Delaware River Basin Commission

The Flexible Flow Management Program: Effects on the Delaware River Basin



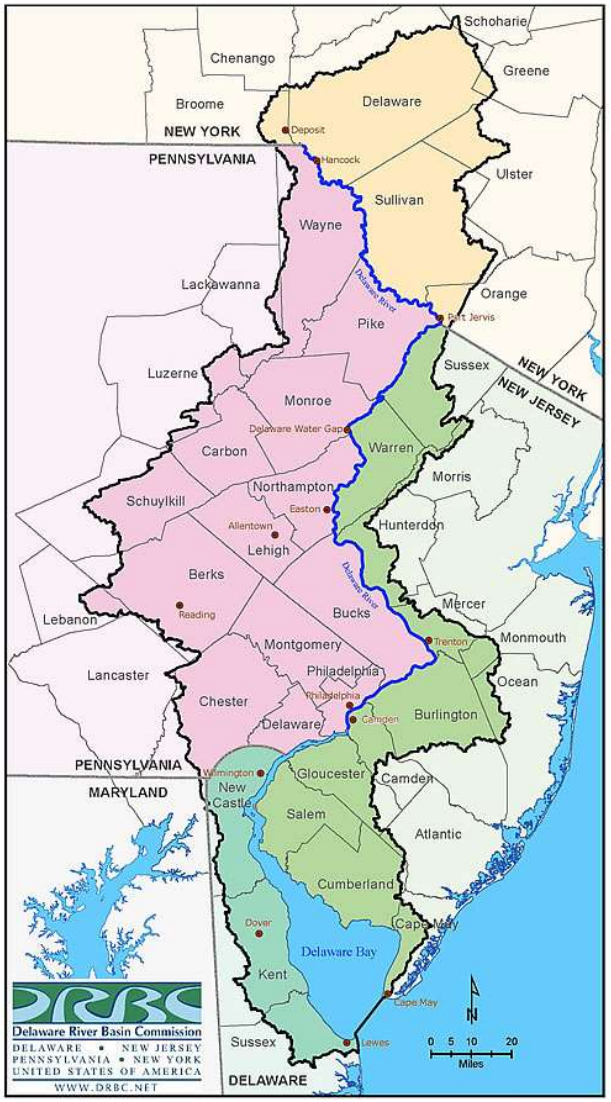


Amy L. Shallcross, P.E.
Manager, Water Resource Operations

CDRW Webinar
May 10, 2023

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

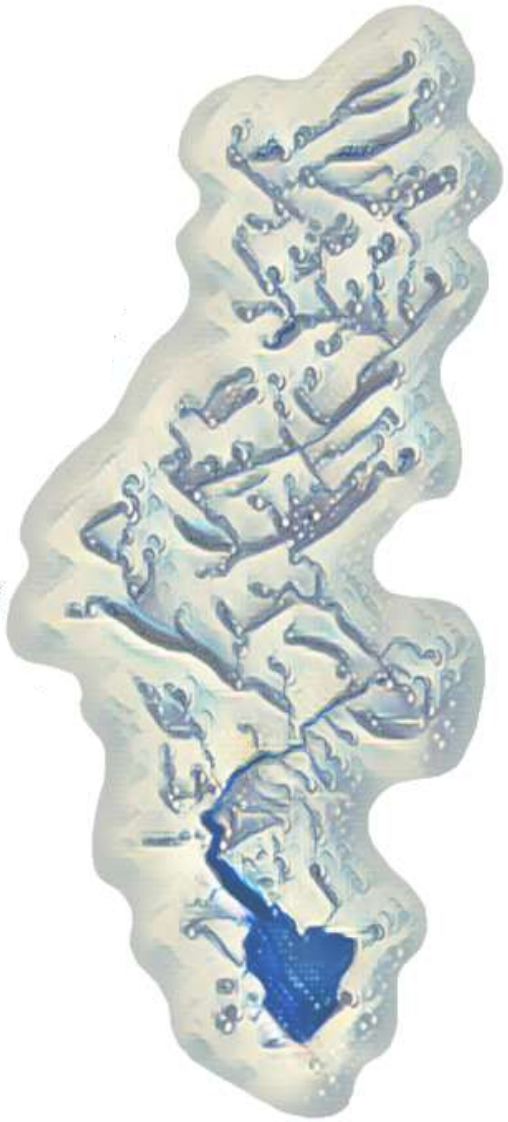
The presentation, as given, contained animation. Some slides were simplified for posting.



The Setting

- Delaware River Main stem 330 miles long
- Forms an interstate boundary along its entire length
- Drains 13,539 square miles of watershed in 4 states
- 14.2 million people (approximately 5% of the U.S. population) rely on the waters of the Delaware River Basin
- 150 miles designated by Congress as “Wild and Scenic” – remarkable scenic, recreational, geologic, fish, wildlife, historical and cultural values

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA



Today's Webinar

* Evolution of goals and resources of the river for different purposes
* Management of the river to meet those purposes
* Background on the Flexible Flow Management Program (FFMP) and how it works
* Locations in the river where the FFMP matters
* Your role in the FFMP and river management

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

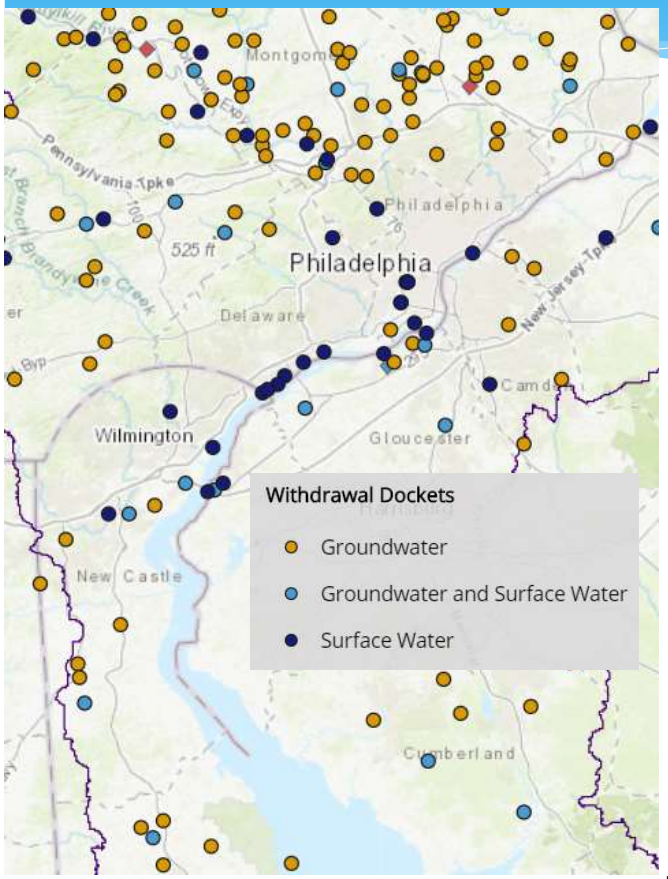
Competing Goals for Basin Waters and Storage

