Data Centers and Water Use in Illinois

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Images by S. Kuykendall

Water is necessary for all living things

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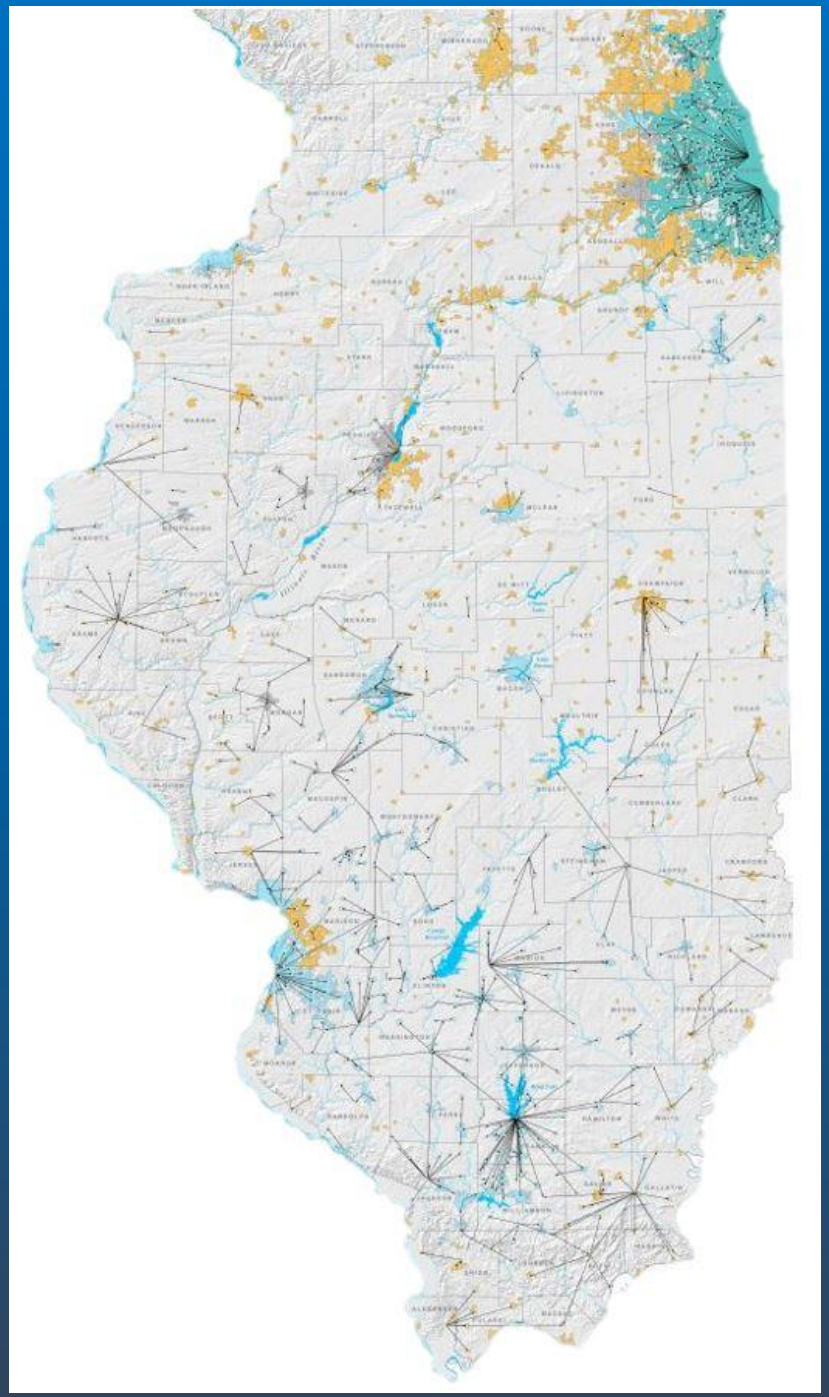
Water is necessary for All Economic Development

Distribution of Public Water Use in in Illinois

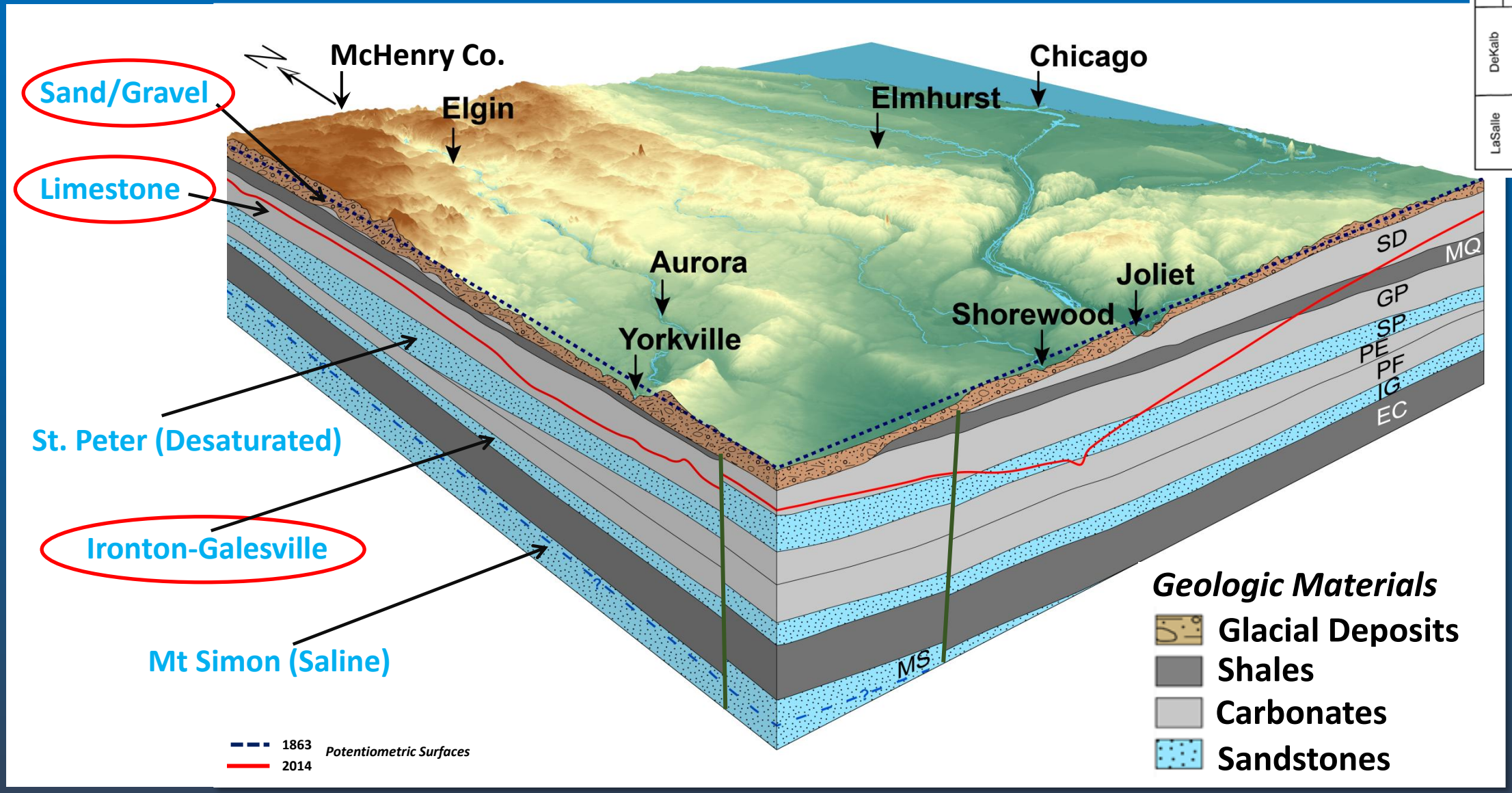
Illinois Drinking Water Comes From:

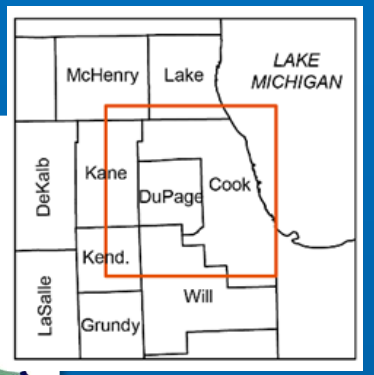
- **Lake Michigan**
  - Lake Michigan Allocation (drinking and storm water)
- **Groundwater**
- **Rivers**
- **Reservoirs**



Illinois State Geological Survey

Northeast Illinois Groundwater Aquifers

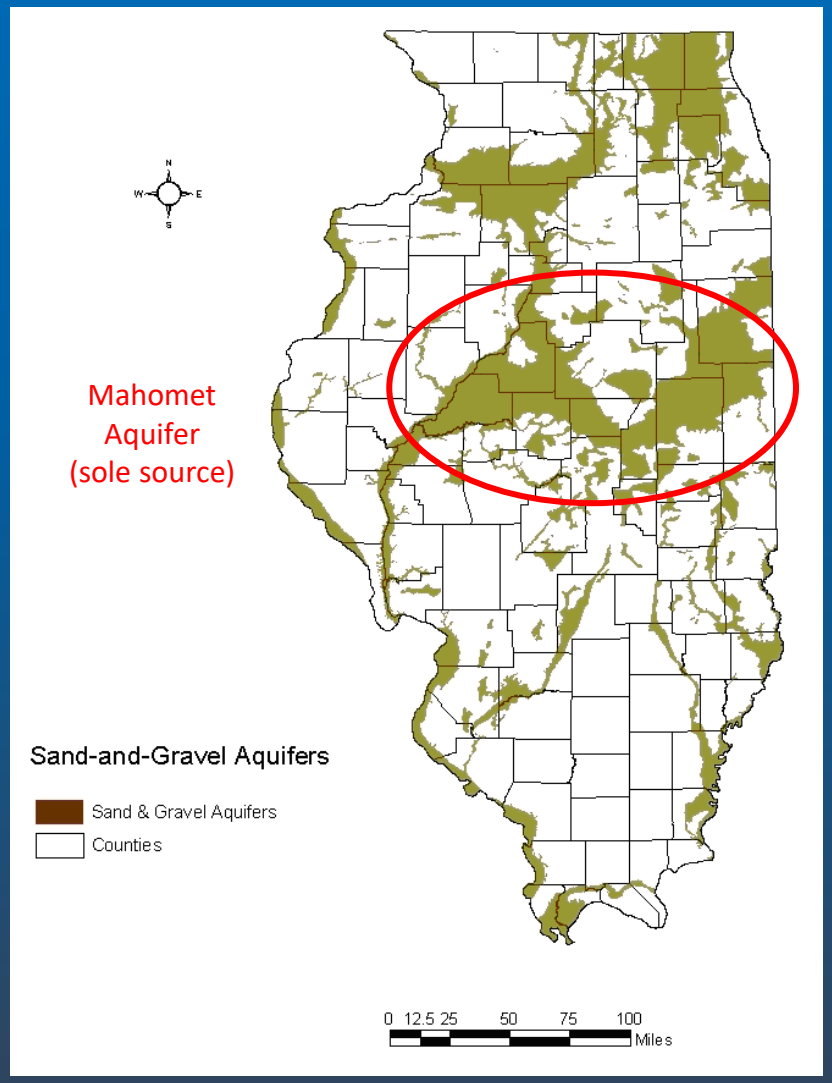




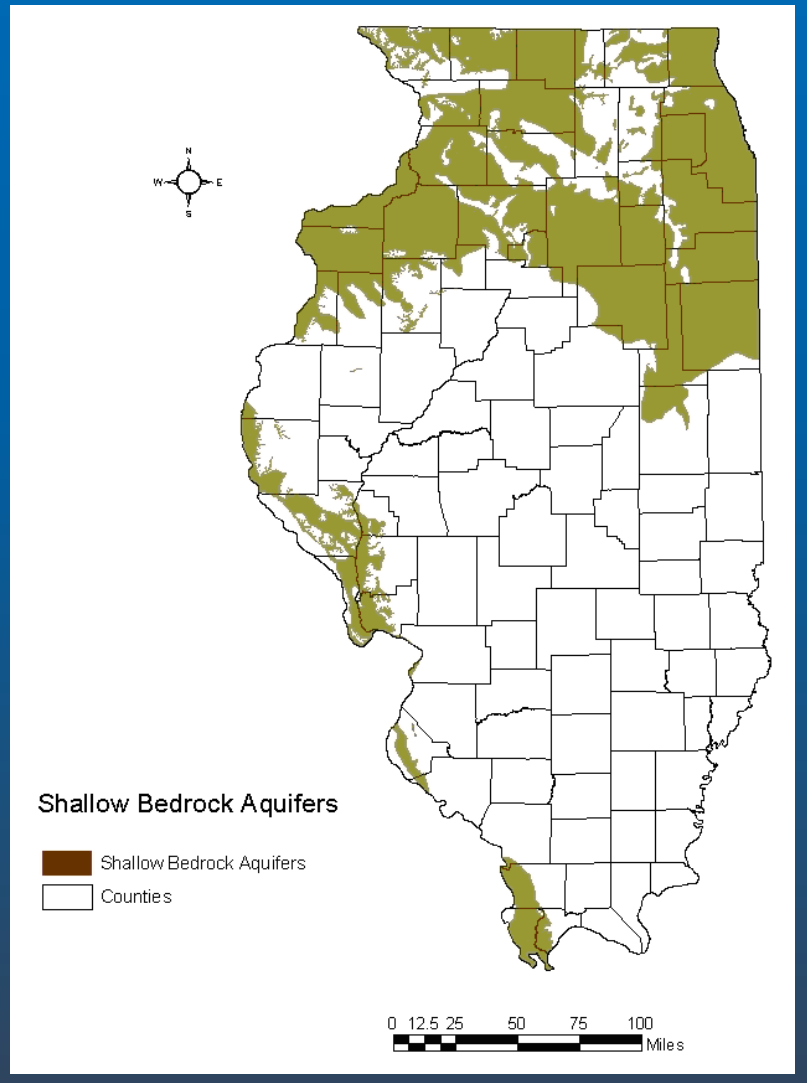
