International Lake Superior Board of Control

Semi-Annual Progress Report to the International Joint Commission

Covering the period March 1, 2019 to August 31, 2019

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International Lake Superior Board of Control

Canada
Mr. Jean-François Cantin, Member
Mr. Rob Caldwell, Secretary

United States
Mr. Steve Durrett, Alt. Member
Mr. Bryce Carmichael, Secretary

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

26 September 2019

Commissioners:

This semi-annual report covers the Board's activities from 1 March to 31 August 2019.

1. Highlights

Over the past six months, water supplies to Lake Superior were consistently above average with the exception of June and August. Water supplies to Lake Michigan-Huron were consistently above average with the exception of August. The monthly mean water levels of Lake Superior remained well above average and higher than in 2018. Lake Superior levels have been near or above record-high values since May. In the past six months, monthly mean Lake Michigan-Huron levels also remained well above average and higher than in 2018. Lake Michigan-Huron's levels approached record-high values, and came very close to exceeding record-high values in June and July. Monthly outflows from Lake Superior and from Lake Michigan-Huron remained above average.

Lake Superior outflows through the winter from December 2018 through March 2019 were determined according to a deviation strategy to offset the effects of hydropower maintenance activities. The Board also received Commission approval to deviate from the regulation plan from May through November 2019 in order to continue to reduce the potential for adverse consequences associated with large month-to-month fluctuations and high flows in the St. Marys Rapids due to capacity restrictions at the hydropower facilities from planned maintenance activities in the spring and fall of 2019. Flows through the Compensating Works continued to be managed by employing multiple, partially open gates in lieu of fully open gates, with the equivalent gate settings ranging from two gates fully open in March and April to a high of nine gates fully open in August.

The Board continued its ongoing public communications and outreach efforts including a public webinar on 10 July, participating in Engineer's Day in Sault Ste. Marie, Michigan, on 28 June, and informal discussions between Board staff, key stakeholders and the public throughout the reporting period. The Board continued to update content on the Board's website and Facebook pages, which continue to grow in popularity.

2. Monitoring of Hydrologic Conditions

The Board continuously monitors the water levels of lakes Superior and Michigan-Huron, and also the water levels and flows in the St. Marys River. The regulation representatives' monthly reports to the Board provide hydrologic assessments and recommendations for the regulation of outflows from Lake Superior. These reports indicate the amount of water available for hydropower purposes, after the requirements for domestic use, navigation, and the fishery (St. Marys Rapids) are met.

Tables 1 and 2 list the recent monthly water levels, net basin supplies, and outflows for lakes Superior and Michigan-Huron, respectively. Figures 1 and 2 compare the monthly water levels for this period to long-term averages and extremes for each lake. Figures 3 and 4 show the monthly precipitation over the lakes Superior and Michigan-Huron basins. Figures 5 and 6 show the monthly net basin supplies for each basin.

Precipitation over the Lake Superior basin was 88 percent of average (1900-2016) from March through August 2019 and would be expected to be exceeded 80 percent of the time. Precipitation was below average in March, June, July and August, near average in May and above average in April. The net basin water supplies to Lake Superior, which are the net amount of precipitation, evaporation, and runoff to the lake, were consistently above average (1900-2008) (driven in part by above-normal snowmelt), with the exception of June and August. On the whole, the March through August net basin supplies to Lake Superior would be expected to be exceeded 32 percent of the time.

Lake Superior's monthly mean levels over the past six months ranged from 32 to 41 cm (12.6 to 16.1 in) above average (1918-2018), reaching record-high values starting in May. Lake Superior's water levels remained consistently above chart datum (183.2 m or 601.1 ft) throughout the reporting period, and on 31 August, the lake was at elevation 183.85 m (603.2 ft), which was 31 cm (12.2 in) above average, and 20 cm (7.9 in) higher than at the same time last year. Record-high monthly mean water levels were set on Lake Superior in May, June, July, and August. This was the longest stretch of record high water levels set on this lake since 1986.

Lake Superior outflows were between 110 and 136 percent of average (1900-2008) over the past six months, with monthly flows ranging from 2,210 to 3,180 m^3/s (78,000 to 112,300 cfs).

Precipitation over the Lake Michigan-Huron basin was average over the past six months and would be expected to be exceeded 54 percent of the time. Precipitation was above average from April through June, and below average in March, July and August. Net basin water supplies to Lake Michigan-Huron were consistently above average with the exception of August, driven by the above-normal rainfall and snowmelt in April through June. On the whole, the March through August net basin supplies to Lake Michigan-Huron would be expected to be exceeded two percent of the time.

Monthly mean Lake Michigan-Huron levels ranged from 56 to 79 cm (22.0 to 31.1 in) above average. Values approached record-high levels in June and July. Water levels remained consistently above chart datum (176.00 m or 577.4 ft) throughout the reporting period, and on 31 August, Lake Michigan-Huron was at elevation 177.27 m (581.6 ft), 74 cm (29.1 in) above average and 31 cm (12.2 in) higher than last year.

The monthly outflows from Lake Michigan-Huron ranged from 124 to 130 percent of average with monthly flows ranging from 6,040 to 7,150 m^3/s (213,300 to 252,500 cfs).

3. Regulation of Lake Superior Outflows

3.1. Outflows

Winter Lake Superior outflows from December 2018 through April 2019 were determined according to a deviation strategy approved 30 November 2018 by the International Joint Commission (IJC). Hydropower capacity was less than normal in December and January due to required maintenance activities. To offset the effects of those activities, the Board allowed release of additional flow through the Compensating Works by maintaining a gate setting equivalent to two gates fully open instead of the typical winter setting equivalent to one-half gate open. Total flows were less than Plan 2012 in December and January, while flows greater than Plan 2012 were released in February and March. The total amount of water released through the St. Marys River was approximately equal to what it would have otherwise been if Plan 2012 flows could have been strictly followed through the winter months. Therefore the net effects on the water levels of Lake Superior and Lake Michigan-Huron were minimal by spring, and flows as prescribed by Plan 2012 were released in April.

The Board also requested and received Commission approval to deviate from the regulation plan from May through November 2019 by letters dated 21 March and 30 April 2019. The objectives of the deviations were to continue to reduce the potential for adverse consequences associated with large month-to-month fluctuations and high flows in the St. Marys Rapids due to capacity restrictions at the hydropower facilities from planned maintenance activities in the spring and fall of 2019. To achieve these objectives while minimizing the long-term impacts on both Lake Superior and Lake Michigan-Huron water levels, flows below those prescribed by Plan 2012 were released from May through June, and flows above those prescribed by the plan were released during July and August. Flows as prescribed by Plan 2012 are expected to be released through the fall.

Several scheduled and unscheduled flow reductions continued to occur at the hydropower plants over the past six months (details are provided in *Section 6* of this report). Operational limitations on hydropower flow capacity in May through August were addressed by adjusting the gate setting at the Compensating Works in accordance with the Board's approved deviation strategy.

The Board's deviation strategy, combined with hydropower maintenance activities and uncontrolled hydrologic impacts, resulted in total outflows being, on average, slightly less than the flow that was prescribed by Plan 2012 during the reporting period.

3.2. Compensating Works Gate Settings and St. Marys Rapids Conditions

During the reporting period, the Board continued to work with the Commission, the hydropower entities, and other stakeholders, to address issues raised related to the gate setting of the Compensating Works, and the unusually high water level and flow conditions in the St. Marys Rapids, while adhering to the principles of the Boundary Waters Treaty and the Orders of Approval for Lake Superior regulation.

Flow through the Compensating Works continued to be managed by employing multiple, partially open gates in lieu of fully open gates, with the equivalent gate settings ranging from two gates fully open in March and April to a high of nine gates fully open in August. A complete summary of gate setting changes is provided in Table 3.

This past winter, in accordance with the Board's deviation strategy, a gate setting equivalent to two gates fully open was maintained by partially opening all sixteen gates, instead of the typical winter setting equivalent to one-half gate open (four gates partially open). The gate setting was increased from the setting equivalent to two gates fully open to a setting equivalent to approximately four gates fully open on 6 May by raising four gates further. From 3 to 7 June, several gates were temporarily adjusted to facilitate underwater inspections of the International Bridge piers. After these inspections, the gates were set to an equivalent setting of six gates fully open by raising five gates. On 18 and 22 July, Gates #7 through 9 were closed to facilitate concrete repairs downstream of Gate #8. However, the repairs could not be completed and are to be rescheduled for a future date. On 5 and 6 August, Gates #7 through 9 were reopened and Gate #10 was raised to provide an equivalent setting of nine gates fully open.

Throughout the reporting period, Gate #1, which supplies water to the Fishery Remedial Works, remained set at approximately 15 m^3/s (530 cfs).

From 7 June through 31 August, Gate #16 was set at 5 cm open at the request of the US Fish and Wildlife Service to facilitate sea lamprey trapping.

4. Governing Conditions during the Reporting Period

The monthly mean levels of Lake Superior ranged between 183.57 and 183.86 m (602.3 and 603.2 ft) during the reporting period, within the limits of 182.76 and 183.86 m (599.6 and 603.2 ft) specified in the Commission's Order (Criterion A).

During the reporting period, the daily mean water levels in the lower St. Marys River at the U.S. Slip gauge downstream of the US Locks varied between 177.03 and 177.68 m (580.8

and 582.9 ft). Therefore, Criterion B of the Commission's 2014 Orders, which restricts outflow to no more than preproject values when the level at U.S. Slip is above 177.94 m (583.8 ft), was not a concern. Furthermore, daily mean U.S. Slip levels stayed well above the ponding restriction threshold (see *Section* 10) of 176.09 m (577.7 ft) for the reporting period. However, while ponding was permitted during the entire reporting period, there was no opportunity for plants to perform ponding operations as they were running at full capacity.

5. Inspection and Repairs at the Compensating Works

Routine monthly maintenance inspections continued to be conducted on the Canadian portion of the Compensating Works by Evolugen (As of July, Evolugen is the new identity for Brookfield Renewable Canada). Monthly inspection observations included public safety features such as fencing and signs, the concrete and masonry structure, gates, and mechanisms, on-site safety equipment such as life jackets and air horns, as well as the noting of anything unusual. In addition to the monthly inspections, the annual dam safety inspection will be completed by the Regional Dam Safety Engineer and an Independent Consulting Engineer on 28 September. The annual inspection will be performed on the Compensating Works structure and the earth dam north of the structure.

New upstream public safety signage was installed on the earth dam north of the Compensating Works at the end of May.

The repair to a cold joint and a crack in the apron concrete downstream of Gate #8 was planned to be repaired at the end of July. Unfortunately, owning to unforeseen circumstances, the repair work was deferred to 2020.

Monthly inspections and routine maintenance continued to be conducted on the US portion by the US Army Corps of Engineers (USACE) Soo Area Office. The monthly inspections found the Compensating Works facilities to be in good condition overall.

