2020 WASHINGTON METROPOLITAN AREA DROUGHT EXERCISE

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C.L. Schultz, S.N. Ahmed, H.L.N. Moltz, and A. Seck

Section for Cooperative Water Supply Operations on the Potomac
Interstate Commission on the Potomac River Basin
30 West Gude Drive, Suite 450, Rockville, Maryland 20850

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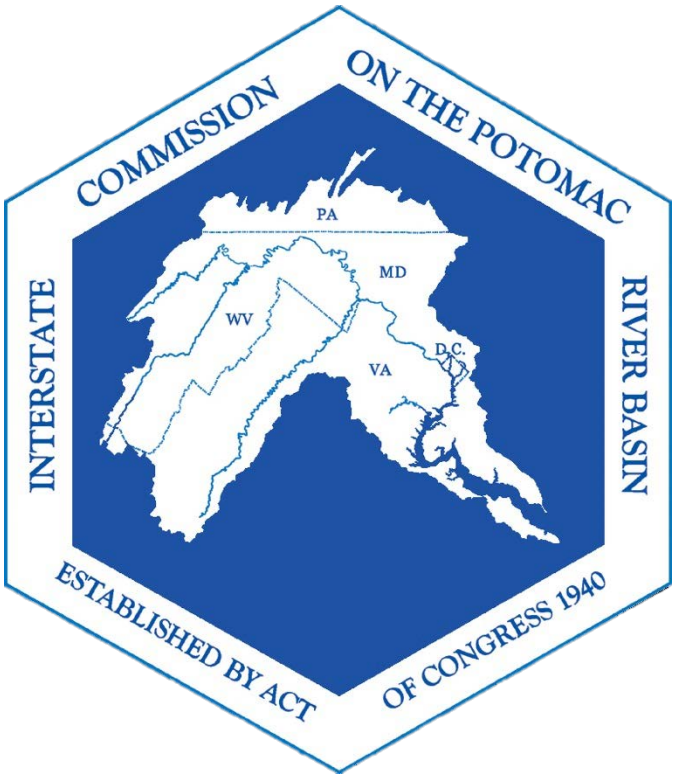
Table of Contents

List of Tables

List of Figures



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The report is available online at www.PotomacRiver.org as ICP21-1_Schultz.pdf.

Introduction

The Washington, D.C., metropolitan area (WMA) relies on the Potomac River for over three-quarters of its water supply. The area's three major water suppliers ("CO-OP suppliers"), Fairfax County Water Authority (Fairfax Water), the Washington Suburban Sanitary Commission (WSSC Water), and the Washington Aqueduct (a Division of the U.S. Army Corps of Engineers) participate in a cooperative system of water supply planning and management. This includes joint funding of water supply storage in reservoirs located upstream of the suppliers' Potomac River intakes and coordinated operations during droughts. This cooperative system is based on a set of agreements entered into more than 35 years ago. The Low Flow Allocation Agreement (LFAA) of 1978 specifies a formula for the allocation of water during shortages. The Water Supply Coordination Agreement (WSCA) of 1982 commits the three suppliers to operate "in a coordinated manner" during droughts to optimize the use of available resources.

During periods of drought, the Interstate Commission on the Potomac River Basin (ICPRB) Section for Cooperative Water Supply Operations on the Potomac (CO-OP) helps manage the CO-OP system by coordinating supplier water withdrawals from the Potomac River and off-river reservoirs. CO-OP also recommends releases from upstream reservoirs when forecasted flow in the river is not sufficient to meet expected needs. These needs include WMA demands and an environmental flow-by of 100 million gallons per day (MGD) on the Potomac River below the Little Falls dam near Washington, D.C.

Each year in which actual drought conditions do not occur, CO-OP conducts a drought exercise. These exercises help maintain drought preparedness by allowing participants to practice and improve communication procedures among organizations. The exercises provide ICPRB's CO-OP staff with an opportunity to practice using operational tools and making management decisions. The exercises also help ensure that during an actual drought, key operational strategies have been tested and discussed with stakeholders beforehand.

This report describes activities conducted during the 2020 drought exercise. The exercise was virtual, and took place on Monday, Tuesday, and Wednesday, November 16-18, from 7:30 AM to 4:00 PM. Communications during the exercise were via telephone, email, and Microsoft Teams Meeting, and all operations were "simulated." Twice daily email reports were sent out to stakeholders reporting on current flow and demand conditions and on simulated operations. This year's exercise included two special events:

- An actual test release from Little Seneca Reservoir, which was conducted over an approximately 12-hour period, beginning at 10:00 AM on Tuesday, November 17.
- A webinar by Hazen & Sawyer on the use of the Potomac OASIS model to provide probabilistic information on future streamflows and reservoir storage levels, which took place on Tuesday afternoon, November 17.

Participants in this year's exercise included staff from:

- ICPRB, which coordinates planning and operations between suppliers;

- Washington Aqueduct, which supplies water to the District of Columbia via DC Water, and to certain areas in Virginia, including Arlington County;
- WSSC Water, which supplies water to Montgomery and Prince George's counties in Maryland, and on a limited basis to other parts of Maryland;
- Fairfax Water, which supplies water to Fairfax County, Virginia, and provides wholesale water to other suppliers in northern Virginia;
- Loudoun County Water Authority (Loudoun Water), which supplies its retail customers in Loudoun County in part with water withdrawn from the Potomac River and treated at its Trap Rock Water Treatment Facility (WTF)[1] and in part with water purchased wholesale from Fairfax Water;
- The U.S. Army Corps of Engineers (USACE), Baltimore District Office, which manages the North Branch Reservoir water quality and water supply releases; and
- Maryland-National Capital Park and Planning Commission (M-NCPPC), which assists in notifying Black Hills Regional Park visitors of Little Seneca release events.

Overview of WMA Drought Operations

The Potomac River is the primary source of raw water for the CO-OP suppliers, which each have one or more intakes on the river upstream of Little Falls dam near Washington, D.C. Fairfax Water also relies on stored water from the Occoquan Reservoir and WSSC Water relies on water stored in a pair of reservoirs in the Patuxent River watershed: T. Howard Duckett (Rocky Gorge) and Triadelphia. The Washington Aqueduct has two intakes on the Potomac River: one at Little Falls dam and one several miles upstream, at Great Falls. In addition, these three suppliers jointly own storage in two reservoirs located upstream of their Potomac River intakes: Jennings Randolph Reservoir (JRR), located on the North Branch of the Potomac River adjacent to Garrett County, Maryland, and Mineral County, West Virginia, and Little Seneca Reservoir, located in Montgomery County, Maryland. JRR is operated by the U.S. Army Corps of Engineers and the dam at Little Seneca is operated by WSSC Water. The water suppliers pay a portion of the operations and maintenance costs of a third upstream reservoir, Savage, which is also located on the North Branch of the Potomac and is operated in conjunction with JRR. These three reservoirs are available to augment Potomac River flow during low-flow periods.

Key CO-OP goals for drought operations are:

- Maintaining Potomac River flow at Little Falls dam, as measured by the USGS gage at that location (Station ID 01646500), at or above the environmental flow-by of 100 MGD, or equivalently, 155 cubic feet per second (cfs).

[1] Loudoun Water has been withdrawing water from the Potomac River since 2018 to provide a portion of its supply, under Virginia Water Appropriations Permit No. 10-2020.

- Maintaining estimated flow below Great Falls, located approximately 9.3 river miles upstream of Little Falls, at or above the recommended minimum flow of 300 MGD (464 cfs). Estimated travel time between Great Falls and Little Falls during extremely low-flow conditions is nine hours.
- Balancing use of storage in system reservoirs to ensure that adequate volumes are maintained in each reservoir to sustain expected withdrawals throughout the remainder of a severe drought and to ensure a 95 percent probability of refill to 90 percent capacity by June 1 of the following year.

Given the travel times between upstream water storages and CO-OP utility Potomac River intakes, estimated to be nine days from JRR and one day from Little Seneca Reservoir during low flow conditions, it is necessary to be able to predict future river flows and future WMA demands. To meet its operational goals during drought, CO-OP staff uses flow and demand forecasts to develop scenarios for release rates from upstream reservoirs and withdrawal rates from system intakes.

Operations scenarios may require "load shifts" by the water suppliers between intakes, that is, the shifting of some portion of a supplier's withdrawal from one intake to another. Fairfax Water and WSSC Water may be asked to make a load shift to their off-Potomac reservoir intakes to help maintain Potomac River flow at Little Falls above the environmental flow-by, or they may be asked to make a load shift to the Potomac River to help preserve storage in their off-Potomac reservoirs. Washington Aqueduct may be asked to shift a portion of its withdrawal from its Great Falls to its Little Falls intake to help increase flow in the stretch of the Potomac River between Great Falls and Little Falls. Load shifting requires close communication between ICPRB CO-OP and water supplier staff to make sure that proposed scenarios are feasible.

Pre-Exercise Activities

A significant amount of preparation takes place prior to a drought exercise. Several pre-exercise tasks are discussed below.

Communications with the Public

A letter was sent to the Montgomery County Executive and County Council members on November 4, 2020, informing them that a test release was planned (Appendix A). The Maryland-National Capital Park and Planning Commission (M-NCPPC) was also informed of the planned release. Additional notification was provided to M-NCPPC and Black Hill Regional Park staff prior to the actual release by both ICPRB and WSSC Water staff. The ICPRB Communications Section also posted a press release on the actual test release from Little Seneca Reservoir on ICPRB's website (Appendix A), and WSSC Water posted the same press release on their website.

Pre-Exercise Meeting

A virtual pre-exercise meeting took place on November 12 via Microsoft Teams Meeting. Pre-exercise meetings give the WMA drought operations team an opportunity to get acquainted or reacquainted. This meeting also gives CO-OP staff a chance to review and update information on the physical and operational constraints of the supplier systems, to obtain information on the expected status of reservoirs and other

system components during the coming year's low-flow season, and to update drought-related contact information. Updated information on the WMA system appears in Table 1, Table 2, Table 3, and Table 4.

Table 1: 2020 Fairfax Water System Information and Operational Constraints.

Facility	MGD	Notes
Griffith plant max. production	120	The Griffith plant production capacity (Occoquan Reservoir) will be increased to 160 MGD at some time in the future.
Griffith plant min. production	45	Based on hydraulic limitations, minimum production at Griffith is approximately 45 MGD. There is also a demand constraint, because only the Griffith plant can serve Prince William County East (approximately 25 MGD) and 20 MGD of the Main service area.
Finished water transfer rates (load shifts) from Western (Potomac) service area to Eastern (Occoquan) service area[1]	-50 to +65	If a load shift to the Occoquan (Griffith plant) is requested to increase Potomac River flow, the maximum East to West transfer rate is 50 MGD, but this is constrained by Griffith plant max. capacity and combined demand in the main Occoquan service area and in Prince William County.[2] 24-hour advance notice is required to configure yard piping at the Pohick Pump Station. If a load shift to the Potomac (Corbalis plant) is requested to conserve Occoquan storage, the maximum West to East transfer rate is 65 MGD. Minimal advance notice is required to implement this change. The fraction of total demand that comes from the Potomac (Western) service area is currently about 60 percent, and includes water sold to Loudoun Water.
Corbalis plant max. production	225	Capacity of the Corbalis plant (Potomac River) will be expanded to 300 MGD at some point in the future.
Corbalis plant min. production	60	Lower in the winter and higher in the summer. The minimum current production at Corbalis is a function of demand in the Potomac service area, pump capacities, and the need to furnish part of Loudoun Water demand directly from the Corbalis plant.

[1]These transfer amounts also depend on demands in the two service areas - in other words, check with Fairfax Water to confirm the feasibility of all load shift requests.

[2]A shift of 10-15 MGD from Griffith to Corbalis can be implemented relatively quickly (J. Thompson, personal communication, November 2019).

Table 2: 2020 Washington Aqueduct System Information and Operational Constraints.

Facility	MGD	Notes
Dalecarlia max. production	225	Winter rate can be constrained due to disinfection contact time. Limited to 150 MGD if Dalecarlia Basin 4 is out of service. Limited to 80 MGD if Dalecarlia Basins 3 and 4 are out of service.
Dalecarlia min. production	50	Minimum sustained rate if McMillan WTP is in service. Otherwise, 100 MGD is the minimum rate.
McMillan max. production	70 - 100	Rate sometimes constrained by filter head loss in summer.
McMillan min. production	55	Constrained by pump size.
Great Falls max. withdrawal[1]	220	Water is drawn from the Potomac River at the Great Falls intake structure and flows by gravity through two conduits to the forebay of the Dalecarlia Reservoir. The combined maximum gravity capacity of the conduits is approximately 220 MGD (or 110 MGD each). The water from the forebay is pumped to the main body of the Dalecarlia Reservoir by the Booster Pumping Station, which has an installed capacity of 325 MGD.
Great Falls min. withdrawal	0	No constraints.
Little Falls max. withdrawal[2, 3]	525	The Dalecarlia Reservoir main body (not the forebay) can be supplied through the Little Falls Pumping Station, which has a maximum installed capacity of 525 MGD (firm capacity, with one 100 MGD pump out of service, is 425 MGD). Water from the Dalecarlia Reservoir is distributed to the Dalecarlia and McMillan Water Treatment Plants.
Little Falls min. withdrawal[2, 3]	50	The observed flow rate of the Little Falls 50 MGD pump is 60 MGD.

[1]Starting in fall 2020, the "old" conduit from Great Falls to the Dalecarlia Forebay will be out of service for about one year.

