One Element of the Nexus: Water Management in the Delaware River Basin

Lafayette College
ES 303 Environment and Energy Systems Engineering

September 23, 2022

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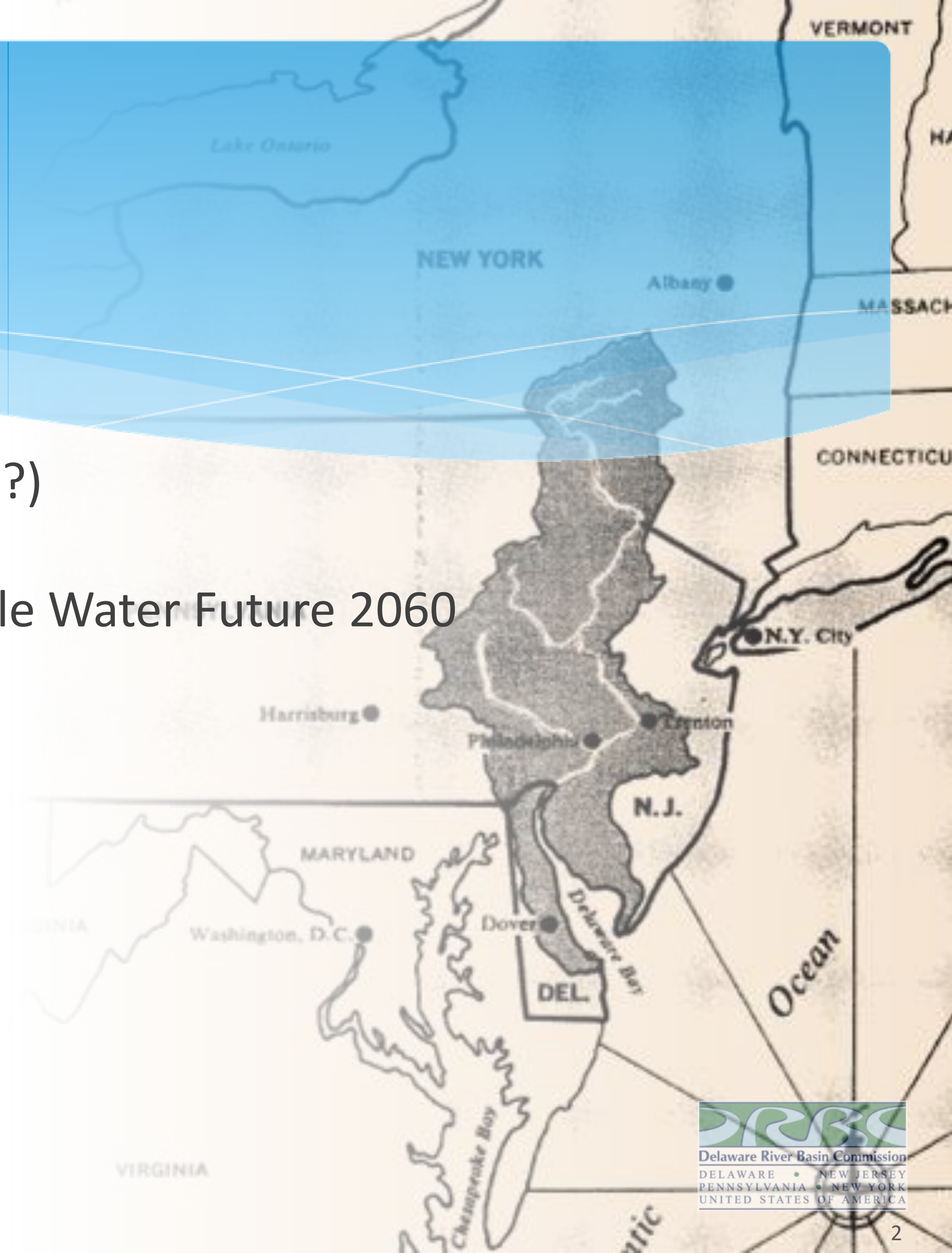
Outline

1. The Delaware River Basin
2. The Delaware River Basin Commission (what is it?)
3. The DRB, the DRBC, and the Nexus
4. Example: Water Supply Planning for a Sustainable Water Future 2060
    - Study background
    - Terminology
    - What does data look like
    - Estimating water withdrawals
    - Projecting water withdrawals
5. Example: Water and Energy in the DRB
6. Publication and Data Deliverable
7. Questions



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1. The Delaware River Basin

The Delaware River viewed from Hawk's Nest
in Sullivan County, New York.
Credit: © Joseph Halliday

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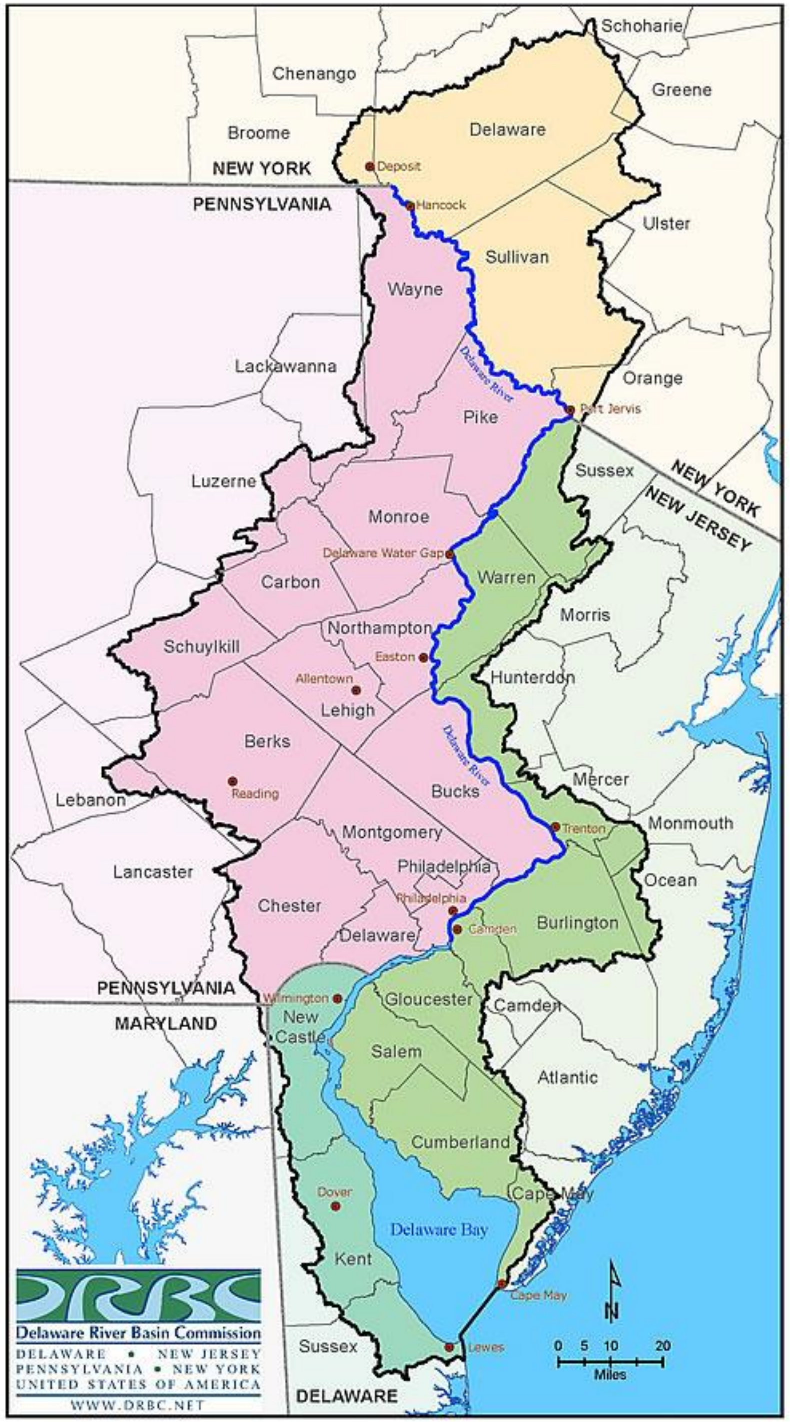
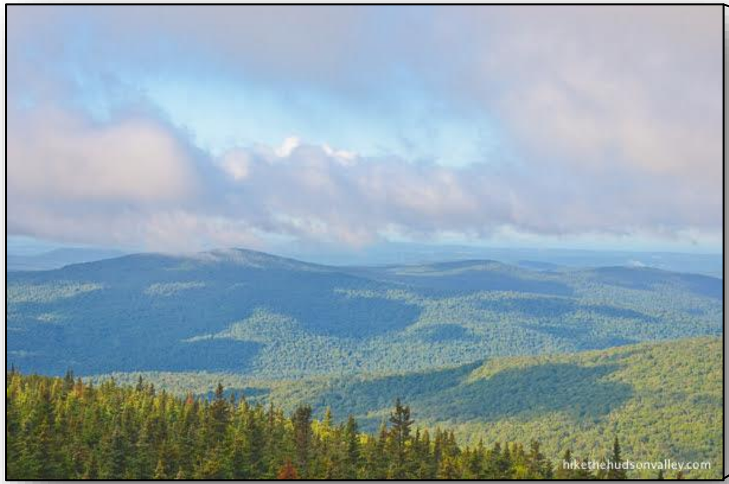


"For the Delaware is a gentle river, gracious and inviting; its charms are never-ending; and, surely, those who see its glories never can forget the river's beauty."

- Harry Emerson Wildes, 1940

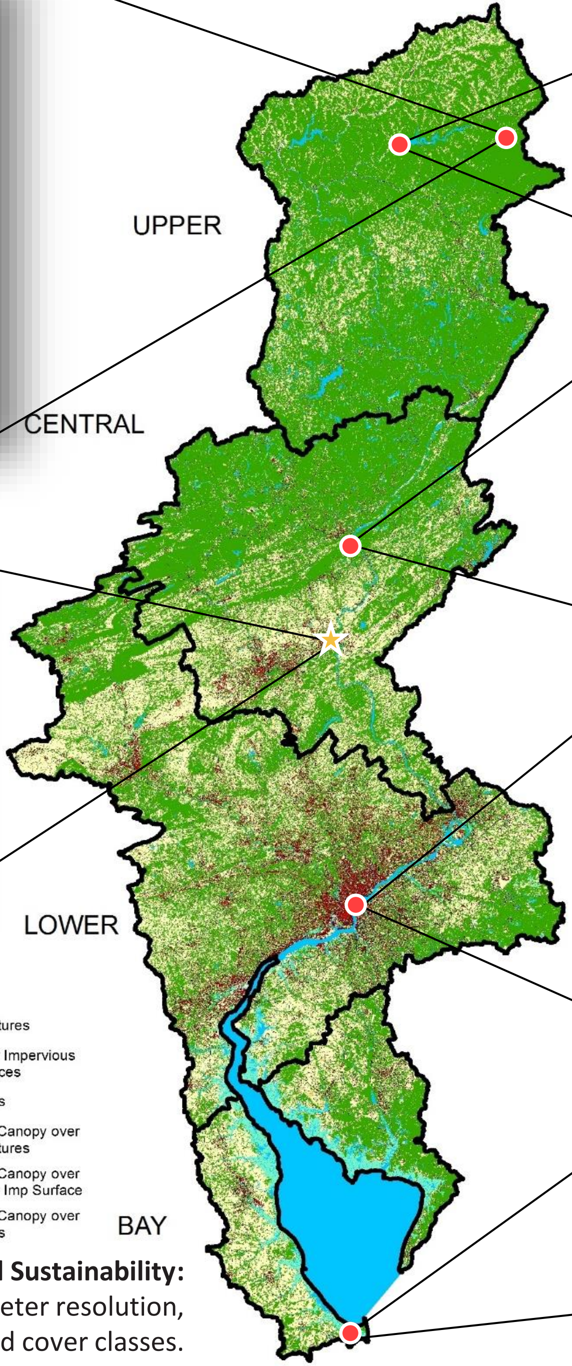
Some Key Highlights:

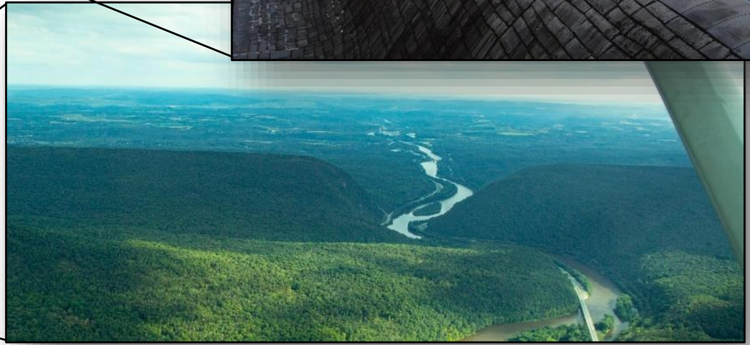
- Delaware River Main stem river is **330 miles long**
- Delaware River forms an interstate boundary over its entire length
- Longest, **un-dammed** U.S. river east of the Mississippi (dams are located on tributaries, not the main stem Delaware)
- **Drains 13,539 square miles** in 4 states (0.4% USA land area).
- **13+ million people** (about 4% of the 2020 U.S. population) rely on the waters of the Delaware River Basin
- Water **withdrawal** in the Basin = **6.4 billion gallons/day**
- **Significant Exports: NYC (up to 800 MGD) and NJ (up to 100 MGD)**
- **Contributes over $21B in economic value** to the region
- Generated **98 TWh of energy in 2020**, cooled by basin waters



View from Balsam Lake Mountain firetower.
in Ulster County, New York
Credit: https://hikethehudsonvalley.com/hikes/balsam-lake-mountain/

Pepacton Reservoir
in Delaware County, New York
Credit: Steven Walsh, DRBC





The Delaware Water Gap
Credit: © Hop On Air LLC
(https://www.flyhopon.com/)
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Lafayette College, Delaware River in background.
Credit: https://about.lafayette.edu/

The Delaware River flowing under
the Benjamin Franklin Bridge with
the Philadelphia skyline behind.
Credit: © Chris Boswell
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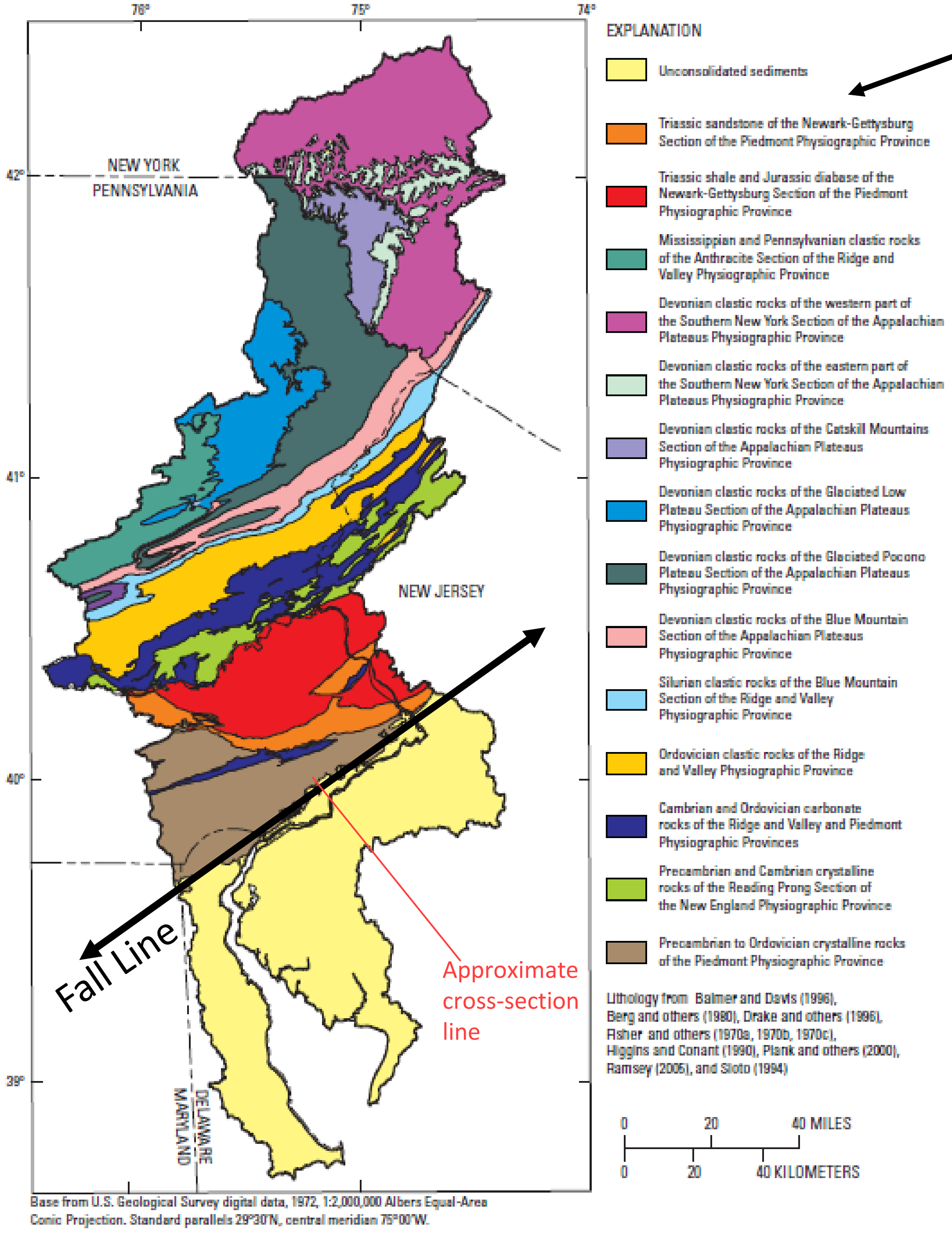
Basin figure adopted from
(Byun et al., 2019)

Shippensburg University's Center for Land Use and Sustainability:
2016 high-resolution land cover dataset is at a 1-meter resolution,
LiDAR-based, and includes 12 land cover classes.

