

Hubbard County Geologic Atlas (Part B: Groundwater Atlas)

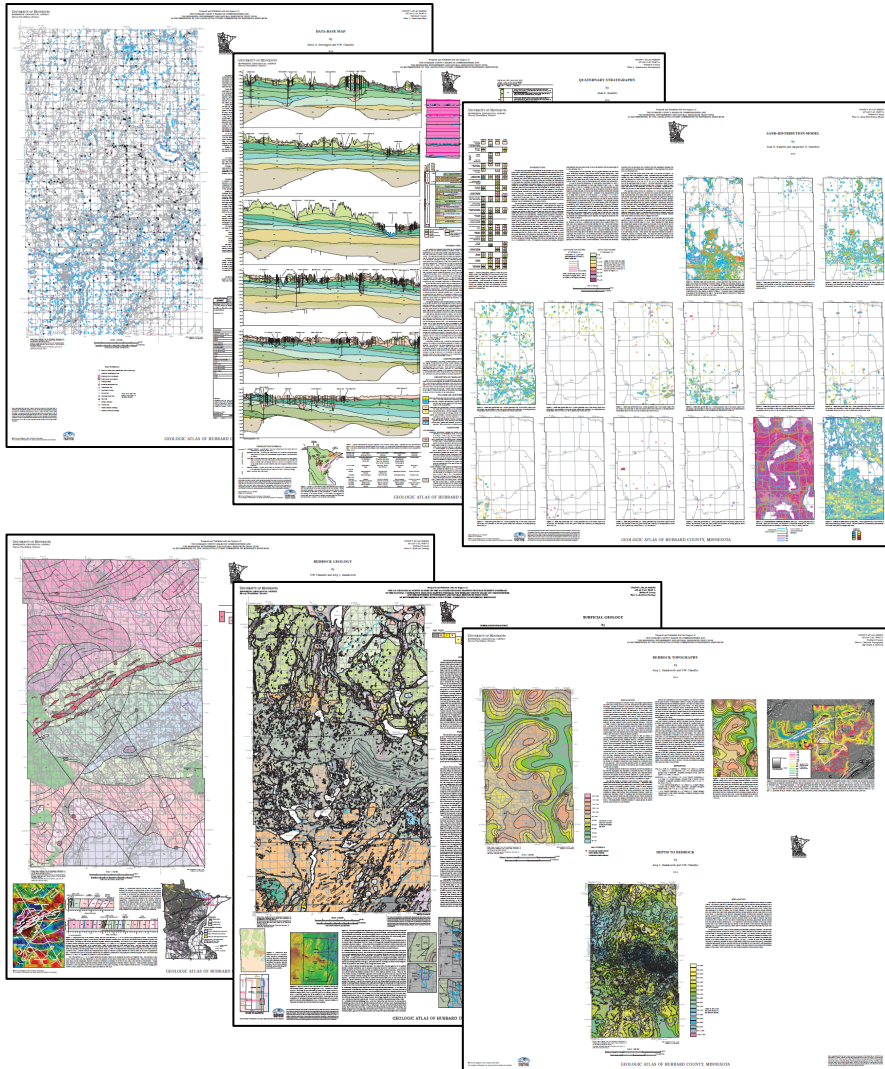


Nicholas (Nick) Budde | Minnesota Department of Natural Resources (DNR)

Hubbard County Coalition of Lake Associations Meeting | Aug. 29, 2024



Part A: Minnesota Geological Survey



Plates (6)

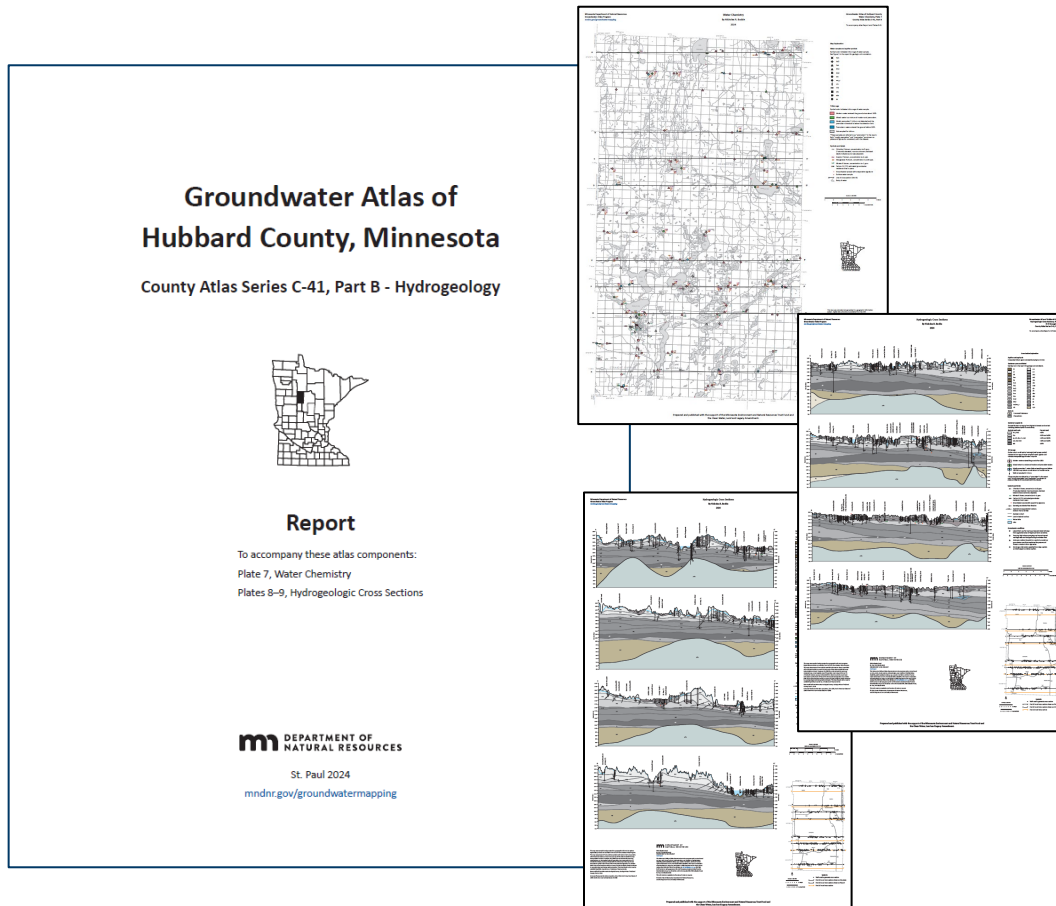
- Geology
 - Surficial
 - Glacial
 - Bedrock

Electronic files

- Plates
- GIS files

cse.umn.edu/mgs/county-geologic-atlas

Part B: Minnesota DNR



Report

- Hydrogeology and groundwater flow
- Water chemistry
- Groundwater pollution sensitivity
- Groundwater use

Plates (3)