6. General Conditions, Repairs and Maintenance at the Hydropower Facilities

6.1. General Conditions at the Hydropower Facilities

All three hydropower plants experience variations in flow capacity as a result of changing hydrologic conditions at any given time of the year, which can affect the plants' abilities to use their full allocations. Allocations were set at "maximum capacity" for each plant throughout the reporting period.

In addition to hydrologic constraints, maintenance activities at the plants can also lead to reduced capacity. Scheduled and unscheduled outages that occurred at the plants during the reporting period are described below.

6.2. Evolugen

As of July 2019, Evolugen is the new identity for Brookfield Renewable Canada. Evolugen remains a company of Brookfield Renewable and focuses on providing renewable energy solutions in Canada. All legal entities remain unchanged. Planned unit outages at the Clergue plant totaled 568 hours during the reporting period (12.9 percent of the reporting period where at least one unit was shut down). Most of these outages were due to annual maintenance and cooler replacement on Unit G2, annual maintenance on Unit G3, and IESO-required compliance testing on all three units. Unplanned outages during the reporting period totaled 1,868 hours (42.3 percent of the reporting period) and were mostly due to blade clearance and stator issues on Unit G3 and a runner blade repair on Unit G2.

6.3. US Government Hydropower Plant

There were 28 unit outages for a total of 1,455 hours, with 1,320 hours attributed to the governor upgrade project, 58 hours due to instrumentation issues, 55 hours in support of divers inspecting the International Bridge, 14 hours due to mechanical issues, and the remaining hours were scheduled maintenance. Unit 1 had five outages, Unit 2 had six outages, Unit 3 had five outages, Unit 3A had four outages, and Unit 10 had eight outages.

The governor and exciter upgrade projects were both successful and completed on schedule. This fall, Units 1, 2 and 3 will have new scaffolding installed. Units 3A and 10 will have the scaffolding installed in the spring.

6.4. Cloverland Electric Cooperative

Cloverland's monthly average was as scheduled for March and April. May and June flows that were scheduled to be around 590 m^3/s (21,000 cfs) were actually 690 m^3/s (24,300 cfs) and 650 m^3/s (23,000 cfs) respectively. This was due to a late start of canal construction in May due to weather and a slightly shorter June construction season due to completing the required canal section early. July and August flows were as forecasted. This fall, canal work was suspended due to a delay in receiving materials. This will allow for nearly maximum flows through the end of the year, with a few hourly flow reductions to facilitate demobilization of the work barge and associated equipment.

Cloverland has begun a two-year project to upgrade its excitation systems and relay protection on all 74 units. This is to replace existing static exciters and protective relays that have reached the end of their useful life. Additional functionality has been added to the new excitation systems to include power-system stabilization and negative-field forcing to assist in reliability issues in the event that the eastern end of Michigan’s Upper Peninsula is isolated from the regional transmission grid. As part of this upgrade, the current hydraulic gate positioners are being upgraded to governor units. This will complement the excitation upgrade to allow the plant to operate as a standalone electrical island in the event of a transmission separation or emergency. It is expected that only two or three units will be out

of service at a time, so there will be minimal impact, if any, to the plant's discharge over and above that seen to date.

Cloverland has added staff to its Hydro Maintenance Department over the last few years and has been increasing unit reliability and availability by being more vigilant with its maintenance schedules and budgets.

7. Flow Verification Measurements

No flow verification measurements were taken this reporting period.

8. Water Usage in the St. Marys River

Table 4 (and Table 5 in cubic feet per second) lists the distribution of outflows from Lake Superior for January 2018 to August 2019. Water uses are divided into four categories: domestic, navigation, fishery, and hydropower. According to the 1979 Supplementary Order, after the first three water requirements are satisfied, the remaining outflow is shared equally between the United States and Canada for hydropower purposes. Any remainder, beyond the flow capacity of the hydropower plants, is discharged through the Compensating Works into the St. Marys Rapids.

As shown in the tables, water used for domestic and industrial purposes was 3 m^3/s (106 cfs) over the past six months, or 0.1 percent of the total monthly outflow. The monthly flow through the locks depends on traffic volume and varied from 4 to 14 m^3/s (141 to 494 cfs) during the past six months. As a percentage of the total river flow, water allocated for navigation varied from 0.2 percent to 0.5 percent in the busiest part of the navigation season. The US locks opened on 25 March and the Canadian lock opened on 24 May.

In accordance with the Commission's Orders to fulfill the fishery needs in the main rapids, a minimum gate setting of one-half gate open is required at all times at the Compensating Works. A setting equivalent to one-half gate open for the main rapids is maintained by having four gates partially open to supply the same quantity of water. This spreads the flow more evenly across the main rapids, and reduces potential damage from ice floes impacting the gates. As outlined in *Section* 3, a setting equivalent to two gates fully open was maintained this past winter using all sixteen gates partially open. In addition, a flow of at least 15 m^3/s (530 cfs) is normally also maintained in the Fishery Remedial Works through Gate #1. The flow in the St. Marys Rapids, including that through the Fishery Remedial Works, ranged from 331 to 1,342 m^3/s (11,700 to 47,400 cfs) over the last six months, or approximately 13 to 42 percent of the total monthly outflow.

The hydropower plants passed an average of 1,883 m^3/s (66,500 cfs) from March to August for electric power production, or approximately 72 percent of the total river flow. All plants were directed to run at their maximum capacities throughout the reporting period, which varies depending on hydrologic conditions, but on average, is assumed to be approximately

2,280 m^3/s (80,500 cfs) for all three plants. The total average monthly difference of 397 m^3/s (14,000 cfs) was due primarily to unit outages as a result of scheduled and unscheduled plant maintenance requirements. Usages at each plant are shown in Tables 4 and 5.

9. Long Lac, Ogoki and Chicago Diversions

Ontario Power Generation (OPG) continued to provide the Board with information on the operations of the Long Lac and Ogoki Diversions. The Ogoki Diversion into Lake Nipigon (which flows into Lake Superior) averaged 129 m^3/s (4,560 cfs) and the Long Lac Diversion averaged 35 m^3/s (1,240 cfs) from March through August. Combined, these diversions were about 97 percent of average for the period 1944-2018.

Slots cut into Waboose Dam provide a minimum flow northward to the Ogoki River of approximately 2 m^3/s (to meet fisheries requirements). This "slot flow" averaged 2.6 m^3/s (90 cfs) from March through August.

Continuous minimum flows of at least 2 m^3/s (70 cfs) are maintained from the Saturday of Victoria Day weekend (in May) through Labour Day from the northern outlet of Long Lake (Kenogami Dam) for environmental enhancement. Outflows through the Kenogami Dam during the reporting period averaged 16 m^3/s (560 cfs).

The Chicago Diversion is comprised of actual withdrawals of water from Lake Michigan, plus the diversion of runoff that once drained to Lake Michigan naturally to the Illinois River. The Chicago District, Corps of Engineers, continues to monitor the measurements and the computation of the diversion of Lake Michigan water by the State of Illinois through the Chicago Diversion. A report is traditionally published annually. These reports typically contain a diversion accounting report for one or more of the previous years, depending on when the diversion accounting data was ready to be reported. A technical committee report is also published every fifth year. Since final numbers are often unavailable for several years, a constant preliminary estimate of 91 m^3/s (3,210 cfs) is employed in regulatory computations. This equates to the maximum amount of diversion permitted on a yearly basis. Actual monthly values tend to be lower than this maximum annual diversion, but can occasionally be higher. Final monthly diversion estimates are currently coordinated through September 2015.

Water diverted into the System at Lake Superior (Ogoki Diversion + Long Lac Diversion) was 164 m^3/s (5,790 cfs). Water diverted from the System at Lake Michigan (Chicago Diversion) was estimated to be 91 m^3/s (3,210 cfs). Therefore, the net inflow into the System was approximately 73 m^3/s (2,580 cfs).

10. Peaking and Ponding Operations at Hydropower Plants

Peaking and ponding operations are the within-day and day-to-day flow variations,

respectively, that enable the hydropower plants to better match their electricity production with demand. However, these variations cause the water levels in the St. Marys River downstream of the plants to fluctuate more than they otherwise would. The Commission has approved guidelines within which the Board may restrict peaking and ponding operations under certain conditions. Specifically, if the minimum level at the U.S. Slip gauge on the lower river is expected to be below the threshold level of 176.09 m (577.7 ft) as a result of ponding operations, then the power entities are required to pass on-peak flows for at least an 8-hour period each weekend and holiday day to provide periods of relatively higher levels on the lower St. Marys River each day. The Board provides summaries of peaking and ponding in its semi-annual reports. Since 2016, the Board provides written reviews every five years that are to include any recommendation for adjusting the IJC Directive, if necessary.

Continued above-average outflows from Lake Superior combined with above-average Lake Michigan-Huron levels resulted in levels at U.S. Slip remaining well above the established threshold, such that ponding was permitted throughout the report period. However, the power entities were unable to conduct peaking and ponding because the hydropower plants were operating at maximum capacity from March through August.

To continue to provide timely information on expected flow variations to the users, the USACE distributes monthly notices during the shipping season (March through January) on expected Lake Superior outflows, and a schedule of flow variations. No related concerns were reported to the Board during the period.

Figure 7 compares the hourly Lake Superior outflow and the hourly levels at U.S. Slip on the lower St. Marys River for the past six months.

11. Great Lakes – St. Lawrence River Adaptive Management Committee

Over the last six months, the Great Lakes – St. Lawrence River Adaptive Management (GLAM) Committee focused primarily on plan evaluation of 2018 conditions and scoping work plan efforts for 2019. GLAM also devoted substantial time and effort into the development of a comprehensive 12-year strategy for completing a review of the performance of the existing regulation plan, and possible recommendations for plan improvements ahead of the IJC-mandated deadline.

GLAM conducted a face-to-face workshop with the members of the Great Lakes Boards of Control the day before the Boards conducted their semi-annual meetings. The intent of this workshop was to provide an opportunity for GLAM members and Board members to finally meet face-to-face, educate the Board members on priorities and issues for GLAM, and most importantly, to facilitate feedback and questions from the members on the GLAM process.

Finally, USACE and Environment and Climate Change Canada (ECCC) staff executed an

International Watersheds Initiative project to collect side-scan sonar bottom mapping of portions of the St. Marys River downstream of the rapids. These data were collected in early spring, with a secondary trip scheduled for the week of the Board meetings to collect vegetation data in these same areas. This information will be used by ECCC staff in the future to further develop an Integrated Ecosystem Response Model (IERM) to help quantify environmental impacts in the River due to regulation strategies.

12. Public Communications and Outreach

The Board hosted its annual public meeting at noon on 10 July using a combined webinar and teleconference format. A total of about 46 people participated, including members of the public, along with IJC staff, Board members, staff, and associates. The US Alternate Chair, Mr. Steven Durrett, presented information describing Plan 2012, expected flows and deviations, current and expected water levels, and Board initiatives. The meeting was then opened for public comment, questions, and concerns. An IJC advisor facilitated the question period and the members of the public submitted questions via the webinar's chat function. Professional facilitation would be preferred in the future. The Board may hold a similar webinar/teleconference meeting with the public again in 2020, the date of which would be set at the March Board meeting. However, the Board may seek out other, more-effective means of outreach and engagement.

