 in) ending the reporting period with a February monthly mean water level 62 cm (24.4 in) above average. Recorded monthly water levels for the period September 2018 through February 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). The average NBS is derived from the 1900-2008 period of record.

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 41.1 cm (16.2 inches) of precipitation from September 2018 through February 2019, which is the same as the long term average (LTA) of 41.1 cm (16.2 in) for this period. Precipitation in September, December, and January were drier than the LTA, whereas October, November, and February were slightly wetter than the LTA.

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 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 varied as expected, it was above-average in November, below average in September, October and January, and approximately average in December and February. 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 from September 2018 to February 2019.

The inflow from Lake Michigan–Huron via the Detroit River (Figure 5), combined with near-average precipitation resulted in an above average NTS for Lake Erie for the period of September 2018 through February 2019. 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 when strong westerly winds raising the level of the lake at the east end resulting in increased outflow and easterly winds having the opposite effect. September to February Niagara River monthly average flows ranged from 6,850 to 7,080 m^3s 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 2019 by the U.S. Army Corps of Engineers (USACE) and Environment and Climate Change Canada (ECCC) indicates that even if low water supply conditions are experienced, the level of Lake Erie would remain above average throughout the spring and summer, primarily because the levels of the upstream lakes are higher than average.

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.

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 February 28, 2019 was 0.02 meter-months (0.07 foot-months) above the long-term operational average elevation. The accumulated deviation was within the maximum permissible accumulated deviation of ±0.91 meter-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 January 26 – February 4, 2019 (inclusive); February 12-14, 16-18, and 24-27, 2019; due to abnormally high flows on October 20, 2018, November 6, 7, 10, 11, 21, 2018, December 29, 2018, January 1, 25, 2019, and February 8, 9 , 2019; and due to an emergency rescue on October 3, 4, 6, 7, 2019.

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.

Several on-going maintenance projects continue at the INCW. The fence and parking lot upgrades was completed during this reporting period. The public safety monitoring project is being operationalized. The bullnose project currently has 3 piers completed in 2018 with 8 piers scheduled for 2019 and 8 more piers scheduled for 2020. The control room and IT upgrades are in design phase with targeted completion in the 4^{th} quarter of the Fiscal Year 2019. The gate refurbishment project is expected to begin execution phase in 2022.

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 a period of 1.5 hours during a communications failure on 14 November, 2018. The Fort Erie gauge, Material Dock gauge, and Ashland Avenue gauge were all out during this time.

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 meters per second (m^3/s) (100,000 ft^3/s (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 crest line. Crest line changes may result in a broken curtain of water which could change the scenic value of the Falls. Changes in the crest line 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 March 1, 2019) showed no evidence of notable change in the crest line 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. For scenic purposes the Treaty prohibits the diversion of Niagara River water that would reduce the flow over Niagara Falls 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 September through February 2019, diversion for the SAB I and II plants averaged 1,668 m^3/s (58,900 cfs) and diversion to the Robert Moses Niagara Power Project averaged 2,388 m^3/s (84,330 cfs). The average flow from Lake Erie to the Welland Canal for the period September through February 2019 was 160.0m^3/s (5,600 cfs). Diversion from the canal to OPG's DeCew Falls Generating Stations averaged 113.2 m^3/s (3,990 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 September through February 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 September through February 2019, the flow at Queenston averaged 6,884 m^3/s (243,110 cfs), which was 1,243 m^3/s (43,900 cfs) above the 1900-2018 average of 5,641 m^3/s (199,210 cfs) for the period. The monthly values ranged between 6,645 m^3/s (234,670 cfs) and 7,033 m^3/s (248,370 cfs). It is interesting to note that November 2018 flow was 12 m^3/s less than the maximum recorded flow for the month, the second highest November mean flow on record and the highest since 1986 (Table 3 & 4).

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 technical review and was distributed to the Niagara Working Committee for review. 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. Continuous daily discharge data during non-ice affected periods will be published by ECCC and USGS (as contributed data) through their respective web sites, using the stage-discharge relationship that continues to be maintained. ECCC completed the reconnaissance, planning, and installation of a new index velocity meter installation during the second half of 2018. The new location is approximately 100 m downstream of the previous location. The new installation was required to replace the former index velocity instrument location, which had become unable to generate discharge data due to a previously reported shore wall collapse. The development of an index velocity relationship at the new location is expected to be ongoing through 2019 and into 2020.

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.

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. Last measurements were taken in November 2018 and next measurements are scheduled for spring of 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 close to the 1978 Rating Equation, with all measurements falling within 1% of the rating. The measurement report has been reviewed by the Niagara Working Committee, comments have been addressed, and 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. 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 and the associated analysis and reporting was completed in early 2018. A similar series of verification measurements were taken the week of May 15, 2018. Data processing and analysis from the 2018 verification exercise is planned to be completed in spring 2019 along with a draft report. The next measurements are scheduled for the spring of 2021.

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. A Gibson Test on unit G10 was witnessed by members of the International Working Committee members on February 28, 2019. A report detailing the results of the 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. The work is taking longer than previously expected and will remain out of service until March 2019. The Sir Adam Beck G5 unit will be overhauled in May 2019 to June 2020. In 2021 to 2023 there will be an extended outage for refurbishment of the Sir Adam Back I power canal. The work will restore the original design conveyance capacity to the canal. From April 2022 until Dec 2023 the SAB diversion capacity is expected to be reduced by 617 cms.

