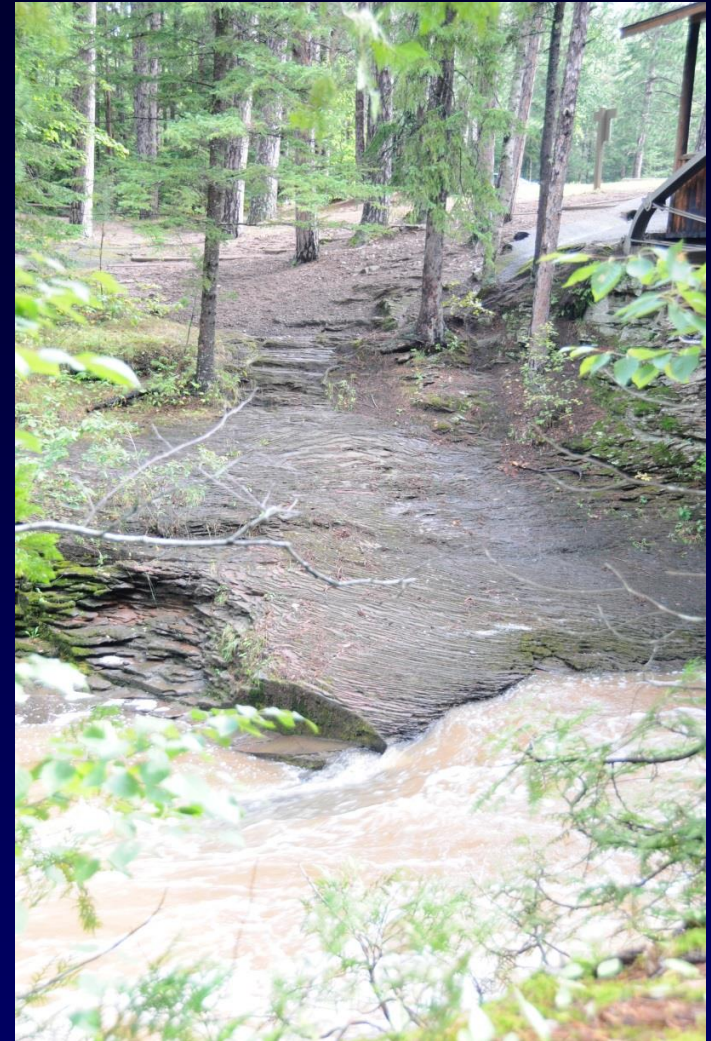


Groundwater in Bayfield County

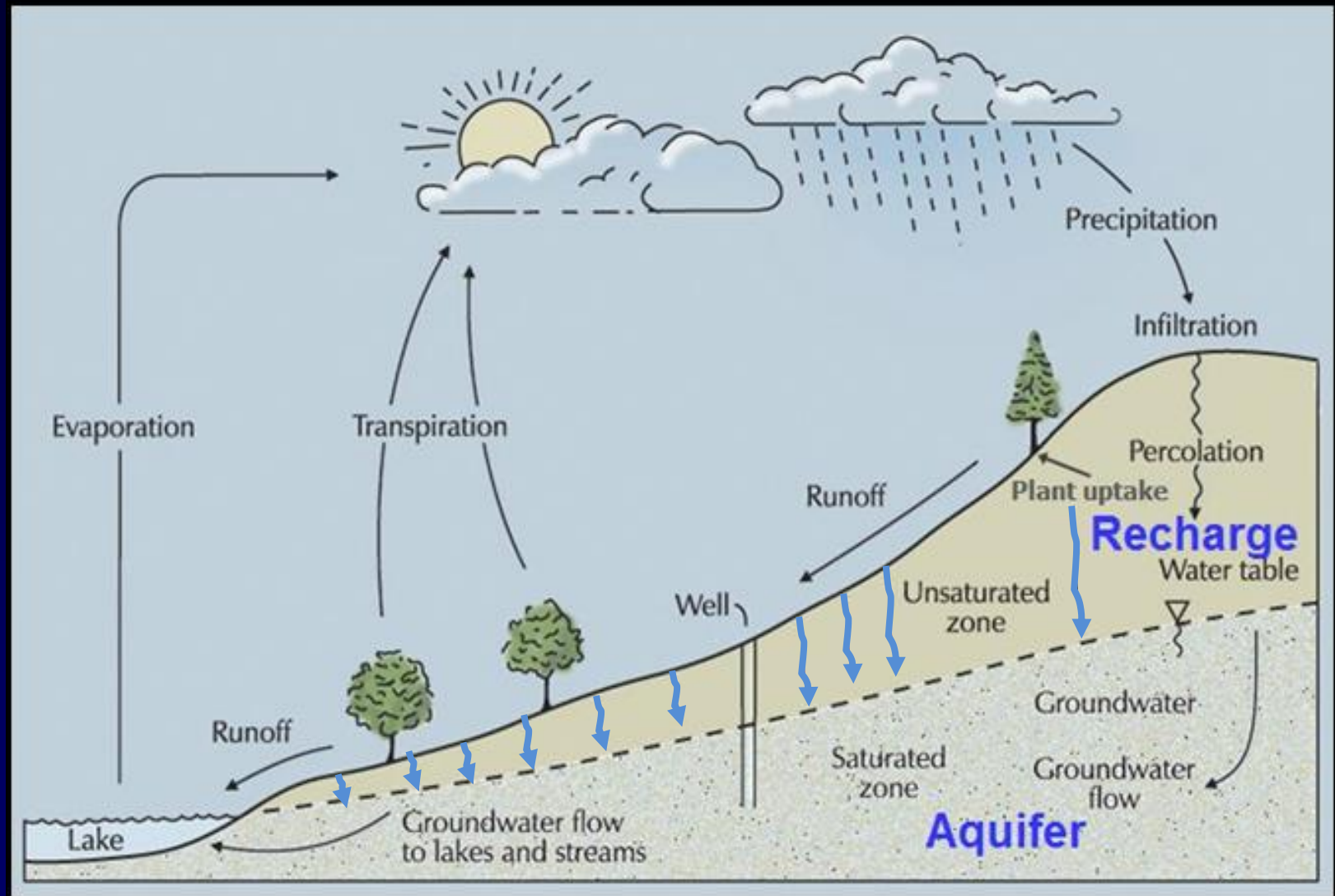
Madeline Gotkowitz
Hydrogeologist
April 23, 2015




Groundwater in Bayfield County

- Groundwater basics
- Hydrogeology across Wisconsin
- Hydrogeology in Bayfield County
- Mapping groundwater features

Wisconsin's Water Cycle





**Groundwater
discharge to
Honey Creek is
“baseflow”**

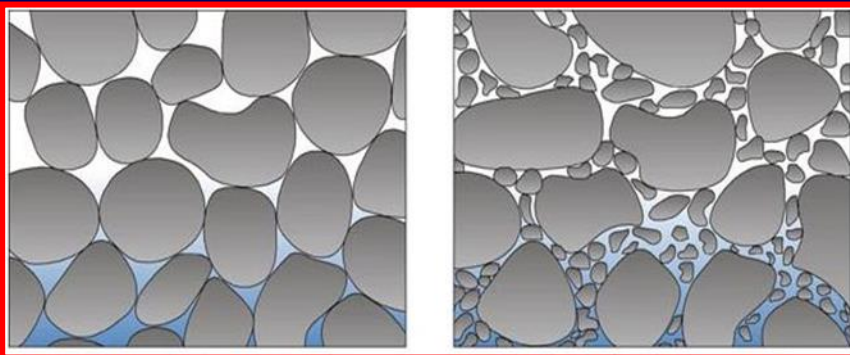
Hydrogeology:

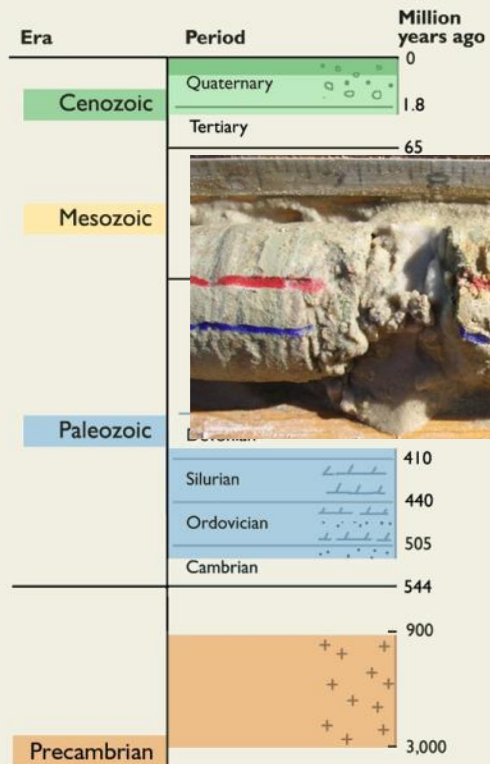
Groundwater flows through rock and sediment



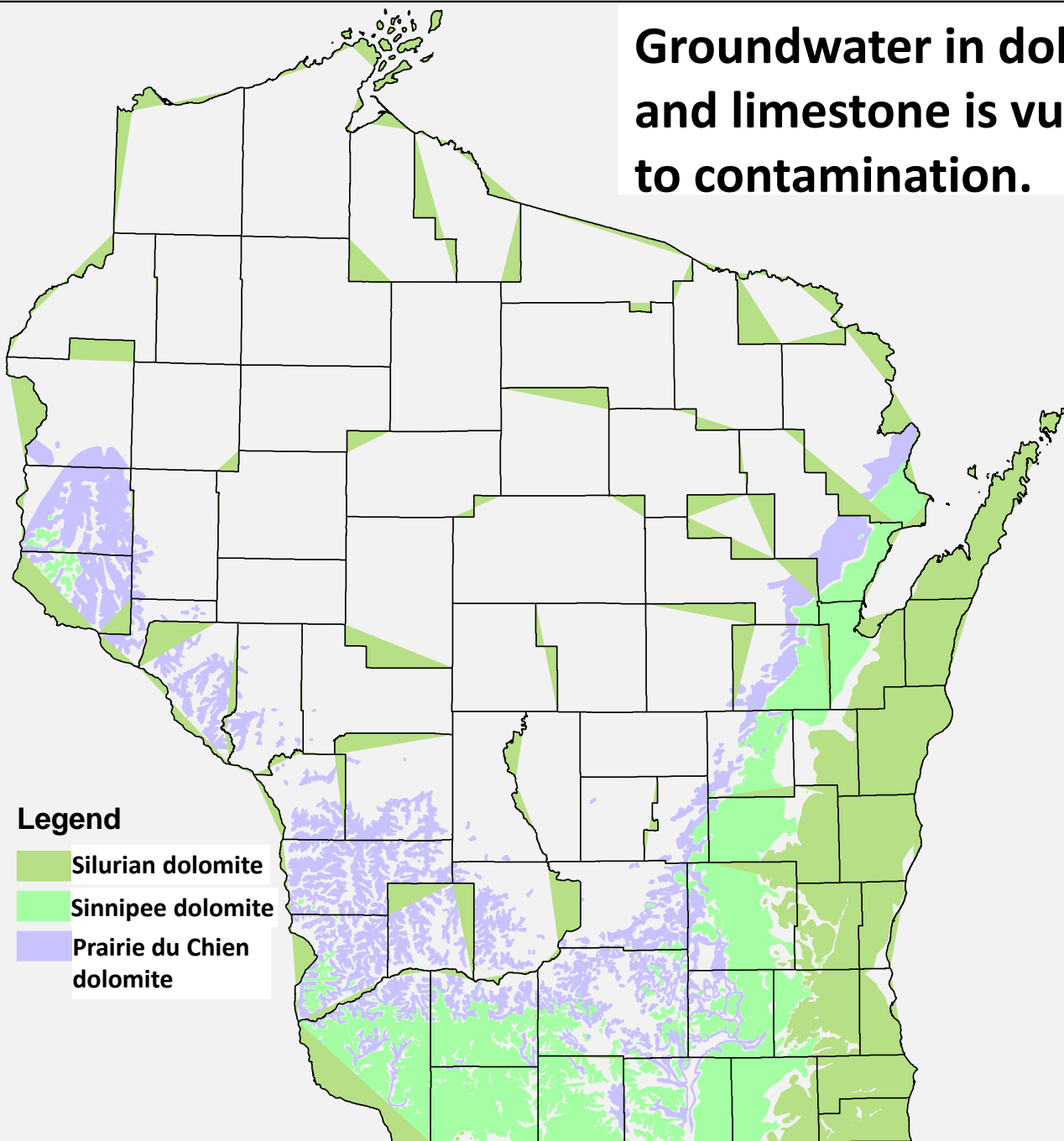
Core of the Wonewoc sandstone

Water under the ground, within an aquifer; porous sand, gravel and rock holds water

