

## MEMORANDUM

### **Flexible Flow Management Program Performance Report June 1, 2020 – May 31, 2021**

The goals of the Flexible Flow Management Program (FFMP) are to Manage droughts and maintain flow objectives during periods of low flows. Additionally, conservation releases are enhanced to maintain tailwater temperatures, and to minimize spilling of reservoirs through use of the Conditional Seasonal Storage Objective (CSSO). The FFMP evaluation period begins on June 1 and ends on May 31 each year. The performance of the FFMP in the release year 2020 – 2021 is summarized below.

The precipitation near Montague was above average for 6 months (July, August, September, October, December, and May) and below average for 6 months (June, November, January, February, March, and April). The precipitation near Trenton was above average for 5 months (August, September, October, November, and February) and below average for 7 months (June, July, December, January, March, April, and May). Although precipitation was average in the summer months of 2020, the storage in the three New York City (NYC) reservoirs (Pepacton, Cannonsville, and Neversink) decreased throughout the summer. At the beginning of the release year, the storage was approximately five (5) Billion Gallons (BG) below the median and remained below the median until the heavy rain delivered by tropical storm Isaias on August 4<sup>th</sup>. After the tropical storm, the storage was above the median value by approximately 5 BG and continued to decrease at a similar rate as before the storm. The minimum storage value was approximately 163.4 BG on October 31, 2020. The storage increased through the remainder of 2020, and a large rain/snowmelt event occurred on December 24. The combined storage increased by approximately 50 BG in 5 days. In 2021, the storage remained near the median, and the reservoirs were full by the end of April.

The flows at Montague and Trenton were mostly within the normal range (defined as the 25<sup>th</sup> to 75<sup>th</sup> percentile of flow on a given day). Exceptions occurred for large rainfall events such as tropical storms Fay and Isaias, the Dec 24 rain/snowmelt event and several snowmelt events in March 2020. Flows were lower than average during the late spring months due to early snowmelt and below average spring precipitation.

In 2020-2021, approximately 21,593 MG of water was used to meet the flow objective at Montague during a dry period in September and October. The amount includes the portion of the conservation release used to meet Montague, but not the amount of conservation release that exceeds what is needed. No water was used from the NYC reservoirs to meet the flow objective at Trenton in Release Year 2020-2021. Water from the lower basin reservoirs (Blue Marsh and Beltzville) to meet the flow objective at Trenton was not required.

As defined in the FFMP, the diversion from NYC shall not exceed 800 million gallons per day (mgd) on average. The average monthly diversion during 2020-2021 for NYC was 538 mgd, with the highest monthly diversions occurring in September and February. Diversions by State of New Jersey may not exceed 100 mgd as a monthly average. The average diversion by New Jersey during 2020-2021 was 95 mgd, with the highest monthly diversion occurring in May.

Conservation releases are designed to protect the aquatic life in the stream reaches below the NYC reservoirs. In 2020-2021, the required conservation releases based on the FFMP tables were as follows: Cannonsville – 88,489 MG, Pepacton – 33,586 MG, and Neversink – 22,578 MG. All or a portion of the releases on a given day may have been used to meet the Montague Flow Objective. Additional releases may have been needed for bank use (see next section). Releases from FFMP Table 4G were in effect on 306 days (83.8 percent of the time) and from Table 4F on 59 days (16.2 percent of the time). The time in Table 4F was during the fall of 2020. During September when flows were low, 21.5 BG was released from the NYC reservoirs to meet the Montague Flow Objective.

The Interim Excess Release Quantity (IERQ) provides 15,468 cfs-days (approximately 10 BG) to further protect the aquatic life in the river by supporting releases for thermal mitigation, rapid flow change mitigation, the Trenton Flow Objective, and amelioration for diversions by New Jersey during drought. In 2020-2021, 820 cfs-days (530 MG) were used for rapid flow change mitigation in October and November. During the summer months of 2020, 2,330 cfs-days (1.5 BG) were used for thermal mitigation.

The summer of 2020 was one of the warmest on record. In July, Orange County, NY ranked as the warmest July in history since 1895 and was 3 degrees C above average. Additionally, the two-month period June – July also ranked as the warmest on record and 2.4 degrees C above average. In the southern basin (using Philadelphia County, PA), the two-month period July – August ranked as the 2<sup>nd</sup> warmest in history (2.3 degrees C above average), and the three-month period June – August was the third warmest on record (2 degrees C above average). The warm temperatures led to several instances when the water temperature in the upper basin triggered releases for thermal mitigation.

The thermal releases are designed to protect stream reaches below the NYC reservoirs from exceeding water temperatures of 24 degrees C, with a goal of the temperature not exceeding 20 degrees C. In 2020-2021, warm air temperatures led to increased water temperatures at the beginning of the release year. The water temperatures at Hale Eddy, Harvard, and Hancock did not exceed 24 degrees C. The water temperature exceeded 24 degrees C on 8 days at Lordville, and 2 days at Bridgeville. There were 8 thermal events in 2020-2021, defined by consecutive days when releases were made. Releases were made on 34 days (not necessarily contiguous) during the summer of 2020, and approximately 2,330 cfs-days (1.5 BG) was used in total for thermal mitigation.

To enhance flood mitigation, water is released from the NYC reservoirs based on a Conditional Seasonal Storage Objective (CSSO). Discharge mitigation releases are made when the combined storage is in zone L1. The amount of the release from each reservoir is determined by its storage. Releases in accordance with the CSSO create a high probability of maintaining fifteen percent void spaces in individual reservoirs between November 1 and February 1, and ten percent void spaces in individual reservoirs between approximately September 15 and March 1. Cannonsville was above the CSSO for 65 days and spilled 9,436 MG over 28 days. Releases to maintain the CSSO and all L1

releases were 32,550 MG and 39,321 MG, respectively. Pepacton was above the CSSO for 62 days and spilled 4,957 MG over 17 days. Releases to maintain the CSSO and all L1 releases were 13,645 MG and 17,290 MG, respectively. Neversink reservoir was above the CSSO for 77 days and spilled 4,720 MG over 39 days. Releases to maintain the CSSO and all L1 releases were 7,875 MG and 9,889 MG, respectively.

Figures and tables are located on pages 4-34. For non-provisional, approved data, contact the NYC Department of Environmental Protection (NYCDEP), the Office of the Delaware River Master (ODRM), or the United States Geological Survey (USGS). This report is available online at: [https://www.nj.gov/drbc/programs/flow/FFMP\\_PerformanceRpts.html](https://www.nj.gov/drbc/programs/flow/FFMP_PerformanceRpts.html).

#### ACKNOWLEDGEMENTS

This report was prepared by the Delaware River Basin Commission staff. Mr. Anthony Preucil and Ms. Amy Shallcross, P.E., Manager of Water Resource Operations, authored this report. Mr. Preucil is a Water Resource Scientist and Ms. Shallcross is the Manager of Water Resource Operations.

#### SUGGESTED CITATION

DRBC. 2021. FFMP Performance Report 2020-2021. Delaware River Basin Commission. West Trenton, NJ.

# Delaware River Basin Commission

## FFMP Implementation Performance

Release Year 2020

June 1, 2020 – May 31, 2021

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***July 21, 2021***



**Delaware River Basin Commission**

DELAWARE • NEW JERSEY  
PENNSYLVANIA • NEW YORK  
UNITED STATES OF AMERICA

# NOTE

**All data used in the analysis are Provisional**

Final/approved data are available from:

NYC Department of Environmental Protection (NYCDEP)

Office of the Delaware River Master (ODRM)

United States Geological Survey (USGS)

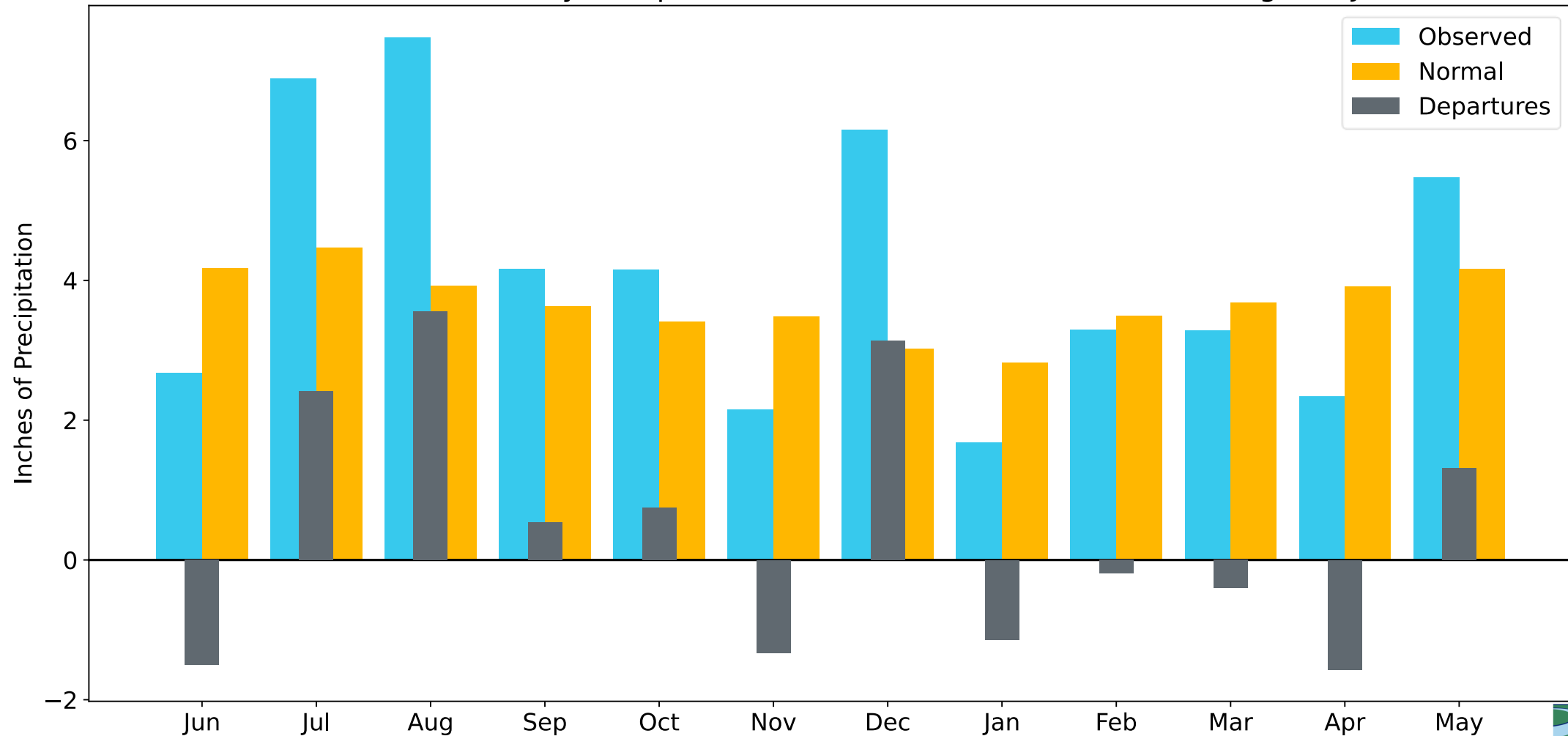
Methodology for calculations is included for reference on the last slide

# FFMP Performance Goals

- \* Manage Droughts
- \* Maintain Flow Objectives
- \* Provide enhanced conservation releases
- \* Maintain desirable tailwater temperatures
- \* Minimize spills using the Conditional Seasonal Storage Objective (CSSO)