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 PG4 will be brought back in service in June 2019. PG1 is scheduled for a 8 month replacement starting June 30, 2019. This leaves 2 of 12 units, PG3 and PG10 remaining for anticipated completion by 2020. The Robert Moses Plant LEM has scheduled control boards to be upgraded in 2020 with unit mechanical upgrades scheduled for 2023. NYPA is also presently in the process of inspecting its’ twin intake conduits connecting the Hydro-plant fore bay and the Niagara River. The inspection process is multi-faceted and is expected to be completed in 2020.

10. Ice Conditions and Ice Boom Operation

Installation of the ice boom may begin when the Lake Erie water temperature as measured at the Buffalo Water Intake reaches 4ºC (39ºF) or on December 16, whichever occurs first. The Lake Erie water temperature reached 4ºC (39ºF) on Wednesday December 12, 2018. The Board issued a media advisory on December 12, 2018 informing the public of the installation, as these conditions met the criteria to begin installation, and the first of the boom's spans was installed on December 13, 2018. Installation of the ice boom was initiated starting from the Canadian side and was installed over the period of 5 days with a minor interruption on December 17 due to adverse weather conditions. Installation of all 22 spans was completed by December 18, 2018.

Weekly reports on the ice conditions for Lake Erie and the Niagara River were prepared and submitted to the Board by the Power Entities beginning on November 26, 2018.

First river ice was spotted on January 19, 2019 in the CGIP. Niagara River temperature was recorded at 0ºC (32ºF) on January 20, 2019. Snow and high winds on January 25, 2019 caused ice to come over the boom and the NYPA and OPG ice breakers were requested however due to abnormal high flows greater than 7,650 cms (270,157 cfs) the breakers deployment was delayed until January 26, 2019. The Niagara Queen II and the Latham deployed at 5:27 AM on January 26, 2019 and at 5:50 AM the NYPA ice affected flood warning notification plan (IA-FWNP) was activated for "flood watch at Lasalle Expressway". On January 27, 2019 additional ice was reported pushed over the boom and the Flood Watch at LaSalle Expressway was elevated to a Flood Warning. On January 28, 2019an ice Boom Pontoon was retrieved from the GIP. All flood watches and warnings had been revoked by January 31, 2019. Ice procedures in affect for NYPA diversion cuts remained in place for this event through February 4, 2019 at which time Ice procedures were terminated.

Strong westerly winds across Lake Erie on February 24 and 25 pushed large quantities of ice over the Lake Erie – Niagara River Ice Boom. At 4:20 pm on February 24, 2019, the NYPA ice affected flood warning notification plan (IA-FWNP) was activated for a "flood watch at Aqualane". This was elevated to a Flood Warning at 5:40 pm that same day. The Flood Warning was cancelled at Aqualane at 8:15 am on February 25, 2019, but a Flood Watch was activated at Lasalle Expressway at the same time. The Flood Watch at Lasalle continued until 4:02 pm on February 25, 2019 when it was cancelled.

The boom is designed to reduce the amount of ice entering the Niagara River by aiding in the formation of a naturally occurring ice arch. However, the boom is not able to hold back the large quantities of ice seen pushed into the Niagara River by the high westerly winds. Ideally under these conditions, the boom, which is made up of a series of floating pontoons, is pushed under water and the ice passes over it, without harming it. The New York Power Authority has identified some damage to the boom due to the strong winds and the large forces of the ice pushing up against it. The full extent of the damage was not determined due to the strong winds and heavy ice conditions limiting the ability to observe the boom. As of February 28, the New York Power Authority reported that, despite damage to the ice boom which included some missing spans, the natural ice arch shows signs of reforming. New York Power Authority's assessment was ongoing subject to safety and operational conditions.

Ice cover on Lake Erie was approximately 93% on February 28, 2019 or approximately 24,000 km^2 (9,300 square miles).

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 https://www.ijc.org/en/nbc/watershed/ice-boom.

11. Other Issues

There were no other issues to report for this reporting period.

12. Public Meetings and Outreach

No public meetings were held during this period. Plans for a booth at the Erie County Fair, New York in August 2019 are being prepared.

13. Membership of the Board and the Working Committee

No changes to Board staff or the Working Committee were made during this reporting period.

14. Attendance at Board Meetings

The Board met once during this reporting period. The meeting was held on September 19, 2018 at the St. Lawrence Power Generation Visitor Center in Cornwall, Ontario. Mr. Aaron Thompson, Canadian Section Chair, Mr. Stephen Durrett, U.S. Alternate Section Chair, and the Secretaries were present in Cornwalll. Canadian Board Member, Ms. Jennifer Keyes, and U.S. Board Member, Mr. David Capka attended remotely via teleconference and webex.