[2]The observed flow rates of the Little Falls pumps are as follow: 50 MGD design rate – 60 MGD observed; 75 MGD design rate – 94 MGD observed; 100 MGD design rate – 125 MGD observed.

[3]Little Falls pump #6 is closest to the USGS gage and may locally depress the water level in the vicinity of the gage (see Figure 1, below). Little Falls pumps #4 and #5 would likely also cause a depression in the gage vicinity (W. Peterson, personal communication, September 2017).

Figure 1: Schematic of pumps at Little Falls.

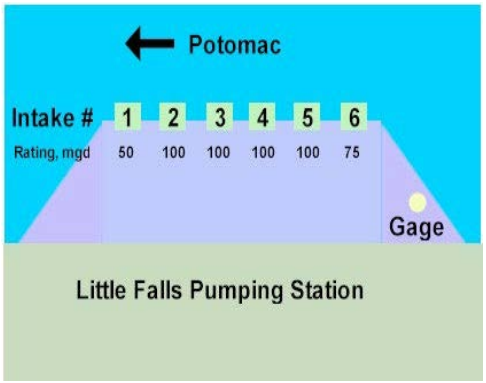

Table 3: 2020 WSSC Water System Information and Operational Constraints.

Facility	MGD	Notes
Patuxent plant max. production[1]	60	A max. of 76 MGD is possible if necessary (K. Wright, personal communication, November 2020). The Patuxent plant max. depends on reservoir levels. When the new plant is completed, it will be rated at 72 MGD with an emergency maximum of 120 MGD.
Patuxent plant min. production	33	CO-OP's PRRISM model assumes an emergency minimum production rate of 20 MGD when Patuxent reservoir storage falls below 1000 MG. WSSC Water staff have said that this could be implemented via periodic plant shutdowns (J.C. Langley, personal communication).
Potomac plant max. production	240	
Potomac plant min. production	100	
Little Seneca Reservoir max. release rate[2]	275	The design max is 275 MGD (K. Wright, personal communication, November 2020). The observed maximum release rate was 280 MGD.

[1]From 2017 to 2020, Brighton Dam was undergoing repairs. This reduced available storage in the Patuxent reservoirs by approximately 4 BG. The work included gate and dam repair and sediment removal. The project was completed in December 2019. The reservoir storage values have recovered to normal levels (T. Supple, personal communication, April 2020; K. Wright, personal communication, November 2020). Dredging of the sediments that have accumulated for 27 years is expected to take place in 2021.

[2]The documented maximum release rate for Little Seneca Reservoir is 275 MGD (K. Wright, personal communication, November 2020). The observed maximum release rate was around 280 MGD during the test release performed on November 17, 2020 (C. Hutchings, personal communication, November 2020).

Table 4: 2020 Loudoun Water System Information and Operational Constraints.

Facility	MGD	Notes
Trap Rock WTF min. production	0	When Trap Rock not in production Loudoun Water transitions to water purchased from Fairfax Water.
Trap Rock WTF max. production	21	The maximum production from the Trap Rock WTF (Potomac River) will be increased to 30 MGD at some time in the future.
Goose Creek Raw Water Pump Station, min.	0	Goose Creek Reservoir serves as an emergency water supply.
Goose Creek Raw Water Pump Station, max.	26	When the Potomac River is not available, Loudoun Water will transition to Beaverdam release and Goose Creek Reservoir using the Goose Creek Crossing (projected summer 2022) to supply a maximum of 26 MGD to Trap Rock WTF.
Potomac River Pump Station min. production	0	When the Potomac River is not available, Loudoun Water will transition to Beaverdam releases and Goose Creek Reservoir using the Goose Creek Crossing.
Potomac River Pump Station max. production	40	At this time there are no plans to increase capacity at the Potomac River Pump Station.

Updating Automated WMA Withdrawal Forecasts

The CO-OP Data Portal processes weather data received from ICPRB's real-time Low Flow Forecast System and then computes and serves real-time, automated 15-day forecasts of daily water withdrawals for each supplier. These withdrawal forecasts help improve streamflow forecasts during low flow periods.

The withdrawal forecast equations are described in Chapter 4 of the 2020 water supply reliability study.[2] The withdrawal forecast for each supplier has the following components: an annual average estimated from the previous six months of withdrawal data made available by an open-source data portal developed by ICPRB CO-OP staff; factors to convert the annual average estimate to a monthly average; and daily variations from the monthly average estimated by linear regression equations that are fed real-time temperature and precipitation data downloaded and processed by the Low Flow Forecast System.

The temperature and precipitation data used in the forecasts are from various products from the National Weather Service, such as the Middle Atlantic Forecast 3-day Quantitative Precipitation Forecasts and the Global Ensemble Forecast System 15-day precipitation and temperature forecasts. Adjustments are made to account for the fact Loudoun Water demand is included in Fairfax Water's forecast. Figure 2 shows an example of the actual daily average withdrawal data compared to the actual monthly average withdrawal data used to forecast WSSC Water's withdrawals 0 to 9 days out into the future for each day of the exercise.

Figure 3 through Figure 5 plot forecast withdrawals versus actual withdrawals for the 0-day (today), 1-day (tomorrow), and 9-day estimates for each of the CO-OP suppliers and Loudoun Water. The three points for each supplier represent the three drought exercise days November 16, 17, and 18. The gray line in each plot represents the perfect forecast. The performance of these forecast models depends on the quality of the last six months of supplier withdrawal data and the reliability of the weather forecast, where missing or erroneous values can skew the forecasts. Refinement of the automated data collection process and regular data review can improve the demand forecast performance.

[2] Ahmed, S.N., Moltz, H.L.N., Schultz, C.L., and Seck, A. 2020 Washington Metropolitan Area Water Supply Study: Demand and Resource Availability Forecast for the Year 2050. ICPRB Report No. 20-3. September 2020.

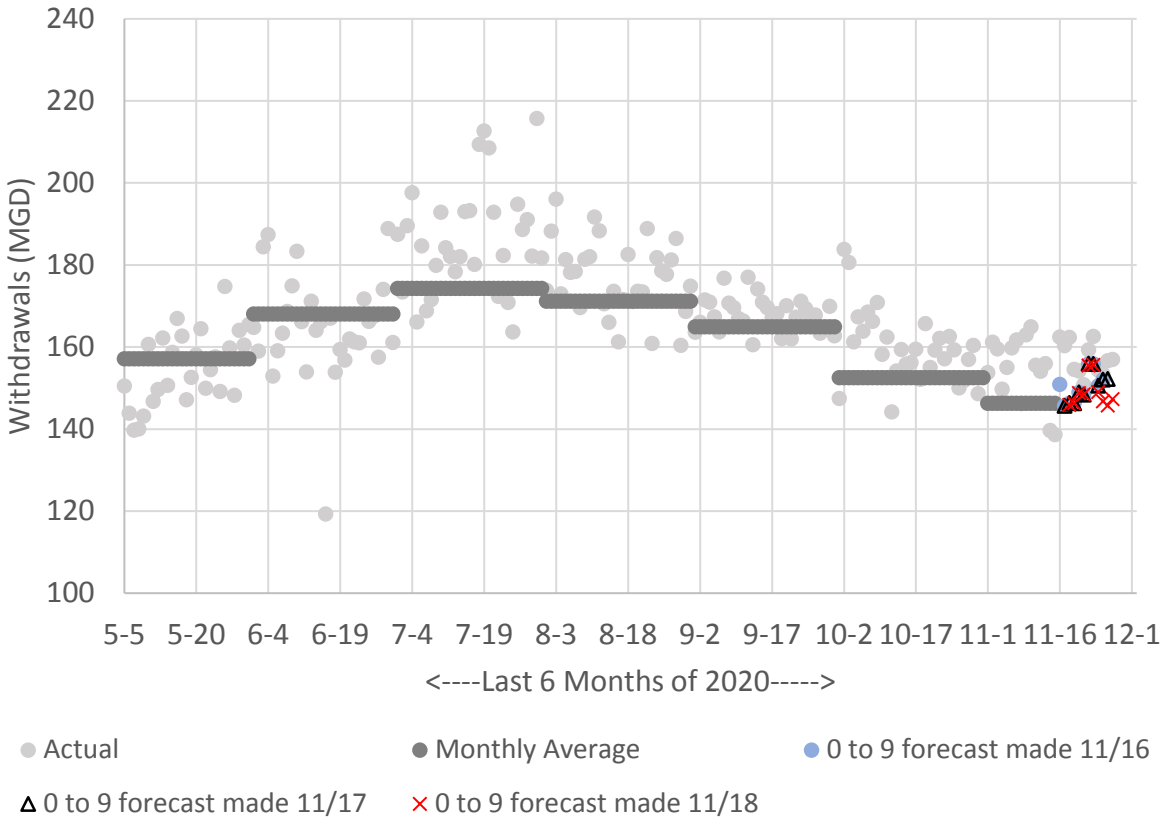

Figure 2: Plot of WSSC Water actual daily average withdrawals, actual monthly average withdrawals, and three 0 to 9 day hindcasts representing the forecasts made for each day of the exercise (November 16-18).

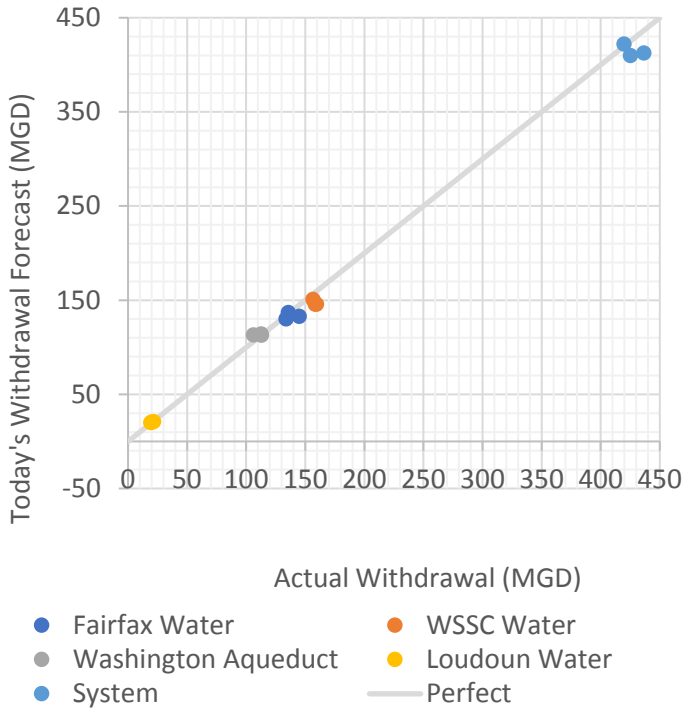

Figure 3: Today (0-day) withdrawal forecast versus actual withdrawals.

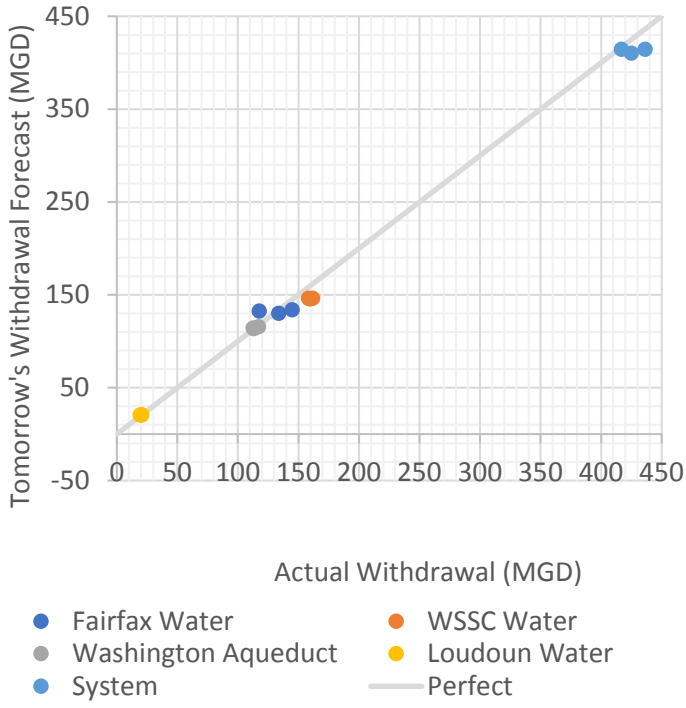

Figure 4: Tomorrow (1-day) withdrawal forecast versus actual withdrawals.

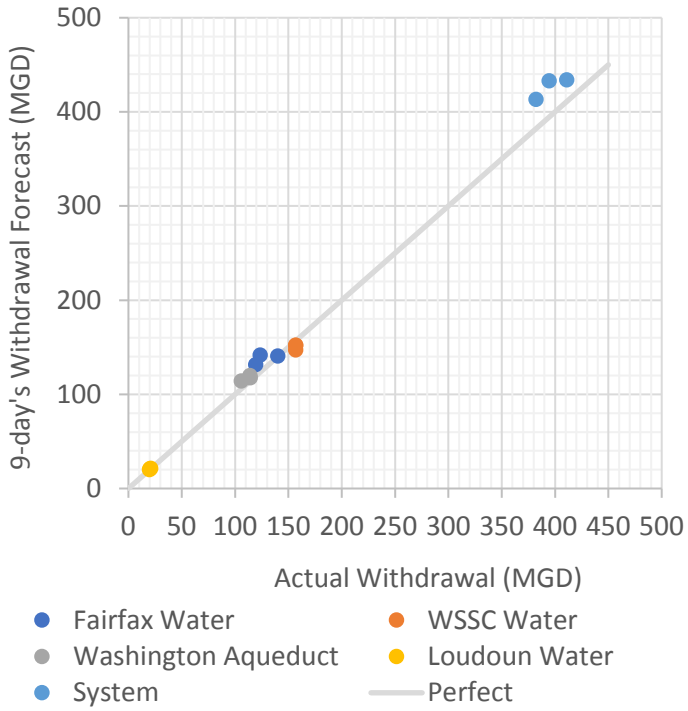

Figure 5: 9-day withdrawal forecast versus actual withdrawals. Loudoun Water is not included in the system total because the data were unavailable.

