
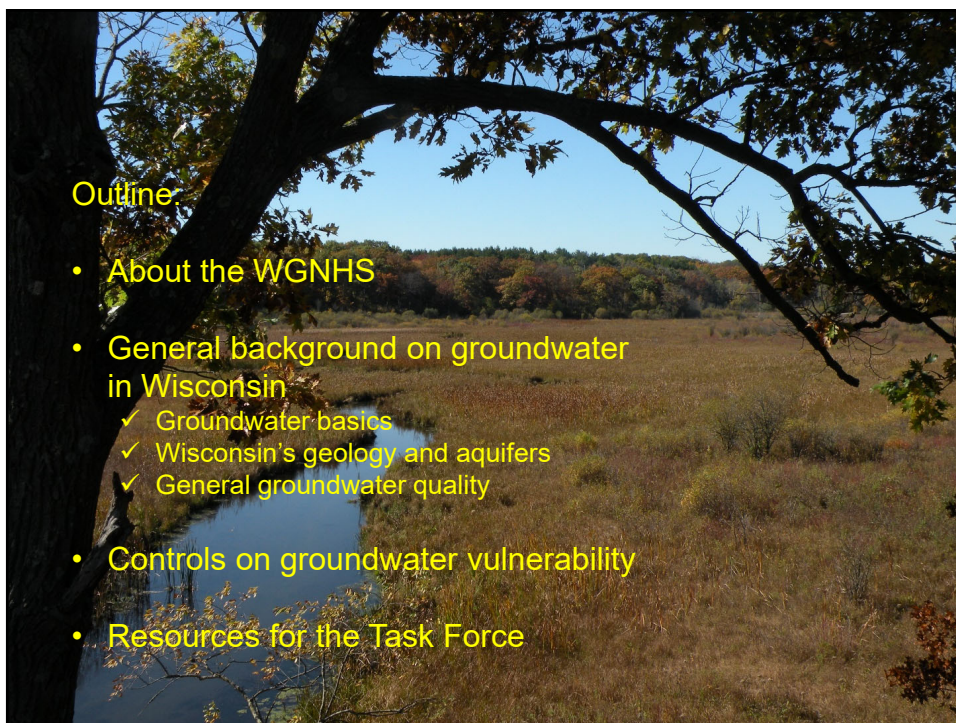


Wisconsin's Groundwater: Basic concepts and information resources

Wisconsin Legislature
Speaker's Task Force on Water Quality
March 20, 2019

Kenneth R. Bradbury, PhD
Director and State Geologist
Wisconsin Geological and Natural History Survey

 Wisconsin Geological
and Natural History Survey
UNIVERSITY OF WISCONSIN-MADISON



Outline

- About the WGNHS
- General background on groundwater in Wisconsin
 - ✓ Groundwater basics
 - ✓ Wisconsin's geology and aquifers
 - ✓ General groundwater quality
- Controls on groundwater vulnerability
- Resources for the Task Force

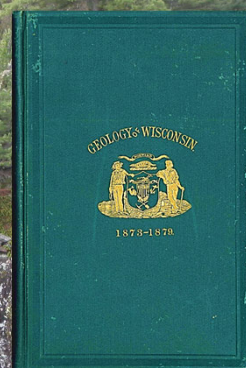
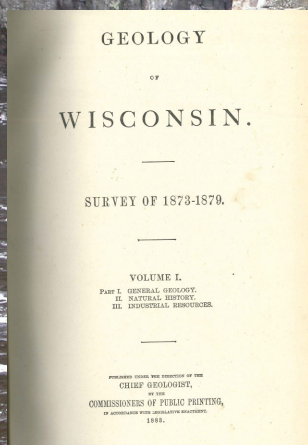
What is the Wisconsin Geological and Natural History Survey?



- Established by State Statute
- We are part of the University of Wisconsin-Madison, Division of Extension
- We do research, inventory, and teaching about the rocks, minerals, and water resources of Wisconsin
- Original Survey in 1853
- Current organization dates to 1897



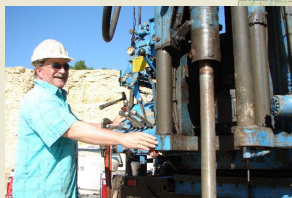
Our legacy...
exploration and science



To his Excellency, the Hon. JEREMIAH M. RUSK,
Governor of Wisconsin:
SIR—I have the honor of submitting herewith Volume I of the
final report of the Geological Survey of Wisconsin.
Most respectfully, your obedient servant,
T. C. CHAMBERLIN,
Chief Geologist.
BELOTT, June 30, 1882.

What we do today...

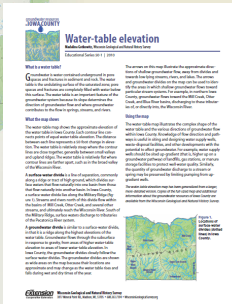
We collect field data



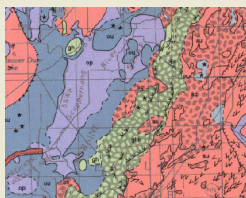
We conduct research



We prepare reports



We make maps



We advise and teach

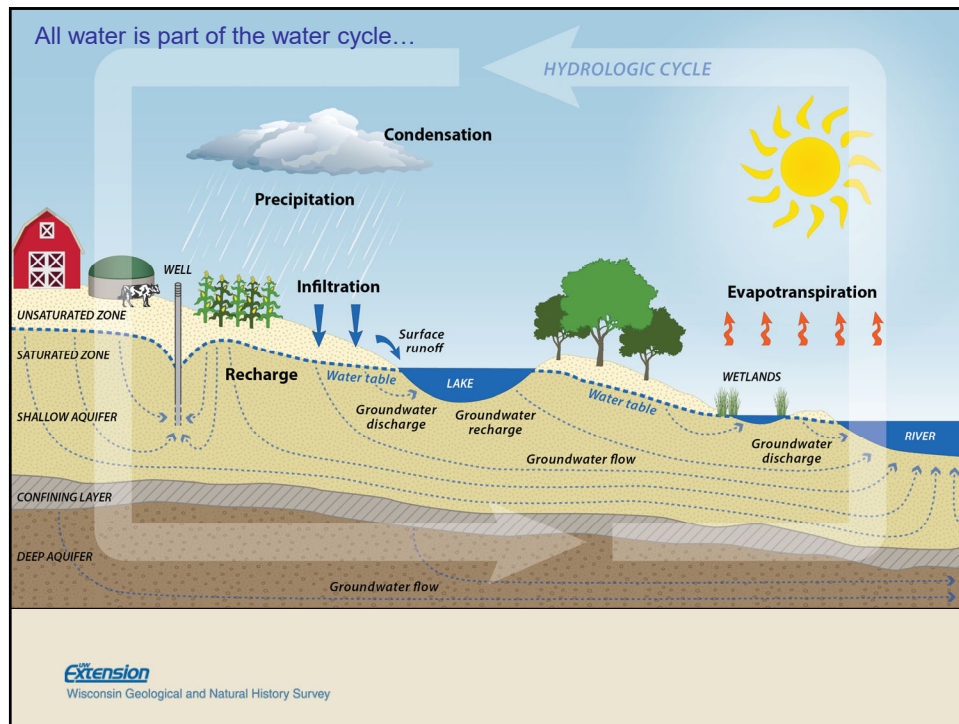


What is groundwater?

