OVERVIEW

Data Center Water Use in Pennsylvania

- What is a data center?
- How do data centers use water?
- How much water do they use?
- How does water use compare?
- What are water use challenges?
- How to reduce water demand?

Site of proposed data center “campus” in Middlesex Township, Cumberland County PA.

Image: A. Yencha, Extension

What is a data center?

- **Any place where multiple computers are located to serve the needs of a computer network**
- **Different types of data centers**
  - **Enterprise** – serve single organization's internal network needs
  - **Colocation** – lease server space to client organizations
  - **Cloud** – support a businesses cloud services
  - **Edge** – support a businesses cloud service near its customers
  - **Hyperscale** – support for artificial intelligence related services
- **Components**
  - **Servers**
  - **Digital storage (memory)**
  - **Networking equipment: racks/switches/routers**
  - **HVAC equipment (cooling)**
  - **Backup power supply equipment**

Basement Data Center

PA DATA CENTER PARTNERS + POWERHOUSE DATA CENTERS

Proposed hyperscale data center: Cumberland Co.

- $15 billion
- $65 million tax revenue
- 700 acres
- 1.35 GW energy demand
- Currently approved for 400,000 gallons/day

Server racks at NERSC by Chiara Coetzee, CC0 1.0 Universal, https://www.flickr.com/photos/dcoetzee/6271167399/in/photostream/

Hyperscale Data Center

Google Data Center, Council Bluffs Iowa by Chad Davis, CC BY 2.0
https://www.flickr.com/photos/146321178@N05/49062863796

- Massive
  - Size – 10,000 square feet
  - Servers - > 5000
  - Energy – 50 – > 100 MW
  - Water – > 100,000gallons/day
- Advantages
  - Scalability
  - Service efficiency
  - Cost efficiency

Conodoguinet Creek, Andy Yencha

How do data centers use water?

Direct Water Use

Water used at the data center

Indirect Water Use

Water used away from the data center

Can be 2 to 3 times as large as direct water use or higher.

Direct water use *. . . . Occurs at the data center*

Cooling

Water used to facilitate heat removal from inside data center

Domestic

Water for sinks and toilets inside data center and to irrigate landscape outside building

Humidification

Water used to maintain desired humidity levels inside data center

Indirect water use *. . . . Occurs away from the data center*

Thermoelectric Power Generation

Water used to create the electricity used by data centers

Computer Equipment Manufacturing

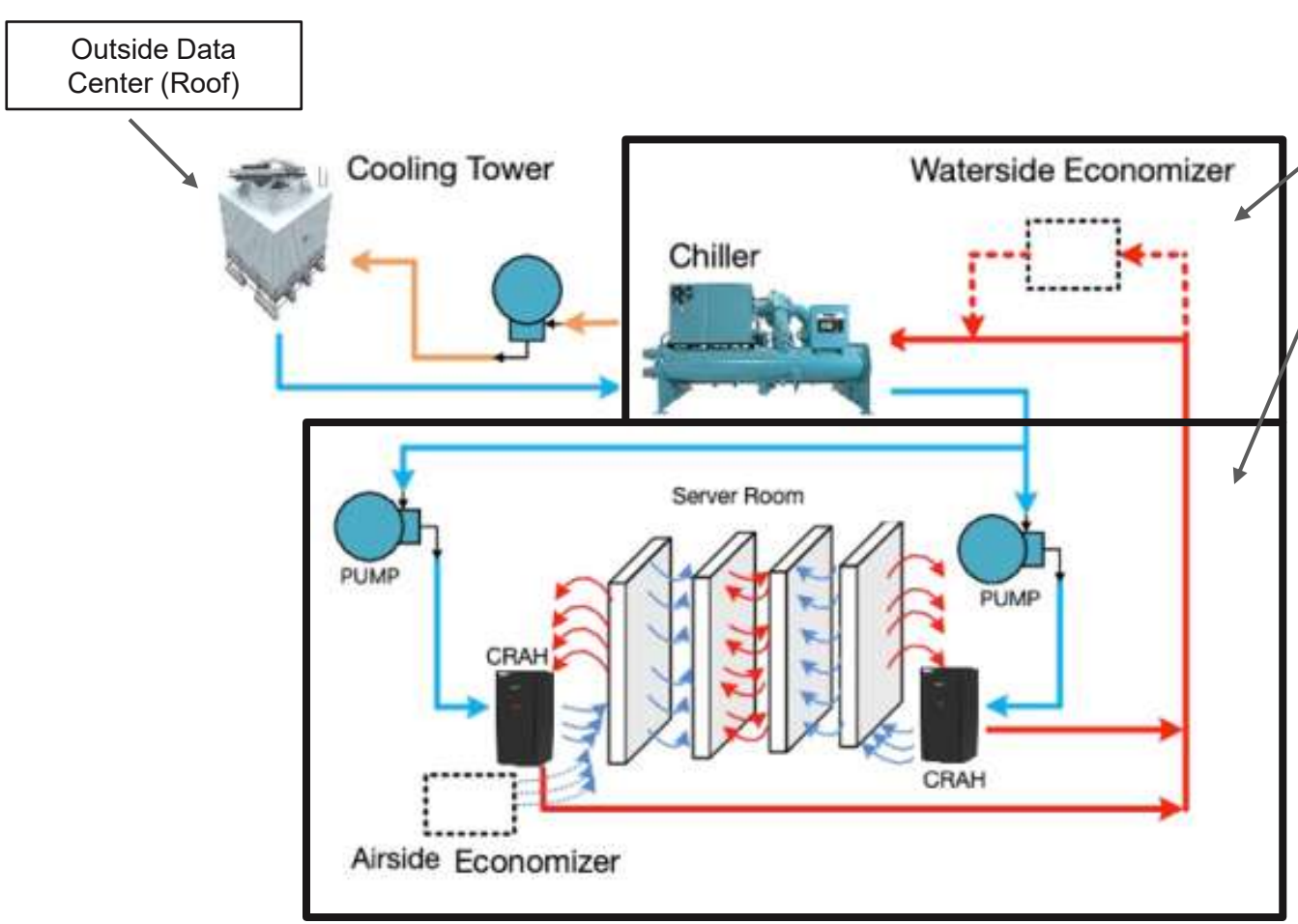
Water used to manufacture the computer related equipment inside data centers.