Cape Henlopen, Delaware.
Credit: Delaware State Parks
https://destateparks.com/Beaches/CapeHenlopen

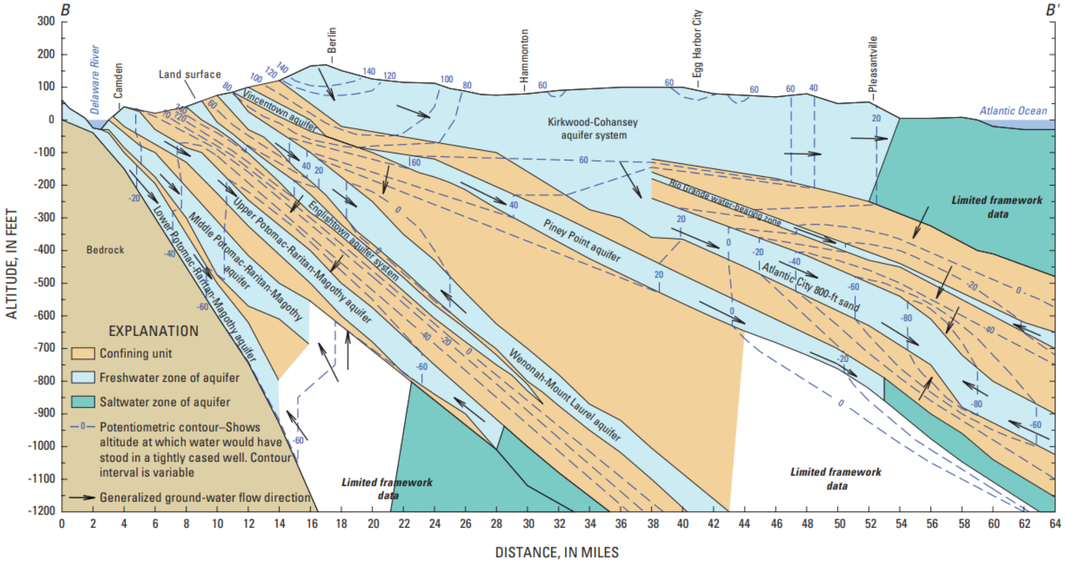


14 major rock types

as categorized by (Sloto & Buxton, 2006)

Basic Basin Geology

- DRB is divided into two physiographic divisions: the Appalachian Highlands & the Atlantic Coastal Plain
- **The Appalachian Highlands** are underlain by fractured bedrock and have high-energy streams and rivers
- **The Coastal Plain** underlain by unconsolidated sediments made of sand, clay and gravel



Cross-sectional figure adopted from (dePaul et al., 2009)

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2. The Delaware River Basin Commission

Ontelaunee Reservoir Dam
near Reading, Pennsylvania.
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What even *is* the Delaware River Basin Commission?

Its website says it is:
"…a regional body with the force of law to oversee a unified approach to managing a river system without regard to political boundaries."

cool…

Those guys…

True… but to be exact…
In 1961, President Kennedy and the four Basin State Governors signed an ***Interstate Compact***, the federal/state law that formed the Delaware Basin Commission (DRBC)

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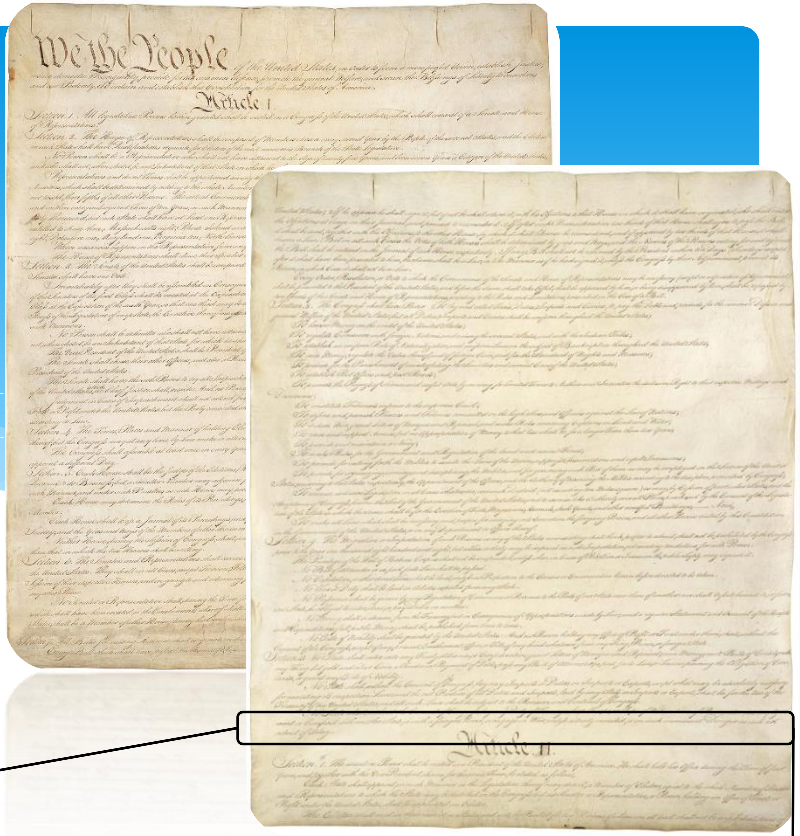
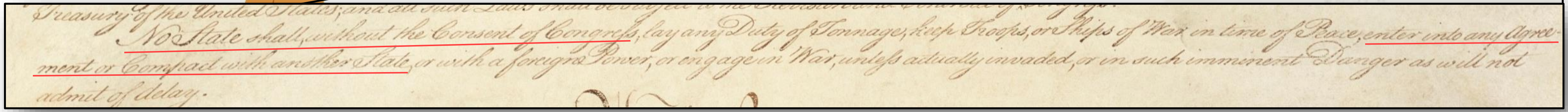
What is an **Interstate Compact**?

"An arrangement between two of more states that is designed to solve their common problems and that becomes part of the laws of each state."

However…





Under Article 1, Section 10, Clause 3 of the US Constitution states:
"No state shall, **without the Consent of Congress**…enter into any Agreement of Compact with another State".

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So, the Delaware River Basin Commission has:

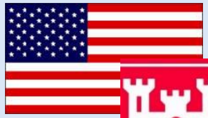
Five Equal Members:

Delaware

New Jersey

Pennsylvania

New York



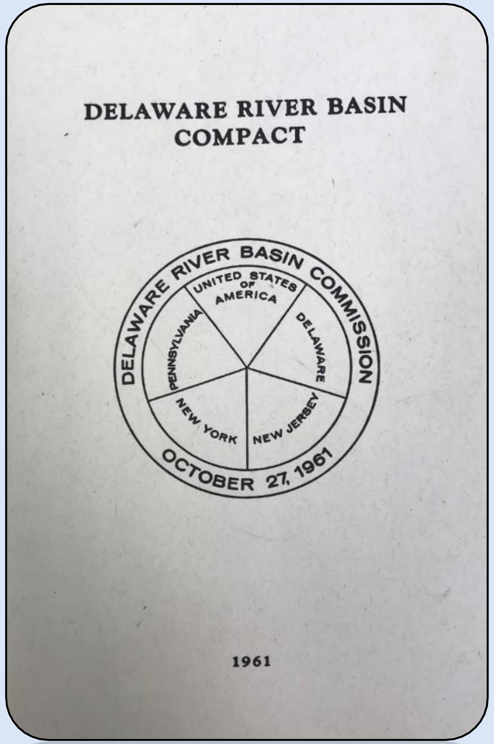

Federal Government

Note: New York City and Philadelphia are "advisors" and not members

(Each with one vote on things such as passing resolutions which can be come law)

&

Rules to follow:



Effectuated by the United States Government as Public Law 87-328

The authority by which DRBC can do things… like science

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1. **Is a Regulatory Agency**
   - Issues dockets (approvals) for projects that impact water resources
     - Discharges : effluent limitations
     - Withdrawals : quantity restrictions / temporal restrictions
     - Reservoirs : minimum releases / operating plans
   - Establish ambient water quality standards

2. **Is a Planning Agency**
   - Long term water supply planning
   - Reservoir and river flow modeling
   - Water quality modeling – dockets, TMDLs, etc.

3. **Does Monitoring & Assessment**
   - Measure and assess water, sediment, biota etc.…

So, the DRBC can do a bunch of different stuff…

… because of the Compact!

DELAWARE RIVER BASIN COMPACT (1961)

3.6 General Powers. The commission may:

…

"(c) Conduct and sponsor research on water resources, their planning, use, conservation, management, development, control and protection, and the capacity, adaptability and best utility of each facility thereof, and collect, compile, correlate, analyze, report and interpret data on water resources and uses in the basin, ….”

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- Water supply shortages and disputes over the apportionment of the basin's waters;
  (1954 U.S. Supreme Court Decree, 2017 Flexible Flow Management Plan)

Why was the DRBC created?

- Severe pollution in the Delaware River and its major tributaries;

- Serious flooding

The Delaware River Basin's flood of record was August 1955. This photo shows the bridge between Easton, Pa. and Phillipsburg, N.J. wiped out during that flood. Photo courtesy of lehighvalleylive.com.

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3. The Nexus, the DRB, and the DRBC

Delaware Water Gap viewed from
Mount Tammany, New Jersey.
Credit: © Tetyana Ohare
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What is the Water, Food, Energy Nexus?

"The water–energy–food nexus is about understanding and managing often-competing interests while ensuring the integrity of ecosystems."
-Food and Agricultural Organization of the United Nations
(https://www.fao.org/land-water/water/watergovernance/waterfoodenergynexus/en/)

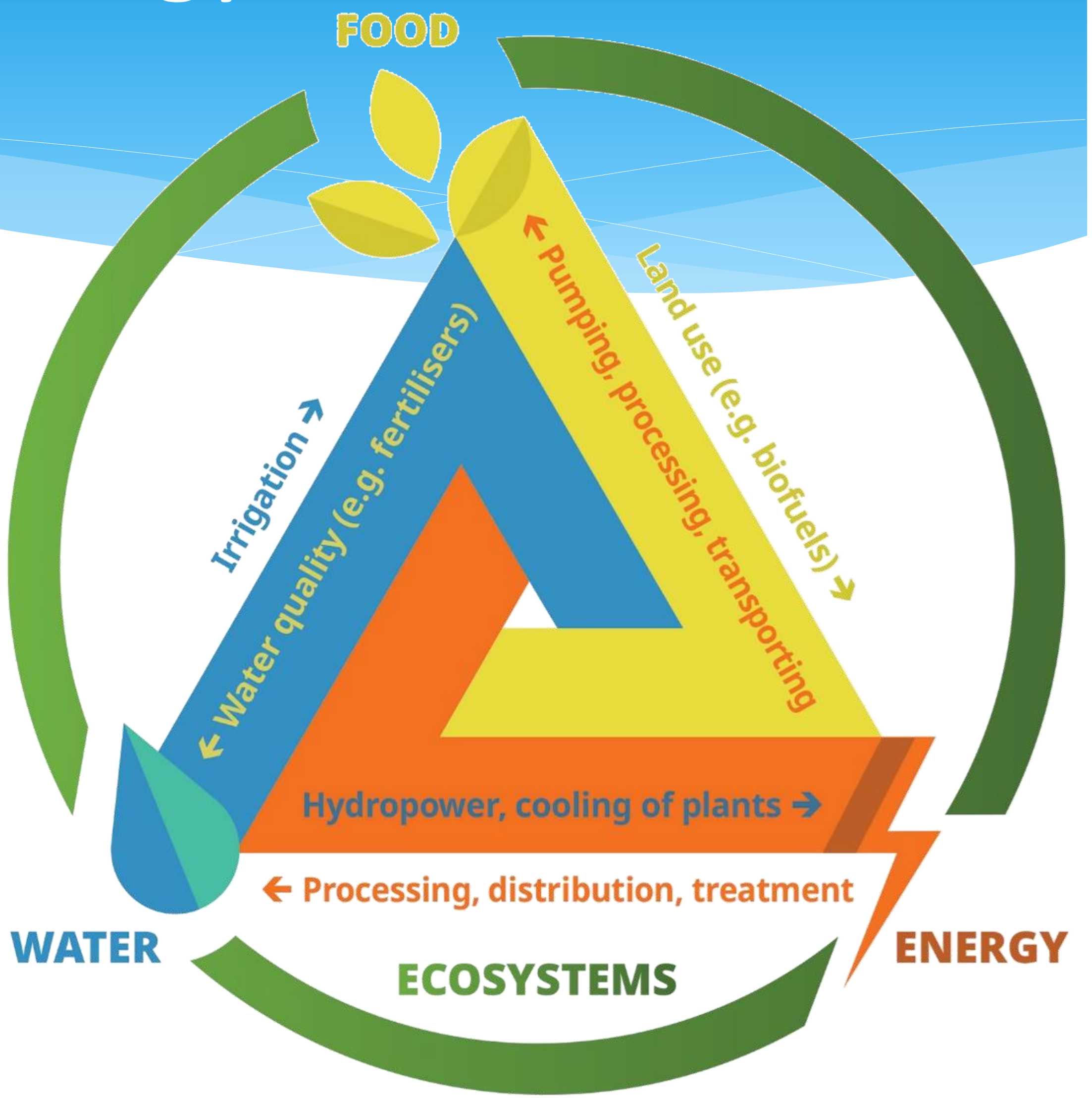


Image adopted from Global Water Partnership Mediterranean
(https://www.gwp.org/en/GWP-Mediterranean/WE-ACT/Programmes-per-theme/Water-Food-Energy-Nexus/)

How does the DRBC mesh with this Nexus?

DRBC's focus is
centered on water (in the DRB).

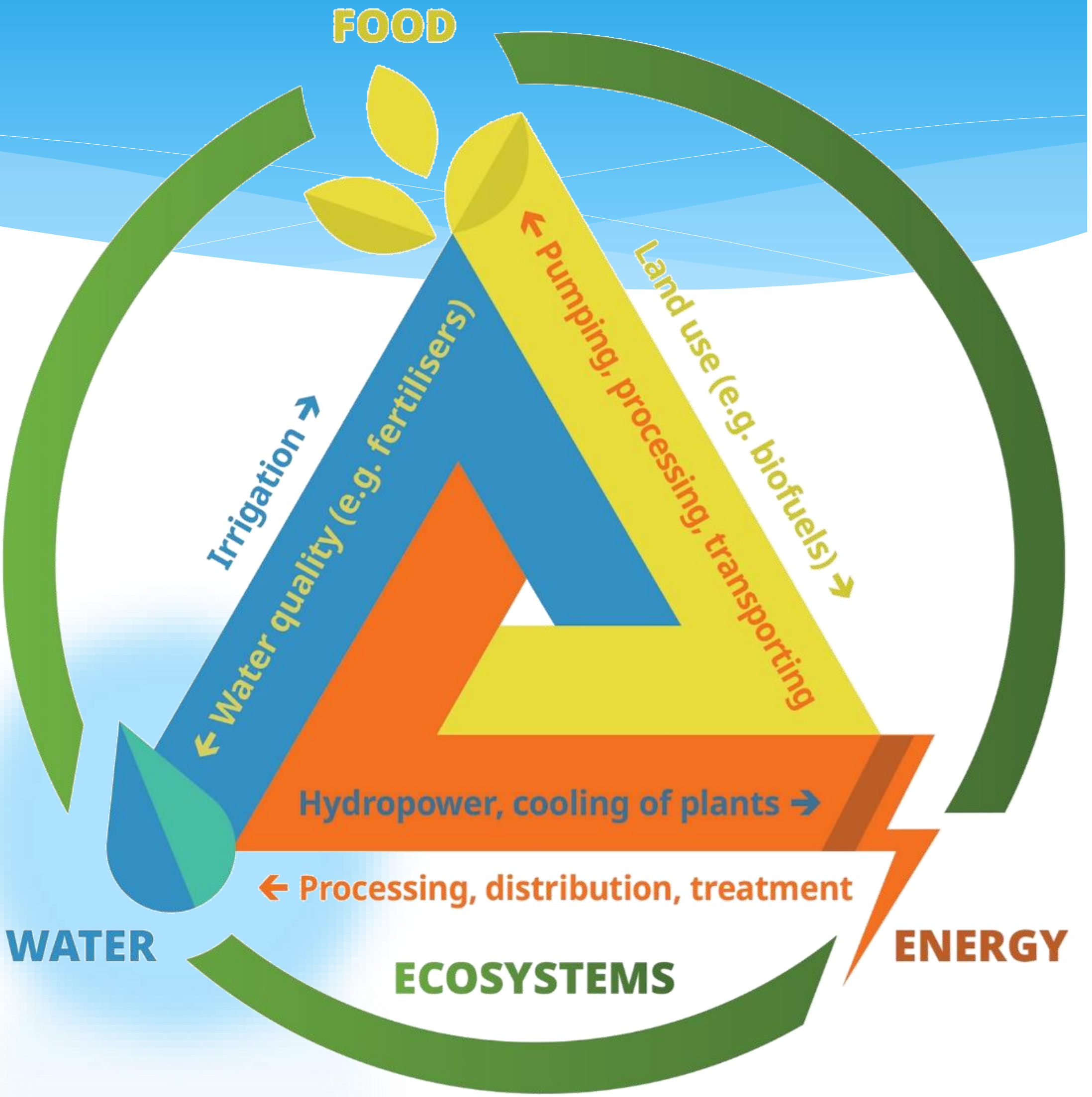
For example, given a power plant requiring water for cooling