Board staff also attended and participated in the annual Soo Locks Engineer's Day on 28 June, hosted by the USACE – Soo Area Office. This was the seventh year that Board staff have participated in this event, which was once again well-attended by the public, with over 8,000 people in attendance. Many of those in attendance stopped at the Board's display table, with professionally-printed banners and large posters showing Great Lakes water levels and an infographic of Plan 2012, along with numerous brochures and hand outs. The Board representatives in attendance were kept busy throughout the day, speaking directly with hundreds of people about water levels, flows, regulation, and other topics of interest. Much of the conversation centered around recent near-record-high water level conditions. Board staff plans to participate in this annual event again next year.

During these events and informally throughout the reporting period, stakeholders voiced concerns and asked questions about water level and flow conditions, how the current regulation plan balances levels, the Board's degree of control of lake levels, and the Board's deviation strategy. Stakeholders in the St. Marys River, including anglers, hydropower entities, commercial navigation and Batchewana First Nation have also expressed concerns over recent gate settings and the resulting high St. Marys River flows. However, the Board noted that people have now become more accustomed to the higher levels and flows in recent years, and most recent comments have been personal accounts. There has also been some positive feedback received with regard to recent conditions as well as the Board's deviation strategy, and the use of multiple partially-open gates in lieu of multiple gates open fully. Some remain concerned about potential impacts due to climate change and variability. There was also increased activity on the Board's Facebook page

stemming from shoreline owners on Lake Ontario concerned with the IJC's management of outflows using Plan 2014 (Lake Ontario) and Plan 2012 (Lake Superior).

The Board continues to issue, at the beginning of each month (and before any significant change in outflows or gate settings), news releases informing the public about Lake Superior regulation and water level conditions. These news releases are sent by both the Canadian and US regulation representative offices to e-mail distribution lists that include various agencies, stakeholders and media outlets. The Board also makes these news releases available to the public online through the Board's Website (https://ijc.org/en/lsbc) and the Board's Facebook page (https://www.facebook.com/InternationalLakeSuperiorBoardOfControl/), both of which continue to grow in popularity. Additional content available online includes information on Board Members and responsibilities, semi-annual reports, meeting minutes, and an interactive map describing some of the important features related to the regulation of outflows through the St. Marys River.

Due to the extremely high water levels on lakes Superior and Michigan-Huron, there was a large focus from the public and media on these high levels. Many areas of the shoreline on both basins experienced flooding and severe erosion. Although not directly Board activities, US regulation representative office staff led a very large outreach campaign this summer and spoke to hundreds of media outlets, responded to countless calls from private citizens and executed several dozen public presentations at various events with as many as 300 attendees each.

13. Board Membership and Meetings

MG Robert Whittle replaced MG Mark Toy as US Co-Chair on 12 July. Mr. Durrett remained the US Alternate Co-Chair.

The Board held meetings on 7 March in Syracuse, New York and 26 September in Burlington, Ontario.

Respectfully submitted,

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Jean-François Cantin	Stephen Durrett
Chair for Canada	Alternate Chair for United States

Figure 1 - LAKE SUPERIOR MONTHLY WATER LEVELS

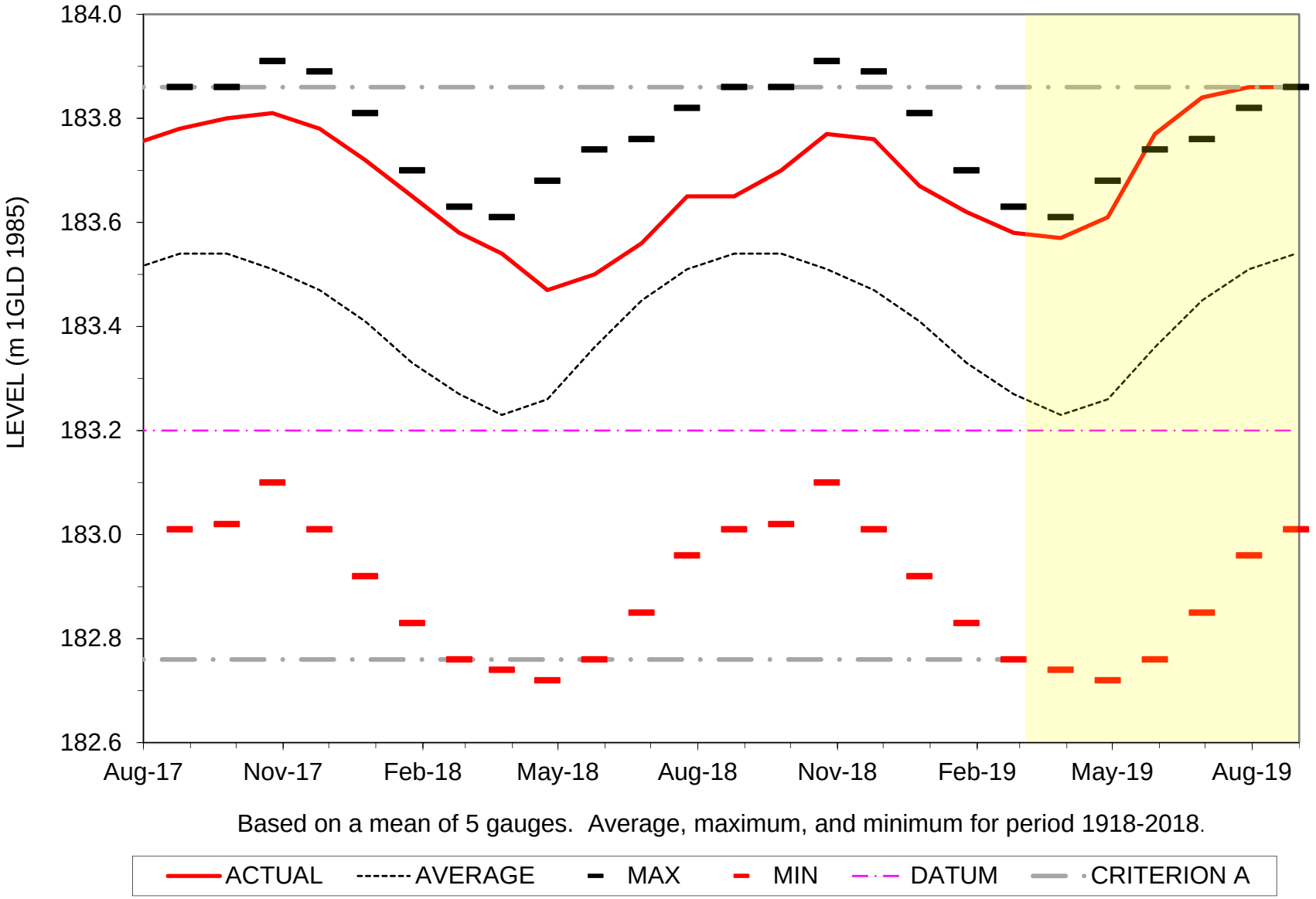
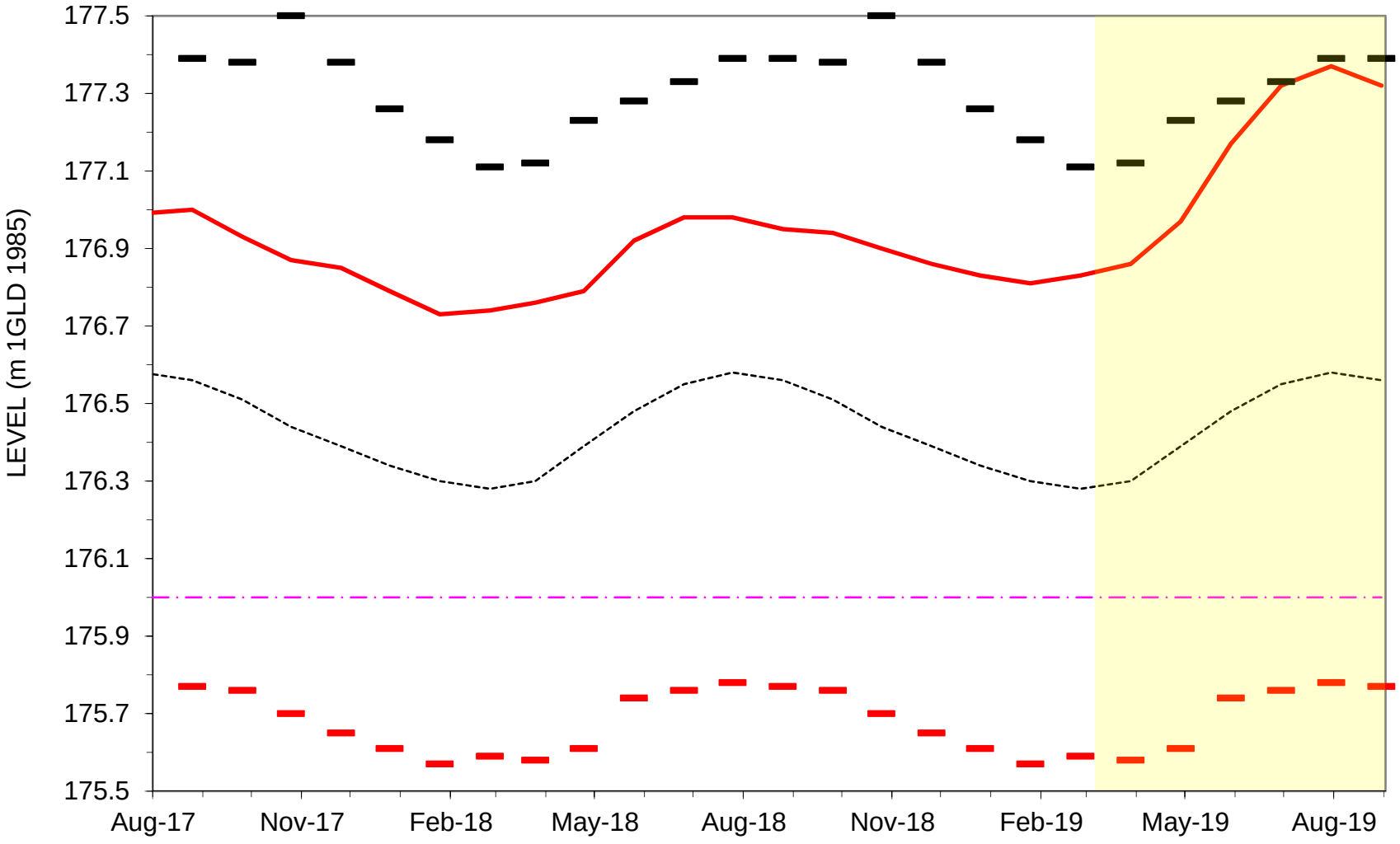


Figure 2 - LAKE MICHIGAN-HURON MONTHLY WATER LEVELS



Based on a mean of 6 gauges. Average, maximum, and minimum for period 1918-2018.

