International Niagara Board of Control

One Hundred Thirtieth Semi-Annual Progress Report

to the

International Joint Commission

Covering the Period September 22, 2017 through March 28, 2018.

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 42 cm (16.5 inches) above its 1918–2016 period-of-record, long-term average level for the month. From September 2017 to January 2018 the lake level fell 23 cm (9.1 inches). This is 6 cm (2.4 inches) more than the average fall of 17 cm (6.7 inches) for that period. Lake Erie began its seasonal rise one month earlier than normal with its level raising 6 cm (2.4 inches) from January to February. Lake Erie water levels typically remains steady during this period. Lake Erie levels ended the reporting period with a February monthly mean water level 42 cm (16.5 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).

Remediation work was completed on the Ashland Avenue Gauge during this reporting period. The project commenced construction on November 1, 2017 during the lower Falls flow period, and was completed 10 November, 2017. Due to the precise coordination of this work, the hourly Ashland data was only unavailable for 1 hour, on November 8, 2017. A value for this hour was extrapolated using previous and after hour data along with Grass Island Pool elevation data. This new design is anticipated to mitigate against infilling of the gauge inlet by providing more natural scouring of river bed material away from the inlet. (Section 4).

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

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. No measurements were taken during the current reporting period. (Section 8).

OPG began an overhaul of G2 at the DeCew Falls generating station in November 2016. The unit is expected to remain out of service until June 2018. NYPA is continuing unit upgrades at the Lewiston Pump Generating Plant as part of its Life Extension Modernization (LEM) project. (Section 9).

Installation of the ice boom was initiated, starting from the Canadian side, on December 16. Due to favourable conditions, all twenty-two spans of the boom were placed by the end of day December 17. Ice cover on Lake Erie was approximately 35% on March 1, 2018 or approximately 3,500 square miles. (Section 10).

The vacant US seat on the Board was filled during this reporting period. On October 1, 2017, Mr. David Capka was appointed to the US vacancy. Mr. Capka is the Director of the Division of Dam Safety and Inspections (D2SI) with the Federal Energy Regulatory Commission's Office of Energy Projects. (Section 13).

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

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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
www.ijc.org

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

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

INTERNATIONAL NIAGARA BOARD OF CONTROL

Cincinnati, Ohio March 28, 2018
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 Thirtieth Semi-Annual Progress Report, covering the reporting period September 22, 2017 to March 28, 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 September mean level at 42 cm (16.5 inches) above its 1918–2017 period-of-record, long-term average level for the month. From September 2017 to January 2018, the lake level fell 23 cm (9.1 inches). This is 6 cm (2.4 inches) more than the average fall of 17 cm (6.7 inches) for that period. Lake Erie began its seasonal rise one month earlier than normal with its level rising 6 cm (2.4 inches) from January to February, when Lake Erie water level typically remains steady. Lake Erie levels ended the reporting period with a February monthly mean water level 42 cm (16.5 inches) above average. Recorded monthly water levels for the period September 2017 through February 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 the major contributor to NBS, both directly on the lake and through runoff due to rain and snowmelt. Recent precipitation data and departures from the long-term average are shown in Table 2 and depicted graphically in Figure 2. The Lake Erie basin received approximately 37.8 cm (14.9 inches) of precipitation during the September 2017 through February 2018 period. This is approximately eight percent below the average for the period. Both November and February precipitation were above average, by 43 percent and 54 percent, respectively. The impact was mitigated by lower than average precipitation in September, December and January.

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 November and February, close to average for January, and below average for September, October, and December.

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 two 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 (Figure 5). As a result, inflow to Lake Erie via the Detroit River was approximately 15 percent above the long-term average from September 2017 through February 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 21 percent above average for the period March through February 2018 (Figure 6). The NTS were above-average for all months except September 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 flows at Buffalo, were well above average 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 for February 2018 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 spring and summer.

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, 2018 was 0.01 metre-months (0.03 foot-months) above the long-term operational average elevation. This was the lowest accumulated deviation value recorded by the INWC in 35 years. A negative overall departure of -.02 metre-months was recorded in May of 1983. 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 December 27, 28, 29, 2017, January 1 – 9 (inclusive), January 12 – 21 (inclusive), January 30, 31, 2018; February 2,3,5,6,7, February 9 – 13 (inclusive), 2018; due to abnormally high flows on October 15-16, 2017, December 5,6,25,26, 2017; and due to an emergency rescue on October 8, 2017.

Gate 15 was taken out of service for a major overhaul on August 11, 2017 and was unavailable until October 14, 2017.

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

4. Gauging Stations

The gauges used to determine flows in the Niagara River, monitor the CGIP levels and the flow over Niagara Falls are the Fort Erie, Material Dock and Ashland Avenue gauges as shown in Enclosure 1. The Buffalo, Slater's Point, and U. S. National Oceanic and Atmospheric Administration (NOAA) Ashland Avenue gauges are used as alternatives in the event of primary gauge failure. The Slater's Point and Material Dock gauges are owned and operated by the Power Entities. Both NOAA and the Power Entities own and operate water level gauges at the Ashland Avenue location. All gauges required for the operation of the INCW were in service during this reporting period, except for as follows: Fort Erie gauge unavailable due to communication failure from October 20 to 21st , 2017, and from November 9 – 12th , 2017

Last year, NYPA retained Allen Marine Services (AMS) to perform remediation work at the Ashland Avenue Gauge, which is used to determine flow over the Falls for purposes of the 1950 Niagara Diversion Treaty. The work was completed during this reporting period. The design involved extending the existing pipe from the gauge house a further 2 m (6 feet) into the river channel and placement of gabion stone mattresses to stabilize the shoreline band and support the inlet pipe extension. An elbow was also installed at the end of the pipe extending downstream to prevent sediment deposition from upstream. This work is expected to mitigate against infilling of the gauge inlet by providing more natural scouring of river bed material away from the inlet. The previous configuration of the pipe required regular maintenance to keep the end of the pipe sediment free.