* **Goals**
  * Recreation
  * Flood Risk/Damage Reduction
  * Water Supply - Low flow augmentation, Industry, Manufacturing, Cooling
  * Water Quality – Salinity, Temperature, Dissolved Oxygen, Fish and Wildlife
  * Power Generation – Hydropower, Thermoelectric
* **Resources** (**FINITE**)
  * Nature
  * Storage
  * Direct from river

LIMITED RESOURCES

Water Users

Drinking Water Providers – Manufacturing – Refining – Energy Production



https://www.nj.gov/drbc/basin/map/interactive-map.html

Phila.gov

Suk

http://wikimapia.org/21274124/Kimberly-Clark-Inc-Chester-Papermill#/photo/1905408

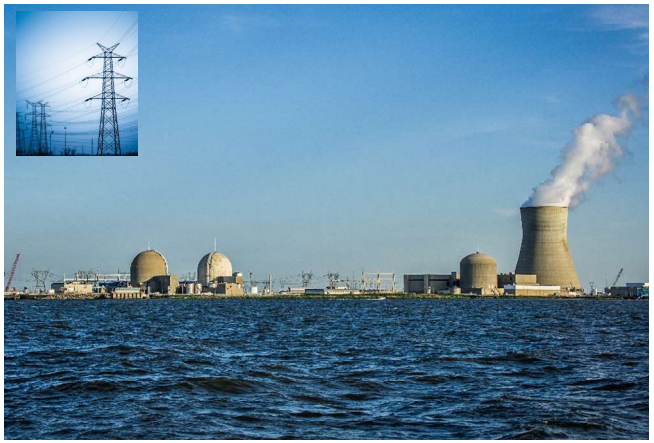
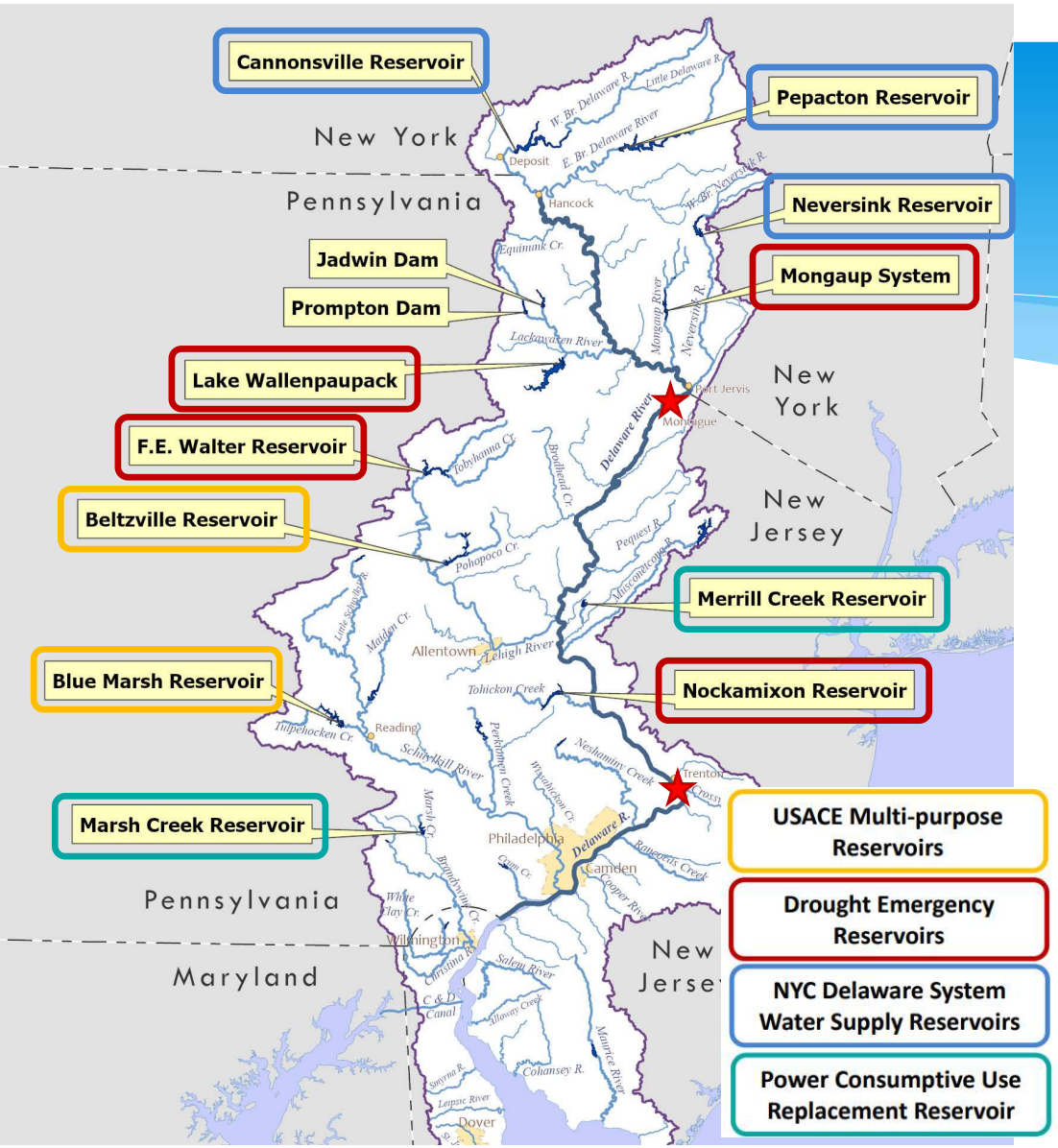


Photo: Peretz Partensky, https://www.flickr.com/photos/ifl/7238282472/in/album-72157629823114004/; unedited



Meeting Goals

- Mother Nature (precipitation)
- Storage (different types for different purposes)
- Minimum flow requirements (a.k.a. flow objectives)
- Drought Management Programs
- Permitting programs
  - Water Use
  - Water Quality

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Water Management Schematic for the Delaware River Basin