Figure 3 - LAKE SUPERIOR BASIN MONTHLY PRECIPITATION

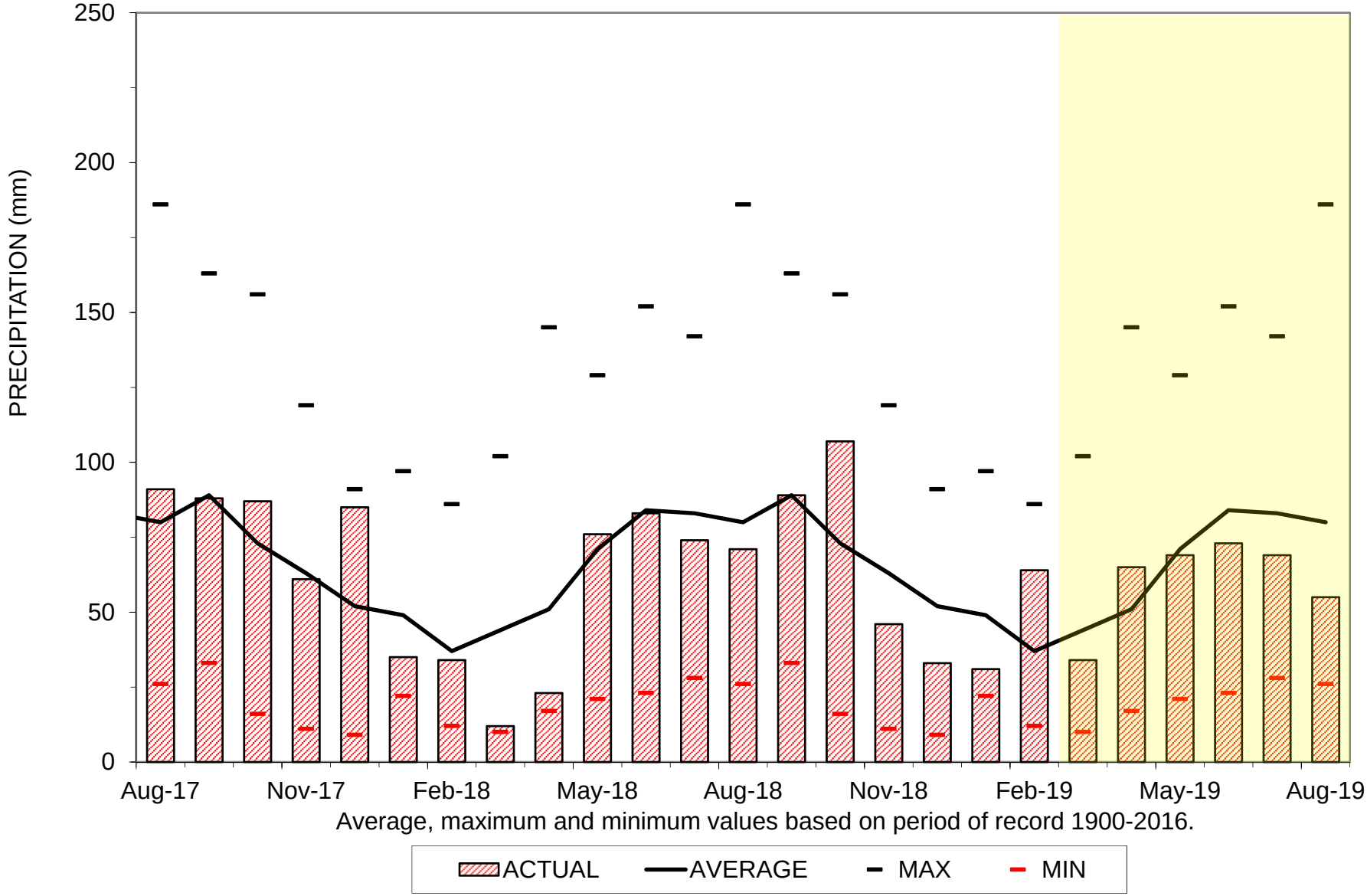


Figure 4 - LAKE MICHIGAN-HURON BASIN MONTHLY PRECIPITATION

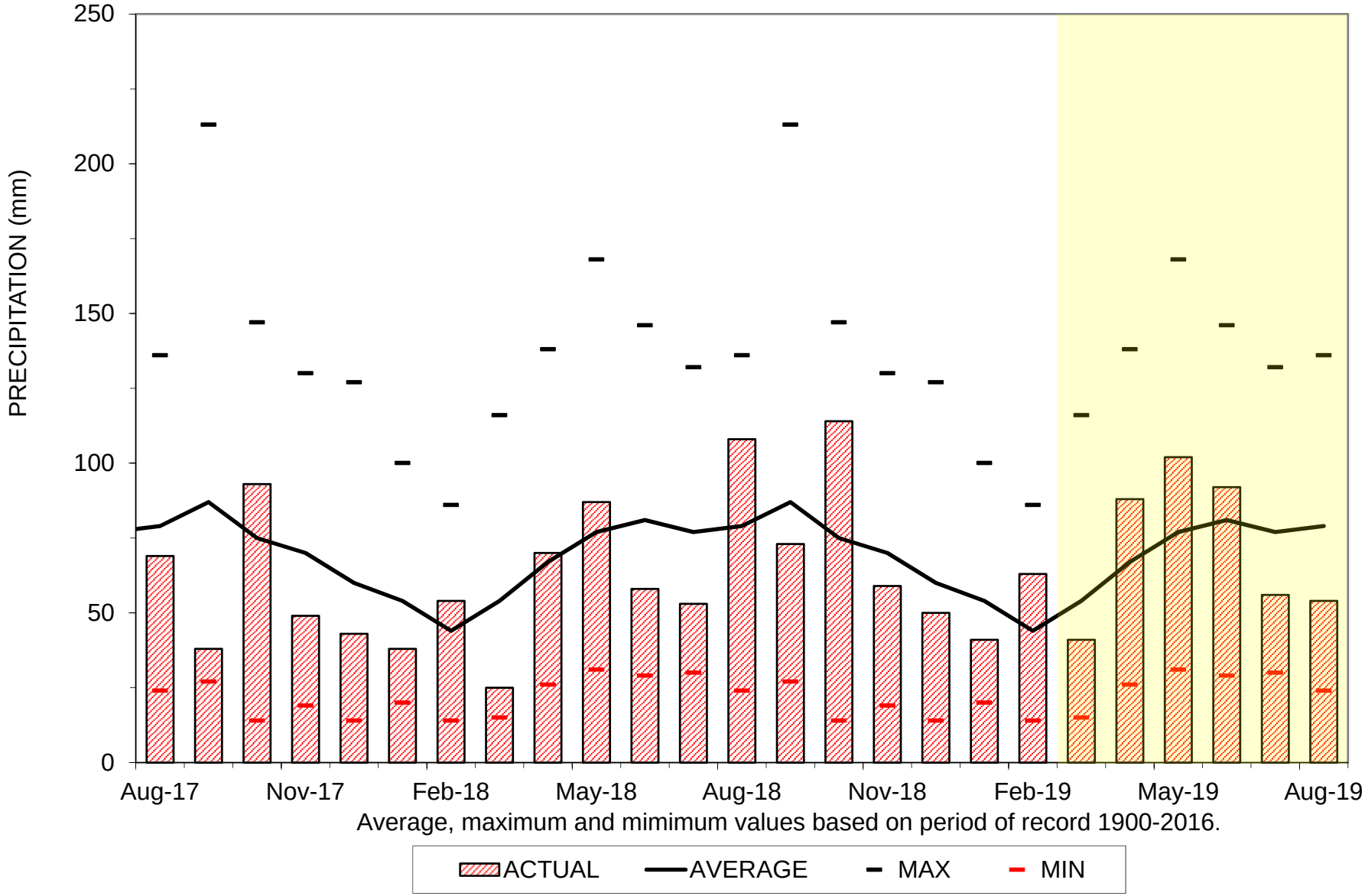
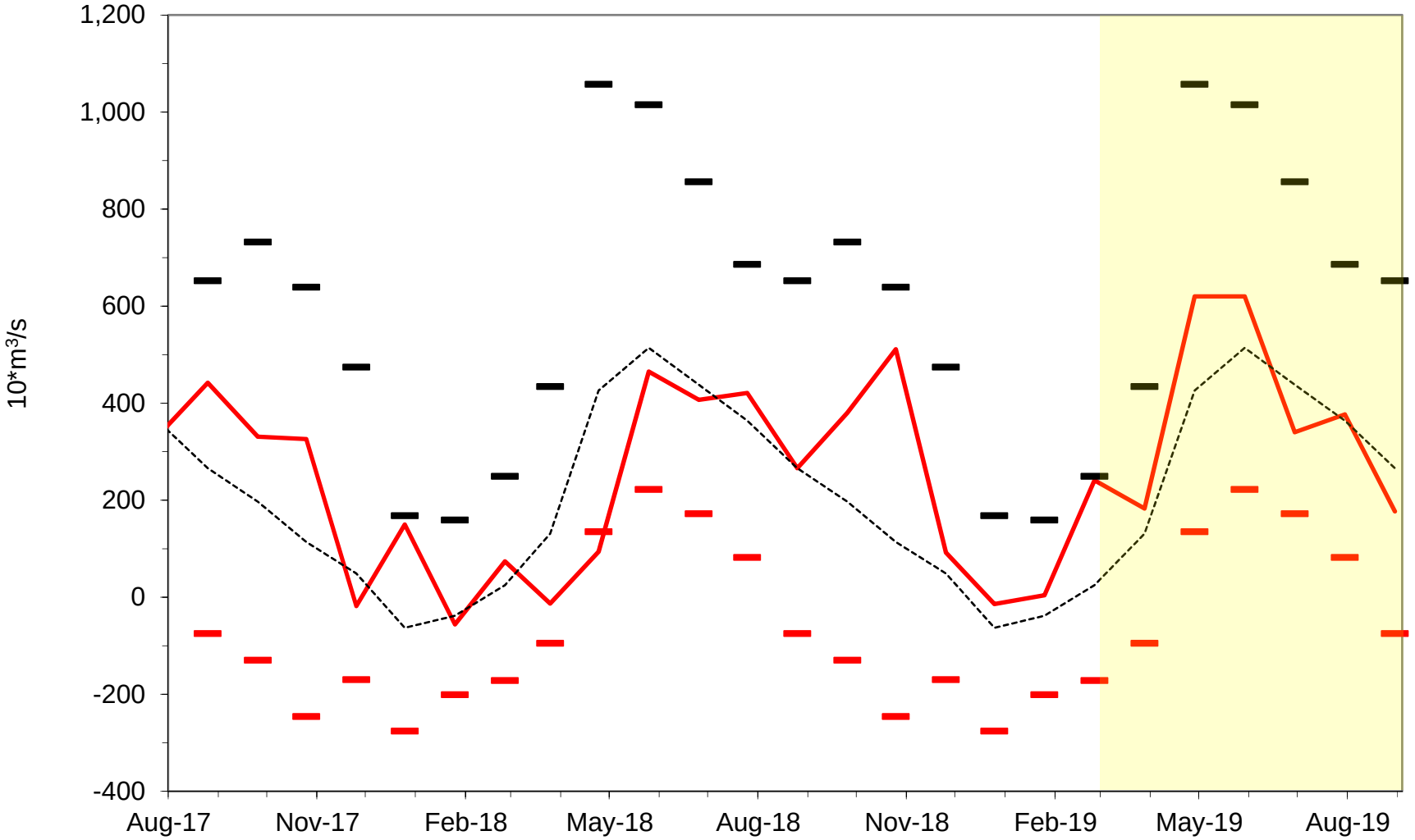
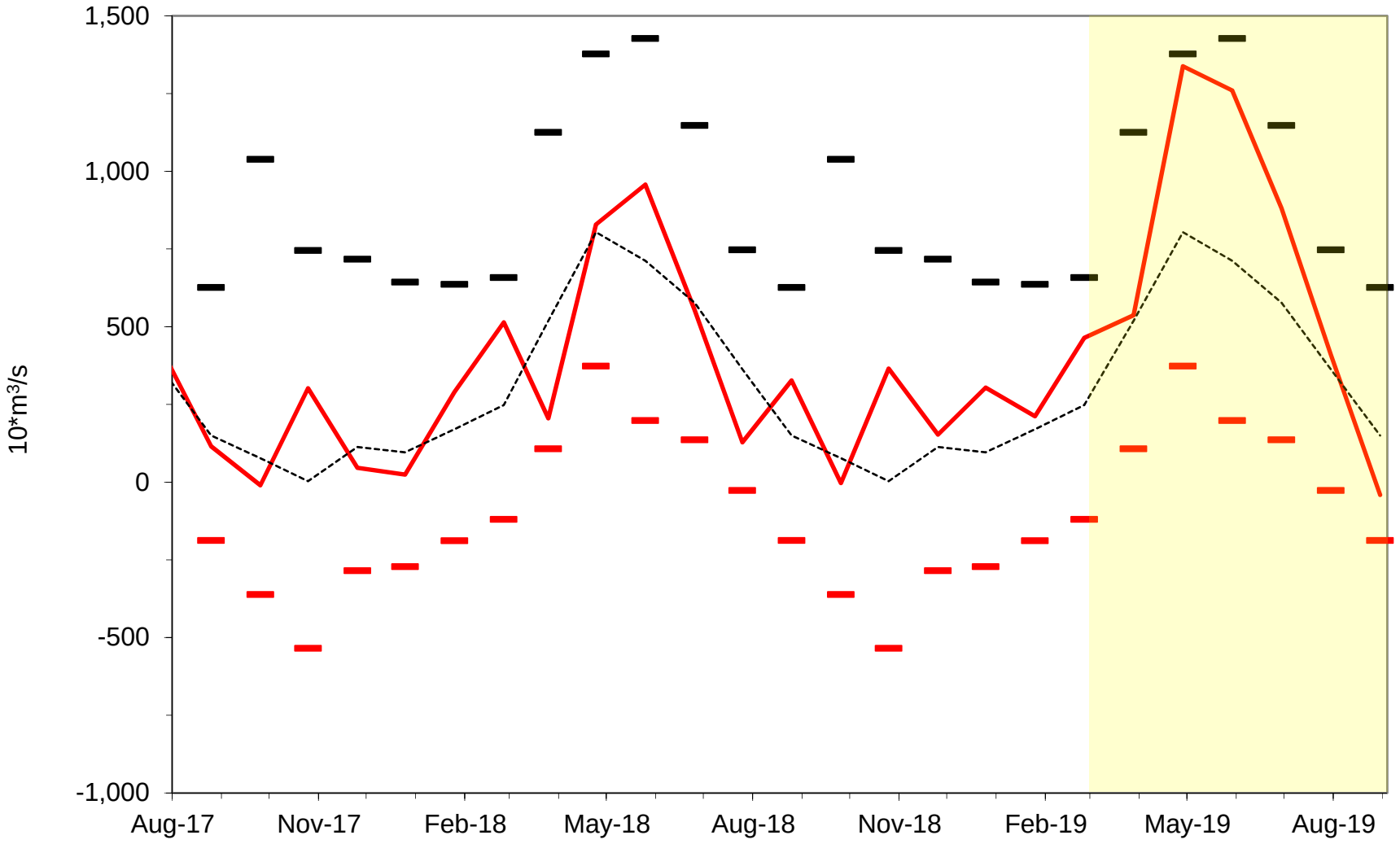