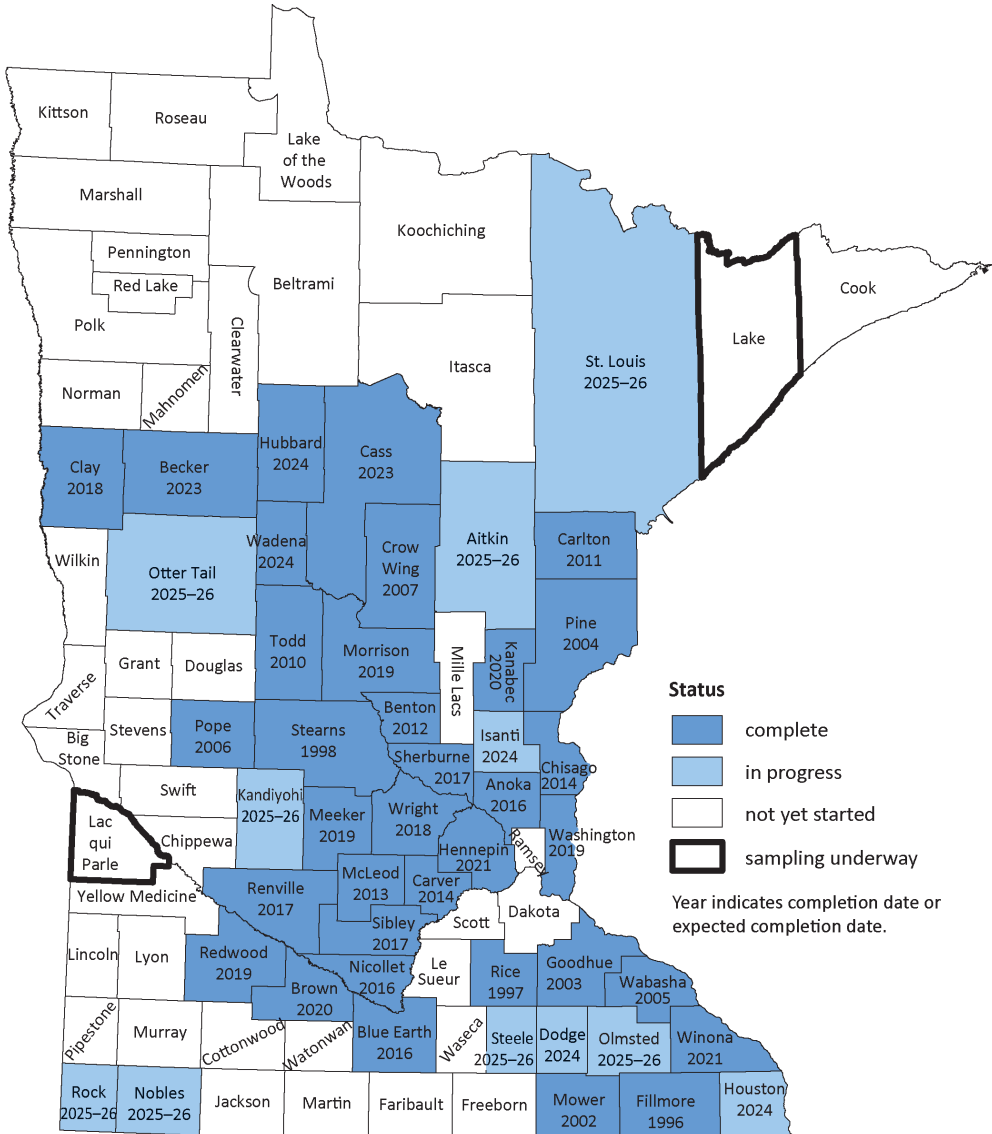
- Water chemistry (1)
- Hydrogeologic cross sections (2)

Electronic files

- Report and plates
- GIS files

mndnr.gov/groundwatermapping

Groundwater: Part B Status



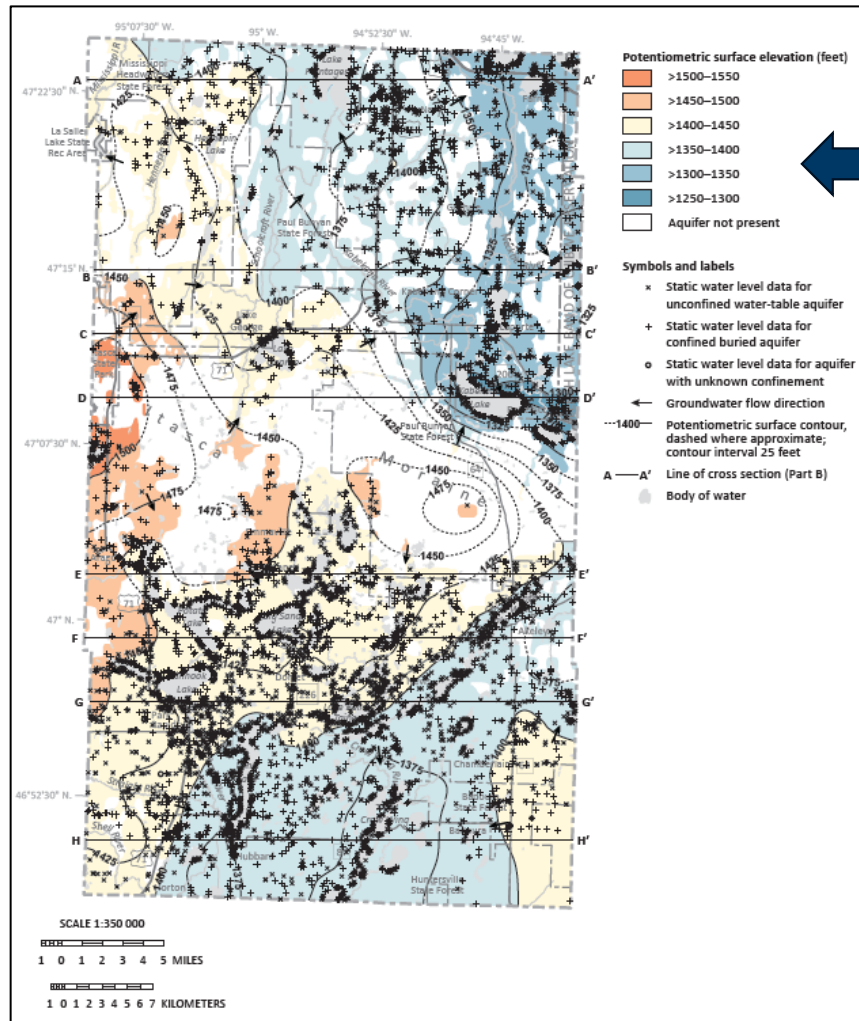
- 35 counties are complete (blue)
- 11 counties are in progress (light blue)
- 39 counties are not started (white)
- 2 counties are actively being sampled (bold black outline)

Statuses are as of August 23, 2024.

How Are Groundwater Atlases Used?

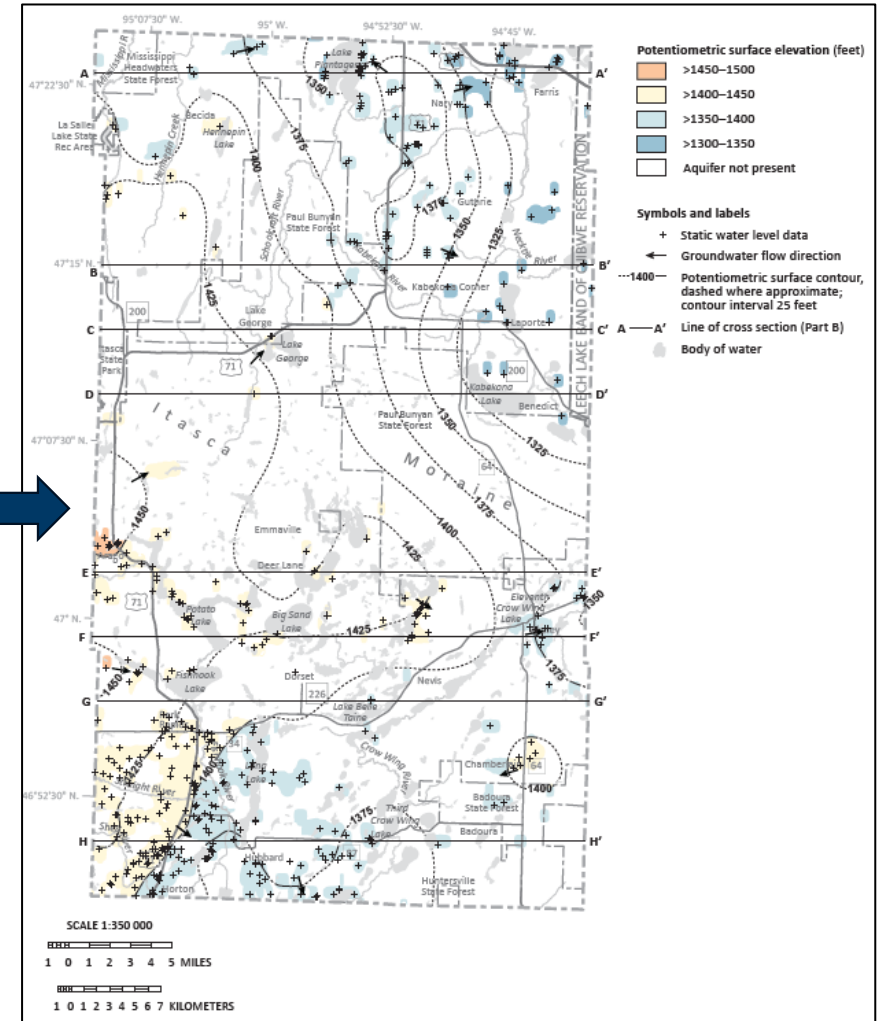
- Planning for location and drilling of water supply wells (public, private, agricultural)
- Groundwater resource protection and management
- Education about groundwater and natural resources
- Pollution sensitivity of aquifers in planning and zoning
- Community development planning (land use, zoning)
- Infrastructure planning (roads, bridges)
- GIS layers of all available information are added to county databases