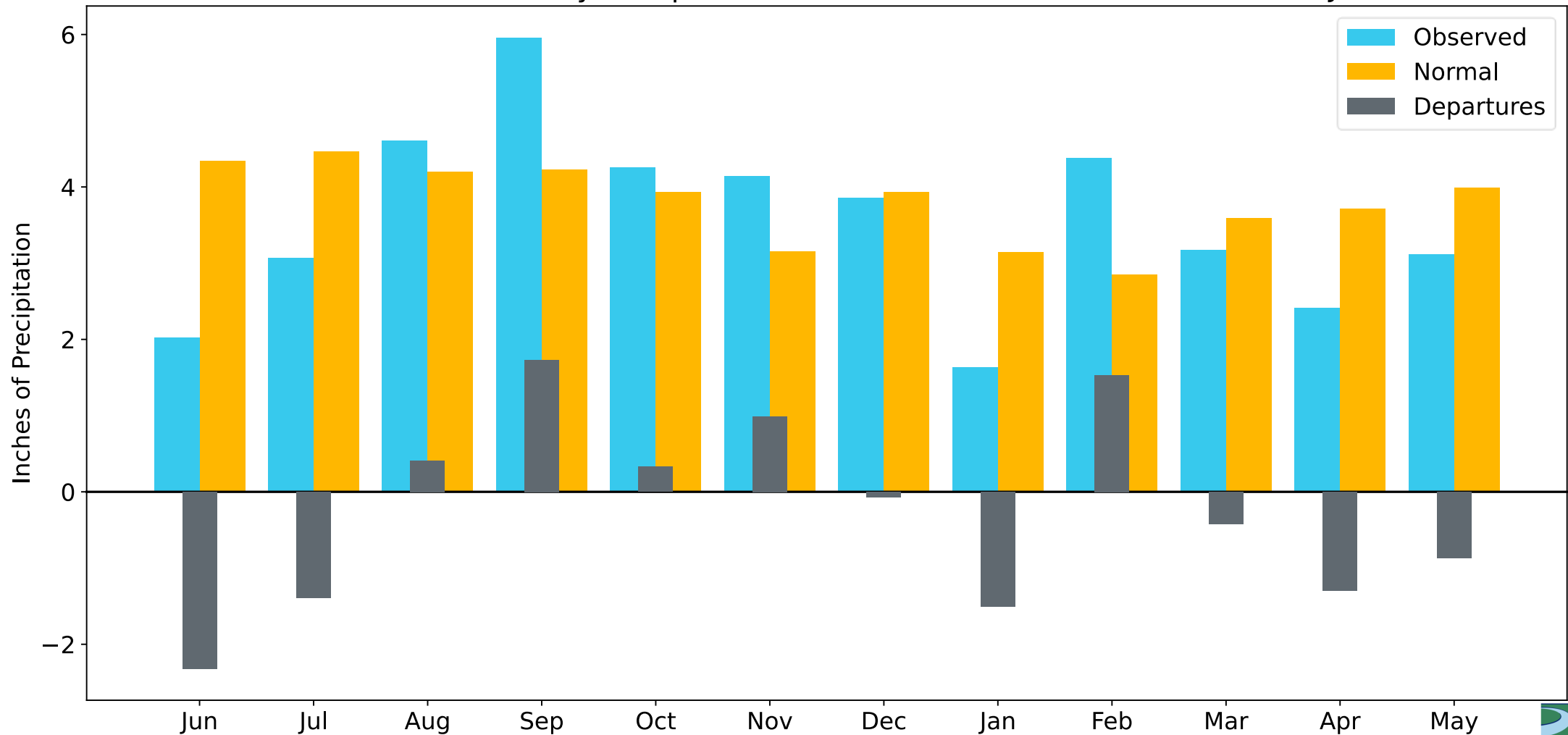
# Precipitation – Montague, NJ

2020-2021 Monthly Precipitation Observations and Normals, Montague, NJ



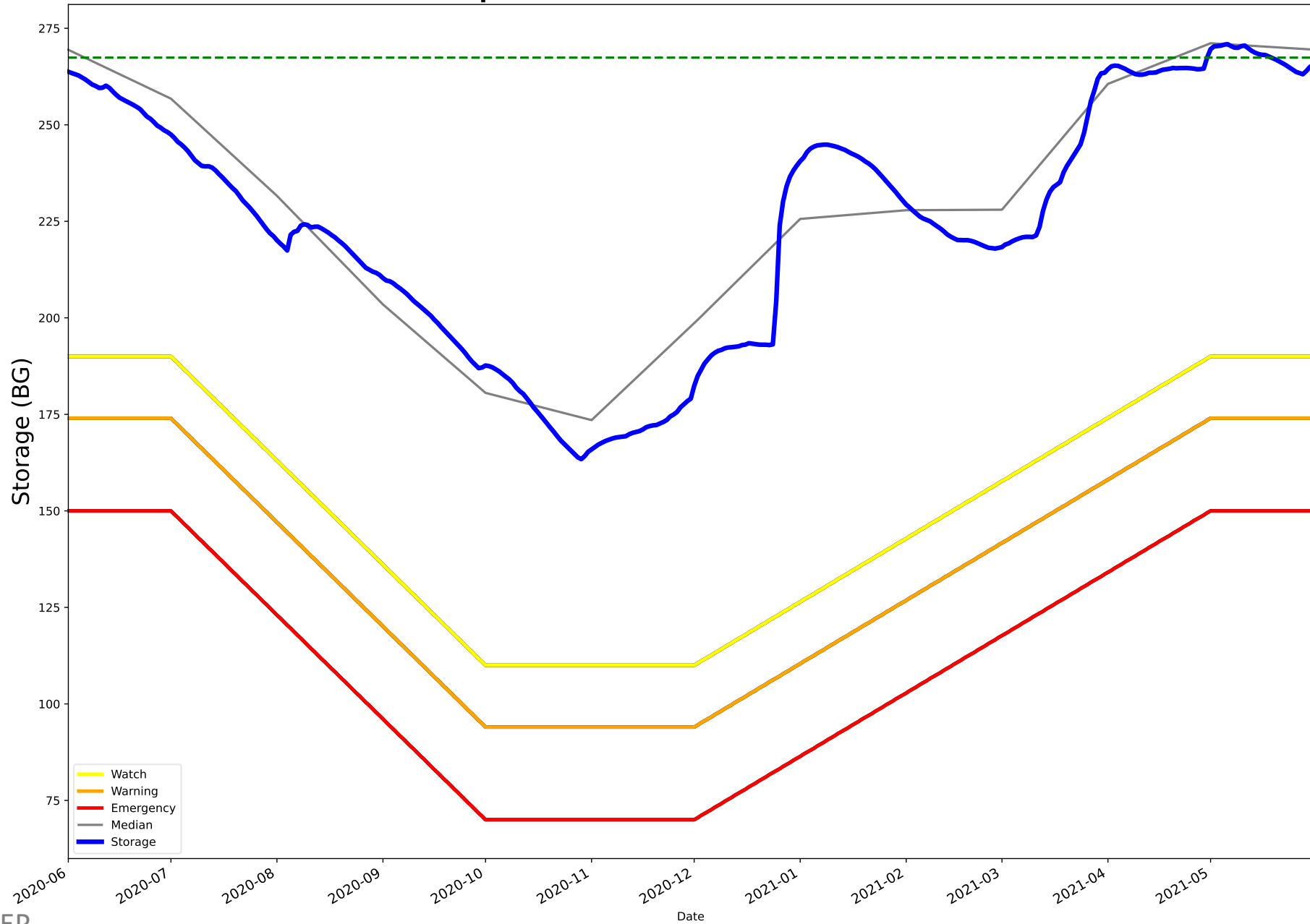
# Precipitation – Trenton, NJ

2020-2021 Monthly Precipitation Observations and Normals, Trenton, NJ





# Combined Storage Amount in the NYC Reservoirs Pepacton + Cannonsville + Neversink



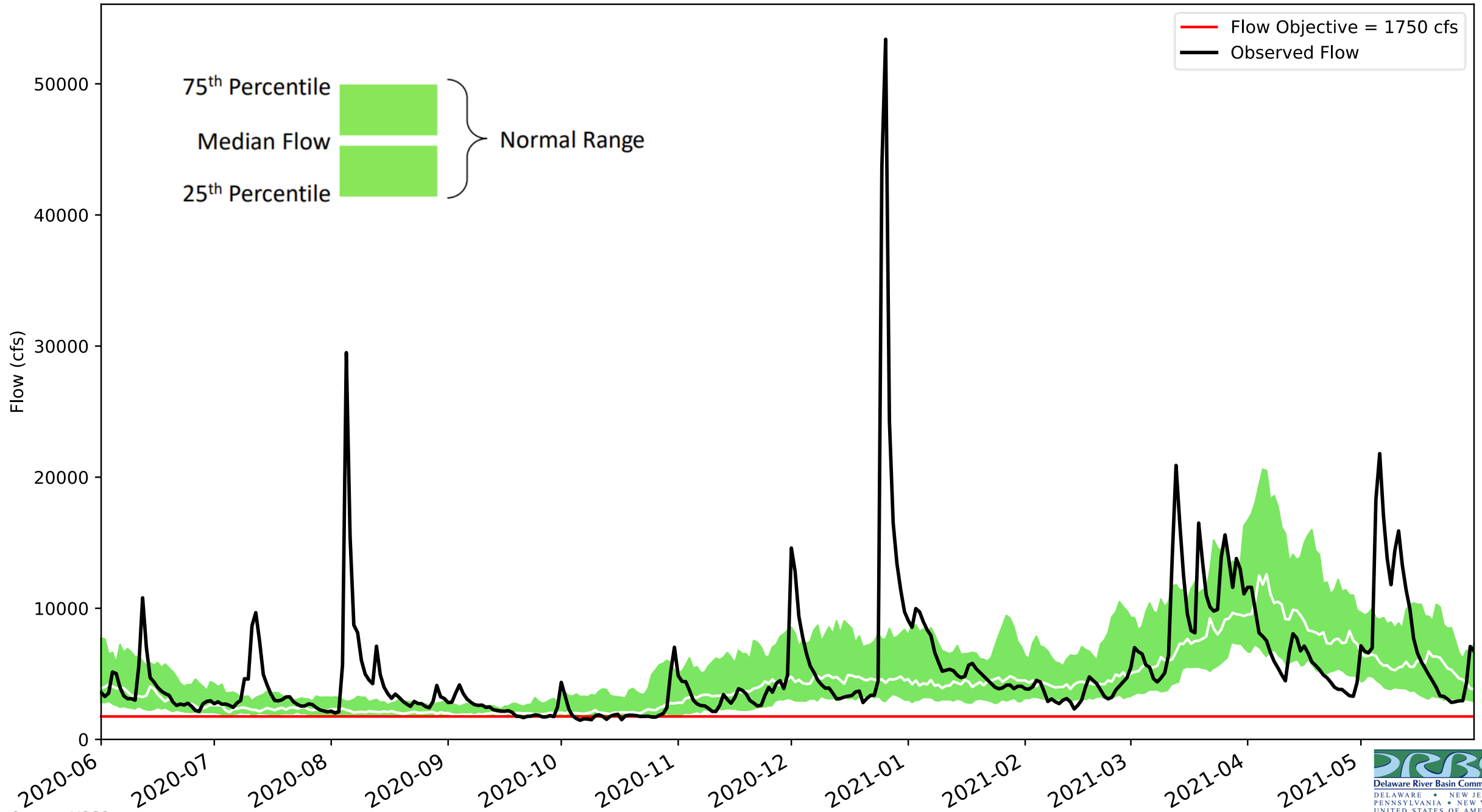
# Flow Objectives

<b>Water Released from NYC to Meet Flow Objectives (MG)</b>	
Montague	21,593*
Trenton	0
Total	21,593