DRBC might regulate:

- quantity of water withdrawal
- pass-by requirements
- quantity/quality of discharge
- large linear infrastructure (*limited**)

DRBC would not regulate the plant itself, for example:

- licensing (FERC, DOE)
- air emissions (EPA, DEP)
- impingement and entrainment (EPA, DEP)
- fuel usage
- cooling technology



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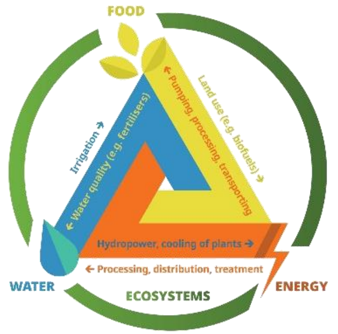
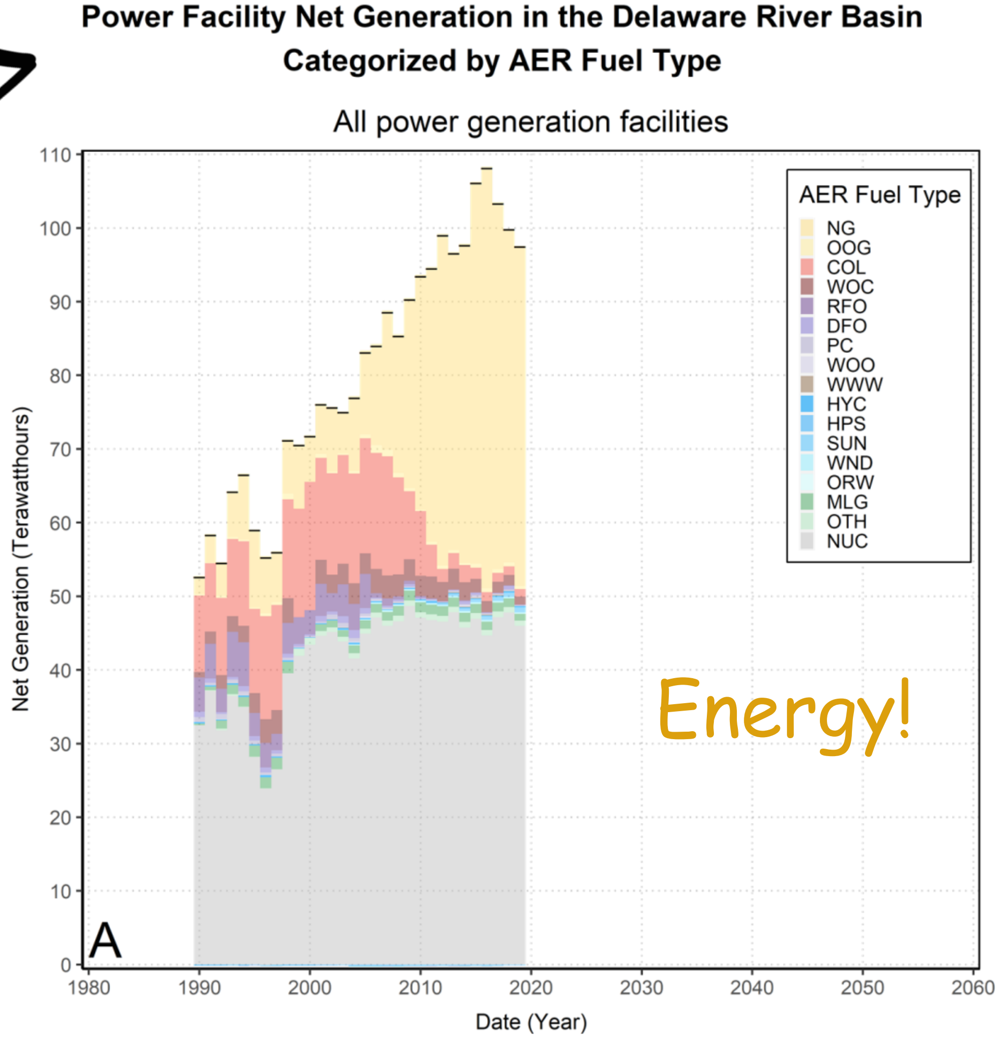
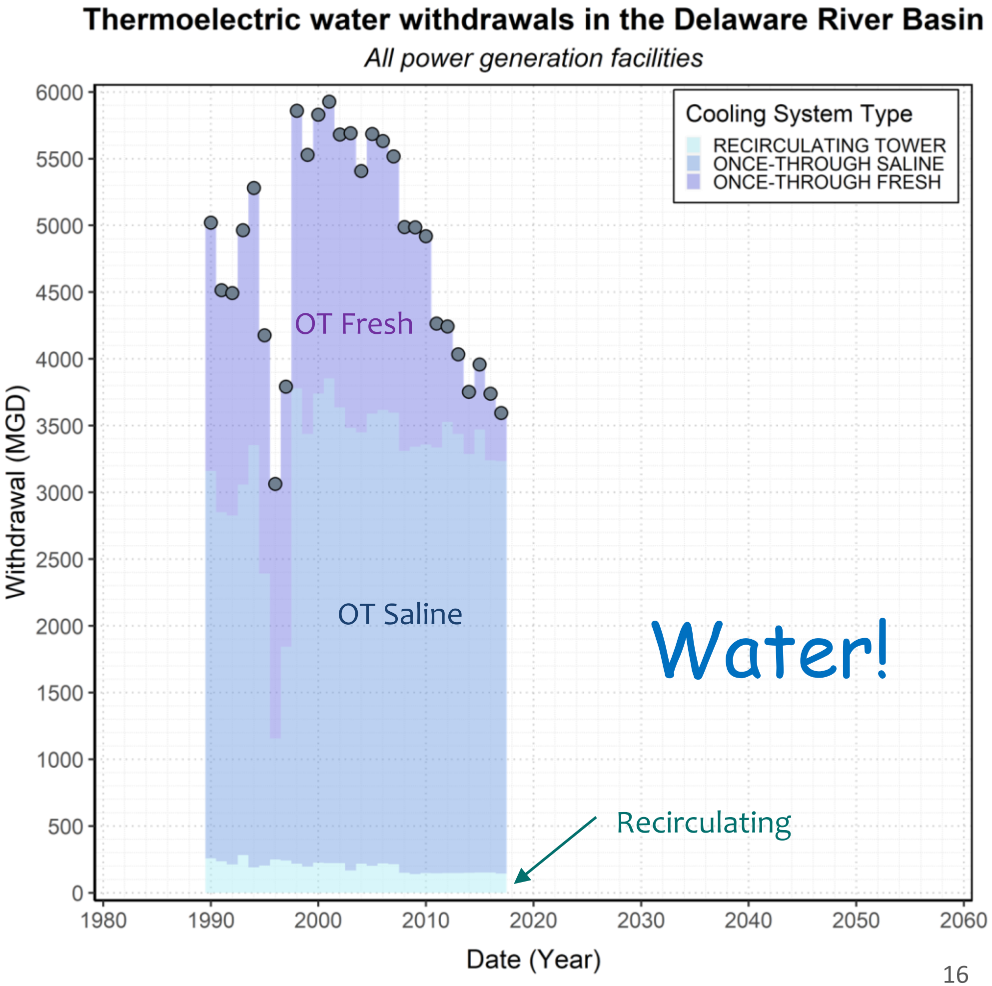
While DRBC does not have regulatory authority, does not mean we ignore those parts of the Nexus!



EXAMPLE

We understand that the way a power plant operates will affect the water needed. This helps understand water planning efforts.





More on this later…

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4. Example: Water Supply Planning for a Sustainable Water Future 2060

Fairmount Water Works
in Philadelphia, Pennsylvania.
Credit: Partnership for the Delaware Estuary
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Background: The driving question

Is there enough water available at the withdrawal locations where the Commission has allocated water, both at current and future demands, during a repeat of the Drought of Record?

1. Estimate current and project future water demands — **published Oct. 2021**
2. Assess groundwater availability — **anticipated Oct. 2022**
3. Assess surface water availability — **up next**

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Background: Planning objectives

Provide projections of future average annual water use in the Delaware River Basin, through the year 2060, to be used in future planning assessments.

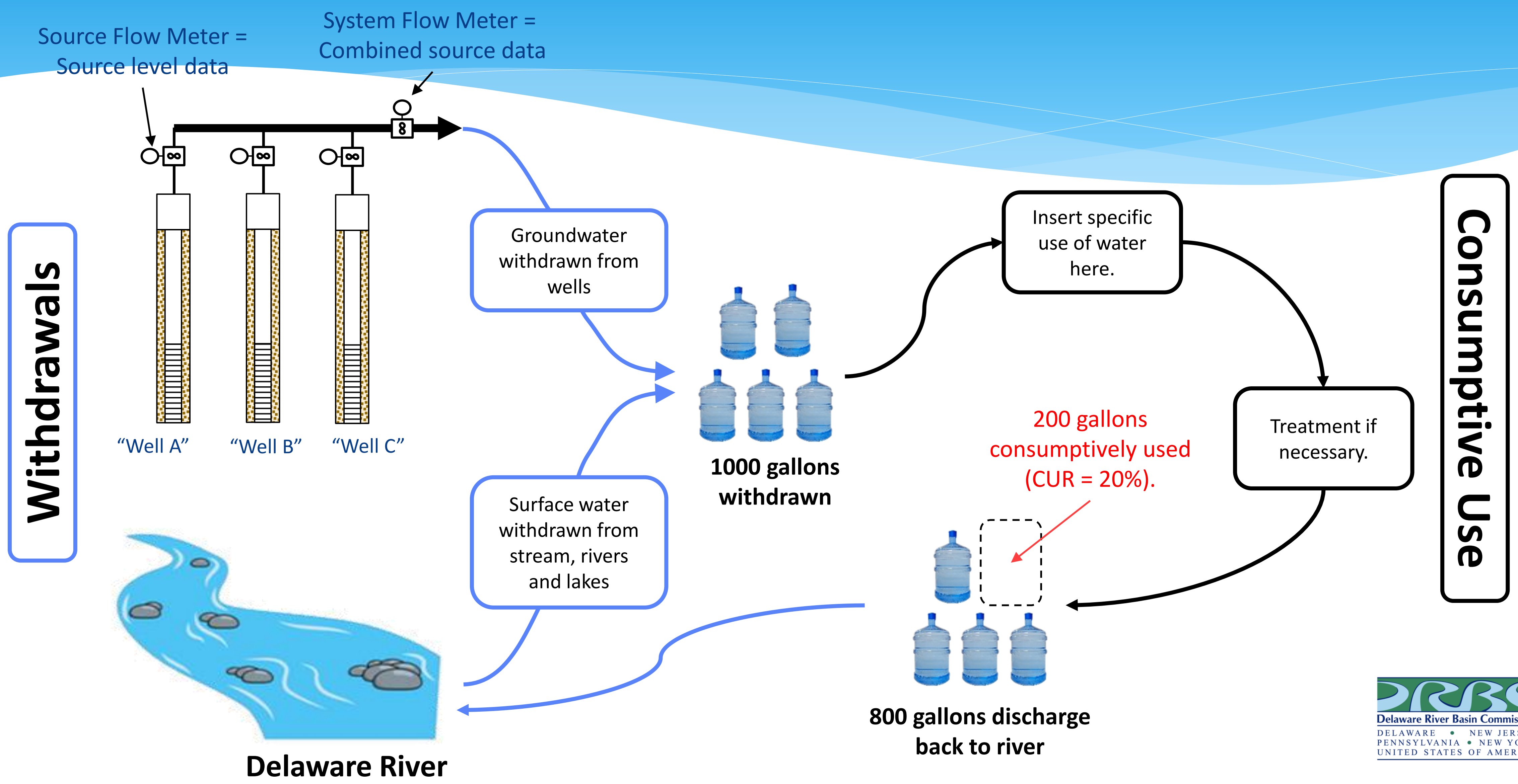
Represent each water use *sector* at the Basin-wide scale.

Apply GW results to the 147 sub-watersheds (Sloto & Buxton, 2006) and the sub-watersheds of SEPA-GWPA.

Apply SW results at the source level for future availability analyses.

Relate results to regulatory approvals.

Terminology: What data are we looking at?



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Terminology: Breakdown by sector… what’s a sector?

(PWS) Public Water Supply

Water withdrawn by a facility meeting the definition of a public water supply system under the Safe Drinking Water Act (Pub. L. No. 93-523, 88 Stat. 1660), or subsequent regulations set forth by signatory parties.

(DIV) Out-of-Basin Diversions

Withdrawals of water for public water supply exported from the Delaware River Basin by the Decree Parties in accordance with a 1954 U.S. Supreme Court Decree (U.S. Supreme Court, 1954).

(SSD) Self-Supplied Domestic

Water withdrawal for domestic use for residents who are not served by a public water supply system; it is assumed in this study that all self-supplied groundwater withdrawals are groundwater.

(PWR) Power Generation

Water withdrawn/diverted by facilities associated with the process of generating electricity. Within the Delaware River Basin, this refers water withdrawn/diverted by both thermoelectric and hydroelectric facilities.

(IND) Industrial

Water withdrawals by facilities associated with fabrication, processing, washing, and cooling. This includes industries such as chemical production, food, paper and allied products, petroleum refining (i.e., refineries), and steel. Due to the generally close relationship, water withdrawn for groundwater remediation purposes are also included in this sector.

(IRR) Irrigation

Water withdrawals which are applied by an irrigation system to assist crop and pasture growth, or to maintain vegetation on recreational lands such as parks and golf courses. This does not include withdrawals/ diversions associated with aquaculture.

(MIN) Mining

Water withdrawals by facilities involved with the extraction of naturally occurring minerals. This includes operations such as mine dewatering, quarrying, milling of mined materials, material washing and processing, material slurry operations (e.g. sand), dust suppression and any other use at such facilities.

(OTH) Other

Facilities not categorized by previous sectors, including but not limited to aquaculture, bottled water, commercial (e.g. hotels, restaurants, office buildings, retail stores), fire suppression, hospital/health, military, parks/recreation, prisons, schools, and ski/snowmaking.

What does the data look like?

State Agencies

DRBC normalizes state data into an integrated database

Bring in metadata as necessary
(+ millions of data)

Metadata examples:
Names, Lat-Long, system categories, GW/SW, interconnections/transfers, regulatory approvals

A data point
System ID; Source ID;
Date (Year & Month); Volume

<u>1990-2017</u>
More than 1.6 million points describe withdrawals from the Delaware River Basin

<u>For certain "sectors":</u>
Link System IDs & Regulatory Approvals (~650 systems)
Generally, systems with withdrawals above review thresholds (100,000 gpd)