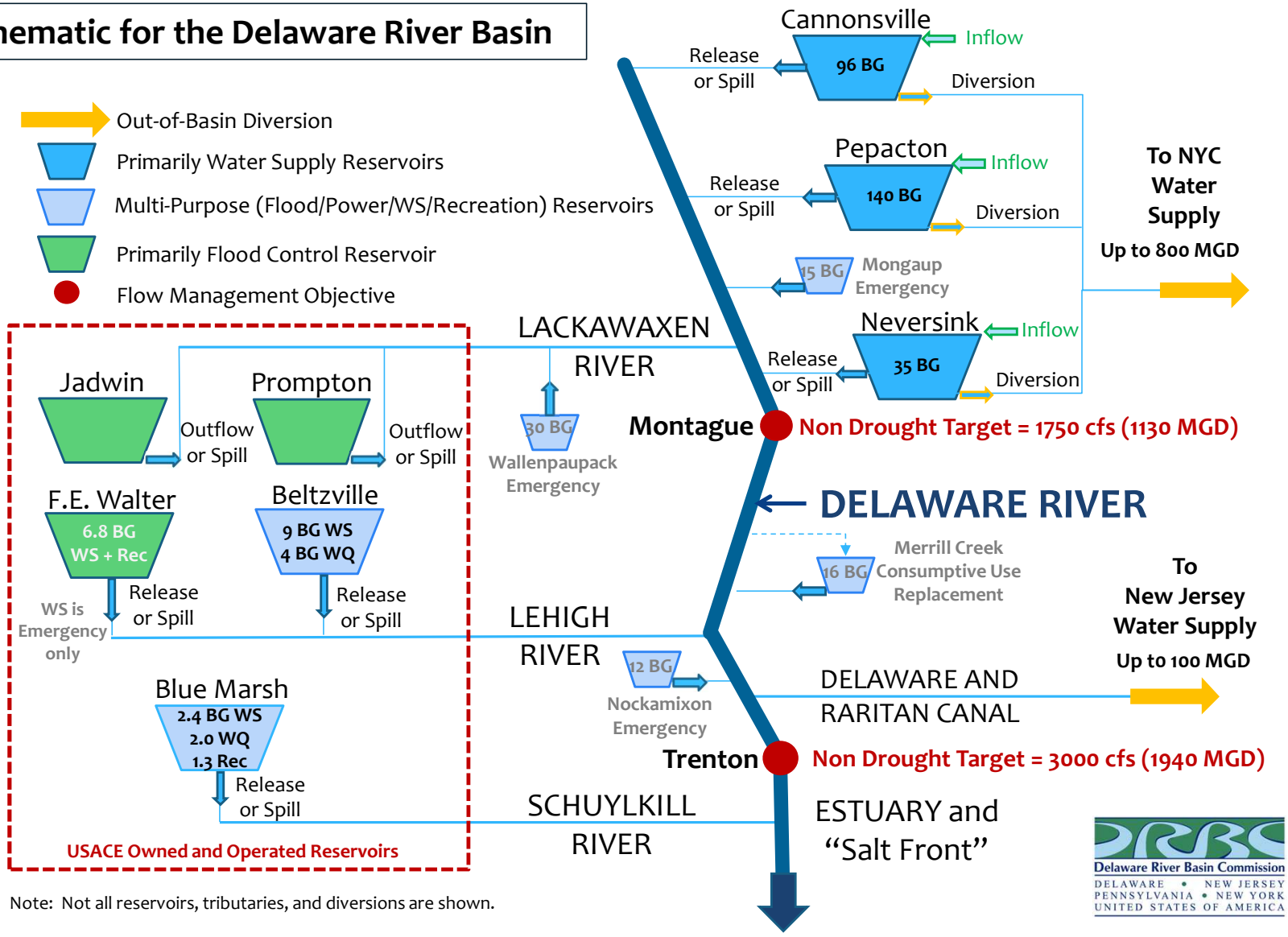
How everything came together:

1834 Canal
1927/29 Hydropower
- Mongaup
- Wallenpaupack

1931 Supreme Court Decree
1945 Delaware Aqueduct
1950s Canal for Water Supply
1954 Neversink
1954 Supreme Court Decree
- Montague Flow Objective
- Diversion Limits NYC/NJ

1955 Pepacton
1955 Hurricane Diane
1958 Nockamixon
1960s Drought
1960 Prompton and Jadwin
1961 FE Walter
1964 Cannonsville
1972 Beltzville
1977 Experimental Fisheries
1978 Blue Marsh
1983 Good Faith Agreement
- Trenton Flow Objective
- Phased Reductions

1988 Merrill Creek
2007 Flexible Flow Mgmt Program



Note: Not all reservoirs, tributaries, and diversions are shown.

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Water Management Development

* D&R Canal constructed to bring goods from New York to Philadelphia in 1834. Purchased by railroad and abandoned for transportation.
* NYC anticipated large population growth and looked west for water supplies (1905). Catskill System completed in 1915.
* Demands for electricity resulted in the development of two hydropower facilities (the Mongaup System - 1927 and Lake Wallenpaupack - 1929)
* Also in 1927, NYC Board of Water Supply approves construction of Neversink and Pepacton

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Delaware Diversion Case -1931

* New Jersey sued New York City and New York State
* NJ claims - impacted by reservoirs (Neversink, Pepacton)
* Concerns:
  * Violation of riparian rights
  * Sanitary effects
  * Municipal water supply
  * Obstruction to navigability
  * Industrial use affects
  * Water power rights
  * Increasing salinity
  * Shad fisheries/oysters
  * Farming
  * Recreation

Conclusion of Special Master: viewed in whole – NJ is impacted

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Delaware Diversion Case -1931 Decree

* NYC responded it would provide benefits:
  * diverting flood and waste waters
  * releasing 275 cfs from the storage in July, August, September and October and on other dry days.
  * **Rejected**
* Court responded with 1931 Decree:
  * Riparian Law applied – no prior appropriation
  * Port Jervis (1535 cfs) and Trenton (3400 cfs) Flow Objectives
  * Limitation on amount required to be released
  * NYC treatment of Port Jervis wastewater
  * NYC Diversion limited to 440 mgd
  * NJ and PA inspections

Shortly thereafter, NYC proposed the development of Cannonsville Reservoir …

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

1954 Supreme Court Decree

* NJ claimed same impacts from Cannonsville
* Court Responded:
  * Riparian Law applied – no prior appropriation
  * Montague Flow Objectives (1750 cfs) – note **NOT for Trenton**
  * NYC treatment of Port Jervis wastewater
  * NYC Diversion limited to 800 mgd when PCN completed
  * NYC to release water not needed (constrained)
  * NJ Diversion limited to 100 mgd
  * Established River Master
  * Inspections of facilities by NJ, PA, DE

Again

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Flooding

1955 Flood: Hurricane Diane

Still the worst flood on record in many locations

* Devastating flooding early in the 1902, 1903, 1904
* Federal government planned flood control reservoirs in the Lackawaxen, Lehigh, and Schuylkill Watersheds
* Prompton, Jadwin, FE Walter (1950s)
* Beltzville, Blue Marsh (1970s)

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Delaware River Basin Commission