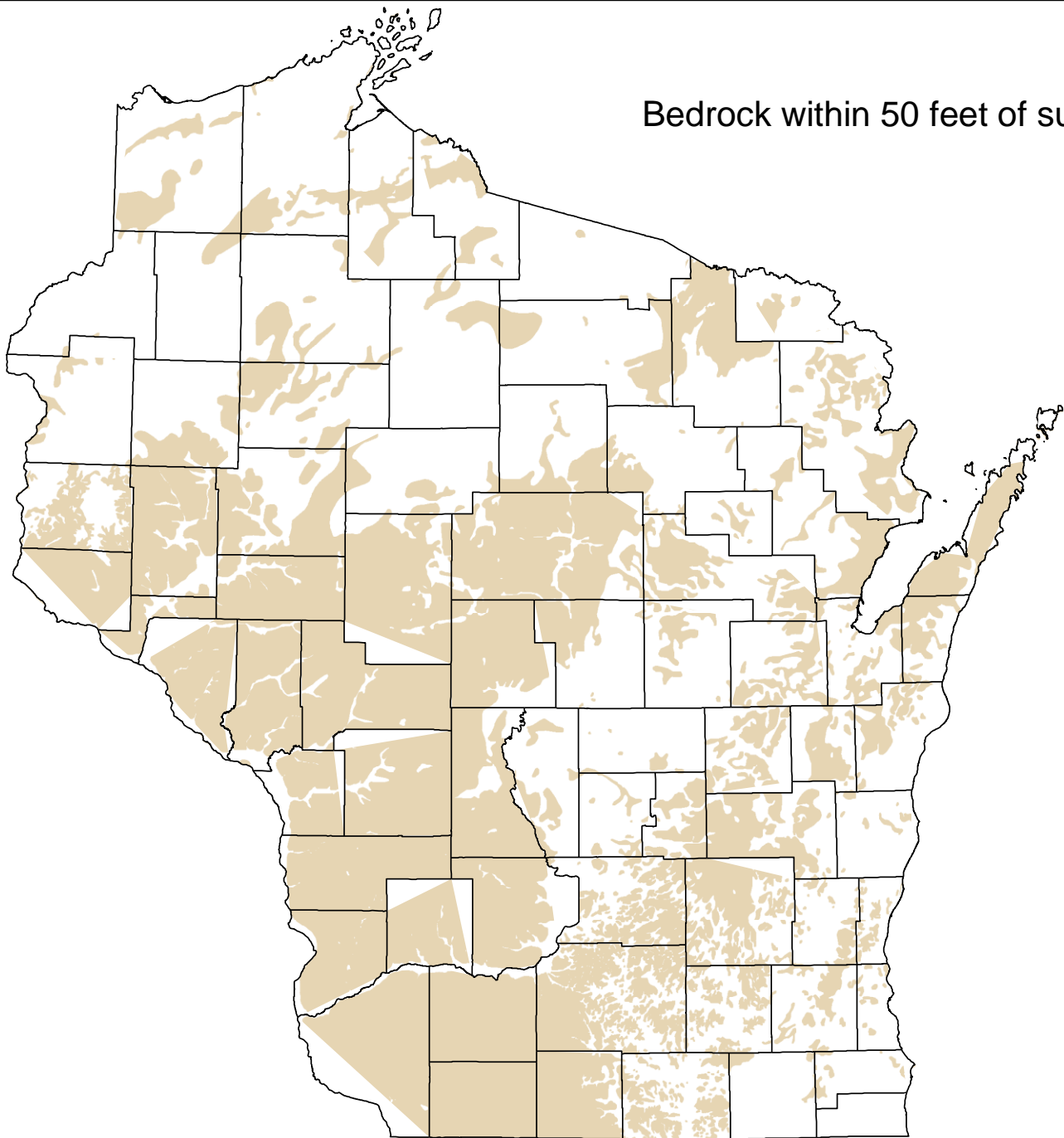




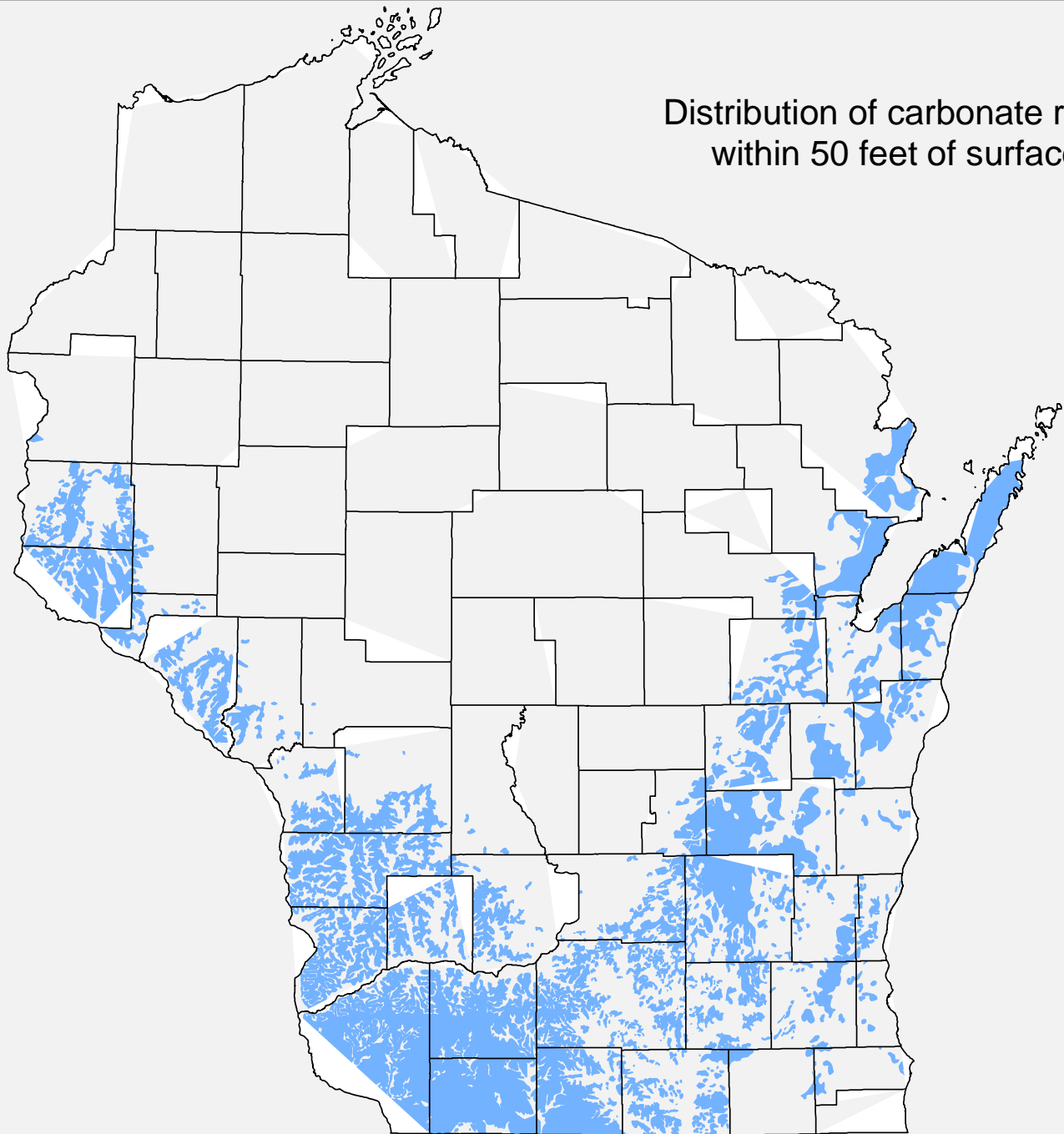
**Groundwater in dolomite
and limestone is vulnerable
to contamination.**



Bedrock within 50 feet of surface



Distribution of carbonate rock
within 50 feet of surface



Calumet and Brown Counties



Wisconsin's groundwater contamination issues are significant...



The left jar contains “brown water” contaminated by manure. Both samples are from the same well.

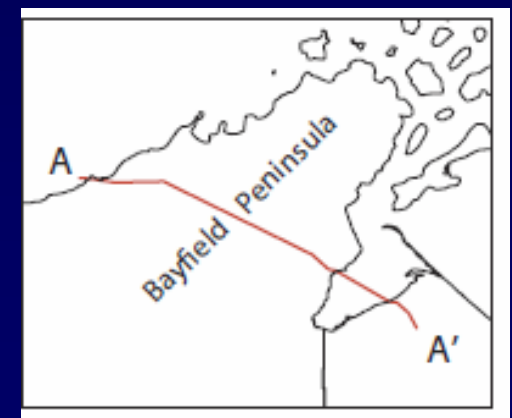
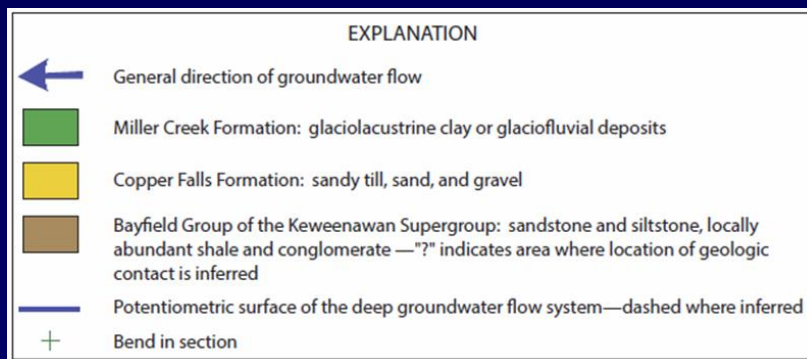
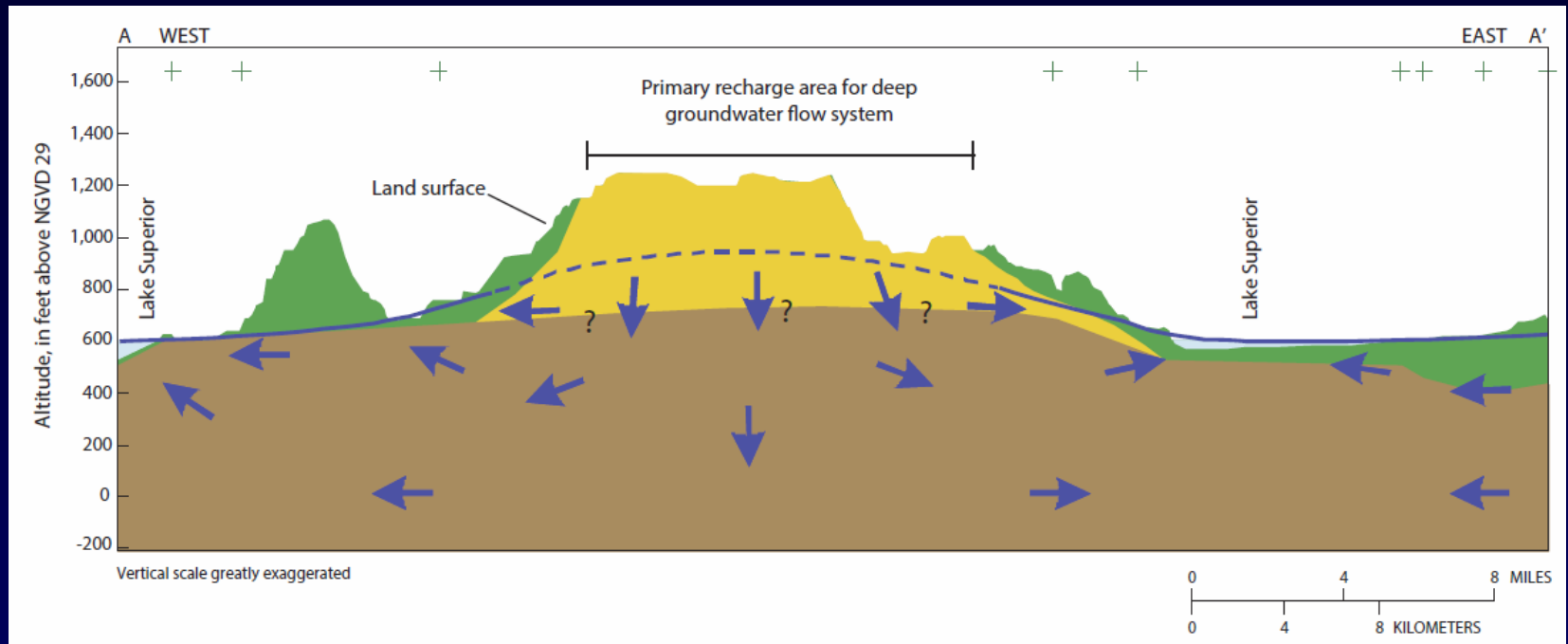
Karst features can be easy to see...