The project commenced construction on November 1, 2017 during the non-tourist flow period, and was completed November 10, 2017. AMS subcontracted two work boats and staffed them with –a couple of 2-man dive teams and a superintendent. The work boats and personnel were brought to the site each morning and returned to dock at the Maid of the Mist facility each evening. Due to the precise coordination of this work, the hourly Ashland data was only unavailable for 1 hour, on November 8, 2017. A value for this hour was extrapolated using data both before and after the missing hour along with Grass Island Pool (GIP) elevation data.

5. Flow over Niagara Falls

The Niagara Diversion Treaty of 1950 sets minimum limits on the flow of water over Niagara Falls. During the tourist season (April-October) day time hours, the required minimum Niagara Falls flow is 2,832 cubic metres per second (m^3/s) (100,000 cubic feet per second (cfs)). At night and at all times during the non-tourist season months (November-March), the required minimum Falls flow is 1,416 m^3/s (50,000 cfs). The appropriate operation of the INCW, in conjunction with power diversion operations, maintains sufficient flow over the Falls to meet the requirements of the 1950 Niagara Diversion Treaty. Falls flow met or exceeded minimum Treaty requirements at all times during the reporting period. The recorded daily average flow over Niagara Falls, covering the period September 2017 through February 2018, 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 March 19, 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 September 2017 through February 2018, diversion for the SAB I and II plants averaged 1,502 m^3/s (53,040 cfs) and diversion to the Robert Moses Niagara Power Project averaged 2,311 m^3/s (81,610 cfs).

The average flow from Lake Erie to the Welland Canal for the period September 2017 through February 2018 was 156.6 m3/s (5,540 cfs). Diversion from the canal to OPG's

DeCew Falls Generating Stations averaged 113.7 m^3/s (4,030 cfs) for the same period of time.

Records of diversions for power generation covering the period September 2017 through February 2018 are shown in Figure 10.

The monthly average Niagara River flow at Queenston, Ontario, for the period of September 2017 through February 2018, and departures from the 1900–2017 long-term average are shown in Table 3. Maximum and minimum monthly average flows for the 1900–2017 period of record are shown in Table 4. During the period September 2017 through February 2018, the flow at Queenston averaged 6,636 m^3/s (234,350 cfs), which was 1,004 m^3/s (35,460 cfs) above the 1900-2017 average of 5,632 m^3/s (198,890 cfs) for the period. The monthly values ranged between 6,374 m^3/s (225,100 cfs) and 6,875 m^3/s (242,790 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. 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 in May 2015. The next measurements are scheduled for May 2018.

ECCC continues to monitor continuous water levels from a gauge at a proposed International Gauging Station located near the International Railway Bridge discharge measurement section. Flow measurements continue throughout the year by the USGS New York and ECCC. 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 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. Preliminary 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 is being reviewed and is expected to be finalized in the spring of 2018. 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 and is expected to be finalized in the spring of 2018. A similar series of verification measurements is planned for 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 unit is expected to remain out of service until June 2018.

NYPA is continuing unit upgrades at the Lewiston Pump Generating Plant as part of its Life Extension Modernization (LEM) project. The Life Extension Modernization project for the Lewiston Pump Generation Plant began in the year 2012, which serves to upgrade all 12 pump-turbine units with digital controls and replacement/refurbished mechanical parts and equipment. It was developed as an 8-10 year program with unit upgrades and re-starts every 8 months, and is currently targeted for completion by the year 2020. Unit 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

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 was 4ºC (39ºF) on December 16. As these conditions met the criteria to commence installation, the first of the boom's spans was installed on December 16, 2017. Installation of the ice boom was initiated starting from the Canadian side and to favourable conditions all twenty-two spans of the boom were placed by the end of the day on December 17.

A practice drill for NYPA's Flood Warning Notification Plan in the event of Ice Affected Flooding on the Upper Niagara River was conducted on December 21st, 2017 by Ed Barbiero.

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 December 14, 2017.

Lake Erie water temperature dropped from 38 F to 33 F from December 24 to December 27, 2017. First ice was spotted on December 27, 2017 in the CGIP as a 50’ band of shale ice passed the NYPA intakes causing no concern. Lake Erie water temperature dropped to 0ºC (32ºF) on January 2, 2018. Persistent high winds and a decline in water temperature created many ice floes in the CGIP for the first week of 2018, causing both ice breakers to be called into action throughout the first week of the new year. On January 7, 2018, the air temperatures went from -16ºC (3.2ºF) to 0ºC (32ºF) reducing ice coverage in the Niagara River from almost full ice coverage to trace amounts by the end of day.

On January 2, 2018 NICC reported a break in the ice boom at span L. It was later determined to be span M and NYPA crews completed repairs by January 8, 2018. The US Coast Guard reported an ice boom pontoon in the Lower Niagara River which was later recovered by NYPA crews.

Ice cover on Lake Erie climbed to 93% the first week of January 2018. With above average air temperatures for the last three weeks of January, ice coverage dropped to 60% by the end of the month. February began with temperatures well below freezing causing ice coverage on Lake Erie climb to its seasonal peak of 95%.

On February 16, 2018 members of the INWC conducted a helicopter ice thickness flight. Ice thickness measurements ranged from 25 to 47 cm (10 to 18.5 in). The following week brought unseasonably warm temperatures with a high of 19ºC (66ºF) on February 20, 2018 drastically reducing ice coverage on Lake Erie by the end of the month.