Thompson, Aaron Digitally signed by Thompson, Aaron Date: 2019.04.24 14:39:07 -04'00'

Mr. AARON F. THOMPSON
Chair, Canadian Section

Mr. STEPHEN DURRETT
Alt. Chair, United States Section

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* 2018/2019	Average 1918-2017	Departure	Recorded* 2018/2019	Average 1918-2017	Departure
September	174.66	174.17	0.49	573.03	571.42	1.61
October	174.57	174.07	0.50	572.74	571.10	1.64
November	174.58	174.00	0.58	572.77	570.87	1.90
December	174.59	173.99	0.60	572.80	570.83	1.97
January	174.63	174.00	0.63	572.93	570.87	2.06
February	174.61	173.99	0.62	572.87	570.83	2.04

Table 2: Monthly average precipitation on the Lake Erie basin

	Centimetres			Inches			
Month	Recorded* 2018-2019	Average 1900-2016	Departure	Recorded* 2018-2019	Average 1900-2016	Departure	Departure (in percent)
September	7.20	8.20	-1.00	2.82	3.23	-0.41	-13
October	8.30	7.20	1.10	3.31	2.83	0.48	16
November	8.90	7.30	1.60	3.49	2.85	0.64	22
December	6.20	6.80	-0.60	2.44	2.68	-0.24	-10
January	4.40	6.30	-1.90	1.74	2.48	-0.74	-30
February	6.10	5.30	0.80	2.40	2.11	0.29	14

* Provisional

Table 3: Monthly Niagara River flows at Queenston.

	Cubic Metres per Second			Cubic Feet per Second		
Month	Recorded 2018-2019	Average 1900-2018	Departure	Recorded 2018-2019	Average 1900-2018	Departure
September	6645	5742	903	234,670	202,780	31,890
October	6758	5667	1091	238,660	200,130	38,530
November	7018	5688	1330	247,840	200,870	46,970
December	6966	5724	1242	246,000	202,140	43,860
January	7033	5565	1468	248,370	196,530	51,840
February	6885	5461	1424	243,140	192,850	50,290
Average	6884	5641	1243	243,110	199,210	43,900

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
September	1986	6880	242,960	1934	4340	153,270
October	1986	7220	254,970	1934	4320	152,560
November	1986	7030	248,260	1934	4190	147,970
December	1985	7410	261,680	1964	4270	150,790
January	1987	7240	255,680	1964	3960	139,850
February	1987	6900	243,670	1936	3320	117,240

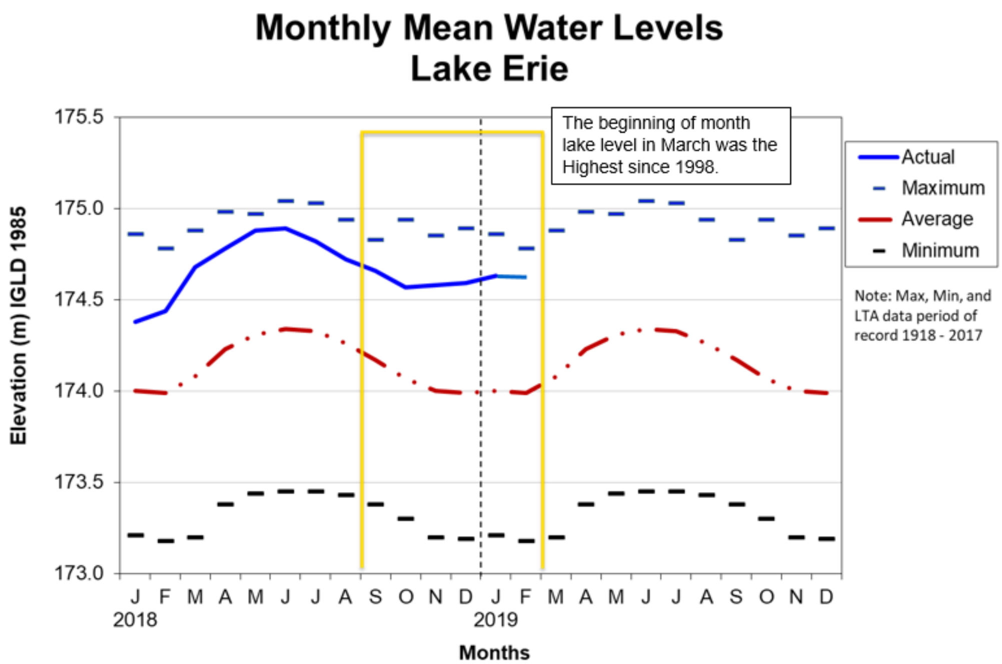


Figure 1: Lake Erie mean monthly and long-term maximum, minimum and average water levels.