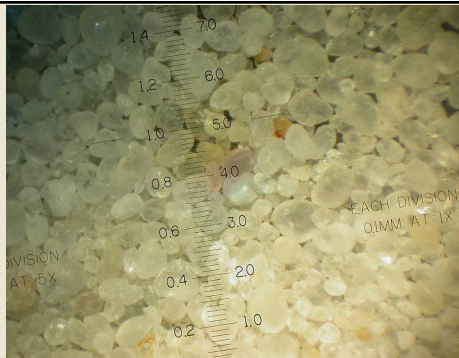
- Groundwater is water filling pores, cracks, fractures, and other voids in geologic materials beneath the earth's surface.

Culver springs, Dane County, WI





Microscope image of sandstone from a Madison supply well. Clean, well-rounded quartz grains create an effective porosity of about 30%

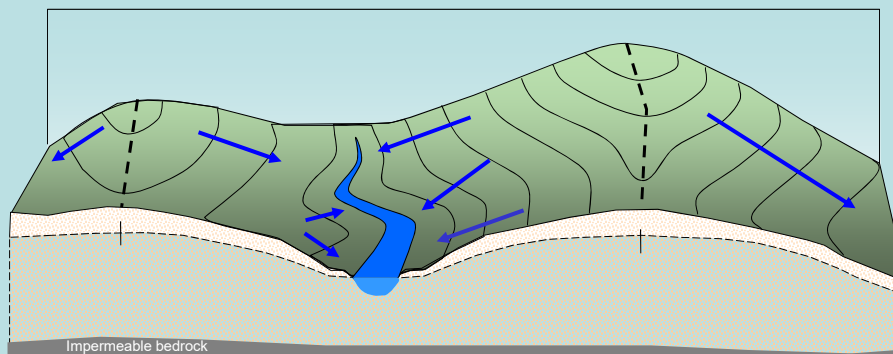


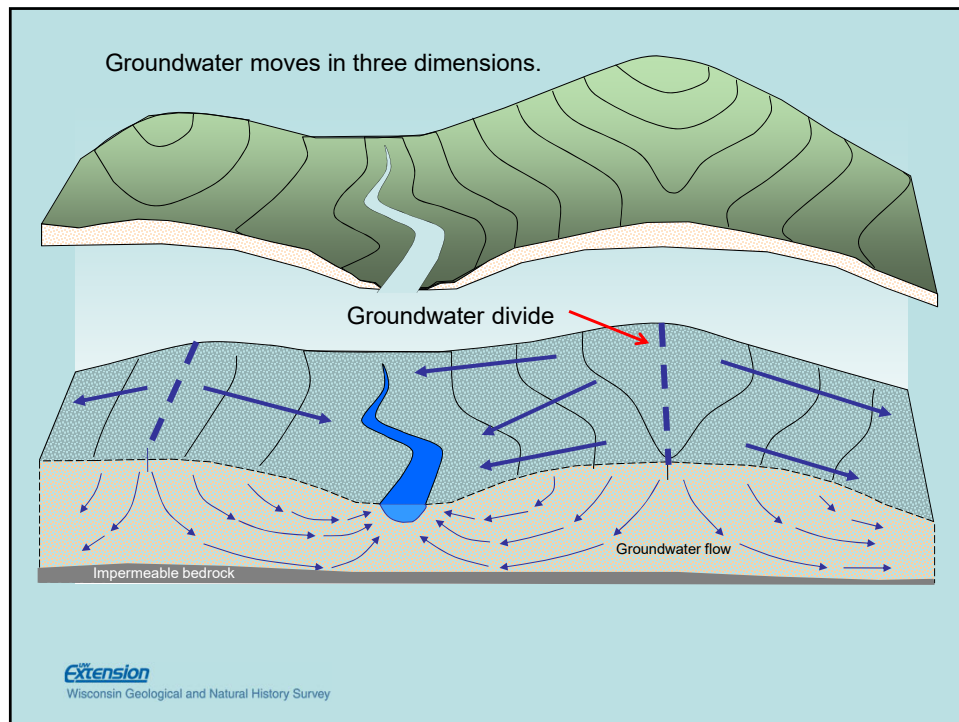
Typical sandstone found near Madison has an effective porosity of 10-15%



Fractured dolomite in Door County, WI. Groundwater can move rapidly through fractures with little attenuation of any contaminants present.

Groundwater moves in three dimensions.





How rapidly does groundwater move?

Flow rates vary widely, and depend on hydraulic conductivity, gradient, and the presence of fractures or other conduits. To generalize...

Clay: inches per year

Sandstone: 10's of feet per year

Limestone, dolomite: 100's to 1000's of feet per day

In fractured media, (i.e. fractured clay, granite, shale) flow volumes can be small, but flow rates can be very rapid

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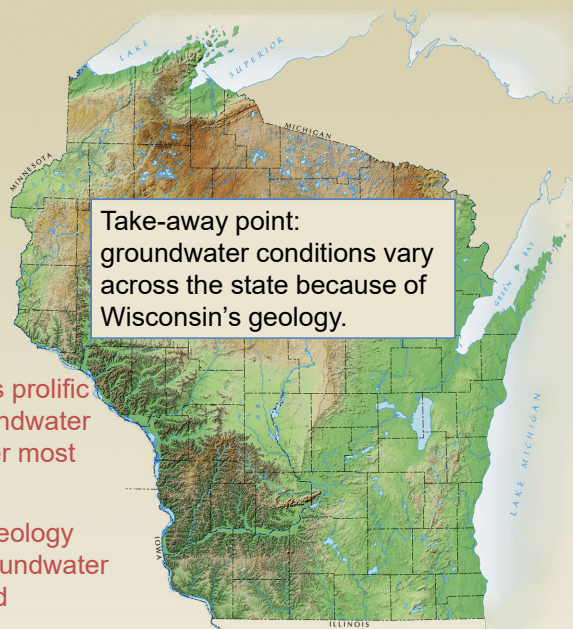
Groundwater sustains springs and wetlands