FOUR STATES SIGN DELAWARE PACT

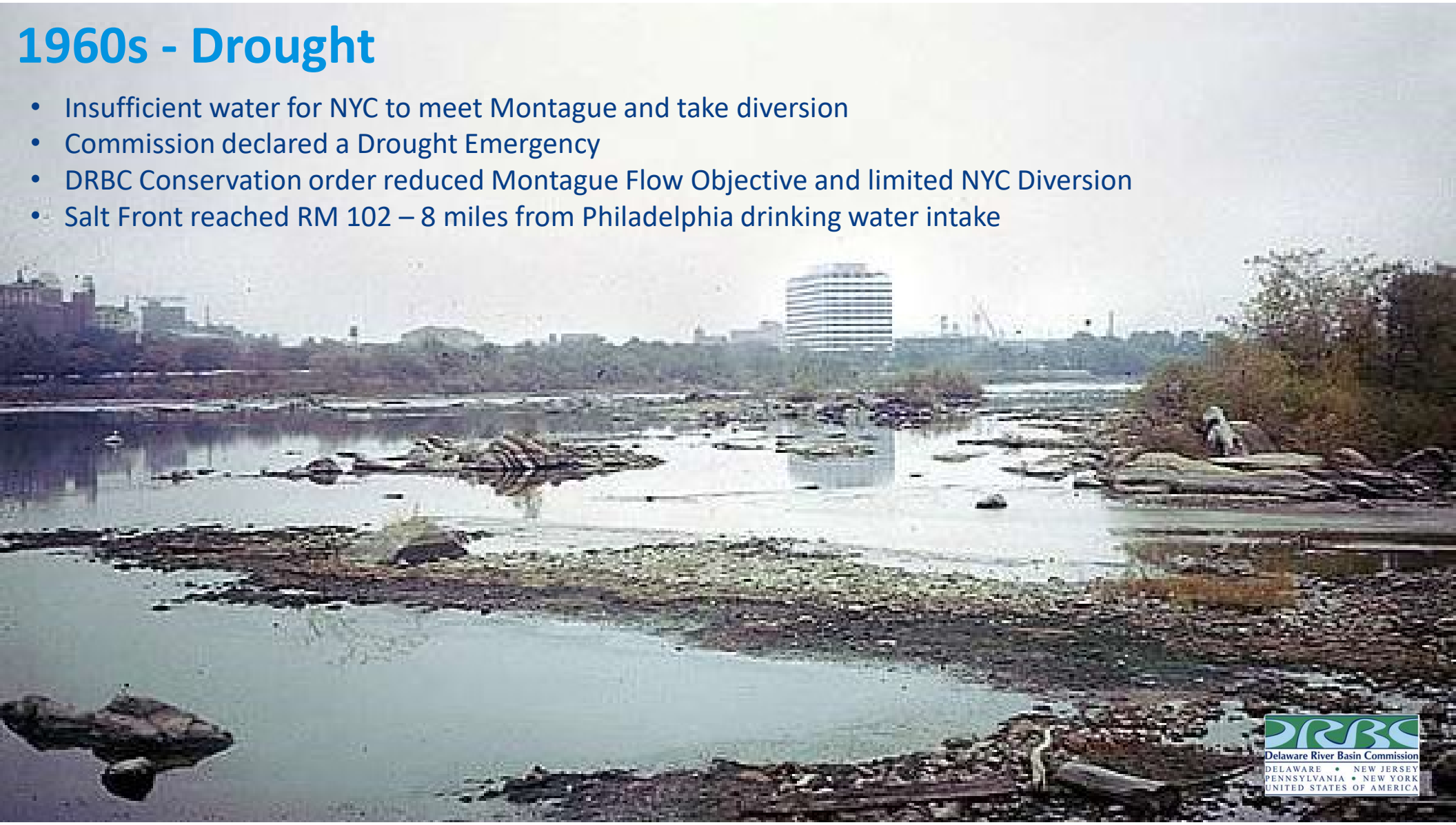
President Joins in Approving Vast Program for Basin Backed by Governors

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

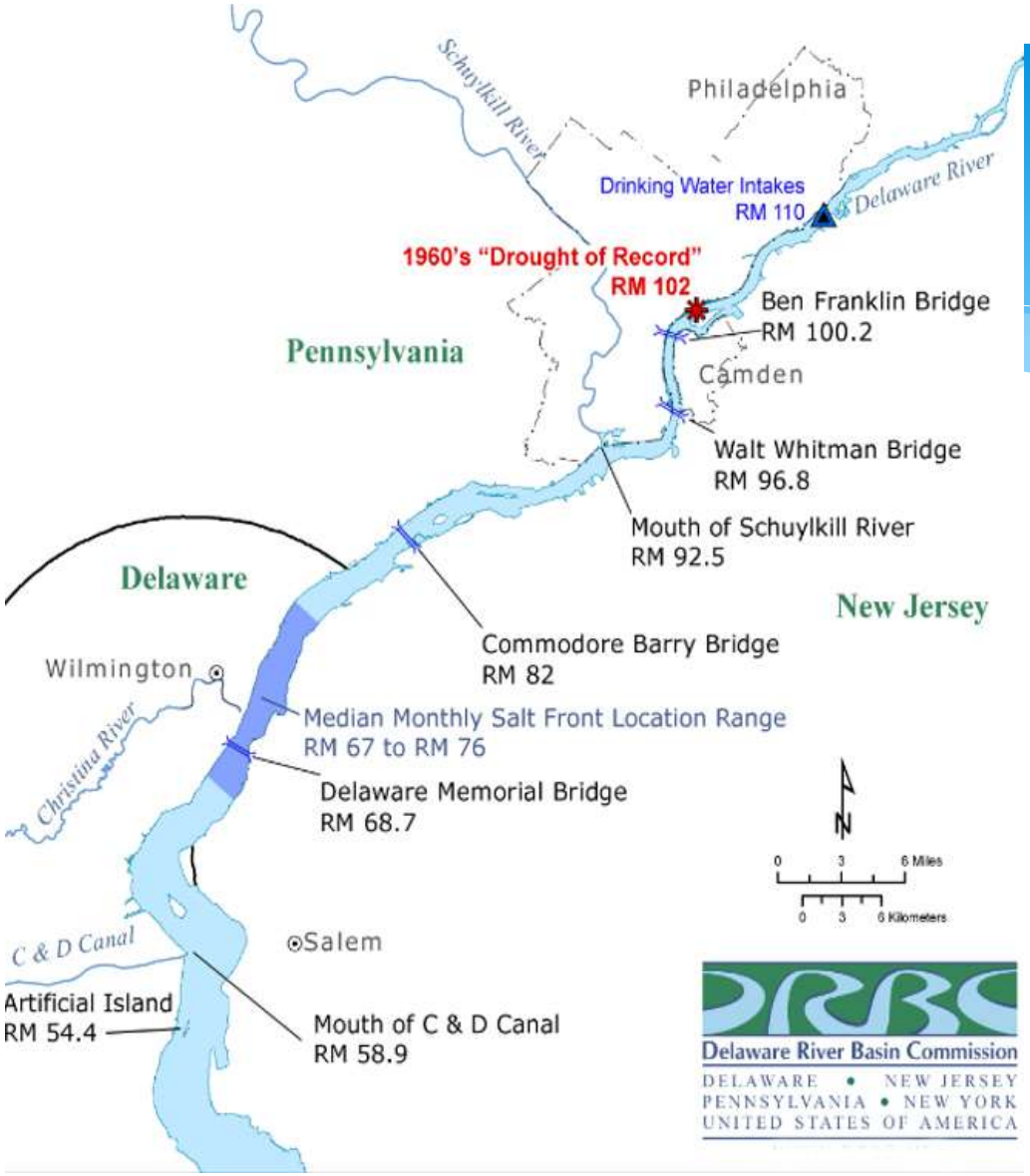
* Established by Compact by DE, NJ, NYS, PA, **U.S.A.** in 1961 to address:
  * Water supply shortages – venue for cooperation
  * Devastating flooding
  * Severe pollution in the main stem and tributaries
* Required to cooperate and collaborate with States and Federal Agencies
* Only four of the five "Decree Parties" (DE, NJ, NYS, PA, **NYC**) Authorized to change provisions of the 1954 Supreme Court Decree only **WITH** the unanimous consent of the parties

