Water Withdrawal and Consumptive Use Estimates for the Delaware River Basin (1990-2017) With Projections Through 2060

Lehigh Valley Planning Commission Environment Committee Meeting

October 25, 2022

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and

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60 years 1961–2021

Delaware River Basin Commission

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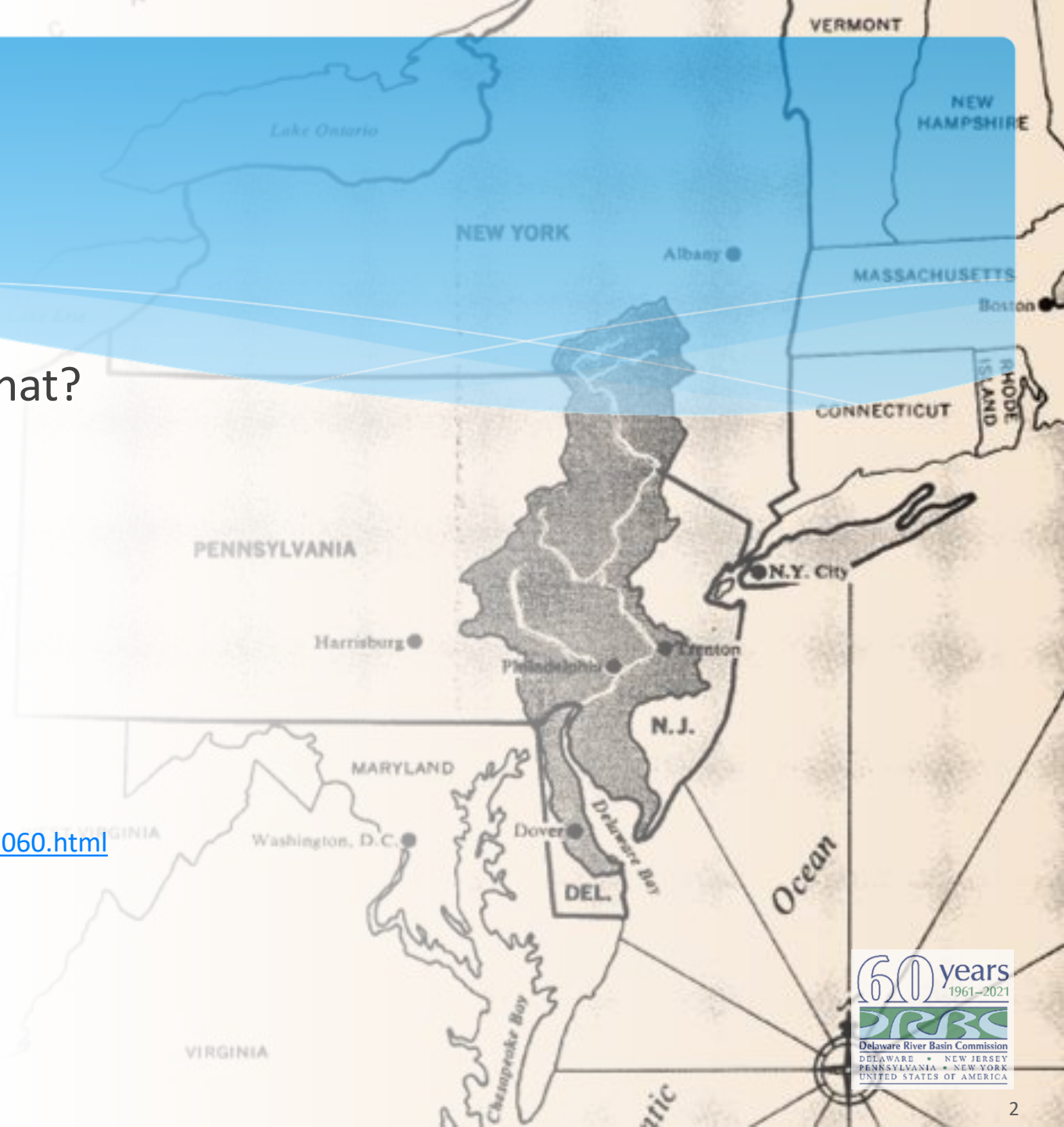
Outline

1. Water Supply Planning – Why and What?
2. Methodology
3. Results: Delaware River Basin
4. Results: What about the Lehigh?
5. Publication & Data Visualization
6. Questions

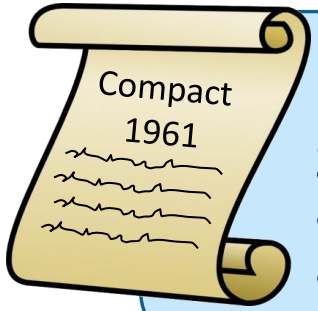
Report & data:
https://www.nj.gov/drbc/programs/supply/use-demand-projections2060.html



1. Water Supply Planning: Why are we projecting withdrawal data?

Is there enough water to meet future demands?

- What are the current/future demands?
- How does it compare against current allocations?
- What about a repeat of the Drought of Record?
- What about climate change?



DELAWARE RIVER BASIN COMPACT (1961)

3.6 General Powers.

- Conduct and sponsor research on water resources
- Collect, compile, correlate, analyze, report and interpret data on water resources and uses in the basin

1. Water Supply Planning: What are the 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.

2. Methodology

Ontelaunee Reservoir Dam
near Reading, Pennsylvania.
Credit: © Melissa Kopf
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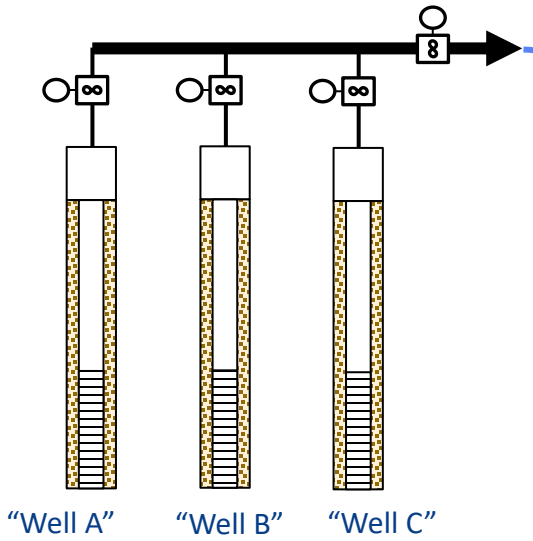
2. Methodology: What data are we looking at?

Withdrawals

Consumptive Use



Groundwater withdrawn from wells

Surface water withdrawn from stream, rivers and lakes

Lehigh River

1000 gallons withdrawn

Insert specific use of water here.

Treatment if necessary.

200 gallons consumptively used (CUR = 20%).

800 gallons discharge back to river

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2. Methodology: 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.

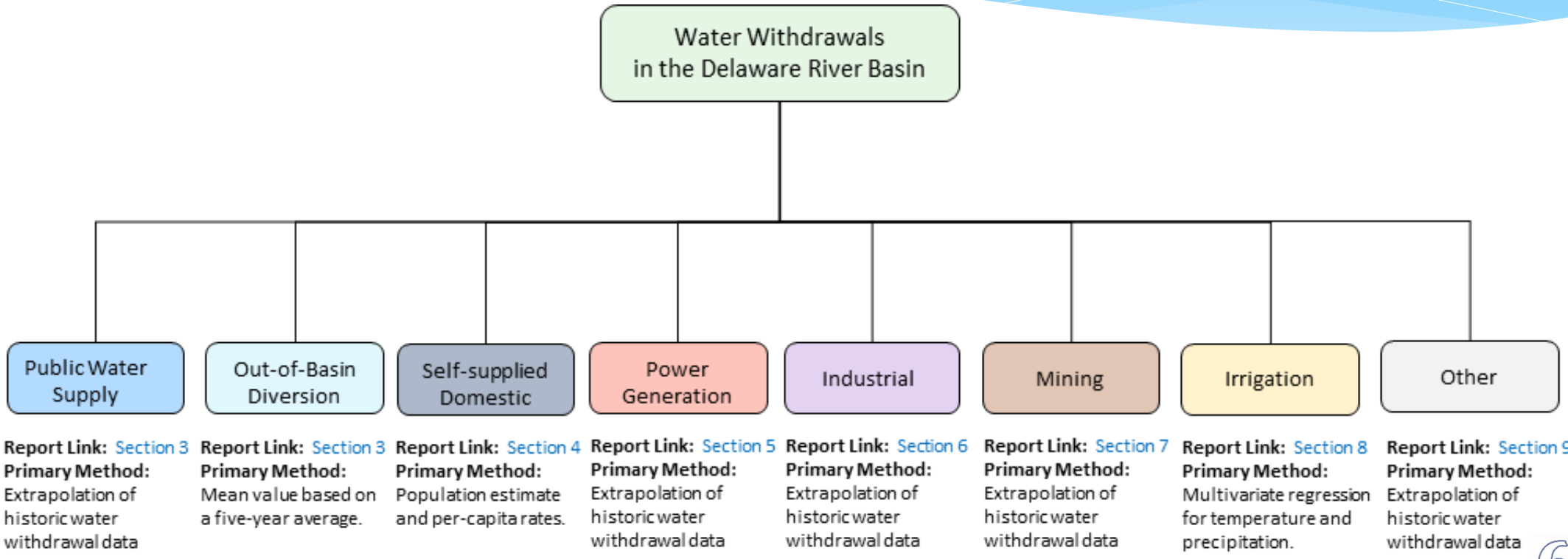
(IRR) Irrigation
Water withdrawals which are applied by an irrigation system to assist crop and pasture growth, or to maintain vegetation on recreational lands such as parks and golf courses. This does not include withdrawals/ diversions associated with aquaculture.