Sinnipee Dolomite: Dane and Iowa Counties



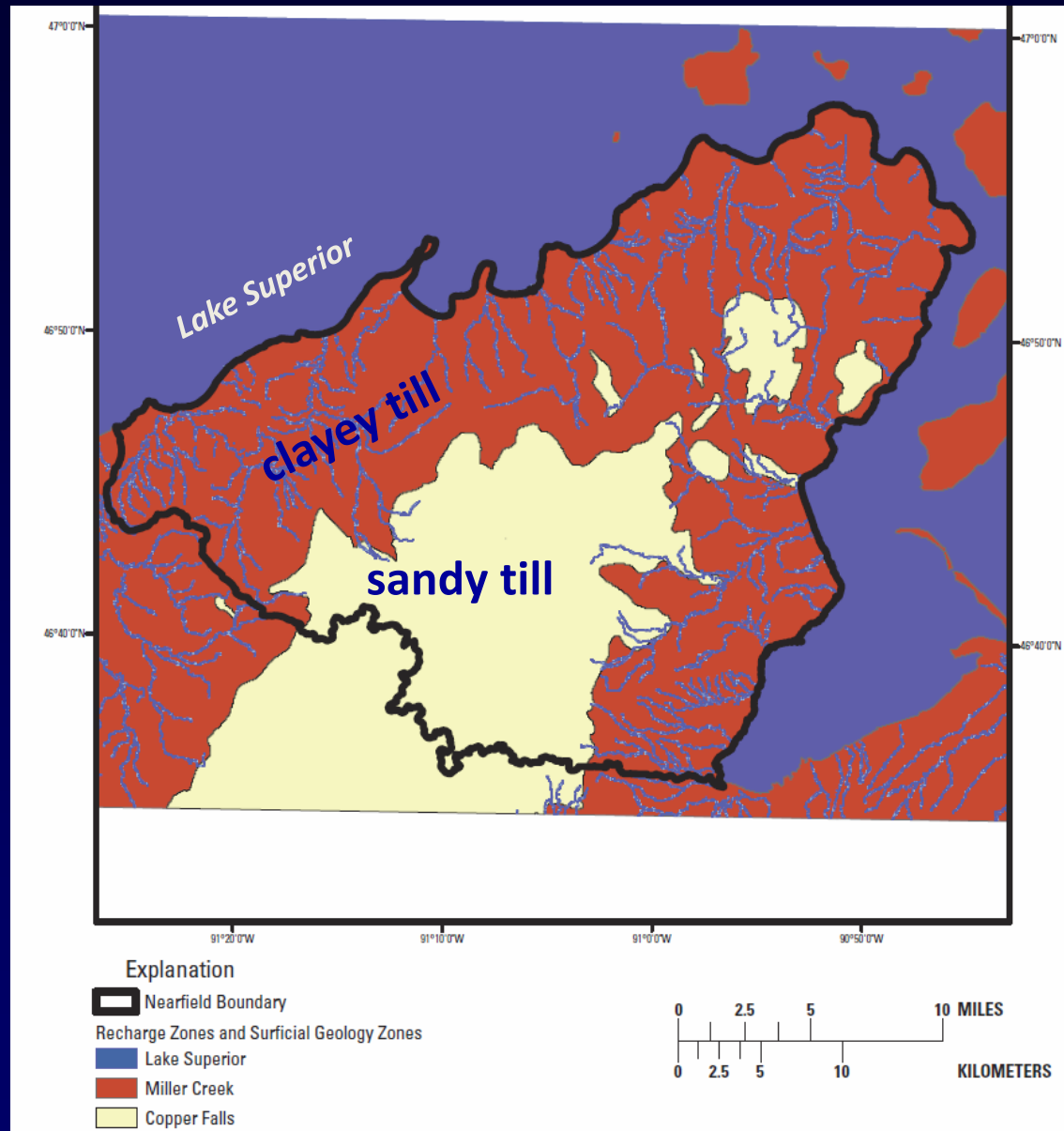
- **Hydrogeology in Bayfield County**

Hydrogeologic cross-section



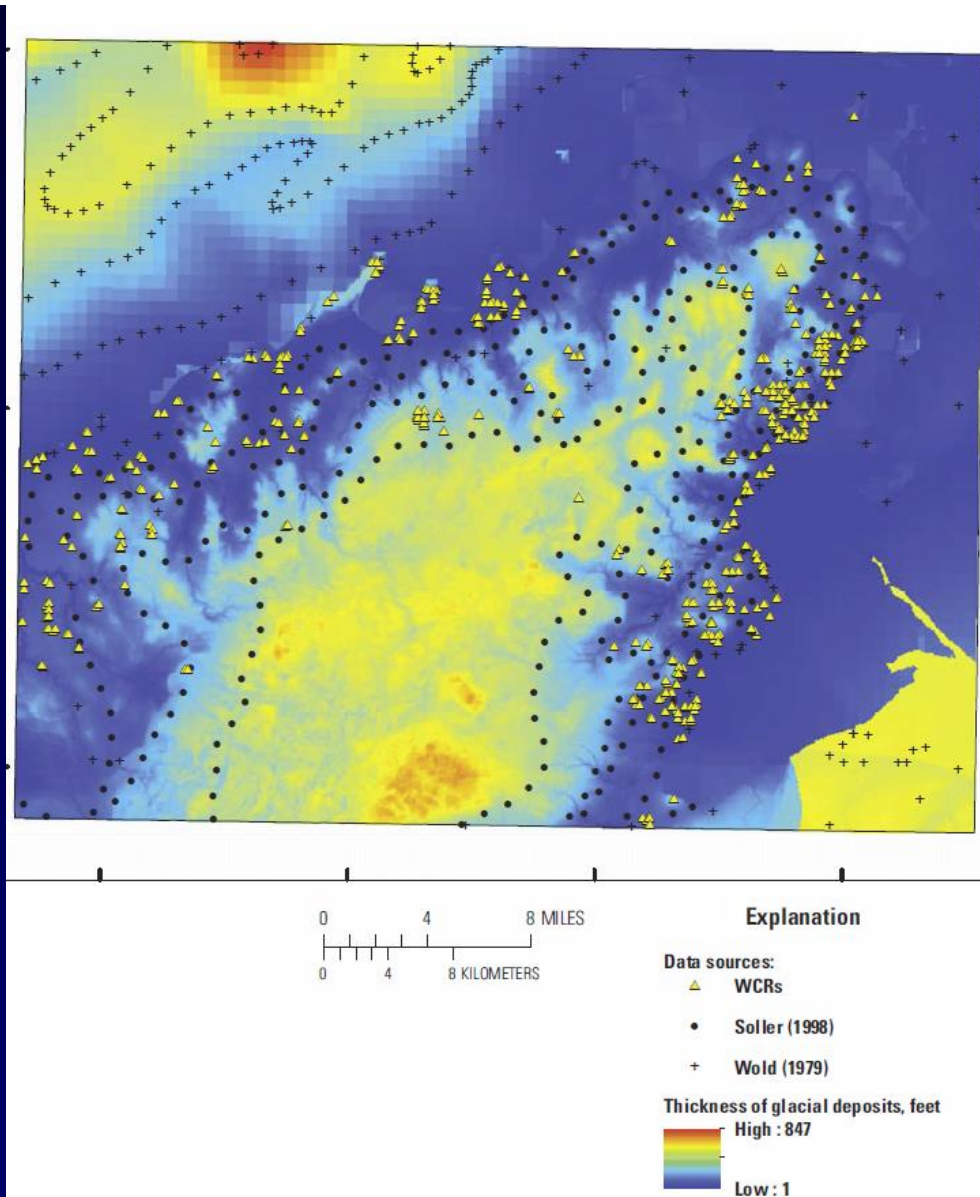
Courtesy of USGS

Glacial geologic formations



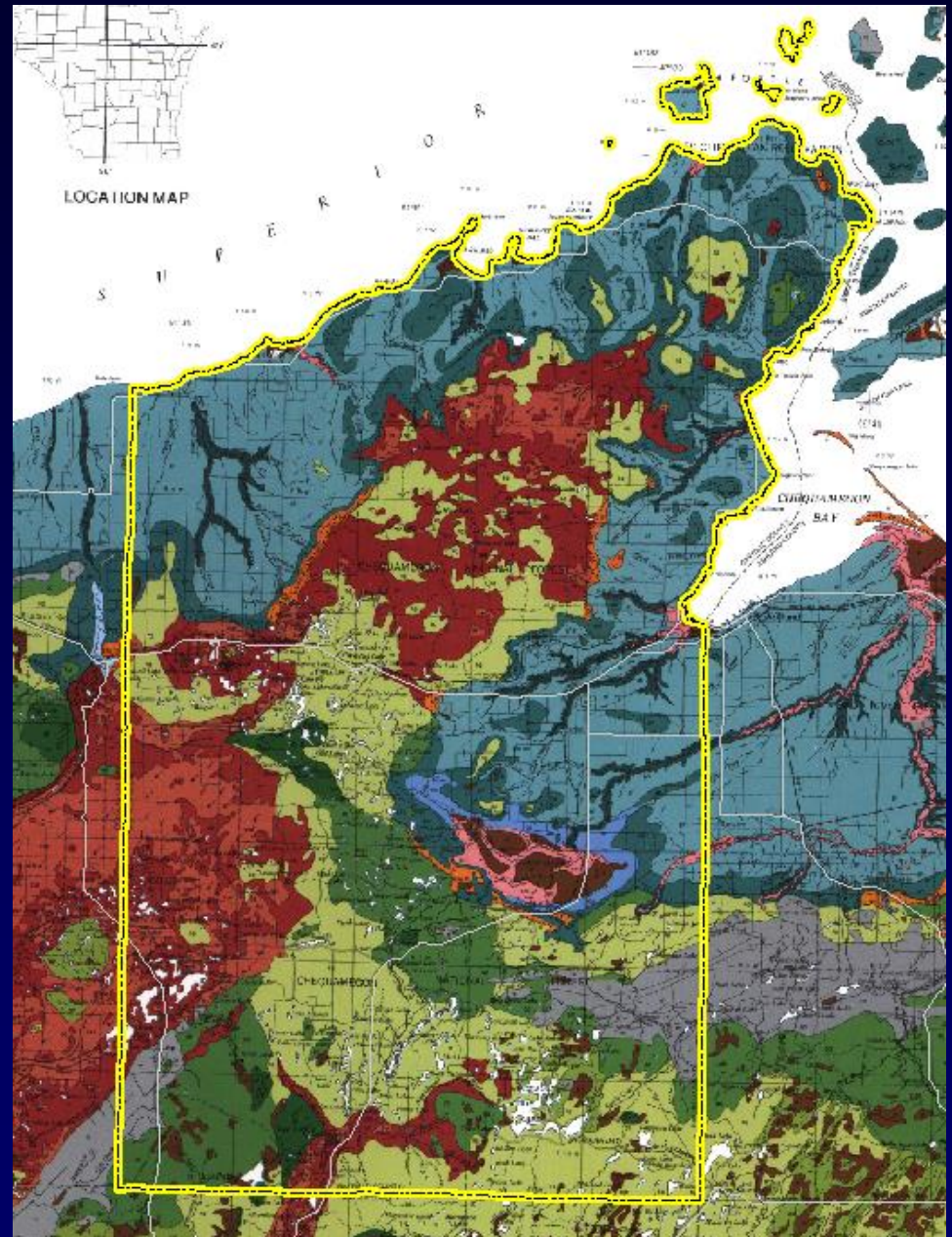
Courtesy of
USGS

Thickness of glacial deposits

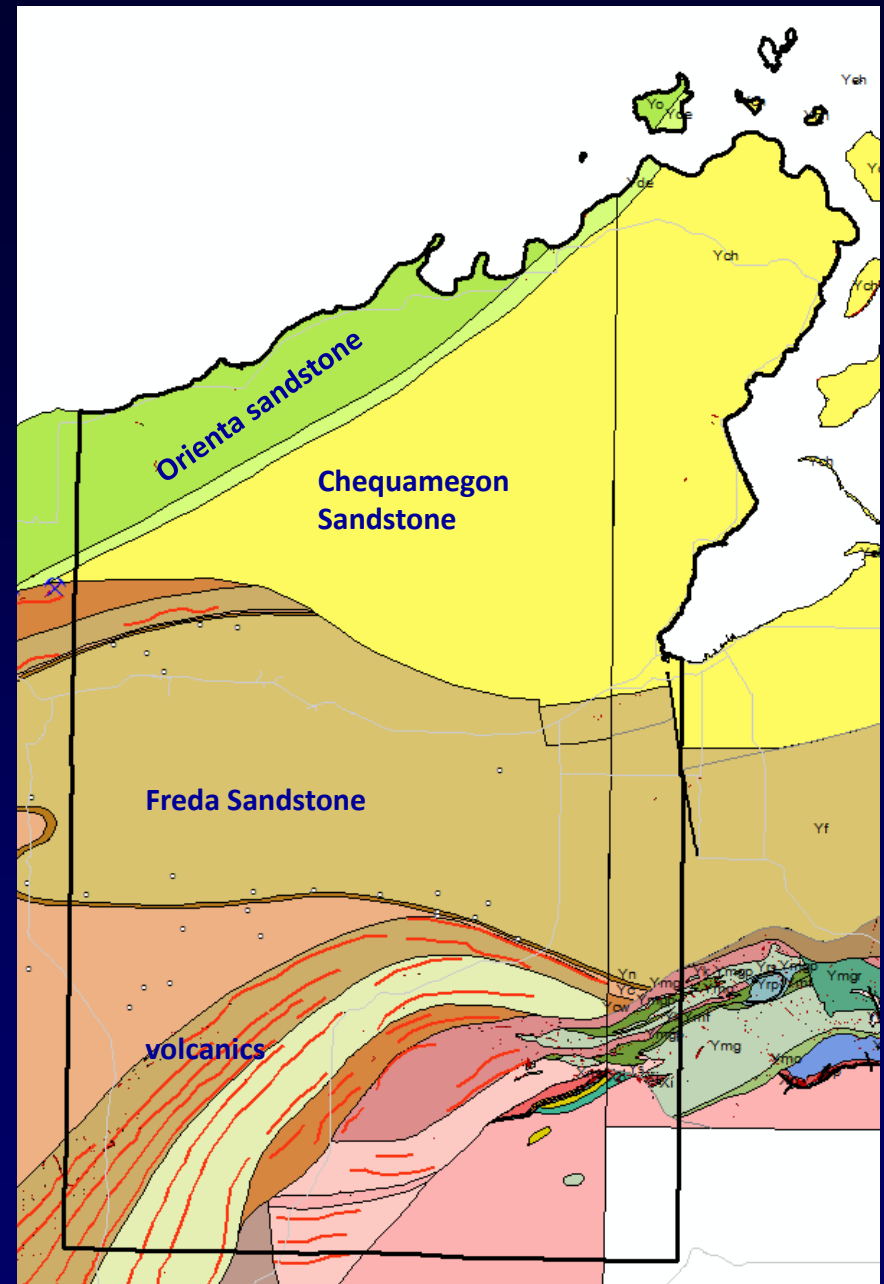


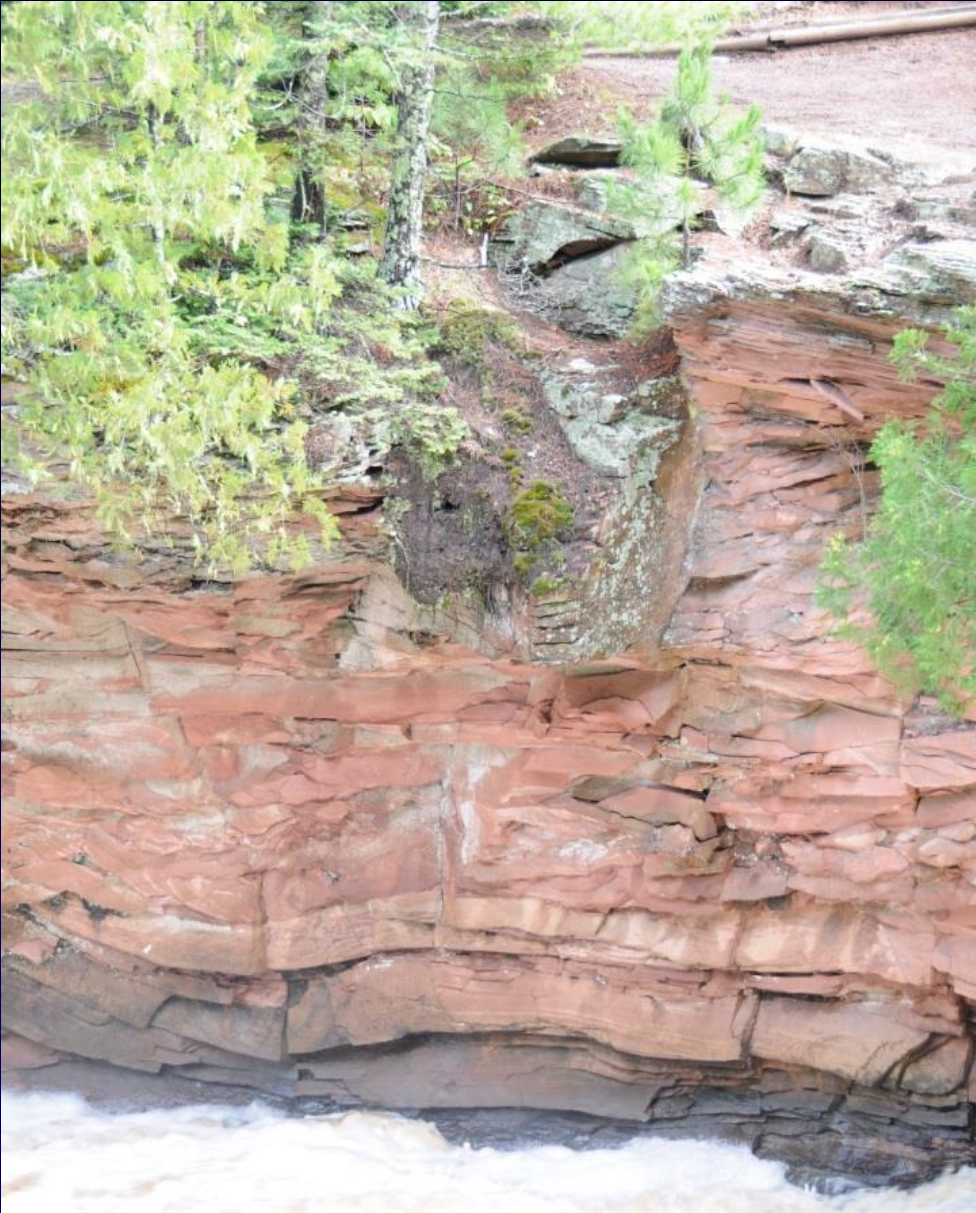
Courtesy of
USGS

Glacial geology



Bedrock Geology

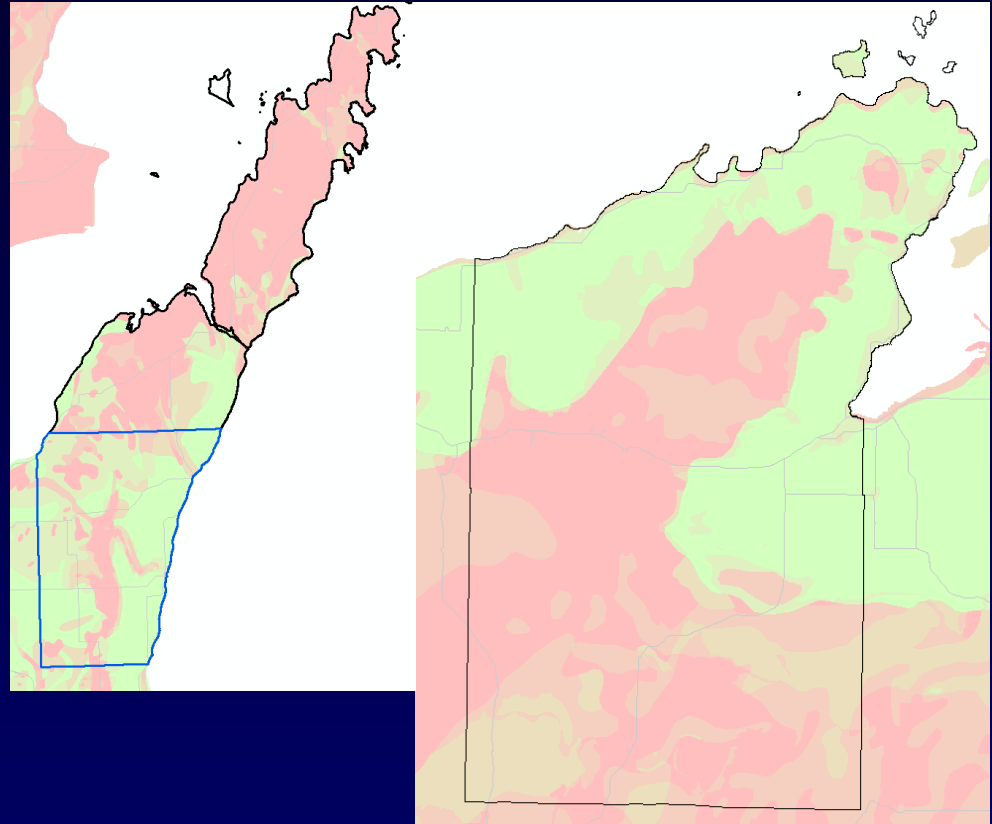
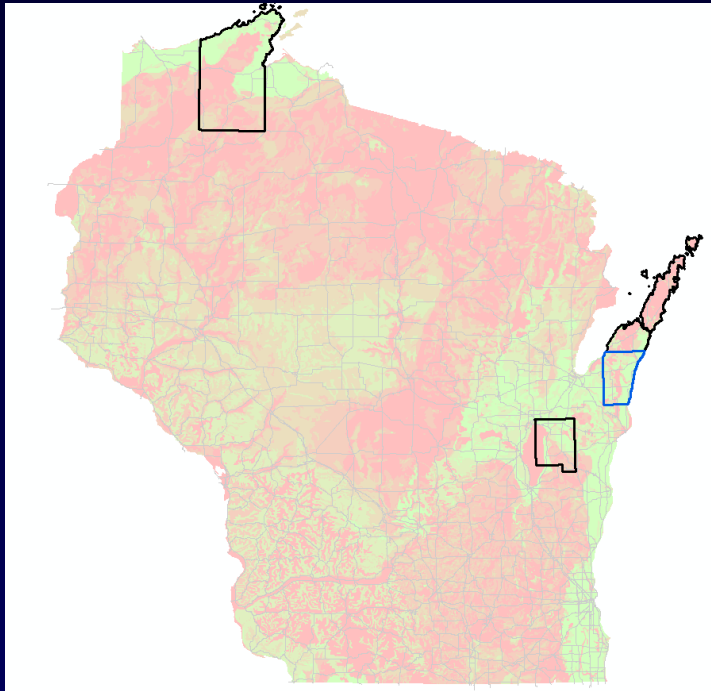




Orienta Sandstone Amnicon Falls State Park

Photo: E. Stewart, WGNHS

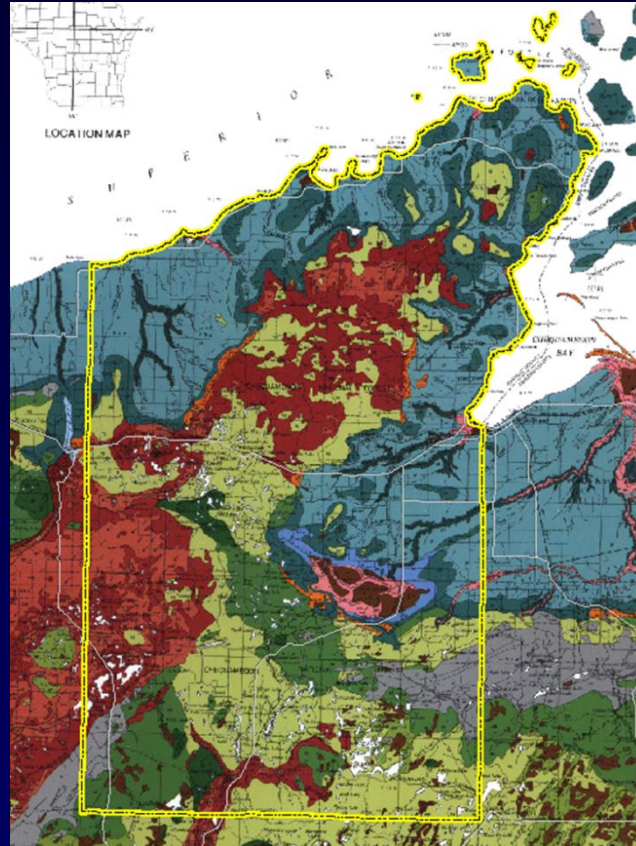
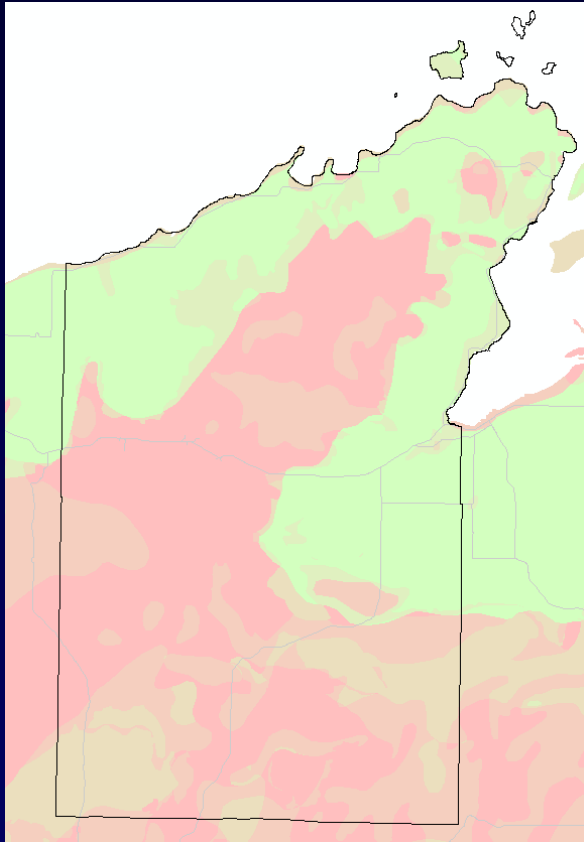