1960s - Drought

- Insufficient water for NYC to meet Montague and take diversion
- Commission declared a Drought Emergency
- DRBC Conservation order reduced Montague Flow Objective and limited NYC Diversion
- Salt Front reached RM 102 – 8 miles from Philadelphia drinking water intake



Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA



Salt Front

monitoring salinity to protect water users

* Where salt water from the ocean meets fresh water from the land
* 250 mg/l isochlor
* 7-day average for reservoir operations
* Concerns
  * Corrosion
  * Drinking Water - taste and odor
  * Health effects
  * Manufacturing processes

Good Faith Agreement

drought management – conservation – storage - fisheries

* Commission directs Decree Parties and staff: *develop a plan to manage **drought** and other issues*
* *Coordinated through DRBC Advisory Committee* - Regulated Flow Advisory Committee (formerly FMTAC)
* Informed by Level B and other studies (comprehensive basin plan)
* **Established Drought Management Plans** DRBC Rulemaking
* Recommendations for reservoir modifications and construction

DELAWARE RIVER BASIN WATER CODE
18 CFR Part 410

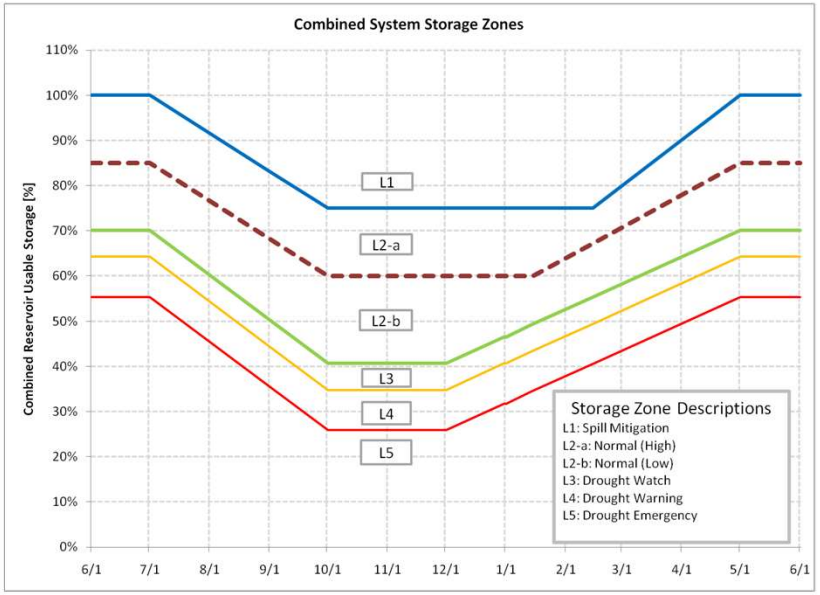
Flow Objective at Trenton (head of tide)
Phased Flow Objectives and Diversions
Reservoir Storage / Flow Augmentation
Regulation of Consumptive Uses
Water Conservation
1960s drought as the planning standard

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Drought Management for the DRB

Figure 1

Drought Zones based on NYC Combined Storage



Delaware Basin Flow Objectives

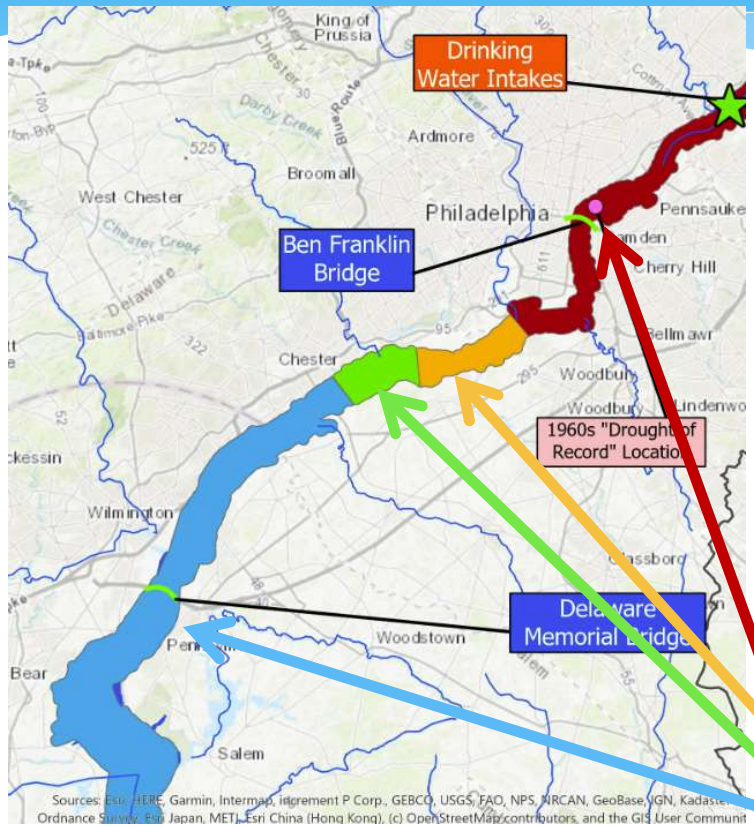
	Montague	Trenton
NYC Storage Condition	(cfs)	(cfs)
Normal (L1, L2)	1,750	3,000
Drought Watch (L3)	1,650	2,700
Drought Warning (L4)	1,550	2,700
Drought Emergency (L5)	1,100-1,650*	2,500-2,900*
Severe Drought (to be negotiated depending upon conditions)		
* Varies with time of year and location of salt front		

7-day average location of Salt Front	Flow Objectives During Drought Emergencies					
	Montague, NJ			Trenton, NJ (Gage+Blue Marsh Releases)		
River Mile	Dec-Apr.	May-Aug.	Sept-Nov.	Dec-Apr.	May-Aug.	Sept-Nov.
Upstream of R.M. 92.5	1,600	1,650	1,650	2,700	2,900	2,900
Between R.M. 87.0 and R.M. 92.5	1,350	1,600	1,500	2,700	2,700	2,700
Between R.M. 82.9 and R.M. 87.0	1,350	1,600	1,500	2,500	2,500	2,500
Downstream of R.M. 82.9	1,100	1,100	1,100	2,500	2,500	2,500

PHASED REDUCTIONS
In NJ/NYC Exports

Drought Status	Diversions NYC	NJ
Normal	800	100
Watch	680	100
Warning	560	90
Emergency	520	80

Trenton Flow Objective During Drought Emergency



Phased Reductions in the Trenton Flow Objective

NYC storage condition	NYC Div. Mgd	NJ Div. mgd	Montague flow objective cfs	Trenton flow objective cfs
Normal	800	100	1,750	3,000
Upper Half-Drought Warning	680	85	1,655	2,700
Lower Half-Drought Warning	560	70	1,550	2,700
Drought	520	65	1,100-1,650*	2,500-2,900*
Severe Drought (to be negotiated based on conditions)				
* Varies with time of year and location of salt front as shown in Table 2.				