Simulated Drought Operations

Scenario

The scenario for this year's exercise, included in the morning email to stakeholders on November 16, was a moderately severe drought in 2021:

> *The day is Monday, August 16, 2021 and the basin is in moderate drought. During the past winter, the weather was unseasonably warm with very little precipitation, resulting in significantly below average winter recharge to the basin's fractured bedrock aquifers. On June 1, all system reservoirs were above CO-OP's target of 90 percent of capacity. But in late June, flow in the Potomac River fell to a level requiring releases from the system's upstream reservoirs, and since that time, periodic releases have been made from Jennings Randolph and Little Seneca reservoirs to augment river flow. Combined upstream water supply storage in Jennings Randolph and Little Seneca is currently 7.5 BG, or 44 percent of combined capacity. The drought stage, per the MWCOG regional plan, is "Warning", and regional voluntary water use restriction are in place.*

Tools

ICPRB staff practiced drought operations procedures and use of the following tools:

- ***DroughtOps Shiny app*** – a "Shiny" application constructed using the R scripting language. This tool automatically downloads data and displays observed and forecasted flows, reservoir storage levels,

WMA withdrawals, and Maryland and Virginia drought management level maps. It also displays WMA drought operations status levels, based on numerical thresholds specified in the WSCA, the LFAA, and the MWCOG regional drought response plan[3]. Finally, it uses Potomac River flow forecasts to compute reservoir release rates required to meet future WMA demands and the environmental flow-by at Little Falls. This application can be run on CO-OP staff desktop computers or via the cloud at a website accessible to CO-OP staff.

- ***Data Portal*** – a password-protected website that collects, processes, and serves data used for drought operations. This website is based on the Drupal content management system and is hosted by AcuGIS. Emails are sent by water suppliers to coop@icprb.org with water withdrawal data and in some cases, reservoir storage data. These data are automatically forwarded to and ingested by the Data Portal, which uses the data to construct text files containing recent and forecasted WMA withdrawals. The Data Portal is also used to exchange data files between the DroughtOps app and the Low Flow Forecast System.
- ***The Low Flow Forecast System (LFFS)*** – a real-time streamflow forecast model used to forecast Potomac River flow at Little Falls. The LFFS uses the FEWS (Flood Early Warning System, by Deltares, Inc.) software platform to download and process streamflow and meteorological data and the Chesapeake Bay Program Watershed Model, Phase 5.2, to provide 15-day forecasts of Potomac River flows.

Activities

For the 2020 exercise, and in the case of actual drought, the operations schedule of activities requires staff to convene at 7:30 AM every morning (during the 2020 drought exercise this was done via Microsoft Teams Meeting, see Table 5 for the daily schedule). First, withdrawal and reservoir level data coming in from the water suppliers are reviewed using the display capabilities of the Data Portal website and the data are checked for completeness. When necessary, water supplier staff are contacted via email and/or phone to request that missing data be supplied. Next, recent and forecasted Potomac River flows and WMA demands are viewed via the DroughtOps Shiny app and forecasts of water availability today, tomorrow, and 9 days in the future are reviewed. Based on these forecasts, a set of operational changes that meets WMA demands, plus the 100 MGD environmental flow-by at Little Falls dam, plus a 120 MGD margin of safety (MOS) is discussed and agreed upon. If a water supply release from JRR is required, phone contact is made with the USACE's Baltimore District Office. For operational changes by CO-OP suppliers, phone contact is made to confirm the feasibility of the change given the supplier's physical system and demand constraints. After confirming that all operational changes are feasible, CO-OP staff send an email to stakeholders reporting on today and yesterday's actual Potomac River flows, CO-OP supplier and Loudoun Water actual withdrawals, and the set of simulated operational changes.

[3] Metropolitan Washington Water Supply and Drought Awareness Response Plan: Potomac River System, Prepared by the Metropolitan Washington Council of Governments Regional Task Force on Water Supply Issues, June 7, 2000.

Each morning of the exercise after sending off the email report, information on special topics was presented and training material that had been prepared for the exercise was discussed. At 1:00 PM, staff again convened and repeated the steps described above to prepare and distribute an afternoon email to stakeholders.

The exercise was based on real-time data in order to practice use of CO-OP's real-time operational tools. To simulate low flow August conditions, the following scaling factors were applied: streamflows were multiplied by a factor of 0.28, and demands were multiplied by a factor of 1.3.

Details on each day's exercise activities are given below.

Day One

On the morning of Day 1 of the exercise, November 16, CO-OP staff first reviewed information provided on the *Situational Awareness* tab of DroughtOps application and noted that yesterday's Potomac River flow at Little Falls had fallen significantly, to just 418 MGD. (Day 1 flows and demands were based on actual conditions on September 15, 2020, with scaling factors applied to simulate drought conditions.) They then reviewed data available on the Data Portal and noticed that WSSC Water's morning data submission was missing. After contacting WSSC Water, staff learned that Corey Hutchins had taken over the data submission role formerly filled by Todd Supple. Corey was provided a password to the Data Portal and he promptly uploaded the missing data.

CO-OP staff viewed and discussed the decision support information appearing in the DroughtOps tool and made the following operational requests (simulated) described below. A copy of the Day 1 morning email report is provided in Appendix B.

Great Falls load shift After reviewing the simulated Potomac River flow forecasts in the DroughtOps tool, staff determined that the only operational change needed was a 75 MGD load shift from Washington Aqueduct's Great Falls intake to their Little Falls intake. This need was indicated by the graph of estimated flow at Great Falls that appears on the *Local Ops* tab of the application (see Figure 6), which was falling and approaching the recommended minimum of 300 MGD. The Dalecarlia Control Room was contacted by phone to request the simulated load shift, and Control Room staff reported that there would be no difficulties in making this operational change.

The special topic discussed on Day 1 was the Loudoun Water protocol. Under the conditions of Loudoun Water's Potomac River water withdrawal permit, Virginia Water Protection permit # 10-2020, I. 2. f (p. 10),

and Part I.J.10 (p. 14), during periods when flow at Point of Rocks is below 1400 cfs, CO-OP will provide Loudoun Water with the following information in its morning drought operations email report[4, 5]:

- Yesterday's observed Potomac River flow at Point of Rocks (USGS Station No. 01638500), $Q_{PR, obs}$,
- Amount of yesterdays flow at Point of Rock attributed to a CO-OP water supply release, $Q_{PR, WS}$, and
- The difference between these two quantities, $Q_{PR} = Q_{PR, obs} - Q_{PR, WS}$.

The flow rate, Q_{PR}, is then used by Loudoun Water to compute its allowed Potomac River withdrawal.

The 2020 Annual WMA Drought Exercise was the first time that CO-OP included Q_{PR} in its morning email reports. The value for $Q_{PR, obs}$ was yesterday's simulated flow at Point of Rocks, available from the *Situational Awareness* tab of the DroughtOps Shiny app. Placeholder values were used for $Q_{PR, WS}$, since no actual release values were available seven days in the past. (The travel time for a release from the North Branch reservoirs to the Point of Rocks gage during low flow conditions is estimated by CO-OP to be seven days.) CO-OP staff plan to add support for the Loudoun Water protocol to the DroughtOps Shiny app, including USACE North Branch reservoirs water accounting equations (see the last section of this report, Lessons Learned).

Day Two

On Day 2, yesterday's flow at Little Falls was 180 MGD and current observed flow was 162 MGD. (Day 2 flows and demands were based on actual conditions on September 18, 2020, with scaling factors applied to simulate drought conditions.) A review of withdrawal and reservoir storage data on Data Portal indicated that all suppliers had made their morning data submissions.

CO-OP staff relied on information displayed in the DroughtOps tool and made the following operational requests (simulated). A copy of the Day 2 morning email report is provided in Appendix B.

JRR water supply release On the DroughtOps *N Br Reservoir Ops* tab (see Figure 7), CO-OP's empirical recession equation forecasted that there would be an 11 MGD deficit in flow at Little Falls in nine days, and the LFFS forecast indicated that the deficit would be 88 MGD. Both results indicated a need for a water supply release from JRR, but the result from the empirical equation was selected because the LFFS had been significantly under-simulating flows in recent weeks. To obtain the targeted flow at Luke, the 11 MGD deficit was added to the USACE's planned 78 MGD (121 cfs) release from water quality storage. An additional 20 MGD "buffer" was added, for a final Luke target of (11 + 78 + 20) = 109 MGD (169 cfs). The buffer is calculated according to the water supply storage balance equation for JRR and in Little Seneca reservoir, as a

[4] See letter from Sarah Marsala (Sivers) of VADEQ to Nicolle Boulay of Loudoun Water dated March 14, 2014 RE: Virginia Water Protections (VWP) Permit No. 10-2020 – Potomac River Water Supply Project, Loudon County, Virginia – Approval of Operations and Maintenance Plan.

[5] See Exhibit A of letter from Nicolle Boulay of Loudoun Water to Sarah Marsala (Sivers) of VADEQ dated February 19, 2014 RE: Loudoun Water Potomac River Water Supply Project – Virginia Individual Permit No. 10-2020 – Condition J.19 – (Operations and Maintenance Plan).

percent of capacity.[6] At 9:00 AM, a call was made to the USACE's Baltimore District Office and a simulated water supply release from JRR was requested, with a Luke target of 169 cfs. A USACE Operations staff person, Laura Felter, reported no issue with the request.

Little Seneca release/Occoquan load shift On the *Local Ops* tab (see Figure 8), CO-OP's "PRRISM algorithm" forecast for tomorrow's flow at Little Falls, based on lagged observed flows at upstream gages, indicated that with no operational changes there would be a 24 MGD deficit. CO-OP addresses one-day deficits by a release from Little Seneca Reservoir combined with a load shift by Fairfax Water to their Occoquan intake. Staff phoned the Fairfax Water Command Operations Center to find out how large a load shift would be possible and spoke with operator, Dave Bolton. Dave said that a 20 to 24 MGD shift to the Griffith plant was feasible, and that this could be implemented in at least a couple of ways. First, flow from one of the three Corbalis pumps could be reduced. He said that this change might need to be temporary; considerations would be storage levels in receiving reservoirs, the Foxmill and Tyson facilities. He said that a more sustainable option might be to turn on the high service pump at Occoquan. After hearing this information, CO-OP staff requested that Fairfax Water make this simulated 24 MGD load shift to address tomorrow's deficit and no Little Seneca release was requested. Use of Occoquan storage is usually preferable to use of Little Seneca storage, due to the Occoquan Reservoir's large watershed and favorable refill characteristics.

Great Falls load shift A graph on the *Local Ops* tab also showed that yesterday's Great Falls to Little Falls simulated load shift by Washington Aqueduct had been successful in maintaining flow between Great Falls and Little Falls above 300 MGD, but that flow was falling and an additional load shift was required. The Dalecarlia Control Room was phoned and a request was made that the simulated pumpage at Little Falls be increased to 150 MGD. The operator reported no issues with this request.

The two special events of the exercise took place on Day 2: the actual test release from Little Seneca Reservoir (described in the section, Little Seneca Test Release, below) and the webinar, Forecast Informed Reservoir Operations by Hazen & Sawyer (slides provided in Appendix C).

Day Three

CO-OP staff relied on information displayed in the DroughtOps tool and made the following operational requests (simulated). A copy of the Day 3 morning email report is provided in Appendix B.

JRR water supply release On the *N Br Reservoir Ops* tab (see Figure 9), CO-OP's empirical recession equation forecasted that there would be no deficit in flow at Little Falls in nine days, and the LFFS forecast indicated that the deficit would be 75 MGD. Again, the result from the empirical equation was selected. To obtain the targeted flow at Luke, an additional 20 MGD "buffer" was added, for a final Luke target of (0 + 78 + 20) = 98 MGD (152 cfs). At 9:00 AM, a call was made to the USACE's Baltimore District Office and a simulated water supply release from JRR was requested, with a Luke target of 152 cfs.

[6] Buffer = (% JRR WS Storage - % LSeneca Storage) x10 MGD (where percentages are based on usable capacities).

Little Seneca release/Occoquan load shift On the *Local Ops* tab (see Figure 10), CO-OP's "PRRISM algorithm" forecast for tomorrow's flow at Little Falls, based on lagged observed flows at upstream gages, indicated that no operational changes would result in a 22 MGD deficit. Staff phoned the Fairfax Water Command Operations Center to find out how large an Occoquan load shift would be possible. The operator, Dave Bolton, said that an additional 22 MGD load shift would ordinarily be possible. But due to current capacity issues at the Griffith plant, this might be difficult since it would require shutting down headers at Corbalis. Based on this information, CO-OP staff asked that the simulated 24 MGD load shift requested yesterday be maintained but not increased, and the operator agreed that would be possible. To address tomorrow's forecasted 22 MGD deficit, a simulated Little Seneca release of 22 MGD was requested via a phone call to the WSSC Water Control Room.