DRBC Project Review Section ->
Continually updating list of active approvals

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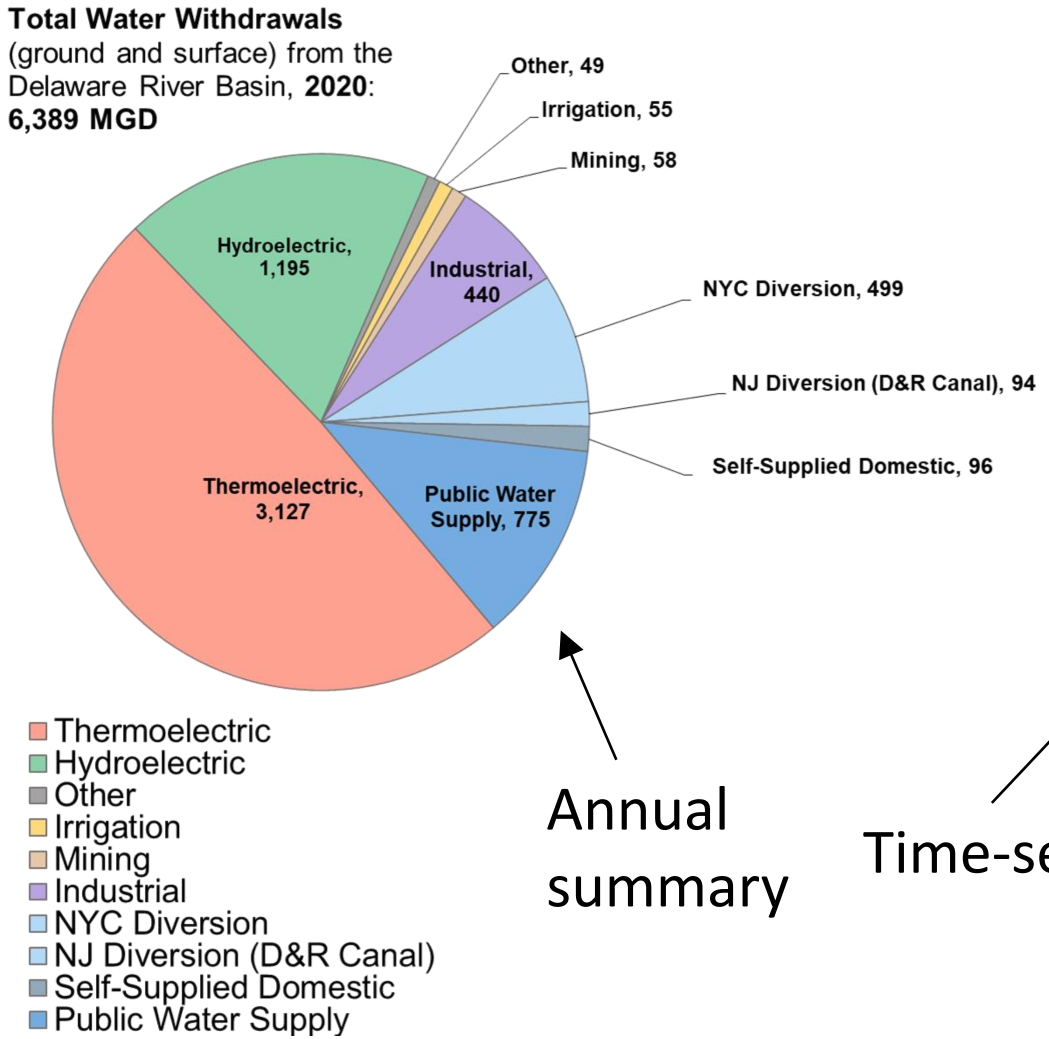
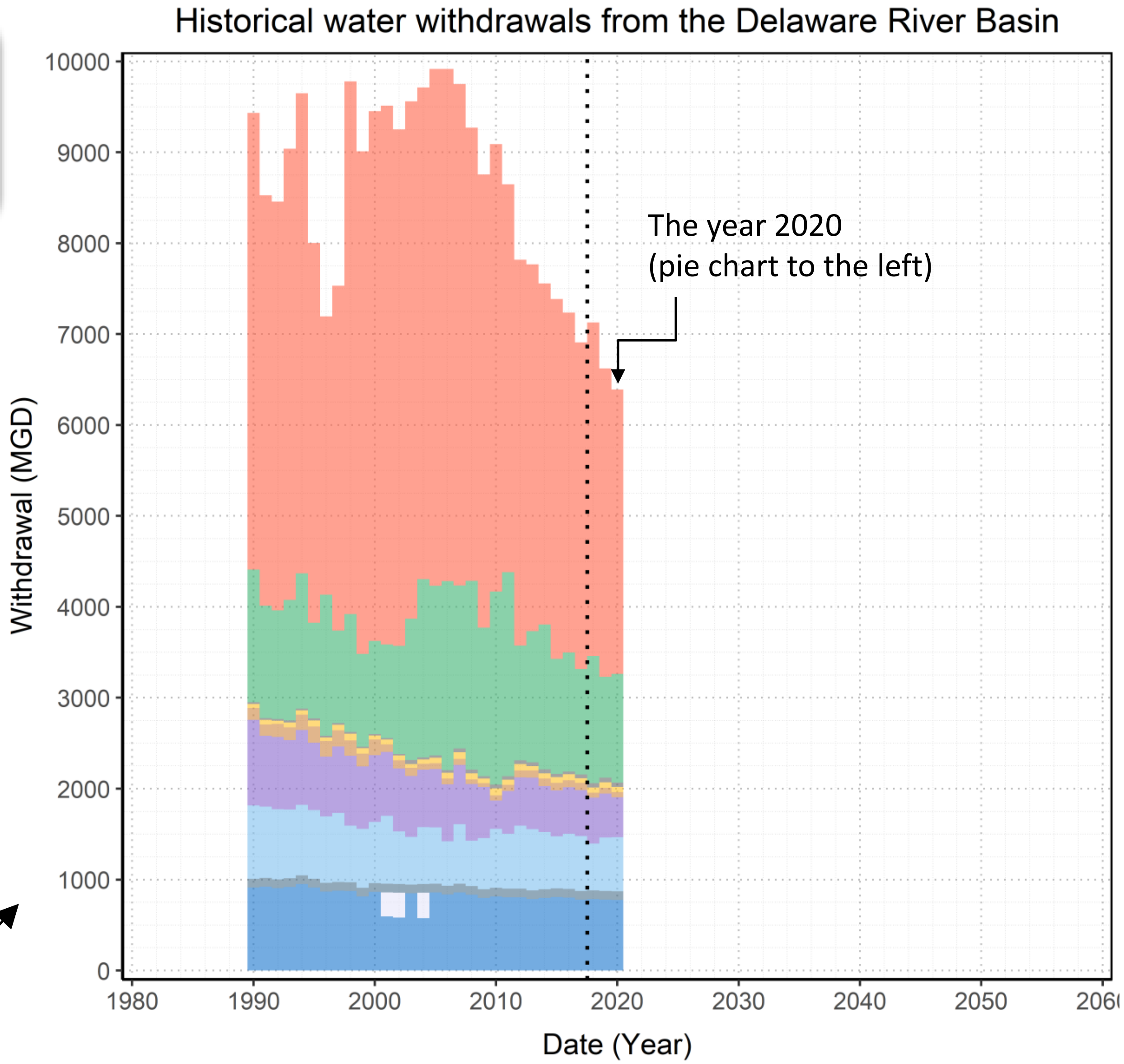
Estimating water withdrawals



Annual summary

Time-series



Large QAQC effort as part of (Thompson & Pindar, 2021)

Annual updates

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What even is 6.4 billion gallons per day?

Per Google searching:
"It turns out that Olympic swimming pools have some pretty specific dimensions. They are 50 meters long, 25 meters wide, and 2 meters deep. In terms of volume, when full, these pools hold **2.5 million liters of water or about 660,000 gallons**."

→ ~ 9,700 Olympic Pools / day

As of 3:45 PM on 09/22/2022:
Daily discharge, cubic feet per second **USGS 01454700**
Lehigh River at Glendon, PA

888 CFS = 1,374 MGD

→ 4.5x the flow of the Lehigh

(much of which is returned)

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Projecting water use: Overview

The primary method is extrapolation of historic reported withdrawal data

Water Withdrawals in the Delaware River Basin

Public Water Supply
Report Link: Section 3
Primary Method: Extrapolation of historic water withdrawal data

Out-of-Basin Diversion
Report Link: Section 3
Primary Method: Mean value based on a five-year average.

Self-supplied Domestic
Report Link: Section 4
Primary Method: Population estimate and per-capita rates.

Power Generation
Report Link: Section 5
Primary Method: Extrapolation of historic water withdrawal data

Industrial
Report Link: Section 6
Primary Method: Extrapolation of historic water withdrawal data

Mining
Report Link: Section 7
Primary Method: Extrapolation of historic water withdrawal data

Irrigation
Report Link: Section 8
Primary Method: Multivariate regression for temperature and precipitation.

Other
Report Link: Section 9
Primary Method: Extrapolation of historic water withdrawal data

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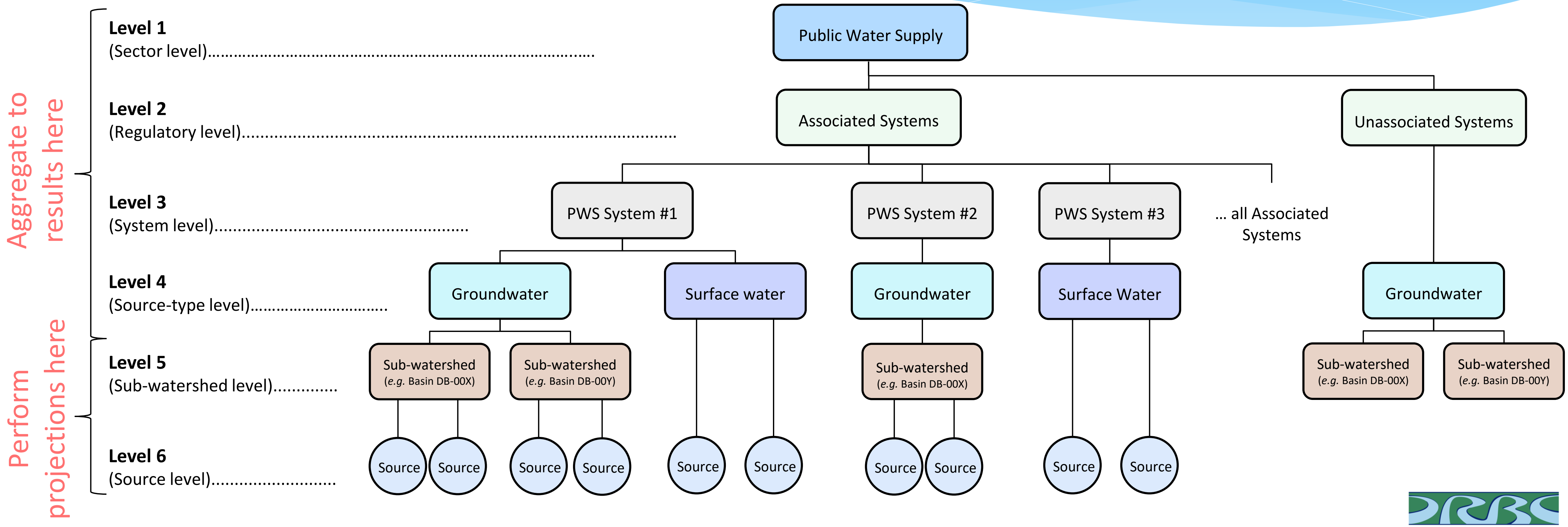
Projecting water use: Staying organized

Where do we start?

Time-series hierarchy



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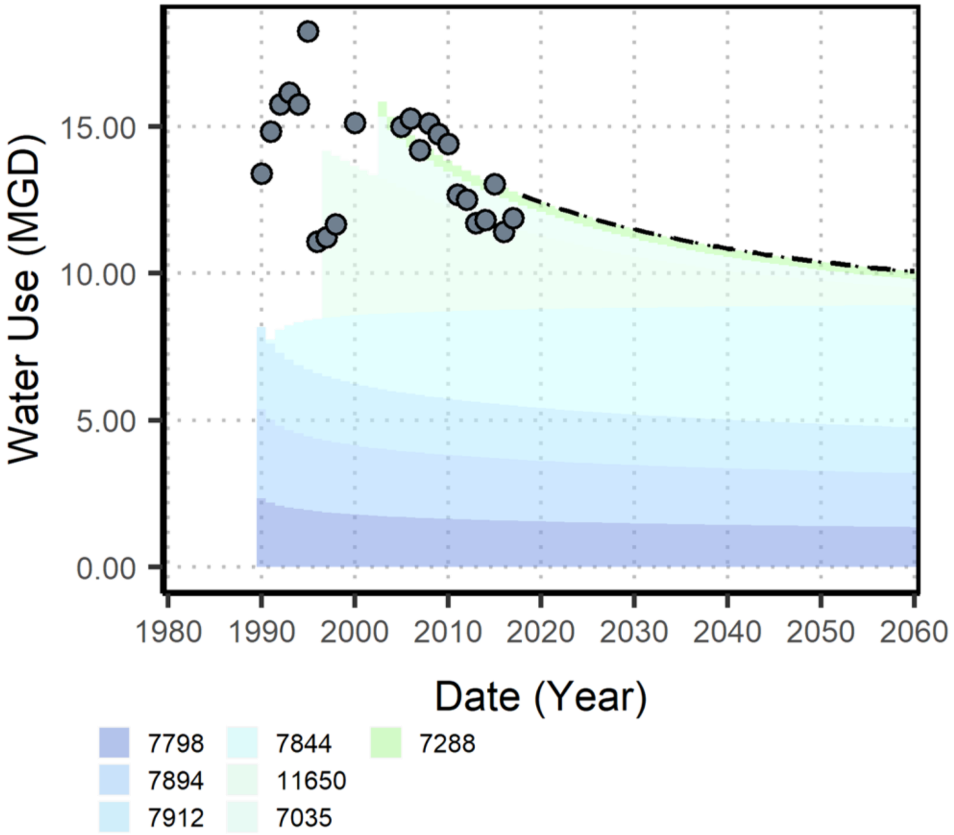
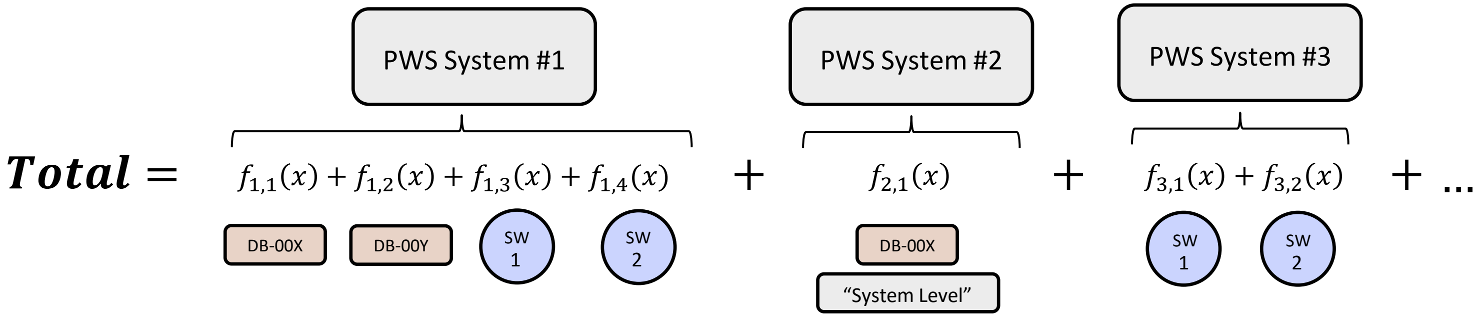
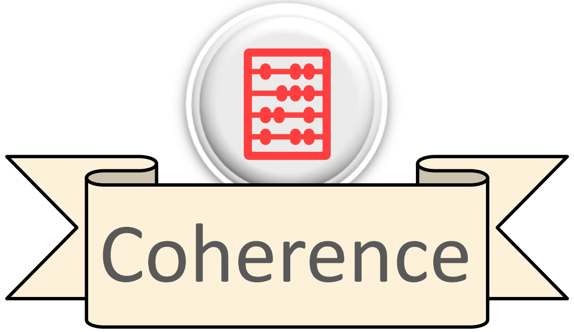
Hyndman, R., & Athanasopoulos, G. (2018). *Forecasting: principles and practice* (2nd ed.). Melbourne, Australia: OTexts. https://otexts.com/fpp2/

Projecting water use: How do analyze results?



"Bottom-up approach"





Do projections aggregate in a manner consistent with the time series?

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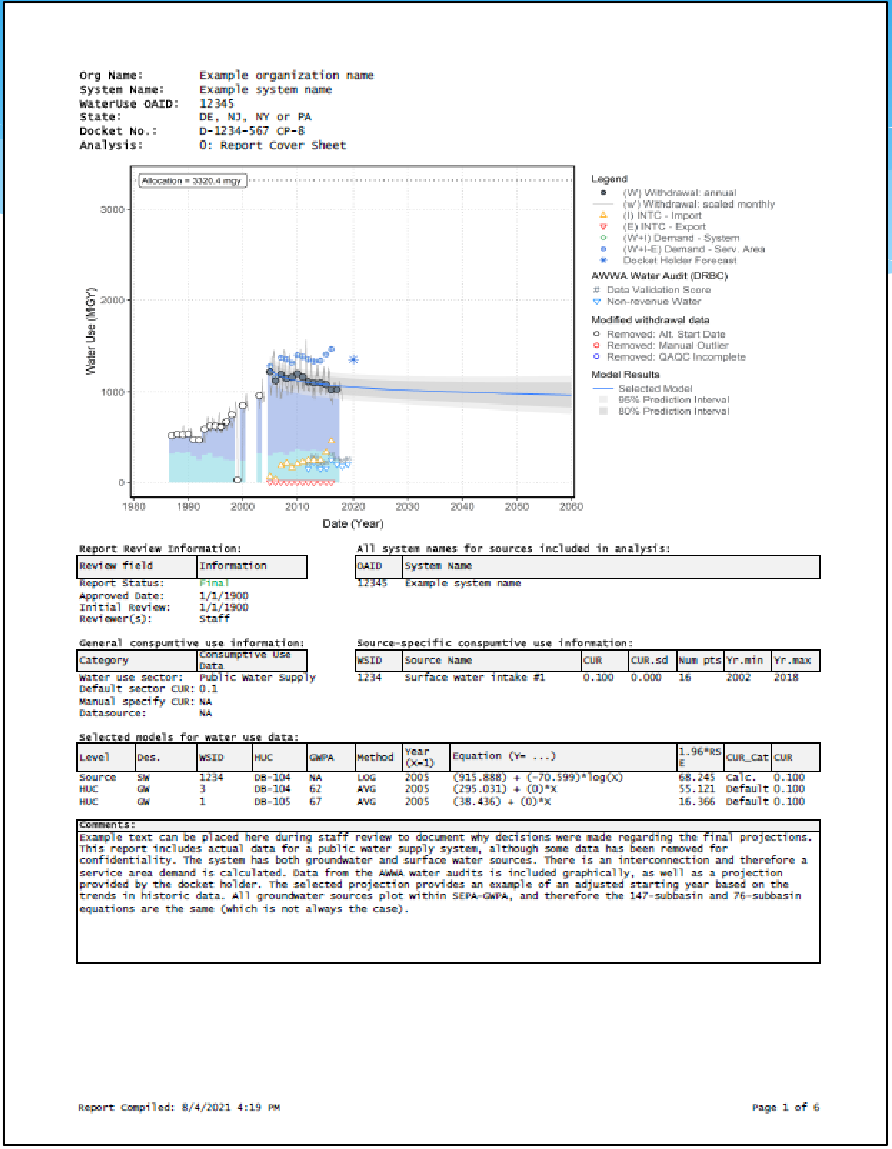
Projecting water use: Implementing the plan?