Illinois State Water Survey

Groundwater Aquifer Distribution in Illinois

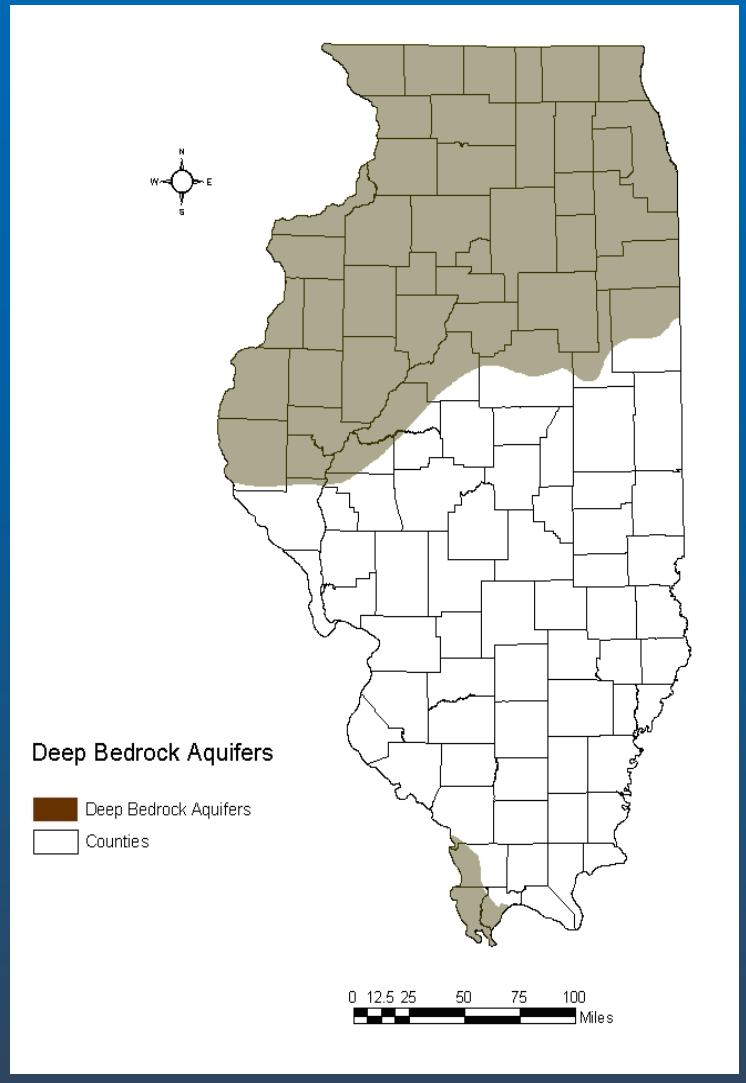
Sand & Gravel



Limestone

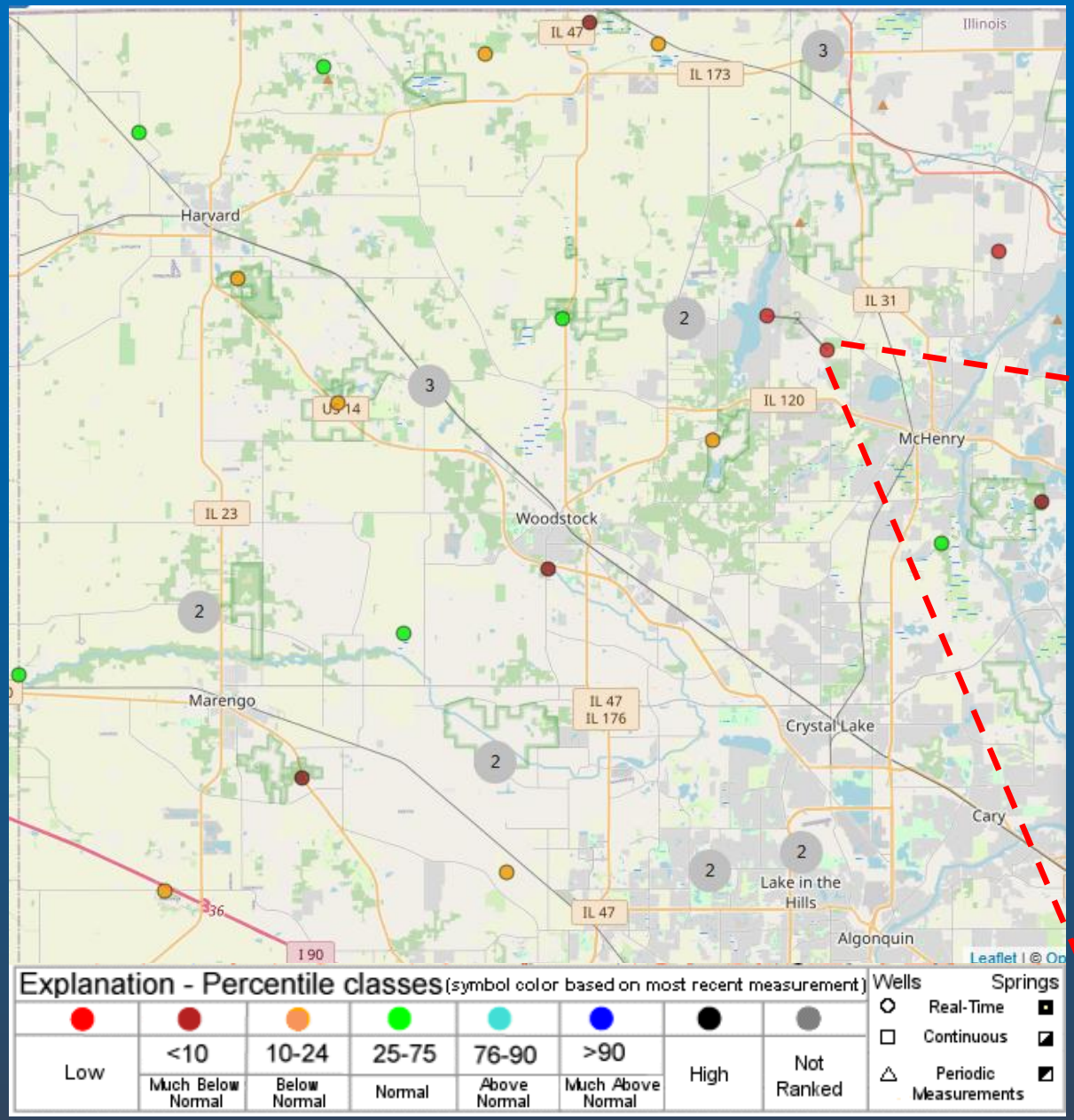


Sandstone

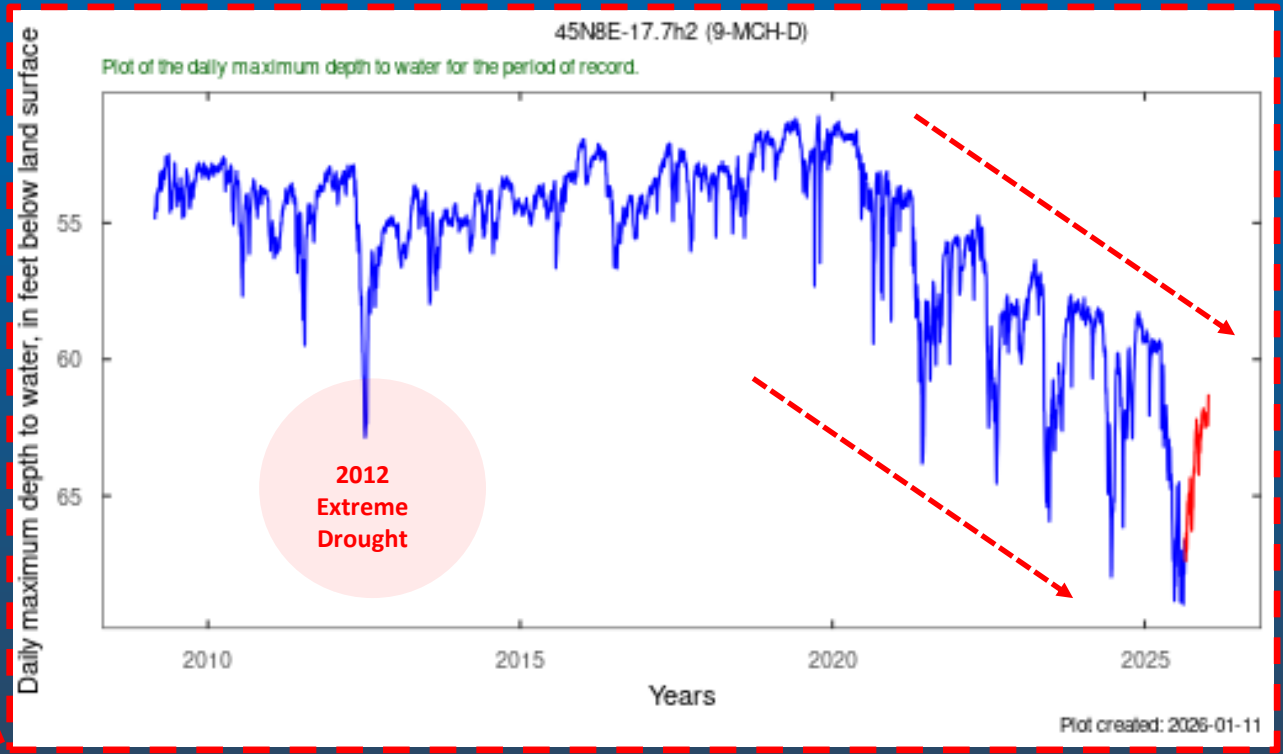


Groundwater Monitoring Well Network (January 2026)