⬆

Manufacturing happens outside of PA

Wastewater Treatment

Water used to treat the wastewater produced by some data centers

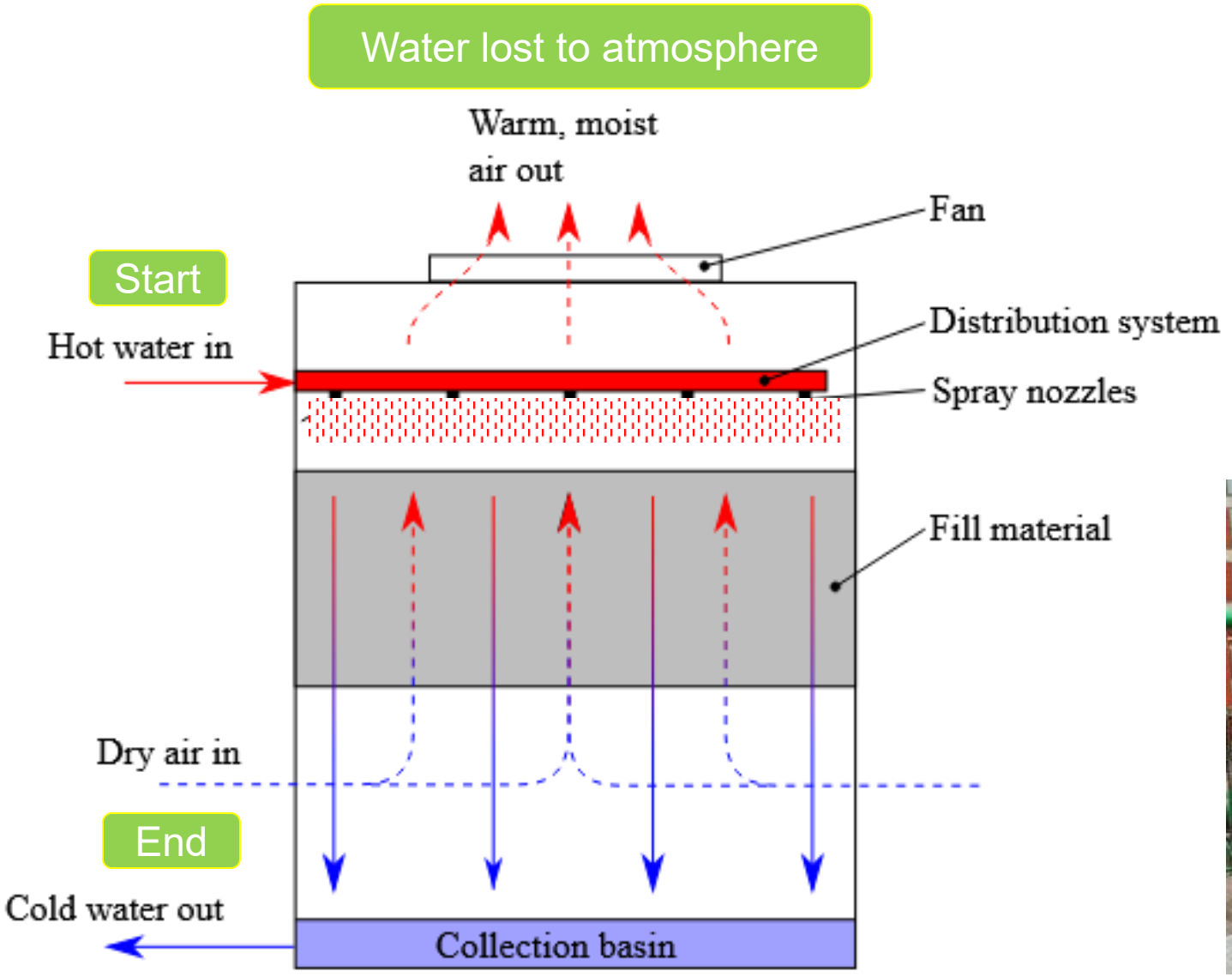


Air Cooling

- Traditional method of cooling
- Two separate cooling loops
  - Internal “server” loop
  - External “evaporative” loop
- Water loss happens in external loop

Diagram from https://dc.mynetworkinsights.com/data-center-cooling-infrastructure/ by Livin Jose

Cooling Tower



By Counterflow_diagram.PNG: Edreher at English Wikipediaderivative work: Zerodamage - This file was derived from: Counterflow diagram.PNG:, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=20683441

By Aloofmanish - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=106912793

To save water, why don't data centers just use air conditioning?

- Using air conditioning can minimize direct water use!
- But it increases electricity demand.
- Using more energy is likely to result in higher indirect water use!

ROBBING PETER TO PAY PAUL

Liquid cooling – Happens inside building

Geothermal cooling could be another cooling option.

An older data center in Pennsylvania has been using underground water for cooling for some time.

- Boyers Data Center, Reading PA
- 200 feet underground in abandoned mine.
- Uses underground reservoir for cooling.

Graphic from Hanwha Data Centers https://www.hanwhadatacenters.com/blog/the-complete-guide-to-energy-efficiency-best-practices-for-digital-infrastructure/
Boyers Data Center, US Department of Energy

How much water do data centers use?