Groundwater Flow

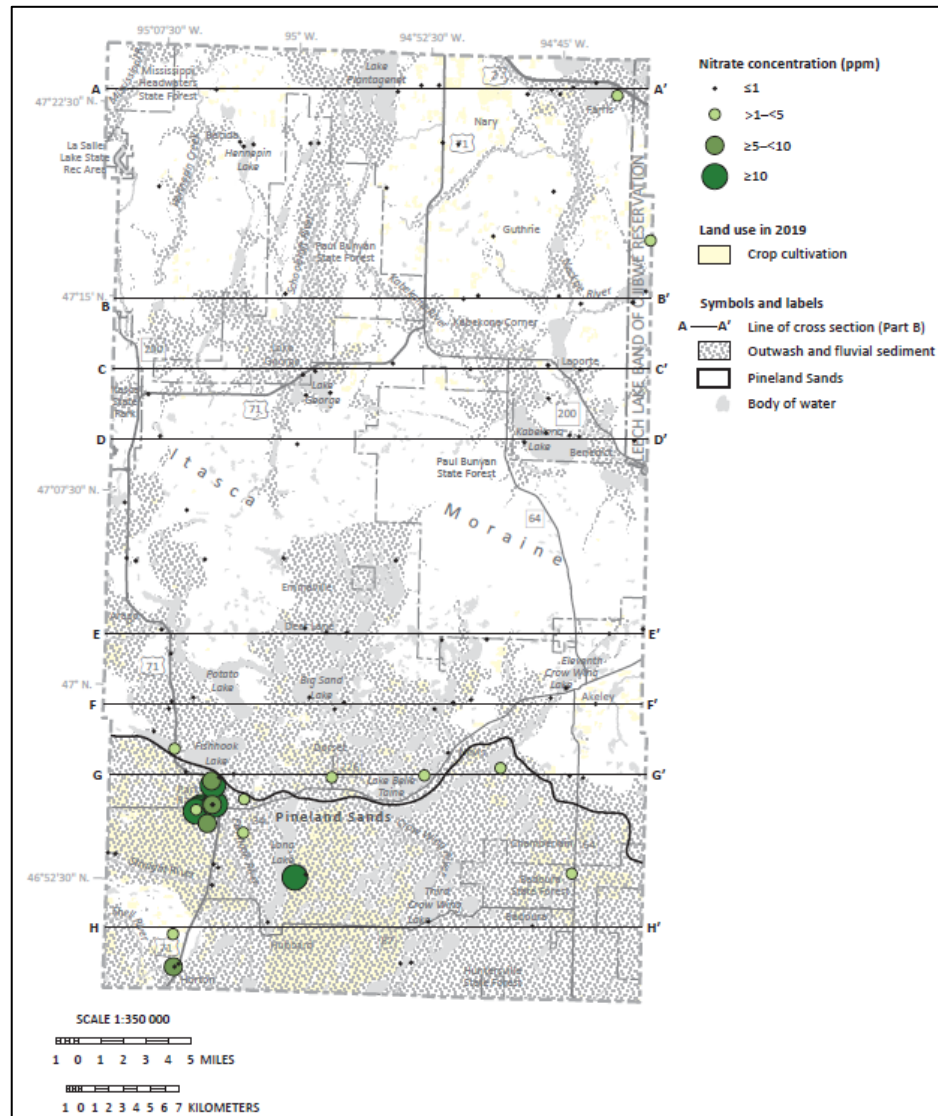


Upper sand aquifers buried by sand or sandy loam sediment

Deeper sand aquifers buried by clay-rich sediment



General Chemistry (100-125 Wells)



Nitrate (fertilizer, septic, manure)

- Drinking water standard (10 ppm) exceeded in 5% of wells
- Likely human-introduced (>1 ppm) in 18% of wells
- Wells $<100'$ deep in sandy south

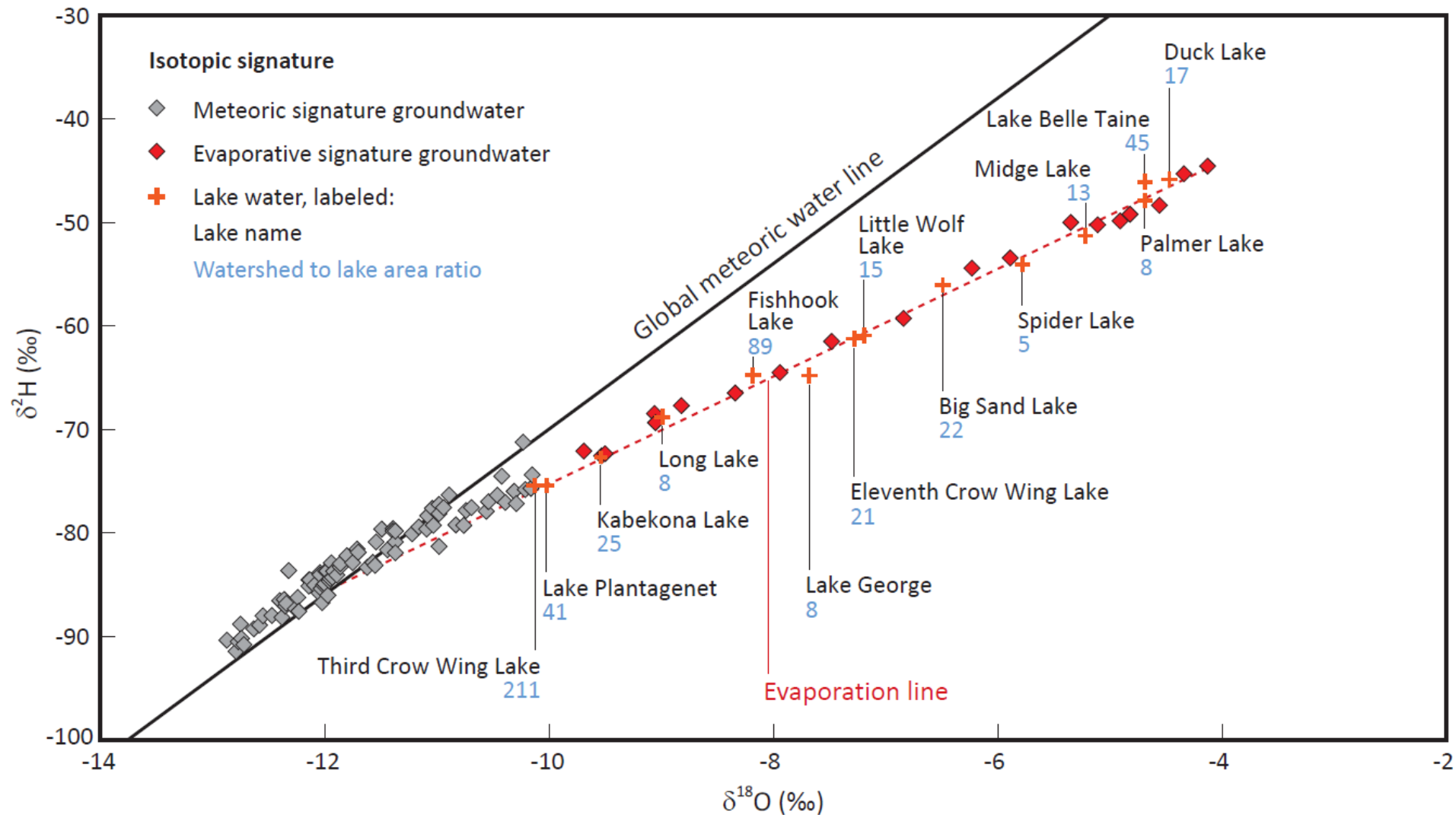
Chloride (road salt, septic, fertilizer)