(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.

2. Methodology: Breakdown by sector

The primary method is extrapolation of historic reported withdrawal data



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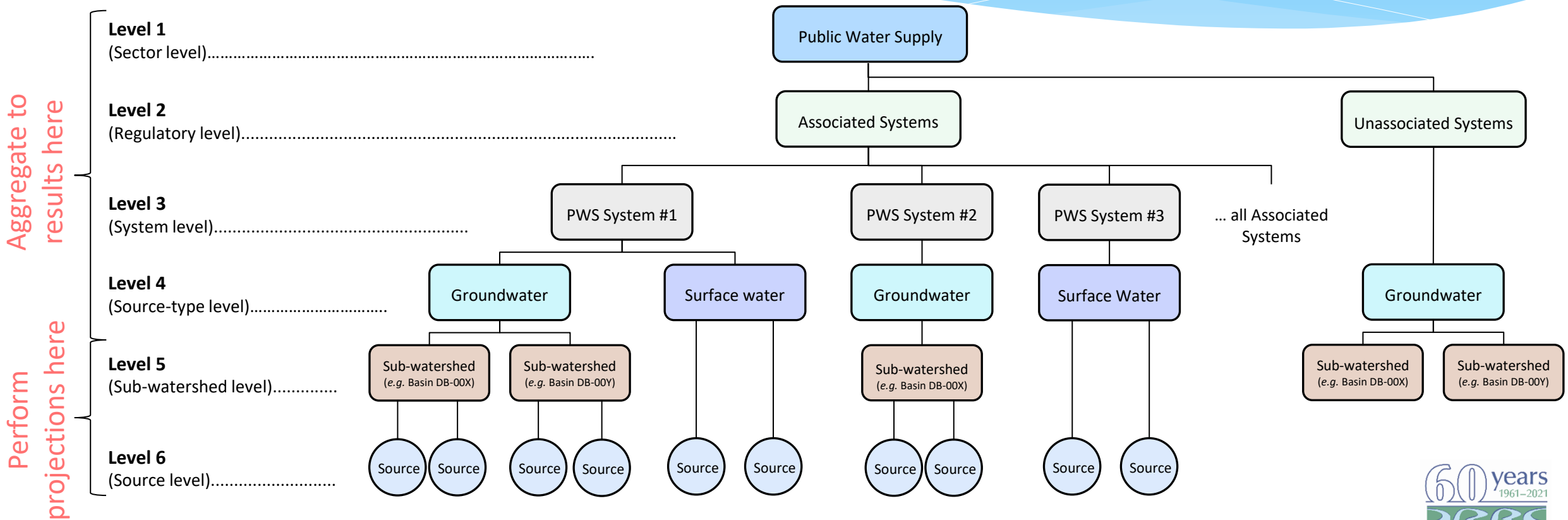
2. Methodology: A plan for projecting data?

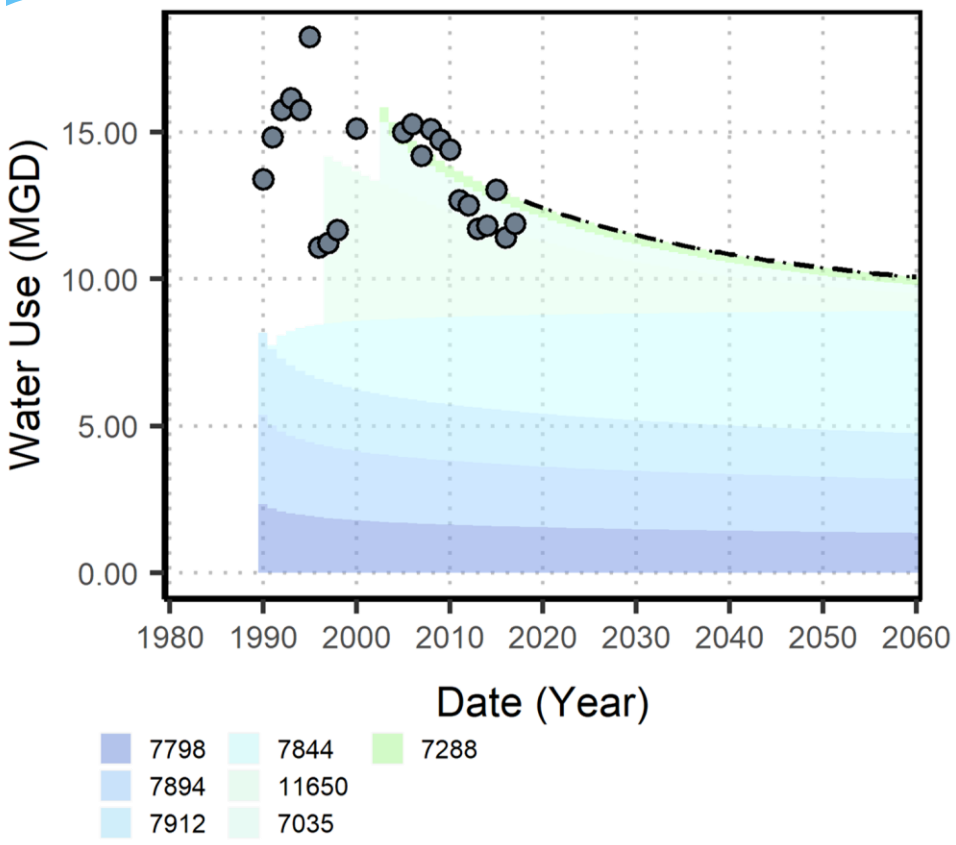
Where do we start?

Time-series hierarchy



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

2. Methodology: How do analyze results?



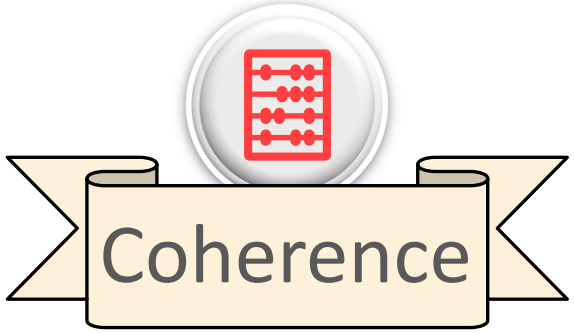
"Bottom-up approach"

$$\boldsymbol{Total} = \underbrace{f_{1,1}(x) + f_{1,2}(x) + f_{1,3}(x) + f_{1,4}(x)}_{\text{PWS System \#1}} + \underbrace{f_{2,1}(x)}_{\text{PWS System \#2}} + \underbrace{f_{3,1}(x) + f_{3,2}(x)}_{\text{PWS System \#3}} + \ldots$$

PWS System #1: DB-00X, DB-00Y, SW 1, SW 2

PWS System #2: DB-00X, "System Level"

PWS System #3: SW 1, SW 2



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

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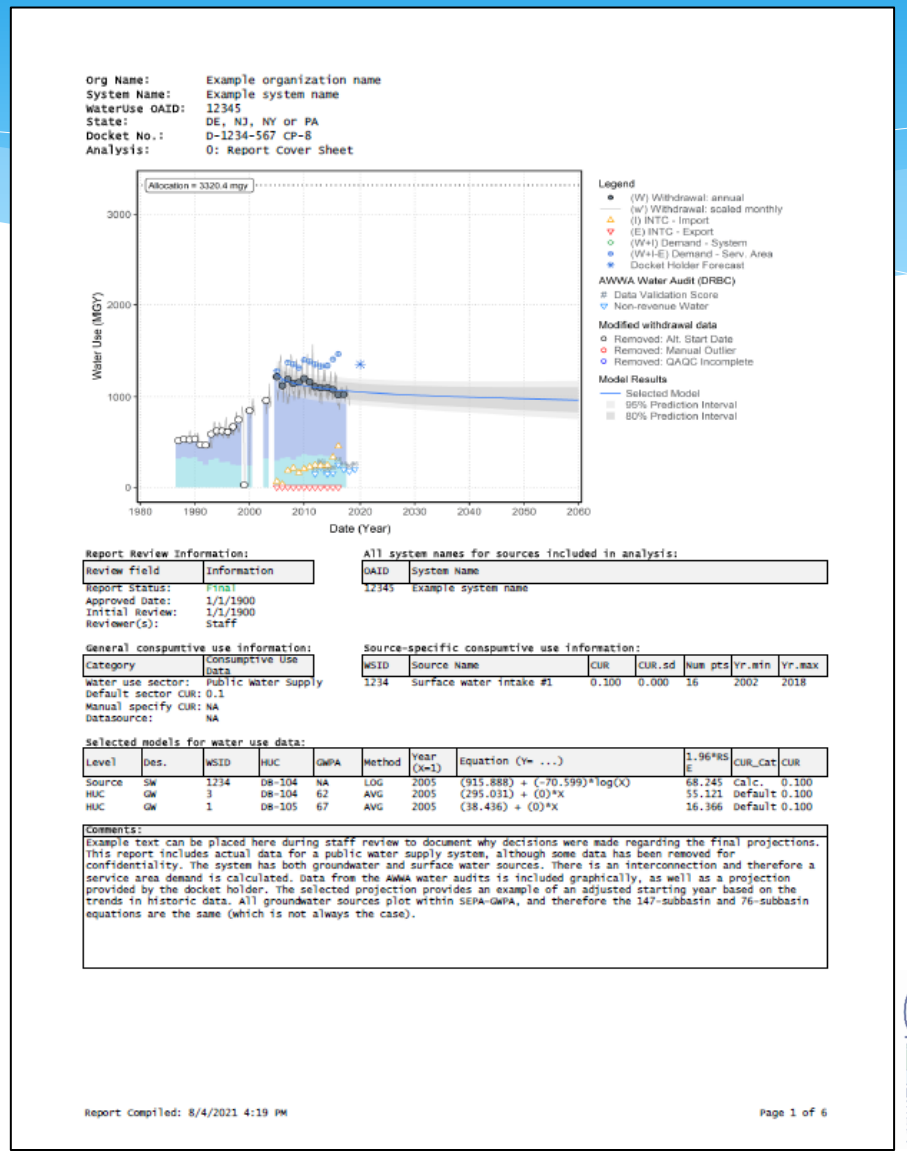
2. Methodology: A plan for projecting data?