Ice cover on Lake Erie was approximately 33% on March 1, 2018 or approximately 5,630 km^2 (3,500 square miles). A coordinating call was held between the INBC Secretaries, NYPA, ICD staff, and the INWC Co-Chairs. Plans for monitoring the ice decay and scheduling of a fixed wing ice coverage survey flight were discussed at this meeting.

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

11. Other Issues

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

12. Meeting with the Public

No public meetings were held during this period.

13. Membership of the Board and the Working Committee

On October 01, 2017, Mr. David Capka was appointed to the role of U.S. Member of the International Niagara Board of control for a three year term ending September 30, 2020. Mr. Capka is the Director of the Division of Dam Safety and Inspections (D2SI) with the Federal Energy Regulatory Commission's Office of Energy Projects.

14. Attendance at Board Meetings

The Board met once during this reporting period. The meeting was held on March 28, 2018 at the Embassy Suites Hotel, Salon Meeting Room in Buffalo, NY. Mr. Aaron Thompson, Canadian Section Chair, Mr. Stephen Durrett, U.S. Alternate Section Chair, and Mr. David Capka, U.S. Board Member were present in Buffalo. Canadian Board Member, Ms. Jennifer Keyes, attended remotely via teleconference and webex.

Mr. AARON F. THOMPSON
Chair, Canadian Section

BG MARK R. TOY
for 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* 2017/2018	Average 1918-2017	Departure	Recorded* 2017/2018	Average 1918-2017	Departure
September	174.58	174.17	0.41	572.77	571.42	1.35
October	174.46	174.07	0.39	572.38	571.10	1.28
November	174.46	174.00	0.46	572.38	570.87	1.51
December	174.40	173.99	0.41	572.18	570.83	1.35
January	174.35	174.00	0.35	572.01	570.87	1.15
February	174.41	173.99	0.42	572.21	570.83	1.38

* Provisional

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

	Centimeters			Inches			
Month	Recorded* 2017	Average 1900-2016	Departure	Recorded* 2017	Average 1900-2016	Departure	Departure (in percent)
September	3.62	8.20	-4.58	1.42	3.23	-1.81	-56
October	7.76	7.21	0.55	3.06	2.84	0.22	8
November	10.45	7.28	3.17	4.10	2.87	1.23	43
December	3.30	6.81	-3.51	1.32	2.68	-1.36	-51
January	4.39	6.31	-1.92	1.73	2.48	-0.75	-30
February	8.28	5.36	2.92	3.25	2.11	1.14	54

* Provisional

Table 3: Monthly Niagara River flows at Queenston.

	Cubic Metres per Second			Cubic Feet per Second		
Month	Recorded 2017-2018	Average 1900-2017	Departure	Recorded 2017-2018	Average 1900-2017	Departure
September	6570	5734	836	232,020	202,490	29,530
October	6603	5658	945	233,180	199,810	33,370
November	6875	5676	1199	242,790	200,450	42,340
December	6833	5713	1120	241,310	201,750	39,560
January	6374	5558	816	225,100	196,280	28,820
February	6561	5452	1109	231,700	192,540	39,160
Average	6636	5632	1004	234,350	198,890	35,460

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

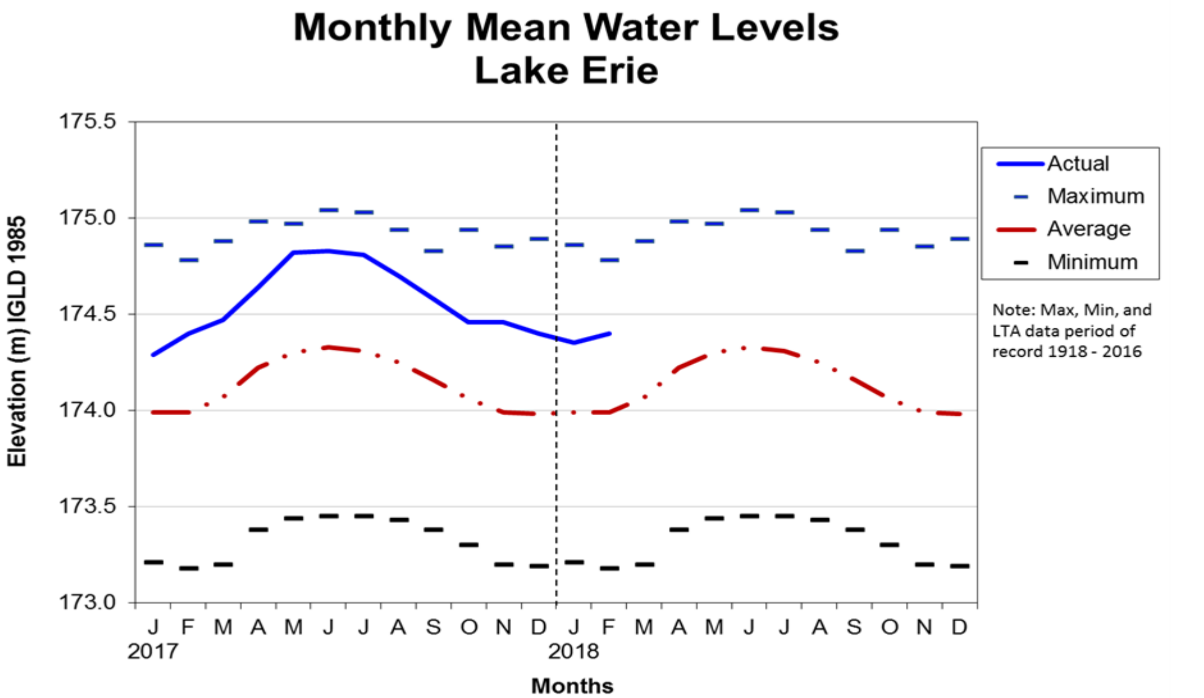


Figure 1: Lake Erie mean monthly and long-term maximum, minimum and average water levels.