Figure 5 - LAKE SUPERIOR MONTHLY NET BASIN SUPPLIES

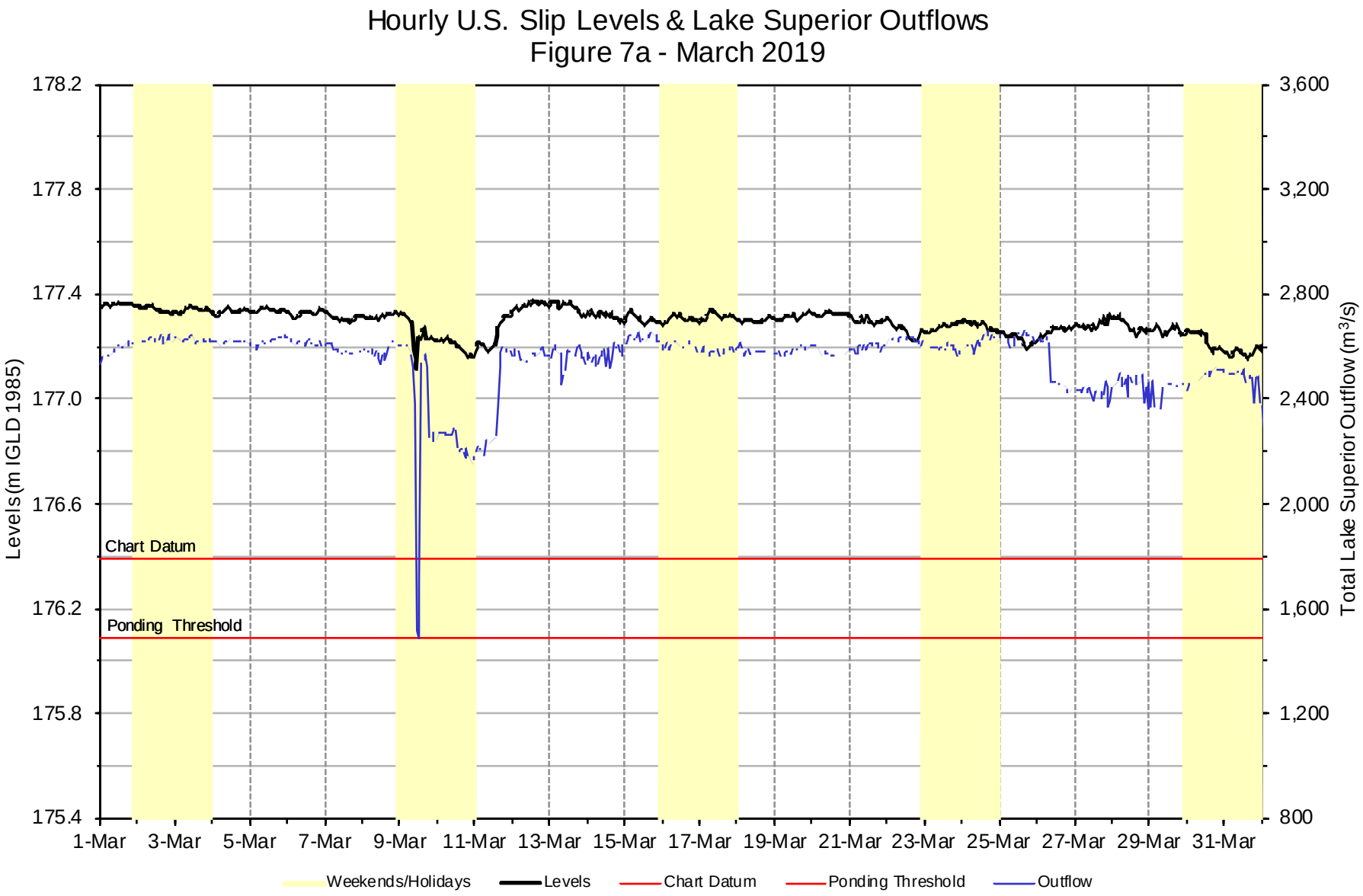


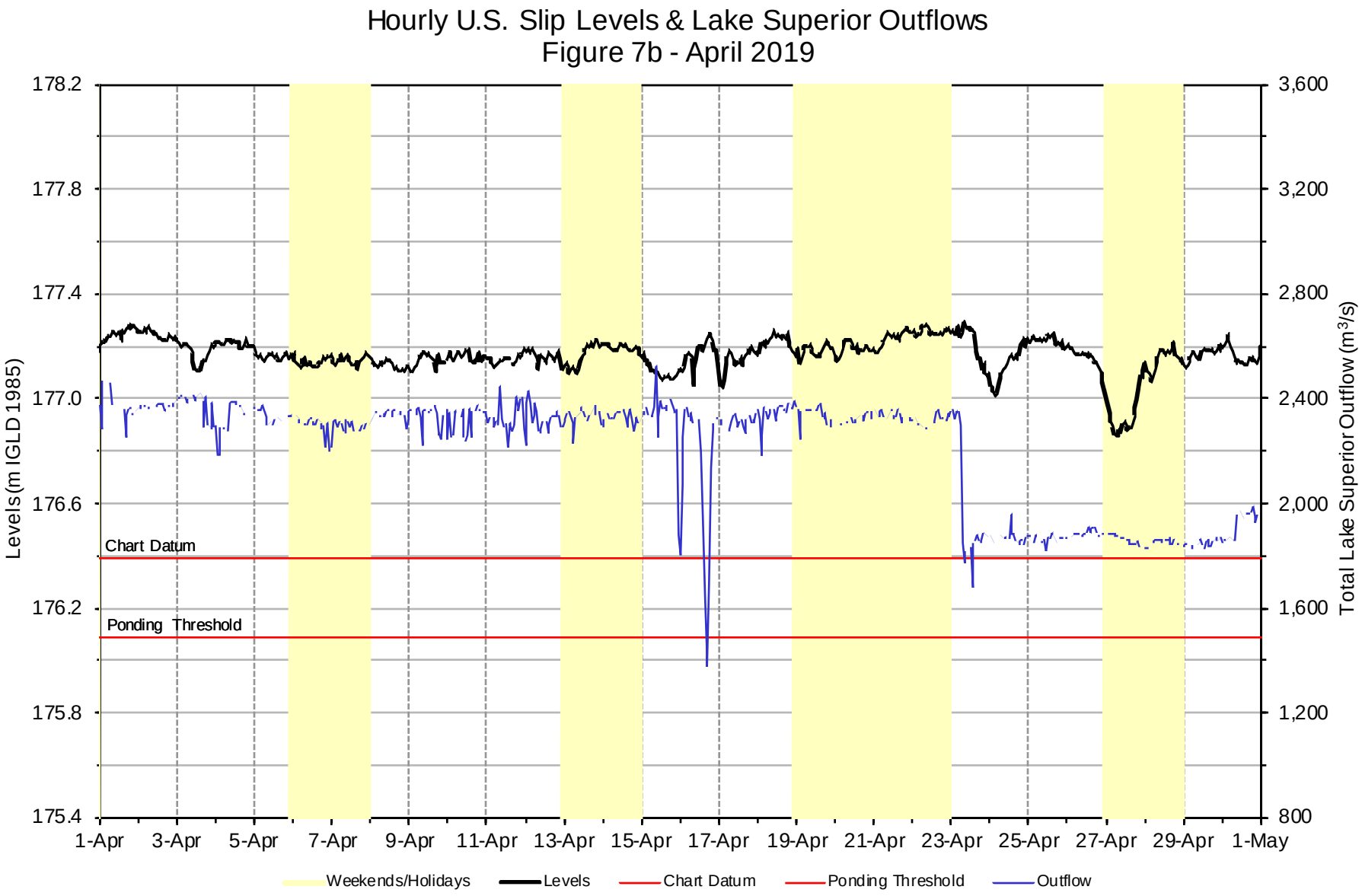
Average, maximum and minimum values based on coordinated period of record 1900-2008.