Great Falls load shift Based on the graphical information appearing on the *Local Ops* tab, it was requested that Washington Aqueduct maintain Little Falls pumpage at 150 MGD. The Washington Aqueduct operator reported no issues with this request.

Table 5: Daily drought operations schedule.

Time	Water supplier task	CO-OP staff task
7:30 AM	• Verify that data on recent withdrawals and reservoir levels has been sent to coop@icprb.org. If necessary, upload data manually. • View data in Data Portal and verify that it is correct. If necessary, make corrections.	• Review withdrawal and reservoir storage data in Data Portal and alert suppliers in the event of missing data. • Review USGS flow data and LFFS data displayed by DroughtOps. If data is missing, troubleshoot and make corrections.
8:00 AM		• Review flow forecasts and forecasted need for additional water at Little Falls today, tomorrow, and nine days in the future. • Devise a preliminary set of operational requests to meet these needs. • If there is a need for water today, phone WSSC Water and request an appropriate load shift to the Patuxent. • If there is a need for water tomorrow, phone Fairfax Water's control room to confirm how much of the need can be met by a load shift to the Occoquan.
9:00 AM		• If a water supply release from JRR is required to meet needs nine days in the future, phone the USACE Baltimore District Office and provide them with the desired flow target, in cfs, at the USGS gage at Luke, Maryland. • If a water supply release from Little Seneca Reservoir is required to meet tomorrow's need, phone WSSC Water's control room to provide them with the desired release rate, in MGD, and also call the M-NCPPC if notification is appropriate. • If a load shift is required to increase river flow below Great Falls, phone Washington Aqueduct's Dalecarlia control room with the desired pumping rate at Little Falls. • Summarize operations in morning email report.
10:00 AM	• Review the morning email report and verify that requested operational changes could be implemented in the event of actual drought.	• Send the morning email report to stakeholders, including yesterday and today's Potomac River flow, CO-OP supplier and Loudoun Water withdrawals, and a summary of operational changes.
12:30 PM	• Verify that data on recent withdrawals and reservoir levels has been sent to coop@icprb.org. If necessary, upload data manually. • View data on Data Portal and verify that it is correct. If necessary, make corrections.	• Review withdrawal and reservoir storage data at Data Portal and alert suppliers in the event of missing data. • Review flow forecasts and forecasted need for additional water at Little Falls today, tomorrow, and nine days in the future. • If there have been significant changes in conditions, repeat steps listed above to make operational revisions.
2:00 PM	• Review the afternoon email report and verify that requested operational changes could be implemented in drought.	• Send the afternoon email report to stakeholders, including a summary of any revisions to the morning operations.

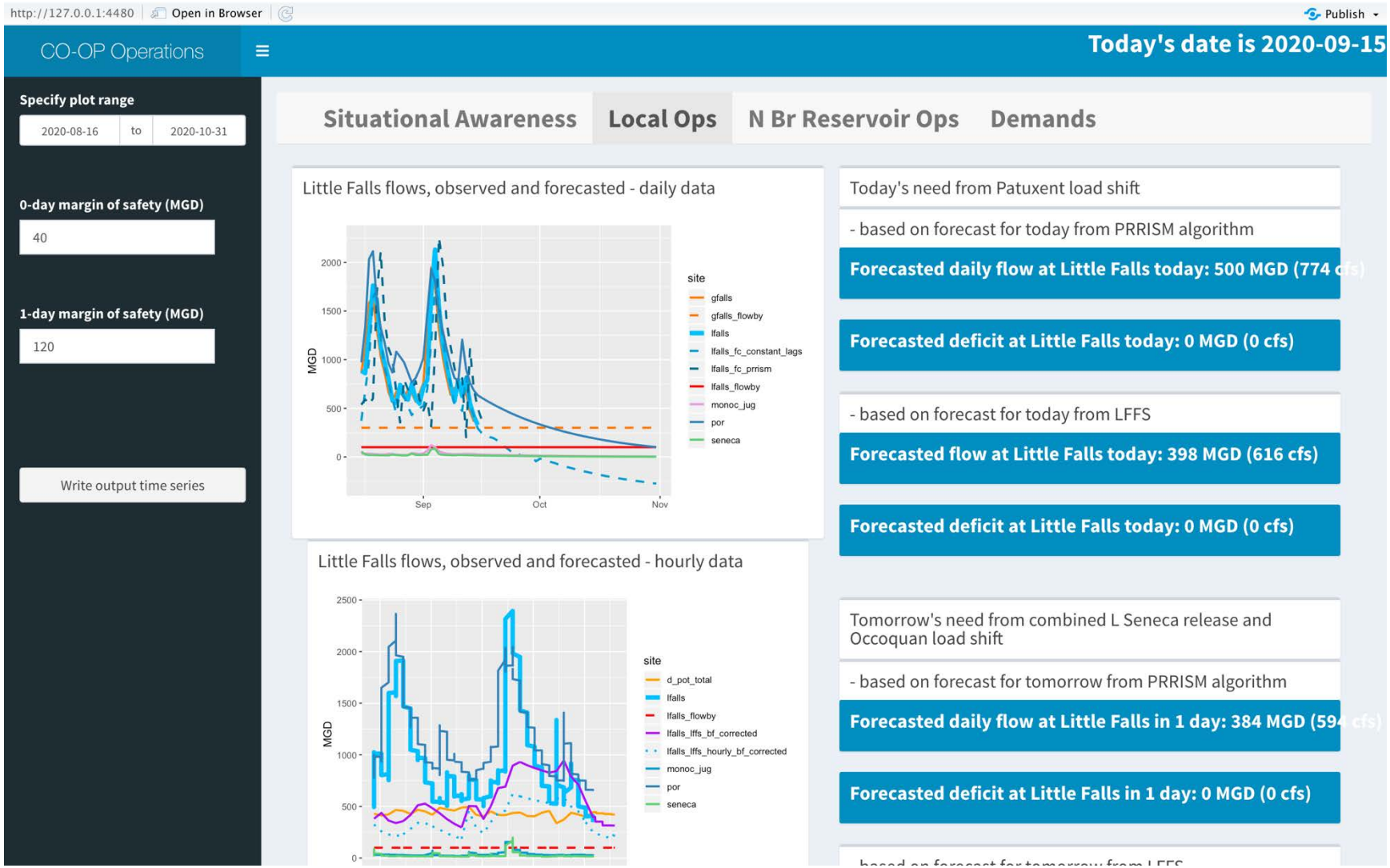

Figure 6: Day 1 screenshot of DroughtOps *Local Ops* tab, showing that flow at Great Falls is falling and approaching the recommended minimum of 300 MGD.

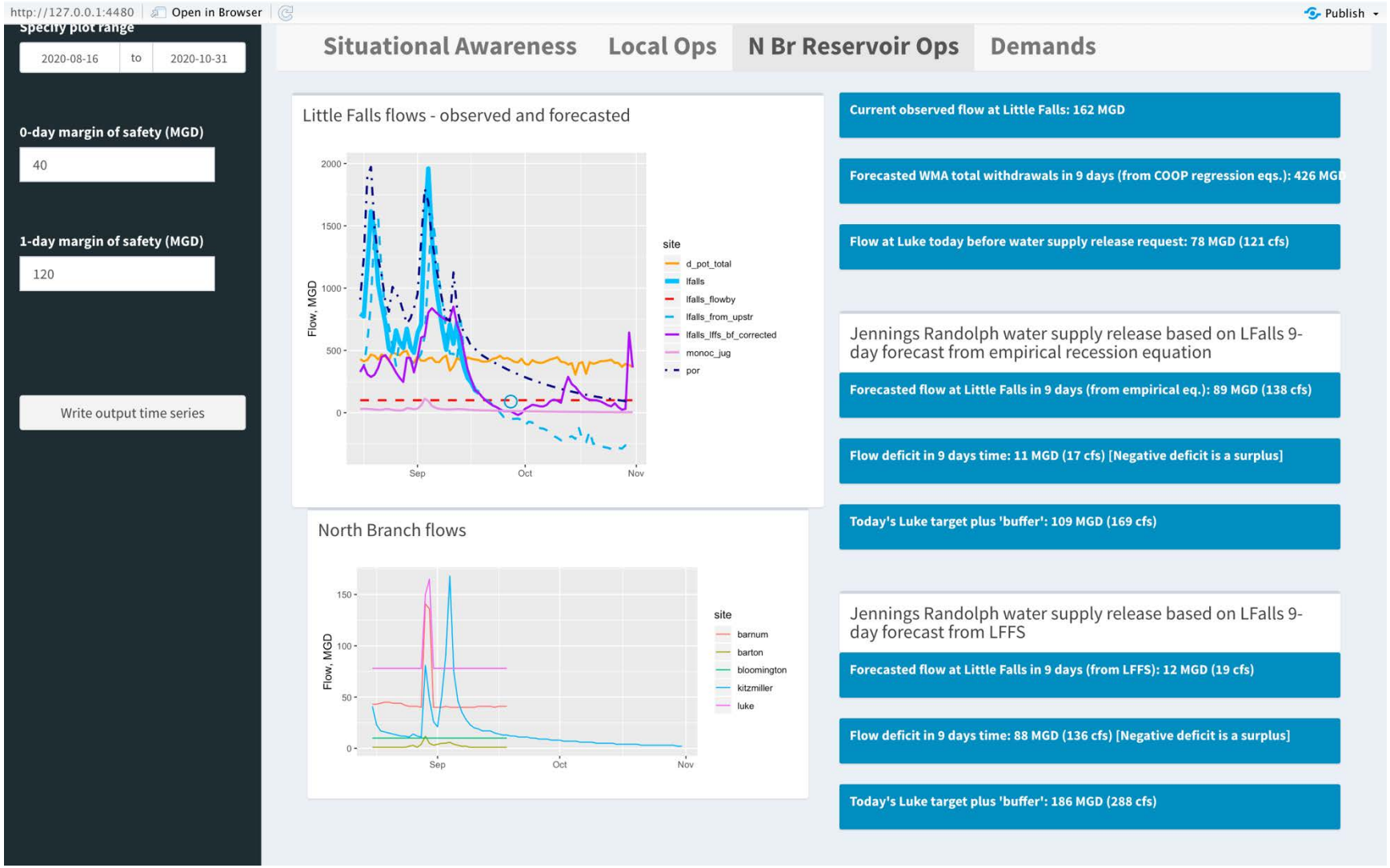

Figure 7: Day 2 screenshot of DroughtOps *N Br Reservoir Ops* tab, with decision support information on potential JRR water supply release.

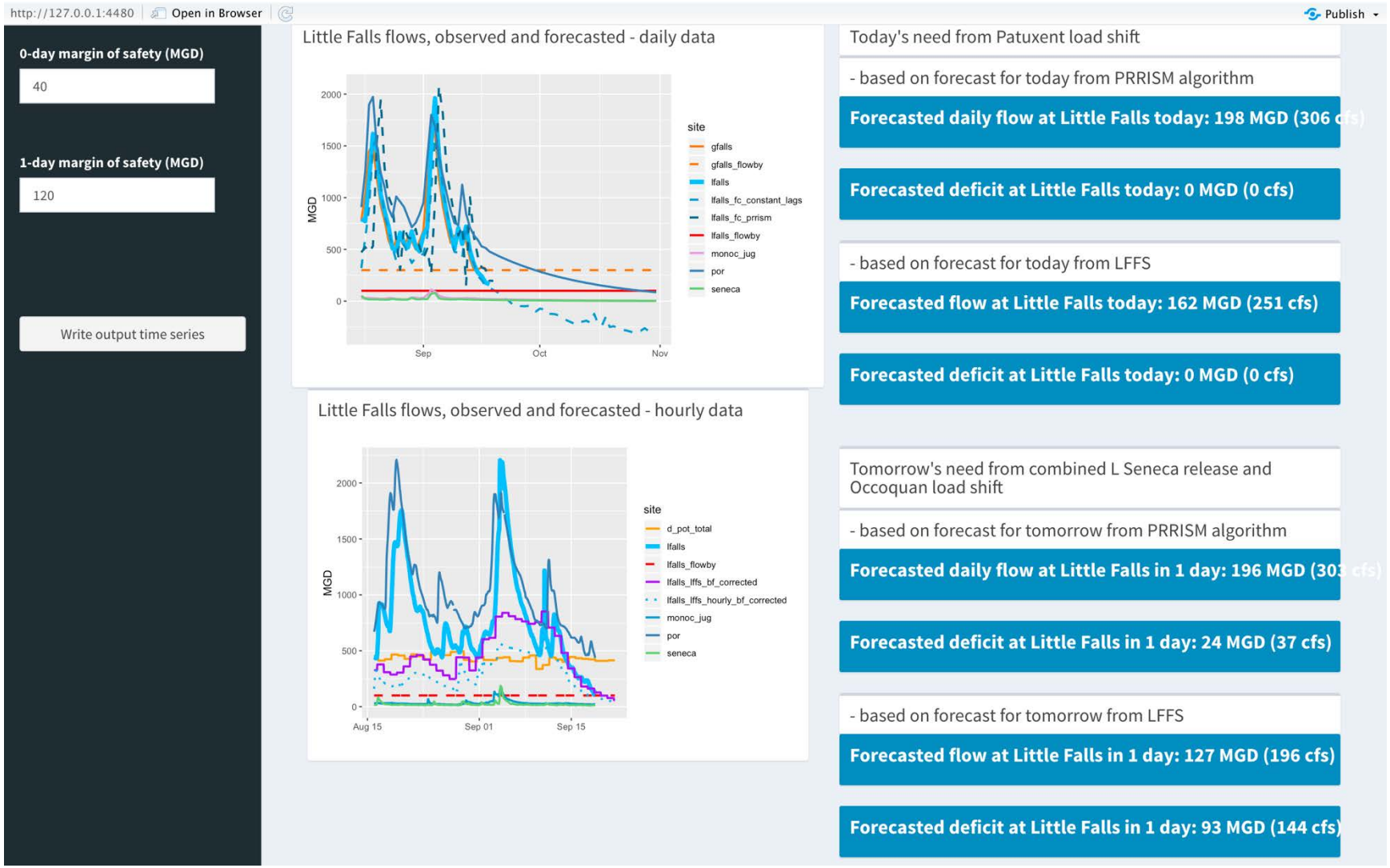

Figure 8: Day 2 screenshot of DroughtOps *Local Ops* tab, showing forecasts of tomorrow's deficit at Little Falls.