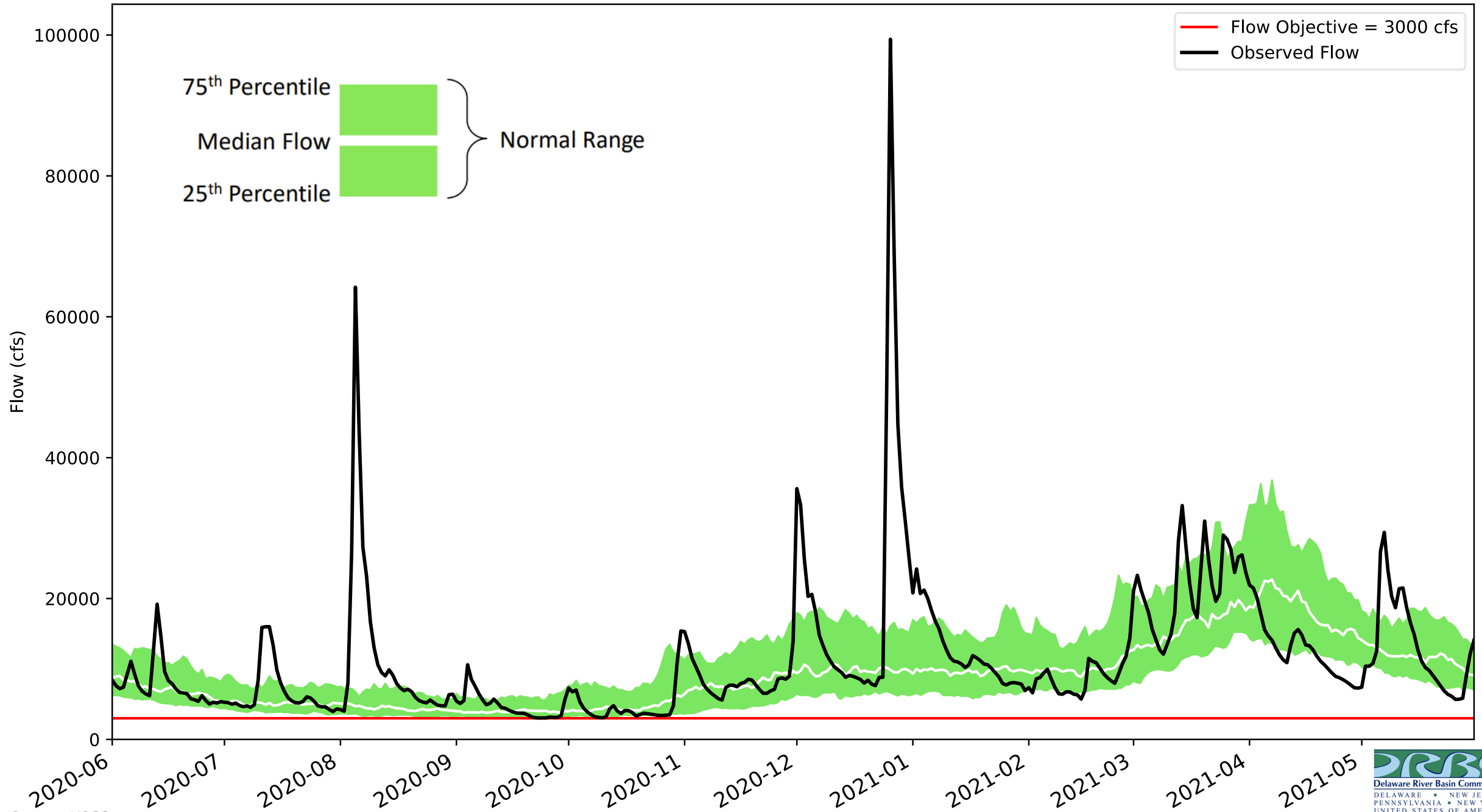
<b>Water Released from Lower Basin to Meet Trenton Flow Objectives (MG)</b>	
Beltzville	0
Blue Marsh	0
Total	0

\*Includes the portion of the conservation releases needed to meet Montague, but not the amount of the conservation release that exceeds what is needed to meet Montague.