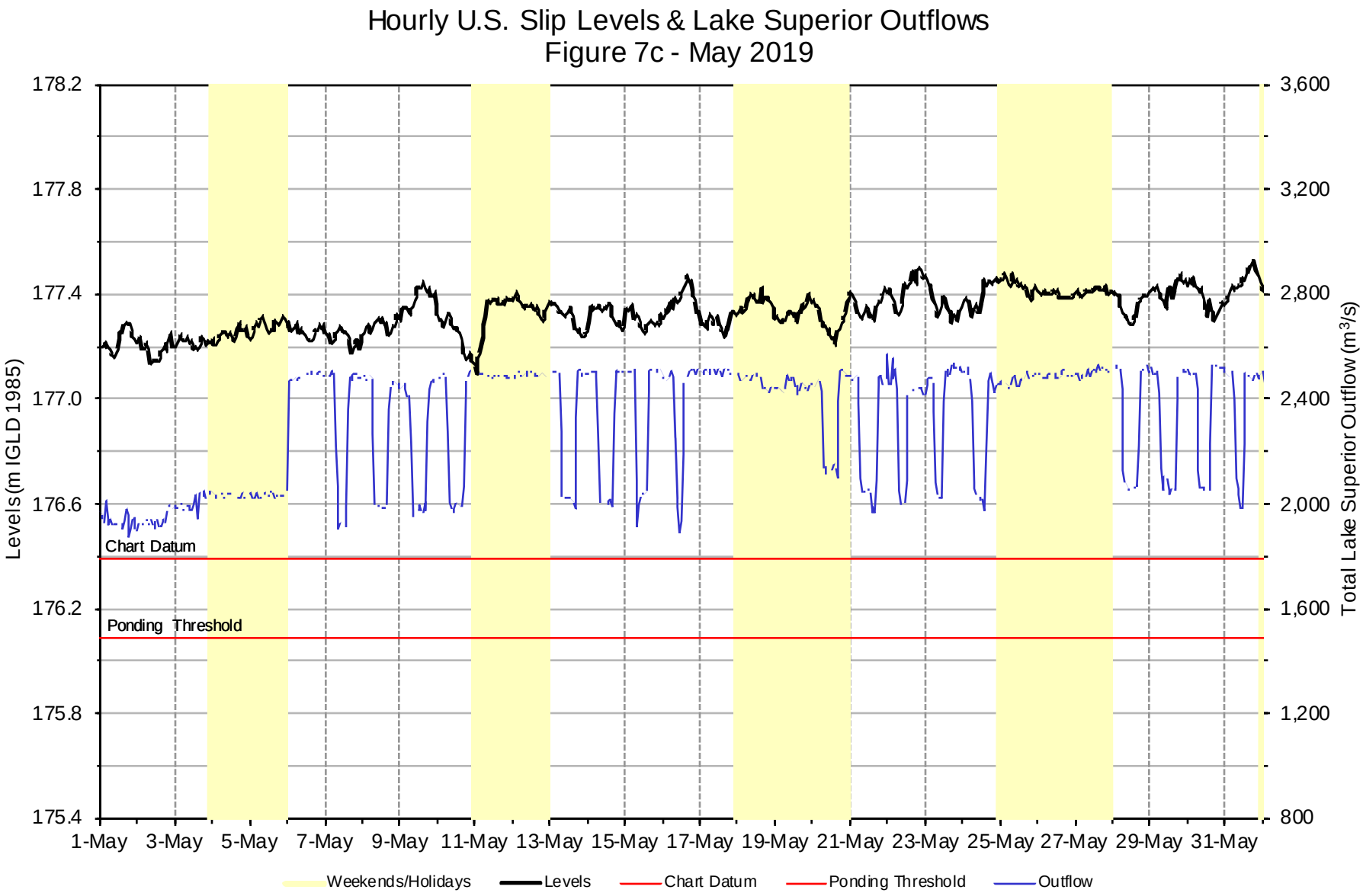
Figure 6 - LAKE MICHIGAN-HURON MONTHLY NET BASIN SUPPLIES



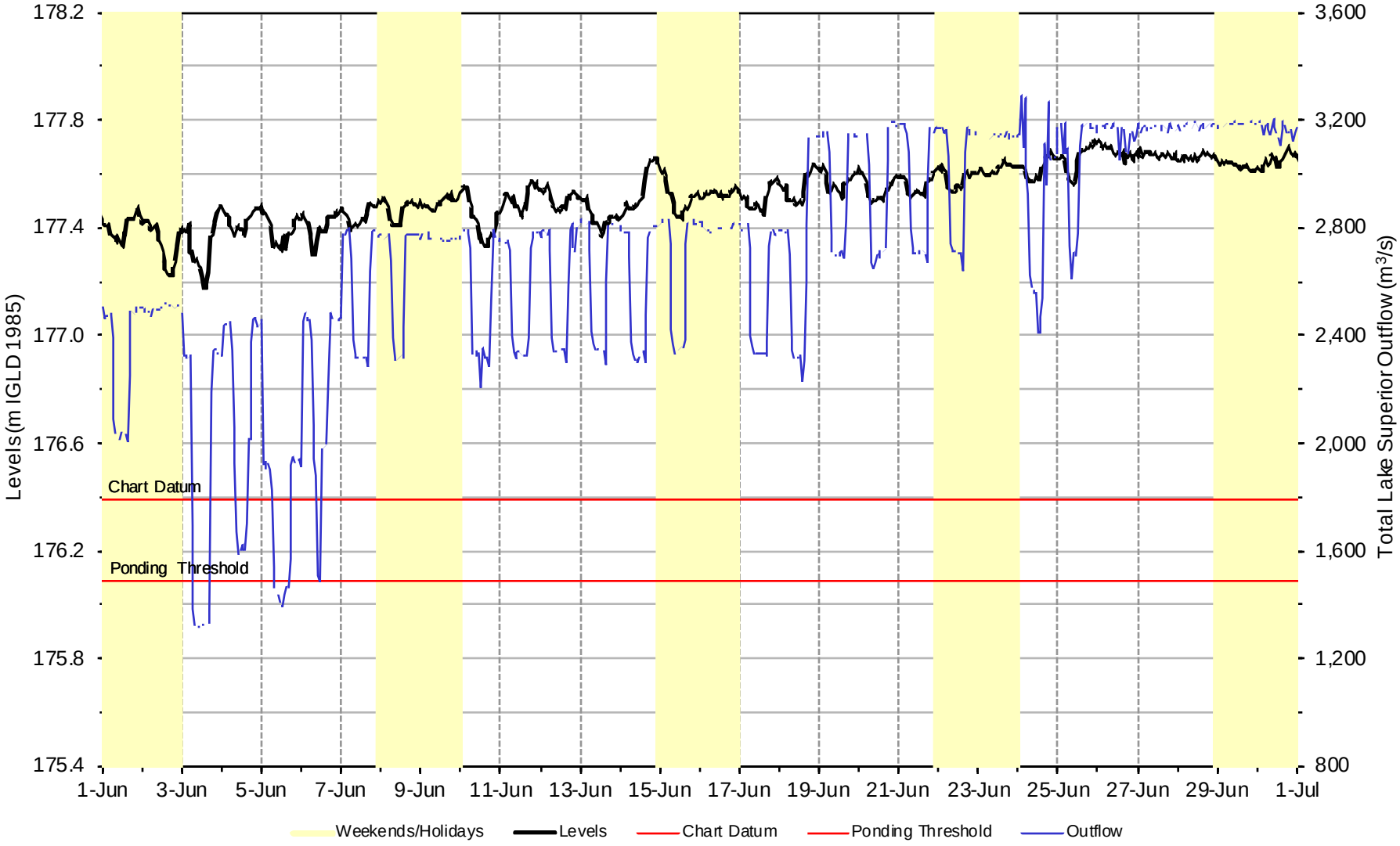
Average, maximum and minimum values based on coordinated period of record 1900-2008.