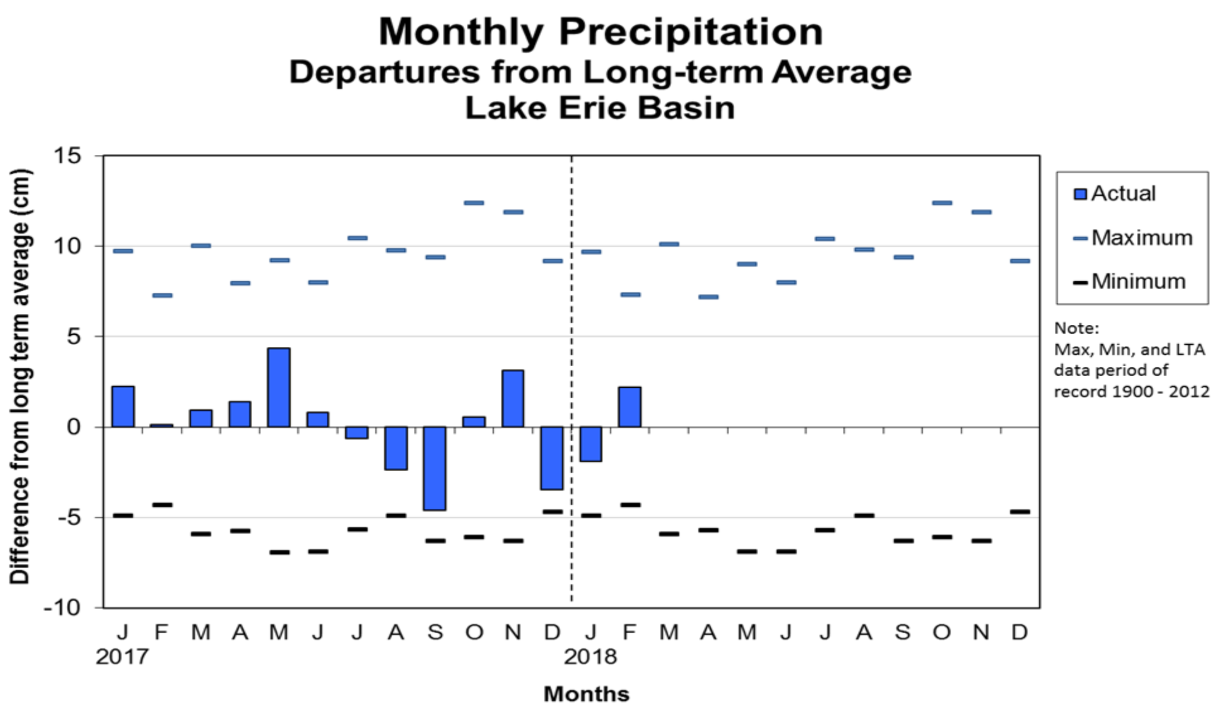


Figure 2: Monthly actual, maximum and minimum precipitation departures from the long-term average on Lake Erie basin.

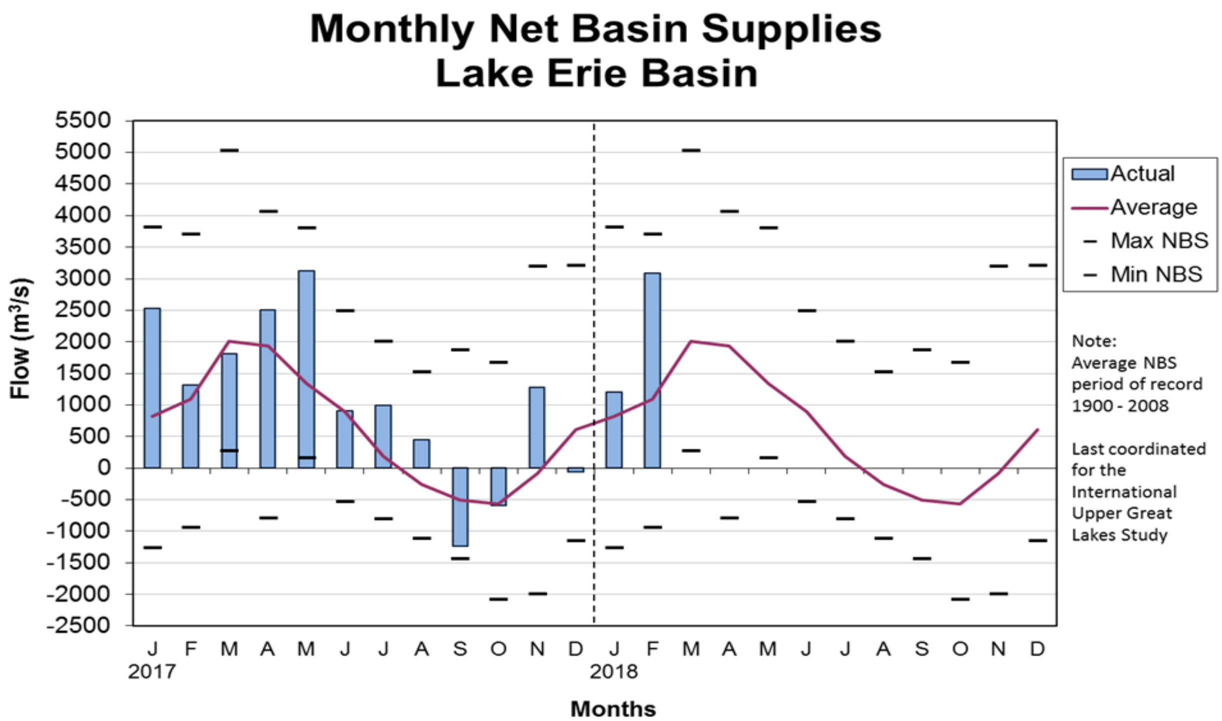


Figure 3: Monthly actual, maximum, minimum and average net basin supplies on Lake Erie basin.