- Likely human-introduced in 34% of wells
- Wells $<100'$ deep in sandy south

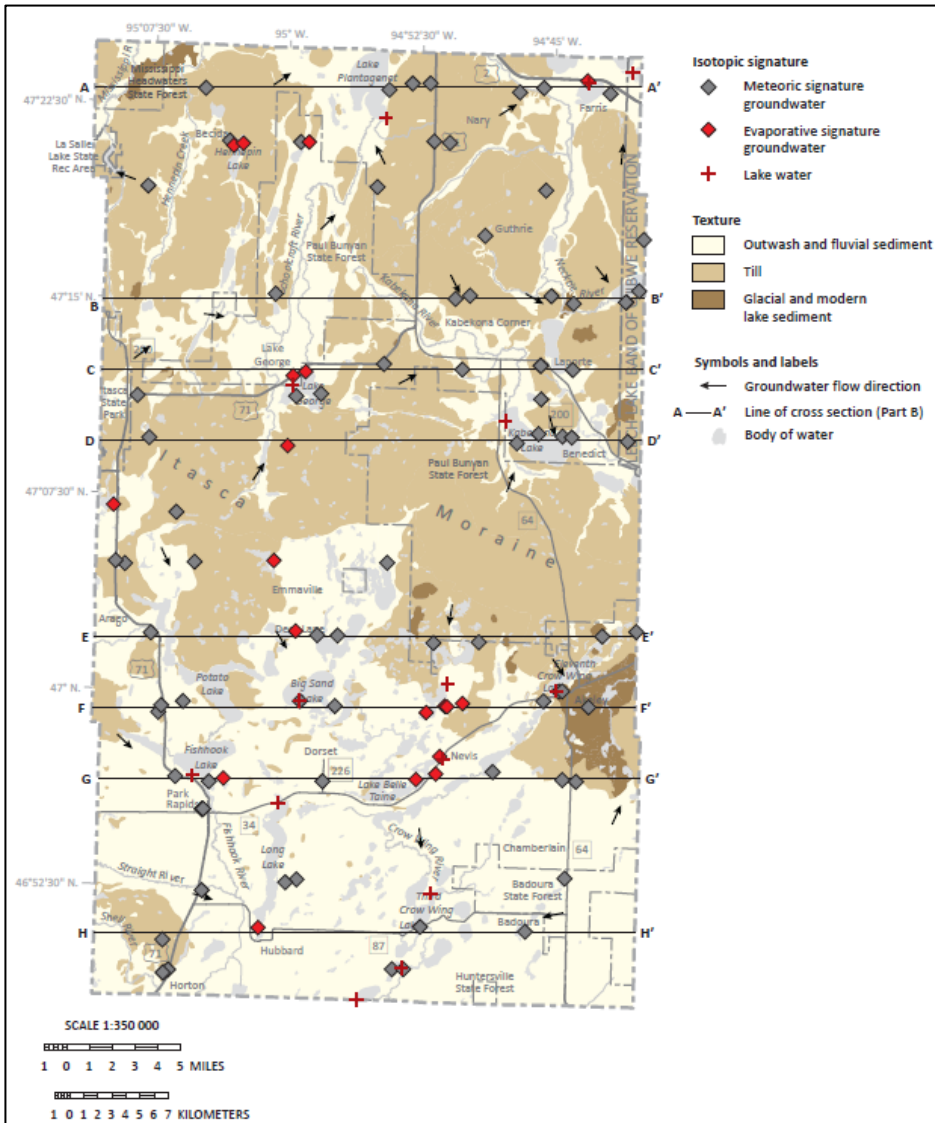
Arsenic (natural)

- Exceeded drinking water standard (10 ppb) in only 3% of wells
- Detected in 75% of wells