Flow Objective During Drought Emergencies

7-day average location of Salt Front	Trenton Drought Emergency Flow Objective (cfs)		
River Mile	Dec-Apr.	May-Aug.	Sept-Nov.
Upstream of R.M. 92.5	2,700	2,900	2,900
Between R.M. 87.0 and R.M. 92.5	2,700	2,700	2,700
Between R.M. 82.9 and R.M. 87.0	2,500	2,500	2,500
Downstream of R.M. 82.9	2,500	2,500	2,500

The location of the salt front determines the flow objective at Trenton during Basinwide Drought Emergency and **ANY** Lower Basin Drought Condition

Reservoir Releases

(a.k.a. Conservation Releases for Habitat Protection)

* **Minuscule** in the beginning – 5 cfs
* D77-20 CP and Major Revisions **DRBC Rulemakings**
  * Revision 1 – default program
  * Revision 4
  * Revision 7
* **Flexible Flow Management Plan**
  * Enhanced releases for fisheries
  * Thermal mitigation
  * Spill mitigation
  * Releases greater than D77-20 CP Rev 1

Experimental Fisheries Programs
Augmented
And drought (base)

Adaptive Management Program
"Converts potentially spilled water into managed water"

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Flexible Flow Management Plan (FFMP)

Conservation Releases and Banks

D77-20-CP Revised

TABLE 1

Reservoir and Operative Dates	Column 1 Basic Conservation Release	+	Column 2 Proposed Augmented Conservation Release	=	Column 3 Total New Conservation Release
Neversink					
4/1 - 4/7	5 cfs		40 cfs		45 cfs
4/8 - 10/31	15		30		45
11/1 - 3/31	5		20		25
Pepacton					
4/1 - 4/7	6		64		70
4/8 - 10/31	19		51		70
11/1 - 3/31	6		44		50
Cannonsville					
4/1 - 4/15	8		37		45
4/16 - 6/14	23		22		45
6/15 - 8/15	23		302		325
8/16 - 10/31	23		22		45
11/1 - 11/30	23		10		33
12/1 - 3/31	8		25		33

23 cfs

325 cfs

BANKS (10 BG):

Normal Only	*Drought Only*
Thermal Mitigation	Thermal Mitigation
Rapid Flow Change	Trenton Flow Objective
Trenton Flow Objective	

FFMP

Schedule of Releases (cfs) during Normal Conditions

Cannonsville / Storage Zone	Summer Jun 1 - 15-Jun	Summer Jun 16 - 30-Jun	Summer Jul 1 - 31-Aug	Fall Sep 1 - 15-Sep	Fall Sep 16 - 30-Sep	Fall Oct 1 - 30-Nov	Winter Dec 1 - 31-Mar	Winter Apr 1 - 15-Apr	Winter Apr 16 - 30-Apr	Spring May 1 - 20-May	Spring May 21 - 31-May
L2	500	500	500	450	400	150	150	350	350	400	450

500 cfs

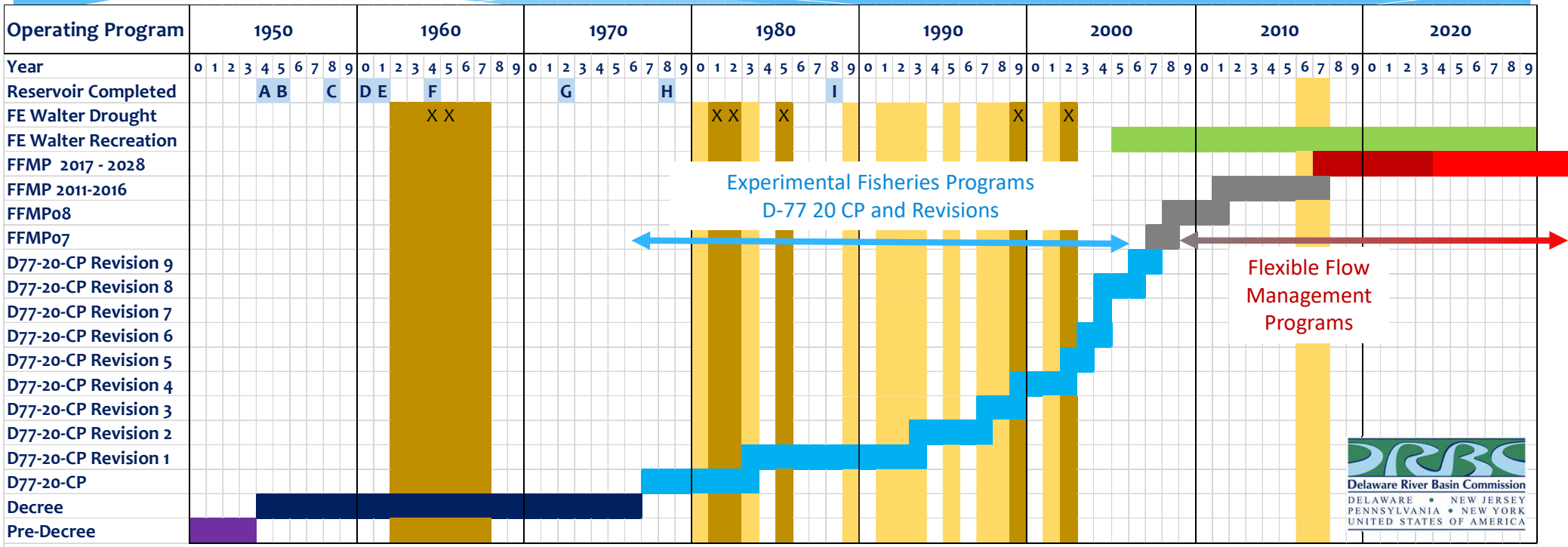
Schedule of Releases (cfs) during Drought Operations

90 cfs

Cannonsville / Storage Zone	Summer Jun 1 - 15-Jun	Summer Jun 16 - 30-Jun	Summer Jul 1 - 31-Aug	Fall Sep 1 - 15-Sep	Fall Sep 16 - 30-Sep	Fall Oct 1 - 30-Nov	Winter Dec 1 - 31-Mar	Winter Apr 1 - 30-Apr	Spring May 1 - 20-May	Spring May 21 - 31-May
L3	135	135	135	85	85	55	55	55	85	85
L4	100	100	100	50	50	50	50	50	60	60
L5	90	90	90	40	40	40	40	40	40	40

Reservoir Operating Programs

Conservation releases – flow objectives – out-of-basin diversions – banks – flood mitigation



X= Reservoir Construction Completed [A=Neversink, B=Pepacton, C=Nockamixon, D=Promtpon and Jadwin, E=FE Walter; F=Cannonsville, G=Belzville, H=Blue Marsh, I=Merrill Creek. Lake Wallenpaupack and the Mongaup System were constructed in the 1920s]; Dates are approximate.