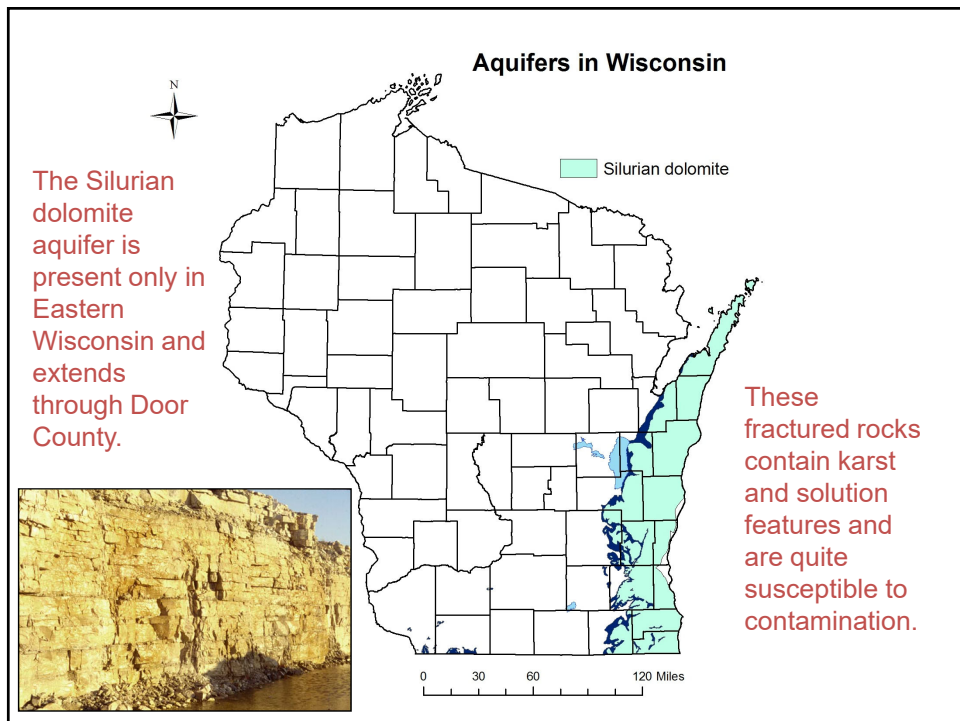
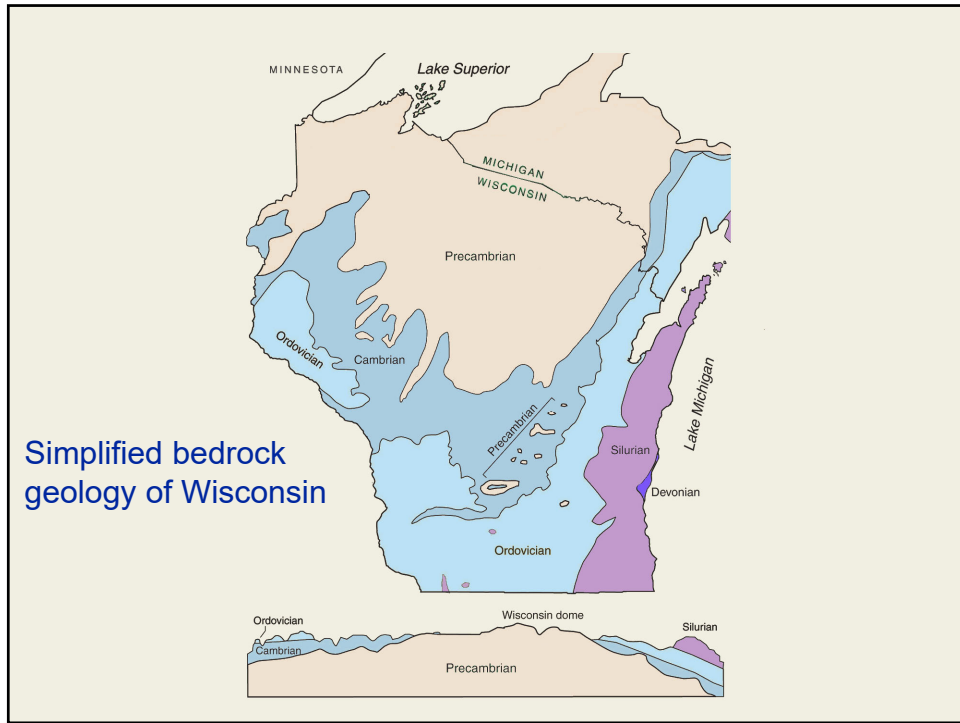