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 consumptive 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 consumptive 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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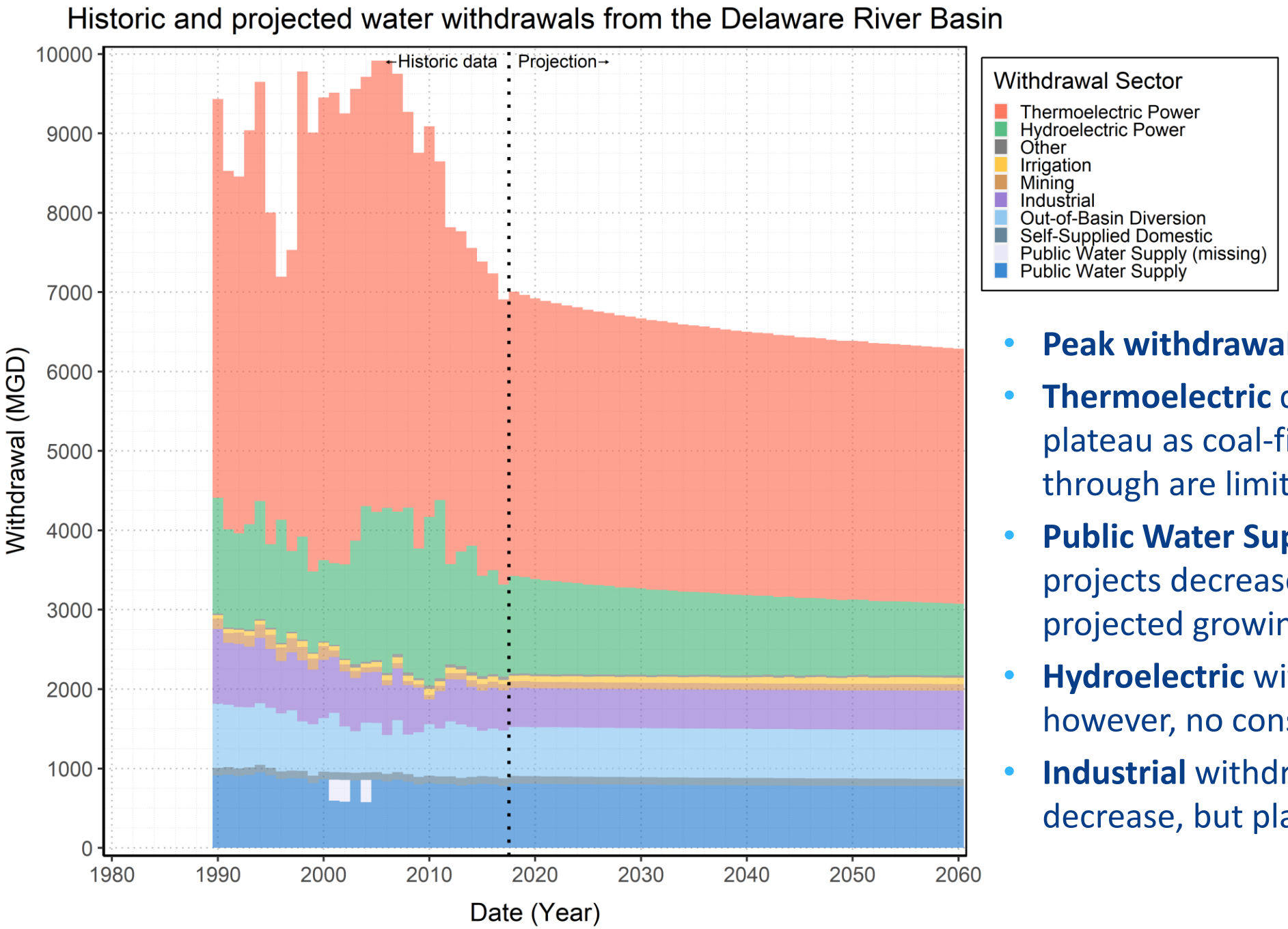
3. Results: Delaware River Basin

Wing Dam on The Delaware River
Lambertville New Jersey on the left and
New Hope Pennsylvania on the right.
Credit: © James Loesch
Used with permission



- **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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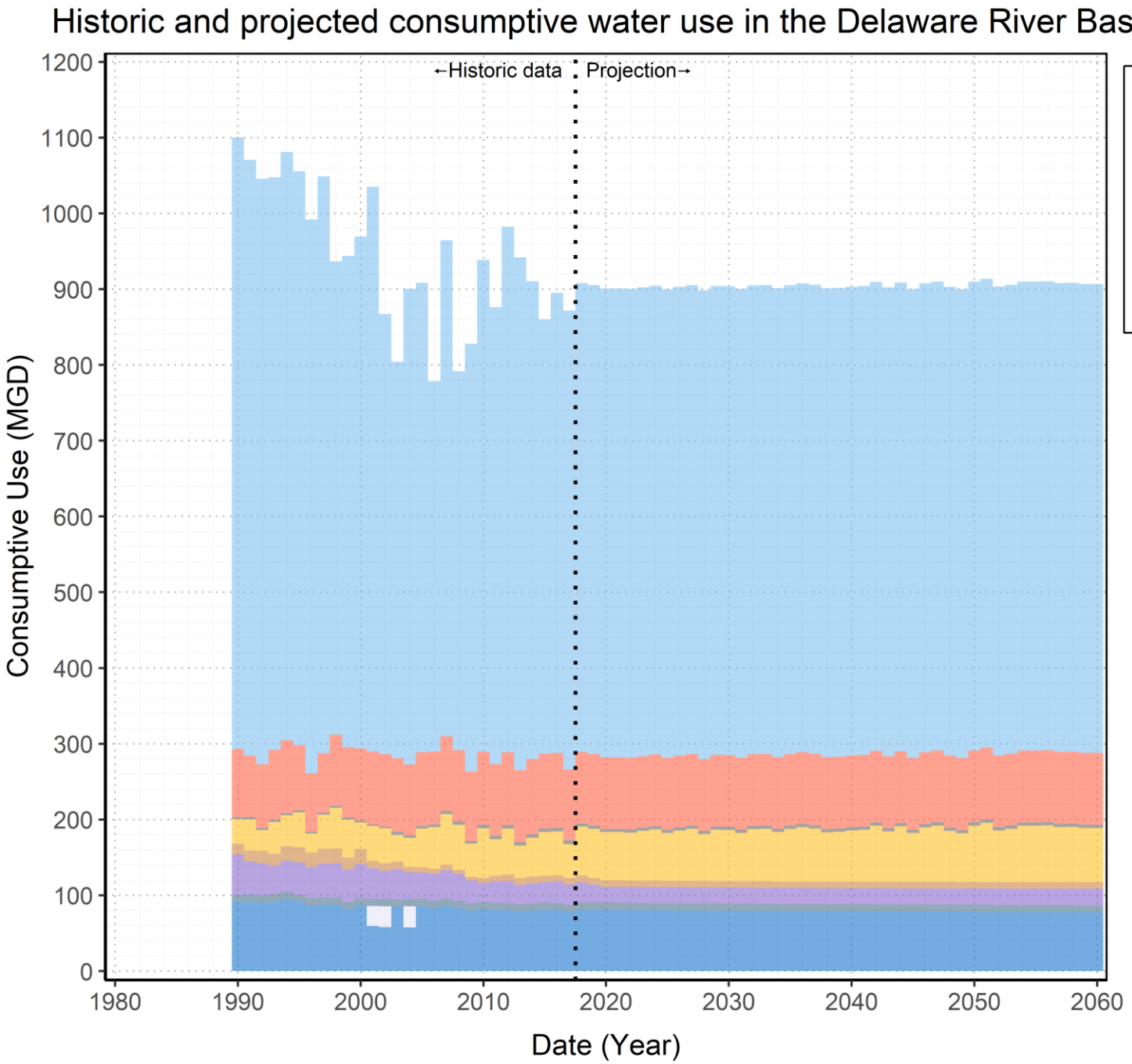