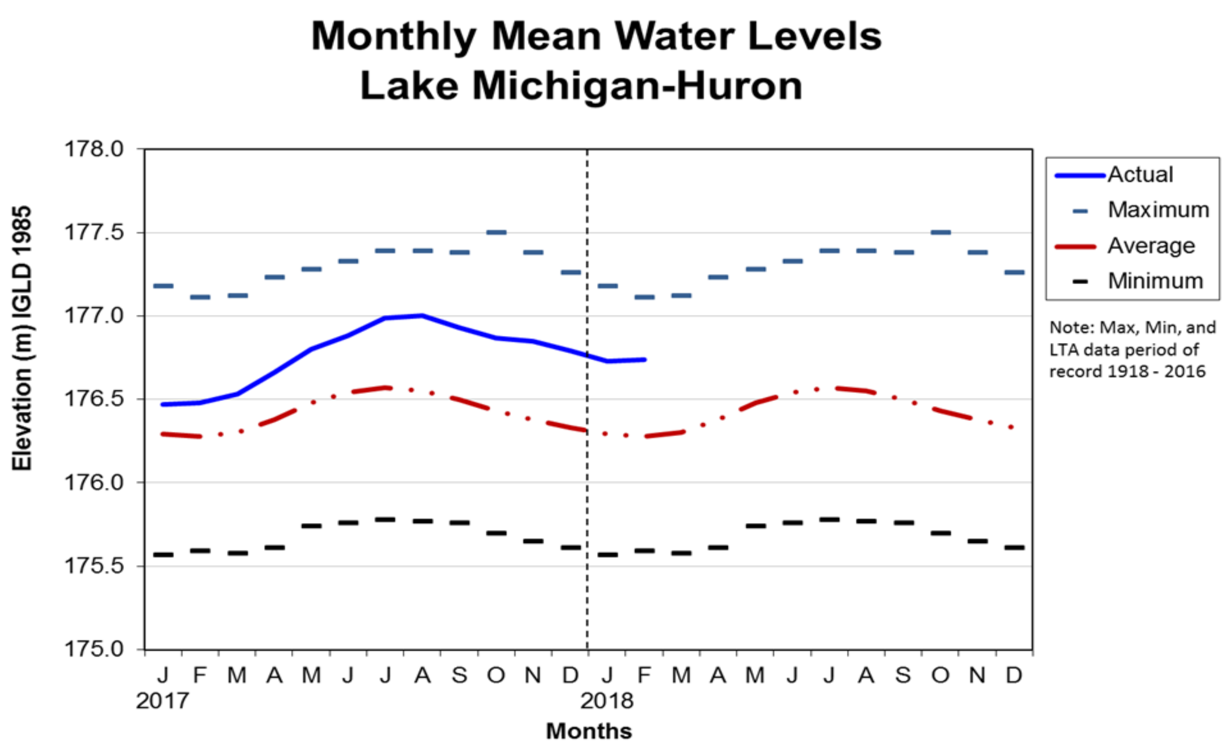


Figure 4: Lake Michigan-Huron mean monthly actual, maximum, minmum and average water levels.

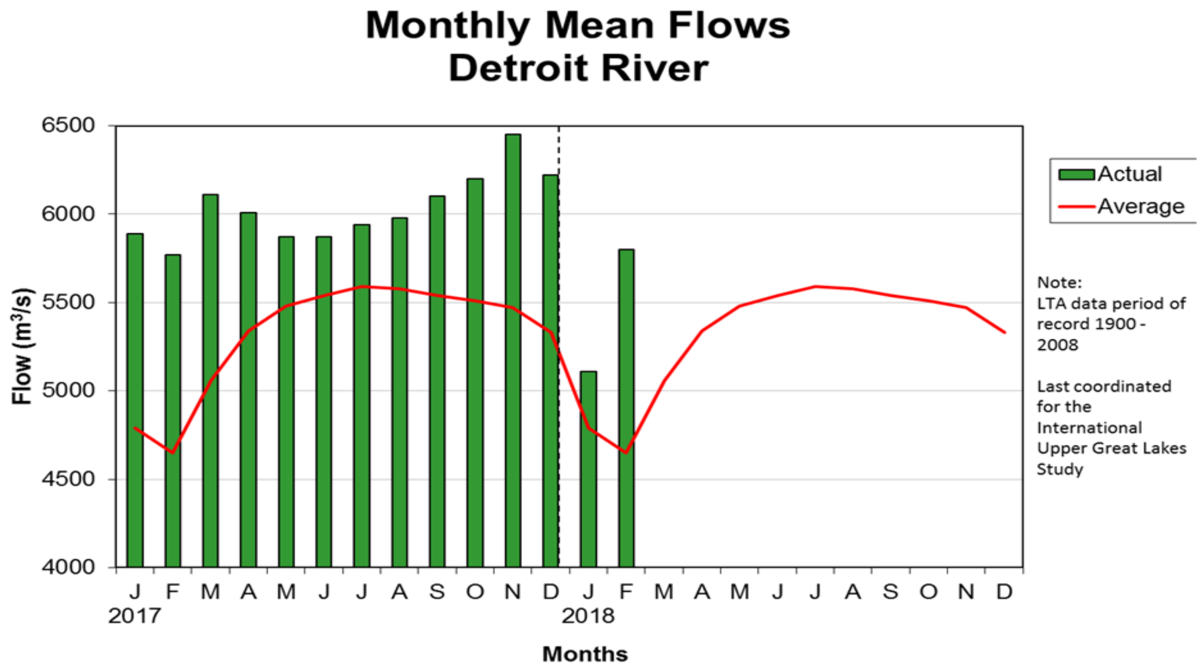


Figure 5: Detroit River mean monthly actual and average flows.