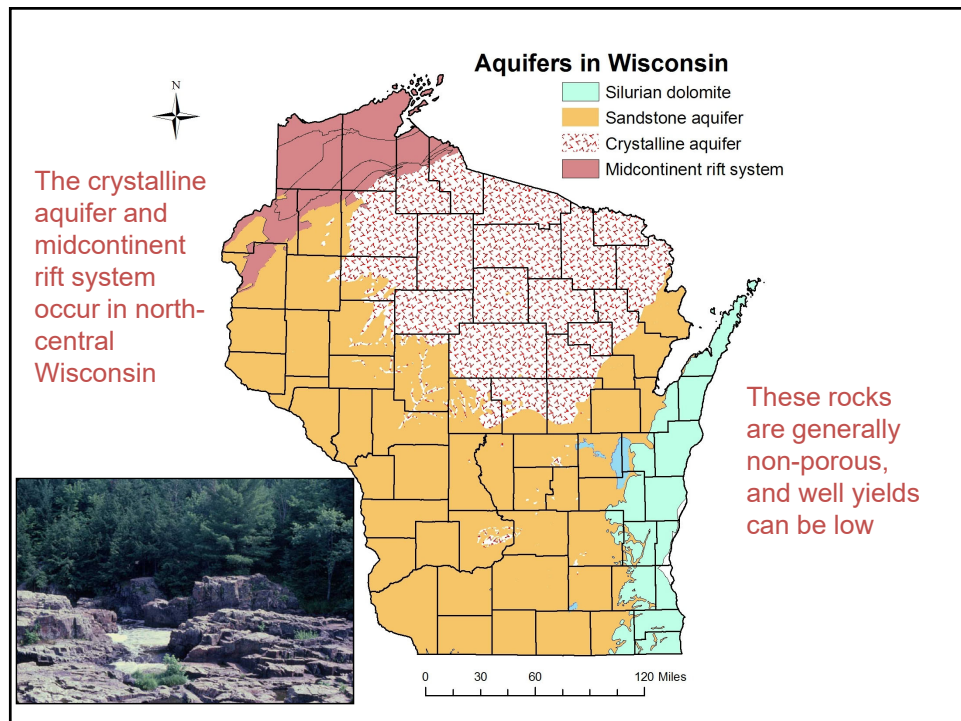
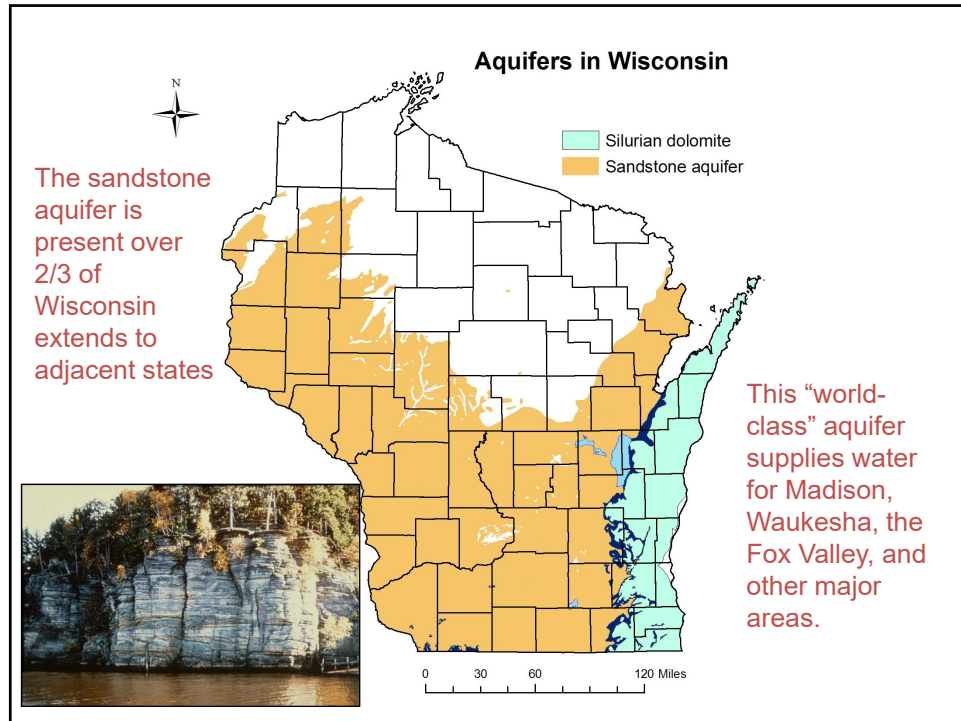
Take-away point:
groundwater conditions vary
across the state because of
Wisconsin's geology.

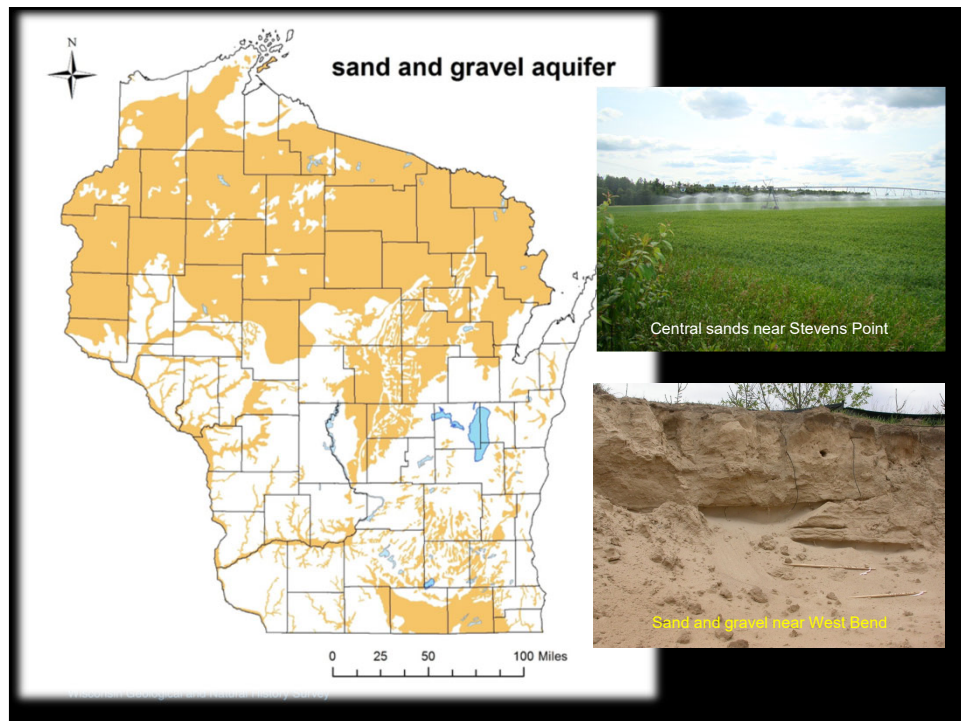
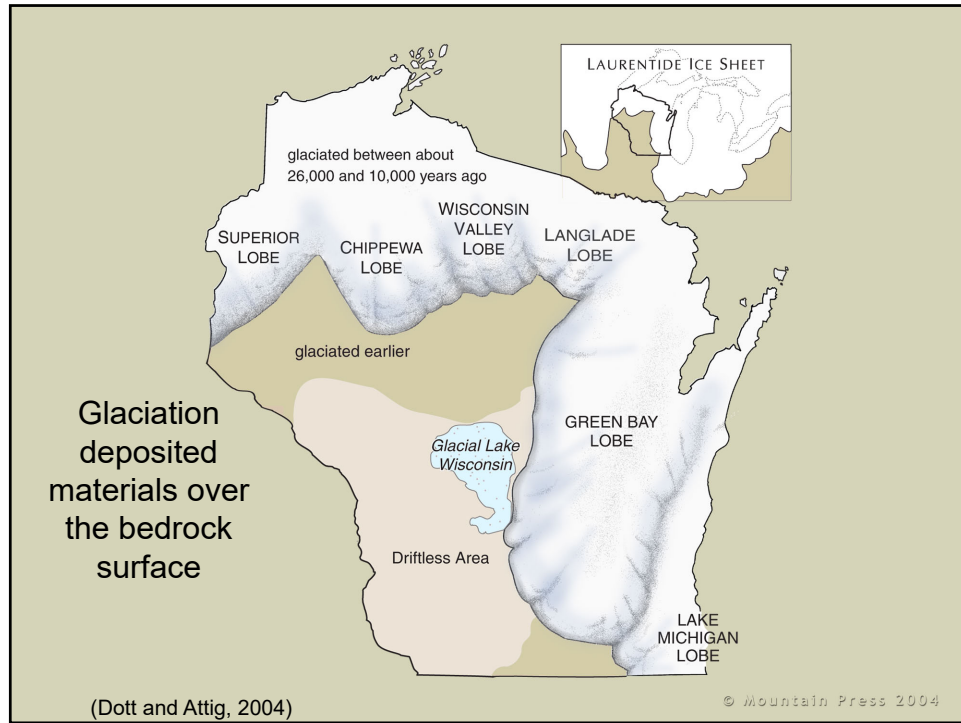
Wisconsin has prolific
aquifers; groundwater
is plentiful over most
of the state