- **Consumptive use projected to remain relatively constant**
- **Largest consumptive use is Out-of-Basin Exports under a U.S. Supreme Court Decree**
- **Thermoelectric** consumptive use constant despite decreased withdrawals due to changes in technology
- **Irrigation** is significant and shows slight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

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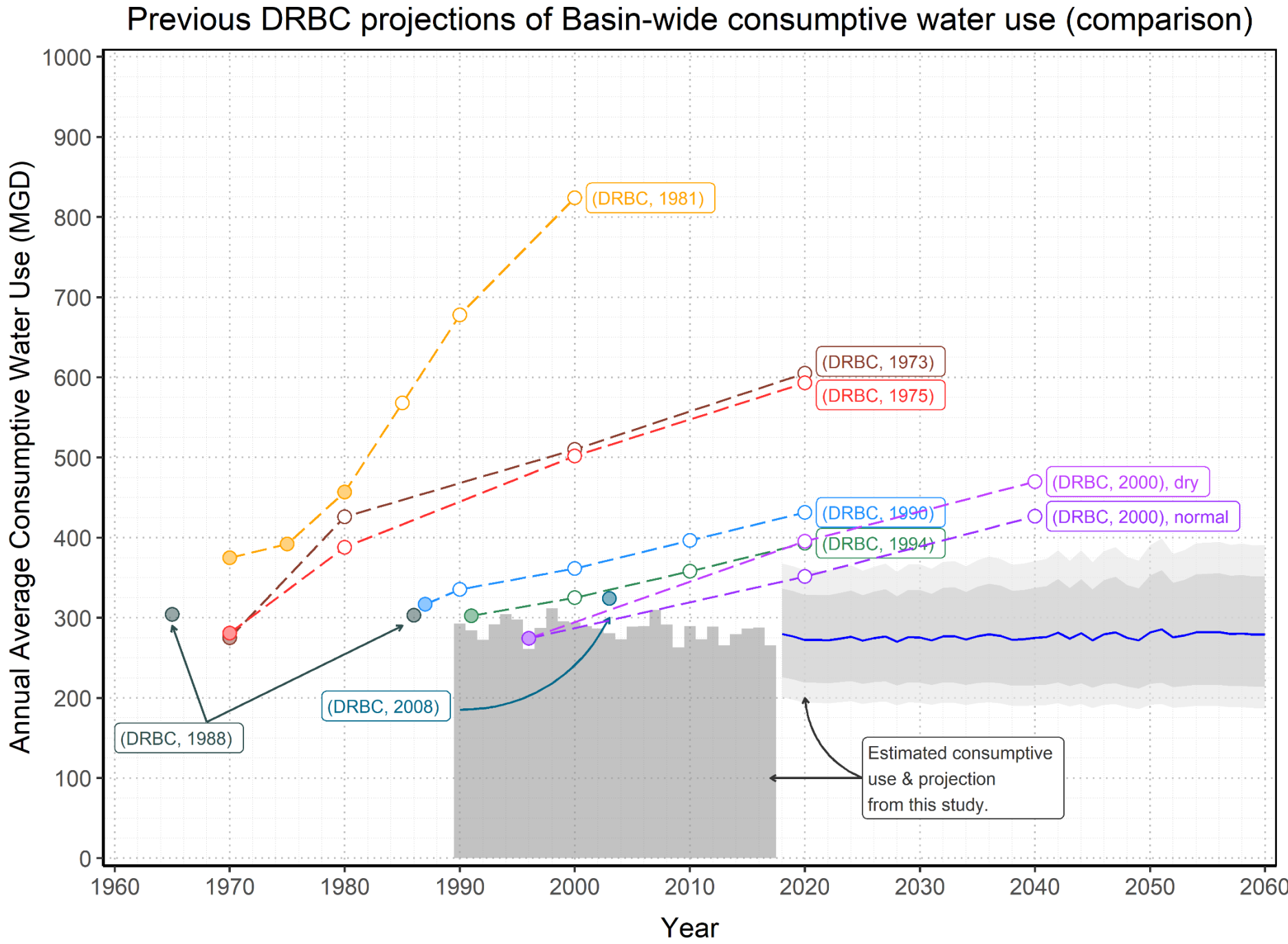

Prior projections often:

- 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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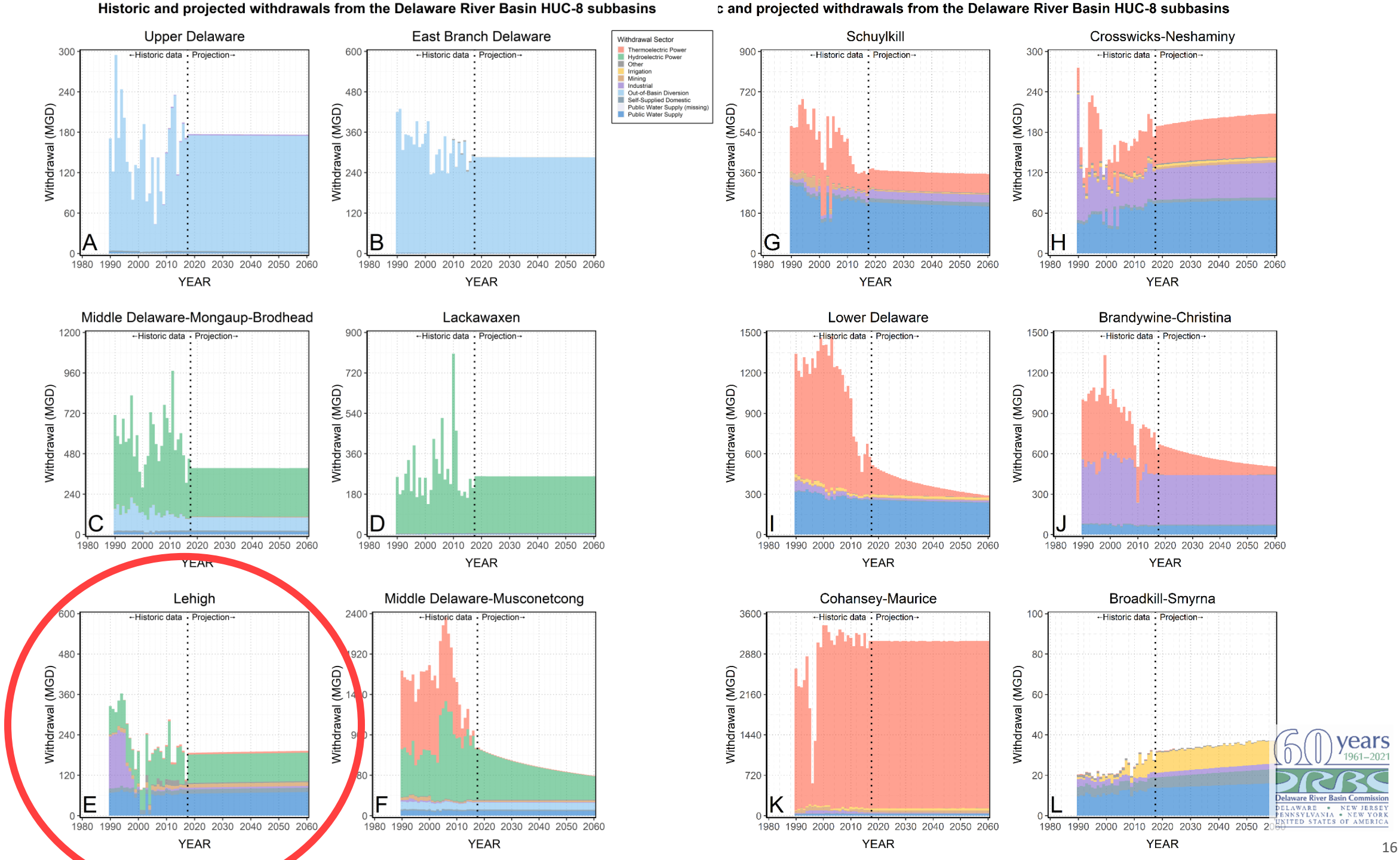
Historic and projected withdrawals from the Delaware River Basin HUC-8 subbasins
c and projected withdrawals from the Delaware River Basin HUC-8 subbasins
Upper Delaware
East Branch Delaware
Schuylkill
Crosswicks-Neshaminy
Middle Delaware-Mongaup-Brodhead
Lackawaxen
Lower Delaware
Brandywine-Christina
Lehigh
Middle Delaware-Musconetcong
Cohansey-Maurice
Broadkill-Smyrna
Withdrawal Sector
Thermoelectric Power
Hydroelectric Power
Other
Irrigation
Mining
Industrial
Out-of-Basin Diversion
Self-Supplied Domestic
Public Water Supply (missing)
Public Water Supply
←Historic data
Projection→
Withdrawal (MGD)
YEAR
A
B
C
D
E
F
G
H
I
J
K
L