mchenryH2O.com

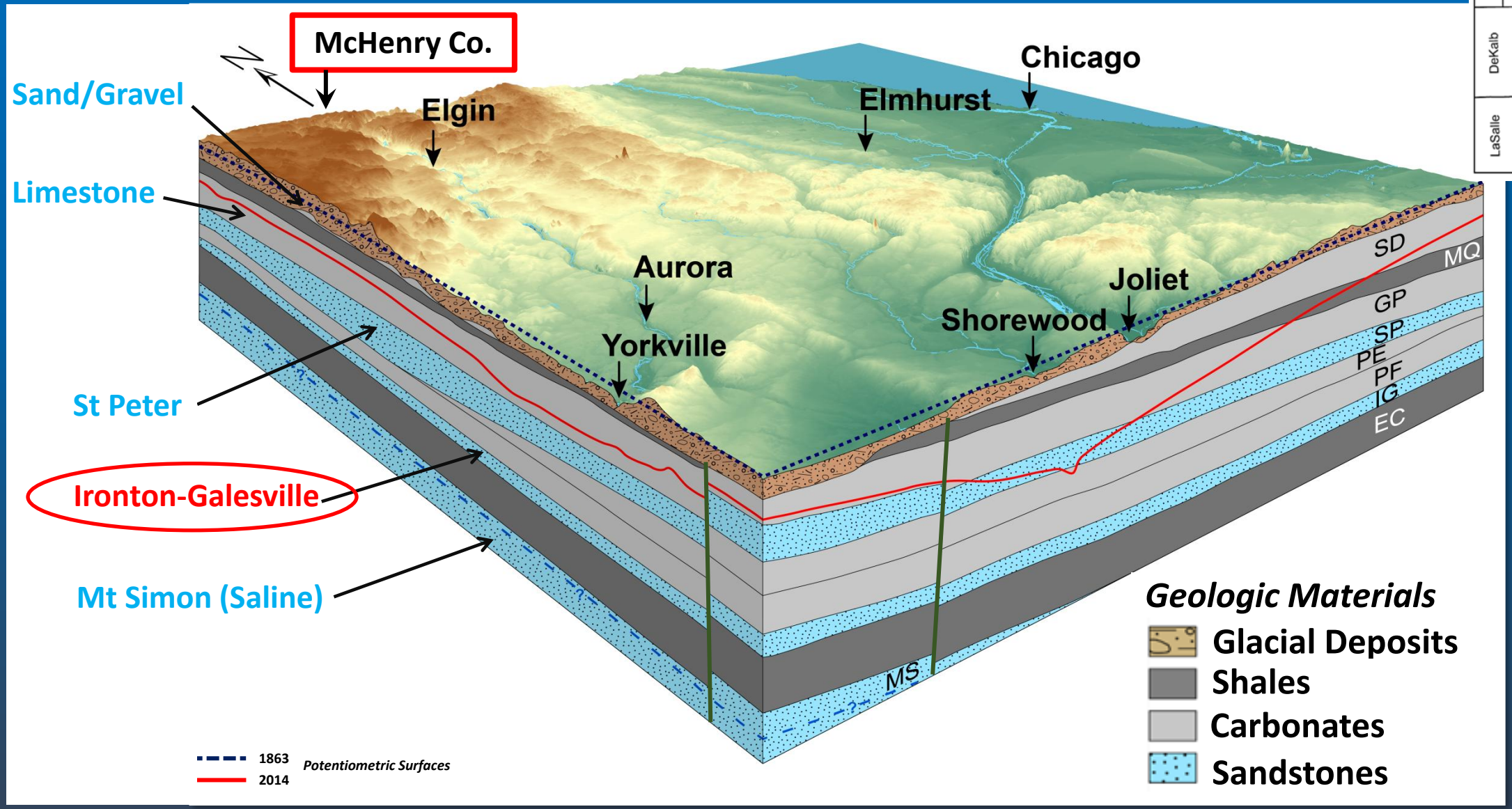


Since 2020 unsustainable drawdown has been observed in this aquifer



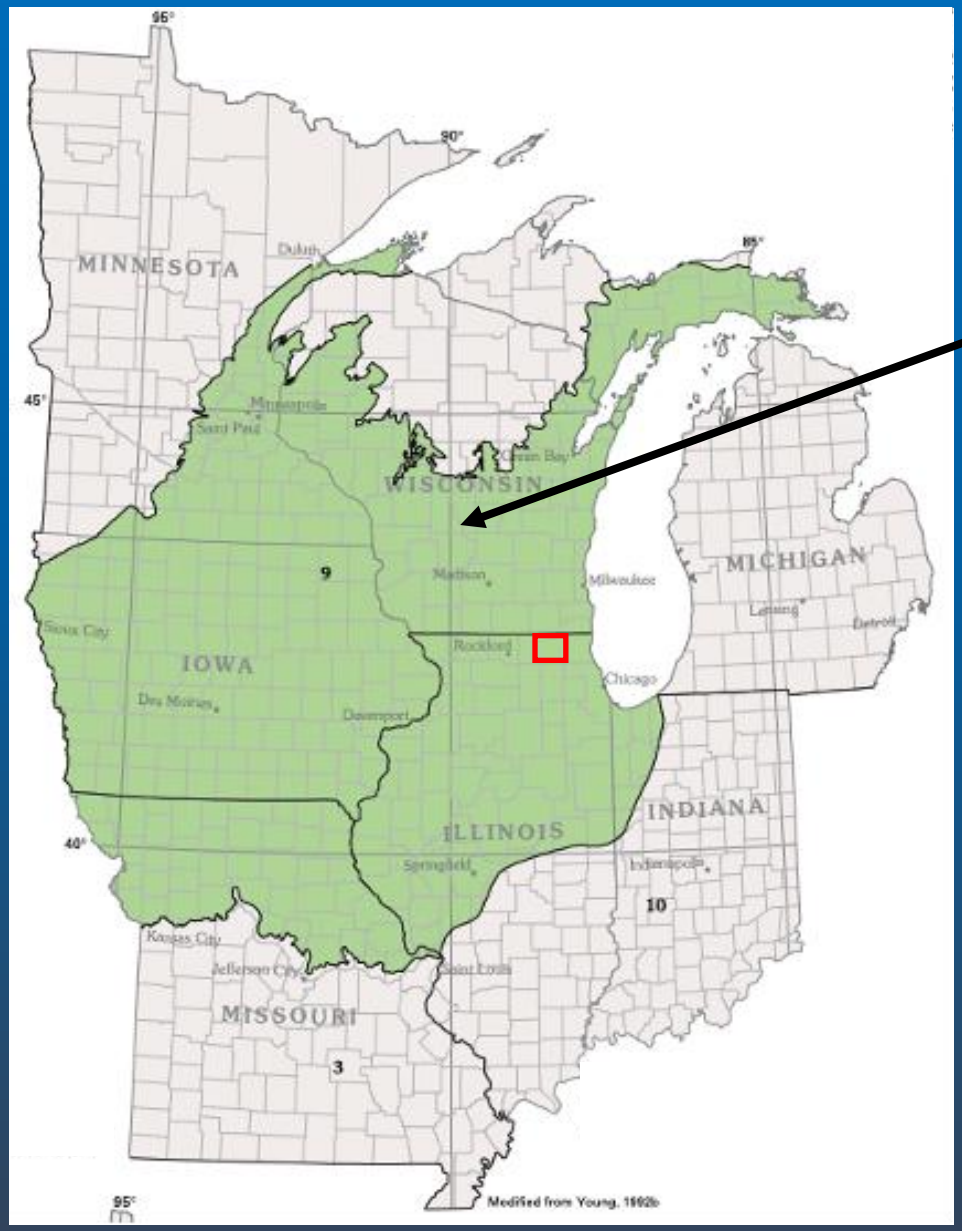
U.S. Geological Survey

Northeast Illinois Groundwater Aquifers



Illinois State Water Survey

Sandstone Aquifer Range

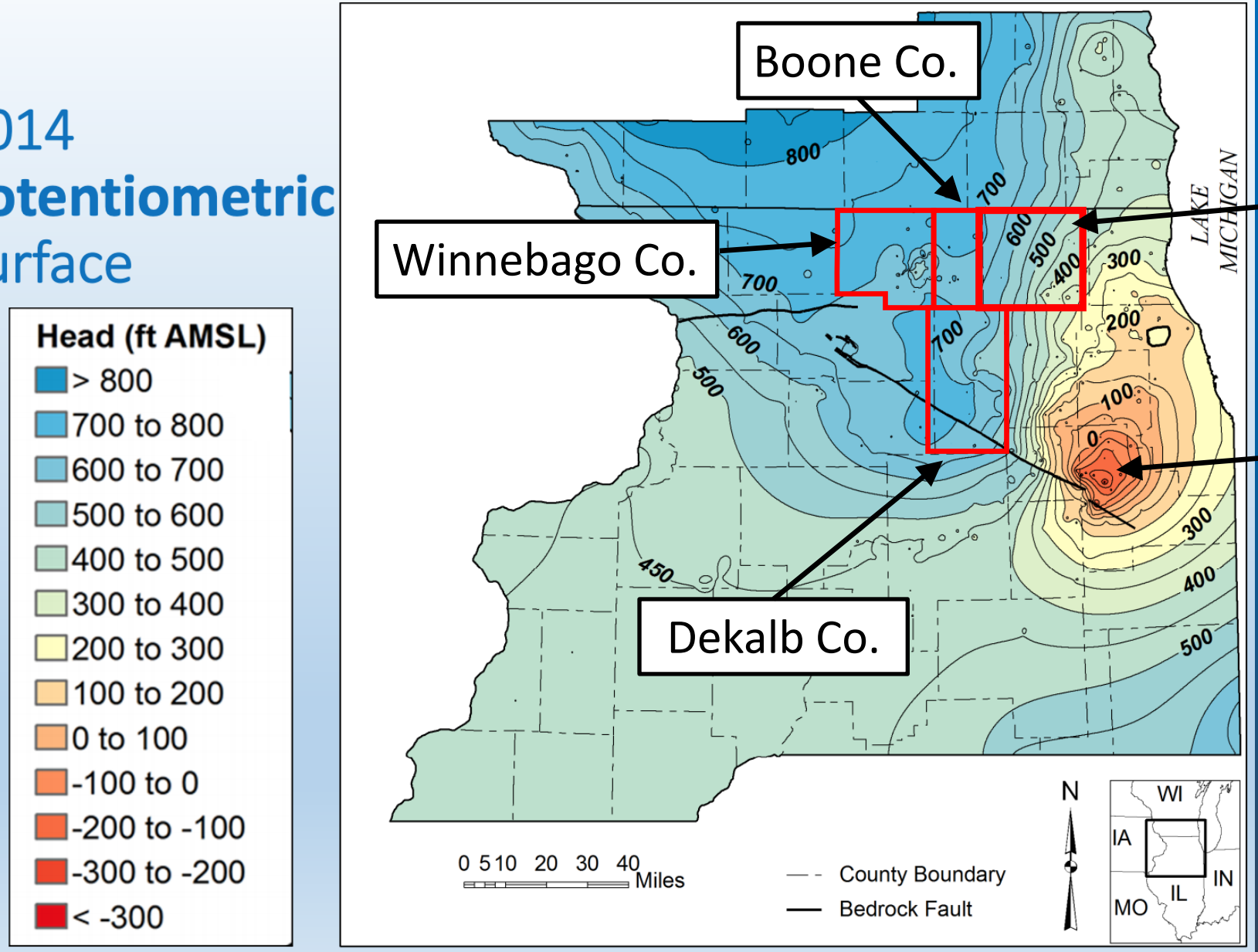


Ironton-Galesville Aquifer Recharge

U.S. Geological Survey

Sandstone Aquifer Desaturation

2014 **Potentiometric** Surface



Illinois State Water Survey

What Are Data Centers

Data Centers

Facilities for servers and computer equipment to store and process data for digital services.

(streaming, cloud computing, and **AI**)

Unique Resource Demands

Data Centers are different from other industries because they operate 24/7 along with their intense demand for energy and water.

Hyperscale

Data Centers have grown from large systems with 3-acre facilities to 40 + acre hyperscale facilities on 500 + acre campuses.

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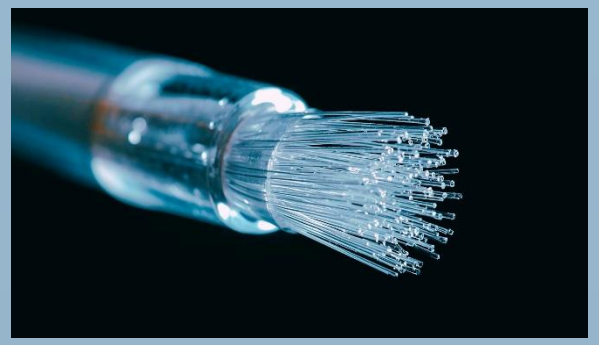
Where Do Data Centers Locate



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NEED ACCESS TO:

- Fiberoptic Networks
- Energy (a lot of energy)
- WATER

Why Do Data Centers Need Water

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DIRECT WATER USE

Cooling! (Computer systems produce massive heat)

General Water Use (faucets, toilets, etc.)