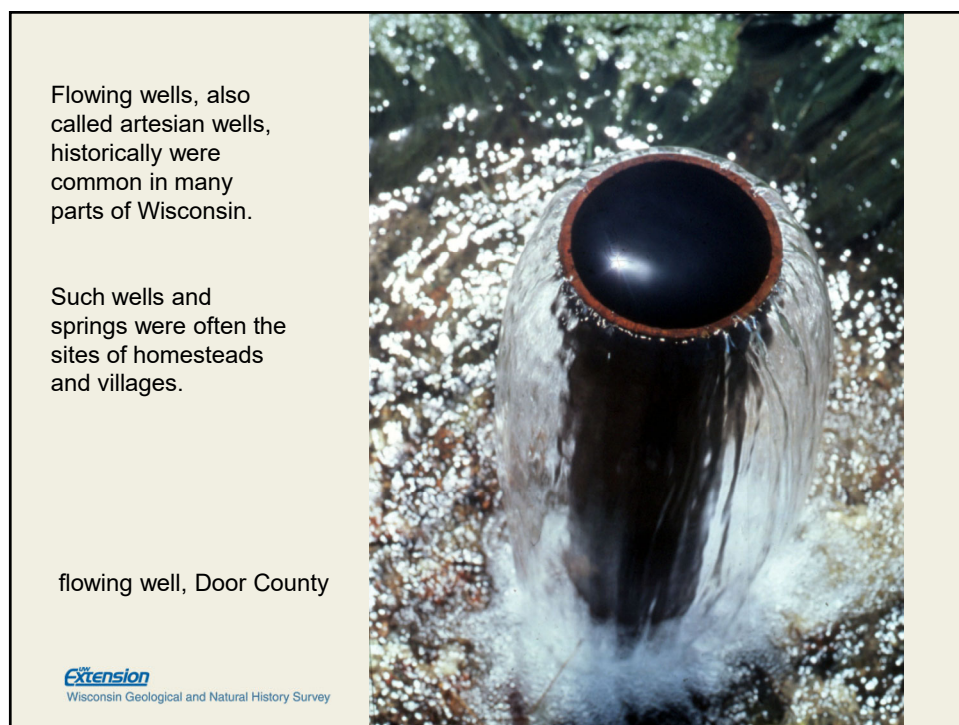
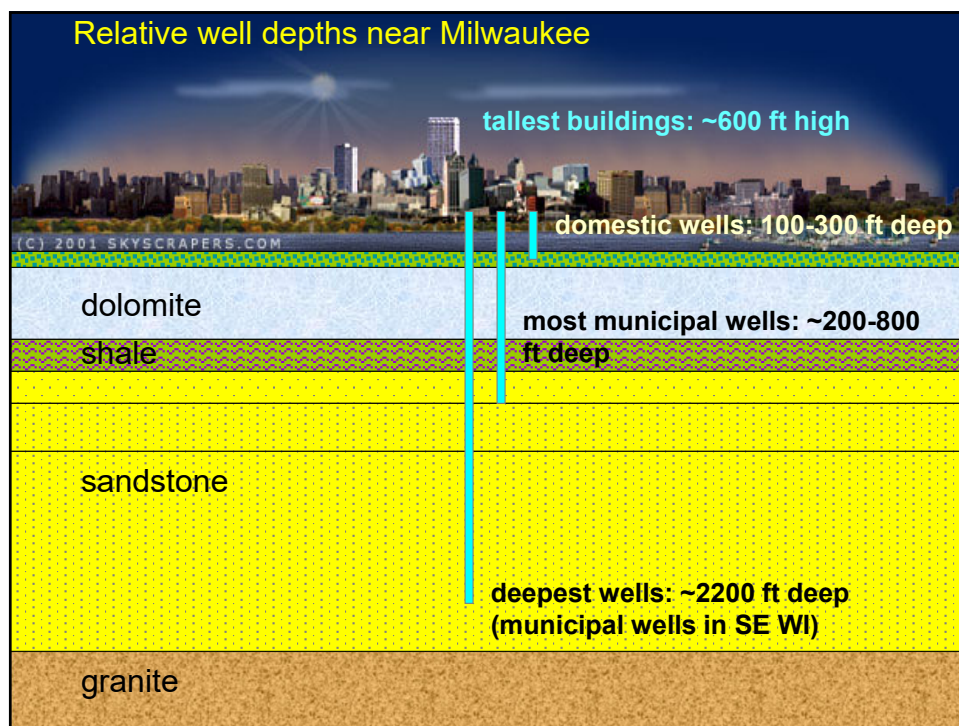
Wisconsin's geology
influences groundwater
availability and
vulnerability.



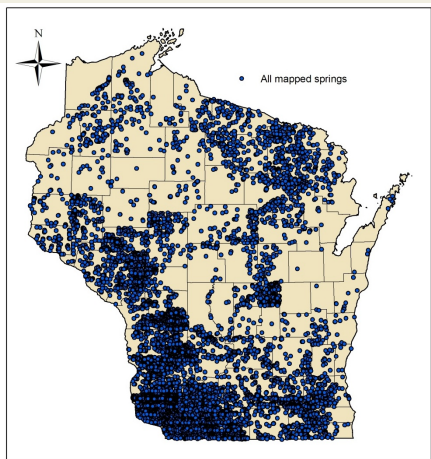








Springs in Wisconsin



Over 10,000 mapped springs!