Wisconsin Groundwater Susceptibility Map



Depth to bedrock, bedrock type, depth to water table, surficial geology, soil type

<http://wi.water.usgs.gov/gwcomp/find/bayfield/susceptibility.html>

Wisconsin Groundwater Susceptibility Map



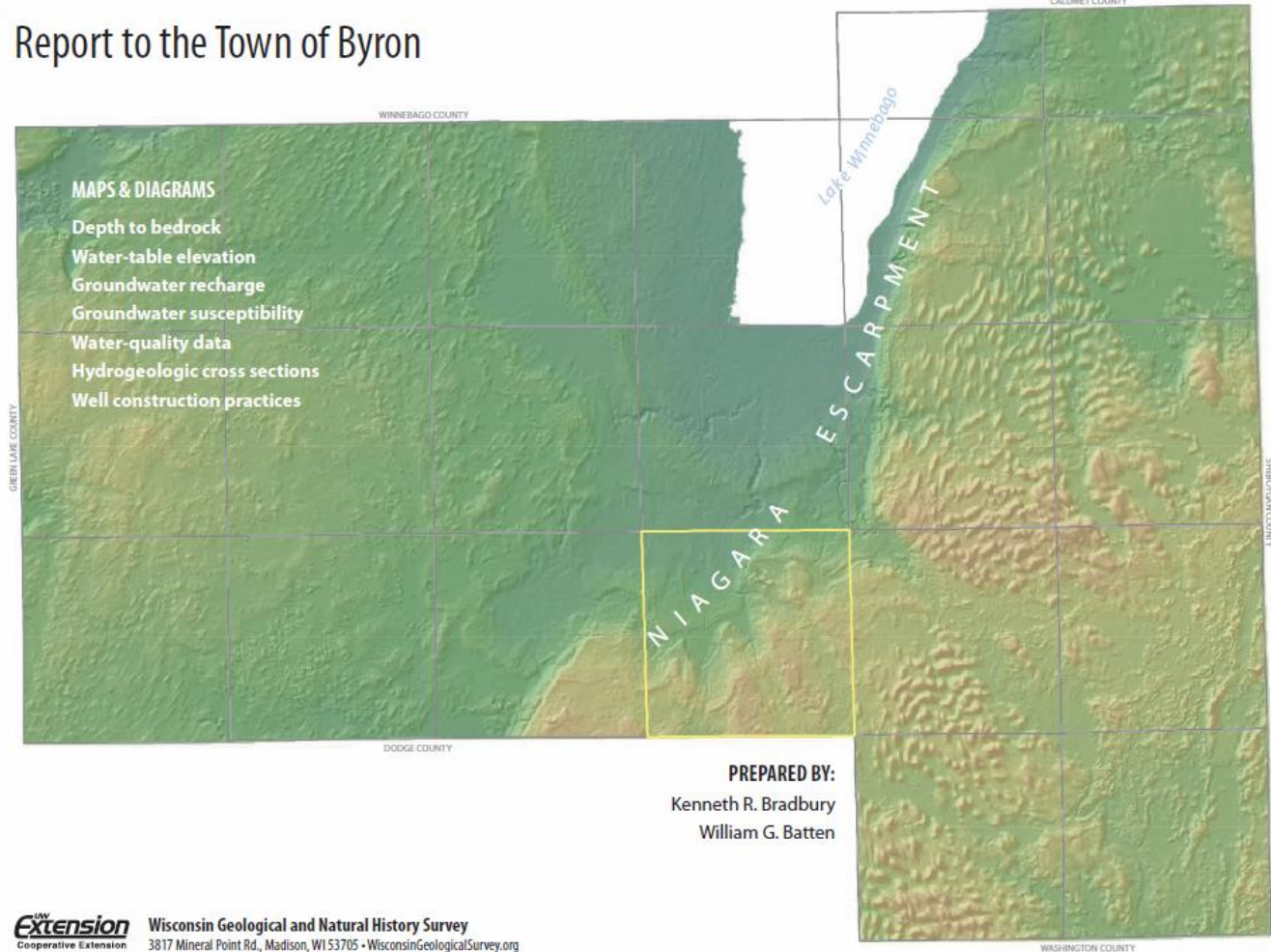
Depth to bedrock, bedrock type, depth to water table, surficial geology, soil type

<http://wi.water.usgs.gov/gwcomp/find/bayfield/susceptibility.html>

Example groundwater study

Groundwater susceptibility maps and diagrams for the Town of Byron, Fond du Lac County, Wisconsin

Report to the Town of Byron



UW
Extension
Cooperative Extension

Wisconsin Geological and Natural History Survey
3817 Mineral Point Rd., Madison, WI 53705 • WisconsinGeologicalSurvey.org