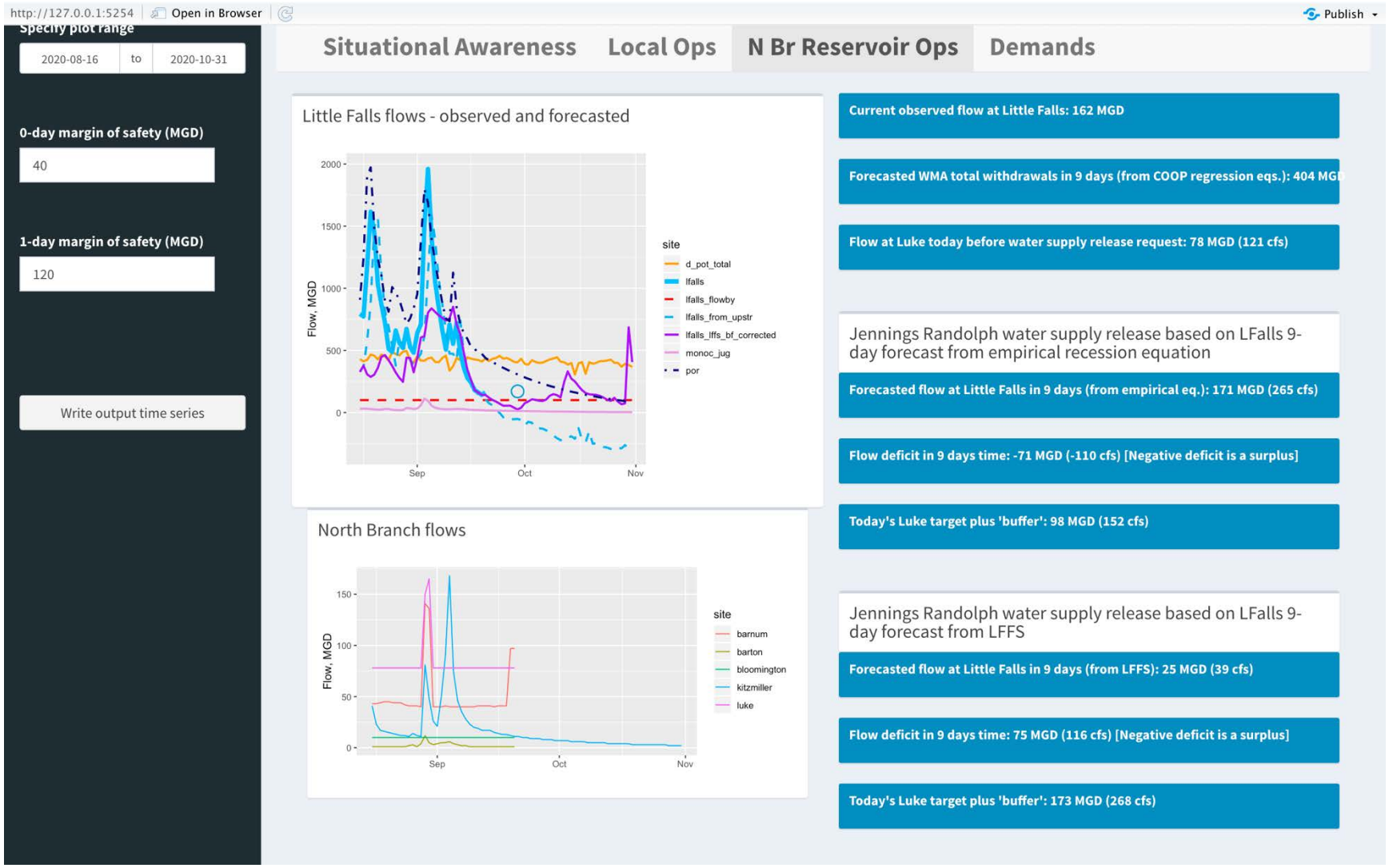

Figure 9: Day 3 screenshot of DroughtOps *N Br Reservoir Ops* tab, with decision support information on potential JRR water supply release.

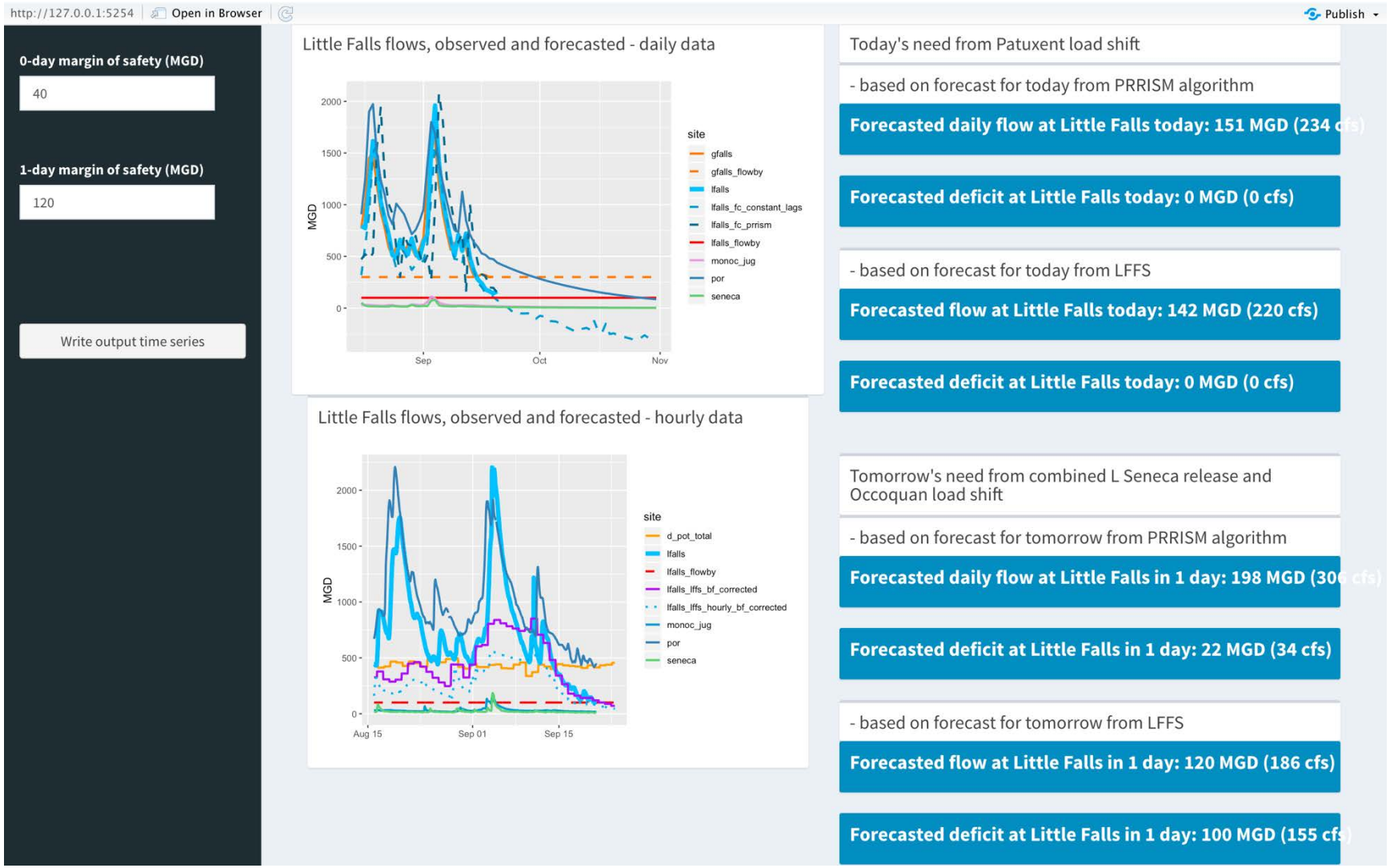

Figure 10: Day 3 screenshot of DroughtOps *Local Ops* tab, showing forecasts of tomorrow's deficit at Little Falls.

Little Seneca Test Release

An actual release from Little Seneca Reservoir was conducted as part of the drought exercise. Prior to the release, concurrence on the release was requested and obtained from the CO-OP supplier General Managers or their designated representatives. The purpose of the release was threefold:

i. to maintain awareness on the part of local government officials and recreational stakeholders of the purpose of Little Seneca Reservoir during droughts,
ii. to test coordination between ICPRB, WSSC Water staff operating the dam at Little Seneca, and staff at Black Hill Regional Park, where the reservoir is located, and
iii. to provide valuable operational data, such as the flow-dependent time of travel from the reservoir to Little Falls dam.

Little Seneca Reservoir was constructed with funds provided by the Washington area water suppliers in the early 1980s. This local reservoir is a key component of the cooperative system. Drought-related releases were made as part of drought operations in 1999 and 2002. Test releases have also been conducted during previous drought exercises in 2003, 2004, 2005, 2010, 2013, and 2015.

Release Operations and Observations

WSSC Water initiated the test release at 10:00 AM on November 17, 2020, increasing flow incrementally until reaching approximately 280 MGD (433 cfs) at 1:00 PM. This release rate continued until 10:00 PM, when incremental reductions in the release rate began until the release rate returned to the pre-release levels by approximately 7:20 AM on November 18, 2020. No rain was recorded for the day before or the day of the release. Table 6 summarizes the Little Seneca release rates for November 17, 2020. A more detailed table of release rates, which was used in the travel time estimates is provided in Appendix D.

Table 6: Summary of Little Seneca Reservoir release rates.

Time	Rate of Flow*
10:00 AM	Slowly started increasing flows from 11 MGD (normal)
10:07 AM	123 MGD
10:33 AM	157 MGD
10:59 AM	211 MGD
11:33 AM	247 MGD
12:00 PM	260 MGD
12:30 PM	269 MGD
1:00 PM	280 MGD
1:00-10:00 PM	280 MGD
10:00 PM +	Slowly decreased flows back to normal flows

* As provided by C. Hutchings (personal communication, November 2020).

The Executive Director of ICPRB, Michael Nardolilli, served as the Observer of the release. As the release was initiated, he was stationed just downstream from the bridge over Little Seneca Creek at Clopper Road on the grounds of The Lodge at Little Seneca Creek. Figure 11 shows the location of the Little Seneca Dam in

reference to the Clopper Road viewing location, the USGS gage on Seneca Creek at Dawsonville (USGS Site No. 01645000), and the confluence with the Potomac River. The estimated distance along the creek from the dam at Little Seneca Reservoir to the Observer's location is 0.92 miles. The USGS gage on Seneca Creek at Dawsonville (USGS Site No. 01645000) is approximately 6 miles downstream of the Little Seneca Reservoir.

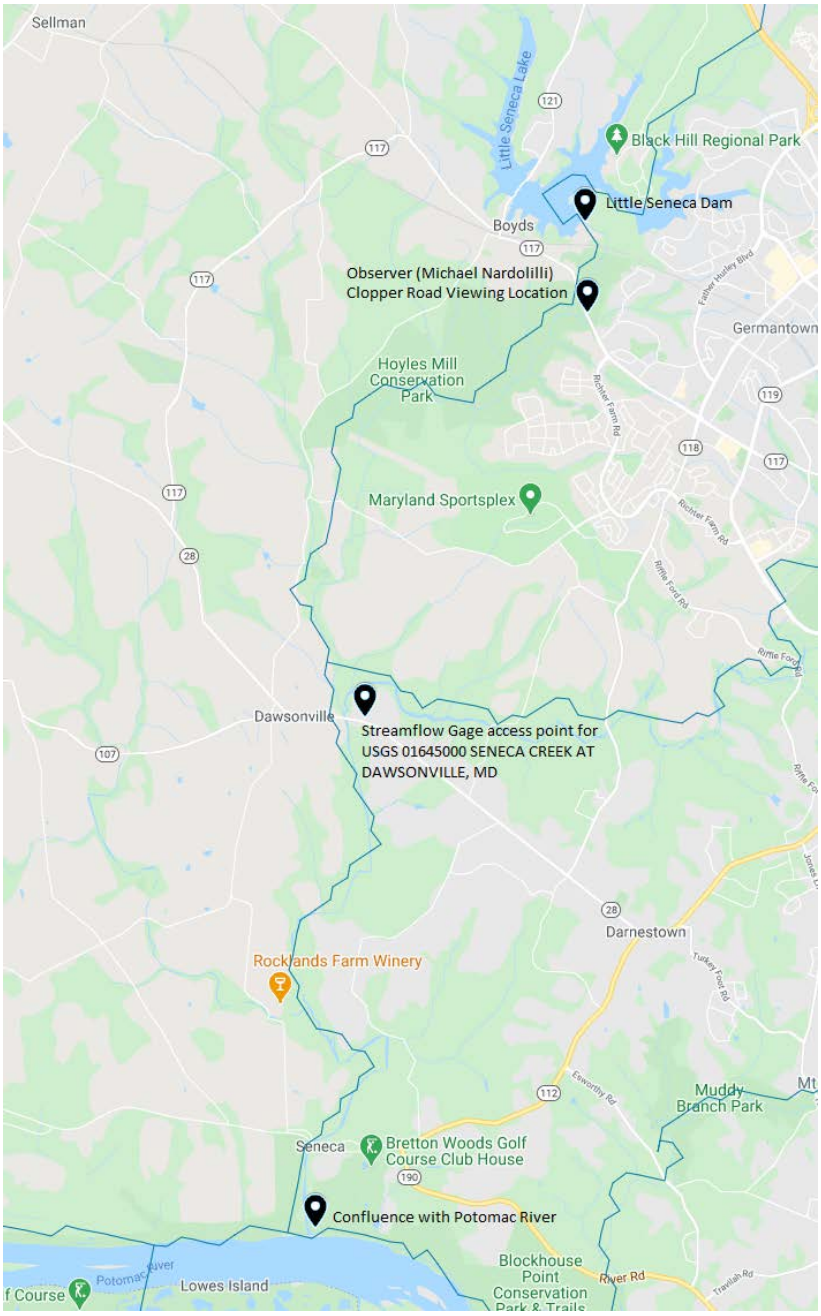

Figure 11: Map showing Little Seneca Dam, Observer's Clopper Road viewing location, and USGS stream gage station No. 01645000, Seneca Creek at Dawsonville, Maryland.