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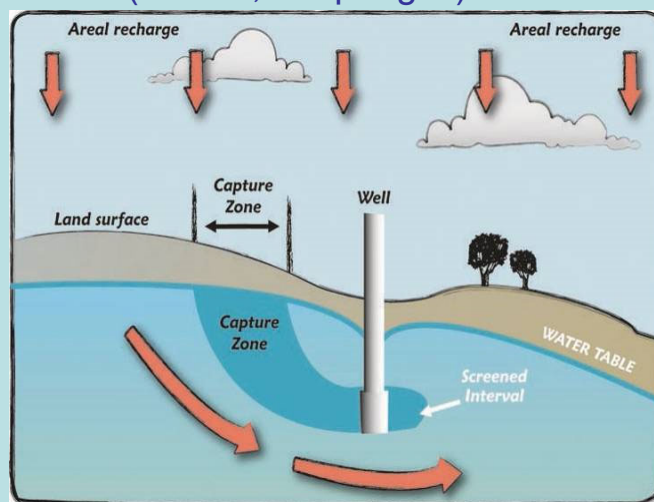
Bethesda Spring, Waukesha County, 1908



Statewide Springs Inventory: Cadiz Springs, Green County, WI

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Capture zone: land surface over which precipitation and snowmelt infiltrate to the water table and flow to the well (or lake, or spring...)



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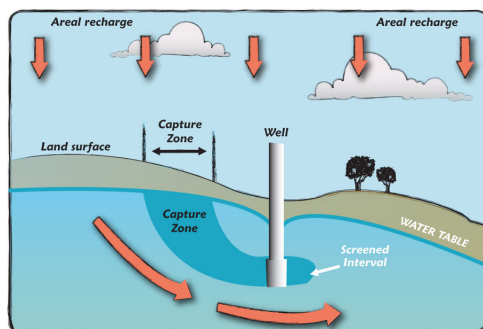


FIGURE 2:

The "capture zone" of a well.
Adapted from Franke et al. 1998

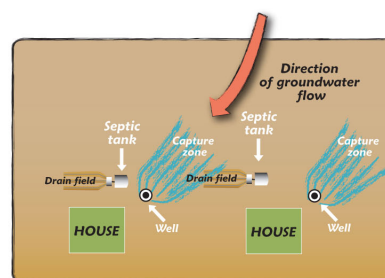


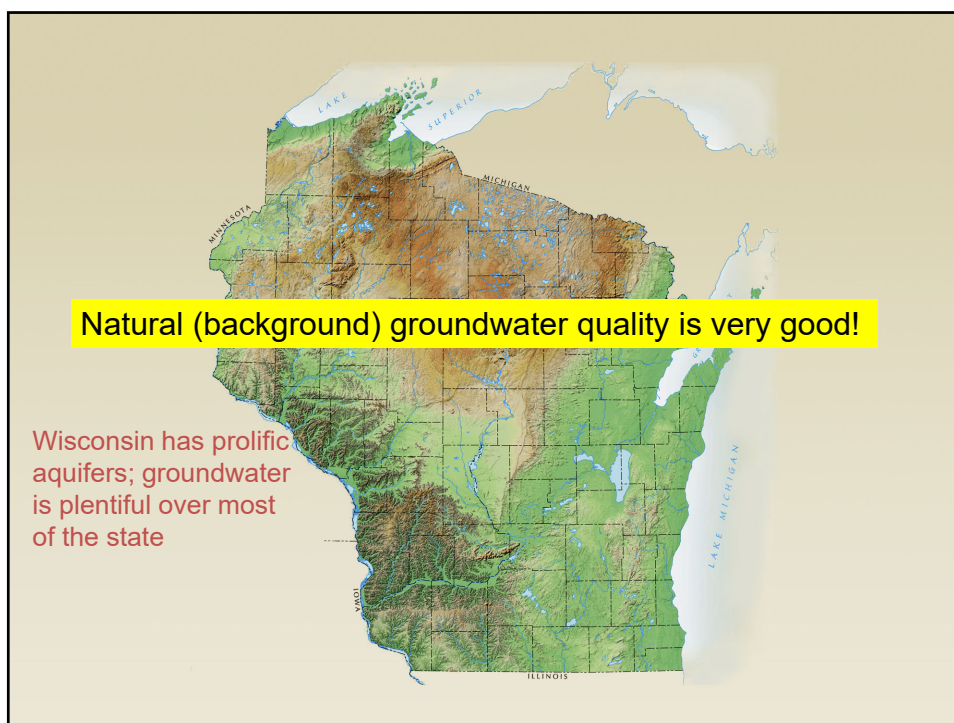
FIGURE 3:

Septic systems are potential sources of contamination to nearby wells.

Capture zones for wells

from Gotkowitz:
<https://www.uwsp.edu/cnr-ap/watershed/Documents/Subdivision%20Wells.pdf>

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What determines natural (background) water quality?

- **Dominant mineralogy** of the aquifer, rocks, and soil (*Example:* limestone or dolomite vs sandstone vs granite)
- Presence of **mineralized zones** within larger aquifers (*Example:* lead and zinc mineralization in western Wisconsin)
- **Depth** of the well (water quality can vary with depth)
- **Age** of the water (varies from days to 1000's of years; "older" water has more time to dissolve minerals)
- **Geochemical and biological processes** occurring in the soil or subsurface
- Quality of **precipitation** – the ultimate source of groundwater

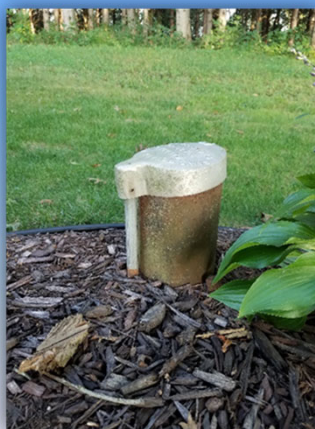
General contaminant types in groundwater