The main model is based on extrapolating historic withdrawal data.

- Significant QAQC of historic data
- 600+ system reports
- 1,100+ equations
- Describe withdrawal & consumptive use

Method		Associated		Unassociated		Subtotal
		GW	SW	GW	SW	
Mean Value		218	71	147	0	436
OLS	Exponential	72	17	36	0	125
	Linear	83	11	11	0	105
	Logarithmic	250	74	69	0	393
Other		62	48	4	0	114
Subtotal		685	221	267	0	1,173

- OLS = Ordinary Least Squares
- Associated means system operate above review thresholds and has allocation regulatory approval.
- Does not include agriculture and self-supplied domestic analyses



Org Name: Example organization name
System Name: Example system name
WaterUse OAID: 12345
State: DE, NJ, NY or PA
Docket No.: D-1234-567 CP-8
Analysis: 0: Report Cover Sheet

Report Review Information:

Review field	Information
Report Status:	Final
Approved Date:	1/1/1900
Initial Review:	1/1/1900
Reviewer(s):	Staff

All system names for sources included in analysis:

OAID	System Name
12345	Example system name

General conspumtive use information:

Category	Consumptive Use Data
Water use sector:	Public Water Supply
Default sector CUR:	0.1
Manual specify CUR:	NA
Datasource:	NA

Source-specific conspumtive use information:

WSID	Source Name	CUR	CUR.sd	Num pts	Yr.min	Yr.max
1234	Surface water intake #1	0.100	0.000	16	2002	2018

Selected models for water use data:

Level	Des.	WSID	HUC	GWPA	Method	Year (X=1)	Equation (Y= ...)	1.96*RSE	CUR_Cat	CUR
Source	SW	1234	DB-104	NA	LOG	2005	(915.888) + (-70.599)*log(X)	68.245	Calc.	0.100
HUC	GW	3	DB-104	62	AVG	2005	(295.031) + (0)*X	55.121	Default	0.100
HUC	GW	1	DB-105	67	AVG	2005	(38.436) + (0)*X	16.366	Default	0.100

Comments:
Example text can be placed here during staff review to document why decisions were made regarding the final projections. This report includes actual data for a public water supply system, although some data has been removed for confidentiality. The system has both groundwater and surface water sources. There is an interconnection and therefore a service area demand is calculated. Data from the AWWA water audits is included graphically, as well as a projection provided by the docket holder. The selected projection provides an example of an adjusted starting year based on the trends in historic data. All groundwater sources plot within SEPA-GWPA, and therefore the 147-subbasin and 76-subbasin equations are the same (which is not always the case).

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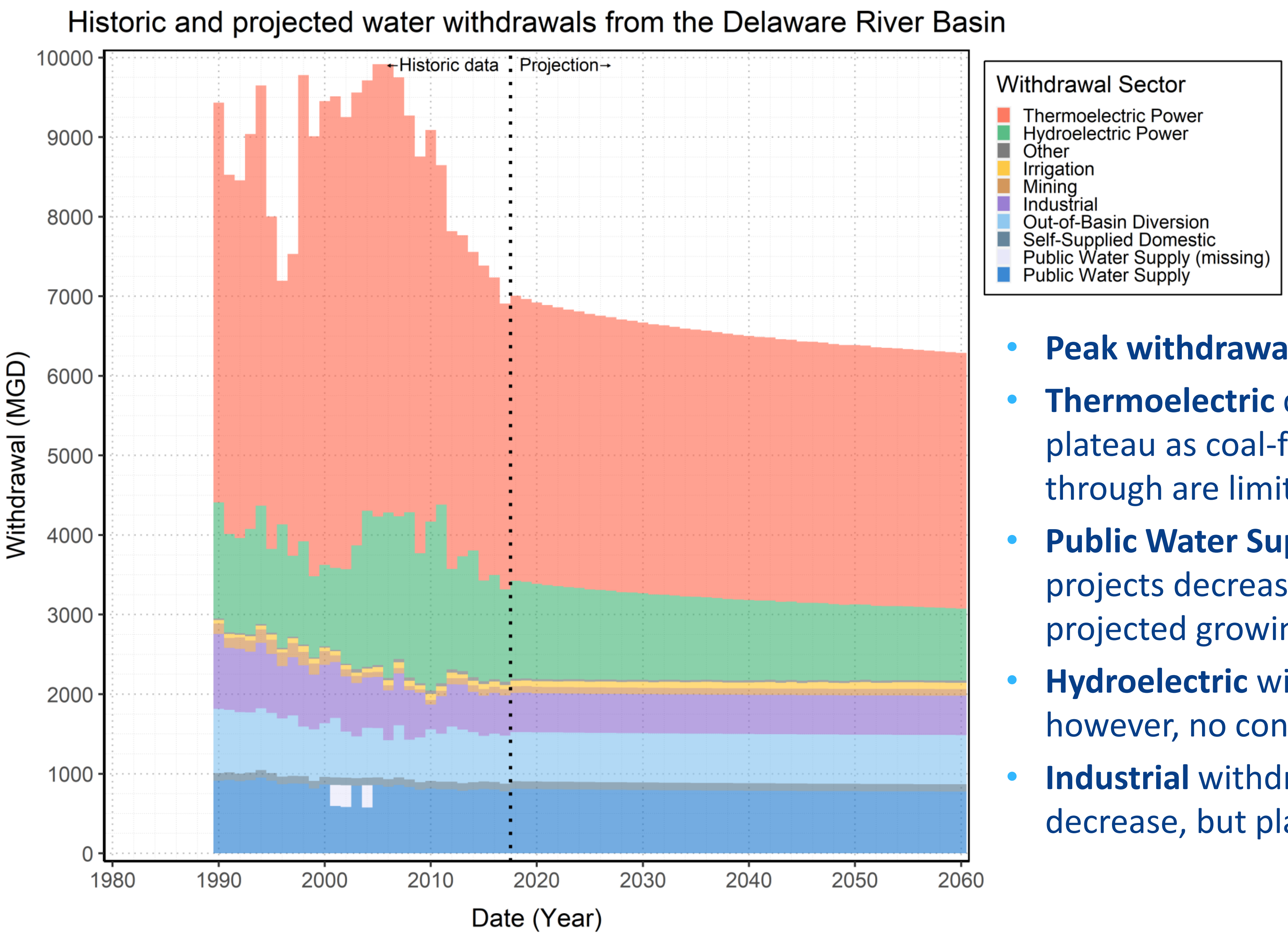

- **Peak withdrawals have occurred**
- **Thermoelectric** decreases since 2007 will plateau as coal-fired facilities using once-through are limiting
- **Public Water Supply** has shown and projects decreases despite historic and projected growing in-Basin population
- **Hydroelectric** withdrawals are significant; however, no consumptive use
- **Industrial** withdrawals historically decrease, but plateau

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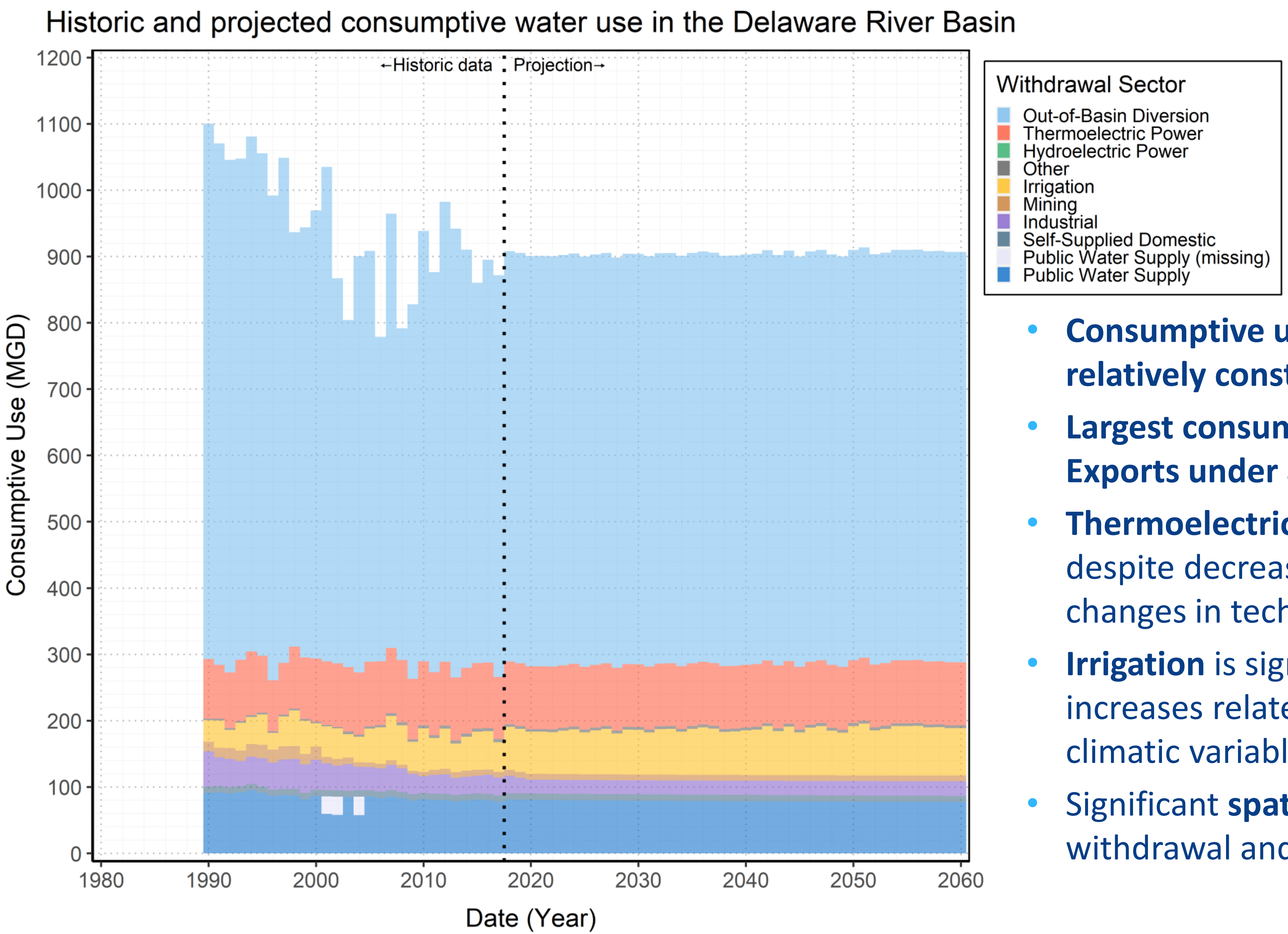
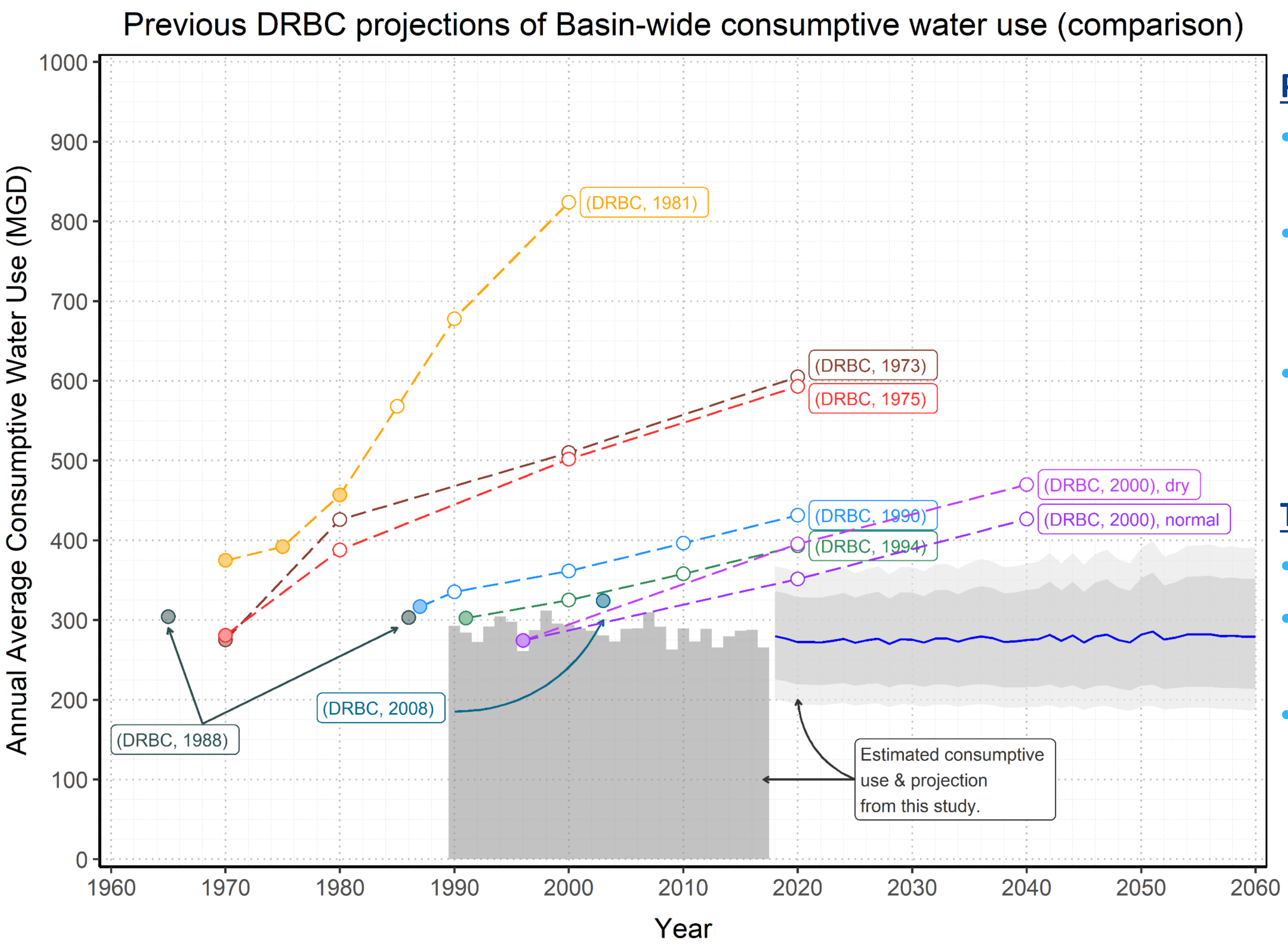


- **Consumptive use projected to remain relatively constant**
- **Largest consumptive use is Out-of-Basin Exports under a U.S. Supreme Court Decree**
- **Thermoelectric** consumptive use constant despite decreased withdrawals due to changes in technology
- **Irrigation** is significant and shows slight increases related to projected changes in climatic variables
- Significant **spatial variation** in terms of both withdrawal and consumptive use



Prior projections often:

- Work from one estimated year of withdrawal data
- Are performed indirectly (e.g., applying population projections)
- May have considered/ accounted for planned facilities (e.g., power)

This study:

- Almost 30 years of data
- Aligns with previous *estimates*
- Most conservative projection

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5. Example: Water and Energy in the DRB

Hope Creek and Salem Generating Stations
in Salem County, New Jersey.
Credit: © John Beatty
Used with permission.