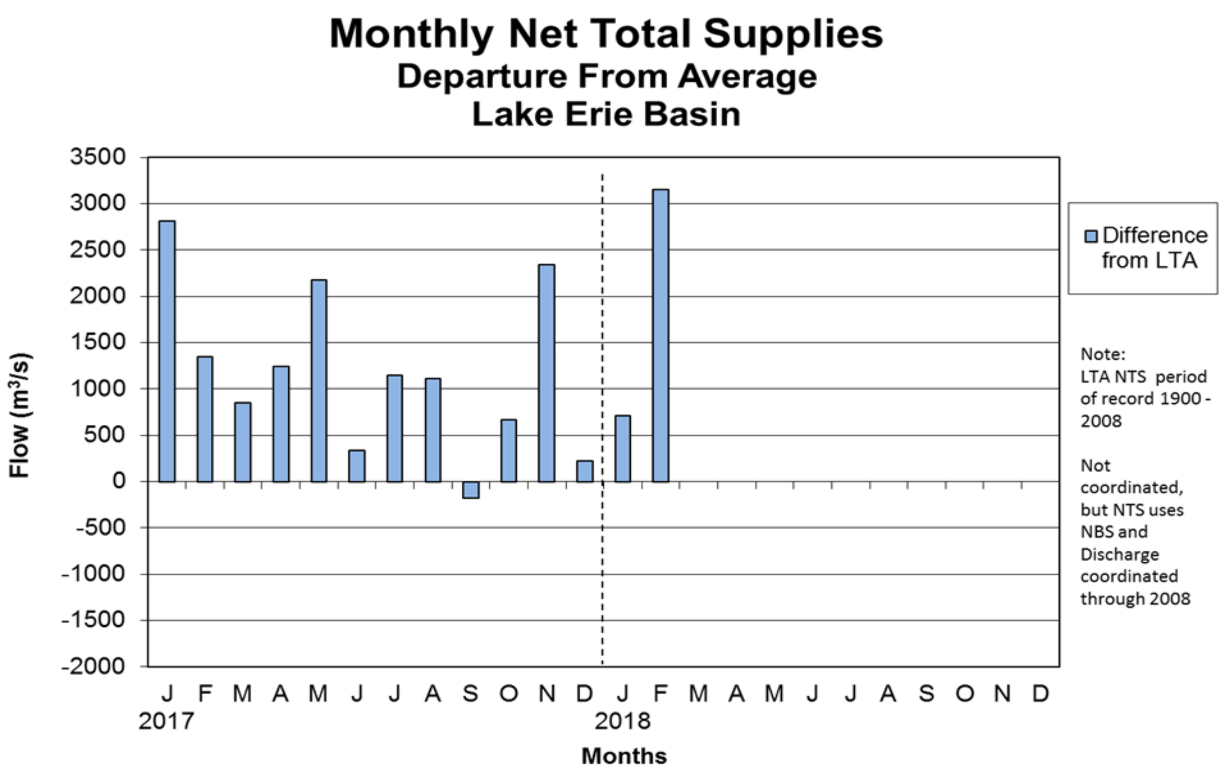


Figure 6: Lake Erie basin monthly net total supplies difference from the long term average.

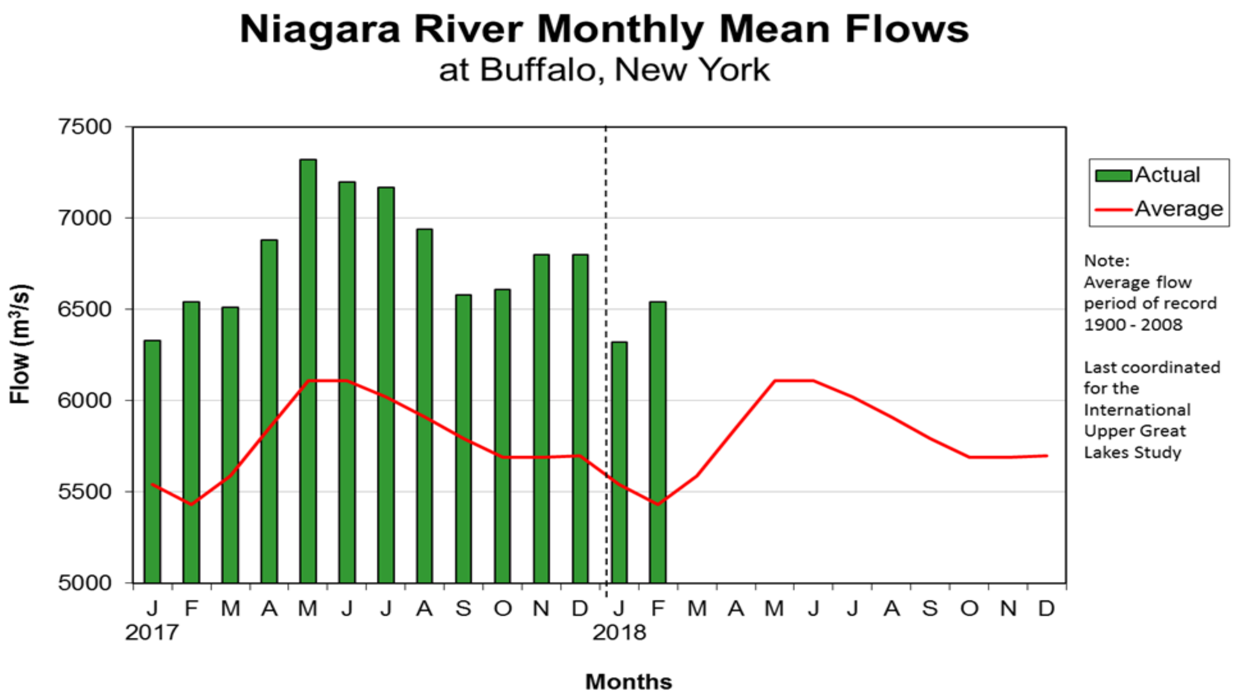


Figure 7: Niagara River mean monthly actual and average flows at Buffalo, New York.