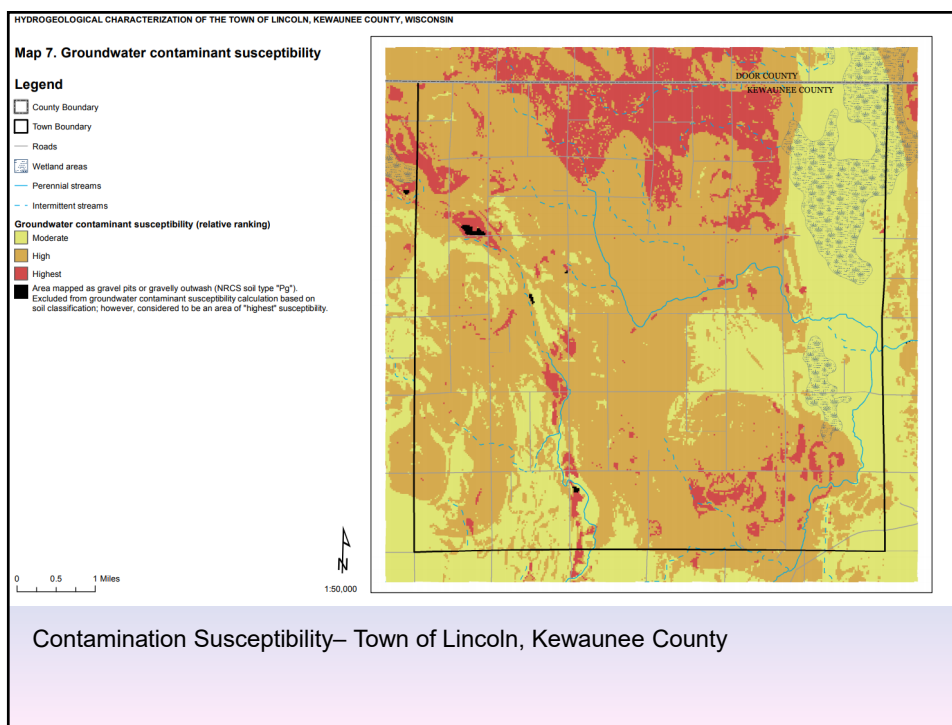
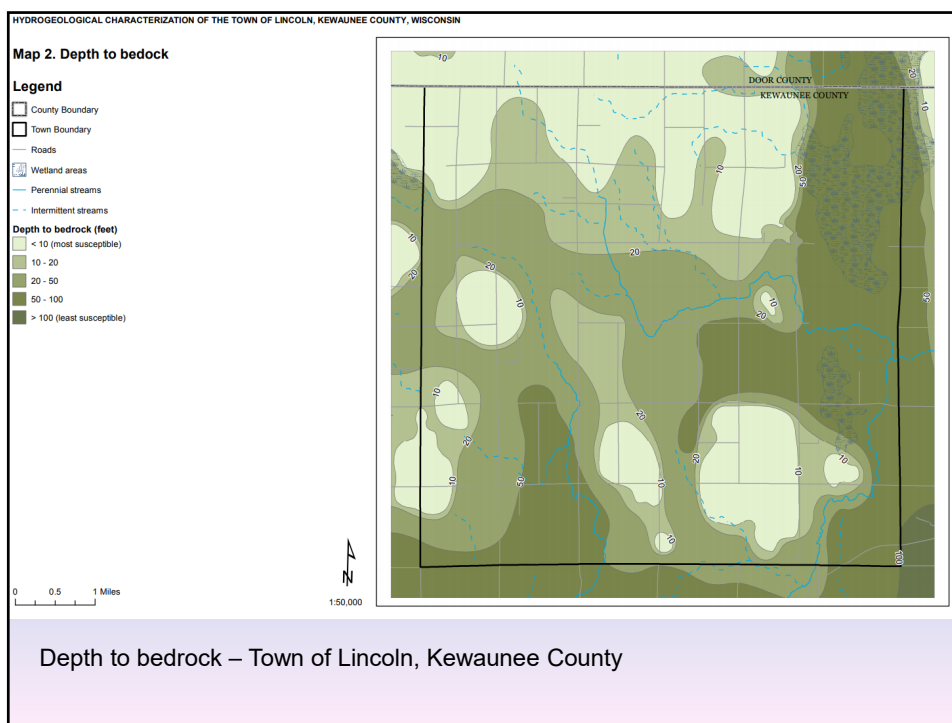
General Types	Categories	Examples
Aqueous Phase (dissolved constituents)	<u>Inorganic</u> (primarily ionic)	Cl ⁻ , SO ₄ ²⁻ , ClO ₄ ⁻
	Major ions	NO ₃ ⁻ , PO ₄ ⁻
	Nutrients	"heavy metals" As, Pb, Cd, Cr
	Trace elements	PCE, TCE, BTEX, PCB's,
	<u>Organic</u> (non-ionic + ionic)	pesticides, MTBE, and 1,4-dioxane, etc.
	Radioactive	³ H, ⁹⁰ Sr, ¹³⁷ Ce
NAPLs (immiscible liquids)	DNAPLs – Much more dense than water	Chlorinated solvents TCE, PCE, DCM, etc.
	DNAPLs – Slightly more dense than water	Liquid Hg, PCB's, some pesticides Creosote and coal tars
	LNAPL – Less dense than water	Petroleum products Fuel oils, jet fuels, petroleum
Particulates (colloids)	Biologically active Chemically active	Bacteria, viruses Colloid (size) facilitated transport – "sorption"

Source: Bradbury and others, 2006

Factors that increase vulnerability to contamination

- Permeable soils
- Thin soils and shallow bedrock
- Fractured bedrock
- Karst and solution features
- Shallow depth to the water table
- Rapid infiltration and recharge
- Improperly abandoned wells
- Faulty or poorly-designed wells
- And others...





Where to find information



The WGNHS web site :
<https://wgnhs.uwex.edu/>

Groundwater Coordinating Council (GCC) Report to
 the Legislature:
<https://dnr.wi.gov/topic/Groundwater/GCC/index.html>

DNR Groundwater page:
<https://dnr.wi.gov/topic/groundwater/data.html>

Available information



- County/regional studies
- Maps
 - Water table
 - Depth to bedrock
 - Geology
- Groundwater levels
 - Statewide network
- Groundwater quality
 - data viewer
- Groundwater quantity
 - High-capacity wells
 - Water use
 - springs
- Well information
 - Construction reports
 - Geologic logs

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About » Wisconsin Geology » Water/Environment » Maps/Data » Research » Education » **Publications »**

I WANT TO KNOW MORE ABOUT:
Landscapes
Learn more about the major landscape features that show Wisconsin's beautiful geology.
[Start learning](#)

Stories from the Field

- Mineral exploration in northern Wisconsin (web app)
Aug 03, 2018
- Lake Superior Legacy Collection website
Apr 10, 2018
- New Publications at the Survey
Apr 03, 2018
- 2017 Year in Review
Feb 28, 2018

Wisconsin Geological & Natural History Survey
The Wisconsin Geological and Natural History Survey (WGNHS) has been working to serve Wisconsin for over 100 years. Part of University of Wisconsin-Extension, we provide objective scientific information about the geology, mineral resources, and water resources of Wisconsin.
[Like](#) [Share](#) You and 3.5K others like this.