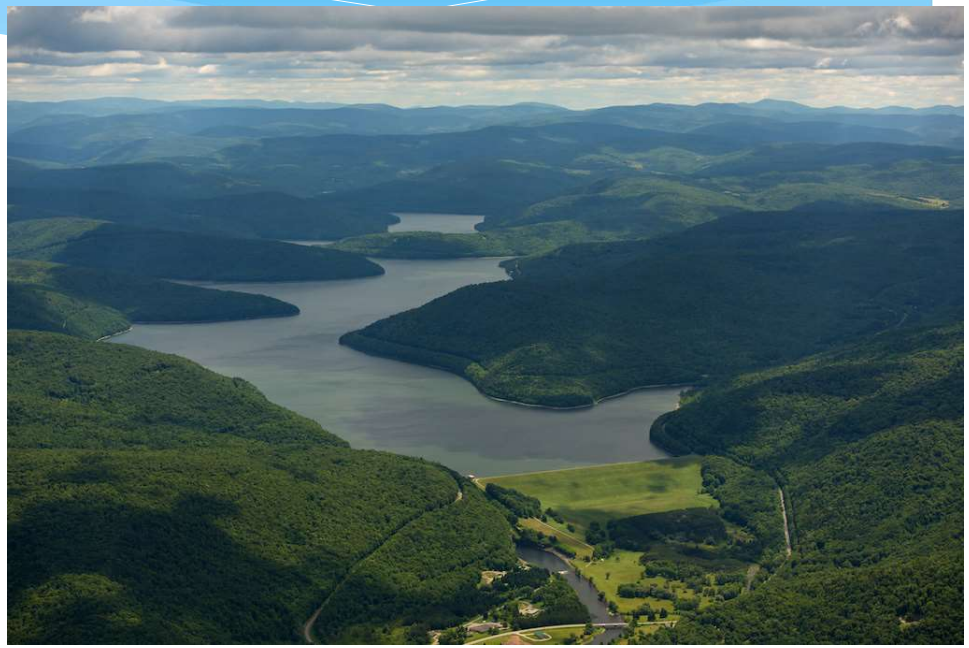
Drought Watch or Warning Drought Emergency X Water Stored in FE Walter for Drought Relief

Release rates have increased significantly over time

Flexible Flow Management Program

adaptive management – based on "forecast available water"

* Protect Water Supplies
* Drought Management (Water Code)
* Habitat Protection Program
  * a.k.a. conservation releases
  * Based on Joint Fisheries White Paper (developed by PAFBC and NYSDEC)
  * Help the cold-water fishery
* Spill Mitigation
* Banks of water for thermal, yo-yo protection, the Trenton Flow Objective and NJ Diversion
* Studies – salinity, storage, water for NJ

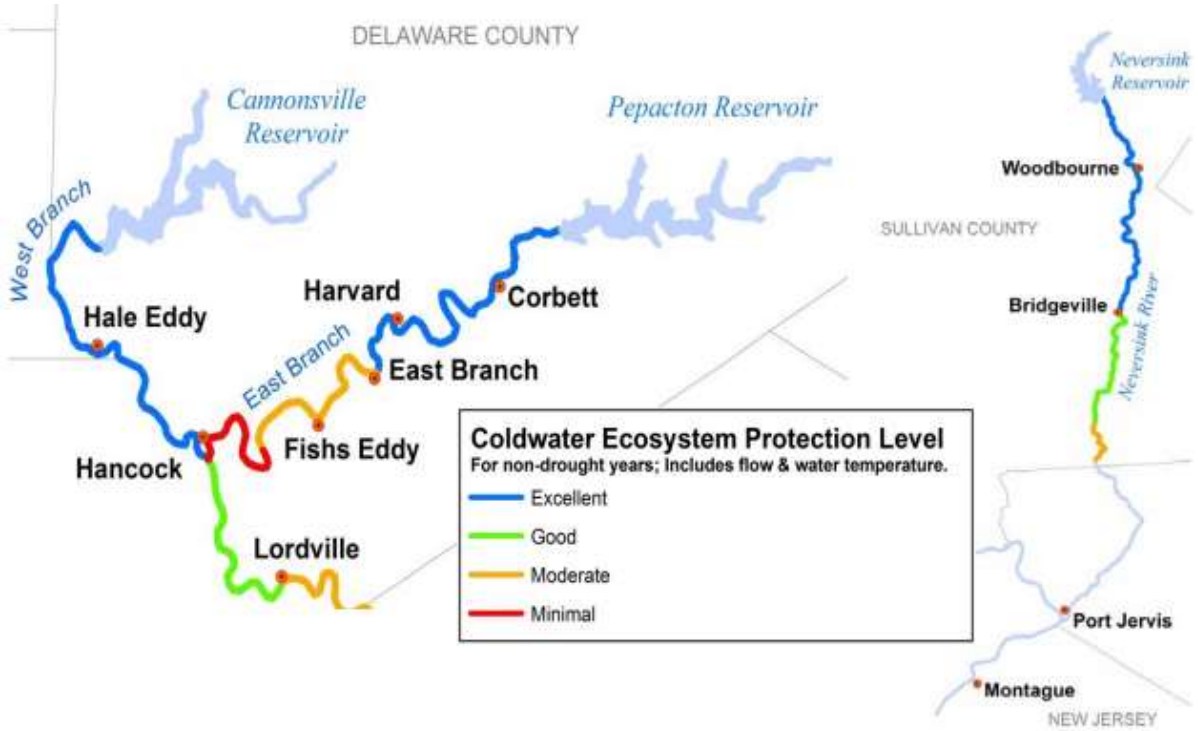


Pepacton Reservoir. Photo courtesy of NYCDEP

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Habitat Protection

(Flow and Temperature)



Goals for Excellent Habitat:

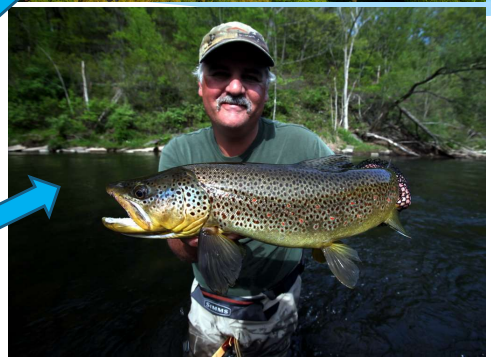
* Summer Temperature typically less than 20°C
* Rare Exceedances greater than 24°C

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

What is “Forecast available water”?