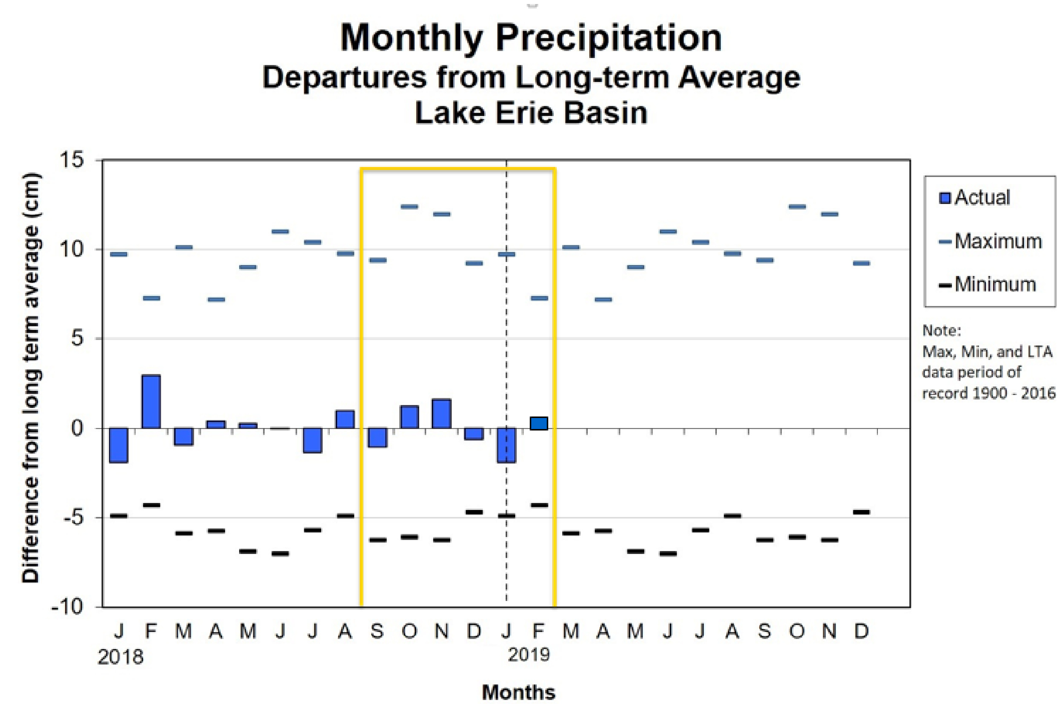


Figure 2: Monthly actual, maximum and minimum precipitation departures from the long-term average on Lake Erie basin.

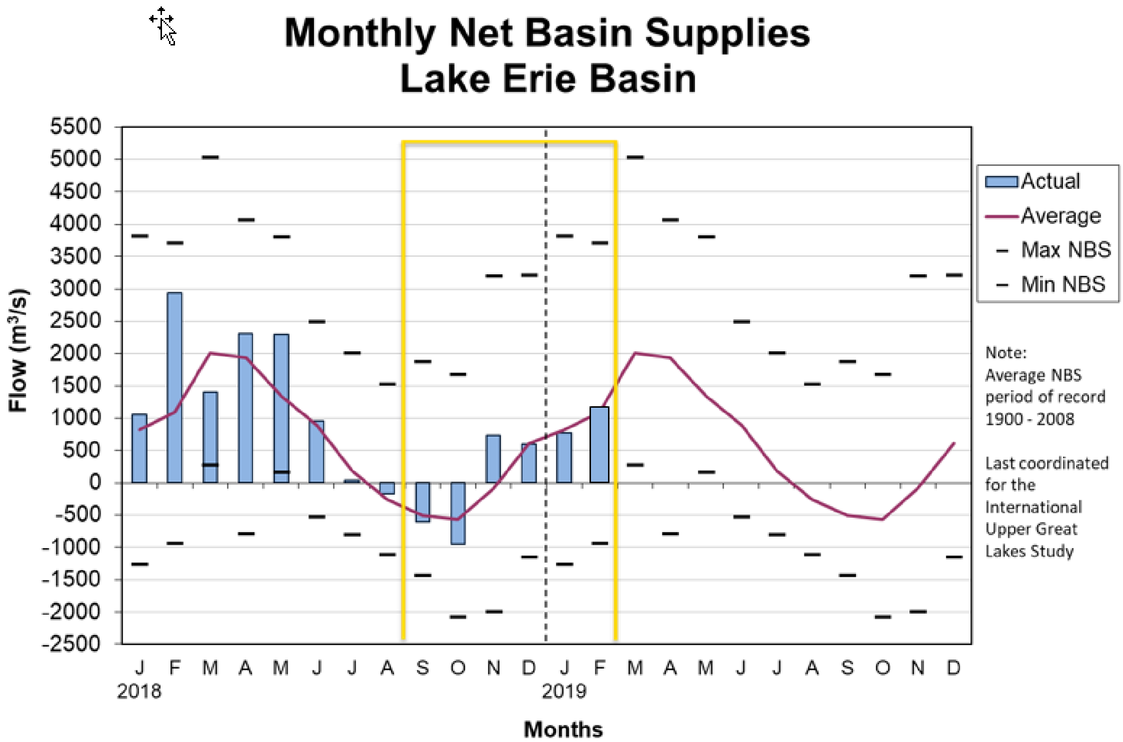


Figure 3: Monthly actual, maximum, minimum and average net basin supplies on Lake Erie basin.