# Flow at Montague



# Flow at Trenton



# Diversions

## Monthly Average Daily Diversion (June 1, 2020 – May 31, 2020)

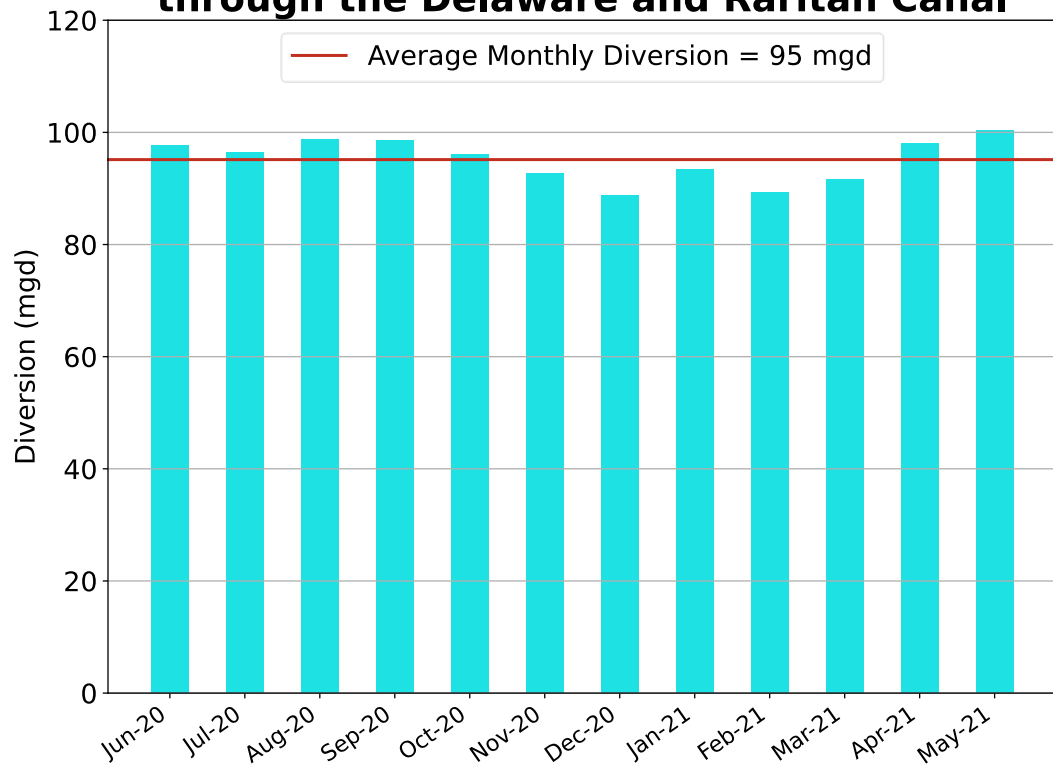
New Jersey

95 mgd

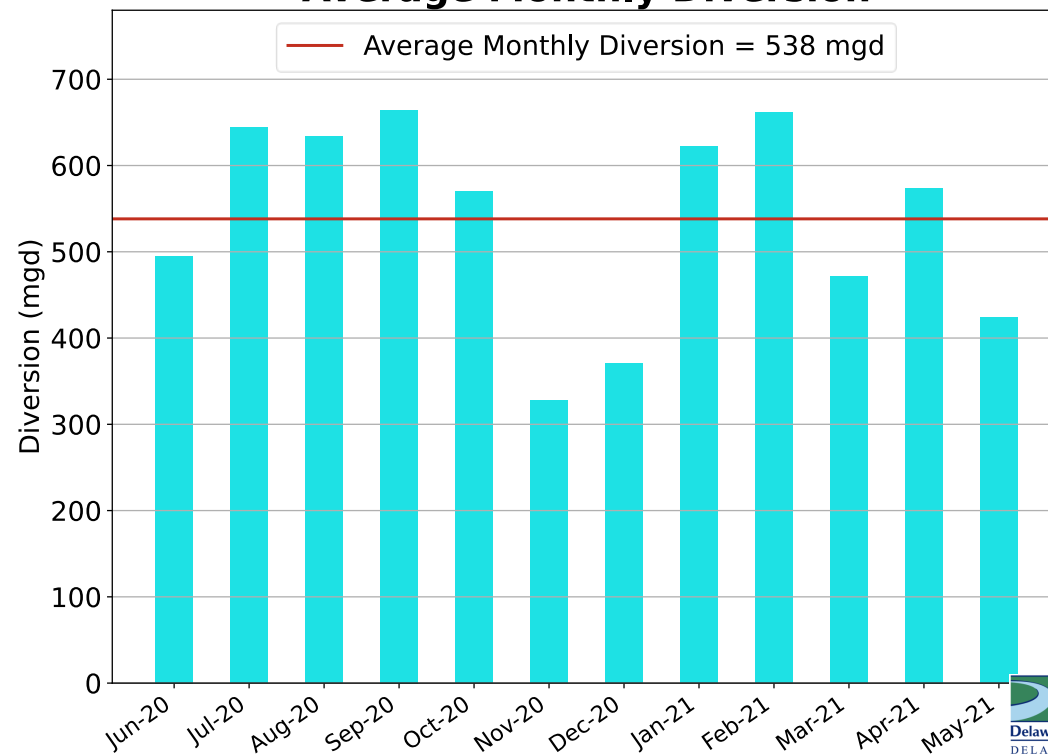
New York

538 mgd

**NJ average monthly diversion through the Delaware and Raritan Canal**



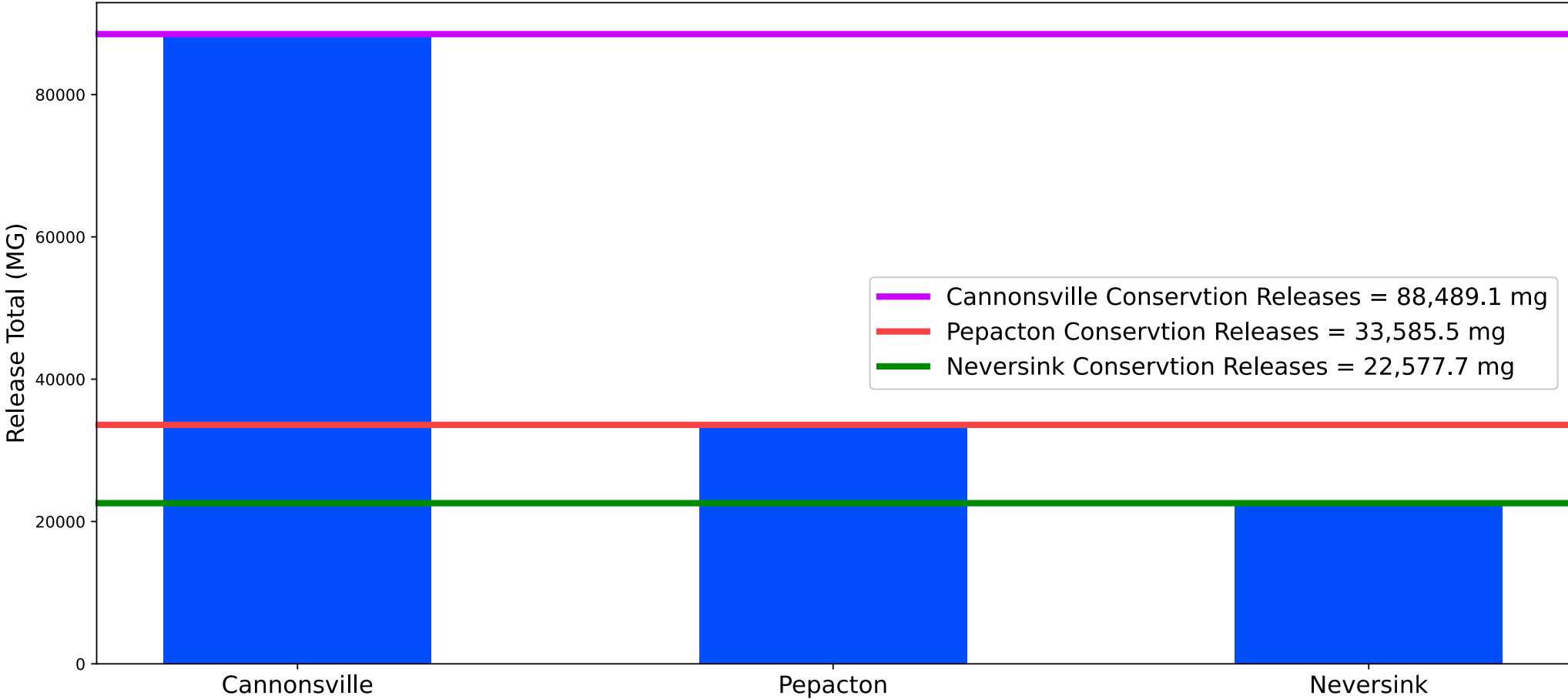
**New York City Average Monthly Diversion**



# Conservation Releases

<b>Volume of Conservation Releases (MG)</b>			
	<b>FFMP 2017 Tables</b> Based on Storage (6/1/20 - 5/31/21)	<b>REV1</b>	<b>Multiple of Revision 1</b>
<b>Cannonsville</b>	88,489	20,665	4.3
<b>Pepacton</b>	33,586	14,562	2.3
<b>Neversink</b>	22,578	8,664	2.6
Values are the conservation releases required by the FFMP Tables Only. All or a portion of the release may have been used to meet the Montague Flow Objective. Additional release volume may have been required for bank use.			

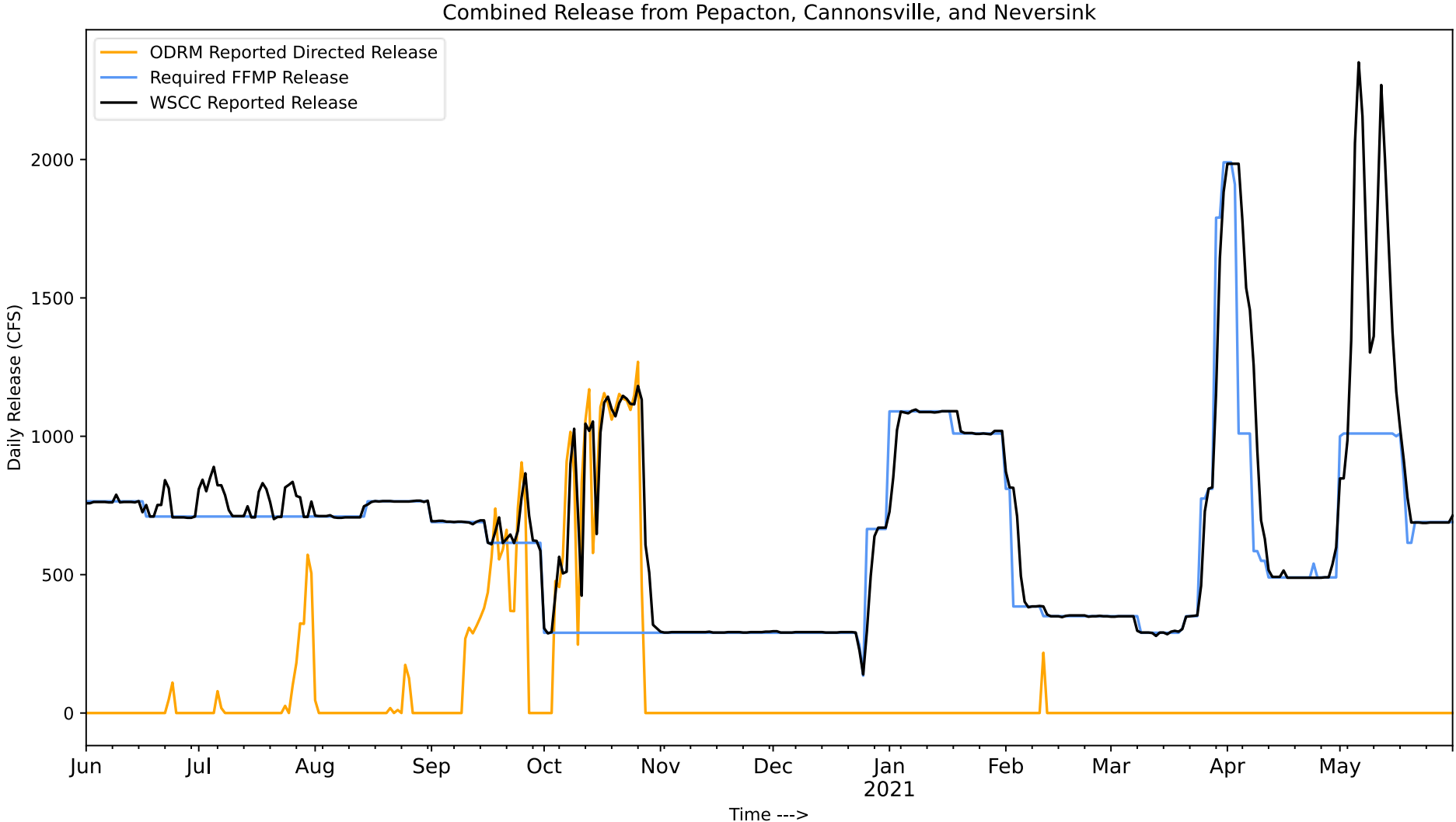
# Conservation Releases from NYC Delaware River Basin Reservoirs FFMP 2020-2021