Hourly U.S. Slip Levels & Lake Superior Outflows
Figure 7a - March 2019
Levels (m IGLD 1985)
Total Lake Superior Outflow (m³/s)
178.2
177.8
177.4
177.0
176.6
176.2
175.8
175.4
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
Chart Datum
Ponding Threshold
1-Mar
3-Mar
5-Mar
7-Mar
9-Mar
11-Mar
13-Mar
15-Mar
17-Mar
19-Mar
21-Mar
23-Mar
25-Mar
27-Mar
29-Mar
31-Mar
Weekends/Holidays
Levels
Chart Datum
Ponding Threshold
Outflow

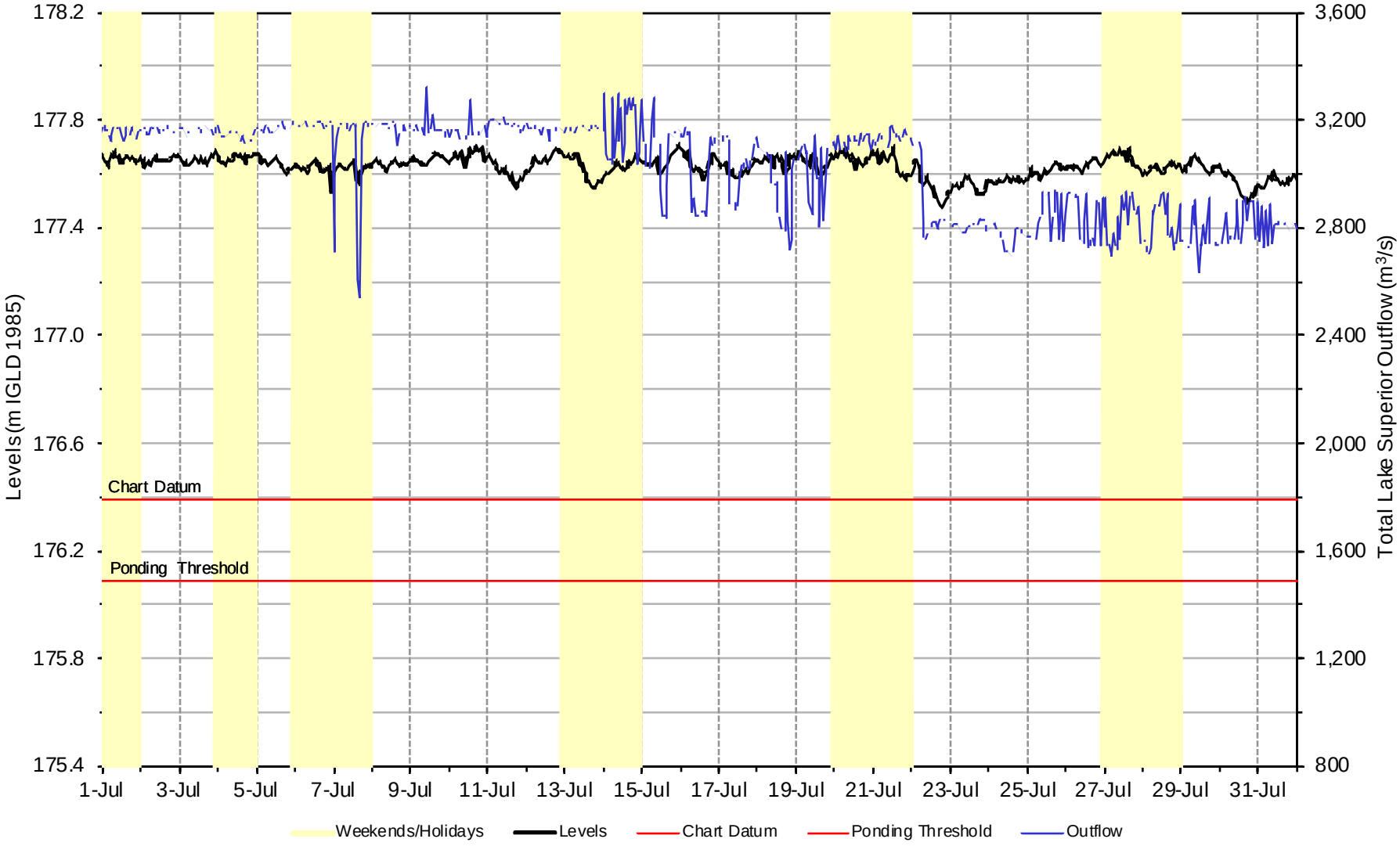

Hourly U.S. Slip Levels & Lake Superior Outflows
Figure 7b - April 2019
Levels (m IGLD 1985)
Total Lake Superior Outflow (m³/s)
178.2
177.8
177.4
177.0
176.6
176.2
175.8
175.4
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
Chart Datum
Ponding Threshold
1-Apr
3-Apr
5-Apr
7-Apr
9-Apr
11-Apr
13-Apr
15-Apr
17-Apr
19-Apr
21-Apr
23-Apr
25-Apr
27-Apr
29-Apr
1-May
Weekends/Holidays
Levels
Chart Datum
Ponding Threshold
Outflow


Hourly U.S. Slip Levels & Lake Superior Outflows
Figure 7c - May 2019
Levels (m IGLD 1985)
Total Lake Superior Outflow (m³/s)
178.2
177.8
177.4
177.0
176.6
176.2
175.8
175.4
3,600
3,200
2,800
2,400
2,000
1,600
1,200
800
Chart Datum
Ponding Threshold
1-May
3-May
5-May
7-May
9-May
11-May
13-May
15-May
17-May
19-May
21-May
23-May
25-May
27-May
29-May
31-May
Weekends/Holidays
Levels
Chart Datum
Ponding Threshold
Outflow

Hourly U.S. Slip Levels & Lake Superior Outflows
Figure 7d - June 2019



Hourly U.S. Slip Levels & Lake Superior Outflows
Figure 7e - July 2019



Hourly U.S. Slip Levels & Lake Superior Outflows
Figure 7f - August 2019

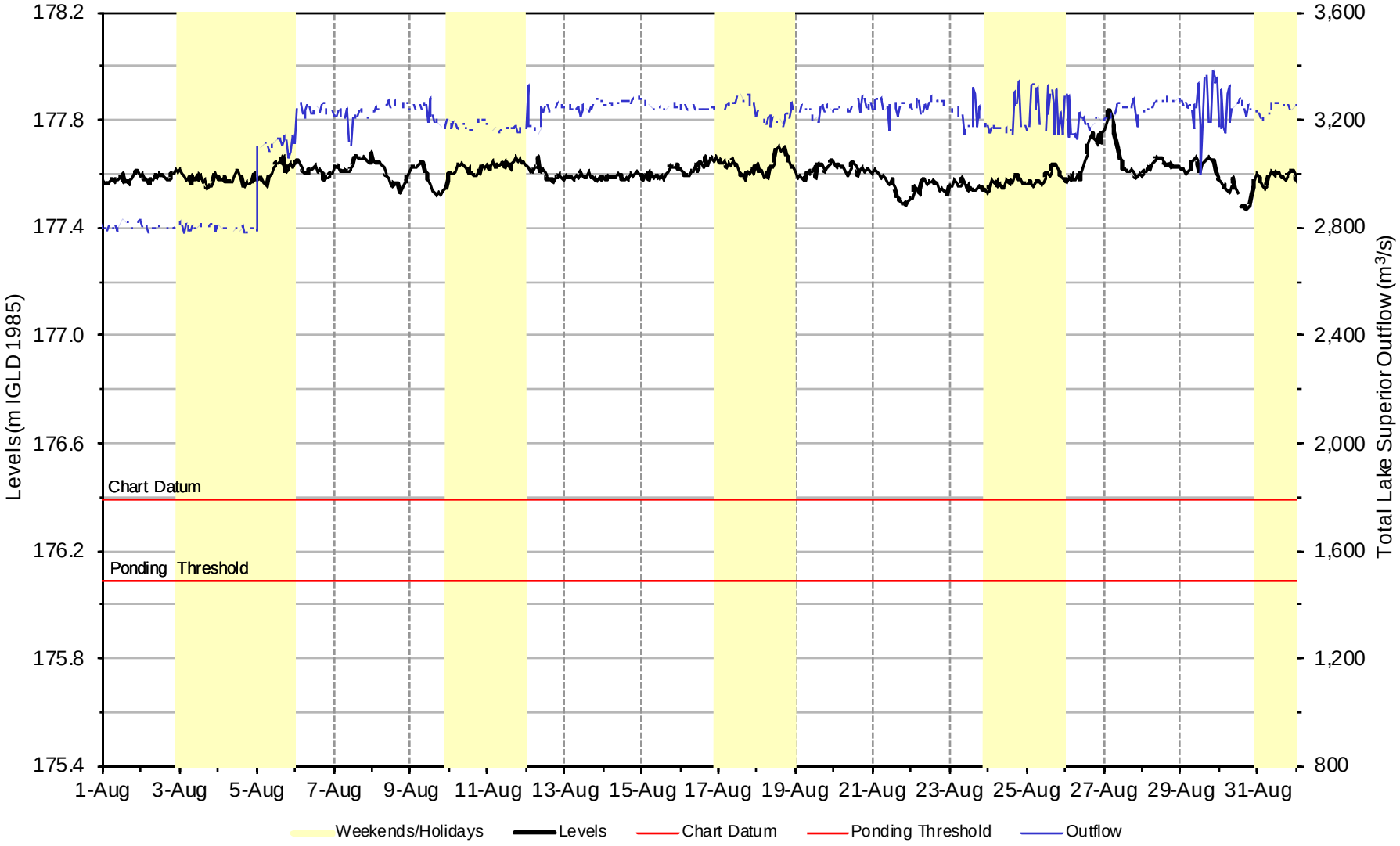


TABLE 1. 2018-2019 Lake Superior Hydrologic Factors

Month	Levels				Net Basin Supplies			Outflows		
	Monthly Mean Recorded[1]		Difference From Average[2]		Monthly Mean Recorded		Exceedence Probability[3]	Monthly Mean Recorded		Percent of Average[4]
	metres	feet	metres	feet	m^3/s	tcfs	(%)	m^3/s	tcfs	
Mar-18	183.54	602.17	0.31	1.02	-130	-5	90	2,470	87	132
Apr-18	183.47	601.94	0.21	0.69	940	33	>99	2,270	80	118
May-18	183.50	602.03	0.14	0.46	4,650	164	60	2,320	82	110
Jun-18	183.56	602.23	0.11	0.36	4,070	144	56	2,470	87	113
Jul-18	183.65	602.53	0.14	0.46	4,210	149	30	2,510	89	110
Aug-18	183.65	602.53	0.11	0.36	2,660	94	48	2,770	98	118
Sep-18	183.70	602.69	0.16	0.52	3,800	134	11	2,620	93	112
Oct-18	183.77	602.92	0.26	0.85	5,110	180	1	2,700	95	119
Nov-18	183.76	602.89	0.29	0.95	920	32	33	2,970	105	134
Dec-18	183.67	602.59	0.26	0.85	-140	-5	28	2,230	79	109
Jan-19	183.62	602.43	0.29	0.95	40	1	26	2,370	84	122
Feb-19	183.58	602.30	0.31	1.02	2,410	85	<1	2,510	89	132
Mar-19	183.57	602.26	0.34	1.12	1,830	65	30	2,550	90	136
Apr-19	183.61	602.40	0.35	1.15	6,200	219	9	2,210	78	115
May-19	183.77	602.92	0.41	1.35	6,200	219	26	2,320	82	110
Jun-19	183.84	603.15	0.39	1.28	3,400	120	73	2,710	96	124
Jul-19	183.86	603.22	0.35	1.15	3,770	133	43	3,030	107	133
Aug-19	183.86	603.22	0.32	1.05	1,770	63	75	3,180	112	135

Notes: m^3/s = cubic metres per second tcfs = 1000 cubic feet per second

[1] Water Levels are a mean of five gauges on Lake Superior, IGLD 1985

[2] Average levels are for period 1918-2018, based on a mean of five gauges. Differences computed as metres and then converted to feet.