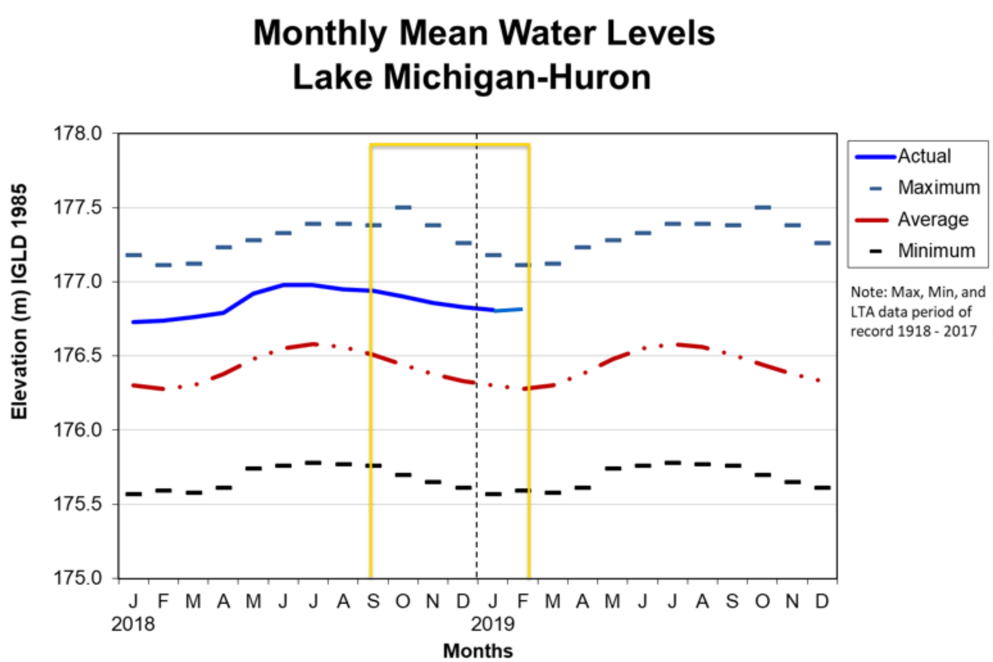


Figure 4: Lake Michigan-Huron mean monthly actual, maximum, minmum and average water levels.

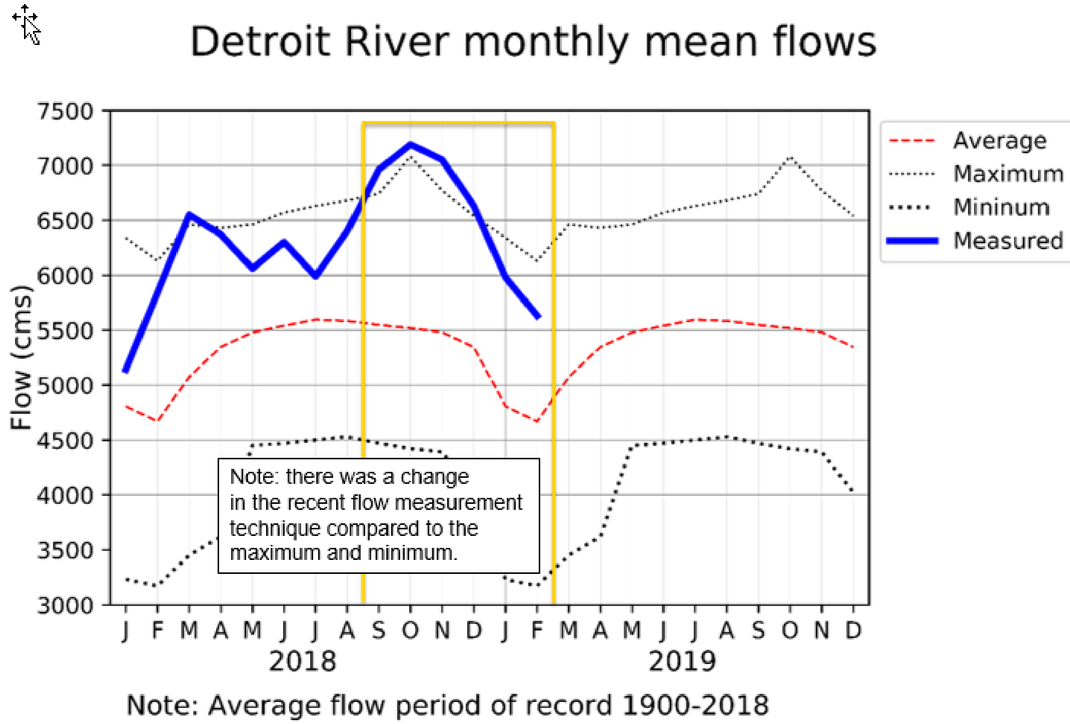


Figure 5: Detroit River mean monthly actual and average flows.