Data Source: NYCDEP



# Actual Releases

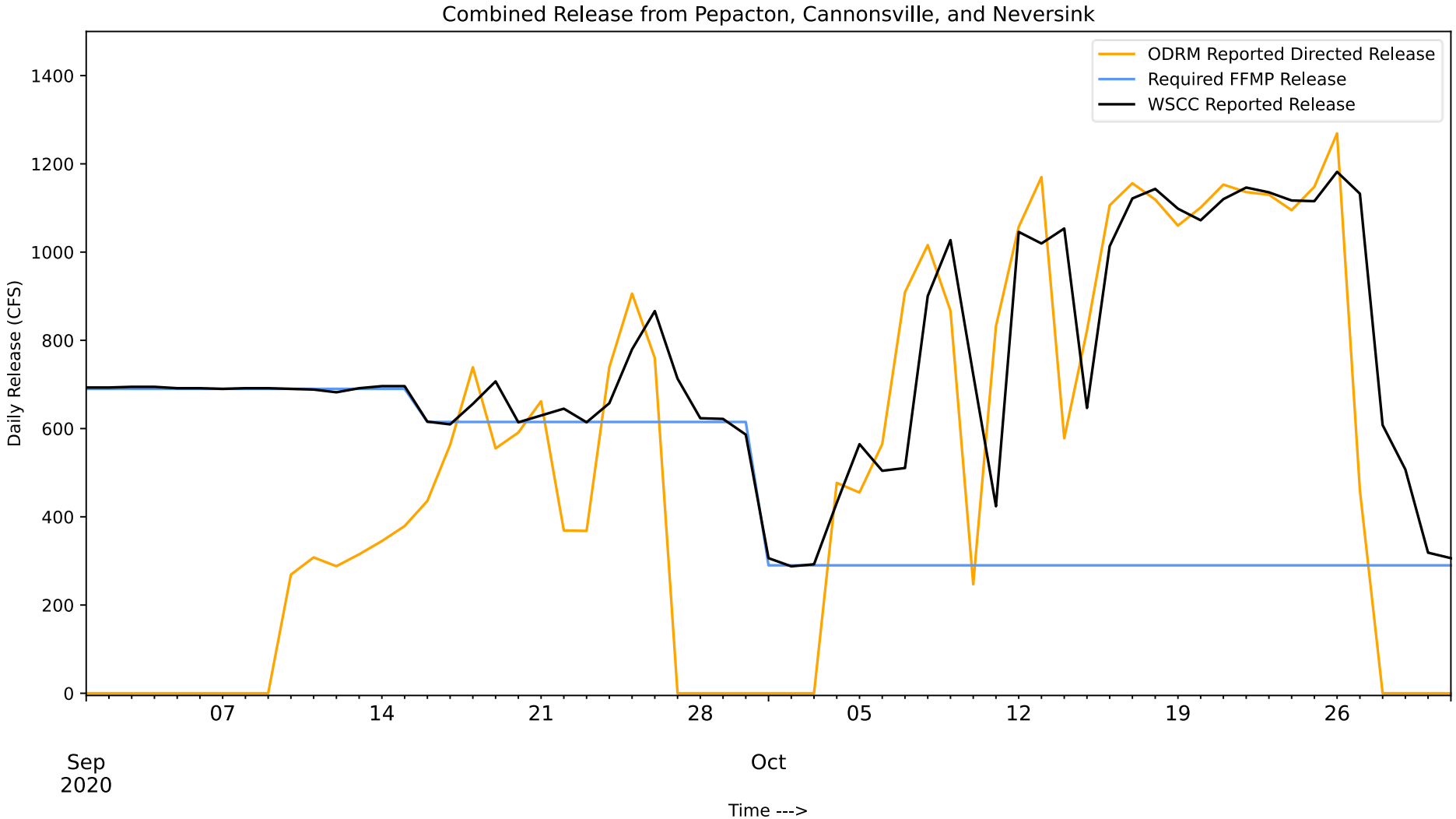


Data Source: NYCDEP, ODRM, USGS





# Actual Releases

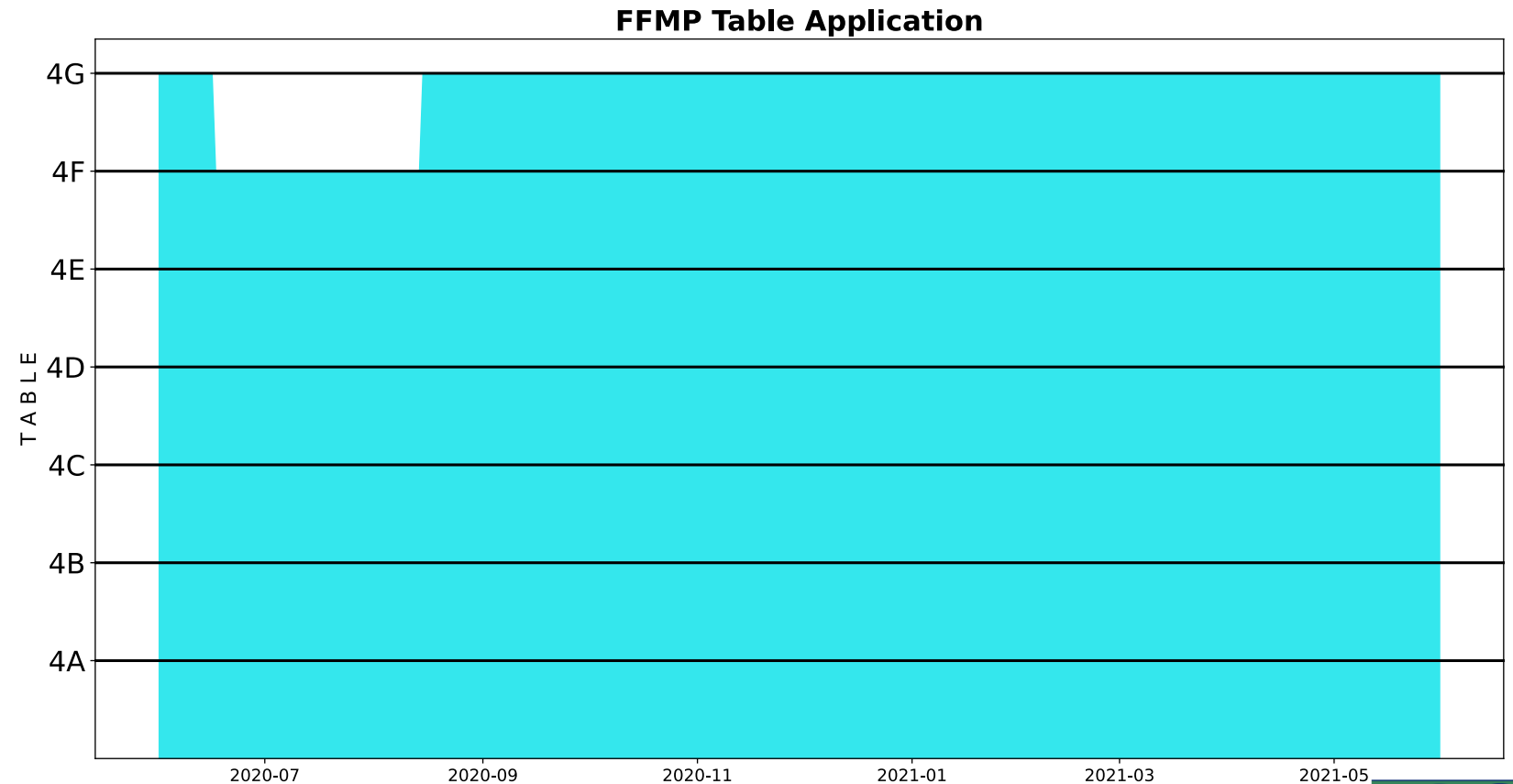


Data Source: NYCDEP, ODRM, USGS

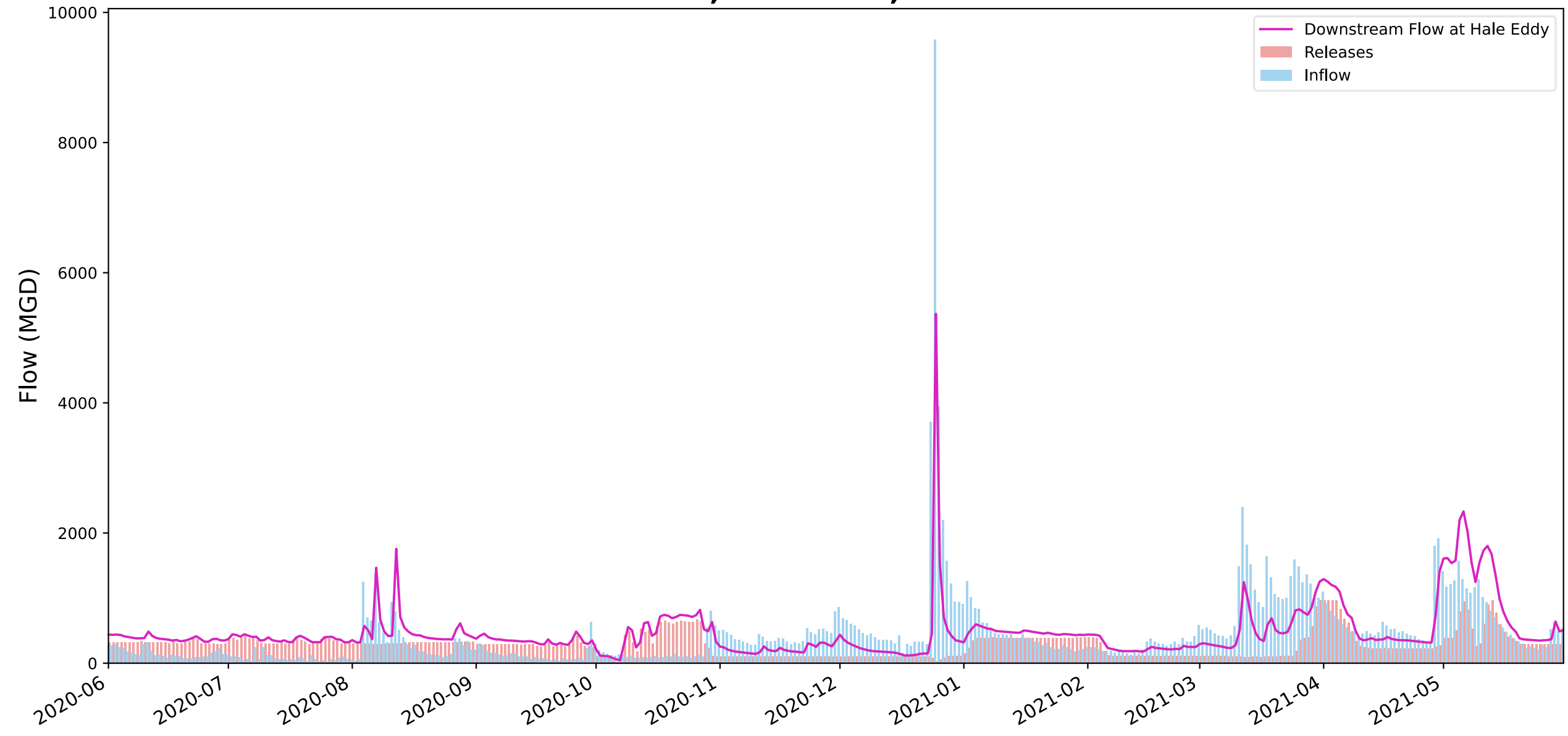


# Time in FFMP Release Tables

FFMP TABLE	Number of Days	Percent
4G	306	83.8
4F	59	16.2
4E	0	0
4D	0	0
4C	0	0
4B	0	0
4A	0	0



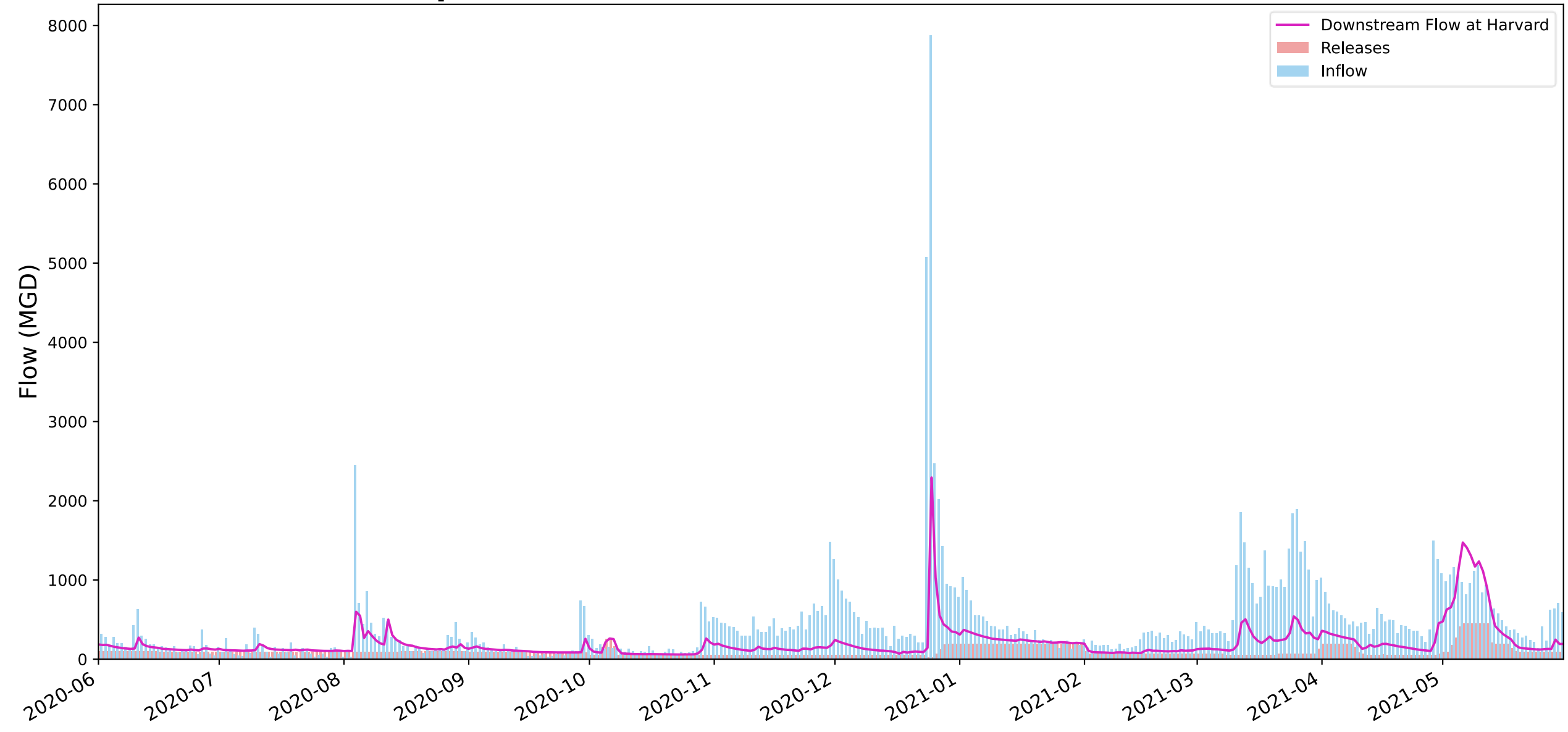
# Cannonsville Inflow, Releases, and Downstream Flow