Fire Suppression

NOTE: Are PFAS - based fire protection methods used?
(i.e., Inergen vs. Novek 1230, or FM-200/HFC-227)

Why Do Data Centers Need Water

INDIRECT WATER USE

Energy Production to Power Data Centers:

Coal, natural gas, and nuclear power systems all boil water to produce steam to run turbines.

Energy systems may also use massive amounts of water for cooling.

Indirect water use calculations may also include water used to extract and refine the fuel source.

NOTE: Solar and wind don't require water to produce energy.

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How Much Water do Data Centers Use?

Very Difficult to Track

Lack of Transparency by Data Center Industry

The persistent lack of readily available, accurate, and consistent information about water usage by data centers has led to significant confusion and public mistrust.

New and Rapidly Changing Technology

Industry is figuring it out as they go so new technologies not widely understood.

No Federal or State Requirements for Reporting Water Use

In the absence of requirements at the Federal or State level, **accurate water usage information will only be available is if Local Governments require it.**

NOTE: Local Governments should require data centers to report accurate levels of **Total Direct Water Use** for entire facility **early in the review process** (include cooling systems for both equipment and building).

How Much Water do Data Centers Use?

Very Difficult to Track

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No Standardized Reporting Methods for Water Use

Some figures only identify a small part of Direct Water Use,

while other figures combine all Direct and Indirect water Uses.

"5 Million Gallons Per Day" vs. "Less than a car wash" for same project

NOTE: Each approach has merit, but only if these figures are presented in proper context.

How Much Water do Data Centers Use?

Very Difficult to Track

+

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Total Direct Water Use

Needed to evaluate impacts to a specific water source (i.e. groundwater aquifer).

Total Direct and Indirect Water Use

Needed to evaluate industries overall impact to water resources.

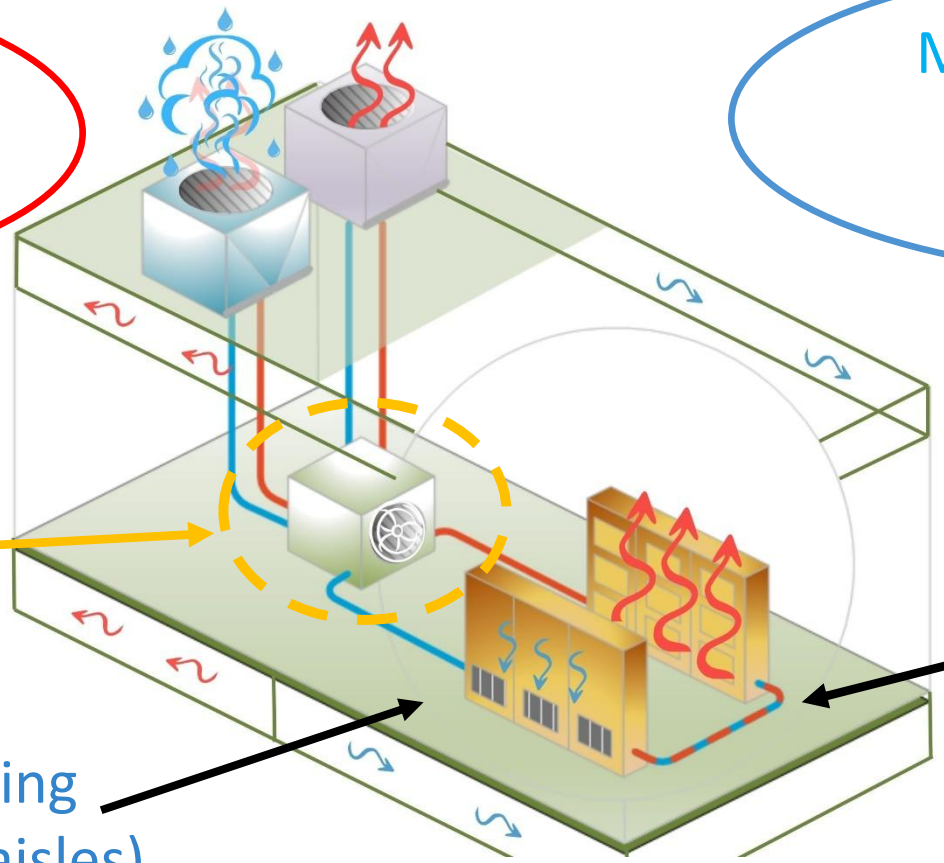
NOTE: When Natural Gas or **Small Modular Nuclear Reactors** are built adjacent to data center, the Direct and Indirect water uses will likely be drawing water from the same sources (i.e. groundwater aquifer).

Data Center Cooling Systems

Less Water Use = Significantly More Energy Use

Evaporative Cooling
(Heavy Water Use)

Mechanical Cooling
uses refrigeration & air
(Heavy Energy Use)



Heat Exchanger

Closed Loop
(Little or No Water Use)

Air Cooling
(cold/hot aisles)

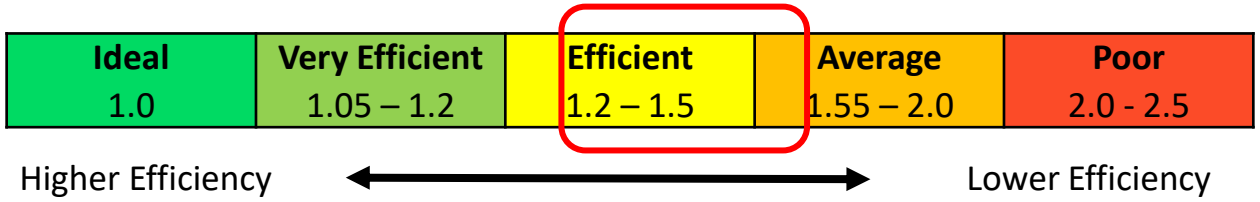
Data Center Efficiency Metrics

Power Usage Effectiveness (PUE)

Measurement of a data center's total energy use against energy used for IT.

Lower PUE means less energy used for cooling.

$$\frac{\text{Total Annual Energy Use}}{\text{Annual IT Energy Use}}$$



Water Usage Effectiveness (WUE)

Measurement comparing data center's water use against its energy use.

Less commonly used.

Data Center Cooling Systems

Direct Evaporative Cooling

Highest water use among cooling options (**Lowest energy use**)

Sprays water directly into the air supply

Cooling occurs as water evaporates into the air stream, leading to high evaporation rates

Cooling depends on continuous water consumption

- High evaporation rate = Higher water consumption
- About 80% of water used in Direct Evaporative systems is lost to evaporation

Indirect Evaporative Cooling

Moderate to lower water consumption among cooling options (depending on the system)

Water is only used on the heat exchangers external side (often intermittently/seasonally)

- No humidification of supply air reduces evaporative demand/water consumption
- Some systems can operate in “dry mode” in cooler climates

Advanced Data Center Cooling Systems

Free Air Systems

- **Uses cool ambient outdoor air to cool IT equipment, significantly saving energy and water.**
- Free air systems filter outside air and mix it with warmer return air to hit optimal temperatures.
- Can only be used when outside temperatures are favorable, needs other cooling systems.