Hard to say precisely!

- Lack of data
- Uncertainty on type of water use
- Lack of standardization
- “Apple to Apple” comparisons difficult because each data center will have unique characteristics
    - Size
    - Location
    - Computer equipment
    - Cooling system

Direct Water Use at Google Data Centers in Eastern U.S.A.

Google

Year 2024

Location	Water Withdrawal (million gallons per year)	Water Consumed (million gallons per year)	Water Discharged (million gallons per year)
Ashburn, VA	59.5	56.0	3.5
Bristow, VA	105.7	84.4	21.3
Sterling, VA	201.2	158.2	43.0
New Albany, OH (275,000 sqft)	405.3	352.7	52.2

Data centers often use municipal water for direct water use needs. Likely reasons include: minimal up-front costs, known quality, may avoid permitting.

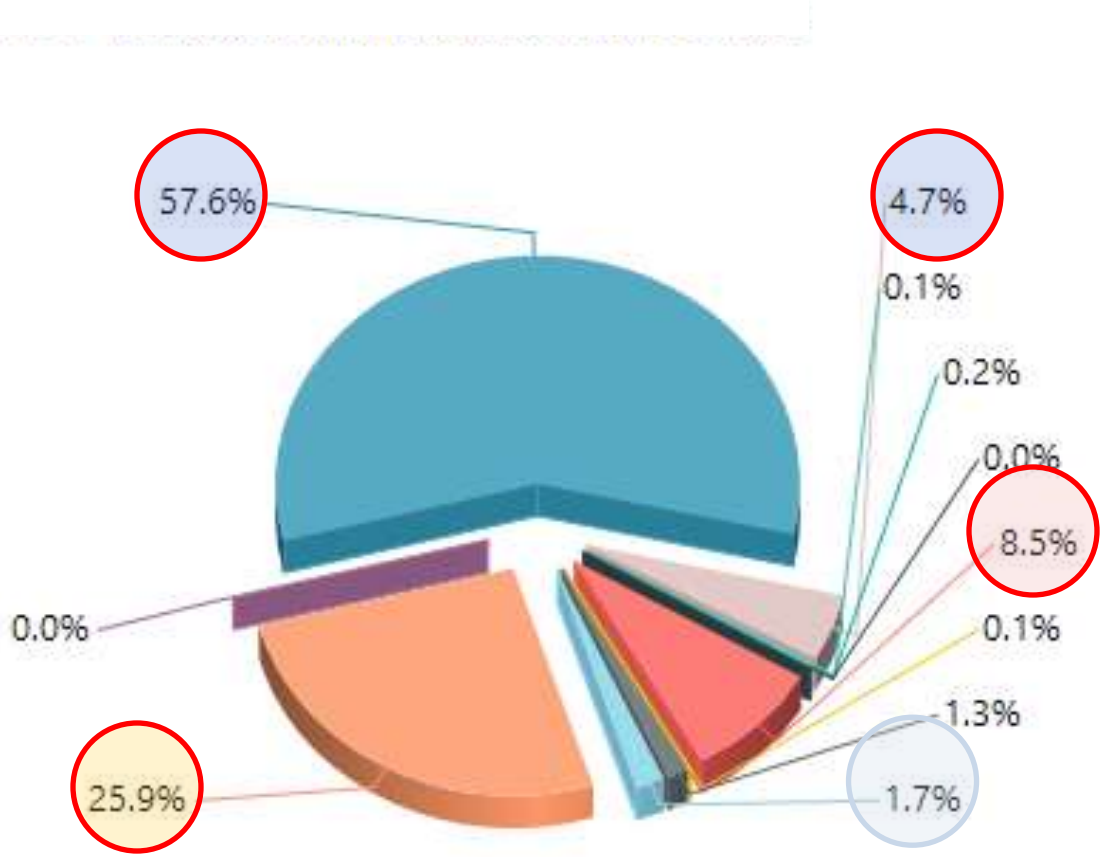
Context:

How does data center water use compare to other water use sectors?

Microsoft stock image

Question

How does data center water use compare to other water use sectors?



Major PA Water Use Sectors

- Commercial & Institutional
- Commercial (Potable)
- Industrial
- Irrigation
- Livestock
- Mining
- Public Water Supply
- Thermoelectric Power-Noncooling Wtr Use
- Thermoelectric Power-Once Thru Cooling
- Thermoelectric Power-Recirc Cooling
- Wastewater Collection and Treatment

How does data center water use compare to other water use sectors?

Major Water Using Sectors	Average daily withdrawal (million gallons per day)	Total annual withdrawal (million gallons per year)	Percentage
Thermoelectric Power	**3,190.4**	**1,164,505.2**	**61%**
Public Water Supply	**1,330.8**	**485,749.4**	**25%**
Industrial Manufacturing	**508.6**	**185,648.8**	**10%**
Livestock and Aquaculture	**105.8**	**38,617.8**	**2%**
Mining	**53.3**	**19,469.3**	**1%**
Wastewater Management	**13.8**	**5,050.4**	**>1%**
Oil and Gas	**10.1**	**3,718.4**	**>1%**
Commercial and Institutional	**8.4**	**3,098.1**	**>1%**
Irrigation	**5.7**	**2,083.6**	**>1%**
Total	5,227,236,773	1,907,941,422,145	100%

HYPOTHETICAL DIRECT WATER USE

What if -- hypothetically – we added 40 data centers to state, with each using an estimated 500,000 gallons per day for direct water use?

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Data Centers* **40 data centers using 500,000 gallons/day*	20.0	7,300.0	1%
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Irrigation	5.7	2,083.6	>1%
Total	5,247,236,773	1,915,241,422,145	100%

HYPOTHETICAL INDIRECT WATER USE

And what if we also estimated that each of these 40 data centers used an additional 1 million gallons per day as indirect water use (power generation)?