Data Source: USGS

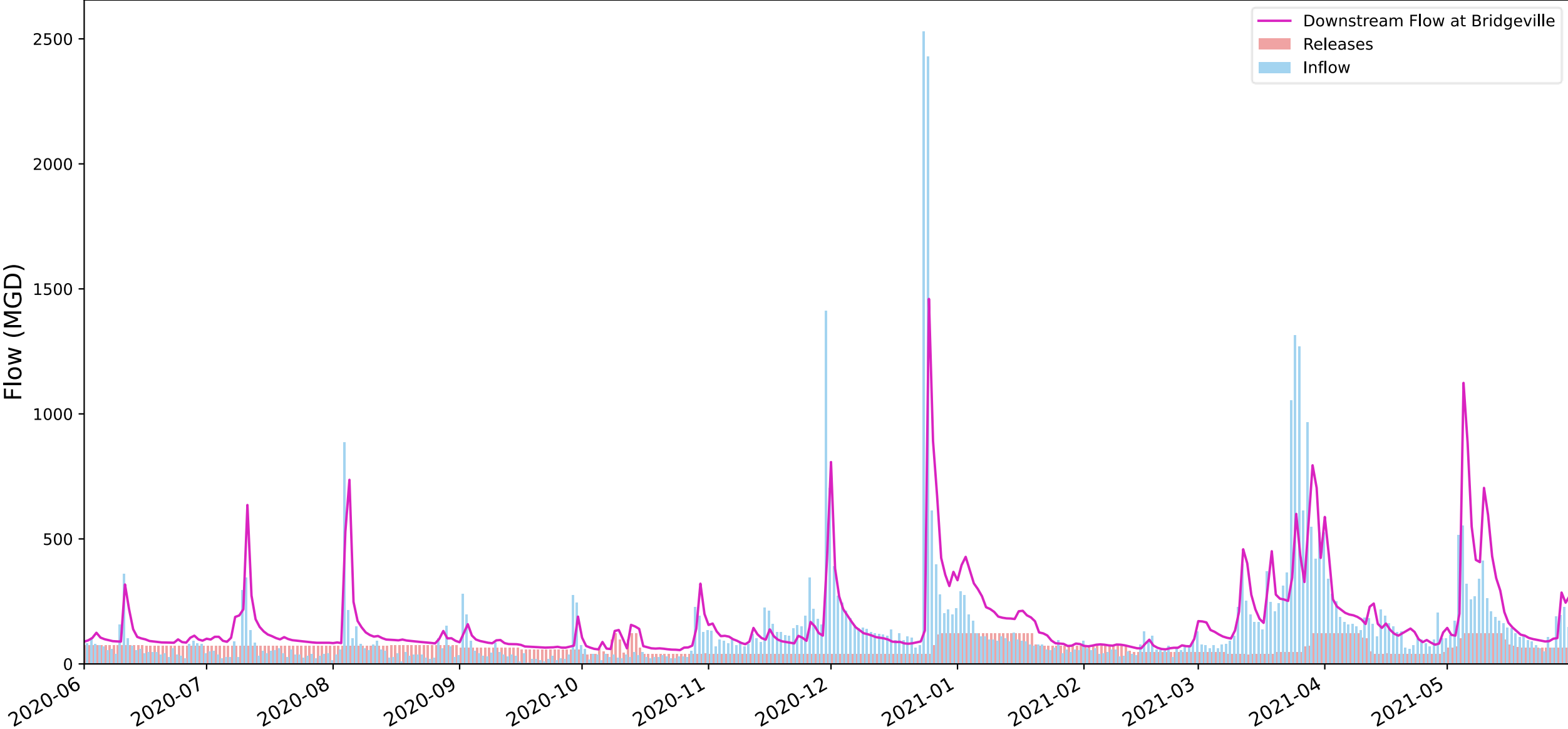


# Pepacton Inflow, Releases, and Downstream Flow



Data Source: USGS

# Neversink Inflow, Releases, and Downstream Flow



Data Source: USGS



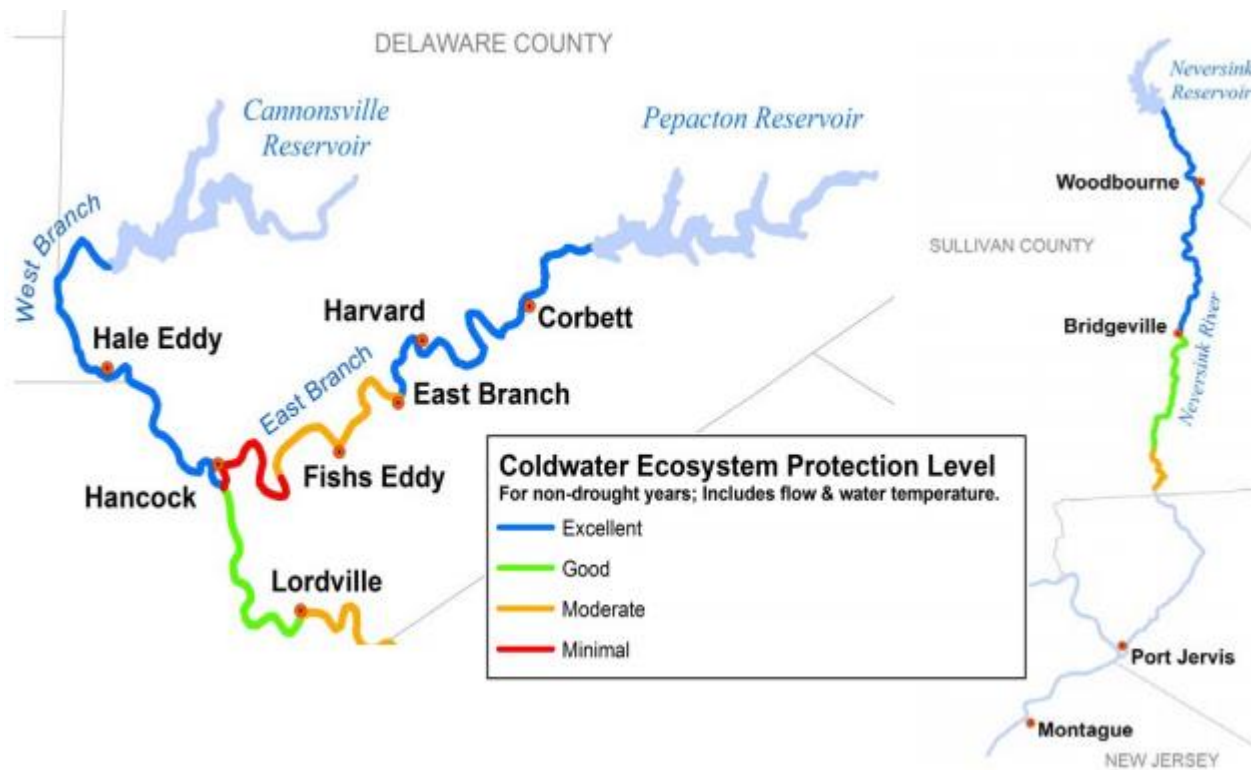
# Bank Use

<b>FFMP 2017 Bank</b>	<b>Used</b>	<b>Size</b>
NJ Diversion Amelioration Bank	0	of 2,545 cfs-days
Rapid Flow Change Mitigation Bank	820	of 1,000 cfs-days
Thermal Mitigation Bank	2330	of 2,500 cfs-days
Trenton Equivalent Flow Objective Bank	0	of 9,423 cfs-days
NJ Diversion Offset Bank	2,300	cfs-days

Thermal Releases were made on 34 days for 8 events in June, July, and early August. 4 rapid flow change events were mitigated in October, and 1 event was mitigated in November.

# Habitat Protection

(Temperature)



## Goals for Excellent Habitat:

- \* Summer Temperature typical less than 20 °C
- \* Rare Exceedances of > 24 °C

# Temperature

## Goals for Excellent Habitat:

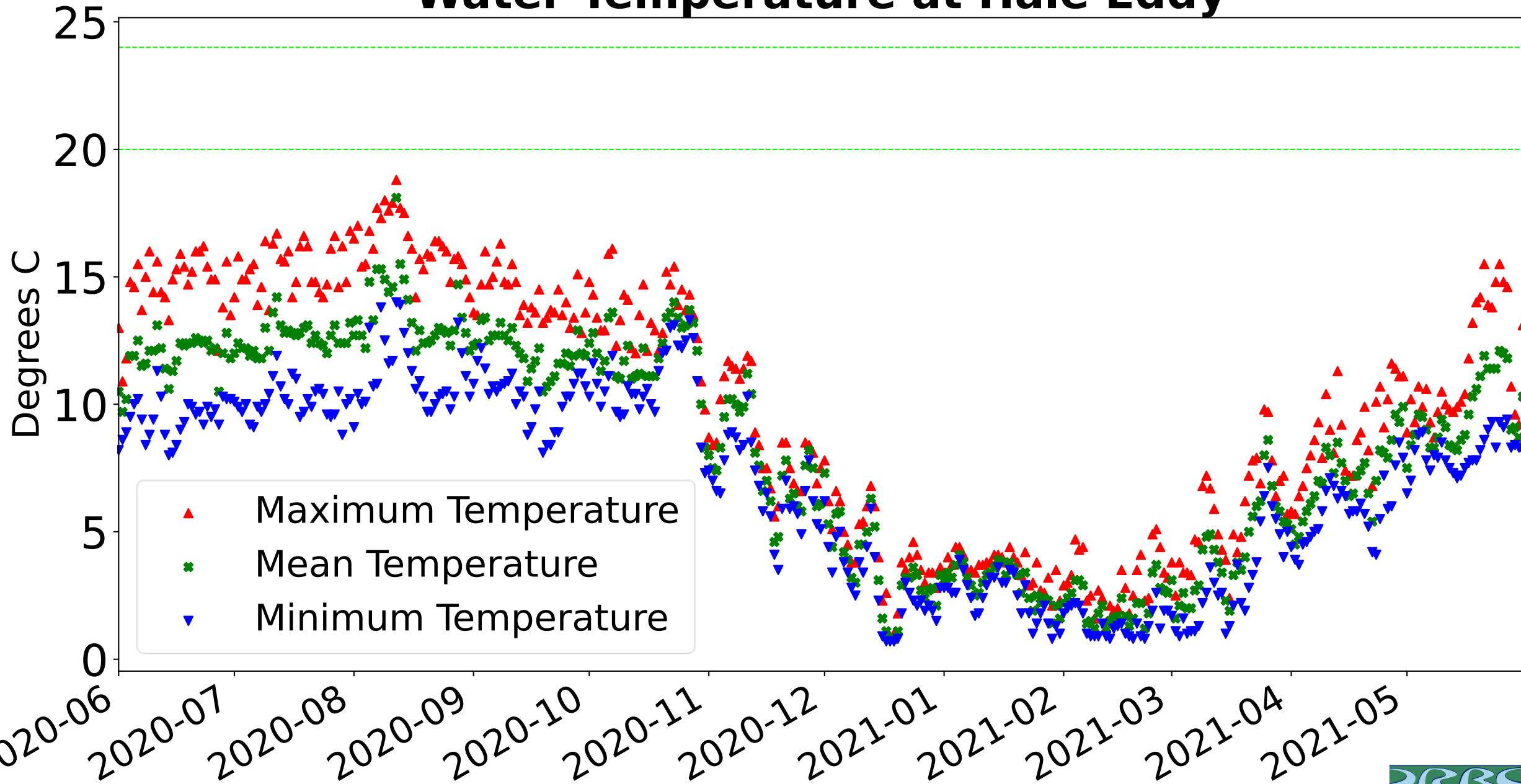
- \* Summer Temperature typical less than 20°C
- \* Rare Exceedances of > 24°C

Location	Exceedances of 24°C		Exceedances of 20°C	
	Days the Maximum Temperature was above 24°C	Days the Average Temperature was above 24°C	Days the Maximum Temperature was above 20°C	Days the Average Temperature was above 20°C
Hale Eddy	0	0	0	0
Harvard	0	0	37	0
Hancock	0	0	3	0
Lordville	8	0	87	61
Bridgeville	2	0	69	16