4. Results: What about the Lehigh?

Fairmount Water Works
in Philadelphia, Pennsylvania.
Credit: Partnership for the Delaware Estuary
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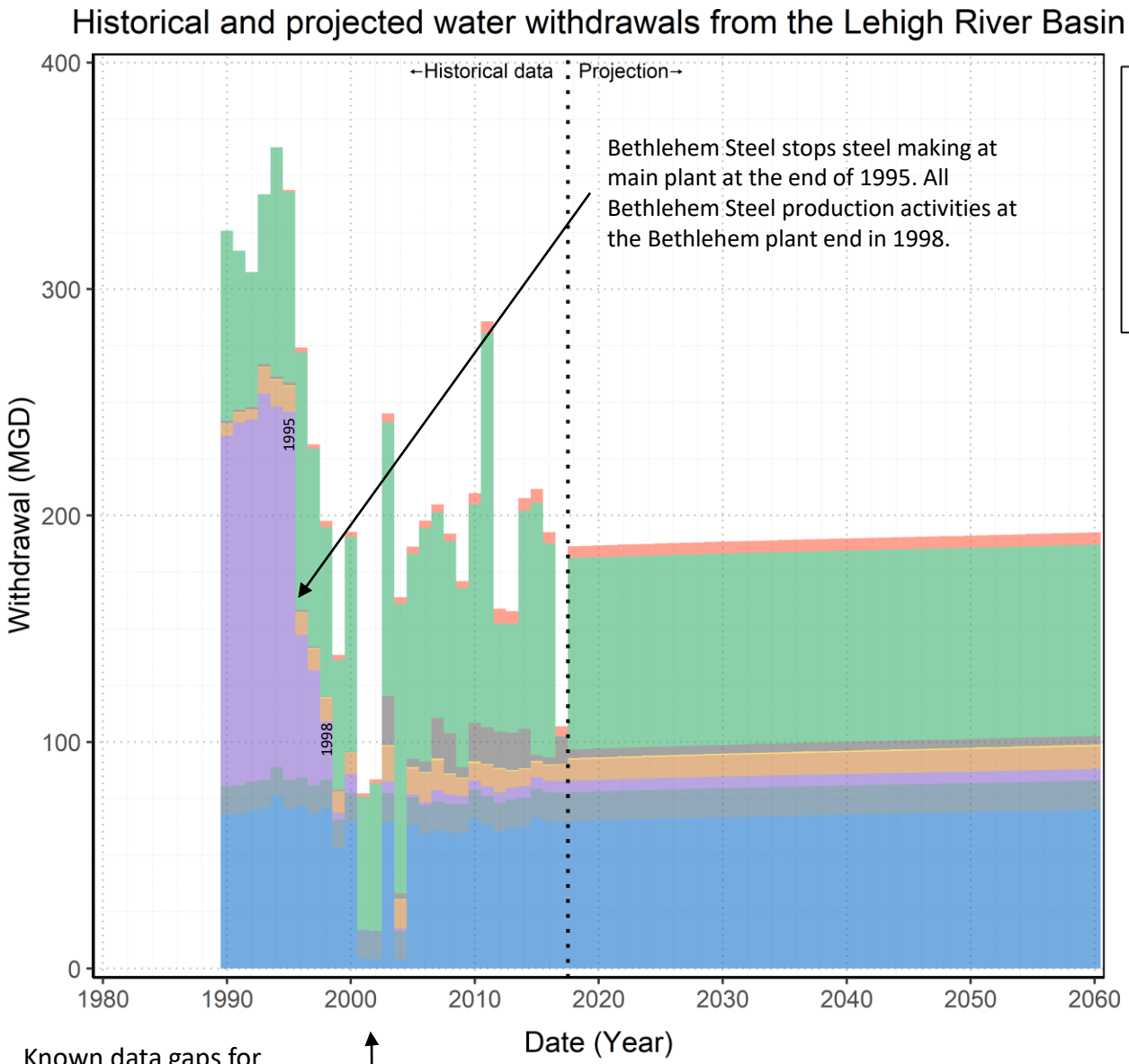
WITHDRAWALS

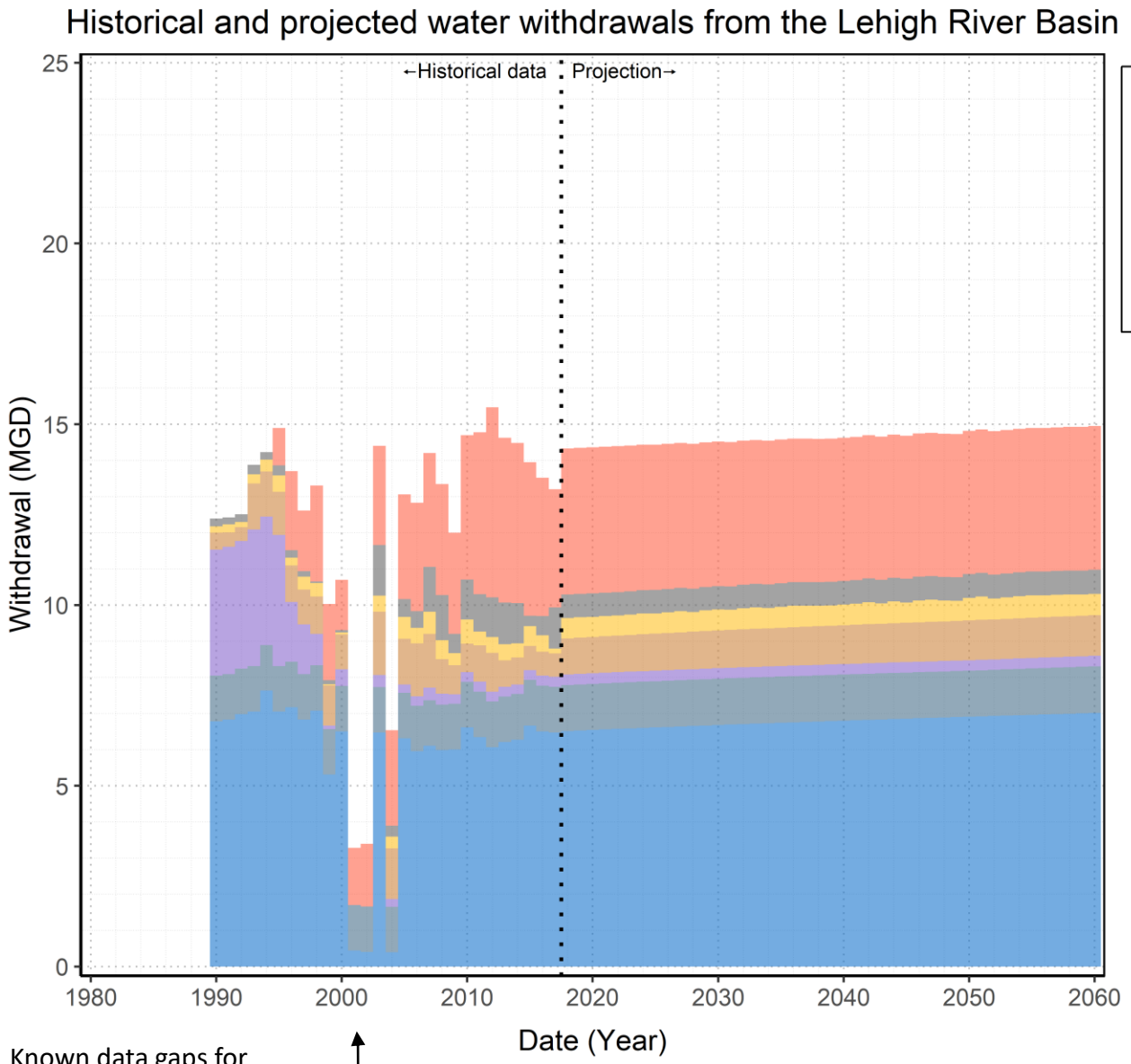


NOTE: The top 10 facilities account for about 80% of the total withdrawal.

Excluding hydroelectric, the top 10 account for about 75%.

Sector	Average Withdrawal (MGD) 2013-2017	Percentage
Hydroelectric Power	70.103	40.0%
Public Water Supply	64.255	36.6%
Self-Supplied Domestic	12.652	7.2%
Other	10.414	5.9%
Mining	7.028	4.0%
Thermoelectric Power	5.269	3.0%
Industrial	5.203	3.0%
Irrigation	0.439	0.3%
Subtotal	175.362	100.0%