March 2010

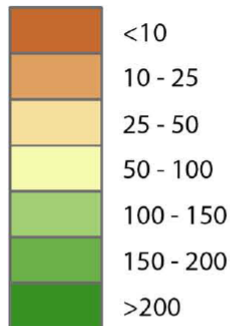
Town of Byron

**Fond du Lac
County**

Town of Byron - Example

Depth to bedrock

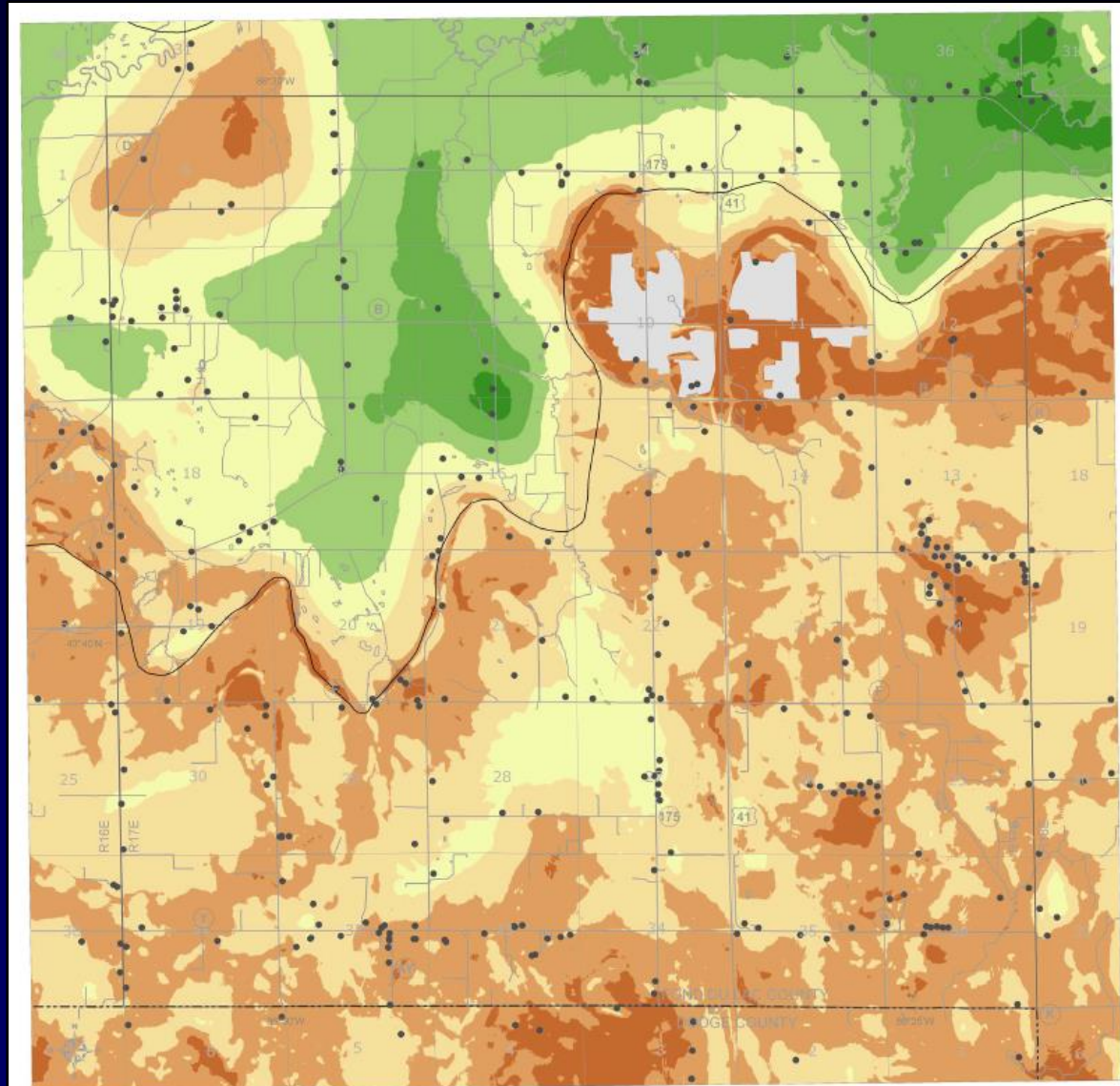
depth to bedrock in feet



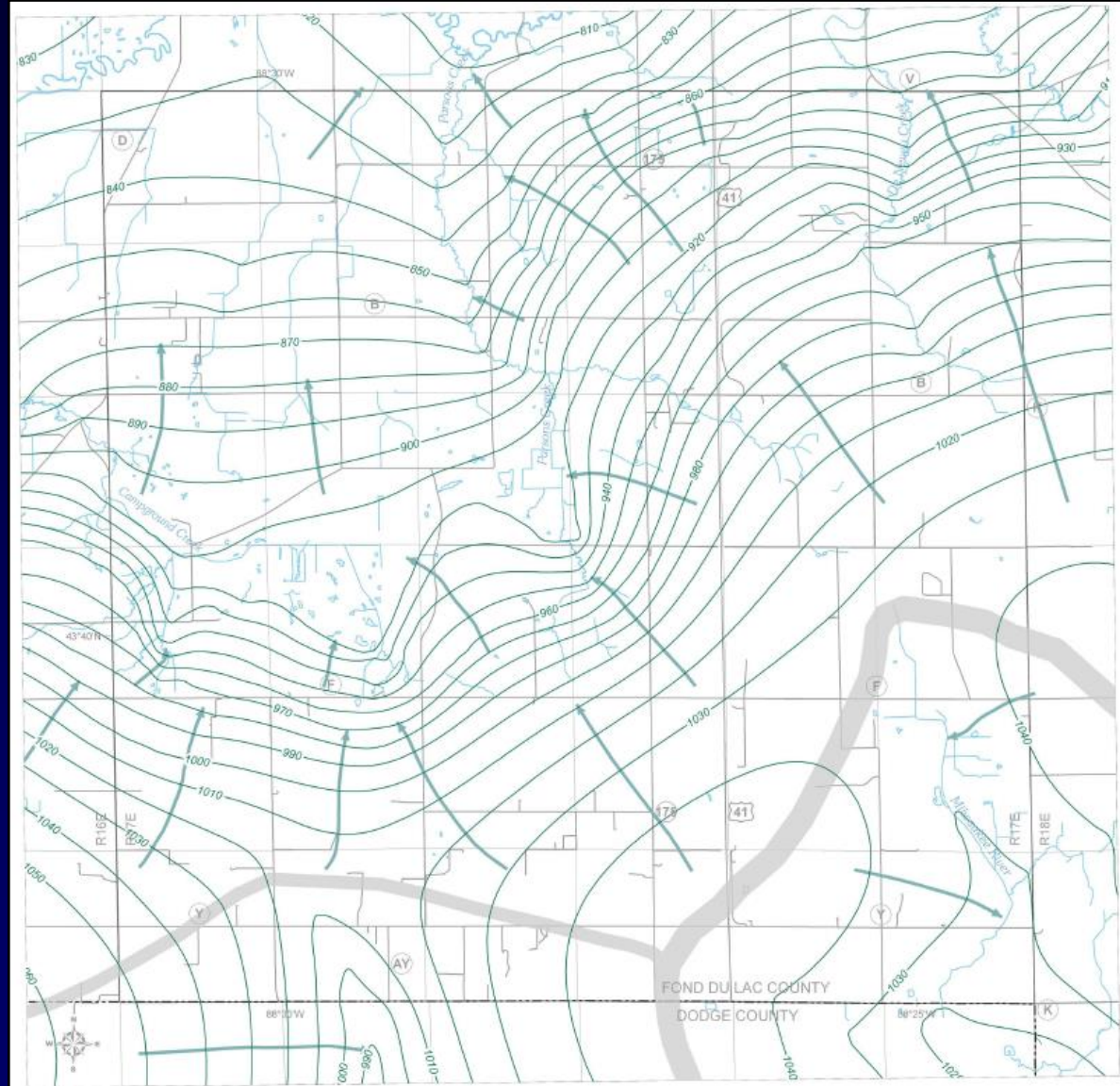
• well

quarries

— Silurian dolomite/
Maquoketa shale contact



Water table elevation



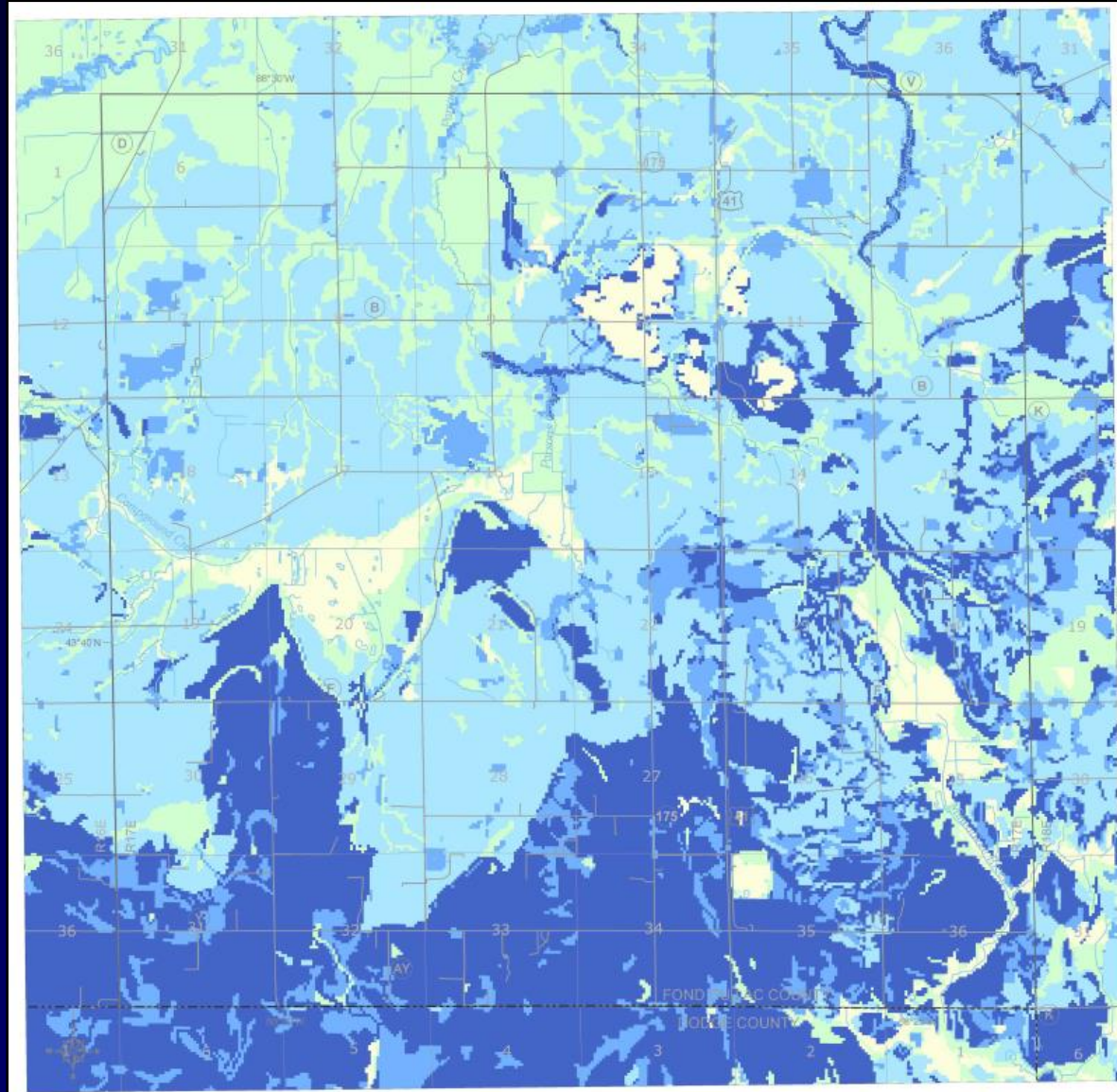
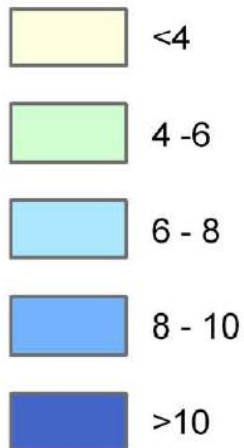
Town of Byron - Example

Groundwater recharge

Estimate accounts for:

- Historical climate data
- Soil moisture capacity
- Soil type
- land-use type

Recharge in inches/year



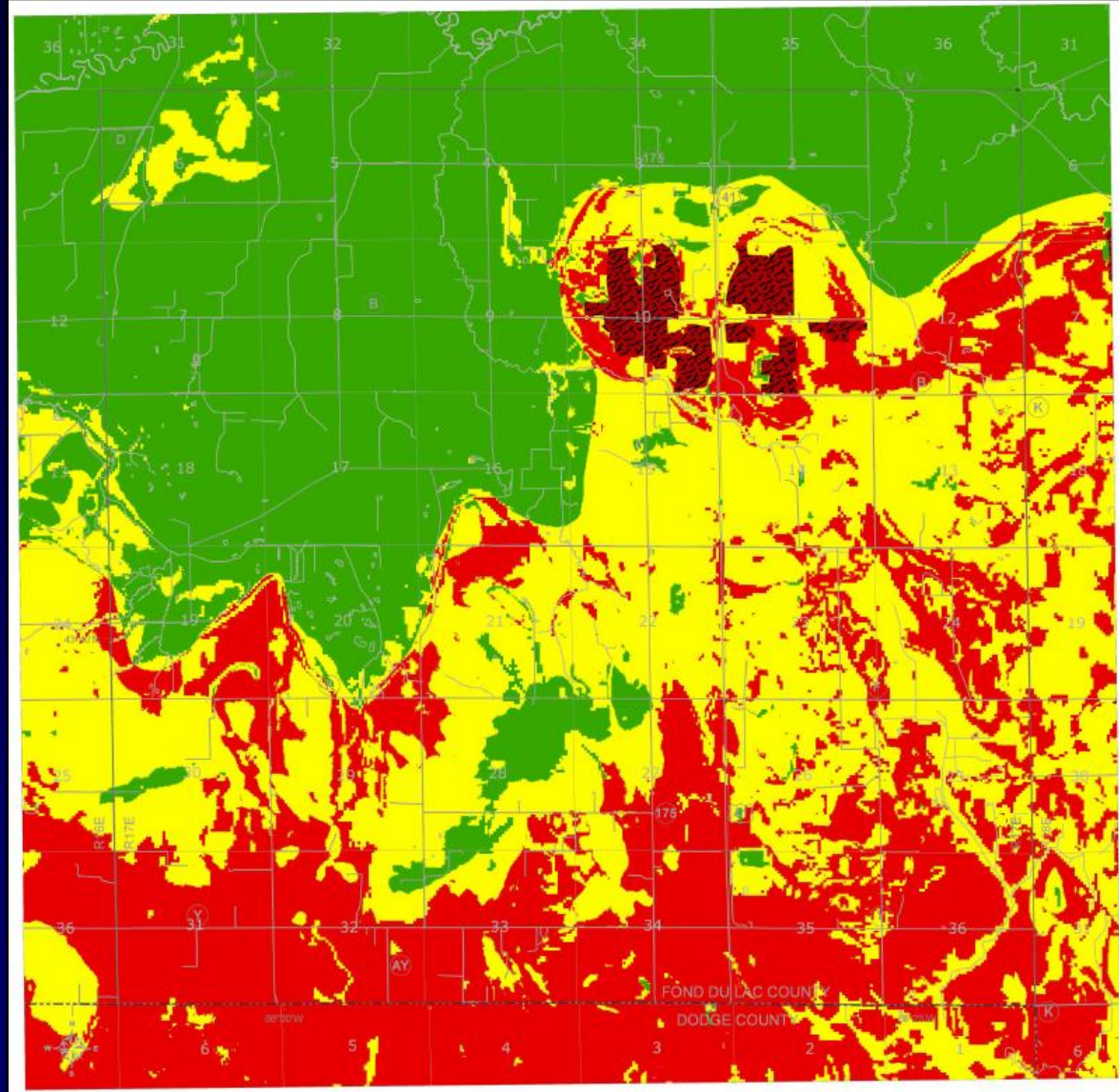
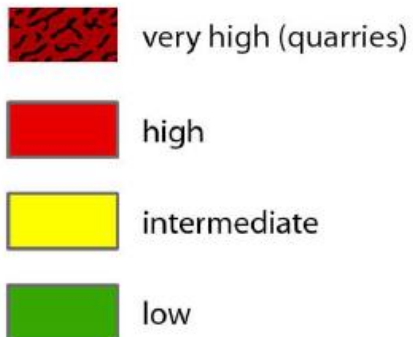
Town of Byron - Example