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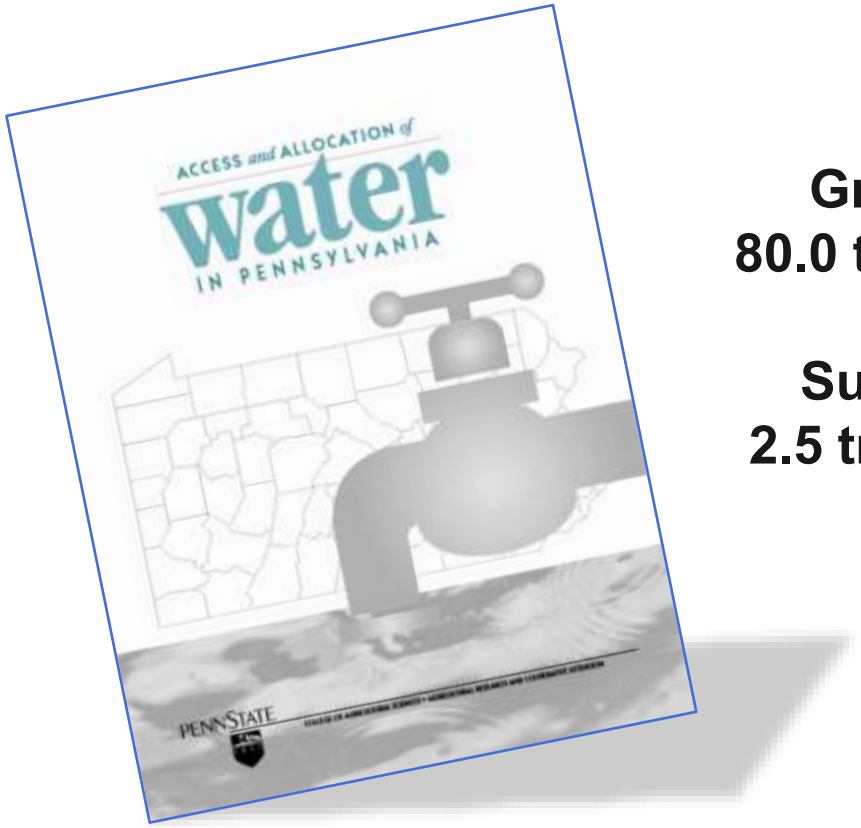
The Digital Water Atlas
https://storymaps.arcgis.com/stories/d945de2b227b44f5adad48faa36af929

PA Has Lots of Water

But also, many existing demands on this water.

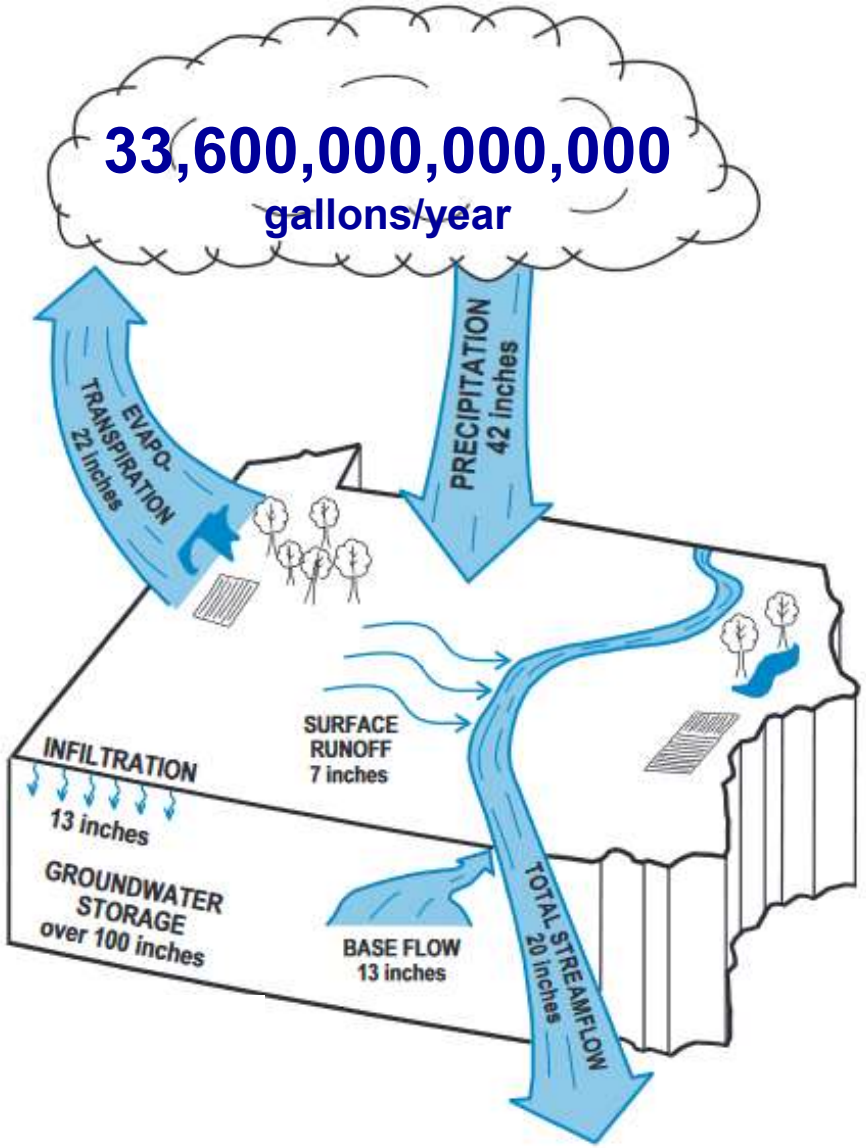
- River and Stream - 85,568 miles
- Publicly Owned Lakes - 125,119 acres
- Delaware Bay – 17 square miles
- Presque Isle Bay – 6 square miles
- Great Lake Shoreline – 77 miles
- Freshwater wetlands – 1.59 million acres
- Acres of tidal wetlands – 1,377 acres
- Groundwater – LOTS!