CONSUMPTIVE USE



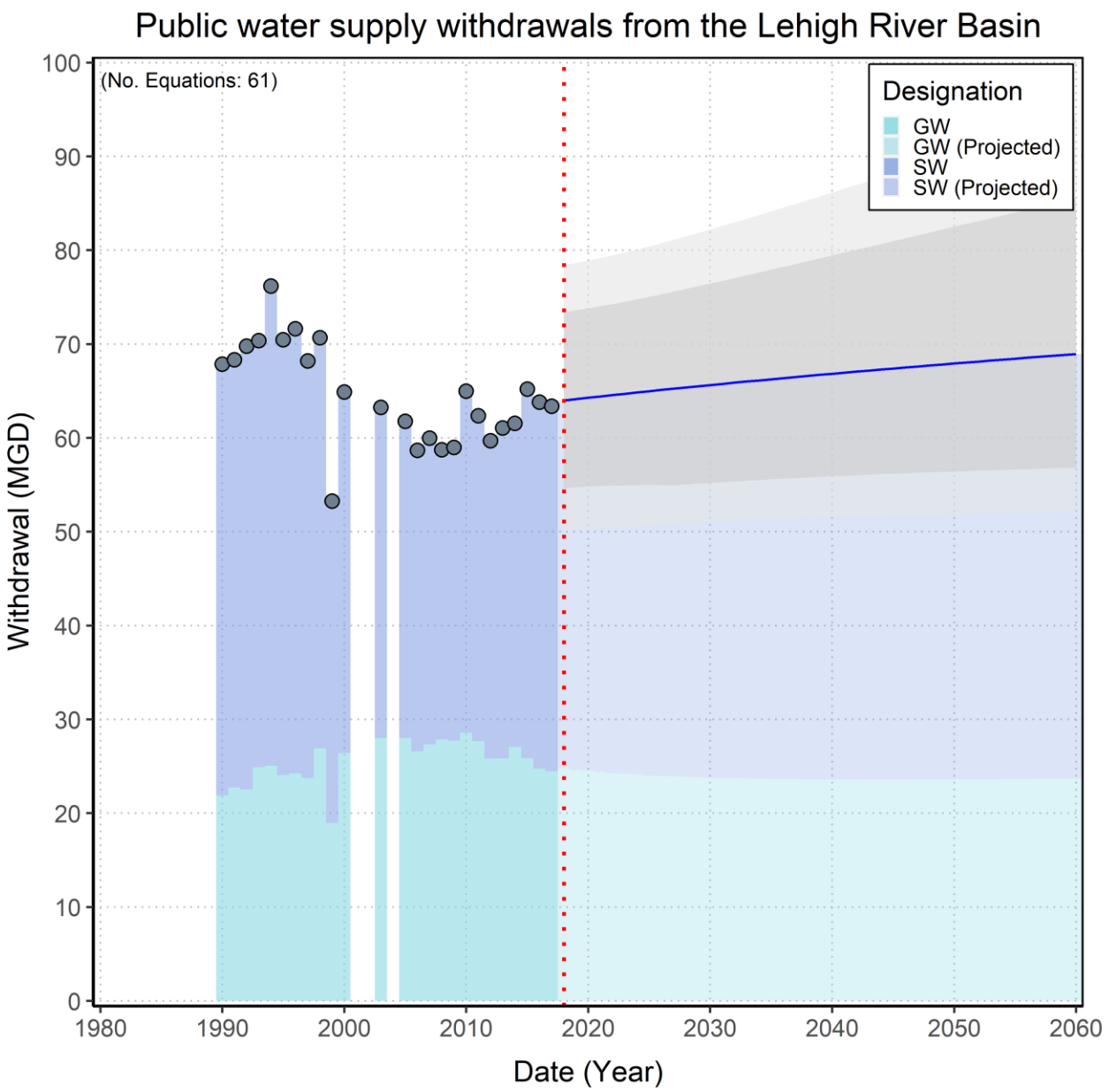
Known data gaps for Public Water Supply in 2001, 2002 and 2004

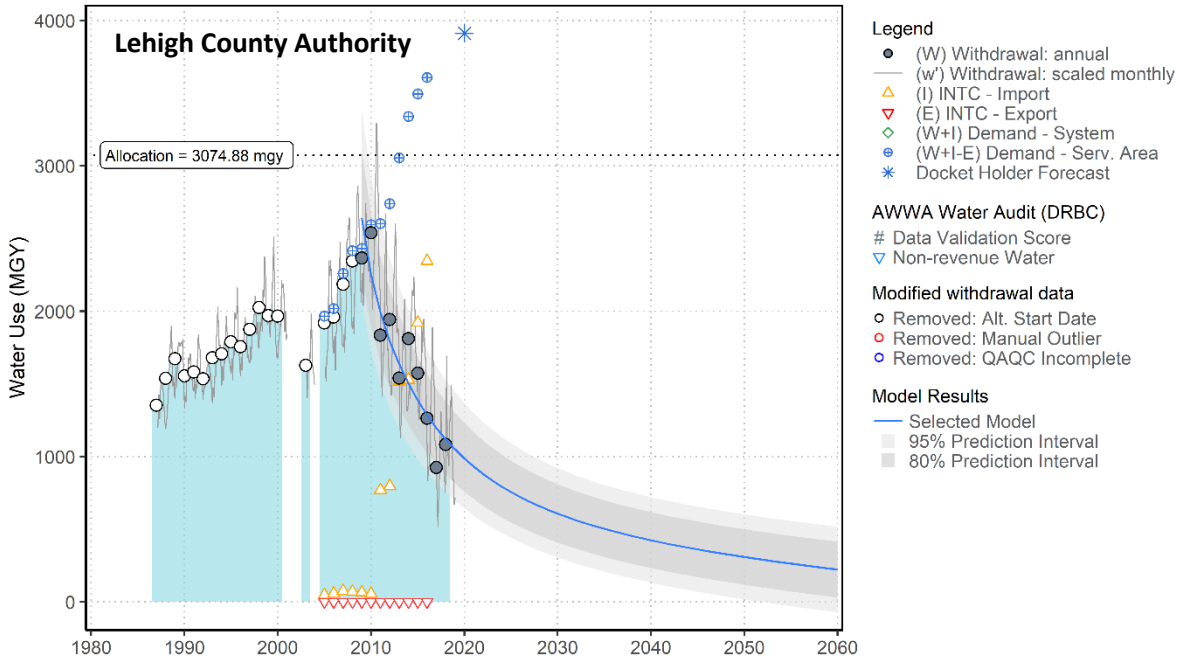
NOTE: The top 10 facilities account for about 75% of the consumptive use.

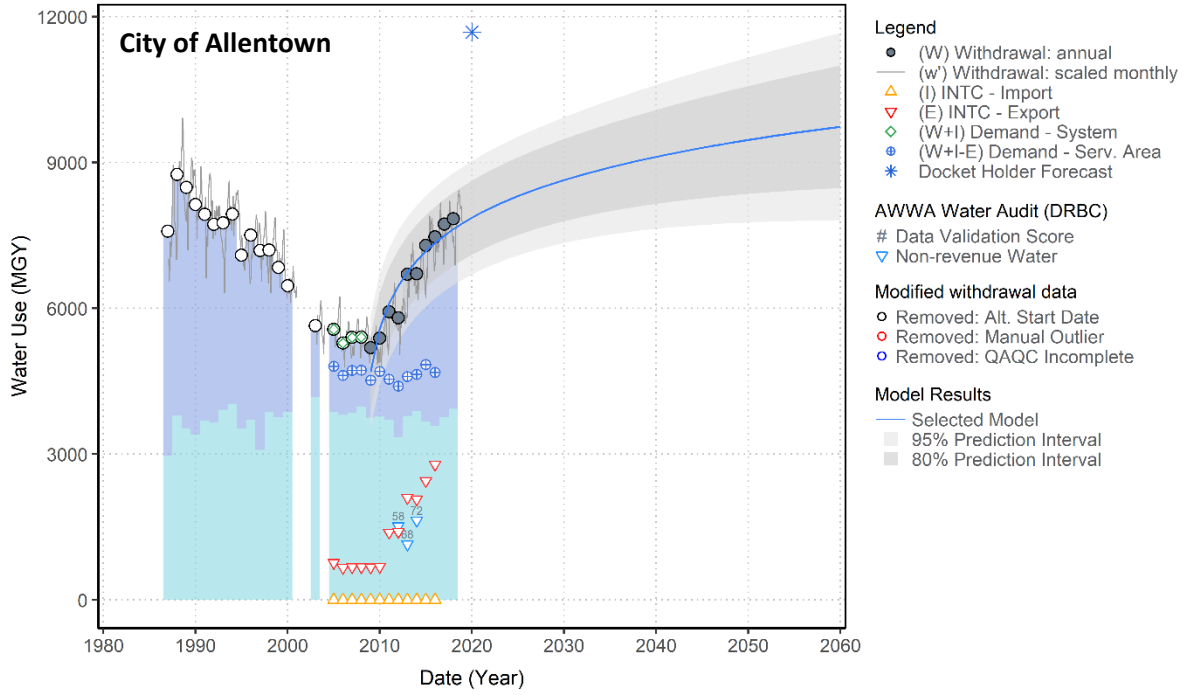
Breakdown by sector:

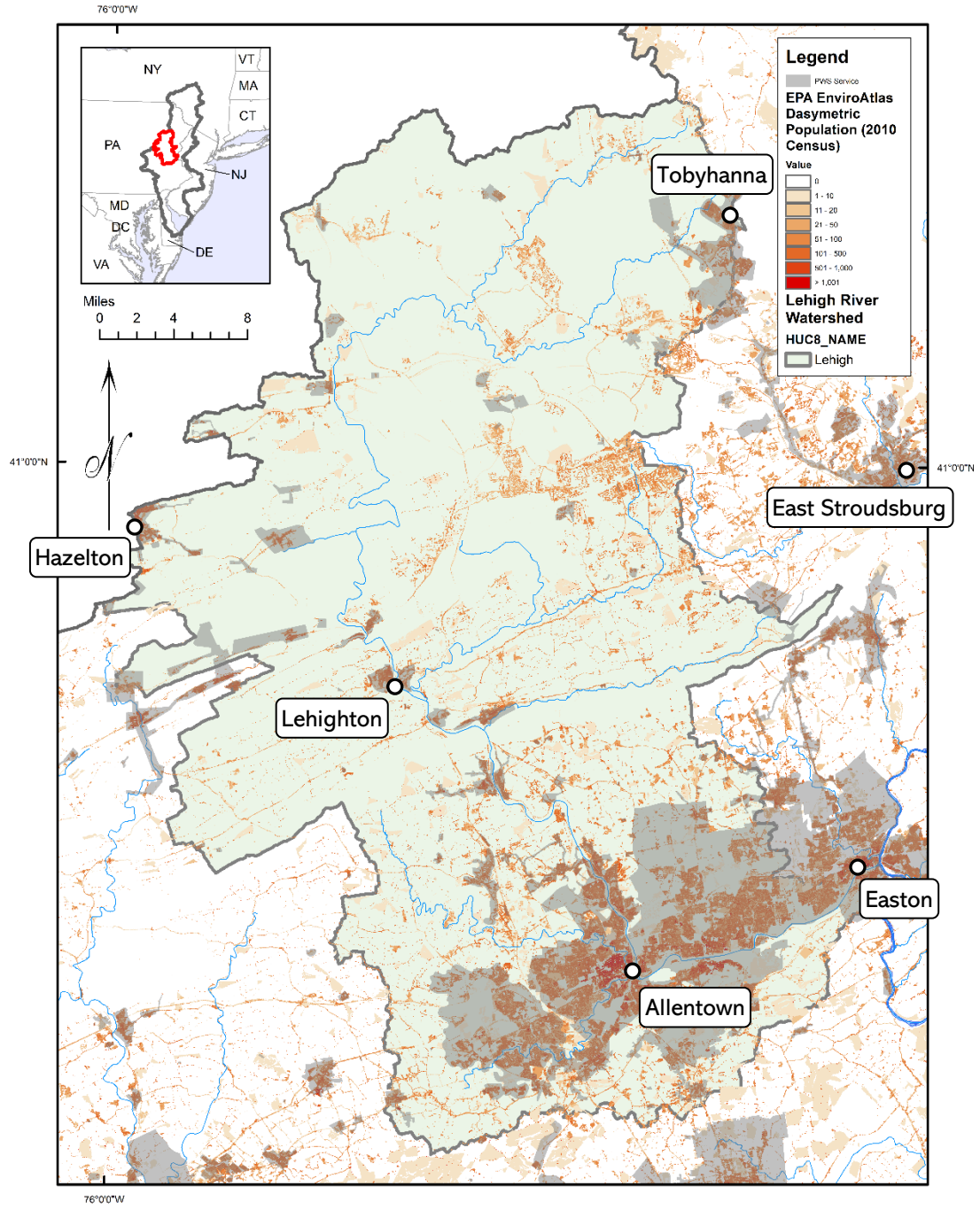
Sector	Average Withdrawal (MGD) 2013-2017	Percentage
Public Water Supply	6.426	46.0%
Thermoelectric Power	4.065	29.1%
Self-Supplied Domestic	1.265	9.1%
Other	0.845	6.1%
Mining	0.690	4.9%
Irrigation	0.395	2.8%
Industrial	0.270	1.9%
Hydroelectric Power	0.000	0.0%
Subtotal	13.956	100.0%