Optimal outdoor temperature range to operate is 41°F to 64°F (systems needs may vary)

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Full Free Cooling **41°F to 64°F** (no mechanical cooling needed)

* Outside air alone can maintain data hall within recommended limits
* Compressors/Chillers can be completely turned off

Partial Free Cooling 64°F to 75°F (Mixed cooling systems)

* Outside air + mechanical cooling

Not Suitable For Cooling 75°F +

* Outside air too warm, requires mechanical cooling

Advanced Data Center Cooling Systems

Single Phase: Direct-to-chip (D2C)

Cooling systems that run liquid coolant directly over the high-heat components in servers.

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Closed Loop – Single Phase:

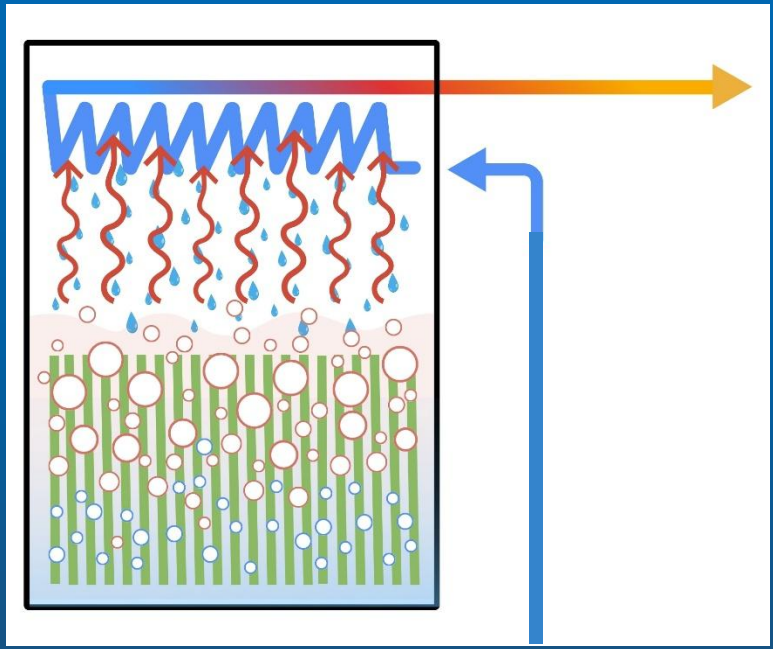
Water typically used as the cooling liquid
to cool equipment and transport heat away.

After filling system, minor water use (in closed loop area)
High energy use

NOTE: Water typically treated with biocides, glycol, and de-scaling chemicals and may need to be refreshed periodically. Are these chemicals and water discharged to WWTP's?

Advanced Data Center Cooling Systems

Two Phase: Closed Loop - Direct to Chip



Closed Loop – Two Phase:

Uses a specialized **dielectric liquid** that boils into vapor at low temperatures (104°F - 140°F) to **quickly and efficiently** remove heat.

No water use (in closed loop area)

High up-front cost…Lower stress on equipment

NOTE: Dielectric fluids contain PFAS and other hazardous chemicals. It is uncertain that State environmental permits would cover these. Local governments should require proper management and disposal of these materials to prevent discharge into WWTP's or the environment.

Advanced Data Center Cooling Systems

Liquid Immersion

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Servers are fully submerged in non-conductive dielectric fluid, capturing heat with high efficiency and significantly reducing energy use.

No water use …Lower energy use

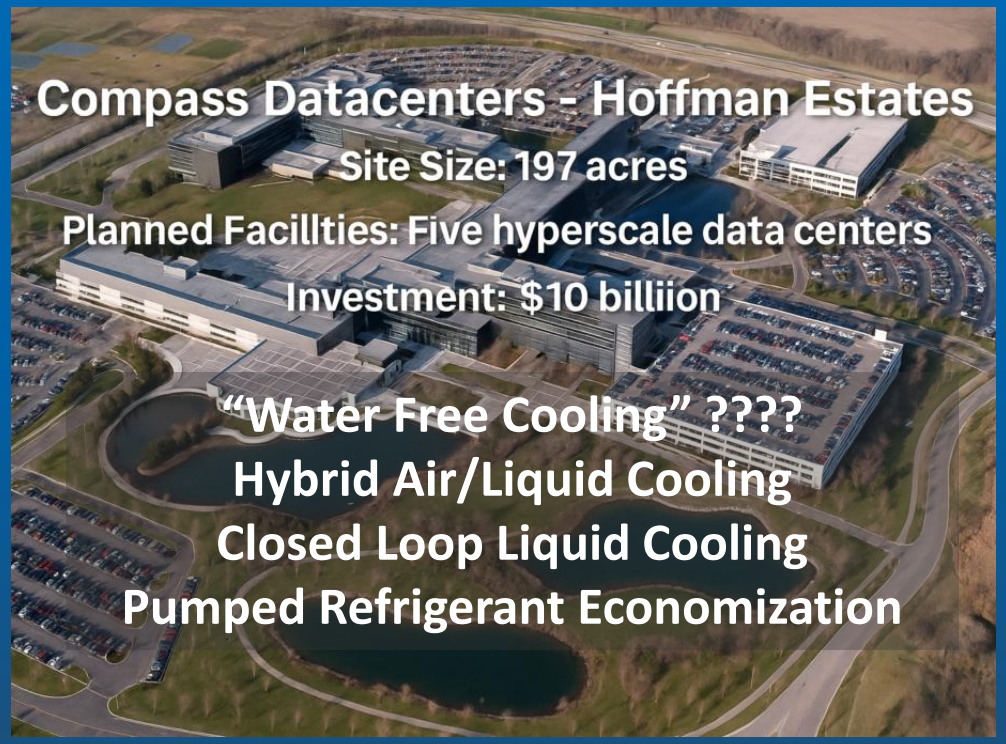
Very high up-front cost…Much higher productivity.

GPU modules in liquid immersion can be stacked more closely together enabling more units in a smaller area.

NOTE: Dielectric fluids contain PFAS and other hazardous chemicals. It is uncertain that State environmental permits would cover these. Local governments should require proper management and disposal of these materials to prevent discharge into WWTP's or the environment.

Hybrid Cooling Approaches

Using a Combination of Cooling Systems – Not a One Size Fits All



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Cooling Tools in Toolbox

Closed Loop Liquid Cooling

Closed Loop Liquid Immersion

Free Air Cooling

Hybrid Air/Liquid Cooling

Geothermal

*Water Reuse ???

* **NOTE**: Perhaps data centers could provide the funding needed to develop "water reuse" technology and infrastructure in the region.