How much water is in PA?



Groundwater
80.0 trillion gallons

Surface water
2.5 trillion gallons



Graphic from: PA DCNR – The Geology of Pennsylvania's Groundwater http://elibrary.dcnr.pa.gov/GetDocument?docId=1752498&DocName=ES3_GW_Pa.pdf

Question

Does PA have enough water to support new data center development?

Answer

The state has abundant water in most places. But we can’t accurately answer this question until we get more information on how much water modern data centers will use, and how many data centers will be built.

Stream image: nature-2940797_960_720 from pixabay free for commercial use no attribution required_ by Coffee

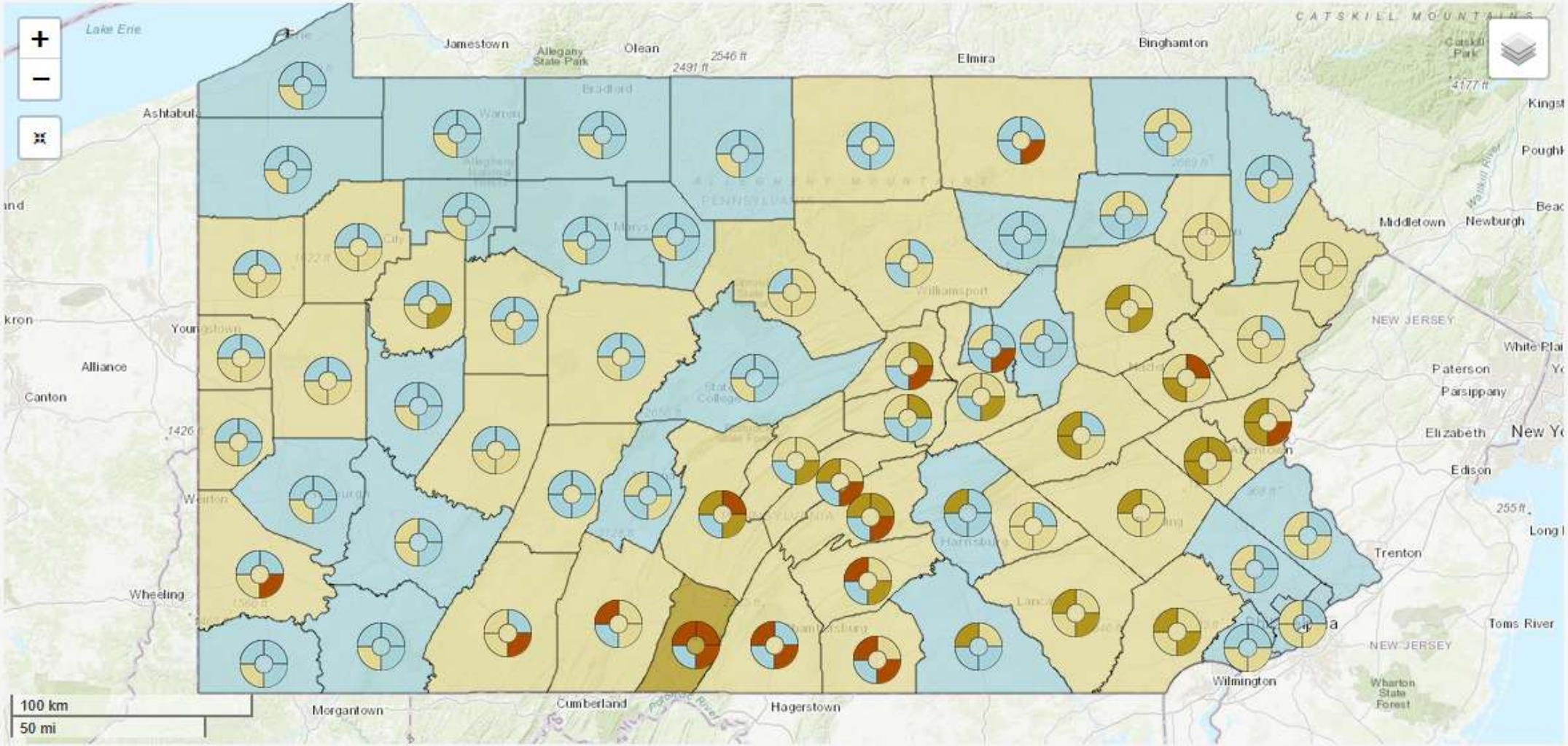
If water is available, why not just use it? Why maintain reserve supply?