Wisconsin Geological & Natural History Survey
Oct 2, 2018 @ 3:00pm
WGNHS collaboration with USGS includes INTEGRATED GEOPHYSICAL MODELING PROVIDES INSIGHTS INTO THE THREE-DIMENSIONAL GEOMETRY OF THE MIDCONTINENT RIFT IN WESTERN LAKE SUPERIOR <https://tinyurl.com/y38mad7> #GSA2018 #WGNHSResearch

Explore our website

- Publications database
- Minerals of Wisconsin
- Wisconsin's geology
- Water & environment
- Well records
- Core repository

Start at the WGNHS website: wgnhs.uwex.edu

Wisconsin Groundwater Coordinating Council (GCC)
Report to the Legislature

At a glance:

Groundwater Quality

Nearly three-quarters of us in Wisconsin rely on groundwater for our primary drinking water supply.

[Read more](#)

1. Groundwater Quality
[Play](#) [Pause](#) [Next](#)

The Groundwater Coordinating Council prepares an annual report each year that summarizes the operations and activities of the council, describes the state of the groundwater resource and its management and makes recommendations. The report is due each August for the preceding fiscal year. The latest report is for Fiscal Year 2018 (July 1, 2017 – June 30, 2018) and is contained on these webpages.

Recommendations
[Recommendations](#)

Agency activities
[Agency activities](#)

Progress portfolio
[Progress portfolio](#)

Monitoring / research
[Monitoring and research](#)

Groundwater quality
[Groundwater quality](#)

Groundwater quantity
[Groundwater quantity](#)

Groundwater

Look up
data about the quality of groundwater near homes or businesses or get an estimate of groundwater availability.

Protect
the quality and quantity of groundwater for your family, business customers and community.

Learn
where your groundwater comes from and how it moves underground to reach your drinking water well and the lakes and streams you enjoy.

Report to the legislature

- Latest Report home
- Executive summary [PDF]
- Full Report [PDF]
- GCC Report archives

Groundwater Coordinating Council

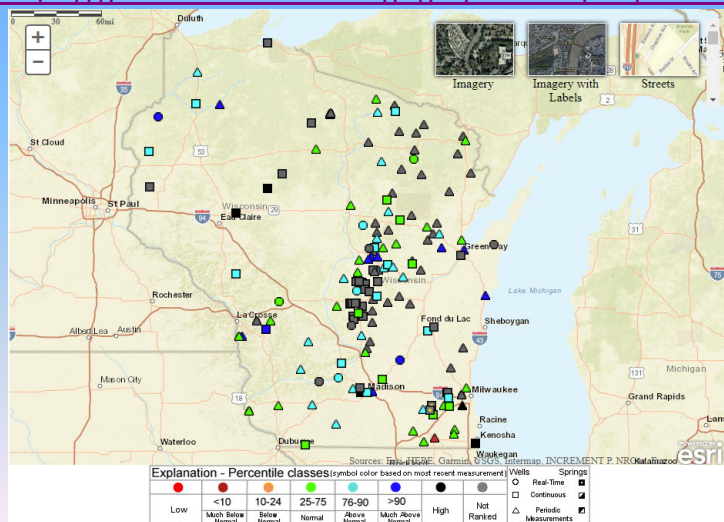
- Overview of the GCC
- Meeting minutes
- Members
- Research & monitoring
- Statutory language relating to the GCC [exit link]
- FAQ

What's a Spring?
What is a spring?

Groundwater levels

Statewide water-level network

<https://groundwaterwatch.usgs.gov/statemap.asp?sc=55&sa=W1>



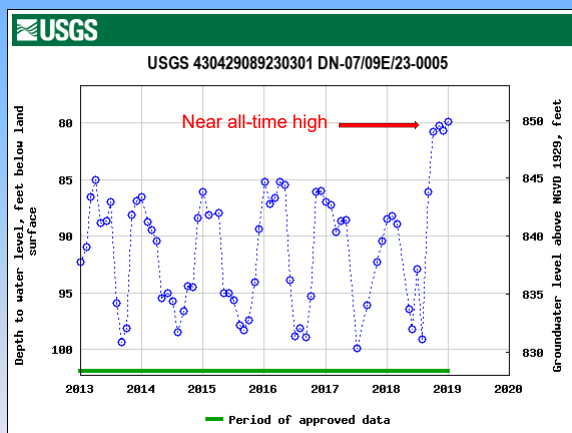
92 wells


45 counties
(out of 72)



Capitol custodians measuring well DN-0005 in basement of Wisconsin Capitol

Well in basement of State Capitol; records back to 1874




**University of Wisconsin
Stevens Point**

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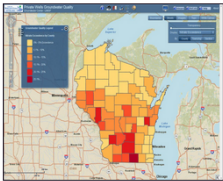
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Center for Watershed Science and Education
 College of Natural Resources and University of Wisconsin-Extension

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[WI Well Water Quality Viewer](#)
[Student Involvement](#)
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Well Water Quality Viewer: Private Well Data for Wisconsin

WI Well Water Quality Interactive Viewer



[Use the Interactive Well Water Quality Viewer](#)

Homeowners and local units of government can use this tool to:

- See what we know about general well water quality in Wisconsin.
- Compare water quality in your area to nearby towns or counties.
- Raise awareness of local groundwater quality issues.
- Promote testing and outreach efforts.
- Encourage well testing in areas where little data exists.
- Highlight the importance of testing well water on a regular basis.

Introduction

Nearly 900,000 households rely on private wells as their primary water supply. Homeowners with private wells are encouraged to have their well tested on a regular basis to determine the safety of the water supply for purposes such as drinking and cooking. While testing is the only way to determine the types and amount of contaminants in a well water system, homeowners and local officials often want to know more about water quality issues in their community.

The WI Well Water Quality Interactive Viewer was created as an educational tool to help people better understand Wisconsin's groundwater resources that many of us rely on for our drinking water.

How does the viewer work?

The viewer relies mostly on voluntarily submitted well water samples from homeowners and other well water data collected by state agencies over the past 25 years. It would not have been made possible without the many well owners who took the initiative to have their wells tested.

Because groundwater quality can often be very site specific for certain contaminants, many water samples are required to get a sense of groundwater quality at a county or watershed scale. By combining all of this data together we are able to look at averages or the number of samples that exceed drinking water standards to get a sense of private well water quality across the state.

- Select a county, township or section to view water quality summaries at different scales.
- Select from one of 14 different water quality parameters.
- Areas that are blank show areas where insufficient well water data exists to summarize well water quality for that area. But you can use the groundwater quality summary statistics tool to see the number of samples that exist in a particular county.

Take-aways:

- Generally abundant groundwater, with good background quality
- Groundwater conditions vary regionally due to Wisconsin's geology
- Soils, geology, and well construction control local vulnerability to contamination
- Many information sources available, but additional resource mapping and study will always be needed



K. Bradbury