Figure 12 is a photo taken at 10:00 AM by the Observer of the trail along Little Seneca Creek at the Clopper Road viewing location (location indicated in Figure 11). There were no observable changes either along the

creek or along the trail until 10:30 AM when the Observer first noticed that water was slowly flowing from the creek over the trail and took this photograph that is shown in the bottom picture (Figure 13).

Figure 12: Seneca Creek at 10:00 AM on November 17, 2020.

Figure 13: Seneca Creek at 10:30 AM on November 17, 2020.

After a visit and tour of the Little Seneca Dam, the Observer returned to the same location along Little Seneca Creek. Figure 14 was photographed at 10:00 AM on November 17, 2020 (before the release). Notice the line of drainpipes under the bridge just above the water level. Figure 15 was photographed at 12:30 PM (after the release). Notice the line of drainpipes are under the water level after the release.

Figure 14: Bridge drainpipes at 10:00 AM on November 17, 2020.

Figure 15: Bridge drainpipes at 12:30 PM on November 17, 2020.

During his visit earlier on November 17, 2020, the Observer noticed a line of rocks across the creek that resembled something that hikers might have constructed to create steeping stones to cross the creek. Figure 16 shows this "crossing" at 10:00 AM on November 17, 2020 (before the release). The line of rocks is clearly visible and creates a small waterfall. Figure 17 shows this same location at 12:30 PM (after the release) and the rocks are overtopped.

Figure 16: Line of Rocks across Creek at 10:00 AM on November 17, 2020.

Figure 17: Line of Rocks across Creek at 12:30 PM on November 17, 2020.

Release Data and Analysis

The Little Seneca Reservoir test release was successful in providing data needed to estimate the time it takes for water to flow from the Little Seneca Dam downstream to the Little Falls Pump Station (USGS Site No. 01646500). These time-of-travel estimates are an input in the drought operation tools. More accurate time-of-travel estimates improve the timing of water released from a reservoir during attempts to fill low flow periods in the Potomac River and therefore reduce wasted water. However, a time-of-travel estimate collected from a test release is only approximate because it depends on current streamflow rates and the reservoir release volume. Therefore, it is important to perform time-of-travel test releases regularly to have sufficient data points to evaluate how flows in the Potomac River respond to water supply releases under varying conditions.

During this test release event, elevated flows in Little Seneca Creek were visible in observed data at the downstream gage for Seneca Creek at Dawsonville, MD (USGS Site No. 01645000) several hours after initiation of the release. The day before the release on November 16, 2020 between 12:00 AM and 12:00 PM, flow downstream of the dam, measured at this gage, ranged from 58 to 74 MGD (89 to 114 cfs) with an average of 64 MGD (99 cfs) over the entire day. As the peak release passed by this gage, between 4:15 PM on November 17, 2020, and 1:00 AM on November 18, observed flow at Dawsonville ranged from 364 to 380 MGD (563 to 588 cfs) with an average of 372 MGD (576 cfs). The release cleared the gage by 8:00 AM on November 18, 2020, when flows returned to around 60 MGD (93 cfs). Figure 18 shows that the Little Seneca release took approximately 3 to 3.25 hours to travel to the Seneca Creek at Dawsonville gage. WSSC Water staff noted that they did not believe that the flow sensors at the Little Seneca Reservoir measured the full flow being released by the dam (C. Hutchings, personal communication, November 2020). This appears to be confirmed by Figure 18 below, which shows a smaller release minus the water quality release trend (277 MGD or 429 cfs average) compared to the Little Seneca Creek flow minus the baseflow trend at the Dawsonville gage (318 MGD or 492 cfs average). These numbers reflect an average water quality release of 3.1 MGD (4.8 cfs) and an average Little Seneca Creek baseflow of 54 MGD (84 cfs). Taking the difference of what was released and what was observed at the gage, would indicate a surplus of water equal to an average of 40 MGD (63 cfs). The conclusion is that a water loss cannot be computed for the Little Seneca Dam release because the sensors at the dam are not accurate enough to capture the true amount of water leaving the reservoir.

An analysis of the data suggests that a travel time of approximately 11.25 hours from Little Seneca Dam to the USGS gage on the Potomac River near Washington, DC Little Falls Pump Station (USGS Site No. 01646500). At first glance, Figure 19 demonstrates that although there was no interference from rain during the water supply release, there was no clearly visible change in flow at the Little Falls gage. However, after computing the difference between the Little Falls flow and the Potomac River at Point of Rocks flow (USGS Site No. 01638500, lagged by 0.6 days) an elevation in flow was visible around 12:00 AM on November 18, 2020, which indicates a time interval of approximate 11.25 hours from the time when the water supply release at the dam reached its peak at approximately 1 PM the previous afternoon. Table 7 summarizes key operational data collected at the three main flow observation points used during the test release: Little

Seneca Dam, Seneca Creek at Dawsonville (USGS Site No. 01645000), and the Little Falls Pump Station (USGS 01646500).

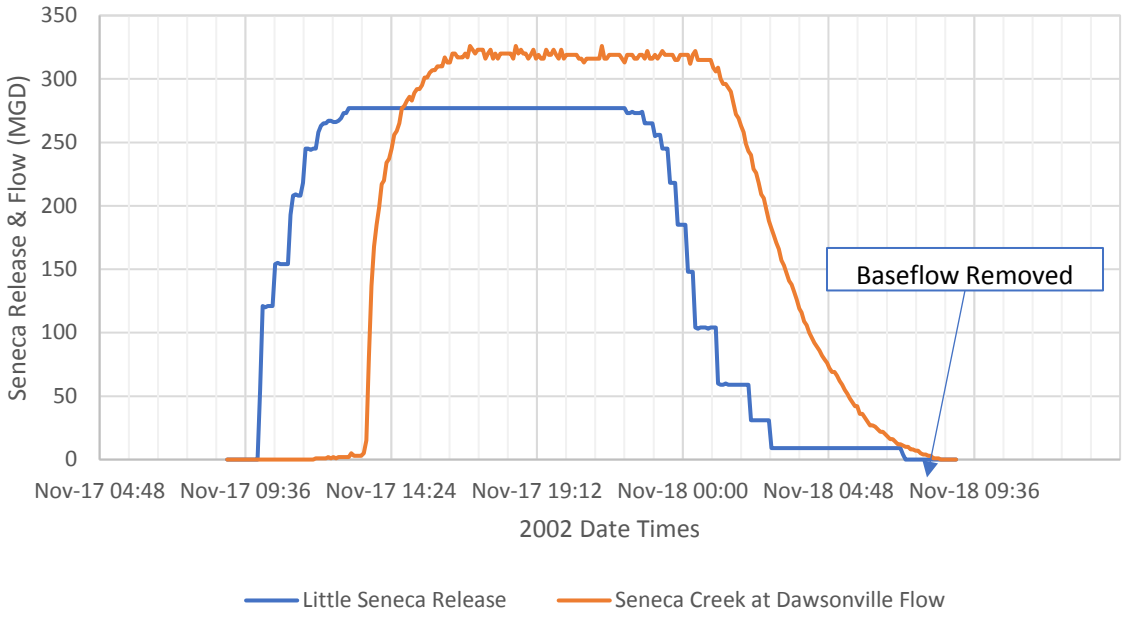

Figure 18: Plot comparing the Little Seneca water supply release (water quality release removed) to the lagged Seneca Creek flow at Dawsonville (average baseflow removed).

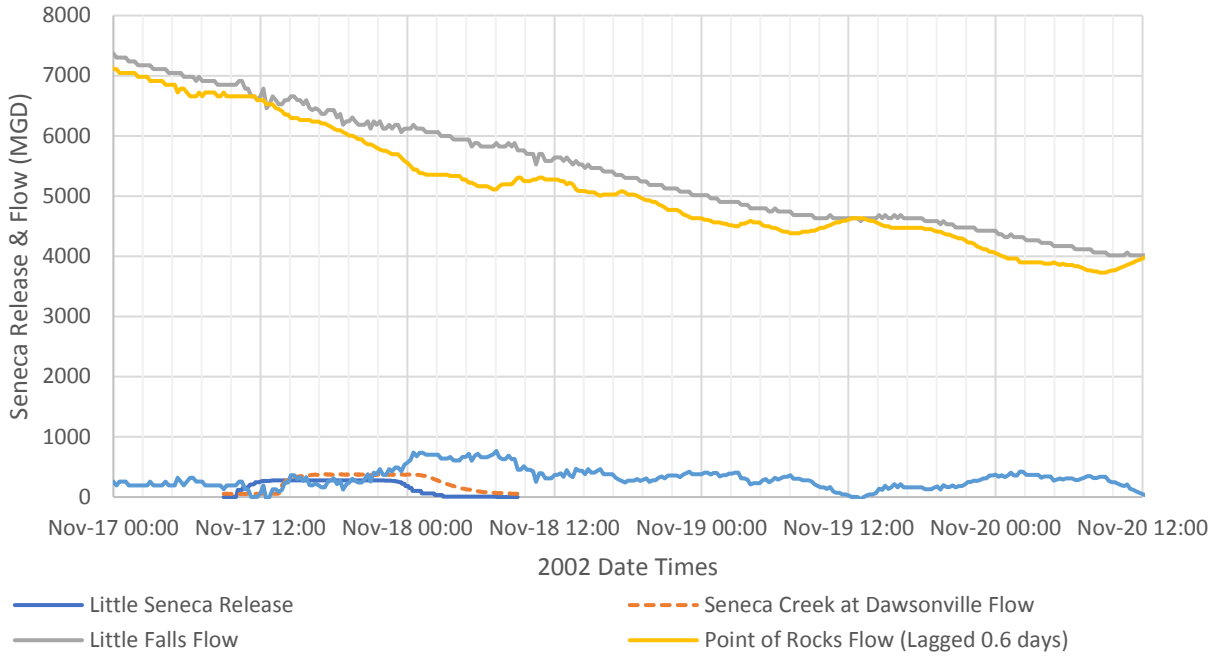

Figure 19: Impact of Little Seneca release downstream at Dawsonville and Little Falls.

Table 7 Summary of Key Little Seneca Release Details and Travel Time Results

Location: Little Seneca Reservoir **Peak Period: Nov 17, 2020 1:00 PM to Nov 18, 2020 10:00 PM**	
Observed total release rate (peak period)	280 MGD (433 cfs)
Average water quality release	3.1 MGD (4.8 cfs)
Average water supply release rate estimate (peak period)	277 MGD (429 cfs)
Ramping time to peak period	3 hours
Location: USGS 01645000 Seneca Creek at Dawsonville, MD **Peak Period: Nov 17, 2020 4:15 PM to Nov 18 1:15 AM**	
Average observed total flow (peak period)	372 MGD (576 cfs)
Average baseflow estimate	54 MGD (84 cfs)
Average water supply estimate (peak period)	318 MGD (492 cfs)
Travel time from dam to Dawsonville	3.25 hours
Location: USGS 01646500 Potomac River near Washington, D.C. Little Falls Pump Station **Peak Period: Nov 18, 2020 12:15 AM to Nov 18, 2020 9:15 PM**	
Observed total flow (peak period)	5,943 MGD (9,195 cfs)
Average flow from USGS 01638500 Potomac River at Point of Rocks lagged by 0.6 days (peak period)	5,280 MGD (8,169 cfs)
Average water supply release plus inflow contributions downstream of Point of Rocks estimate (peak period)	663 MGD (1,026 cfs)
Travel time from Little Seneca dam to Little Falls Pump Station	11.25 hours

Lessons Learned

Drought exercises provide CO-OP staff with insights on how to improve tools and procedures. Below is a list of action items for the coming year.