Lake Water Recharge Determination

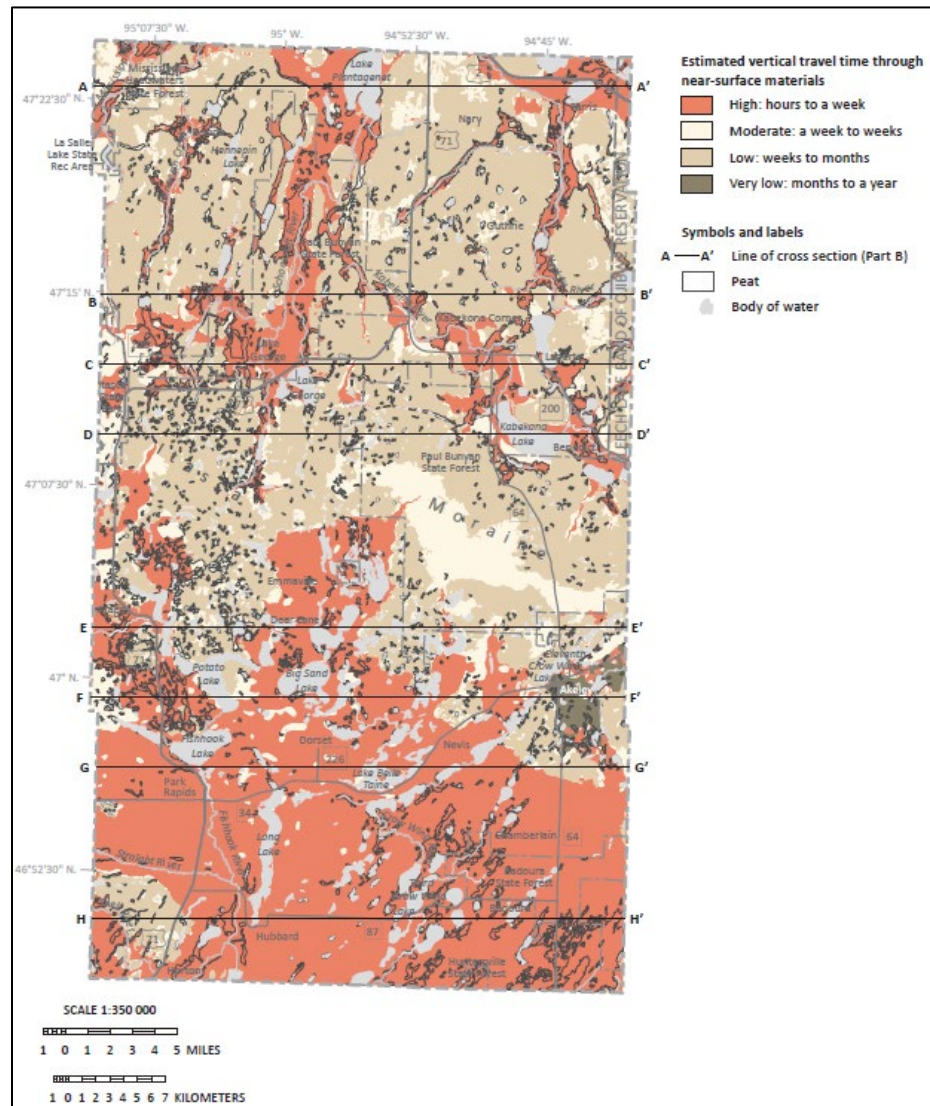


Lake Water vs. Rainwater Recharge



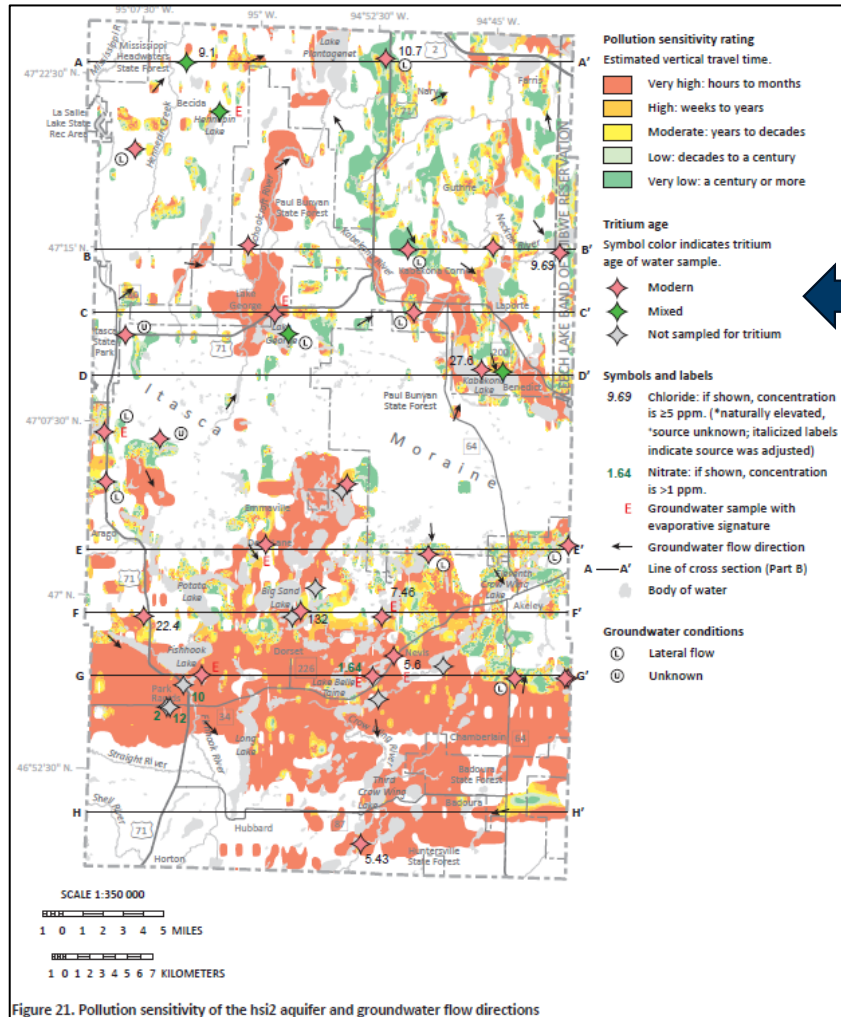
- Lake water recharge in 19 of 101 well samples (19%)
 - Downgradient of lakes
 - Often wells less than 100 ft. deep
 - Often where sand (as opposed to sandy-loam) is at surface
- Connection between lakes and groundwater