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Context: water & energy

Thermoelectric power generation typically uses water in the cooling process

Thermoelectric
(once-through non-contact cooling)


Portland Generating Station, photo credit Google Earth

Thermoelectric
(recirculating cooling towers)


Exelon Limerick, photo credit Google Earth

Hydroelectric power generation uses water as the "primary mover"

Hydroelectric (conventional)


Rio (Mongaup System), photo credit Google Earth

Hydroelectric (pumped storage)


Yards Creek Generating Station, photo credit Google Earth

Good reference (and glossary):

Diehl, T. H., Harris, M. A., Murphy, J. C., Hutson, S. S., & Ladd, D. E. (2013). Methods for estimating water consumption for thermoelectric power plants in the United States. Scientific Investigations Report 2013-5188. Reston, Virginia. U.S. Geological Survey. https://doi.org/10.3133/sir20135188

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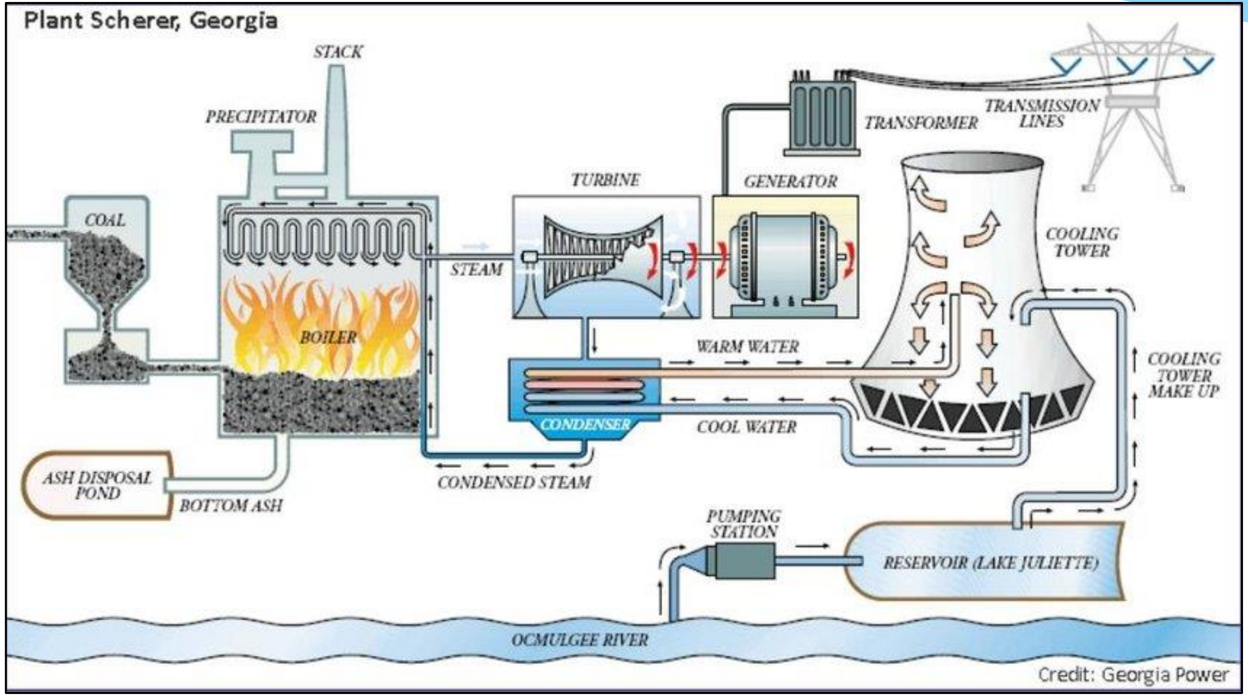
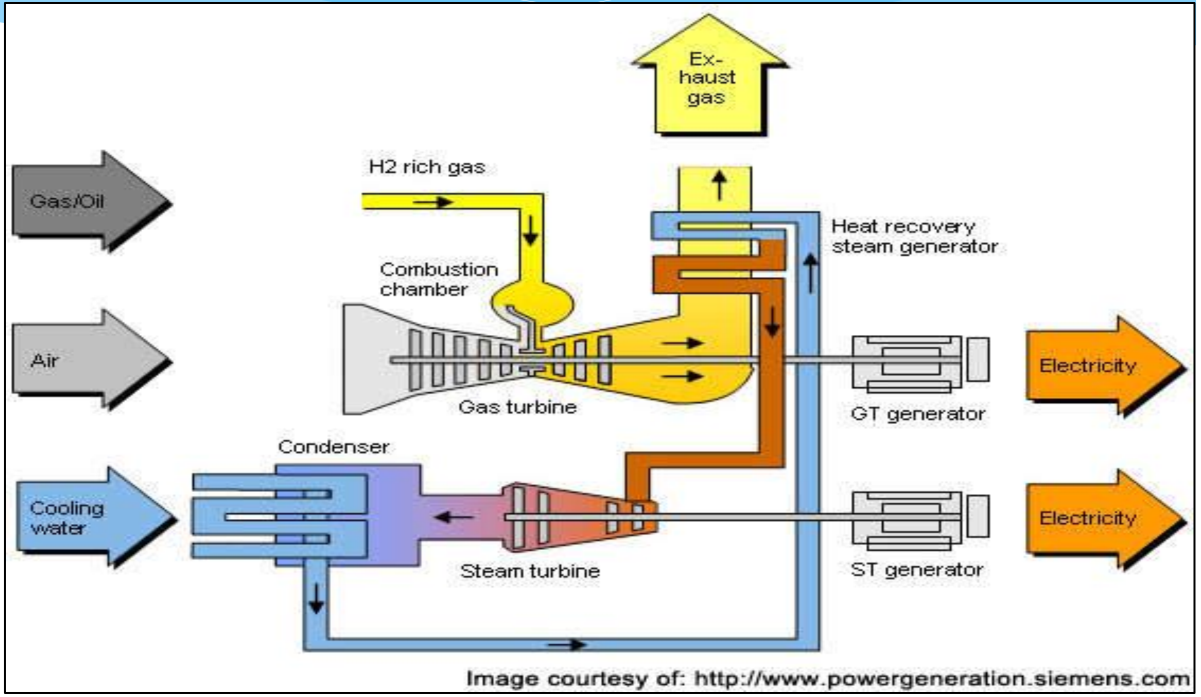
Context: water & energy (thermoelectric)

Electrical Generation Methods



Traditional Steam Turbine



Combined Cycle Turbine

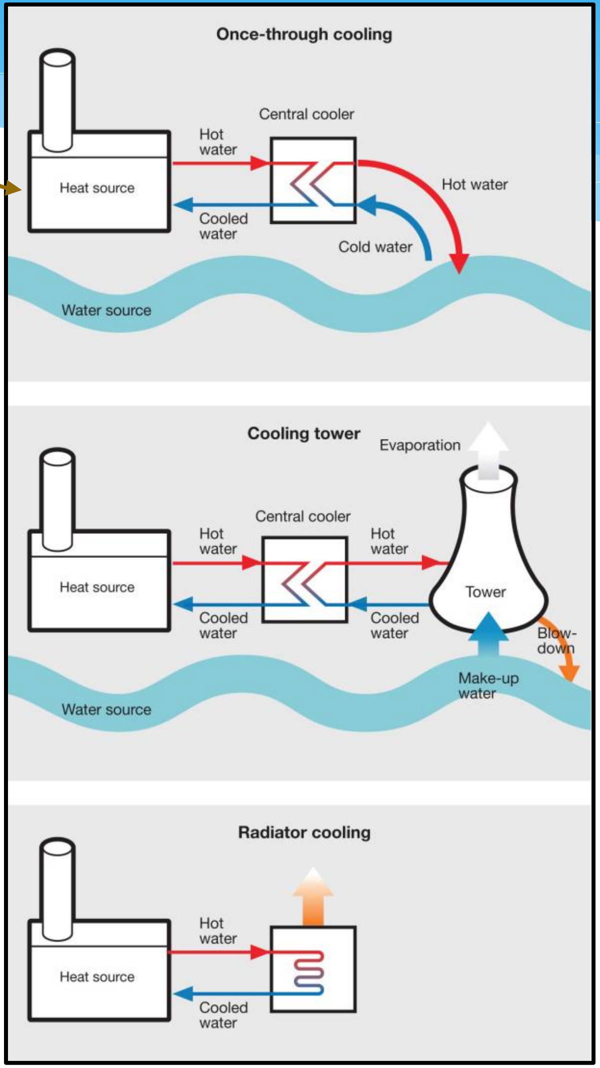
Context: water & energy (thermoelectric)

FUEL

Once through:
Larger withdrawal
Less consumptive

Recirculating tower:
Smaller withdrawal
More consumptive
(evaporation)

Dry cooling:
No cooling withdrawal
(boiler water make-up)



Rantanen, Mikko. 2008. Efficient use and consumption of water in power generation. WÄRTSILÄ TECHNICAL JOURNAL. Online: https://cdn.wartsila.com/docs/default-source/Power-Plants-documents/reference-documents/power-plants-articles/efficient-use-and-consumption-of-water-in-power-generation.pdf?sfvrsn=2

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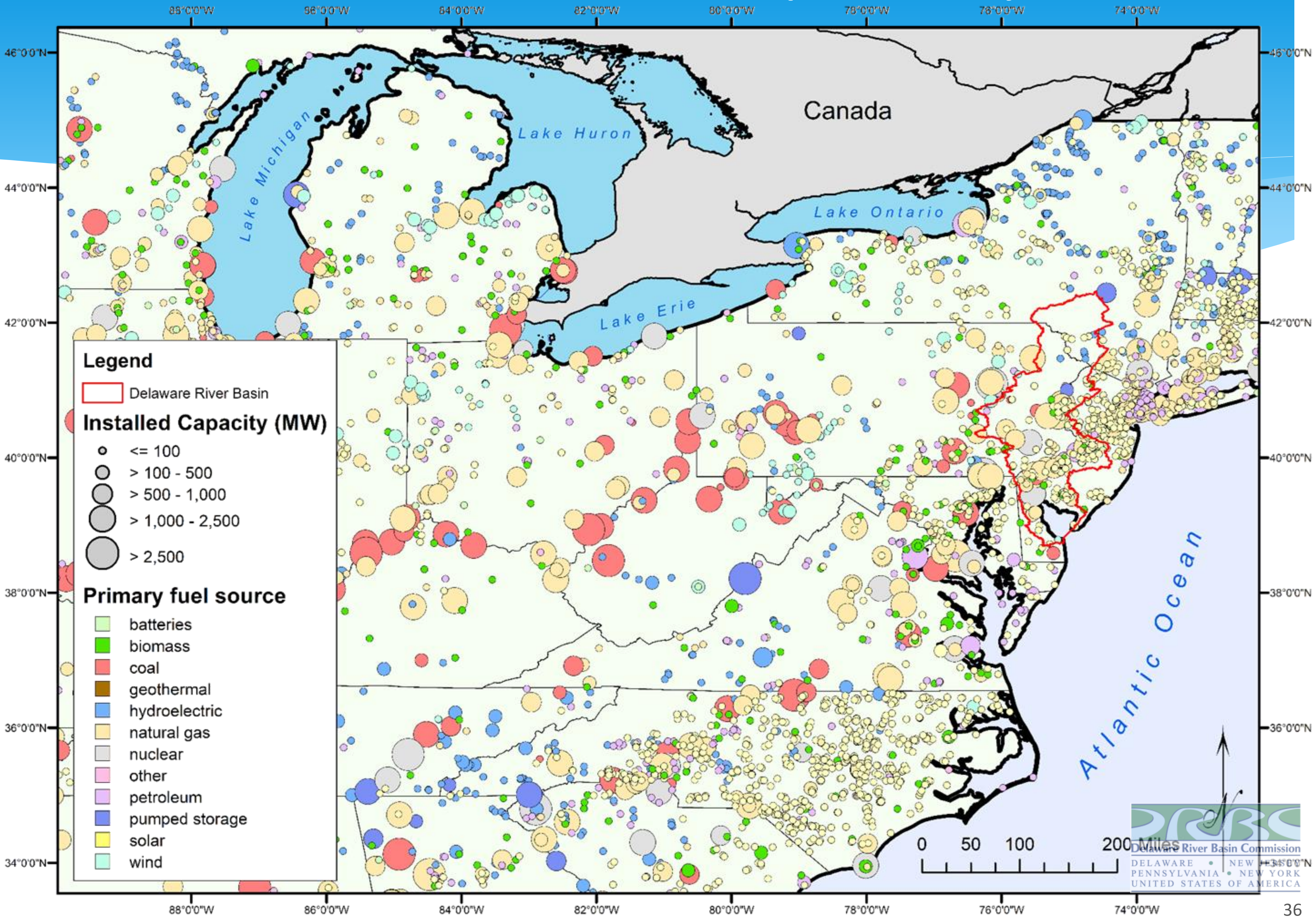
Context: power in the Delaware River Basin, comparatively

<u>Data sources</u>:
EIA: *PowerPlants_US_202004.shp*
https://www.eia.gov/maps/layer_info-m.php

"Operable electric generating plants in the United States by energy source. This includes all plants that are operating, on standby, or short- or long-term out of service with a combined nameplate capacity of 1 MW or more."

Represents "current" facility conditions as of April 2020.
<u>Does not</u> represent net generation, or historic fuels primary fuel types.



Context: power in the Delaware River Basin, comparatively

Data sources:

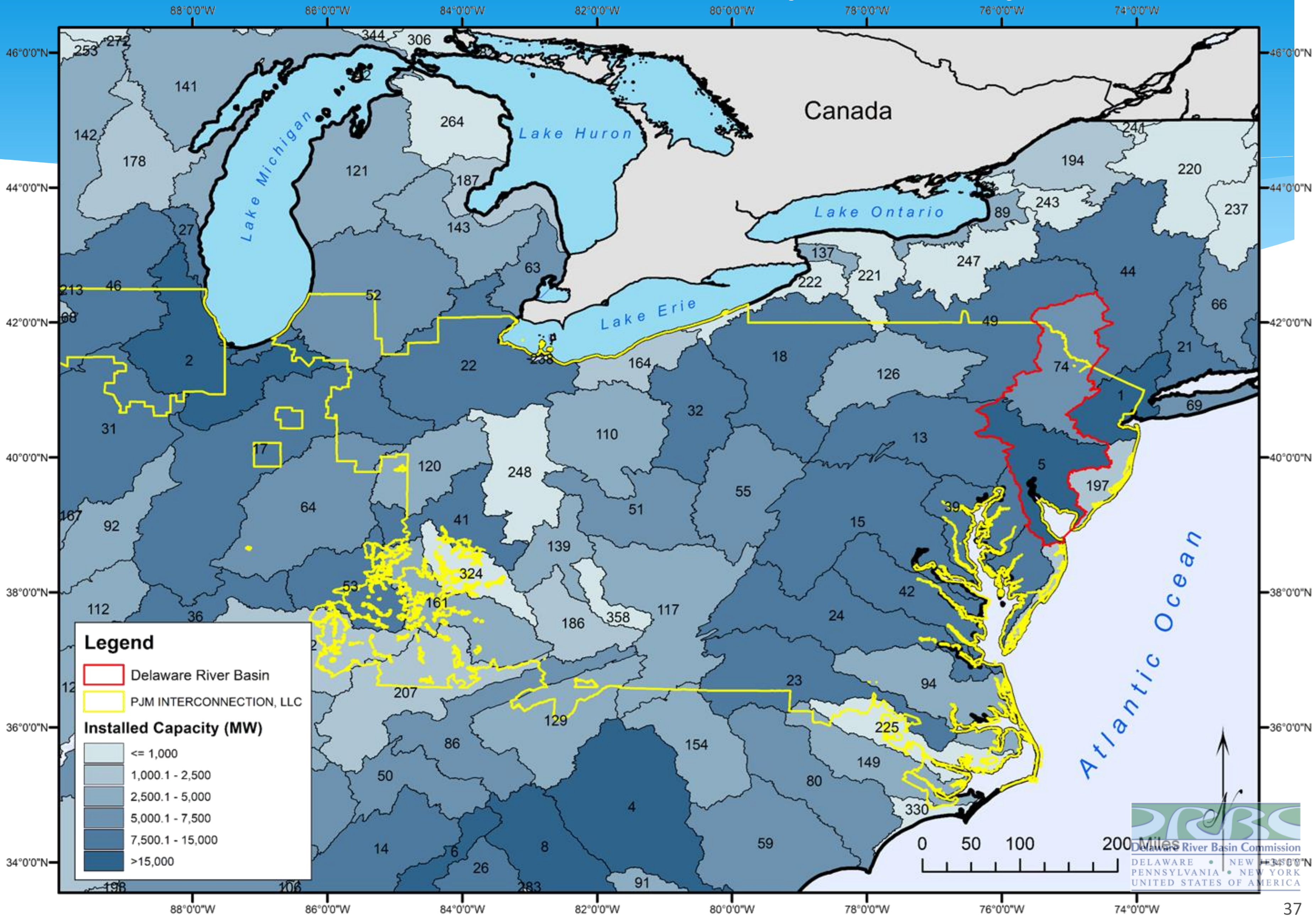
EIA: *PowerPlants_US_202004.shp*
https://www.eia.gov/maps/layer_info-m.php

USGS: *WBD_National_GDB.gdb*
http://prd-tnm.s3-website-us-west-2.amazonaws.com/?prefix=StagedProducts/Hydrography/WBD/National/GDB/

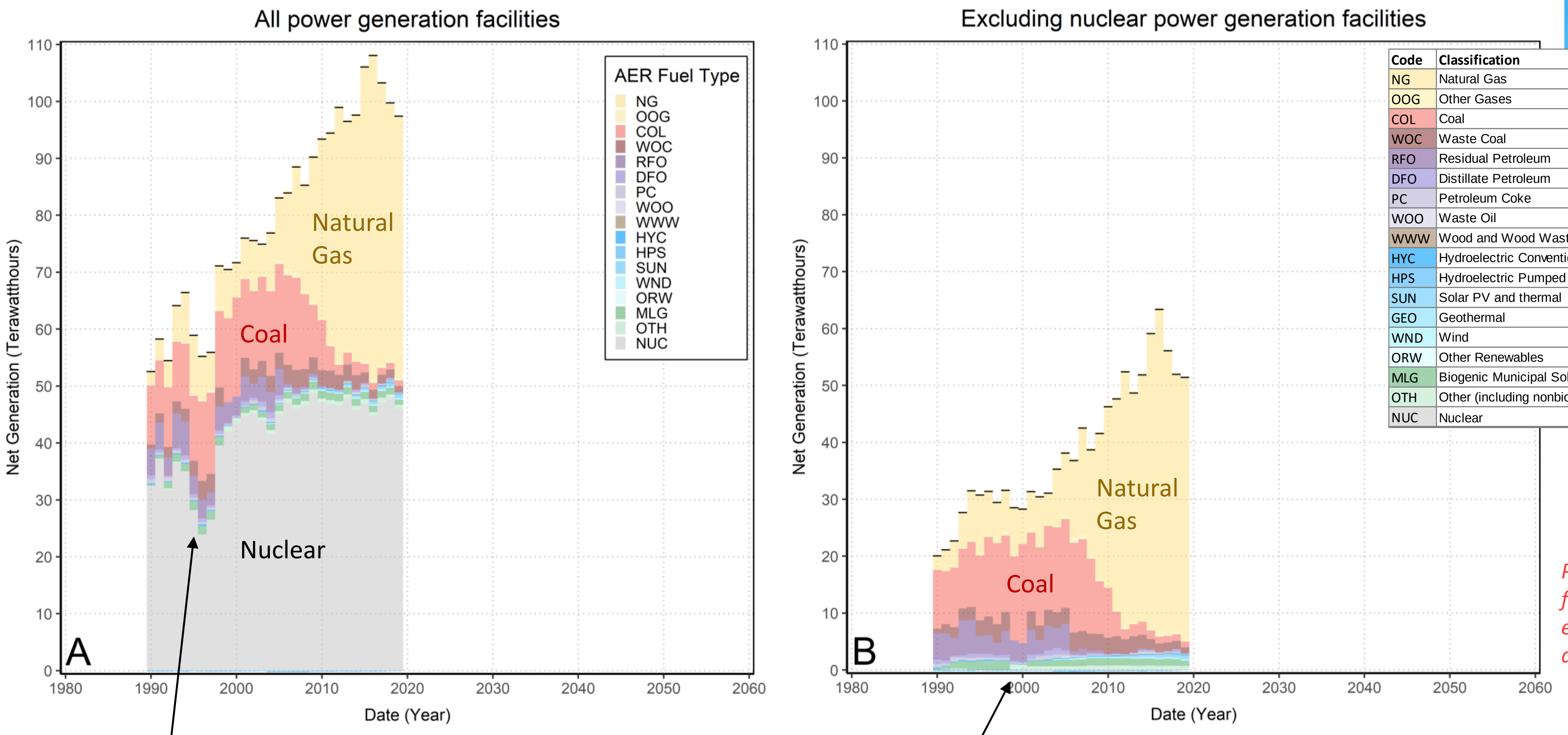
Some notes:

- Aggregate the installed capacity by HUC-6 code.
- 388 HUC-6 codes
  (excludes CN, GU, PR, MX, VI)
- 360 have installed capacity
- (020402) LDRW = 5th / 360
- (020401) UDRW = 74th / 360

Power in the DRB is comparably significant.