[3] Exceedence probabilities are based on the period 1900-2008.

[4] Average flows are for the period 1900-2008.

TABLE 2. 2018-2019 Lake Michigan-Huron Hydrologic Factors

Month	Levels				Net Basin Supplies			Outflows		
	Monthly Mean Recorded[1]		Difference From Average[2]		Monthly Mean Recorded		Exceedence Probability[3]	Monthly Mean Recorded		Percent of
	metres	feet	metres	feet	m^3/s	tcfs	(%)	m^3/s	tcfs	Average[4]
Mar-18	176.76	579.92	0.46	1.51	2,050	72	92	6,220	220	128
Apr-18	176.79	580.02	0.40	1.31	8,290	293	43	6,000	212	117
May-18	176.92	580.45	0.44	1.44	9,570	338	13	5,990	212	112
Jun-18	176.98	580.64	0.43	1.41	5,540	196	52	6,130	216	112
Jul-18	176.98	580.64	0.40	1.31	1,280	45	95	5,930	209	108
Aug-18	176.95	580.54	0.39	1.28	3,270	115	15	5,950	210	108
Sep-18	176.94	580.51	0.43	1.41	-30	-1	64	6,070	214	111
Oct-18	176.90	580.38	0.46	1.51	3,650	129	5	6,260	221	115
Nov-18	176.86	580.25	0.47	1.54	1,530	54	39	6,200	219	115
Dec-18	176.83	580.15	0.49	1.61	3,040	107	14	6,070	214	117
Jan-19	176.81	580.09	0.51	1.67	2,120	75	37	5,290	187	116
Feb-19	176.83	580.15	0.55	1.80	4,640	164	8	5,270	186	119
Mar-19	176.86	580.25	0.56	1.84	5,370	190	45	6,040	213	124
Apr-19	176.97	580.61	0.58	1.90	13,380	473	2	6,570	232	128
May-19	177.17	581.27	0.69	2.26	12,600	445	2	6,790	240	127
Jun-19	177.32	581.76	0.77	2.53	8,810	311	7	6,960	246	128
Jul-19	177.37	581.92	0.79	2.59	4,110	145	36	7,050	249	128
Aug-19	177.32	581.76	0.76	2.49	-410	-14	87	7,150	252	130

Notes: m^3/s = cubic metres per second tcfs = 1000 cubic feet per second

[1] Water Levels are a mean of six gauges on Lake Michigan-Huron, IGLD 1985

[2] Average levels are for period 1918-2018, based on a mean of six gauges. Differences computed as metres and then converted to feet.

[3] Exceedence probabilities are based on the period 1900-2008.

[4] Average flows are for the period 1900-2008.

TABLE 3
COMPENSATING WORKS GATE CHANGES

Date	Gate Change	Final Gate Settings *	Gate Equivalent (approx.)	Notes
2019				
6-May	Raised 11 - 14	2 - 10, 15, 16 open 26 cm (10 in.); 11 - 14 open 165 cm (65 in.)	4	Deviation strategy to better manage operational limits on hydropower flow capacity
3-Jun	Temporarily closed 14, closed 15 - 16	2 - 9, 15 open 26 cm (10 in.); 10 open 71 cm (28 in.); 11 - 14 open 254 cm (100 in.); 16 open 5 cm (2 in.)	6	Gates temporarily adjusted to facilitate underwater inspections of the International Bridge piers; Continue deviation strategy to better manage operational limits on hydropower flow capacity; Sea lamprey trapping**
5-Jun	Closed 9 - 14			
6-Jun	Temporarily closed 2 - 8			
7-Jun	Raised 10 - 14, partially opened 15 - 16			
18-Jul	Closed 7 - 8	2 - 6, 15 open 26 cm (10 in.); 10 open 71 cm (28 in.); 11 - 14 open 254 cm (100 in.); 16 open 5 cm (2 in.)	5	Gates 7-9 closed to facilitate concrete repair; Continue deviation strategy to better manage operational limits on hydropower flow capacity; Sea lamprey trapping**
22-Jul	Closed 9			
5-Aug	Partially opened 9 - 10	2 - 7, 15 open 26 cm (10 in.); 8 open 122 cm (48 in.); 9 - 14 open 254 cm (100 in.); 16 open 5 cm (2 in.)	9	Continue deviation strategy to better manage operational limits on hydropower flow capacity; Sea lamprey trapping**
6-Aug	Partially opened 7 - 8			

* Gate 1 remained open 20 cm (8 in.) throughout reporting period (fishery requirement of approximately 15 m^3/s).

** Gate 16 set to 5 cm (2 in.) open at request of US Fish and Wildlife Service to allow for sea lamprey trapping

TABLE 4
MONTHLY DISTRIBUTION OF LAKE SUPERIOR OUTFLOWS
(UNITS: m^3/s)

YEAR AND MONTH	POWER CANALS					NAVIGATION CANALS			DOMESTIC USAGE				FISHERY	TOTAL
	US GOVT HYDRO	CEC	US TOTAL	BREG	TOTAL POWER CANALS	UNITED STATES	CANADA	TOTAL NAV CANALS	SAULT STE MARIE US + CAN	ESSAR ALGOMA STEEL	ST MARYS PAPER	TOTAL DOM USAGE	ST MARYS RAPIDS	LAKE SUPERIOR OUTFLOW
2018														
JAN	390	777	1,167	699	1,866	3.0	0	3	0.2	2.8	0	3	193	2,065
FEB	392	777	1,169	736	1,905	0	0	0	0.2	2.6	0	3	191	2,099
MAR	385	748	1,133	1,144	2,277	3.6	0	4	0.2	2.5	0	3	188	2,472
APR	367	709	1,076	994	2,070	9.2	0	9	0.2	2.7	0	3	185	2,267
MAY	371	664	1,035	998	2,033	10.2	0.3	10	0.2	3.1	0	3	272	2,318
JUN	390	651	1,041	1,092	2,133	10.7	1.2	12	0.2	3.1	0	3	319	2,467
JUL	392	787	1,179	809	1,988	17.3	1.9	19	0.3	3.0	0	3	496	2,506
AUG	388	778	1,166	719	1,885	19.6	1.7	21	0.2	3.1	0	3	860	2,769
SEP	375	630	1,005	682	1,687	11.8	1.0	13	0.2	3.1	0	3	914	2,617
OCT	390	635	1,025	679	1,704	10.4	0.3	11	0.2	2.7	0	3	978	2,696
NOV	390	613	1,003	682	1,685	9.6	0	10	0.2	3.0	0	3	1,272	2,970
DEC	370	757	1,127	678	1,805	9.6	0	10	0.2	3.4	0	4	412	2,231
2019														
JAN	381	742	1,123	908	2,031	4.8	0	5	0.2	3.5	0	4	333	2,373
FEB	385	718	1,103	1,068	2,171	0	0	0	0.2	3.5	0	4	331	2,506
MAR	397	749	1,146	1,069	2,215	3.7	0	4	0.2	3.2	0	3	331	2,553
APR	262	766	1,028	836	1,864	9.2	0	9	0.2	3	0	3	333	2,209
MAY	397	688	1,085	540	1,625	11.3	0.2	12	0.2	3.2	0	3	679	2,319
JUN	391	651	1,042	717	1,759	11.7	1.1	13	0.2	3.2	0	3	931	2,706
JUL	396	781	1,177	843	2,020	12	1.5	14	0.2	3.2	0	3	992	3,029
AUG	397	786	1,183	634	1,817	12.4	1.6	14	0.2	3.2	0	3	1,342	3,176

NOTE: Power canals columns include flows through power plants and spillways
NOTE: Discharge through Davis Lock included in US navigation flows (July and August 2018)

TABLE 5
MONTHLY DISTRIBUTION OF LAKE SUPERIOR OUTFLOWS
(UNITS: cfs)

YEAR AND MONTH	POWER CANALS					NAVIGATION CANALS			DOMESTIC USAGE				FISHERY	TOTAL
	US GOVT HYDRO	CEC	US TOTAL	BREG	TOTAL POWER CANALS	UNITED STATES	CANADA	TOTAL NAV CANALS	SAULT STE MARIE US + CAN	ESSAR ALGOMA STEEL	ST PAPER	TOTAL DOM USAGE	ST RAPIDS	LAKE SUPERIOR OUTFLOW
2018														
JAN	13,800	27,400	41,200	24,700	65,900	106	0	106	7	99	0	106	6,800	72,900
FEB	13,800	27,400	41,200	26,000	67,200	0	0	0	7	92	0	106	6,700	74,000
MAR	13,600	26,400	40,000	40,400	80,400	127	0	127	7	88	0	106	6,600	87,200
APR	13,000	25,000	38,000	35,100	73,100	325	0	325	7	95	0	106	6,500	80,000
MAY	13,100	23,400	36,500	35,200	71,700	360	11	371	7	109	0	106	9,600	81,800
JUN	13,800	23,000	36,800	38,600	75,400	378	42	420	7	109	0	106	11,300	87,200
JUL	13,800	27,800	41,600	28,600	70,200	611	67	678	11	106	0	106	17,500	88,500
AUG	13,700	27,500	41,200	25,400	66,600	692	60	752	7	109	0	106	30,400	97,900
SEP	13,200	22,200	35,400	24,100	59,500	417	35	452	7	109	0	106	32,300	92,400
OCT	13,800	22,400	36,200	24,000	60,200	367	11	378	7	95	0	106	34,500	95,200
NOV	13,800	21,600	35,400	24,100	59,500	339	0	339	7	106	0	106	44,900	104,800
DEC	13,100	26,700	39,800	23,900	63,700	339	0	339	7	120	0	141	14,500	78,700
2019														
JAN	13,500	26,200	39,700	32,100	71,800	170	0	170	7	124	0	141	11,800	83,900
FEB	13,600	25,400	39,000	37,700	76,700	0	0	0	7	124	0	141	11,700	88,500
MAR	14,000	26,500	40,500	37,800	78,300	131	0	131	7	113	0	106	11,700	90,200
APR	9,250	27,100	36,350	29,500	65,850	325	0	325	7	106	0	106	11,800	78,100
MAY	14,000	24,300	38,300	19,100	57,400	399	7	406	7	113	0	106	24,000	81,900
JUN	13,800	23,000	36,800	25,300	62,100	413	39	452	7	113	0	106	32,900	95,600
JUL	14,000	27,600	41,600	29,800	71,400	424	53	477	7	113	0	106	35,000	107,000
AUG	14,000	27,800	41,800	22,400	64,200	438	56	494	7	113	0	106	47,400	112,200

NOTE: Power canals columns include flows through power plants and spillways

NOTE: Discharge through Davis Lock included in US navigation flows (July and August 2018)

NOTE: Flows for individual users were originally coordinated in m^3/s, and are converted here to U.S. customary units (cfs) and rounded to 3 significant figures. Total flow for each category and total Lake Superior flow in this table are computed from the individual flows in cfs.