Near-surface Pollution Sensitivity



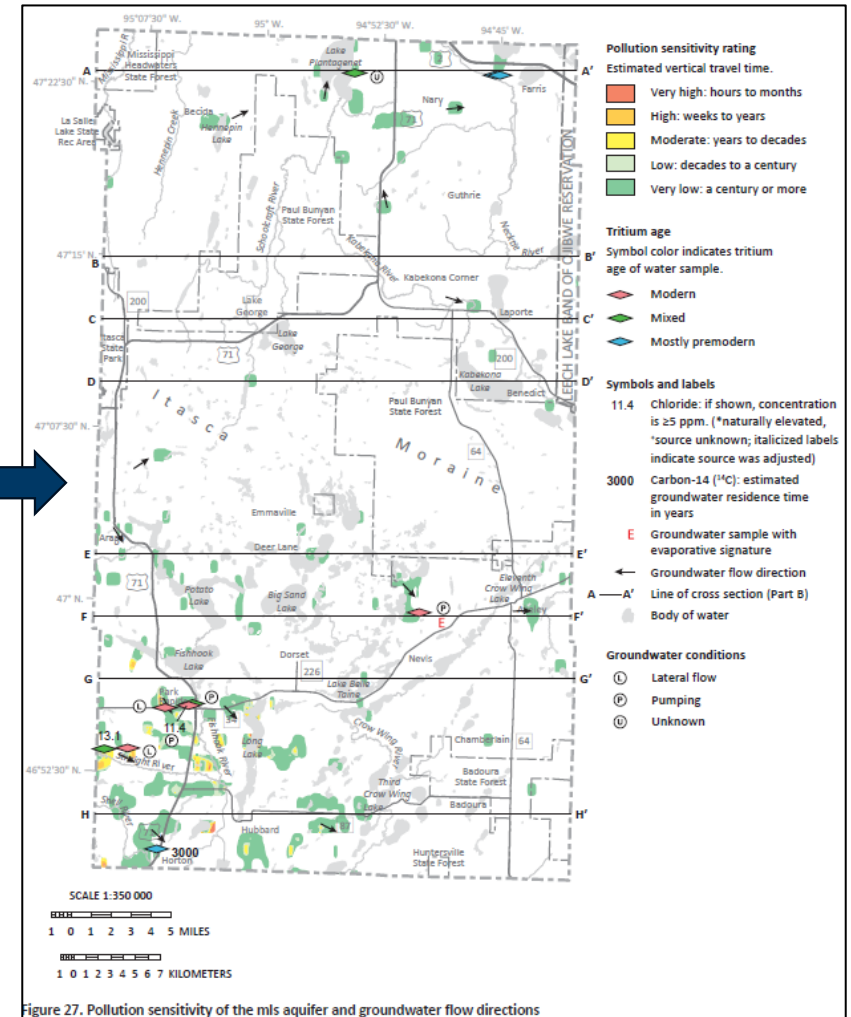
- The upper 10 feet of subsurface

Buried Sand Aquifer Pollution Sensitivity

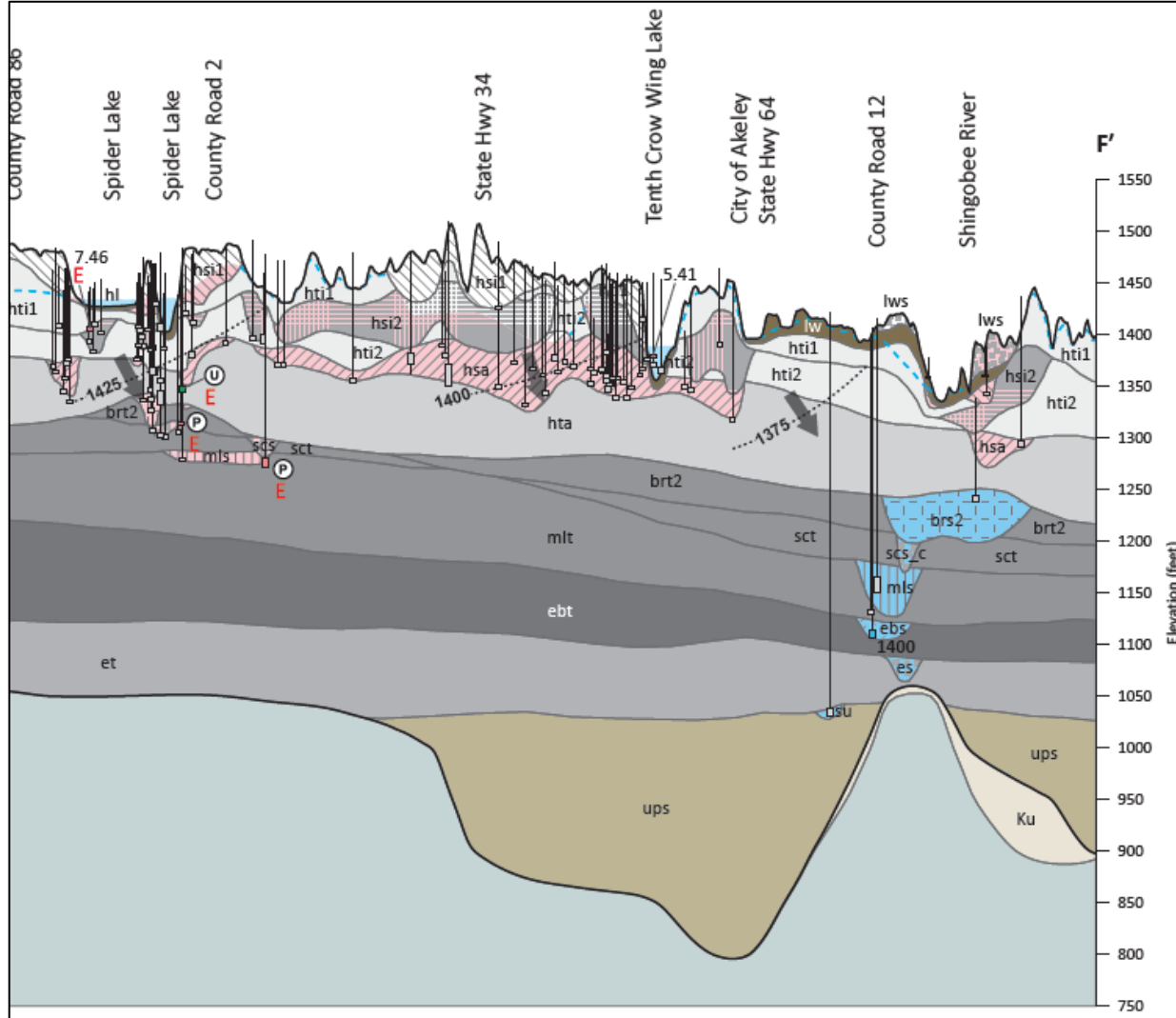


Shallowly buried

More deeply buried



Hydrogeologic Cross-Sections



- What do they show?

Upcoming Hubbard County Workshop



- 12:30 to 3:30 p.m., **Wednesday, Sept. 11** in Park Rapids, Minnesota
- For more information or to register, contact nicholas.budde@state.mn.us by **Friday, Sept. 6.**
- Wadena County workshop likely in November

Thank You!

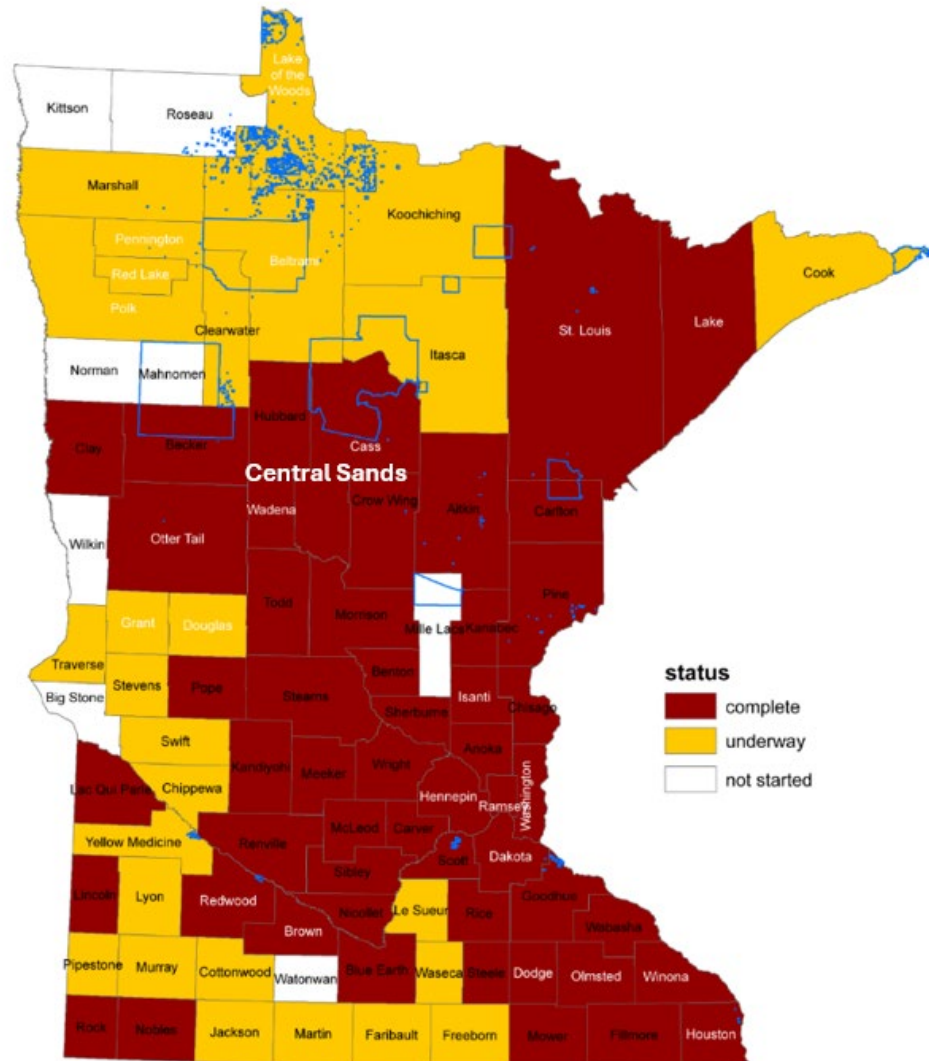
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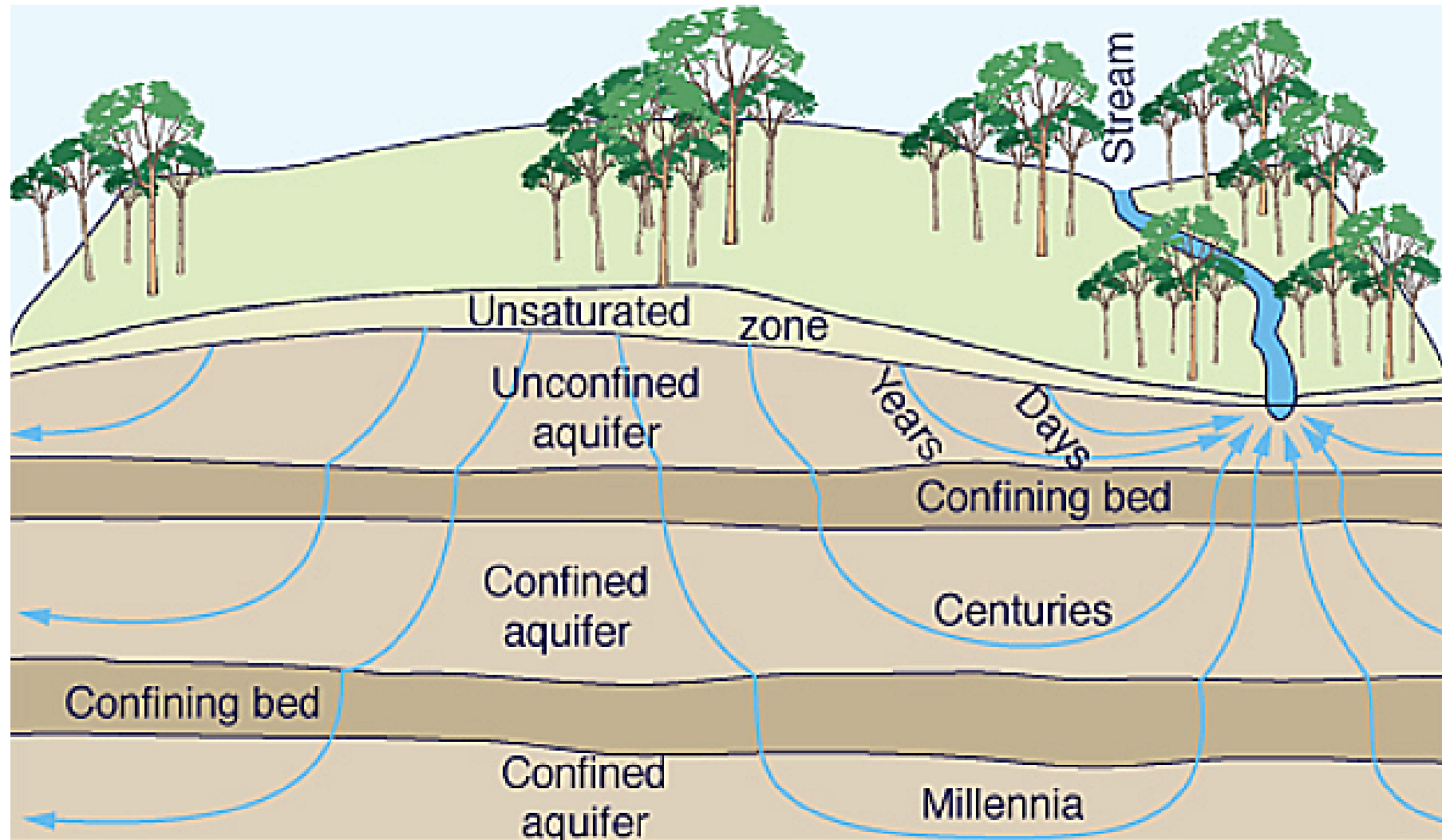
Geology: Part A Status