- Provides margin of error during drought
- PA flora and fauna also need water
- Annual precipitation is variable
  - Climate change may make droughts worse
- Water availably is already tight is a few areas
  - Critical Water Planning Areas
  - SEPA Groundwater Protection Area

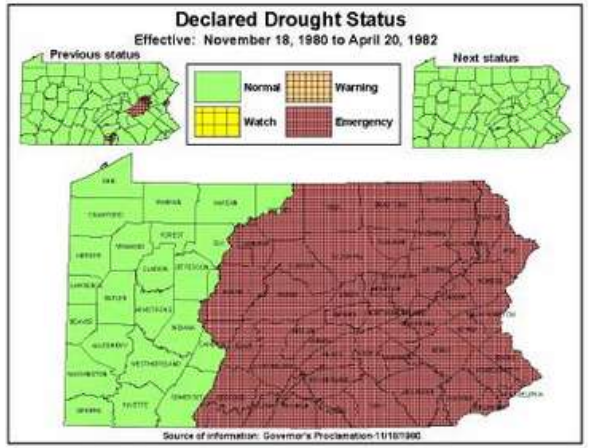
Pennsylvania Drought Condition Monitoring - Sunday, January 11, 2026

Map | Information | Data

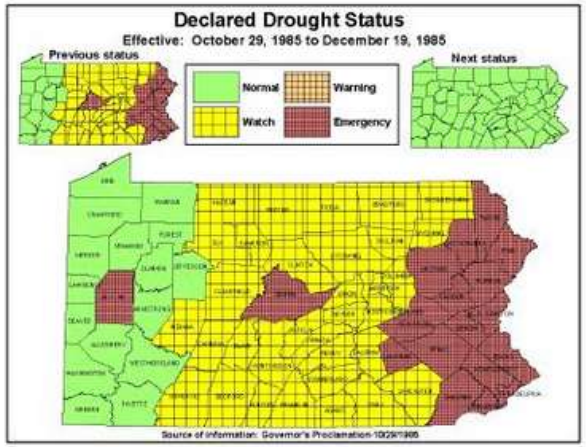
USGS science for a changing world