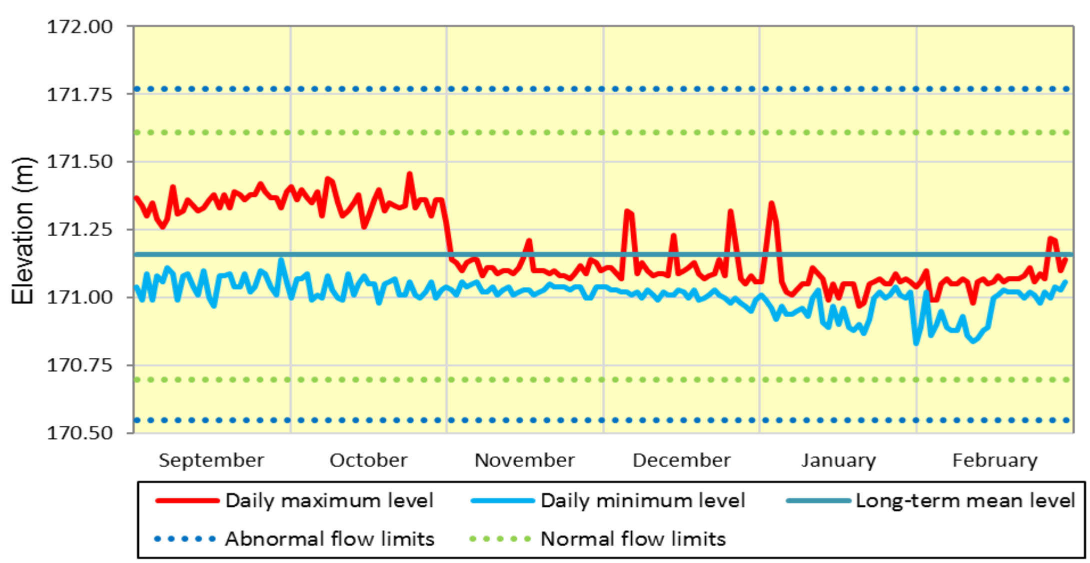


Figure 8: Daily maximum and minimum water levels at Material Dock gauge (September 2017 through February 2018).