- 52 counties are complete (maroon)
- 27 counties are in progress (gold)
- 8 counties are not started (white)
- 23 counties are supported all or in part by Clean Water Funds (county names in white)

*Statuses are as of May 17, 2024.
Minnesota counties are labeled
Tribal government boundaries (blue outlines)*

Flow Pathways and Residence Time



Source: United States Geological Survey; Winters, 1998, Figure 3.

Stratigraphic Column

	Part A	Part B	Part B aquifer system	Potentiometric surface figure	Pollution sensitivity figure
Modern lake sediment	hl	hl			
Colluvium	co	co			
Floodplain alluvium	al	al [†]			
Alluvial fan sediment	fa	fa [†]			
Terrace deposits	te	te [†]			
Glacial lake sediment	hil	hil			
Blackduck Formation	bds	bds [†]		Figure 7	
	bt	bt			
Glacial Lake Willabee	lws	lws			
	lw	lw			
Independence Formation, South Long Lake Member	iso	iso ^{†*}			
Hewitt Formation, Itasca Phase	hsi1	hsi1 [†]	Upper system	Figure 20	
	hti1	hti1		Figure 21	
	hsi2	hsi2		Figure 22	
Hewitt Formation, Alexandria Phase	hsa	hsa	Figure 7	Figure 22	
	hta	hta		Figure 23	
Browerville Formation	brs1	brs1	Figure 7	Figure 23	
	brt1	brt1		Figure 24	
	brs2	brs2 [†]		Figure 24	
	brt2	brt2			
Lake Henry Formation, Sauk Centre Member	scs	scs	Lower system	Figures 7 & 8	Figure 25
	sct	sct			

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	hta	hta		Figure 23	
Browerville Formation	brs1	brs1	Figure 7 & 8	Figure 24	
	brt1	brt1		Figure 25	
	brs2	brs2		Figure 26	
	brt2	brt2			
Lake Henry Formation, Sauk Centre Member	scs	sct	Lower system	Figure 25	
Unnamed Rainy Formation	urs	urt		Figure 26	
Lake Henry Formation, Meyer Lake Member	mls	mlt		Figure 27	
Smoky Hills Formation	shs	sht	Figure 8	Figure 28	
Unnamed Winnipeg Formation	uws	uwt		Figure 29	
St. Francis Formation	sfs	sft			
Eagle Bend Formation	ebs	ebt			
Unnamed Superior Formation	prs	prt			
Elmdale Formation	es	et			
Undifferentiated	su	su			
	ups	ups			

[†]Surficial sand
^{*}Unit is a surficial aquifer except where buried in the northeast, near Akeley, or overlain by modern alluvial sediment.
^{*}Unit is not shown on cross sections.