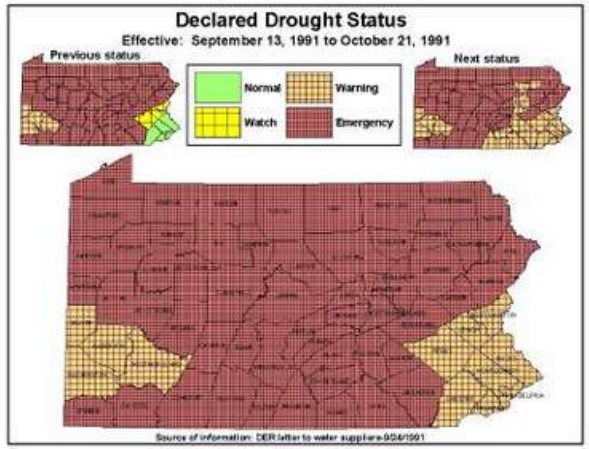
PennState Extension



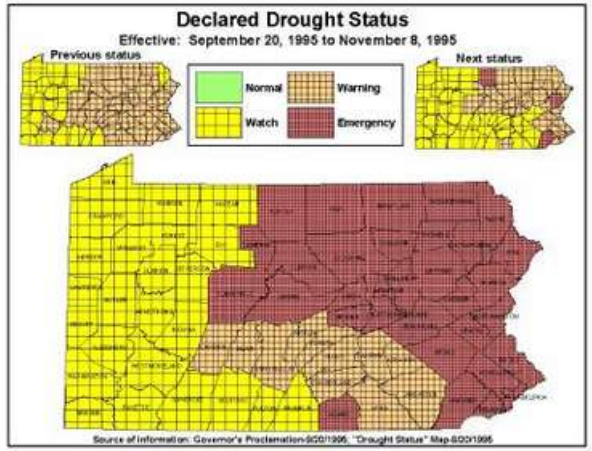
Nov. 1980 - April 1982



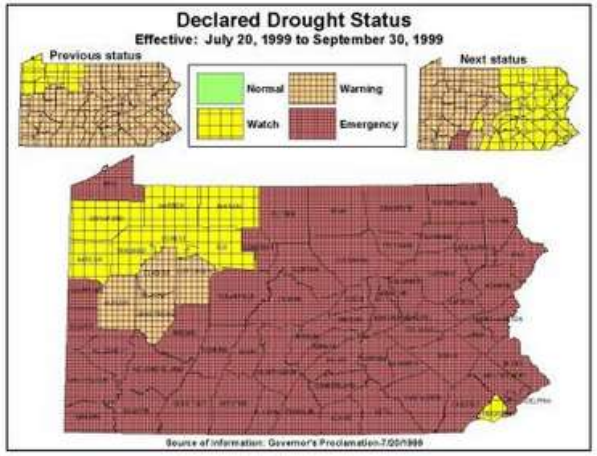
1985



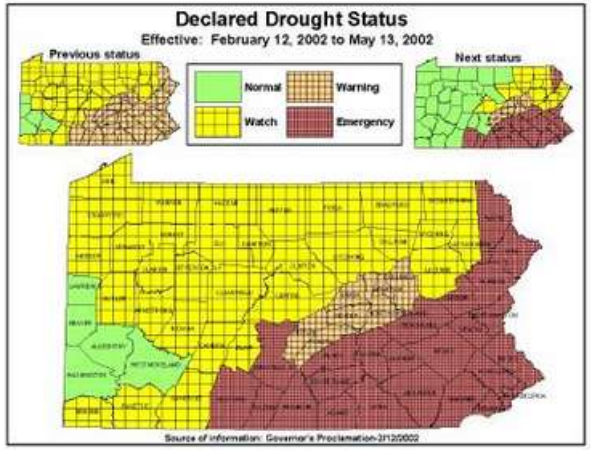
1991-1993



1995



Late 1998 -1999

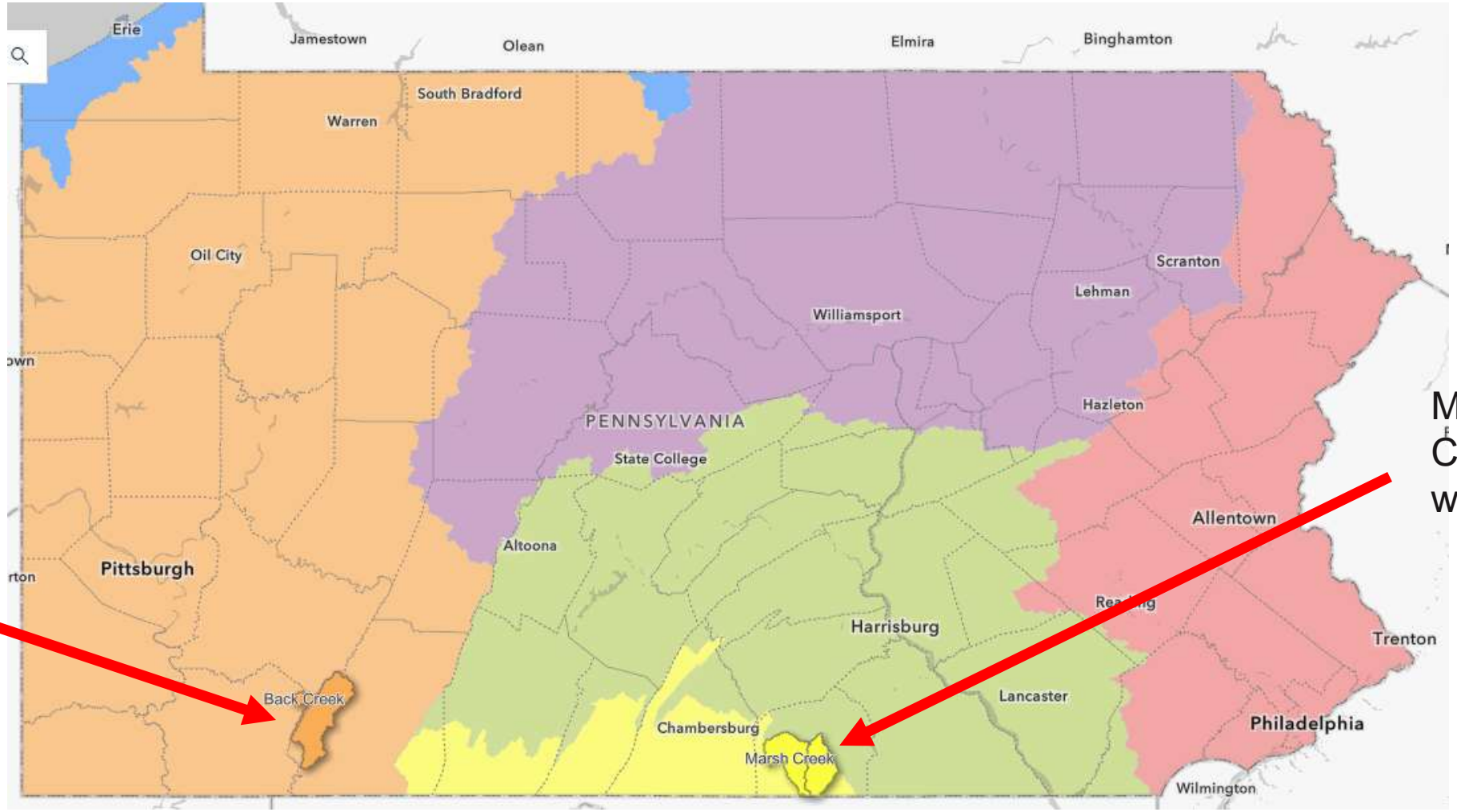


2001 - 2003

Critical Water Planning Areas

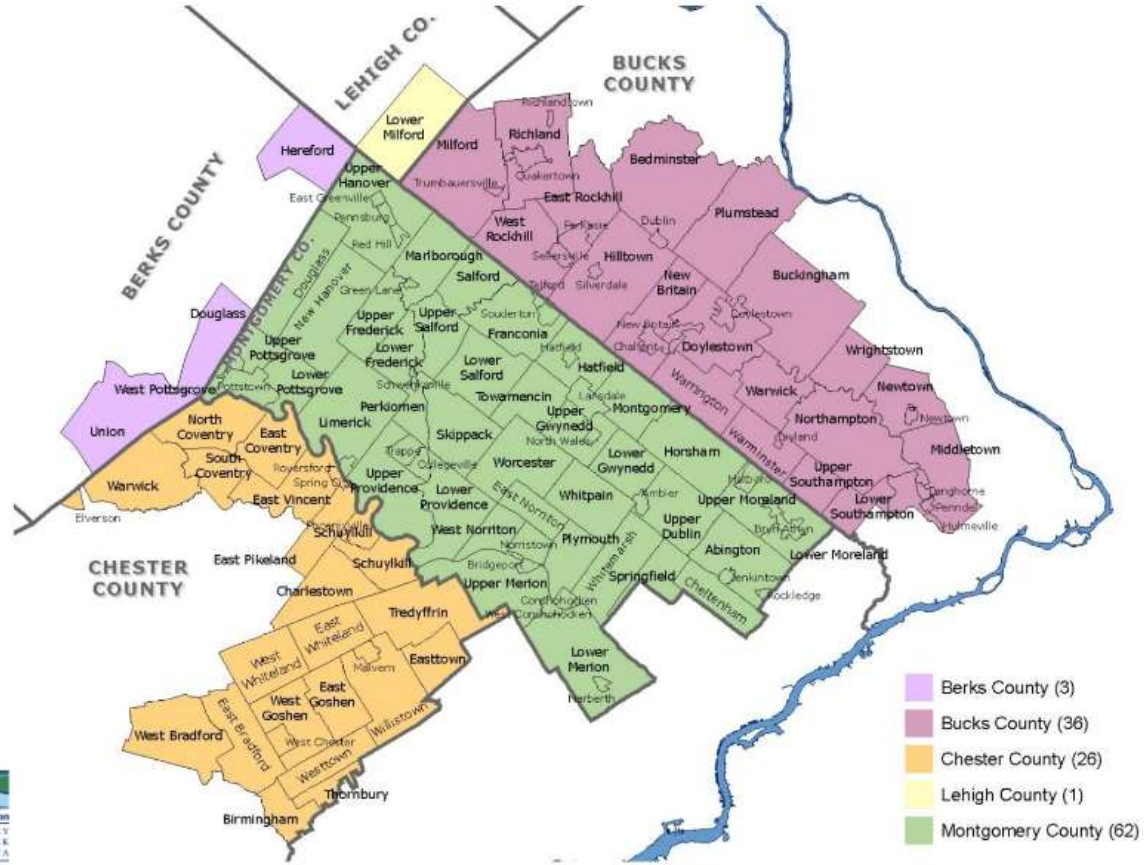
4 watersheds currently recognized by state as critical water planning areas based on available water supplies