Current Centralized Energy System

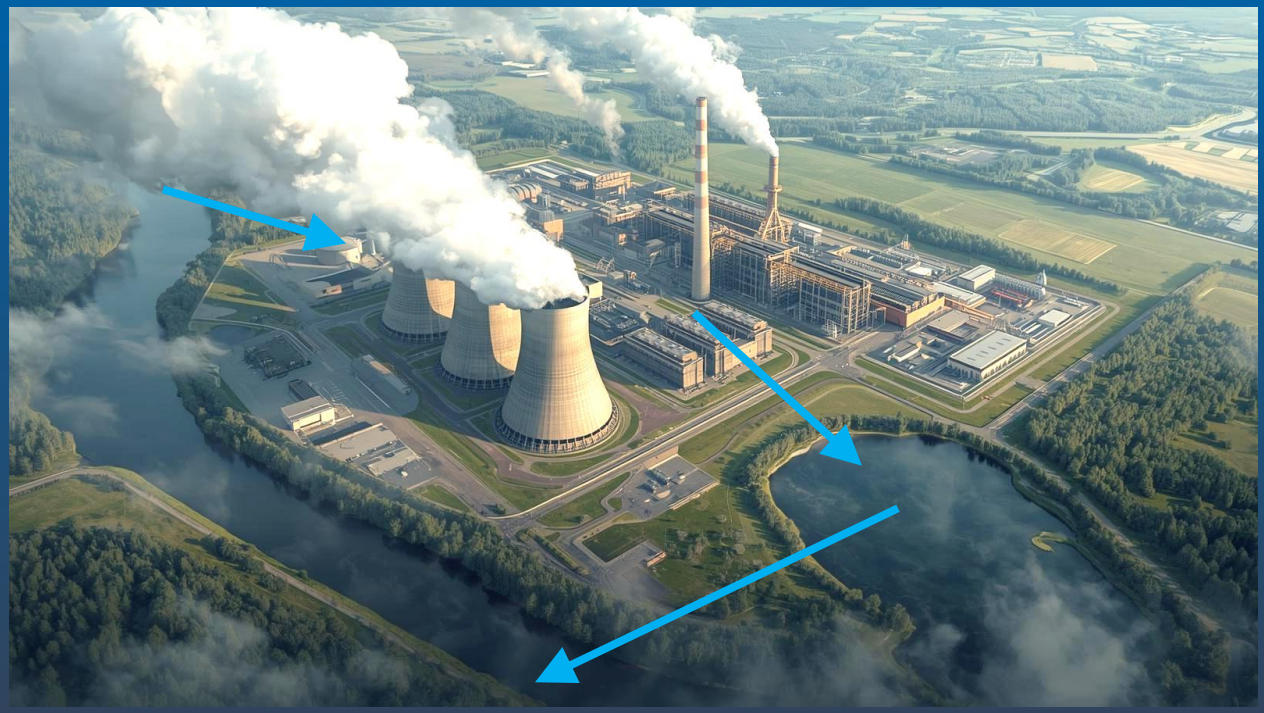
Large power plants typically located near a river or lake that provides water for steam and cooling.

Much of that water is lost to evaporation as part of these processes.

Water that is recovered returns to original water source.

(most water-use data for energy production based on this assumption)

Power Plant
Adjacent to River



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"Decentralized" Energy System

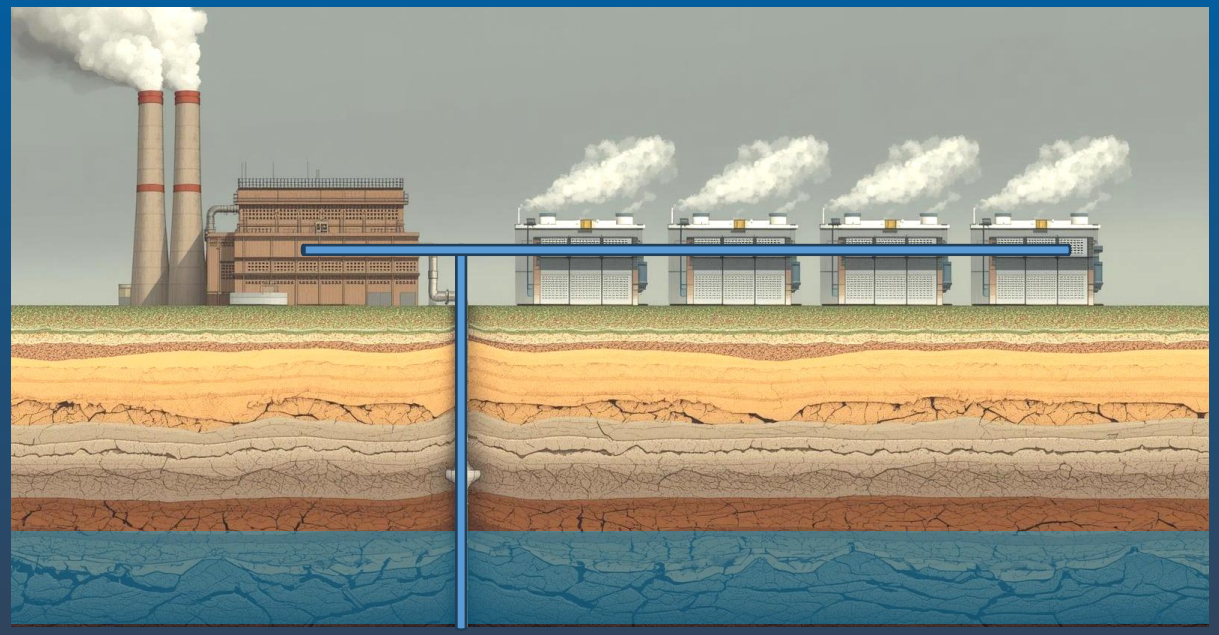
On-Site Energy Production

To help reduce disruptive impacts from data center energy demands,
Pressure for on-site energy production is increasing.

When groundwater is used, water is not returned to source,
significantly increasing "consumptive use".

Power plants built next to data centers

Each drawing water from the same groundwater aquifer



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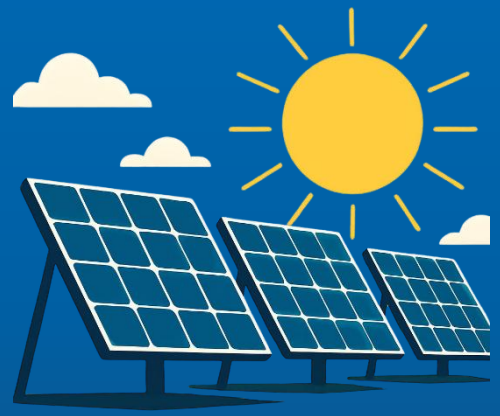
Onsite Energy Production Systems

The Type of Energy System and How They Operate Determines Water Consumption



Solar Photovoltaic

No direct use of water for energy production

Solar farms typically require large area of land

Wind Energy Systems

No direct use of water for energy production

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Onsite Energy Production Systems

The Type of Energy System and How They Operate Determines Water Consumption

!!! When groundwater is used, it is not returned to original source !!!

Natural Gas Systems

Single Cycle: uses more water but is more energy efficient

Combined Cycle: Uses less water but is less energy efficient

Natural Gas Cooling System

Once-Through: Large volume of water needed

Closed Cycle/Recirculating: Significantly less water, but more evaporative loss/consumption

Dry Cooling: Expensive/rare, reduces water use up to 95%, but looses efficiency in hot temps

Onsite Energy Production Systems

The Type of Energy System and How They Operate Determines Water Consumption

!!! When groundwater is used, it is not returned to original source !!!

Nuclear Systems - Small Modular Reactors (SMR)

Rapidly developing industry – Many designs working to be brought to scale **(currently theoretical)**

Carbon free but historically nuclear power had highest water consumption

Use water to generate steam and most use water for cooling (some systems minimize/eliminate water use)

Examples of reactor systems being proposed to power data centers include:

Advanced Light-Water Reactors: water use is similar to current nuclear plants, but said to be more efficient

High-Temperature Gas-Cooled Reactors: Uses helium as the primary coolant reducing water consumption

Molten Salt Reactors (MSR): Uses salt as the primary coolant reducing water consumption

Questions?

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