Historic power data: DRB-facilities net gen. (AER fuel type)



Code	Classification
NG	Natural Gas
OOG	Other Gases
COL	Coal
WOC	Waste Coal
RFO	Residual Petroleum
DFO	Distillate Petroleum
PC	Petroleum Coke
WOO	Waste Oil
WWW	Wood and Wood Waste
HYC	Hydroelectric Conventional
HPS	Hydroelectric Pumped Storage
SUN	Solar PV and thermal
GEO	Geothermal
WND	Wind
ORW	Other Renewables
MLG	Biogenic Municipal Solid Waste and Landfill Gas
OTH	Other (including nonbiogenic MSW)
NUC	Nuclear

Proportions of each facility's net generation to each fuel type are from annual reports.

Salem Generating Station temporarily shut down around 1996 (including part of 1995 & 1997)

e.g., no data for “WOC” (1999-2000) due to manual classification of AER fuel types, given the best available data resolution. Likely captured as “COL”

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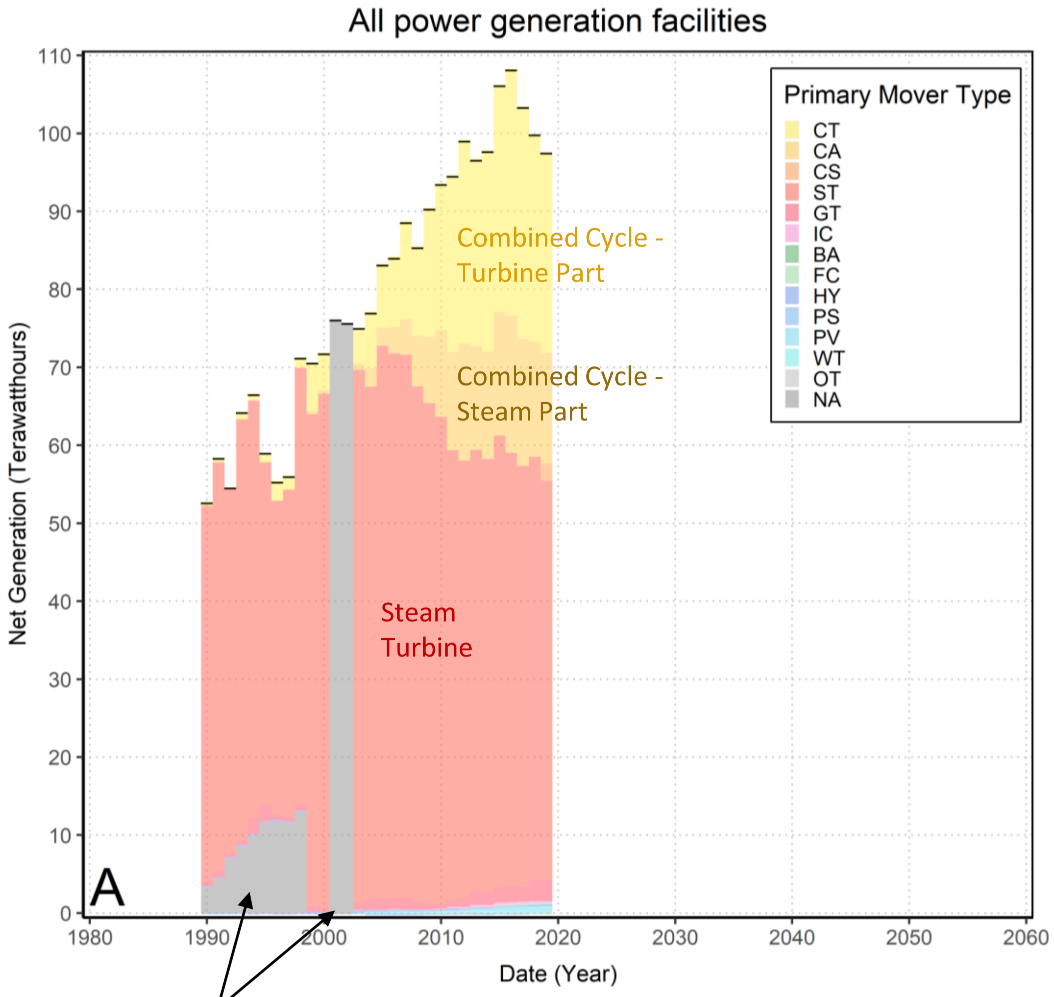
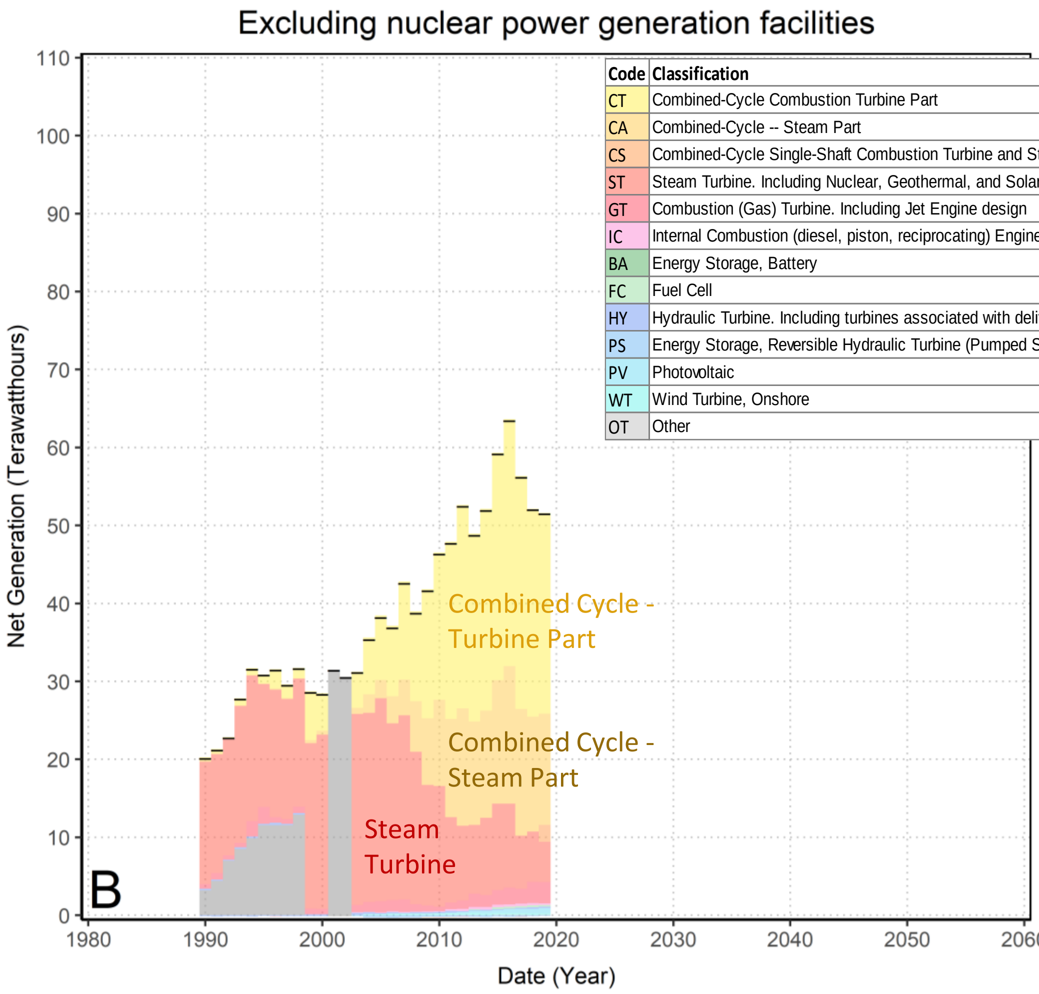
Historic power data: DRB-facilities net gen. (primary mover)



Data gaps due to unavailable information reported to EIA forms



Code	Classification
CT	Combined-Cycle Combustion Turbine Part
CA	Combined-Cycle -- Steam Part
CS	Combined-Cycle Single-Shaft Combustion Turbine and Steam Turbine share of single generator
ST	Steam Turbine. Including Nuclear, Geothermal, and Solar Steam (does not include Combined Cycle).
GT	Combustion (Gas) Turbine. Including Jet Engine design
IC	Internal Combustion (diesel, piston, reciprocating) Engine
BA	Energy Storage, Battery
FC	Fuel Cell
HY	Hydraulic Turbine. Including turbines associated with delivery of water by pipeline.
PS	Energy Storage, Reversible Hydraulic Turbine (Pumped Storage)
PV	Photovoltaic
WT	Wind Turbine, Onshore
OT	Other

Proportions of each facility's net generation to each primary mover type are from annual reports.

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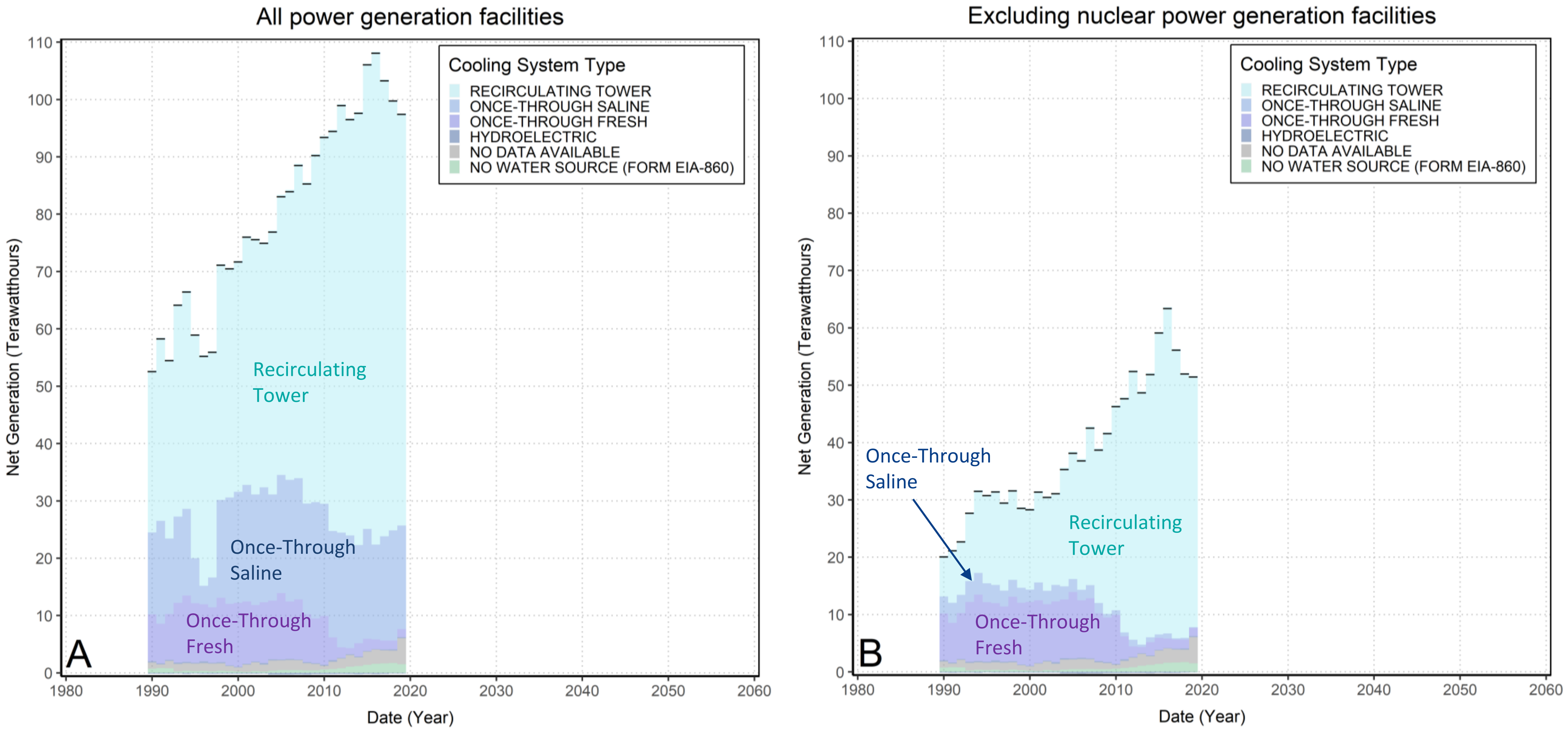
Historic power data: DRB-facilities net gen. (cooling system)



A single cooling system classification is assigned to each facility's historic net generation data (i.e., not reported annually).

Cooling system classifications primarily obtained from supplemental data for (Harris & Diehl, 2019). Facilities which were not classified (mainly retired facilities) were classified by DRBC.

Harris, M. A., & Diehl, T. H. (2019). *Withdrawal and Consumption of Water by Thermoelectric Power Plants in the United States, 2015: Scientific Investigations Report 2019–5103*. Reston, Virginia. U.S. Geological Survey. https://doi.org/10.3133/sir20195103

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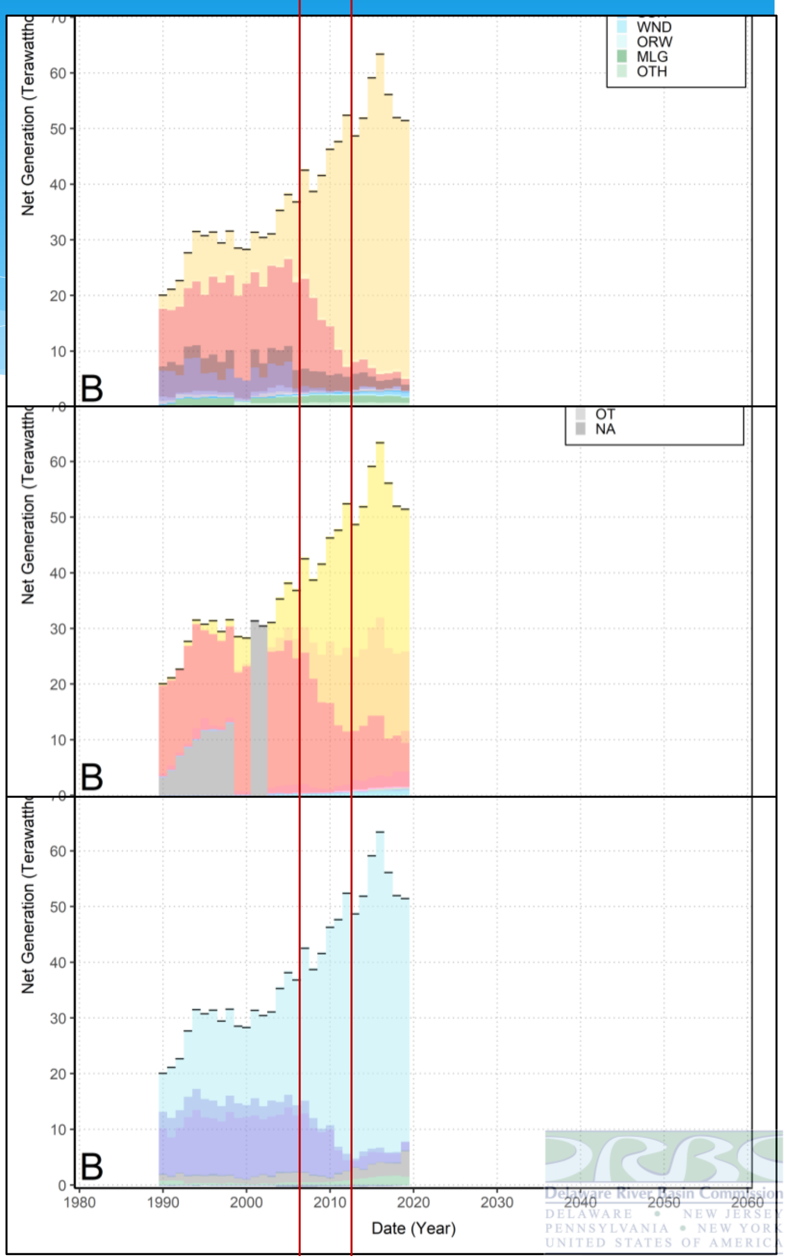
Notes on historic DRB net generation

Key notes:

1. In the DRB, total net generation reached a peak of 108.328 Twh in 2016, followed by the largest decrease in recent history (-10.748 Twh), to 97.580 Twh in 2019.
2. As a percent of total **non-nuclear** net generation, DRB decreases in the following categories are observed from 2007-2012:
   i. AER Fuel Type “COL” (coal) decreased from 38.0% to 3.4%
   ii. Primary Mover “ST” (steam turbines) decreased from 55.4% to 18.2%
   iii. Once-through freshwater cooling decreased from 24.6% to 3.5%
   iv. Counter to findings reported by (Harris & Diehl, 2019) for 2010-2015 where the national net generation decreased ~7%, the DRB increased ~13.6%
3. However, (Harris & Diehl, 2019) also reported:
   i. For 2008 through 2017, 47% of total retired generation capacity was from coal-fired power plants, and 26% were NG steam turbines (EIA, 2018)
   ii. More than half the plants which became active were NGCC, all but one with recirculating cooling system

These are notes based on observations of reported data. It is understood that regulations such as Clean Air Act, Clean Water Act and market forces have influenced the observed trends; however, it is not in the scope of this study to determine such cause-and-effect relationships.