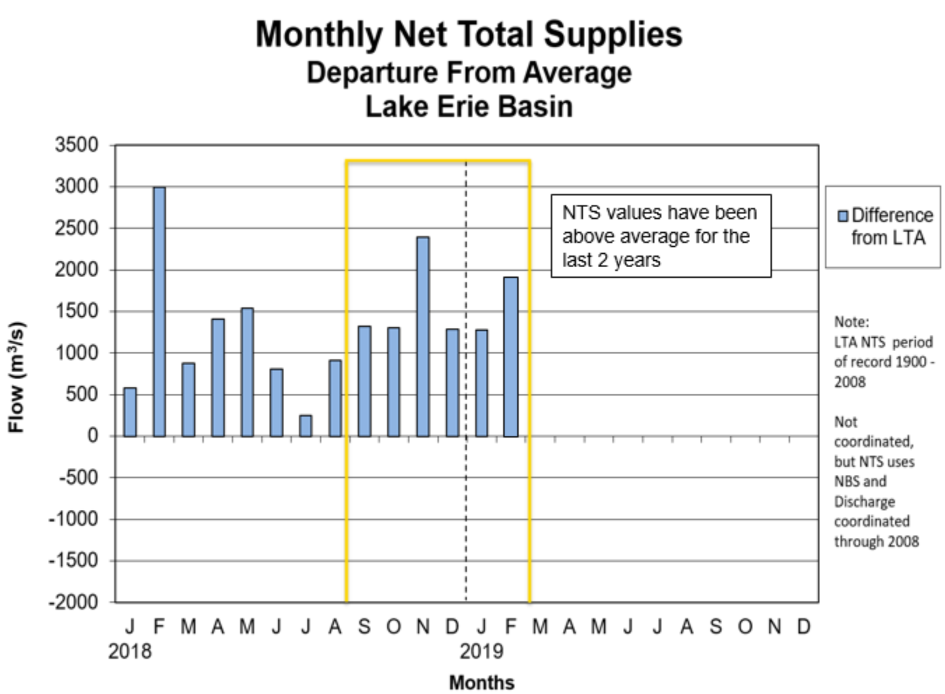


Figure 6: Lake Erie basin monthly net total supplies difference from the long term average.

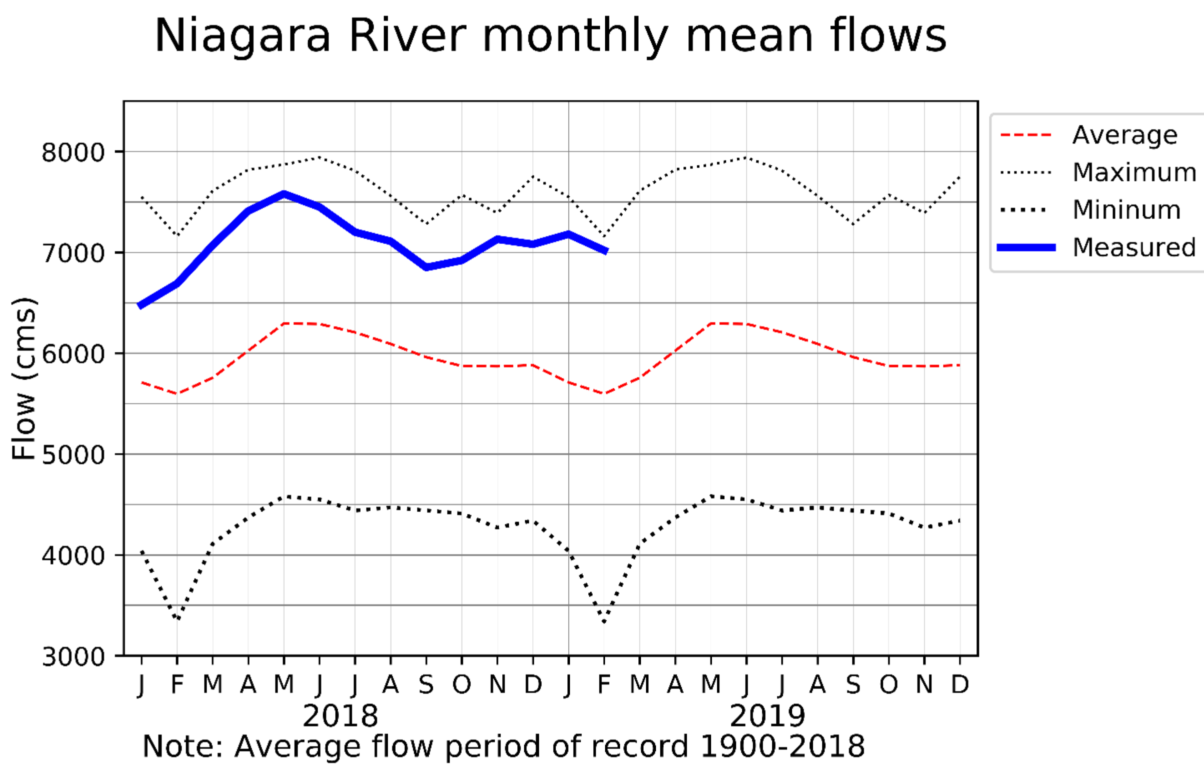


Figure 7: Niagara River mean monthly actual and average flows at Buffalo, New York.