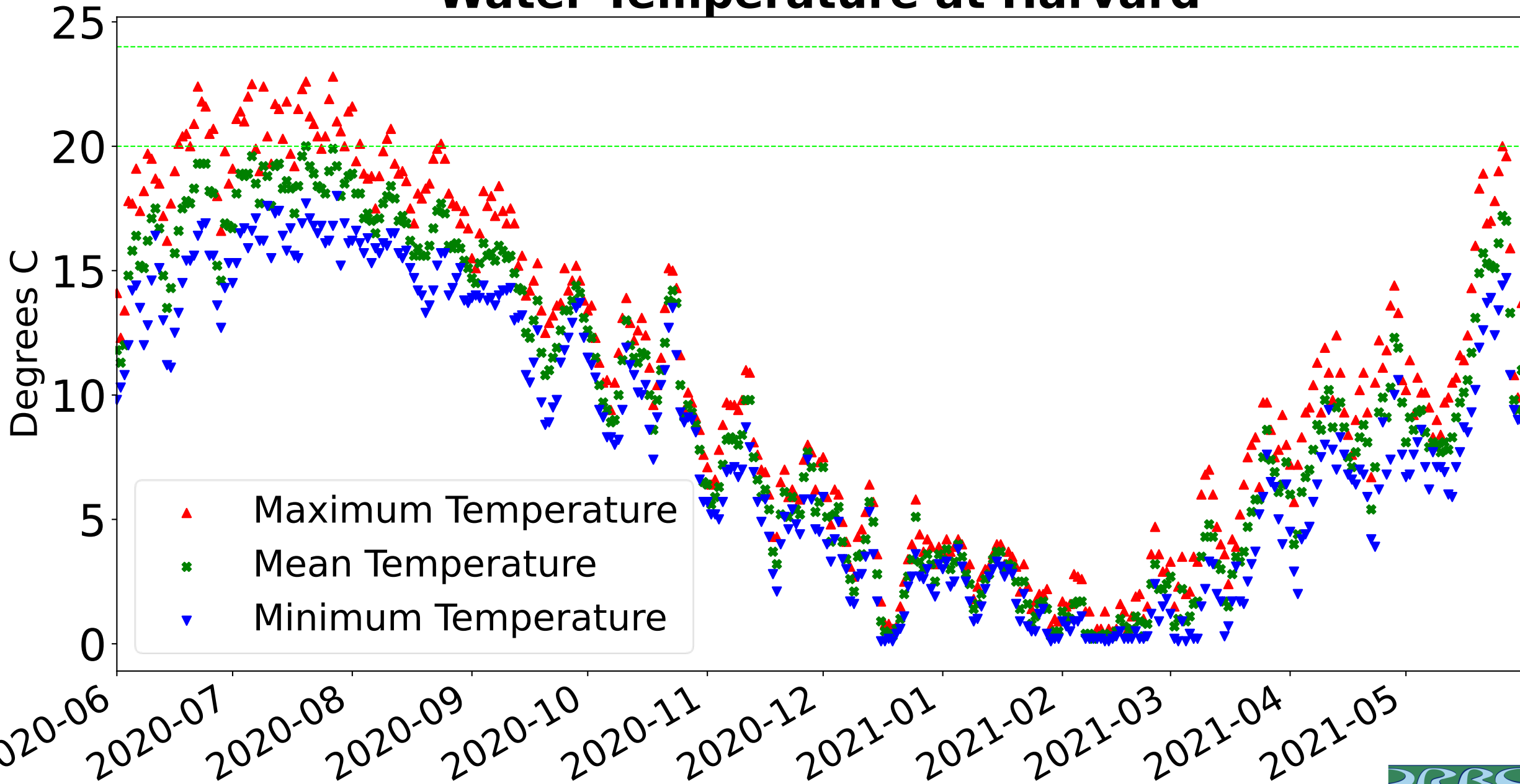
Thermal Releases were made on 34 days for 8 events in June, July, and early August. Approximately 1.5 BG was used from the bank.