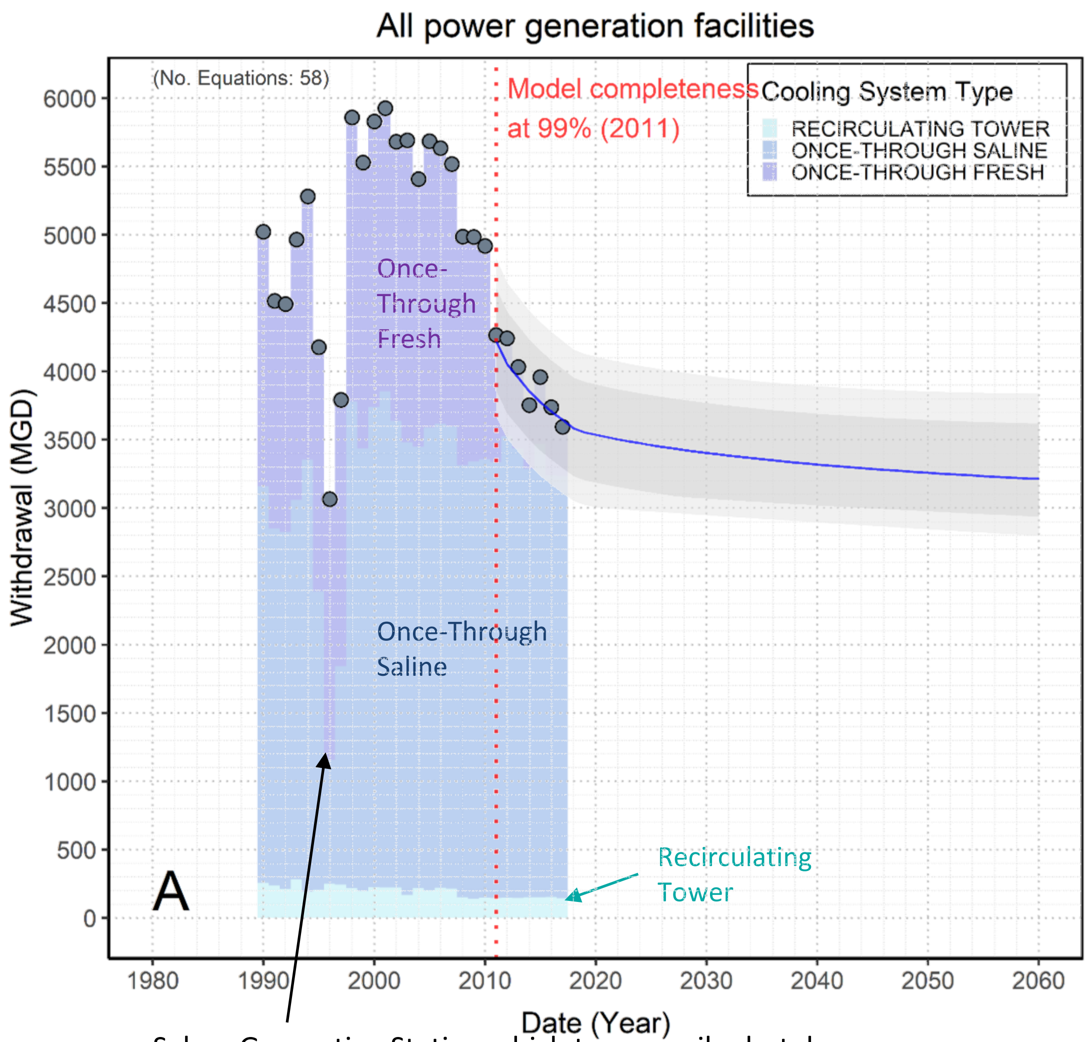
Timeframe between lines: 2007-2012



Non-nuclear facilities

USEIA. (2018). Almost all power plants that retired in the past decade were powered by fossil fuels. U.S. Energy Information Administration. https://www.eia.gov/todayinenergy/detail.php?id=34452

Thermoelectric: all facilities (water withdrawals)



Salem Generating Station which temporarily shut down around 1996, uses once-through saline water cooling (including part of 1995 & 1997)

Regarding withdrawal data:

1. Overall, water withdrawals by thermoelectric facilities appears to have peaked around the year 2000 with a reported annual average of about 5,927 MGD (*in 2001*).
2. The decrease in total withdrawal from 2007-2017: 1,923 MGD (~34.8%)
3. Most decreases associated with facilities using once-through freshwater cooling systems.
4. Findings are generally consistent with those estimated nationally by the model presented in in Harris & Diehl, 2019.

Regarding projections:

1. Projected continued decrease 2017-2060 (430 MGD, 11.7%) with dramatic plateau (non-nuclear facilities)
2. Uneven predictive intervals, skewed higher (when a predictive interval for an individual facility is calculated to be negative, it is instead taken as zero)

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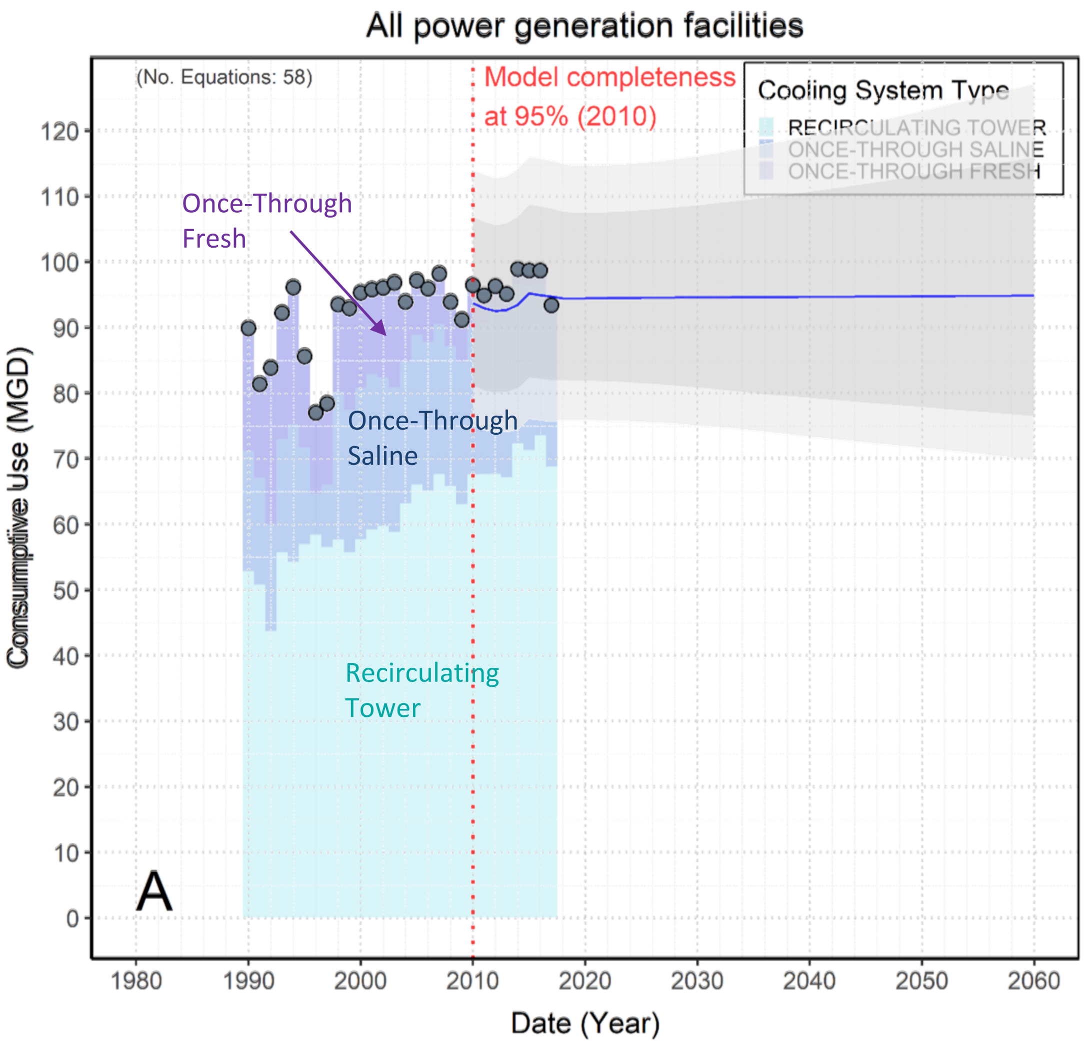
Thermoelectric: all facilities (consumptive use)



Regarding consumptive use data:

1. Relatively stable over the last 20 years:
   Average annual value of 95.7 MGD (1998-2017).
2. Consumptive increasingly attributed to facilities using recirculating cooling.
3. Nationally, the model in Harris & Diehl, 2019 estimated that thermoelectric water consumption decreased about 21% between 2010 and 2015. The DRB appears to be counter to the national trend
   (*note*: a national trend is likely inherently comprised of many varying sub-trends).

Regarding projections:

1. The same projection equations as total water withdrawal… each projection equation had a CUR applied to it.
   (The same as calculating the consumptive use data).
2. Aggregated projections create an “average model” of about 93 MGD, predictive intervals relatively symmetric.

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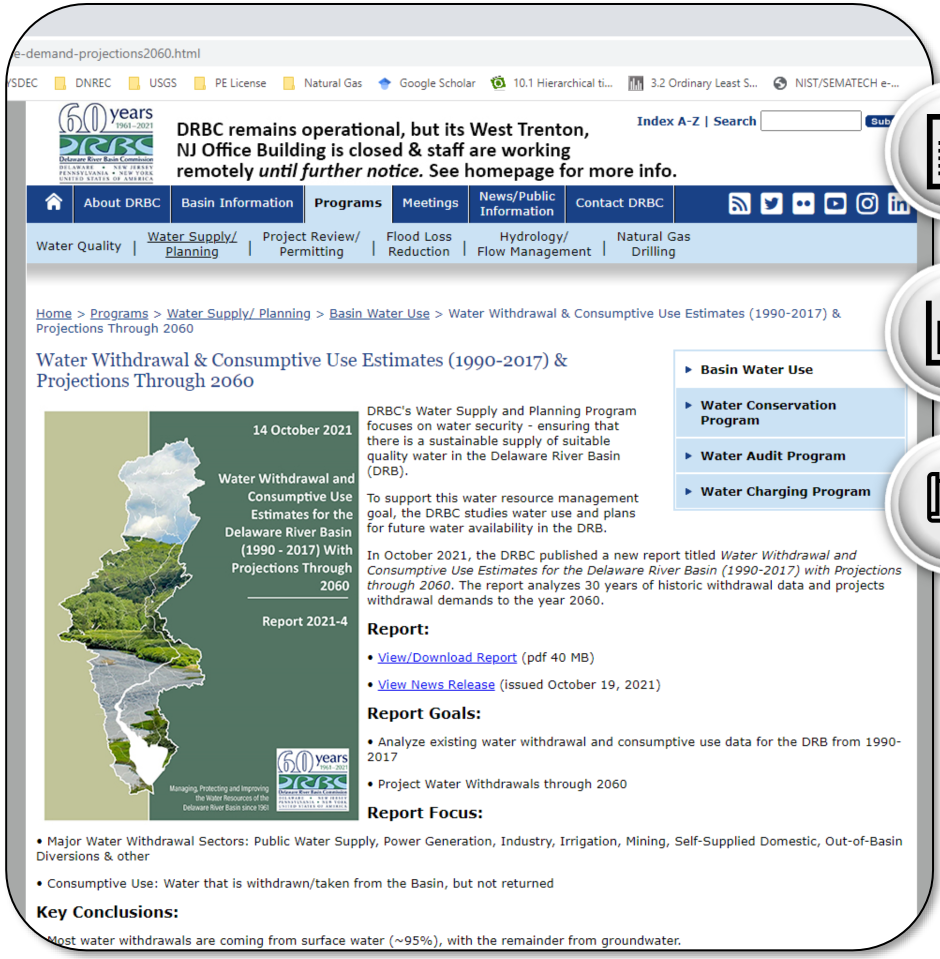
6. Publication & Data Deliverable

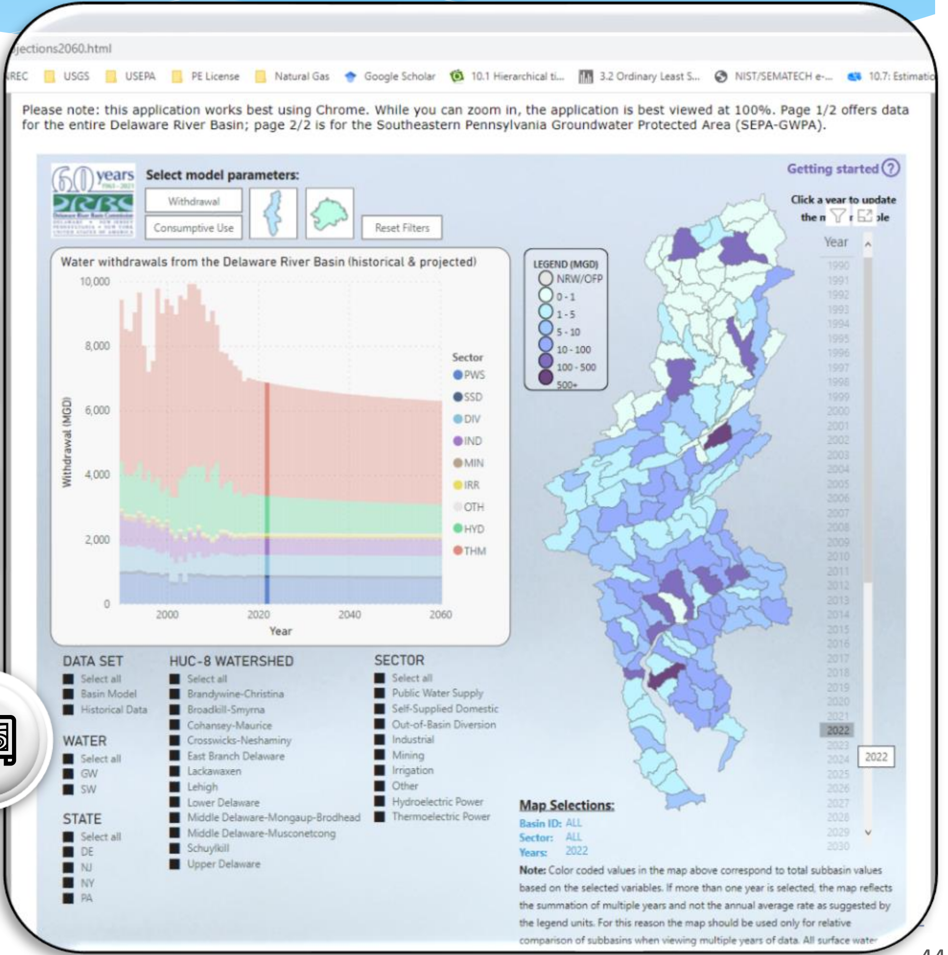
Report webpage:

https://www.nj.gov/drbc/programs/supply/use-demand-projections2060.html



You can:

- Download the report (~40 MB) (Best viewed with Adobe)
- Download the dataset (~10 MB) MS Excel File (no macros)
- Download high resolution maps from the report
- Interact with the Power BI data visualization tool



7. Questions

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