1. Submission of water supplier data
    a. Meet with water supplier staff and identify ways to improve reliability of the data submissions. Aim for twice daily automated submissions so that submission process needn't change during drought operations.
    b. Ask WSSC Water to add reservoir storage volume (or water level) data to daily email submissions.
2. Data Portal
    a. Add capability to download and automatically compute North Branch reservoir storage levels.
    b. Provide training to WSSC Water and Fairfax Water on entering future Occoquan and Patuxent withdrawals.
3. DroughtOps tool
    a. Add value box with Great Falls flow to *Situational Awareness* or *Local Ops* tab.
    b. Add capability to download and automatically compute North Branch reservoir storage levels.
    c. Improves graphs of withdrawals on *Demands* tab to allow user to confirm that the automated calculation is performing correctly on any given day. Include in these changes the addition of computed monthly averages, as in Figure 2 of this report. Also, allow user to input recent annual averages.
    d. Add capability to enter and store water supply releases.
    e. In calculation of JRR water supply release Luke target, include amount from buffer equation, which helps keep JRR and Little Seneca water supply storage in balance.
    f. Add information to support Loudoun Water protocol, including USACE accounting of water supply release amount.
    g. Add capability to compute reservoir inflows.

Appendix A: Letter to Montgomery County Executive and Council regarding Little Seneca Release

INTERSTATE COMMISSION ON THE POTOMAC RIVER BASIN

30 W. Gude Drive, Suite 450
Rockville, MD 20850
(301) 984-1908
www.potomacriver.org

November 4, 2020

Mike Little
Acting Regional Operations Manager
Black Hill Regional Park
20930 Lake Ridge Drive
Boyds, MD 20841

Dear Mr. Little:

The Interstate Commission on the Potomac River Basin (ICPRB) and the regional water suppliers will be conducting the 2020 annual drought exercise from November 16 to 18. **I am writing to notify you that part of this year's exercise will be an actual test release from Little Seneca Reservoir.** Also, during the exercise, I intend to observe the release and would like to know (1) the best observation location for viewing; (2) if you are available for a meeting. We very much appreciate your continued cooperation and look forward to your participation in our exercises and release events.

The attached letter is being sent to the Montgomery County Executive and the County Council to make them aware of this plan. While we do not know which day of the exercise the release will occur (it will depend on flow conditions), we will contact you both the day before the release is expected. In an actual drought, releases could occur with less notice if there is a sudden drop in Potomac River flow.

Our staff members will be in close touch with you on the exact start time and duration of the release. If Little Seneca remains full, an approximate release of 300 to 400 million gallons per day for one day would produce up to a 2-foot drawdown. An estimate of the lake drawdown is provided in Table 1 (page 2) for a one-day release duration.

The ICPRB is an interstate compact commission established by Congress in 1940. Its mission is to protect and enhance the waters and related resources of the Potomac River basin through science, regional cooperation, and education. Represented by appointed commissioners, the ICPRB includes the District of Columbia, Maryland, Pennsylvania, Virginia, West Virginia, and the federal government.

Table 1: Little Seneca Lake drawdown estimates, assuming 3.9 billion gallon starting volume*

Water Supply Test Release, million gallons per day	Duration, days	Reservoir Volume, billion gallons	Surface Area, acres	Water Height, feet	Drawdown, feet
300	1	3.6	424	384	1
400	1	3.5	407	383	2

* Estimated values from Figure 3 of Ortt *et al.*, 2011.

Finally, can you take a minute to review the contact information we have for you? Our understanding is that you prefer to be notified by email only, and you will forward information to relevant staff members. When specifics are known for the Little Seneca release, we should call you directly. We like to have personal cell phones for people, in the event we need to reach you during non-business hours.

Office: 301-528-3461
Cell: 240-876-5350
Email: mike.little@montgomeryparks.org

Park main line: 301-528-3490

If you have any questions, contact me at mnardolilli@icprb.org or 301-274-8105.

Sincerely,

Michael A. Nardolilli, Executive Director Interstate Commission on the Potomac River Basin

CC:
Steve Root, Park Manager
Black Hill Headquarters
20930 Lake Ridge Drive,
Boyds, MD 20841

Appendix B: Morning Email Reports to Stakeholders

Day One: Potomac Flow and Demand Update (Monday 2020-11-16 AM)

Today is the first day of the 2020 Washington Metropolitan Area Drought Exercise, which will be conducted from Monday, November 16 through Wednesday, November 18.

From the suppliers we need

- Every morning by 7:30 AM: most recent (yesterday's and early morning of today) hourly withdrawals and most recent reservoir storage levels
- Every afternoon by 1:00 PM: update of today's hourly withdrawals

Data can be submitted via your automated email. Data not in your email can be submitted via Data Portal (https://icprbcoop.org). If you need a password or assistance, email sahmed@icprb.org.

The scenario for this week's exercise is as follows:

> The day is Monday, August 16, 2021 and the basin is in moderate drought. During the past winter, the weather was unseasonably warm with very little precipitation, resulting in significantly below average winter recharge to the basin's fractured bedrock aquifers. On June 1, all system reservoirs were above CO-OP's target of 90% of capacity. But in late June, flow in the Potomac River fell to a level requiring releases from the system's upstream reservoirs, and since that time, periodic releases have been made from Jennings Randolph and Little Seneca reservoirs to augment river flow. Combined upstream water supply storage in Jennings Randolph and Little Seneca is currently 7.5 BG, or 44% of combined capacity. The drought stage, per the MWCOG regional plan, is "Warning", and regional voluntary water use restriction are in place.

In our morning and afternoon updates, we will first give ACTUAL flows, withdrawals, and reservoir storage levels, in order to test our data communications and processing procedures. We will then give SIMULATED operations, in order to exercise CO-OP's operations support tools operational policies. The ability to make SIMULATED operational changes will be verified by phone with the appropriate suppliers.

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Daily Potomac flow and demand update (Monday 2020-11-16)

****
RECENT CONDITIONS – ACTUAL

Recent basin-wide average precipitation (above Little Falls):
(based on CO-OP's Low Flow Forecast System analysis of National Weather Service gridded multi-sensor precipitation estimates)
Yesterday's area-weighted average basin precipitation: 0.19 (inches)
Past 3-day cumulative area-weighted average basin precipitation: 0.19 (inches)
Past 7-day cumulative area-weighted average basin precipitation: 1.73 (inches)

Daily Flows:
Little Falls gage flow 2020-11-15: 11052 MGD (17100 cfs)
Little Falls gage flow 2020-11-16: 8855 MGD (est., based on recently available real time data) (13700 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2020-11-15: 9630 MGD (14900 cfs)
Point of Rocks flow 2020-11-16: 7239 MGD (est., based on recently available real time data) (11200 cfs)

Yesterday's Net Potomac withdrawal (2020-11-15):

FW Corbalis withdrawal (Potomac): 79 MGD
WSSC Potomac withdrawal: 90 MGD
Aqueduct withdrawal: 106 MGD
Loudoun withdrawal: 0 MGD
Total Potomac withdrawal: 275 MGD

Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2020-11-15):
FW Occoquan withdrawal: 57 MGD
WSSC Patuxent withdrawal: 48 MGD

Total system withdrawal: 380 MGD

Loudoun Water Broad Run discharge:
Yesterday's (2020-11-15): 8 MGD

Today's estimated production* (2020-11-16):
FW estimated production: 159 MGD
WSSC estimated production: 153 MGD
Washington Aqueduct estimated production: 113 MGD
Total estimated production: 425 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

Tomorrow's estimated production* (2020-11-17):
FW estimated production: 152 MGD
WSSC estimated production: 148 MGD
Washington Aqueduct estimated production:114 MGD
Total estimated production: 414 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

Reservoirs - Usable storage (2020-11-16 A.M., BG):
Facility, %Full, Current, Capacity*
WSSC's Patuxent reservoirs, 81%, 8.28, 10.2
Fairfax Water's Occoquan reservoir, 95%, 8.1, 8.5
Little Seneca Reservoir, 100%, 3.91 ,3.9
Jennings Randolph Total Reservoir, 79%, 23.1, 29.4
Jennings Randolph water supply**, 100%, 13.1, 13.1
Jennings Randolph water quality**, 61%, 10.0, 16.3
Savage Reservoir, 65%, 4.1, 6.3
*Storage and capacities for Occoquan, Patuxent and Little Seneca reservoirs are provided by Washington metropolitan area water utilities, and based on best available information. Storage and capacities for Jennings

Recommended (SIMULATED) operations for today (2020-11-16 A.M.):

Fairfax Water:
Keep Potomac withdrawal rate (SIMULATED) as steady as possible.

WSSC:
Keep Potomac withdrawal rate (SIMULATED) as steady as possible.

Seneca (release date, time, amount in MGD):
There are no releases at this time.

Washington Aqueduct:
Shift 75 MGD of withdrawals from Great Falls to Little Falls.

Loudoun:
The following values are provided under the protocol developed to satisfy the Virginia Water Protection permit # 10-2020, Part I. 2. f (p. 10), and Part I.J.10
$Q_{PR, obs}$ = 9630 MGD
$Q_{PR, WS}$ = 0 MGD
Q_{PR} = 9630 MGD

North Branch reservoirs (USACE, Baltimore District):
There are no releases at this time

Day Two: Potomac Flow and Demand Update (Tuesday 2020-11-17 AM)

This is the second day of our 2020 Washington metropolitan area (WMA) annual drought exercise.

Two special events are taking place today:

- An ACTUAL test release is requested from Little Seneca Reservoir at 10 AM today at a rate of 400 million gallons per day (MGD) to be continued for 12 hours.
- A webinar on "Forecast Informed Reservoir Operations" by Hazen & Sawyer at 2:00 PM via Microsoft Teams Meeting. If you would like to attend and haven't received a link, contact sahmed@icprb.org.

Thank you to the water suppliers and the Black Hill Regional Park staff for your active participation in this exercise. Reported below are actual recent conditions and simulated drought operations.

****

RECENT CONDITIONS – ACTUAL

Recent basin-wide average precipitation (above Little Falls):
(based on CO-OP's Low Flow Forecast System analysis of Middle Atlantic River Forecast Center (MARFC) gridded multisensor precipitation estimates)

Yesterday's area-weighted average basin precipitation: 0 (inches)
Past 3-day cumulative area-weighted average basin precipitation: 0.19 (inches)
Past 7-day cumulative area-weighted average basin precipitation: 1.73 (inches)

Potomac River Flows:
Little Falls gage flow 2020-11-16: 8531 MGD (13200 cfs)
Little Falls gage flow 2020-11-17: 6916 MGD (est., based on recently available real time data) (10700 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2020-11-16: 7109 MGD (11000 cfs)
Point of Rocks flow 2020-11-17: 5752 MGD (est., based on recently available real time data) (8900 cfs)

Yesterday's Net Potomac withdrawal (2020-11-16):
FW Corbalis withdrawal (Potomac): 79 MGD
WSSC Water Potomac withdrawal: 89 MGD
Washington Aqueduct withdrawal: 106 MGD
Loudoun Water withdrawal: 0 MGD
Total Potomac withdrawal: 274 MGD

Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2020-11-16):
FW Occoquan withdrawal: 57 MGD
WSSC Water Patuxent withdrawal: 67 MGD

Yesterday's total system withdrawal (2020-11-16): 398 MGD

Loudoun Water Broad Run discharge:
Yesterday's (2020-11-16): 8 MGD

Today's estimated production* (2020-11-17):
FW estimated production: 150 MGD
WSSC Water estimated production: 146 MGD
Washington Aqueduct estimated production: 114 MGD
Total estimated production: 410 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

Tomorrow's estimated production* (2020-11-18):
FW estimated production: 155 MGD
WSSC Water estimated production: 146 MGD
Washington Aqueduct estimated production: 113 MGD
Total estimated production: 414 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

****
Recommended (SIMULATED) operations for this morning (2020-11-17 A.M.):

Fairfax Water:
Load shift (SIMULATED) 24 MGD off the Corbalis plant (Potomac) and onto the Griffith plant (Occoquan). Keep Potomac withdrawal rate as steady as possible.

WSSC Water:
Keep Potomac withdrawal rate (SIMULATED) as steady as possible.

Little Seneca (release date, time, amount in MGD):
No (SIMULATED) water supply release. (An ACTUAL test release is requested for November 17, 2020, at 10 AM at a rate of 400 million gallons per day (MGD) to be continued for 12 hours.)

Washington Aqueduct:
Increase (SIMULATED) withdrawals at Little Falls to 150 MGD. Great Falls per operational preference.

Loudoun Water:
The following values (SIMULATED) are provided under the protocol developed to satisfy the Virginia Water Protection permit # 10-2020, Part I. 2. f (p. 10), and Part I.J.10
QPR, obs = 514 MGD (695 cfs) (SIMULATED)
QPR, WS = 40 MGD (SIMULATED)
QPR = 474 MGD (SIMULATED)

North Branch Reservoirs A.M. Summary:
Begin (SIMULATED) water supply release with a Luke target of 169 cfs. This is equivalent to 109 MGD.

Reservoirs - Usable storage (2020-11-17 A.M., BG):
Facility, %Full, Current, Capacity*
WSSC's Patuxent reservoirs, 81%, 8.26, 10.2
Fairfax Water's Occoquan reservoir, 100%, 8.05, 8.05
Little Seneca Reservoir, 100%, 3.9, 3.9
Jennings Randolph Total Reservoir, 79%, 23.2, 29.4
Jennings Randolph water supply**, 100%, 13.1, 13.1
Jennings Randolph water quality**, 62%, 10.1, 16.3
Savage Reservoir, 65%, 4.1, 6.3
*Storage and capacities for Occoquan, Patuxent, and Little Seneca reservoirs are provided by Washington metropolitan area water utilities and based on the best available information. Storage and capacities for Jennings Randolph and Savage reservoirs are based on observed water levels and available US ACE water level/storage tables from 1998. ICPRB estimates that sedimentation has resulted in a loss of total available storage in Jennings Randolph Reservoir of 1.6 BG in recent years, and this loss is not reflected in the numbers above.
** ICPRB's initial estimate. The final accounting of Jennings Randolph's water supply versus water quality storage will be provided later by the US ACE.