Groundwater contaminant susceptibility

Combination of factors

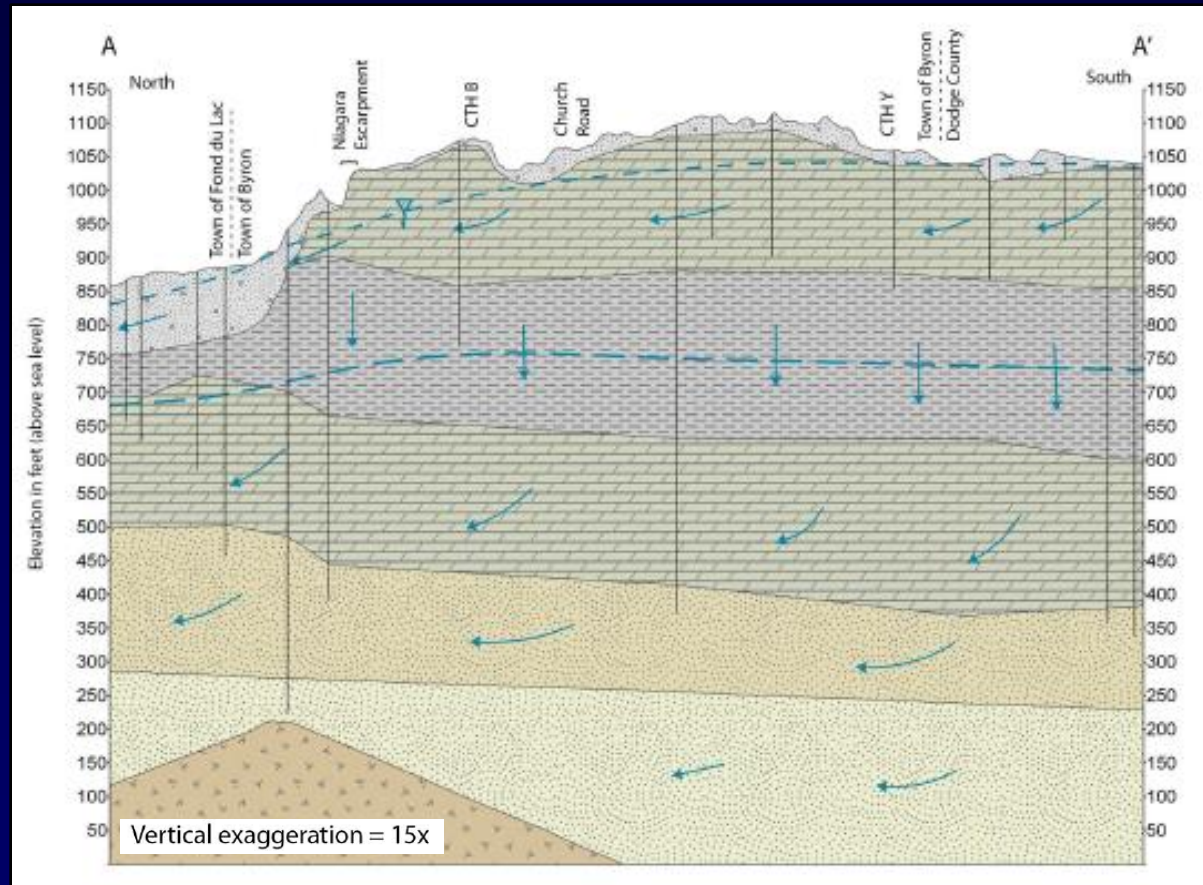
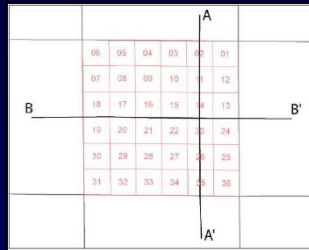
- Depth to bedrock
- Bedrock type
- Depth to water table
- Recharge rate

Relative susceptibility



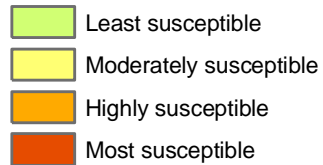
Town of Byron - Example

Hydrogeologic cross sections



Iowa County Groundwater: susceptibility versus contamination

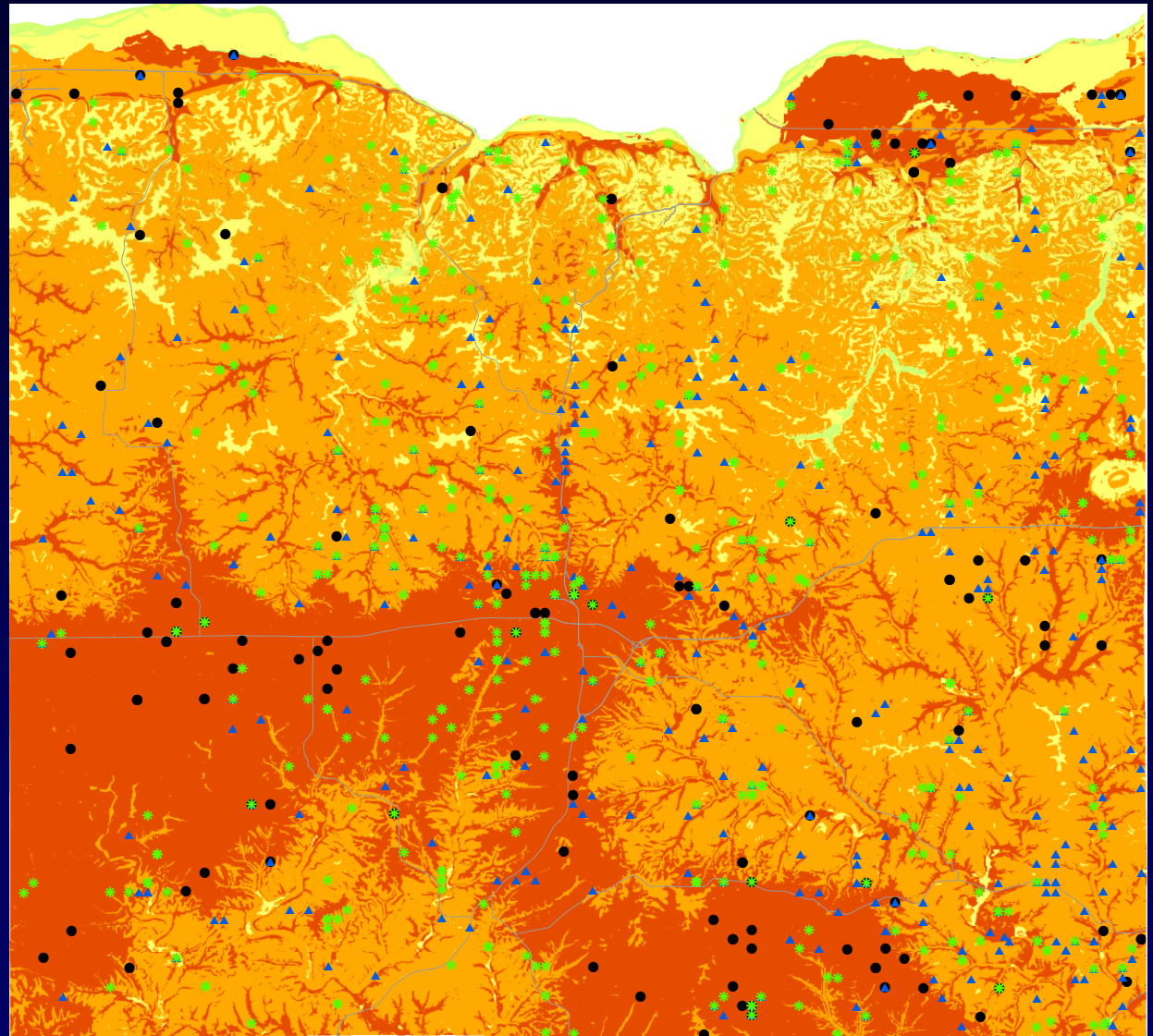
Susceptibility



Nitrate, mg/L



893 wells tested
14 % > 10 mg/L NO₃
46 % > 2 mg/L NO₃



Data from Central Wisconsin Groundwater Center and UW Extension.

Next steps: questions and discussion

Groundwater susceptibility map requires:

Collect, compile and analyze data:

Depth to the water table

Depth to bedrock

Glacial deposits (sandy till versus clay till)

Bedrock type (sandstone or basalt)

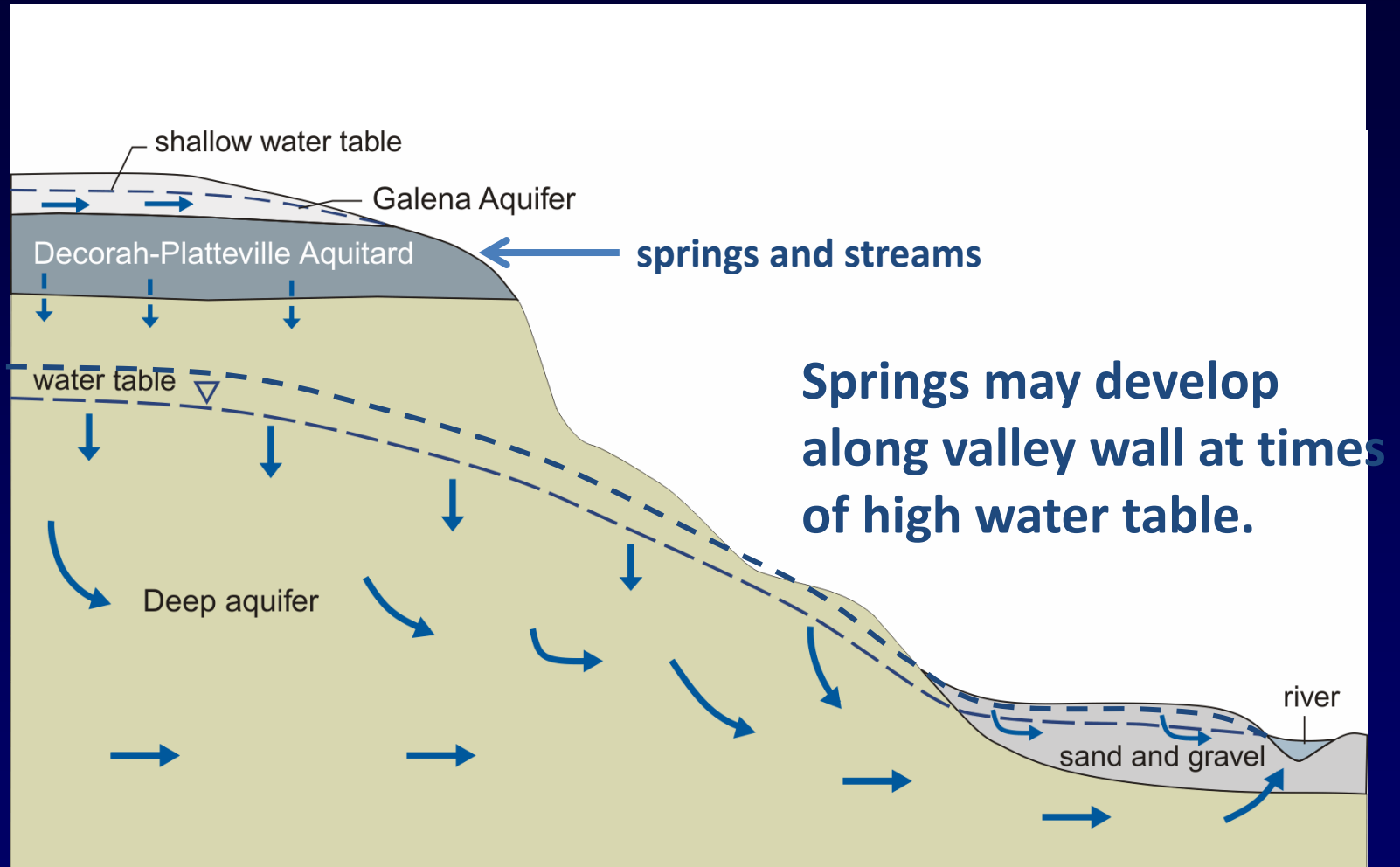
Map of groundwater recharge rates

Alternative:

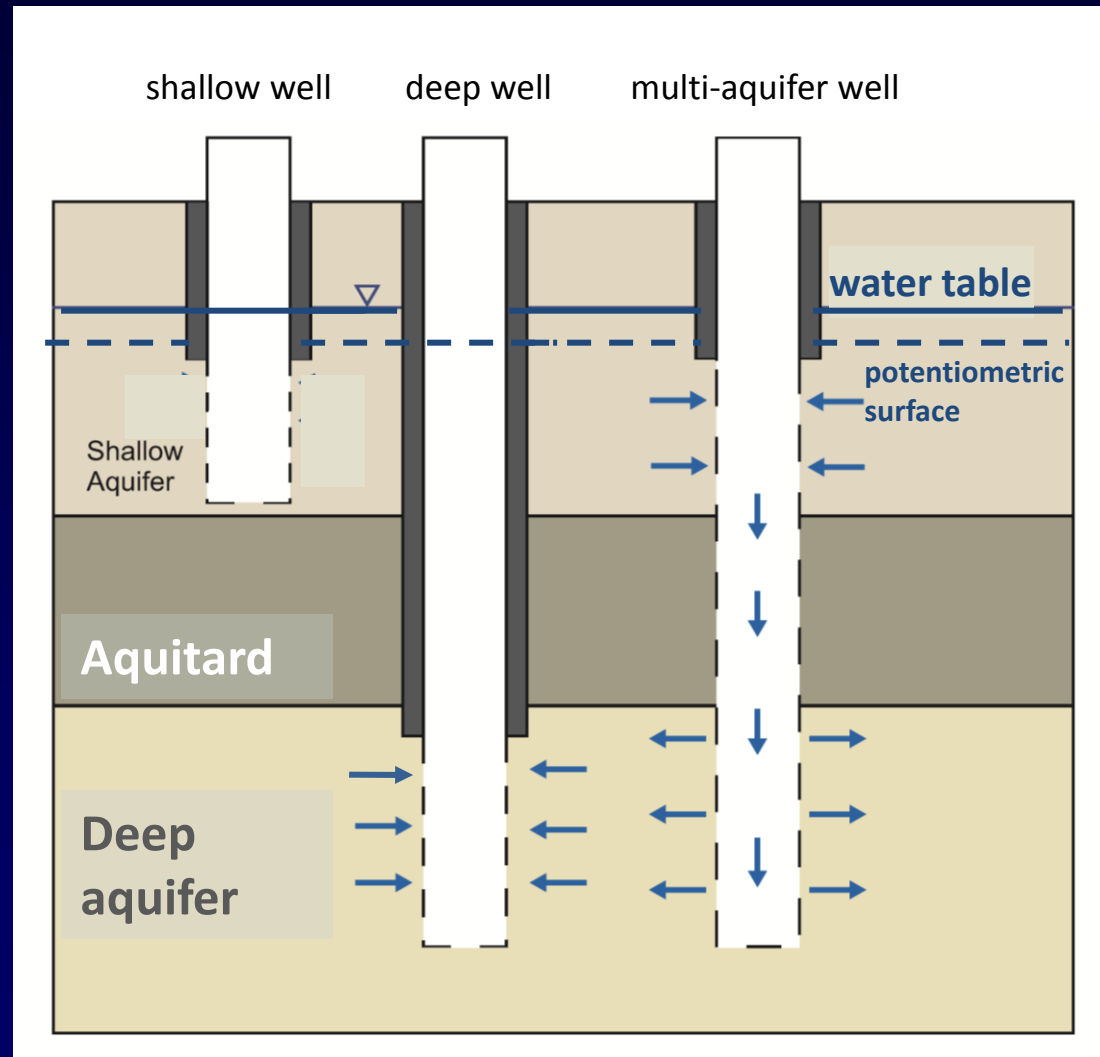
Develop hydrogeologic cross sections in ag-dominated areas to illustrate wells, groundwater and surface water in areas of interest

Facilitate use of this information through educational and outreach efforts in Bayfield County

The Decorah-Platteville aquitard separates the shallow Galena aquifer from the deep aquifer.