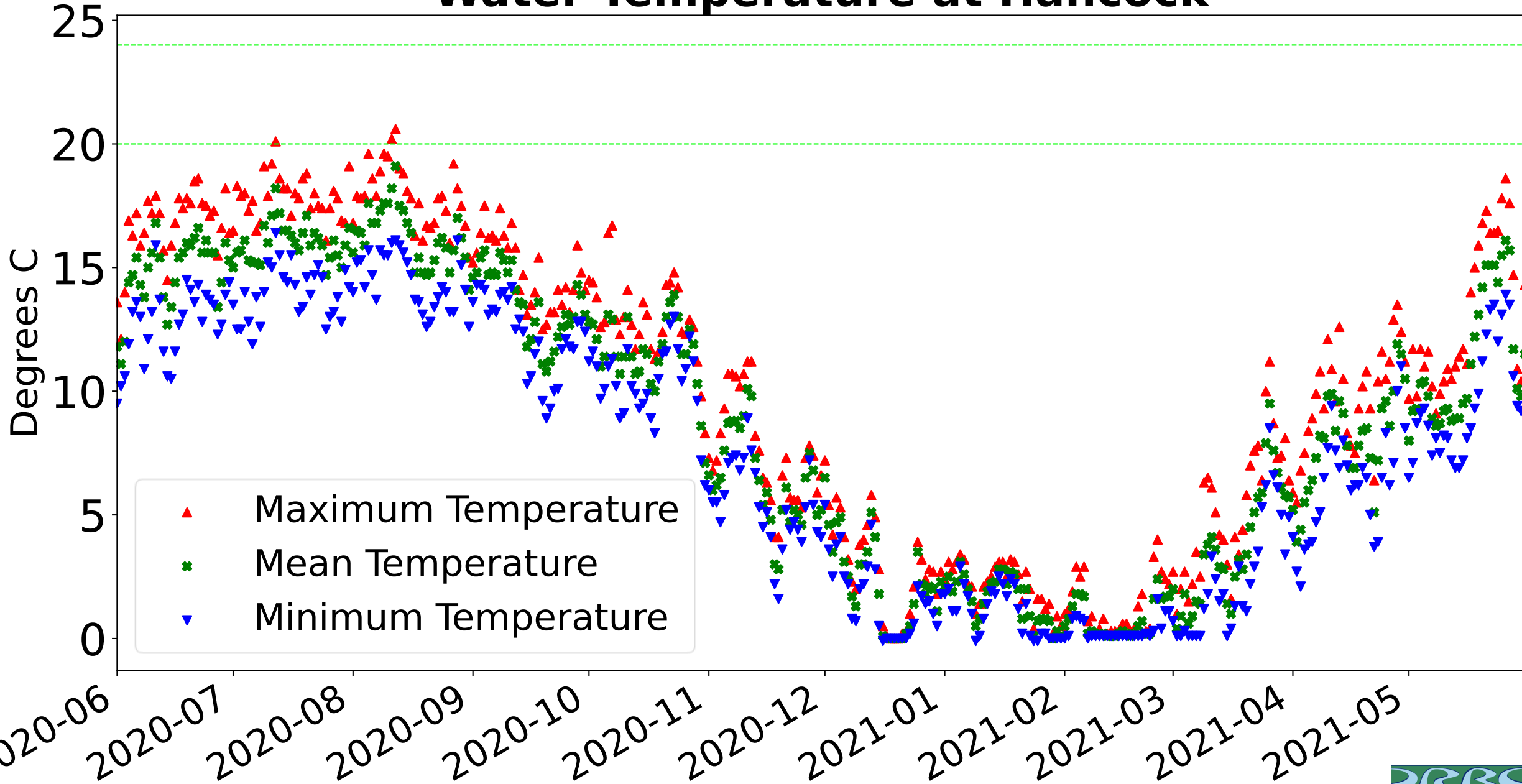
# Water Temperature at Hale Eddy



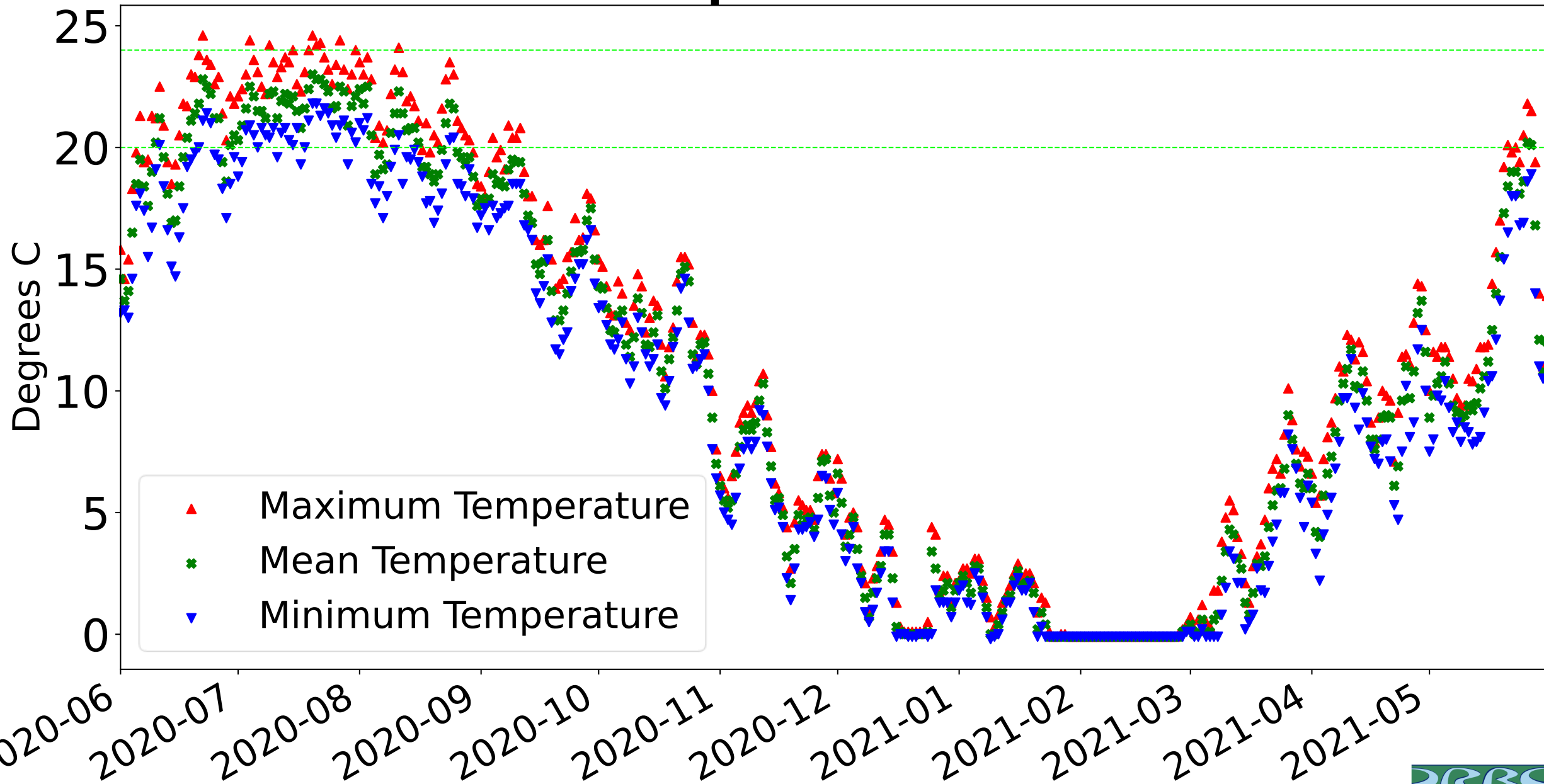
# Water Temperature at Harvard



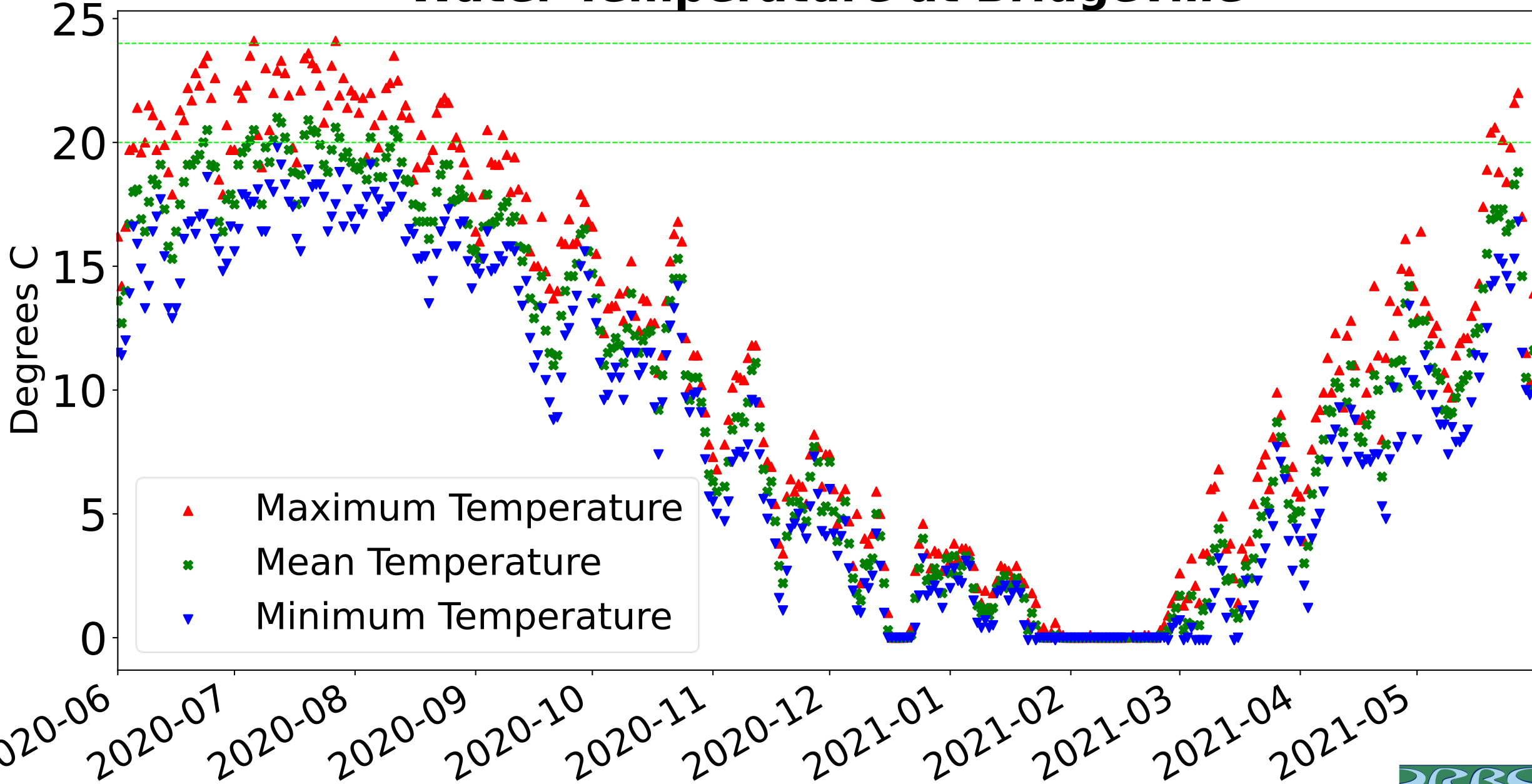
# Water Temperature at Hancock



# Water Temperature at Lordville



# Water Temperature at Bridgeville



# Temperature Rankings

June - August

PERIOD	VALUE	1901-2000 MEAN	ANOMALY	RANK (1895-2020)	WARMEST/COOLEST SINCE	RECORD
<u>Jul-20</u>	76.2°F	70.8°F	5.4°F	126th Coolest	<u>Coolest since: 2019</u>	<u>1895</u>
1-Month	(24.6°C)	(21.6°C)	(3.0°C)	1st Warmest	Warmest to Date	2020
<u>Jun-Jul 2020</u>	72.6°F	68.4°F	4.2°F	126th Coolest	<u>Coolest since: 2019</u>	<u>1903</u>
2-Month	(22.6°C)	(20.2°C)	(2.4°C)	1st Warmest	Warmest to Date	2020

Orange County, NY

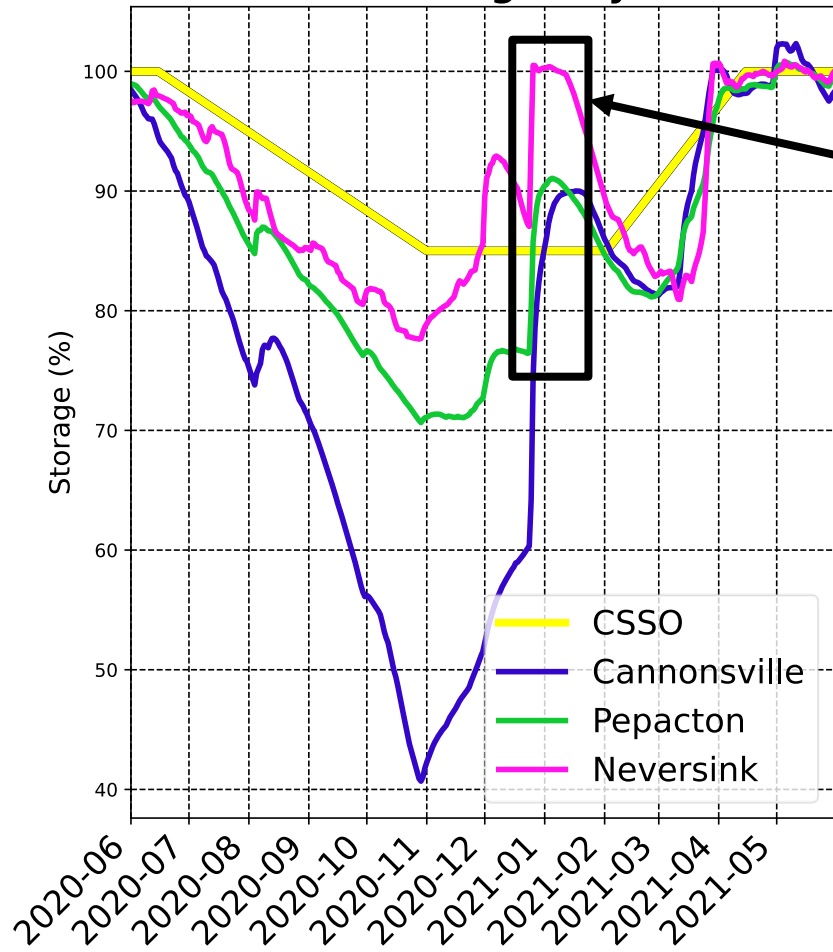
PERIOD	VALUE	1901-2000 MEAN	ANOMALY	RANK (1895-2020)	WARMEST/COOLEST SINCE	RECORD
<u>Jul-Aug 2020</u>	78.8°F	74.6°F	4.2°F	125th Coolest	<u>Coolest since: 2019</u>	<u>1927</u>
2-Month	(26.0°C)	(23.7°C)	(2.3°C)	2nd Warmest	<u>Warmest since: 2018</u>	<u>2016</u>
<u>Jun-Aug 2020</u>	76.9°F	73.2°F	3.7°F	124th Coolest	<u>Coolest since: 2019</u>	<u>1927</u>
3-Month	(24.9°C)	(22.9°C)	(2.0°C)	3rd Warmest	<u>Warmest since: 2016</u>	<u>2010</u>

Philadelphia County, PA



# Discharge Spill Mitigation

**Usable Storage and Conditional Season Storage Objective**



December 25 – Rain/Snowmelt event

	Spill Volume (MG)	Days
<b>Cannonsville</b>	9,436	28
<b>Pepacton</b>	4,957	17
<b>Neversink</b>	4,720	39

	CSSO Releases (MG) L1-a + L1-b	Number of days above CSSO (L1-a or L1-b)	All L1* Discharge Mitigation Releases (MG)
<b>Cannonsville</b>	32,550	65	39,321
<b>Pepacton</b>	13,645	62	17,290
<b>Neversink</b>	7,875	77	9,889

\* L1 releases include L1-a, L1-b, and L1-c

# Summary

- \* Warm water temperatures in June and July required use of the thermal mitigation bank on 34 separate days.
- \* The maximum water temperature exceeded 24°C on 8 days at Lordville and 2 days at Bridgeville.
- \* Dry conditions during September and October required releases of approximately 21.5 BG to meet the Montague Flow Objective.
- \* The conservation releases were based on Table 4G for 84 percent of the year.
- \* The three NYC reservoirs were below the CSSO for most of the time between June 2020 and December 2020. For most of 2021, the reservoirs have been above or near the CSSO.



# Methodology

- \* Slide 7: Amount of water released for flow objectives is calculated by summing the NYC WSCC spreadsheet directed release column for each reservoir. Since directed releases include thermal releases (which is water not released for meeting Montague specifically), this amount of water is removed from the releases for Montague.
- \* Slide 10: Diversions
  - \* NJ Diversion is calculated using the daily discharge observations from the USGS Port Mercer gage, 01460440. The averages are of the daily discharge for each month and the average of the daily discharge for the entire year (release year 6/1-5/31).
  - \* NYC diversion is determined from the WSCC data spreadsheet (column E, daily total). The averages are of the daily discharge for each month and the average of the daily discharge for the entire year (release year 6/1-5/31).
- \* Slide 11: Conservation release volume: the sum of the conservation released based on the zone (L1, L1-a, L1-b, L1-c, L2) and FFMP Table (4F, 4G). It should be noted that more water may have been released for Montague. For example, if no releases were required for Montague, this is the amount of water that would have been released with minor differences related to transitions among tables and zones.
- \* Slide 14: Conservation releases, same as slide 11 but displayed as a graph.
- \* Slide 15: Plot and table of the number of days in each FFMP table from the NYC WSCC end-of-month reports, column AA.
- \* Slide 19: Bank Use: was obtained from the accumulated Daily River Master Data, dated June 1, 2020.
- \* Slide 28: CSSO: When Combined NYC storage is above L1, water is released from each reservoir in accordance with Figure 2 and Tables 4A – 4G of the FFMP Appendix A. Releases to maintain the CSSO occur when the individual storage of a reservoir is in zone L1-a or L1-b. Number of days above CSSO refers to total days when reservoir is in L1-a or L1-b. L1 Discharge Mitigation occurs when the reservoir is in zone L1-a, L1-b, or L1-c



# Presentation Available On DRBC's Website

[https://www.nj.gov/drbc/programs/flow/FFMP\\_PerformanceRpts.html](https://www.nj.gov/drbc/programs/flow/FFMP_PerformanceRpts.html)