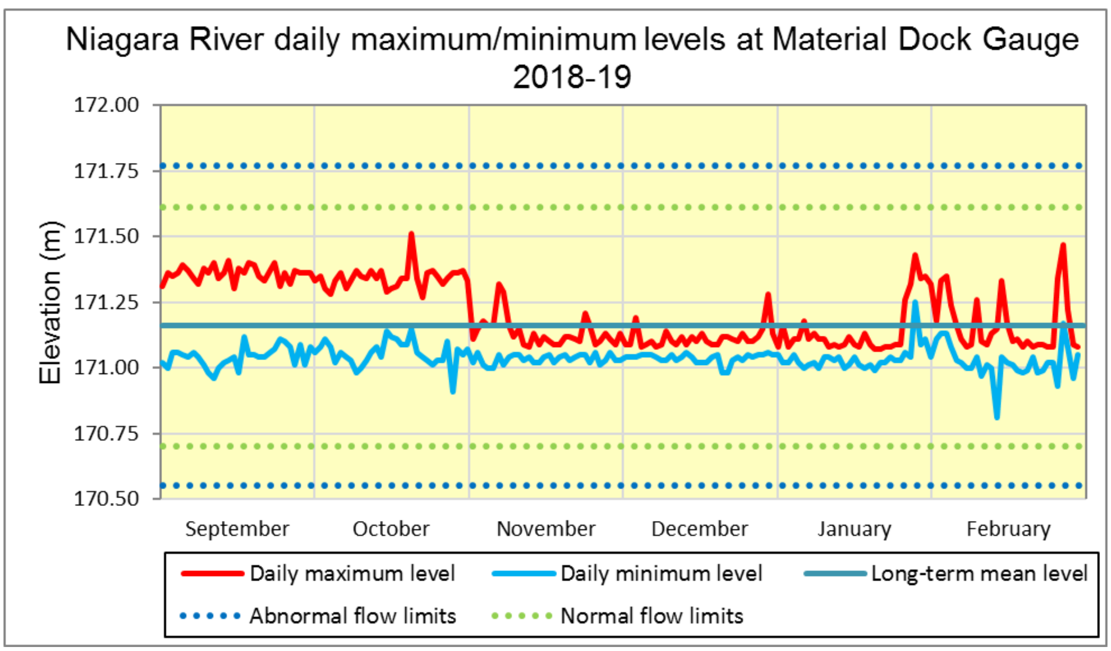


Figure 8: Daily maximum and minimum water levels at Material Dock gauge (September 2018 through February 2019).

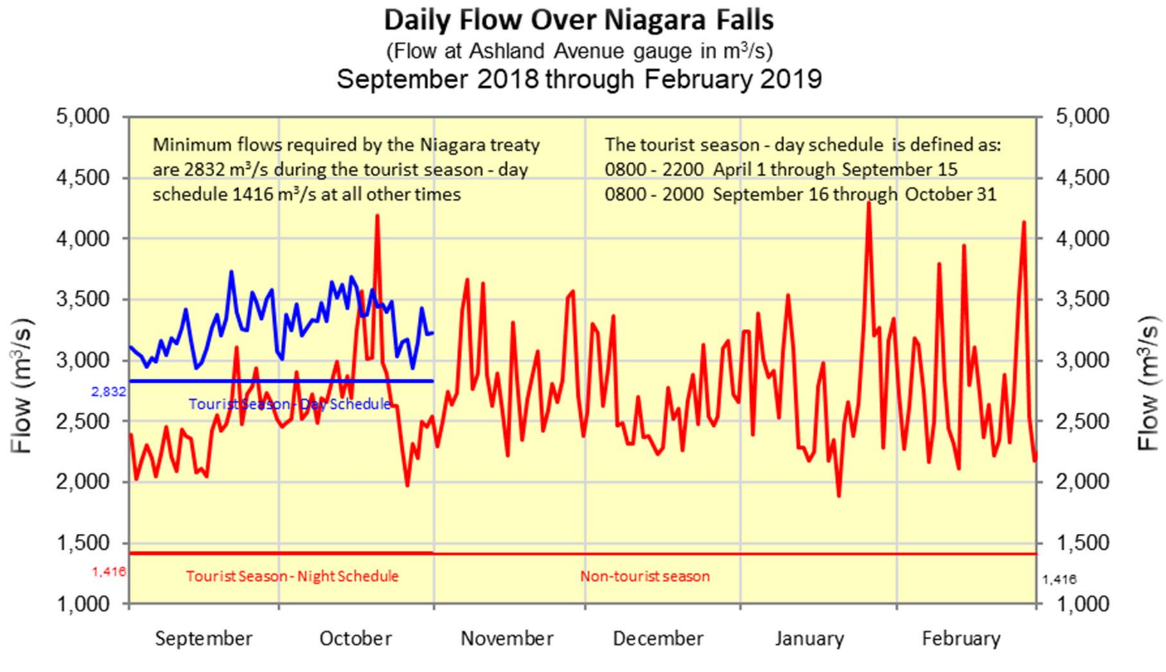


Figure 9: Daily flow over Niagara Falls from September 2018 through February 2019 (flow at Ashland Avenue in m^3/s).