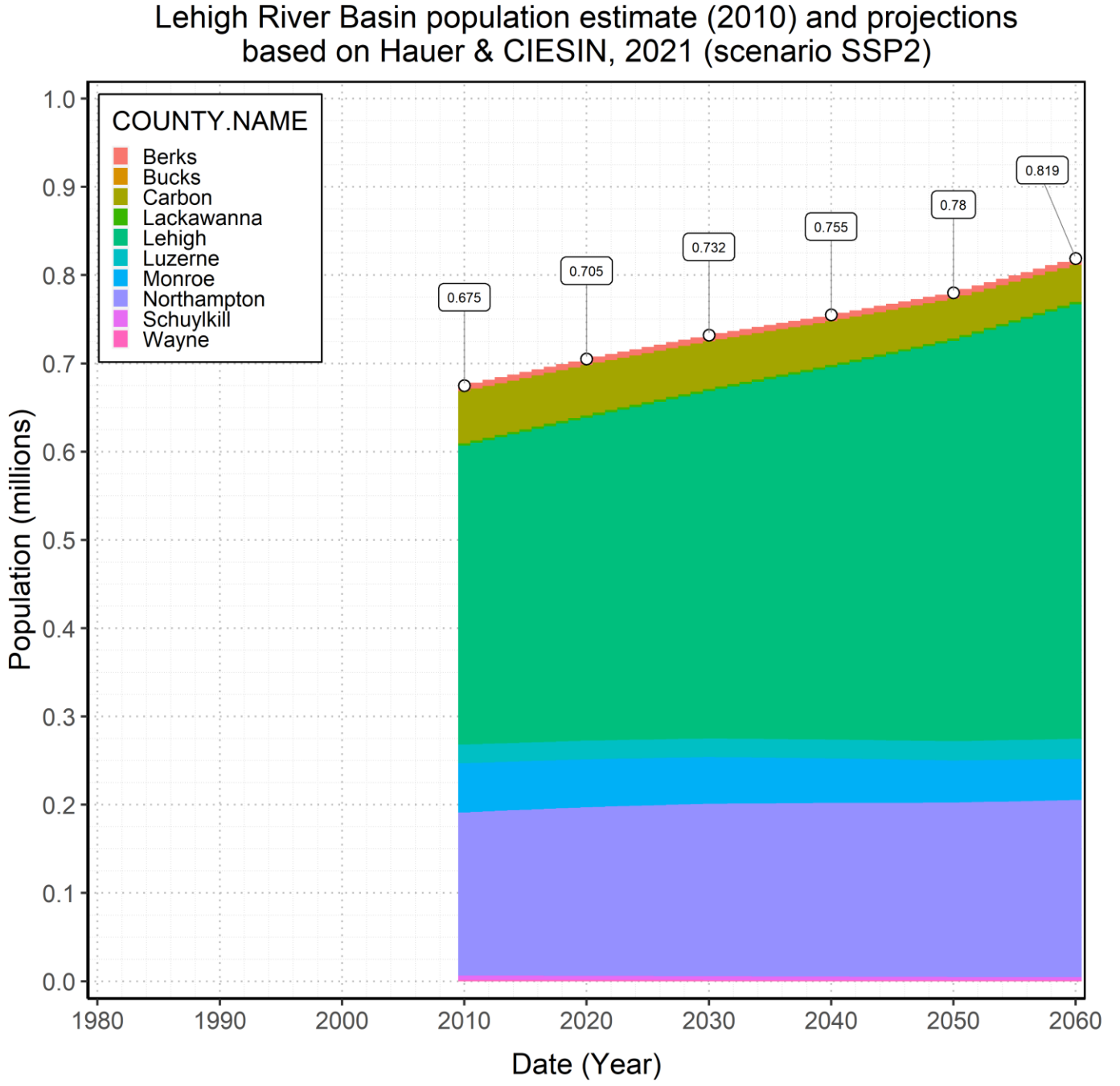
Public Water Supply







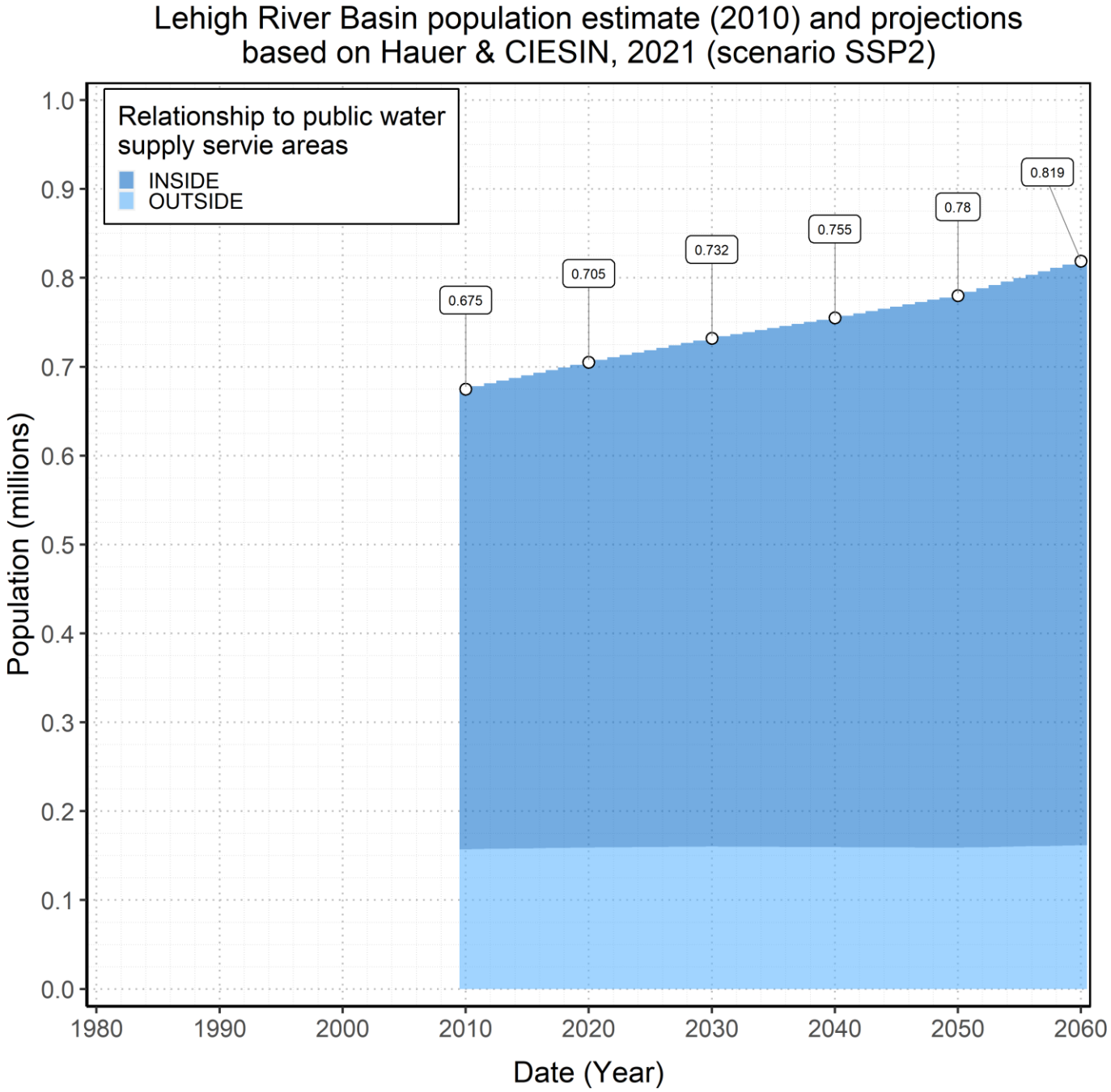

76°0'0"W
NY
VT
MA
CT
PA
NJ
MD
DC
VA
DE
Miles
0 2 4 8
Legend
PWS Service
EPA EnviroAtlas Dasymetric Population (2010 Census)
Value
0
1 - 10
11 - 20
21 - 50
51 - 100
101 - 500
501 - 1,000
> 1,001
Lehigh River Watershed
HUC8_NAME
Lehigh
41°0'0"N
Tobyhanna
East Stroudsburg
Hazelton
Lehighton
Easton
Allentown


Lehigh River Basin population estimate (2010) and projections based on Hauer & CIESIN, 2021 (scenario SSP2)
COUNTY.NAME
Berks
Bucks
Carbon
Lackawanna
Lehigh
Luzerne
Monroe
Northampton
Schuylkill
Wayne
0.675
0.705
0.732
0.755
0.78
0.819
Population (millions)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1980
1990
2000
2010
2020
2030
2040
2050
2060
Date (Year)

YEAR	Population inside Service Areas	% Change	Withdrawals by PWS from the Lehigh River Basin (MGD)	% Change
1990			67.878	
2000			65.042	-4.2%
2010	518,170		66.129	1.7%
2020	546,014	5.4%	65.453	-1.0%
2030	571,968	4.8%	66.808	2.1%
2040	595,397	4.1%	68.014	1.8%
2050	621,482	4.4%	69.110	1.6%
2060	657,364	5.8%	70.126	1.5%
DELTA (2010-2060):		26.9%		6.0%

Interesting notes:

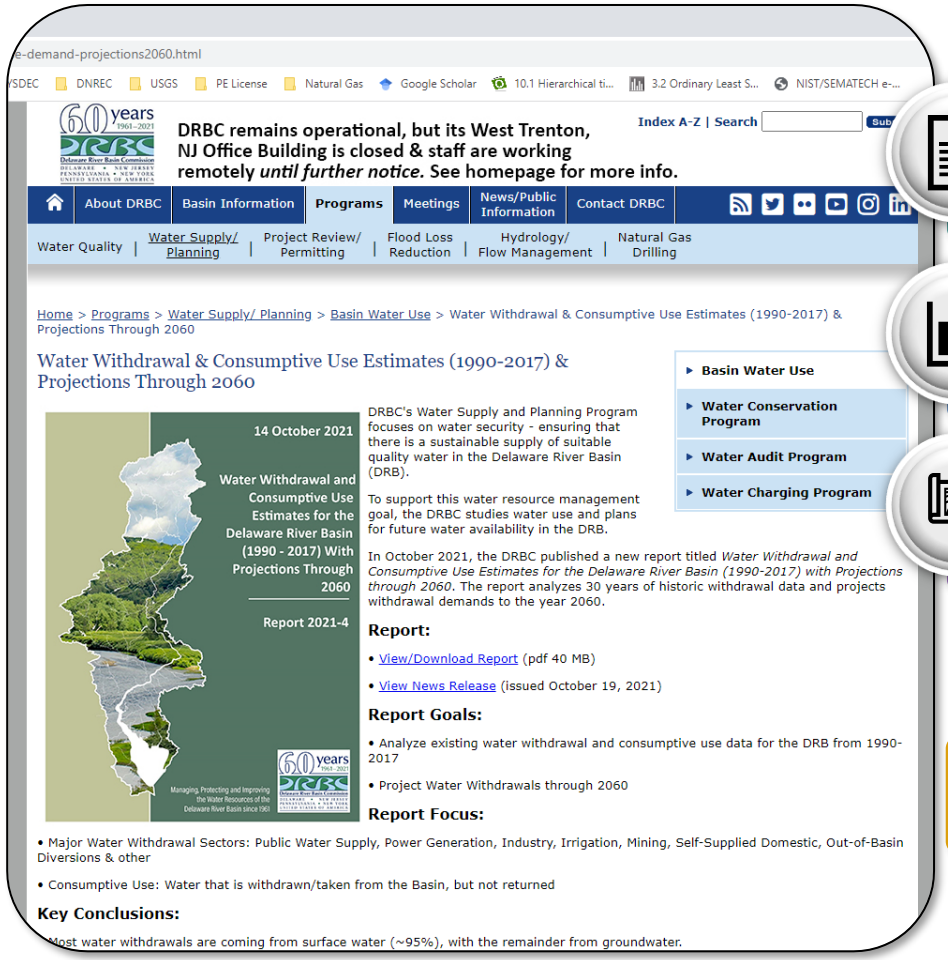
- The trend in PWS withdrawals in the Lehigh River Basin is opposite of the Basin-wide trend.
- The rate of population growth expected within PWS service areas is expected to exceed the growth in withdrawals for PWS.
- HIGH LEVEL – assuming no transfer of water in/out of the Lehigh River Basin (not true) it would appear performance is increasing.



5. Publication & Data Deliverable

Report webpage:

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



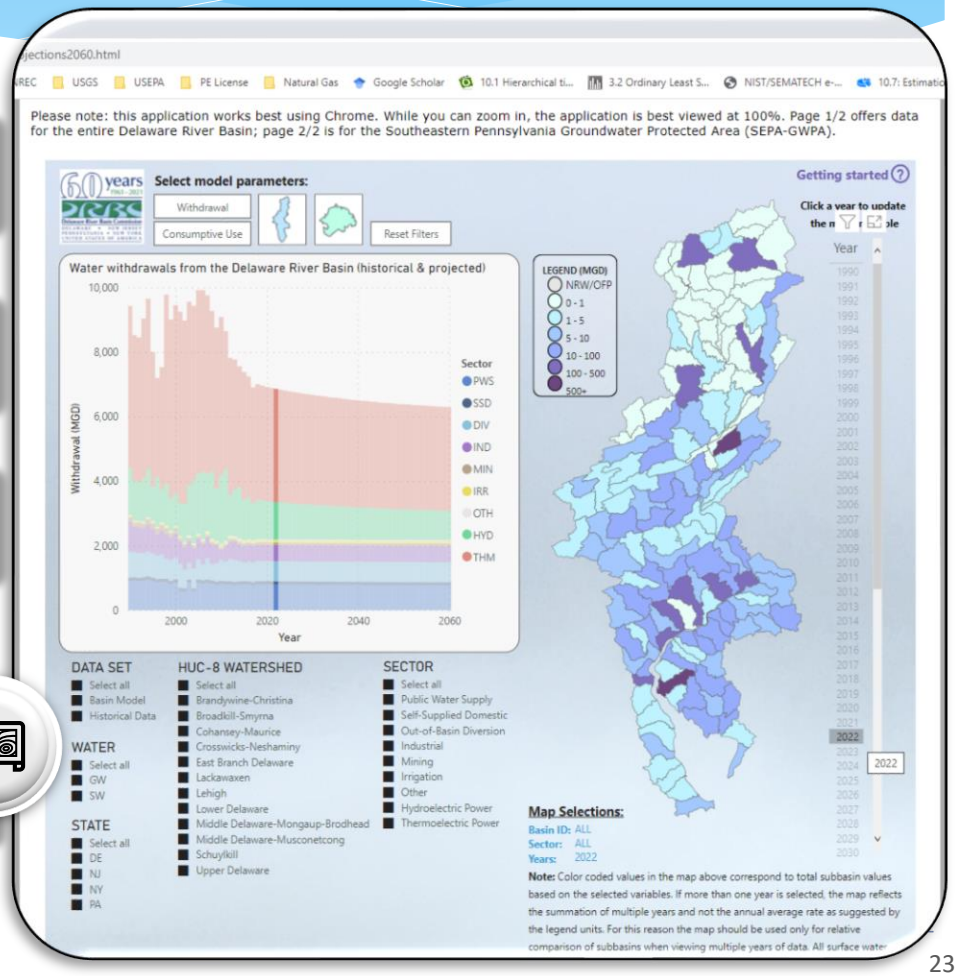
You can:

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



6. Questions

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