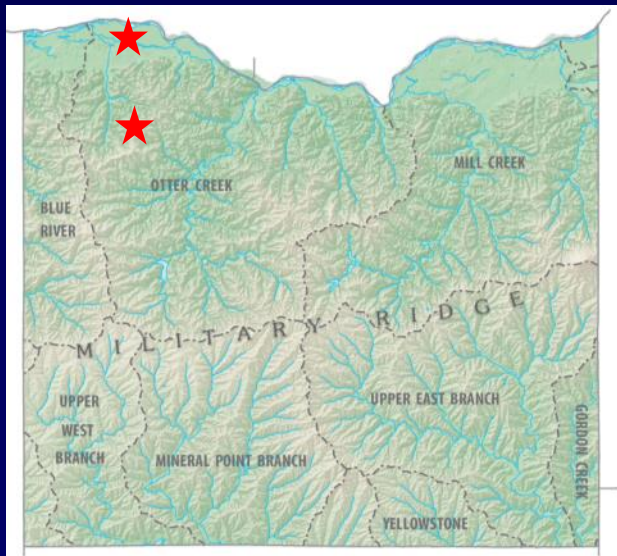


In upland areas, multi-aquifer wells can provide a pathway for groundwater to flow from the shallow to the deep aquifer.



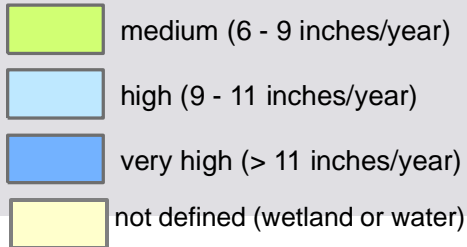
Groundwater flows from high to low elevations.

One use of the water table map is to identify where groundwater comes from that flows to a well or stream.



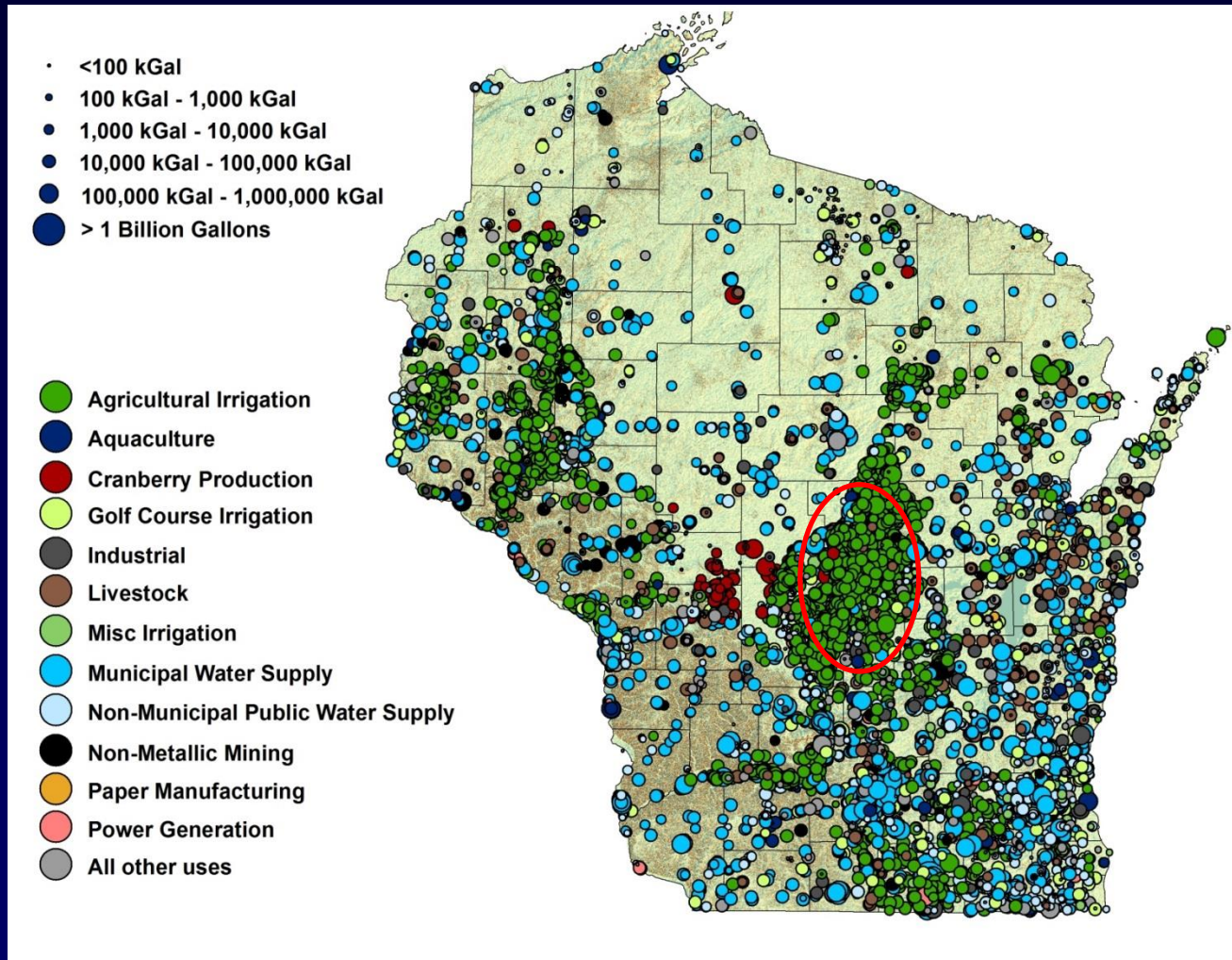
Groundwater recharge rates are high in Iowa County, due to permeable soil, and forest and agricultural land use.

**Infiltration,
in an average year**



**Does this mean
that there is an
unlimited supply
of water?**

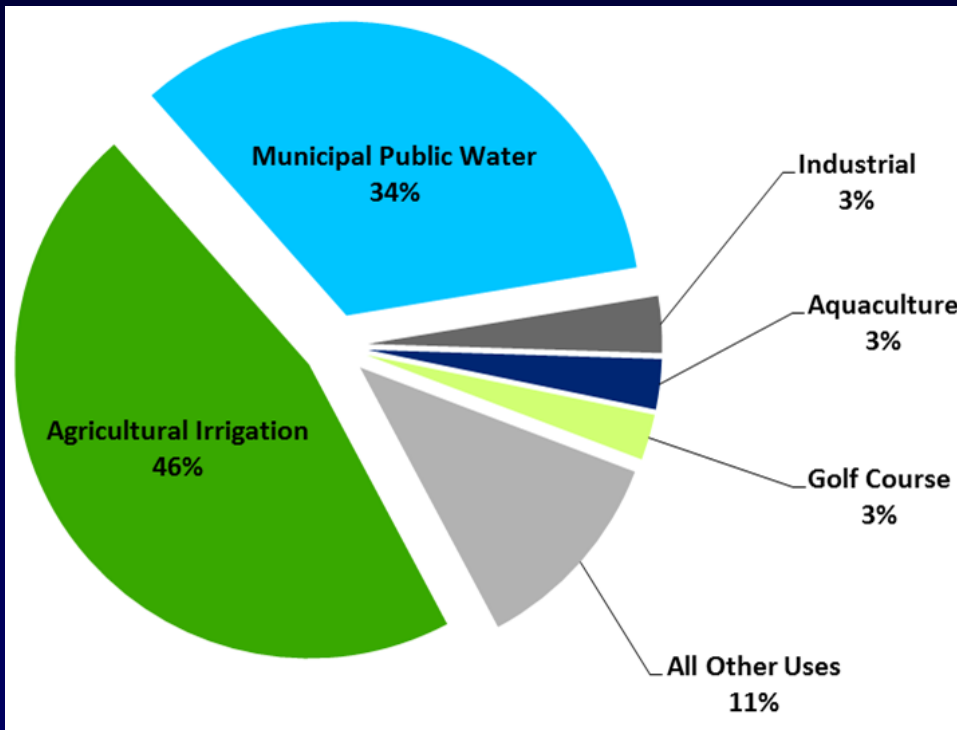
Lots of wells near one stream are like... too many straws in the glass



Source: R. Smail, Wisconsin DNR

How do we use our groundwater?

2012 Wisconsin Withdrawals



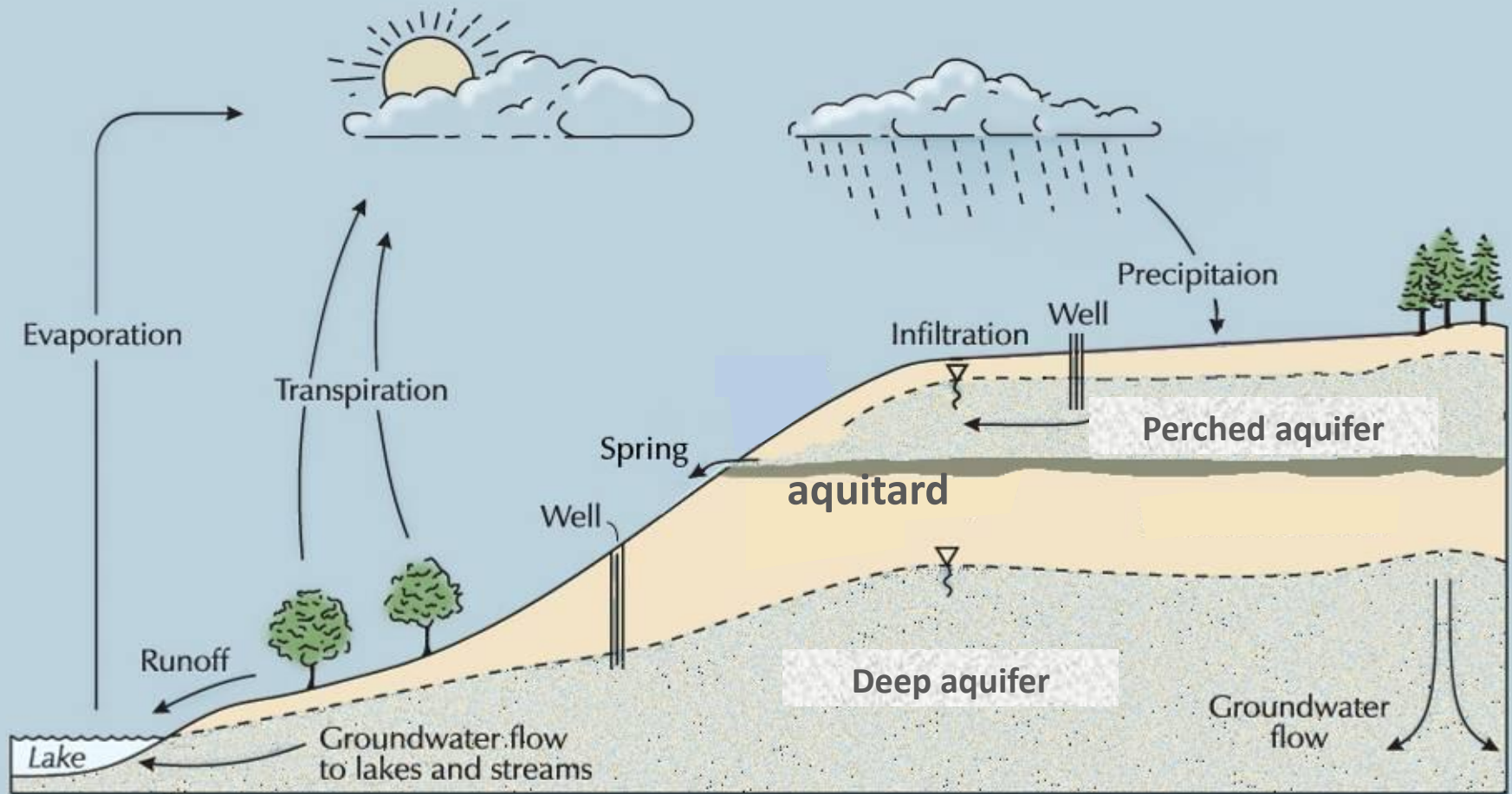
Source: R. Smail, Wisconsin DNR

- Agricultural irrigation surpassed municipal public water in 2012 due to the drought
- Groundwater pumping is about 760 million gallons per day
- Could cover the land area of Wisconsin with $\frac{1}{4}$ inch of water
- Enough water to fill Lambeau Field over 600 times
- Is that a lot of water? Is it too much?