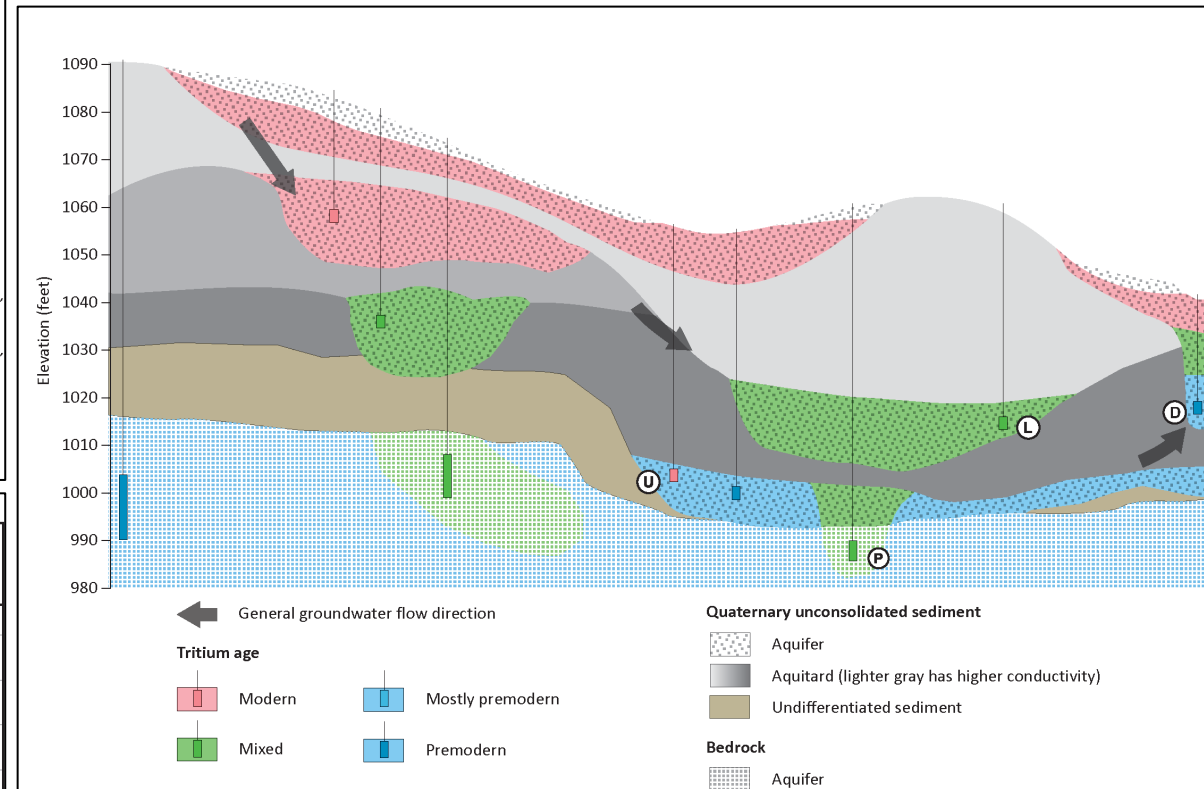
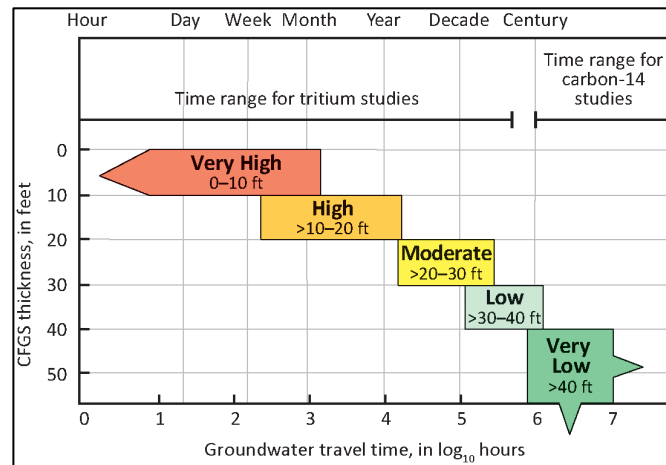
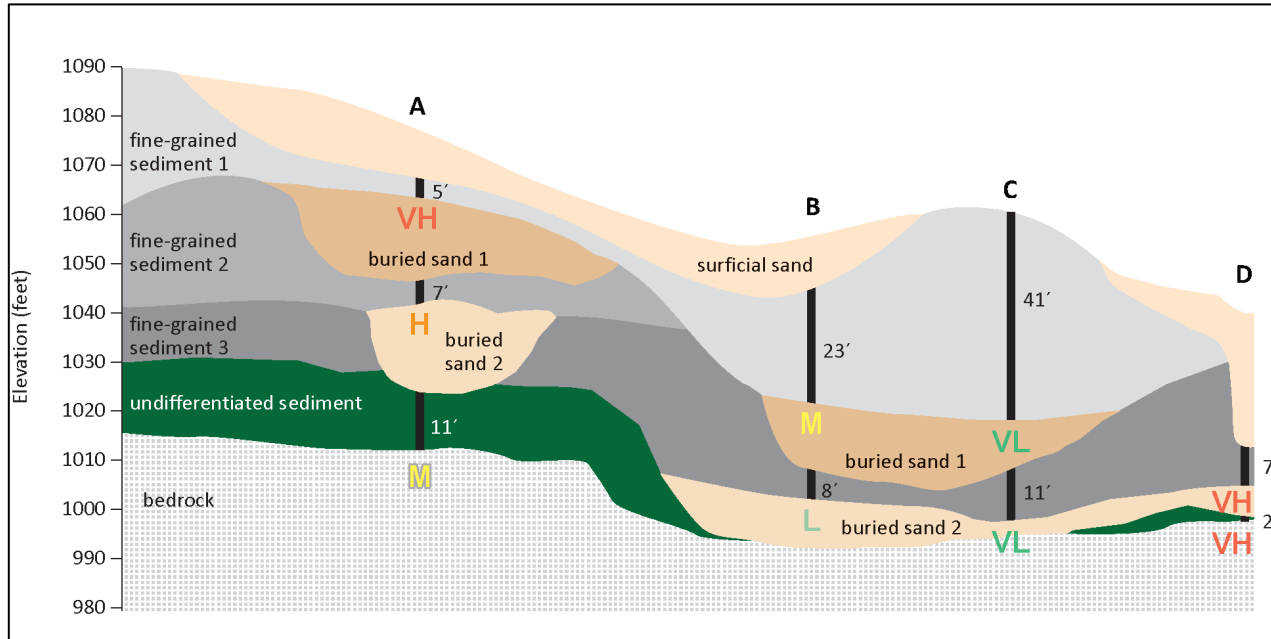
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	urt	urt			Figure 27
Lake Henry Formation, Meyer Lake Member	mls	mls			Figure 27
	mlt	mlt			Figure 28
Smoky Hills Formation	shs	sht			Figure 28
	sht	sht			
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	uwt	uwt			
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	sft	sft			
Eagle Bend Formation	ebs	ebs			
	ebt	ebt			
Unnamed Superior Formation	prs	prs [*]			
	prt	prt			
Elmdale Formation	es	es			
	et	et			
Undifferentiated	su	su			
	ups	ups			

[†]Surficial sand

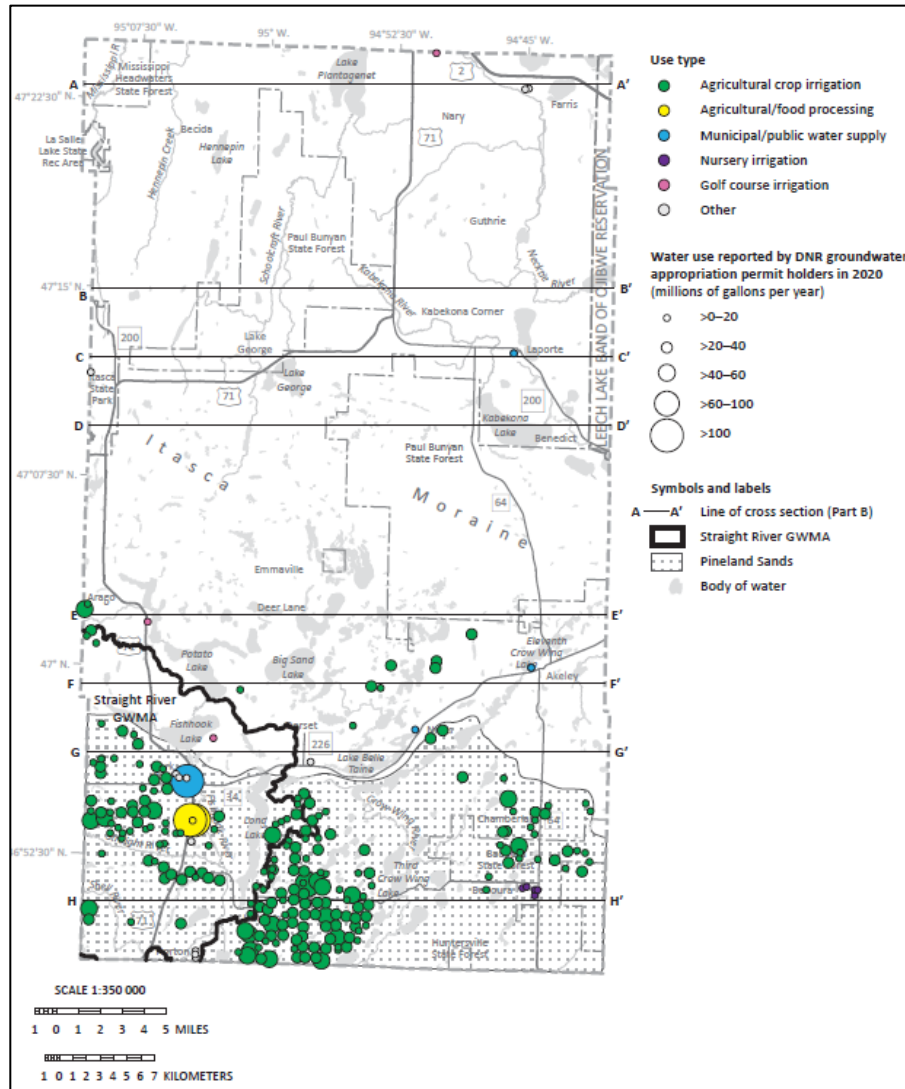
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Buried Aquifer Sensitivity Model



DNR-permitted Groundwater Use



- >10,000 gallons/day or 1 million gallons per year