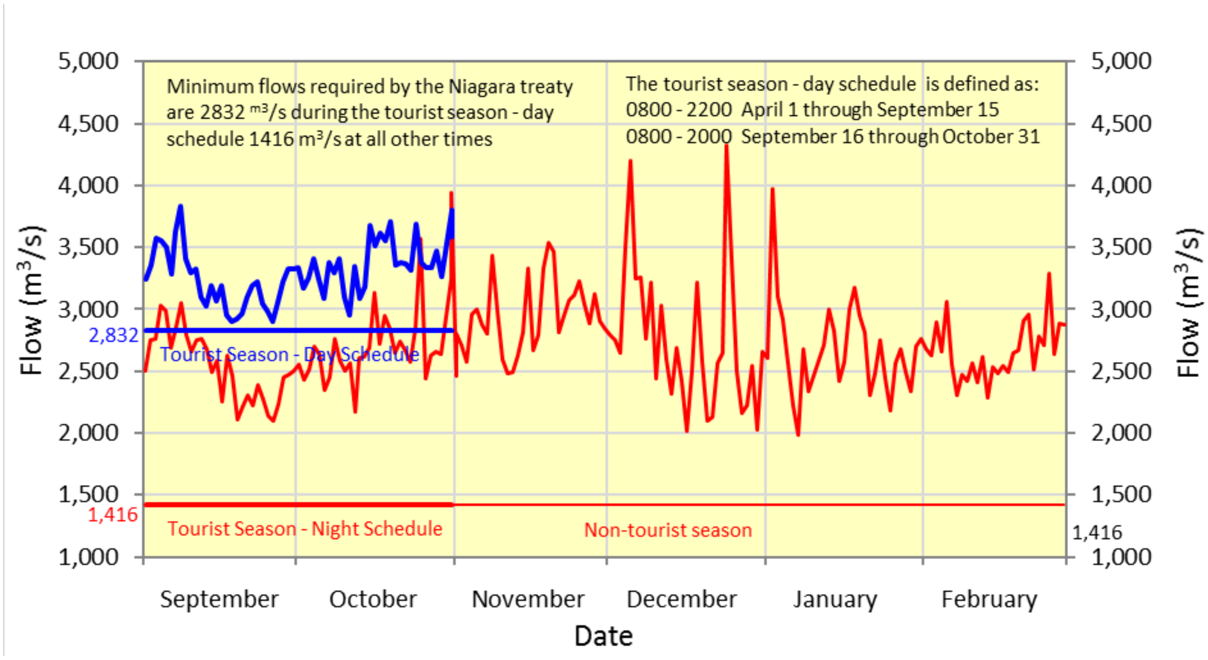
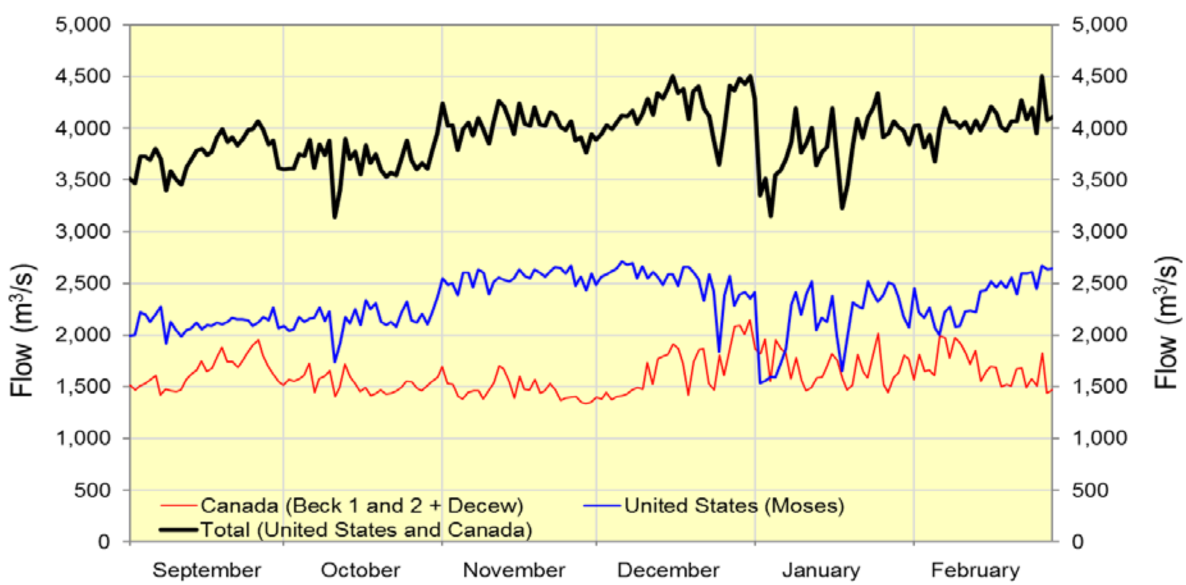
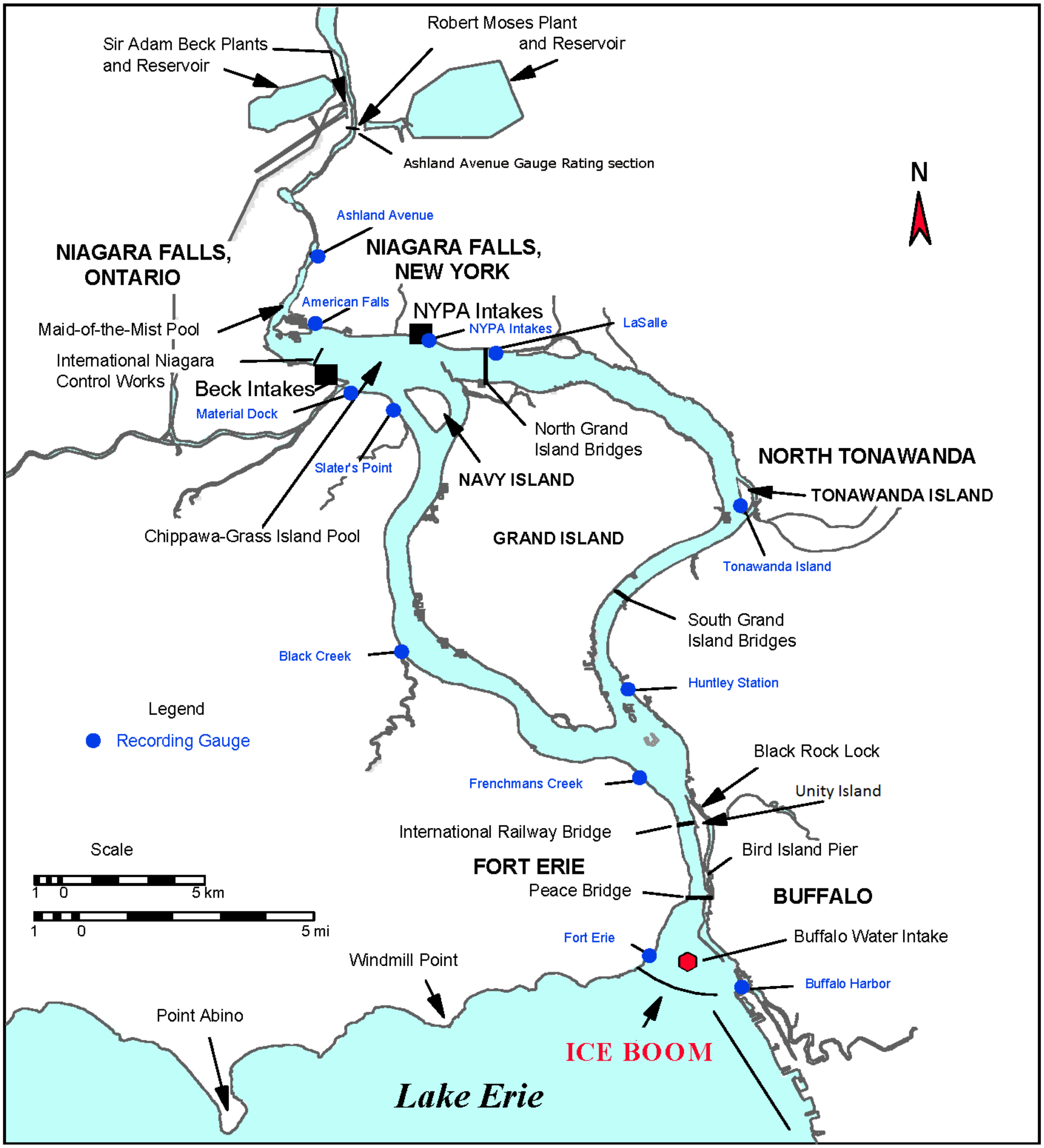


Figure 9: Daily flow over Niagara Falls from September 2017 through February 2018 (flow at Ashland Avenue in m^3/s).



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 (September 2017 through February 2018).



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