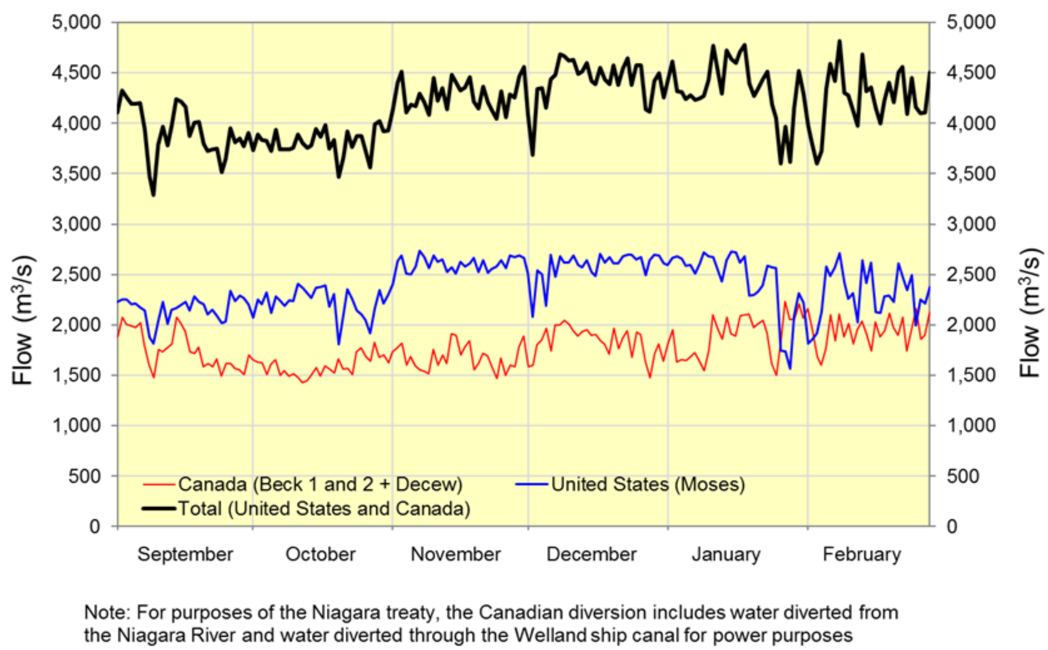
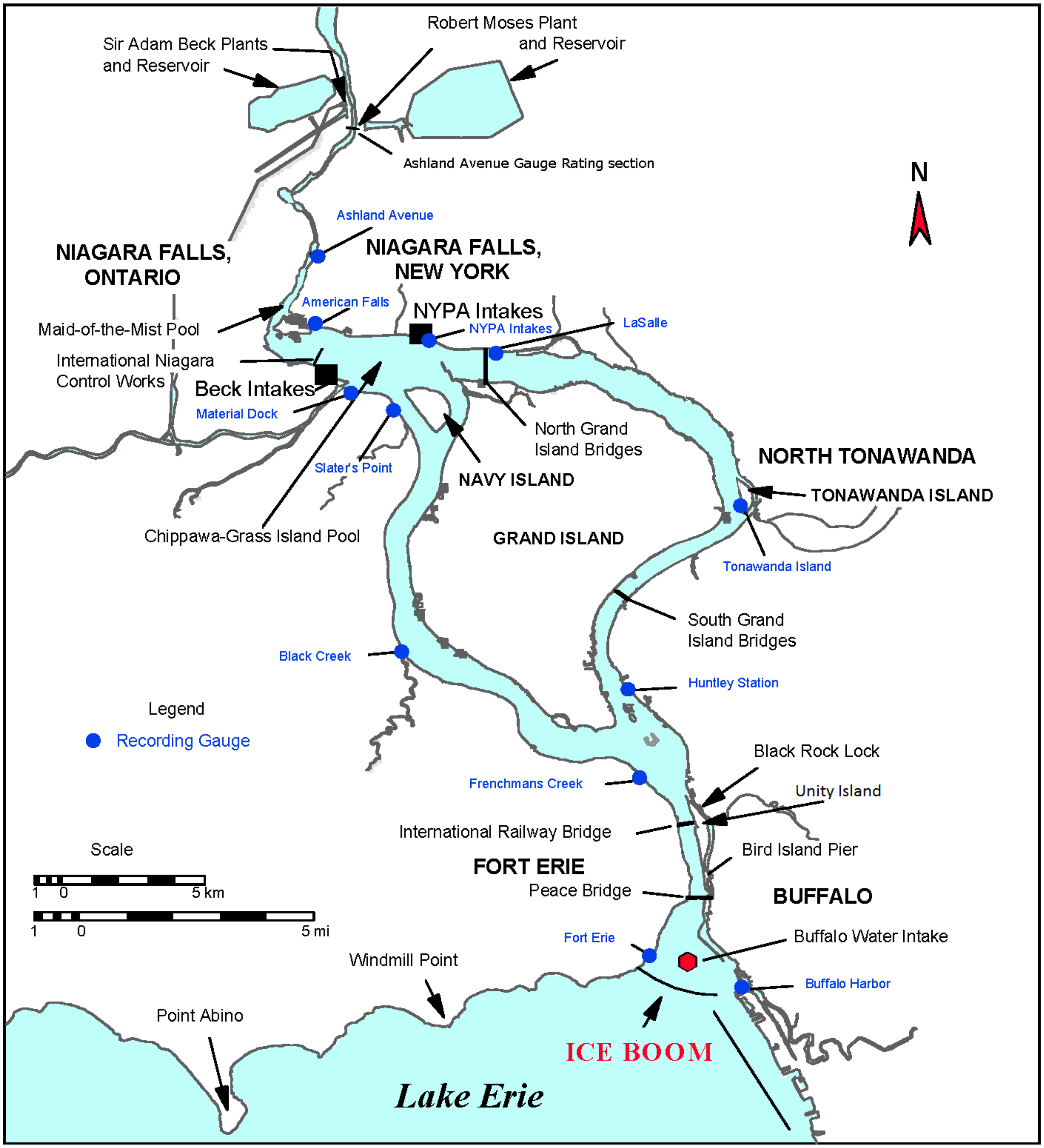


Figure 10: Daily diversion of Niagara River water for power purposes (September 2018 through February 2019).



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