Black & Laurel Hill Creek watersheds



Marsh & Rock Creek watersheds

Southeast Pennsylvania Groundwater Protected Area



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

PennState Extension

Water Withdrawal Rules – Susquehanna and Delaware River Basins

Statewide

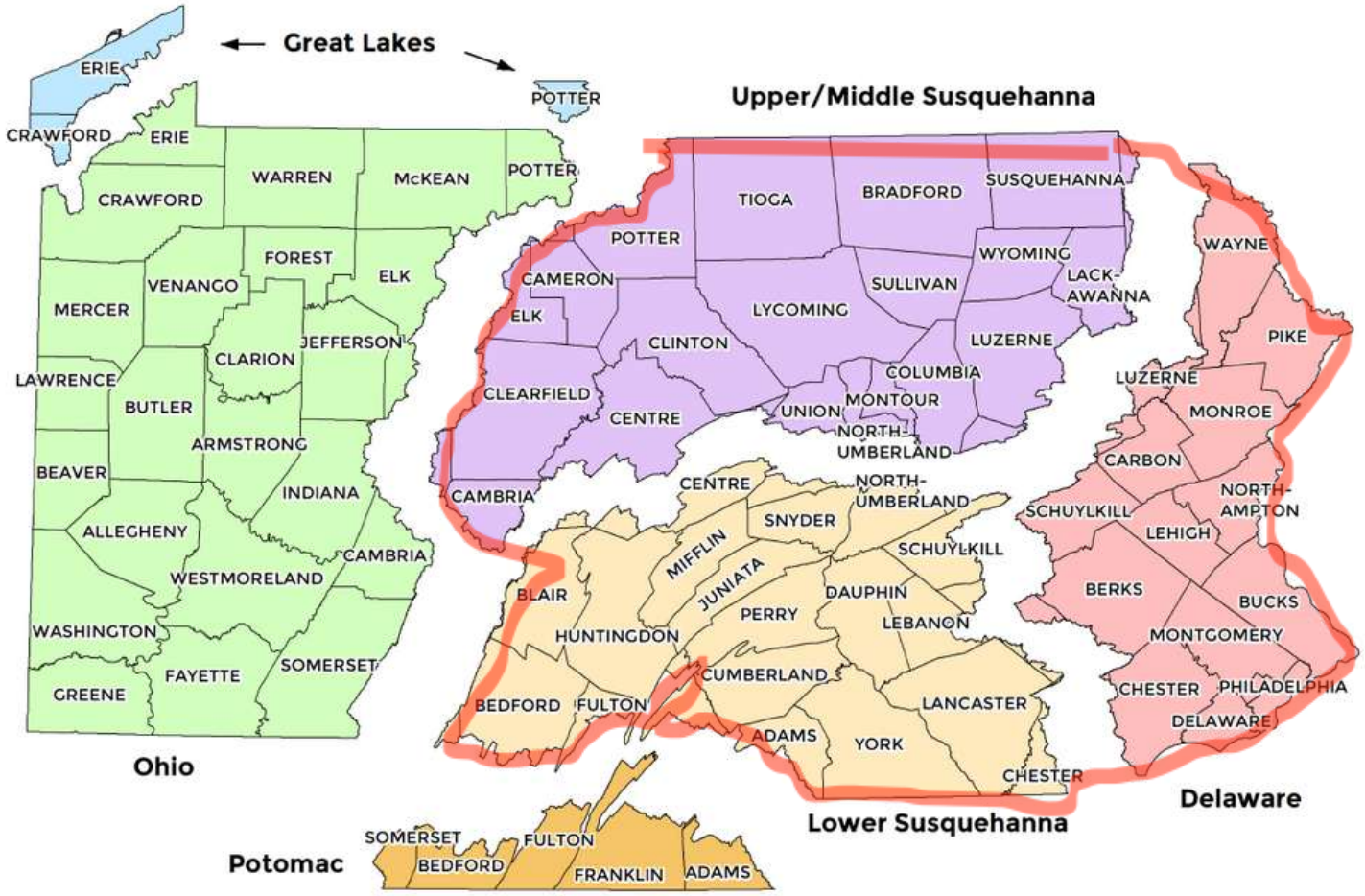
2002 Water Resources Planning Act

Registration and water use reporting required for withdrawals exceeding 10,000 gallons/day over any 30-day period.

Delaware & Susquehanna Basins

1961 & 1971 Interstate Compacts

Review and approval required for withdrawals exceeding 100,000 gallons/day over any 30-day period (Less in some circumstances).



Ways to reduce water demand

- Increase water efficiency at thermoelectric power plants
  - Dry & hybrid cooling
- Develop more green energy options
  - Wind & Solar
- Use equipment that can tolerate higher operating temperatures
  - GPUs and CPUs
- Employ more energy efficient cooling at the data center level
  - Direct to chip
  - Immersion

Microsoft Stock Image