“Forecast Available Water” is an estimated amount of water not needed for water supply, that can be released to protect water habitats in river reaches downstream of the reservoirs and avoid spills.

Water Supply

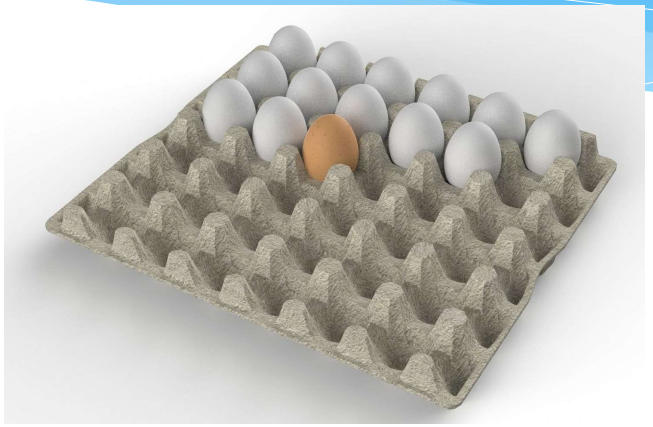


Conservation releases

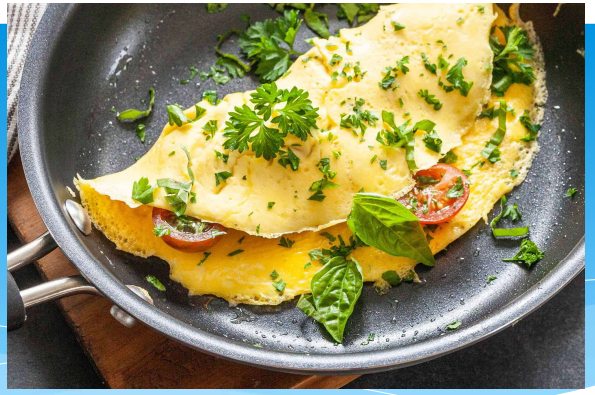
Spilled

An analogy for determining "forecast available water"

Farmers estimate how many eggs their chickens can provide based on their age, productivity, mood, and other factors



I need 3 eggs per day for my omelet and 36 for my brunch party in two weeks



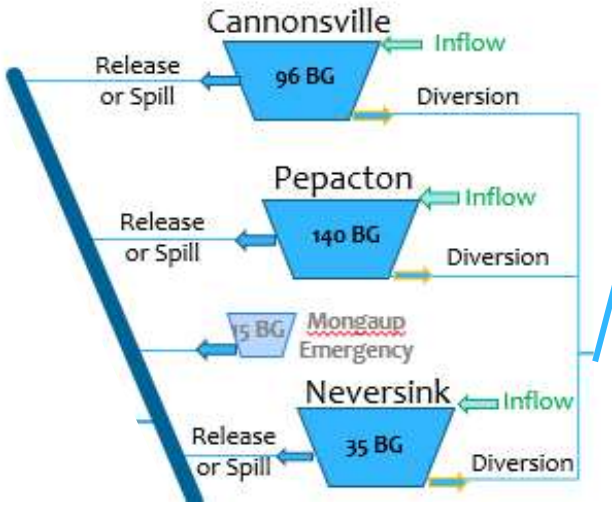
I also want a BIG cupcake every day, but NEED (must have) at least a small one for my sweet tooth

If the farmer gives me too many eggs, I am likely to break them, because I only have so much space to store them, and I can only eat so many omelets and cupcakes.

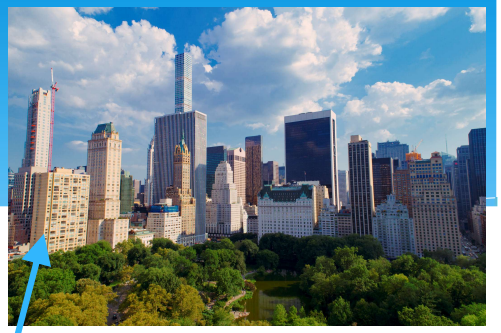
What is “Forecast Available Water?”

NOAA and NWS provide seasonal forecasts of weather, streamflow, and snowmelt to NYCDEP

NYC estimates water demands and uses a sophisticated model to determine an amount water that can be used for releases without impacting water supply (one goal is to be full in May/June prior to increase in water use)



Water Supply



Healthy Habitat

Spills are a waste of water

Banks: Excess Release Quantity (ERQ)

* ERQ was established in the Decree – released over 120 days between 6/15 and 3/15
* ERQ determined as a portion of the difference in the safe yield – maximum demand
* Through DRBC (Water Code) – water can be banked and used for Trenton if agreement
* FFMP pre-determines amount banked and purpose
  * Thermal Mitigation
  * Rapid Flow Change (avoid yo-yo)
  * Trenton Flow Objective
  * NJ Diversion Amelioration (allows NJ to take more during drought)
* All or portion can be reallocated to an extraordinary needs bank (w agreement)

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Spill Mitigation

* Maintain “space” in the reservoirs to delay flood waters
* Even full reservoirs can reduce the impact of flooding
  * Outflow is limited by the capacity of the reservoir
  * Water backs up behind the spillway (e.g., reservoir more than 100 percent)
* Reservoirs only capture runoff from 14 percent of the basin (ability is limited)
* Not the purpose of the reservoirs, but they can “help” with flood mitigation
* Extent/amount depends on many factors – rain (intensity, track, location), prior conditions (wet/dry, snowpack)
* NYC still needs to protect water supply – flood mitigation is not the purpose of the reservoirs

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

How does the FFMP impact you?

* More water in the river is better for fish, recreation, and water quality
* When water is abundant, more water is released
* Avoiding spills “helps” with flood mitigation
* Drought management programs protect water supplies along the entire mainstem of the Delaware River (including those for Philadelphia and Central/SW New Jersey)
* Flow Objectives have protected lower basin drinking water supplies from salt water

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Your Role in the FFMP and River Management

* Sign up for DRBC list-serves
* Get involved – volunteer to follow DRBC Advisory Committee Meetings and report to your organization
* Be informed - Request additional information sessions
* Review and comment on studies underway to inform the next FFMP

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA

Additional Resources

(too much information)

* FFMP 101 FAQs – coming soon from CDRW!
* Amy.Shallcross@drbc.gov, DRBC.gov , Interest List-Serves
* River Management in the DRB (a.k.a.) flow management
* Drought Management and Information
* NYC Water Supply and Watershed Management
* Evolution of Releases for Fish and Wildlife
* Good Faith Agreement
* FFMP (see 2018 *Appendix A Final* for details on reservoirs)
* Office of the Delaware River Master

Delaware River Basin Commission
DELAWARE • NEW JERSEY
PENNSYLVANIA • NEW YORK
UNITED STATES OF AMERICA