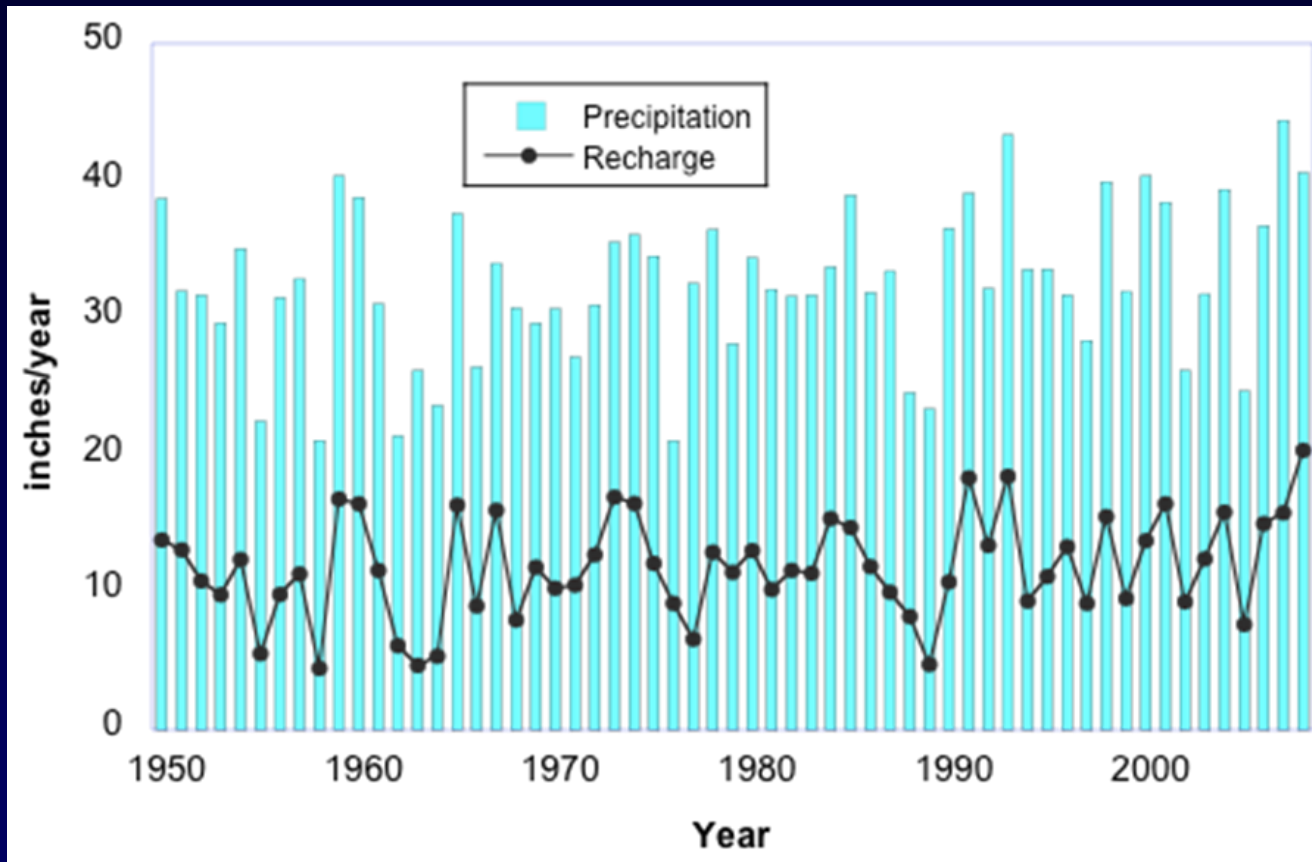


Sinkhole in SE Wisconsin

Perched groundwater in the Driftless Area, which has extensive *aquitards*.



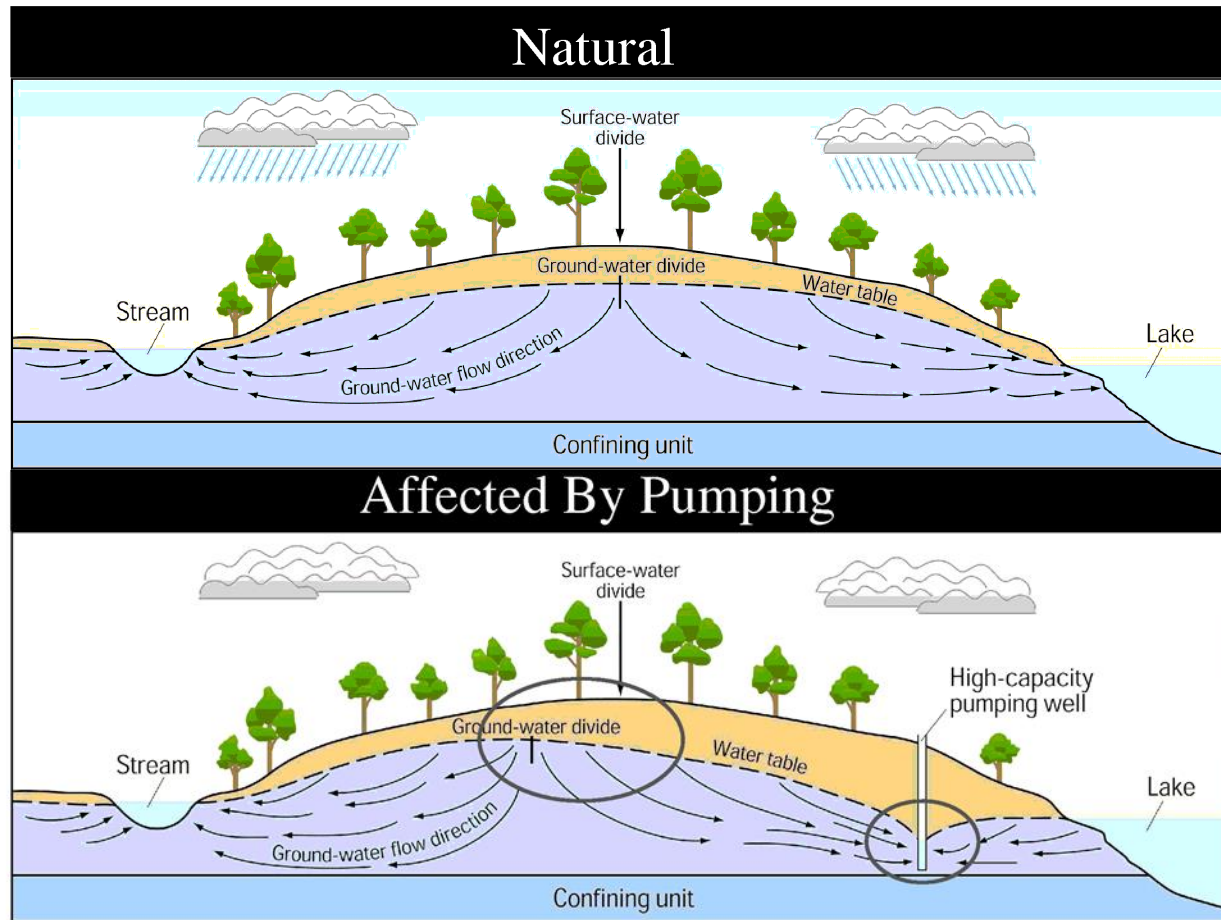
How much recharge do we get?



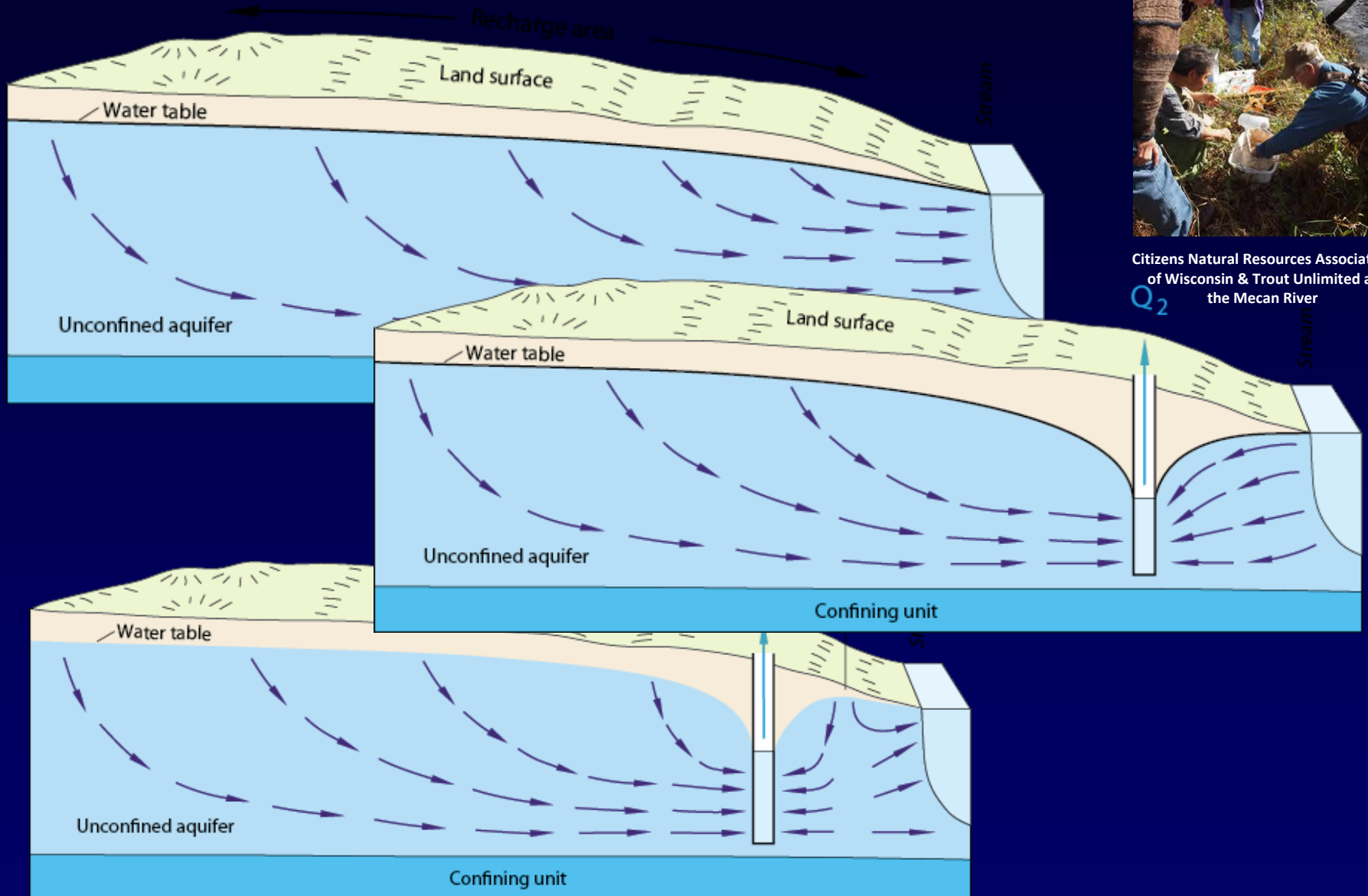
Hart et al., 2012

On average, about 8 to 10 inches per year in Dane County, Wisconsin
Approximately 28,000 million gallons per day in Wisconsin
We pump about 760 million gallons per day

Where does well water come from?

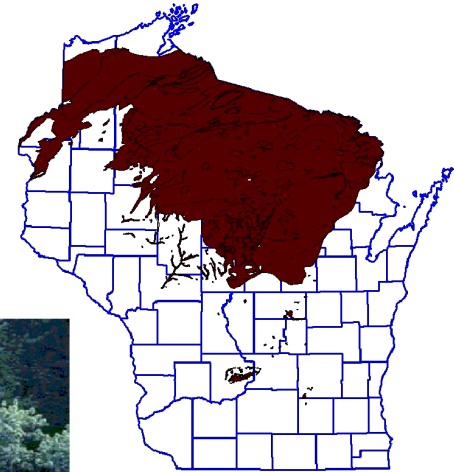


Pumping reduces discharge



Citizens Natural Resources Association
of Wisconsin & Trout Unlimited at
the Mecan River

Precambrian rock
Fractured
Low well yield



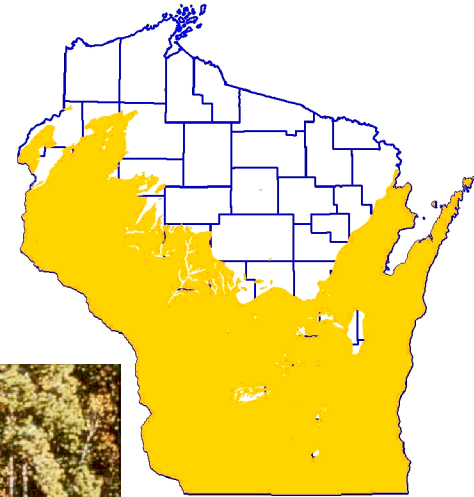
“Sandstone” aquifer

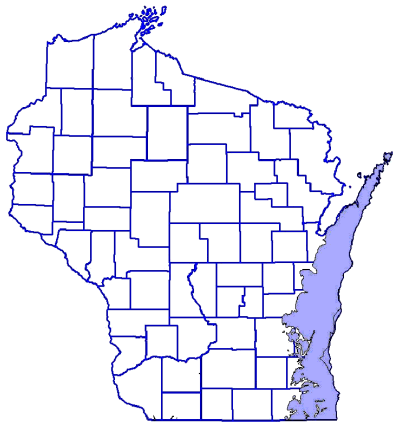
Sandstone and dolomite

Extensive and thick

Very porous- great storage!

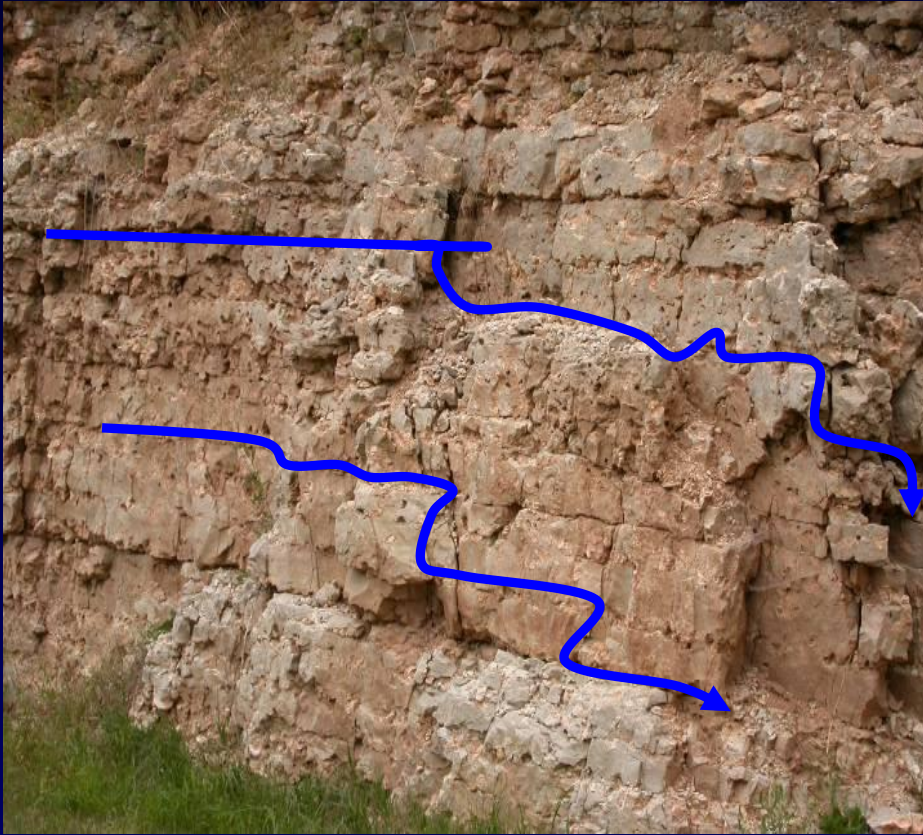
Yields prolific water to wells





Dolomite aquifer:
Shallow bedrock
Lots of fractures
Vulnerable to contamination

Dolomite and limestone are easily dissolved...



Caves, sinkholes and fractures are common in this rock. Contaminants reach groundwater quickly...



Pine Lake, Waushara County

Photos courtesy of G. Kraft, UW Extension



**Tributary of Tenmile Creek
Adams County, WI 2013**

Relative well depths