Day Three: Potomac Flow and Demand Update (Wednesday 2020-11-18 AM)

This is the third and last day of our 2020 Washington metropolitan area (WMA) annual drought exercise. Reported below are actual recent conditions and simulated drought operations. Today we requested a simulated Little Seneca release of 22 MGD. This was based on the drought scenario and not yesterday's actual release. We will provide analysis on the travel time of this test release in our report. You can follow the release at the USGS gage 01645000 SENECA CREEK AT DAWSONVILLE, MD here.

****

RECENT CONDITIONS – ACTUAL

Recent basin-wide average precipitation (above Little Falls):
(based on CO-OP's Low Flow Forecast System analysis of Middle Atlantic River Forecast Center (MARFC) gridded multisensor precipitation estimates)
Yesterday's area-weighted average basin precipitation: 0 (inches)
Past 3-day cumulative area-weighted average basin precipitation: 0.19 (inches)
Past 7-day cumulative area-weighted average basin precipitation: 1.73 (inches)

Potomac River Flows:

Little Falls gage flow 2020-11-17: 6722 MGD (10400 cfs)
Little Falls gage flow 2020-11-18: 5823 MGD (est., based on recently available real time data) (9010 cfs)
Note: Gage flow at Little Falls is measured after water supply withdrawals.
Point of Rocks flow 2020-11-17: 5552 MGD (8590 cfs)
Point of Rocks flow 2020-11-18: 4770 MGD (est., based on recently available real time data) (7380 cfs)

Yesterday's Net Potomac withdrawal (2020-11-17):
FW Corbalis withdrawal (Potomac): 76 MGD
WSSC Potomac withdrawal: 94 MGD
Aqueduct withdrawal: 113 MGD
Loudoun withdrawal: 6 MGD
Total Potomac withdrawal: 288 MGD

Yesterday's Patuxent, Occoquan, and Net Total System Withdrawal (2020-11-17):
FW Occoquan withdrawal: 58 MGD
WSSC Water Patuxent withdrawal: 66 MGD

Yesterday's total system withdrawal (2020-11-17): 407 MGD

Loudoun Water Broad Run discharge:
Yesterday's (2020-11-17): 7 MGD

Today's estimated production* (2020-11-18):
FW estimated production: 150 MGD
WSSC Water estimated production: 146 MGD
Washington Aqueduct estimated production: 114 MGD
Total estimated production: 410 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

Tomorrow's estimated production* (2020-11-19):
FW estimated production:153 MGD
WSSC estimated production:146 MGD
Washington Aqueduct estimated production:116 MGD
Total estimated production:415 MGD
*Based on CO-OP daily demand forecasting models. FW includes the LW purchase and excludes Falls Church. Washington Aqueduct includes Falls Church

****

Recommended (SIMULATED) operations for this morning (2020-11-18 A.M.):

Fairfax Water:
Maintain the (SIMULATED) load shift of 24 MGD off the Corbalis plant (Potomac) and onto the Griffith plant (Occoquan). Keep Potomac withdrawal rate as steady as possible.

WSSC Water:
Keep Potomac withdrawal rate (SIMULATED) as steady as possible.

Appendix C: Little Seneca Reservoir Release Data

Table 8: Little Seneca Reservoir Release Data (T. Supple, personal communication, November 2020).

Date and Time	Total Flow (MGD)
11/17/20 9:00	3.10
11/17/20 9:05	3.10
11/17/20 9:10	3.10
11/17/20 9:15	3.10
11/17/20 9:20	3.11
11/17/20 9:25	3.10
11/17/20 9:30	3.10
11/17/20 9:35	3.10
11/17/20 9:40	3.10
11/17/20 9:45	3.10
11/17/20 9:50	3.10
11/17/20 9:55	3.10
11/17/20 10:00	3.11
11/17/20 10:05	58.10
11/17/20 10:10	124.10
11/17/20 10:15	123.32
11/17/20 10:20	123.68
11/17/20 10:25	124.08
11/17/20 10:30	123.88
11/17/20 10:35	156.69
11/17/20 10:40	157.86
11/17/20 10:45	156.79
11/17/20 10:50	157.00
11/17/20 10:55	156.92
11/17/20 11:00	157.32
11/17/20 11:05	195.90
11/17/20 11:10	211.39
11/17/20 11:15	211.71
11/17/20 11:20	211.40
11/17/20 11:25	210.83
11/17/20 11:30	221.45
11/17/20 11:35	248.05
11/17/20 11:40	247.98
11/17/20 11:45	247.26
11/17/20 11:50	248.46
11/17/20 11:55	248.34
11/17/20 12:00	261.30
11/17/20 12:05	266.43
11/17/20 12:10	268.36
11/17/20 12:15	268.21
11/17/20 12:20	269.75
11/17/20 12:25	269.78
11/17/20 12:30	269.39
11/17/20 12:35	269.53
11/17/20 12:40	269.95
11/17/20 12:45	272.28
11/17/20 12:50	276.31
11/17/20 12:55	276.43
11/17/20 13:00	279.91
11/17/20 13:05	280.06
11/17/20 13:10	280.04
11/17/20 13:15	279.94
11/17/20 13:20	279.99
11/17/20 13:25	280.10
11/17/20 13:30	280.12
11/17/20 13:35	280.15
11/17/20 13:40	280.12
11/17/20 13:45	280.12
11/17/20 13:50	280.17
11/17/20 13:55	280.15
11/17/20 14:00	280.20
11/17/20 14:05	280.17
11/17/20 14:10	280.14
11/17/20 14:15	280.13
11/17/20 14:20	280.09
11/17/20 14:25	280.04
11/17/20 14:30	280.11
11/17/20 14:35	280.14
11/17/20 14:40	280.01
11/17/20 14:45	280.17
11/17/20 14:50	280.19
11/17/20 14:55	280.14
11/17/20 15:00	280.12
11/17/20 15:05	280.19
11/17/20 15:10	280.22
11/17/20 15:15	280.12
11/17/20 15:20	280.11
11/17/20 15:25	280.11
11/17/20 15:30	280.19
11/17/20 15:35	280.22
11/17/20 15:40	280.22
11/17/20 15:45	280.19
11/17/20 15:50	280.13
11/17/20 15:55	280.08
11/17/20 16:00	280.10
11/17/20 16:05	280.18
11/17/20 16:10	280.21
11/17/20 16:15	280.15
11/17/20 16:20	280.13
11/17/20 16:25	280.21
11/17/20 16:30	280.21
11/17/20 16:35	280.17
11/17/20 16:40	280.21
11/17/20 16:45	280.22
11/17/20 16:50	280.22
11/17/20 16:55	280.14
11/17/20 17:00	280.17
11/17/20 17:05	280.17
11/17/20 17:10	280.19
11/17/20 17:15	280.19
11/17/20 17:20	280.21
11/17/20 17:25	280.18
11/17/20 17:30	280.21
11/17/20 17:35	280.26
11/17/20 17:40	280.18
11/17/20 17:45	280.25
11/17/20 17:50	280.17
11/17/20 17:55	280.24
11/17/20 18:00	280.14
11/17/20 18:05	280.24
11/17/20 18:10	280.20
11/17/20 18:15	280.24
11/17/20 18:20	280.15

11/17/20 18:25	280.17
11/17/20 18:30	280.08
11/17/20 18:35	280.20
11/17/20 18:40	280.18
11/17/20 18:45	280.20
11/17/20 18:50	280.10
11/17/20 18:55	280.22
11/17/20 19:00	280.21
11/17/20 19:05	280.22
11/17/20 19:10	280.13
11/17/20 19:15	280.16
11/17/20 19:20	280.15
11/17/20 19:25	280.14
11/17/20 19:30	280.21
11/17/20 19:35	280.21
11/17/20 19:40	280.21
11/17/20 19:45	280.12
11/17/20 19:50	280.11
11/17/20 19:55	280.21
11/17/20 20:00	280.16
11/17/20 20:05	280.22
11/17/20 20:10	280.20
11/17/20 20:15	280.21
11/17/20 20:20	280.16
11/17/20 20:25	280.17
11/17/20 20:30	280.17
11/17/20 20:35	280.13
11/17/20 20:40	280.20
11/17/20 20:45	280.22
11/17/20 20:50	280.10
11/17/20 20:55	280.12
11/17/20 21:00	280.24
11/17/20 21:05	280.21
11/17/20 21:10	280.17
11/17/20 21:15	280.12
11/17/20 21:20	280.15
11/17/20 21:25	280.06
11/17/20 21:30	280.12
11/17/20 21:35	280.12
11/17/20 21:40	280.17
11/17/20 21:45	280.00
11/17/20 21:50	280.22
11/17/20 21:55	280.01
11/17/20 22:00	280.18
11/17/20 22:05	280.14
11/17/20 22:10	276.33
11/17/20 22:15	276.10
11/17/20 22:20	276.78
11/17/20 22:25	275.94
11/17/20 22:30	276.22
11/17/20 22:35	276.38
11/17/20 22:40	276.67
11/17/20 22:45	268.03
11/17/20 22:50	268.10
11/17/20 22:55	268.51
11/17/20 23:00	267.92
11/17/20 23:05	258.52
11/17/20 23:10	259.19
11/17/20 23:15	258.92
11/17/20 23:20	248.22
11/17/20 23:25	248.13
11/17/20 23:30	247.98
11/17/20 23:35	221.03
11/17/20 23:40	220.70
11/17/20 23:45	221.26
11/17/20 23:50	188.08
11/17/20 23:55	187.93
11/18/20 0:00	188.04
11/18/20 0:05	187.78
11/18/20 0:10	151.04
11/18/20 0:15	150.72
11/18/20 0:20	150.71
11/18/20 0:25	107.43
11/18/20 0:30	106.34
11/18/20 0:35	106.78
11/18/20 0:40	107.20
11/18/20 0:45	107.09
11/18/20 0:50	106.36
11/18/20 0:55	107.15
11/18/20 1:00	107.17
11/18/20 1:05	107.47
11/18/20 1:10	62.76
11/18/20 1:15	62.43
11/18/20 1:20	62.42
11/18/20 1:25	62.66
11/18/20 1:30	62.45
11/18/20 1:35	62.48
11/18/20 1:40	62.15
11/18/20 1:45	62.02
11/18/20 1:50	62.20
11/18/20 1:55	62.55
11/18/20 2:00	62.53
11/18/20 2:05	62.60
11/18/20 2:10	62.09
11/18/20 2:15	34.46
11/18/20 2:20	34.58
11/18/20 2:25	34.54
11/18/20 2:30	34.57
11/18/20 2:35	34.38
11/18/20 2:40	34.49
11/18/20 2:45	34.35
11/18/20 2:50	34.38
11/18/20 2:55	12.00
11/18/20 3:00	12.00
11/18/20 3:05	12.00
11/18/20 3:10	12.00
11/18/20 3:15	12.00
11/18/20 3:20	12.00
11/18/20 3:25	12.00
11/18/20 3:30	12.00
11/18/20 3:35	12.00
11/18/20 3:40	12.00
11/18/20 3:45	12.00
11/18/20 3:50	12.00
11/18/20 3:55	12.00
11/18/20 4:00	12.00
11/18/20 4:05	12.00
11/18/20 4:10	12.00
11/18/20 4:15	12.00
11/18/20 4:20	12.00
11/18/20 4:25	12.00
11/18/20 4:30	12.00
11/18/20 4:35	12.00

11/18/20 4:40	12.00
11/18/20 4:45	12.00
11/18/20 4:50	12.00
11/18/20 4:55	12.00
11/18/20 5:00	12.00
11/18/20 5:05	12.00
11/18/20 5:10	12.00
11/18/20 5:15	12.00
11/18/20 5:20	12.00
11/18/20 5:25	12.00
11/18/20 5:30	12.00
11/18/20 5:35	12.00
11/18/20 5:40	12.00
11/18/20 5:45	12.00
11/18/20 5:50	12.00
11/18/20 5:55	12.00
11/18/20 6:00	12.00
11/18/20 6:05	12.00

11/18/20 6:10	12.00
11/18/20 6:15	12.00
11/18/20 6:20	12.00
11/18/20 6:25	12.00
11/18/20 6:30	12.00
11/18/20 6:35	12.00
11/18/20 6:40	12.00
11/18/20 6:45	12.00
11/18/20 6:50	12.00
11/18/20 6:55	12.00
11/18/20 7:00	12.00
11/18/20 7:05	12.00
11/18/20 7:10	12.00
11/18/20 7:15	6.88
11/18/20 7:20	2.78
11/18/20 7:25	3.13
11/18/20 7:30	3.13
11/18/20 7:35	3.13

11/18/20 7:40	3.13
11/18/20 7:45	3.13
11/18/20 7:50	3.13
11/18/20 7:55	3.13
11/18/20 8:00	3.12
11/18/20 8:05	3.15
11/18/20 8:10	3.14
11/18/20 8:15	3.14
11/18/20 8:20	3.14
11/18/20 8:25	3.12
11/18/20 8:30	3.14
11/18/20 8:35	3.13
11/18/20 8:40	3.13
11/18/20 8:45	3.12
11/18/20 8:50	3.13
11/18/20 8:55	3.13
11/18/20 9:00	3.14