ARSENIC

Key Takeaways

Given the seriousness of arsenic contamination in groundwater and its human health impacts, there is an urgent need to address Wisconsin's arsenic contamination problem. GCC member agencies and partners continue to proactively address arsenic concerns through well drilling advisories, health studies, well testing campaigns, studies aimed at improving geological understanding and developing practical treatment technologies.

GCC member agencies are working on multiple initiatives related to reducing arsenic contamination in groundwater (see groundwater management sections – DHS, DNR, UW, WGNHS and the Regional Drawdowns and Research Highlights sections).

For actions to address arsenic contamination in groundwater, see the Recommendations Section of the report.

Sections in this document

What is arsenic?

Arsenic is an odorless and tasteless, naturally occurring element present in soil and rock. Under certain environmental conditions, arsenic can dissolve and be transported in groundwater. It can also be released as a by-product from agricultural and industrial activities. Everyone is exposed to small amounts of arsenic since it is a natural part of the environment, but under some geologic conditions elevated amounts of arsenic can be released to groundwater.

What are the human health concerns?

The Wisconsin health-based groundwater quality enforcement standard (ES) for arsenic in groundwater, and the maximum contaminant level (MCL) for arsenic in public drinking water, are both 10 parts per billion (ppb), or 10 micrograms per liter (ug/L) (WI NR 140.10, WI NR 809.11). People who drink water containing arsenic in excess of 10 ppb over many years could experience skin damage or problems with their circulatory system, nervous system, and have an increased risk of getting cancer.

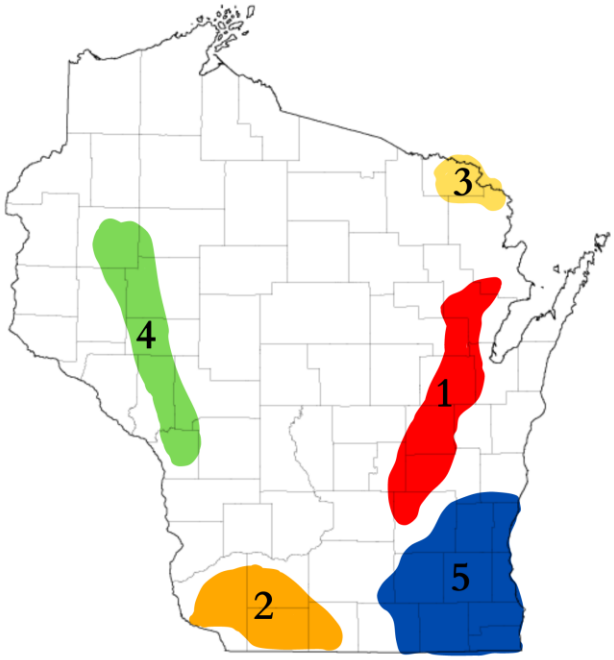
How widespread is arsenic in Wisconsin?

The extensive research completed in Wisconsin over the past 20 years illustrates the highly variable nature of Wisconsin's geologic sources of arsenic to

groundwater. A well with no detectable arsenic can be right across the street from a well that test above the 10 ppb drinking water protective health level. Arsenic concentrations can vary over time too. This makes regular testing - with efficient, accurate and affordable methods - critical. Wisconsin Groundwater Research and Monitoring Program (WGRMP) funded researchers have been important partners in this effort and have designed portable field sampling kits, improved upon existing laboratory methods and developed sensors that can detect arsenic levels in groundwater. Researchers from the WGNHS funded by the WGRMP are working to understand the mineralogy of the Tunnel City rock formation in western Wisconsin, which may help define the risk of arsenic contamination in that region.

In Wisconsin, most arsenic found in groundwater is naturally occurring, released from minerals in bedrock and glacial deposits.

Arsenic has been detected above the 10 ppb ch. NR 140 ES in the groundwater in every county in Wisconsin. Arsenic contamination of groundwater is common in northeastern Wisconsin in areas around Winnebago and Outagamie counties and moderately high levels of arsenic (10 ppb – 30 ppb) are also common in some parts of southeastern Wisconsin.



Arsenic contamination is most common in northeastern Wisconsin (regions 1 & 3), but is also found in other areas throughout the state (regions 2, 4 & 5).

In northeastern Wisconsin, a geologic formation called the St. Peter Sandstone contains arsenic-rich minerals. When sulfide minerals common in this rock are exposed to oxygen in the air – either at the water table elevation or from drilling activity – chemical reactions solubilize these minerals and lead to very high levels of arsenic in water (exceeding 100 ppb, or 10 times the ES, with many reaching the thousands of ppb). In low-oxygen groundwater environments, arsenic can be released from the St. Peter Sandstone at lower concentrations which may still exceed the ES. This more moderate contamination may result from the direct release of arsenic from sulfide minerals or from arsenic that is bound to iron oxide minerals and mobilized in groundwater under reducing (where dissolved oxygen is low) geochemical redox conditions.

In southeastern Wisconsin, most wells draw from glacial sand and gravel deposits or from Silurian dolomite bedrock formations. While oxidizing conditions tend to release arsenic from sulfide minerals in northeastern Wisconsin, reducing conditions

tend to release arsenic from iron compounds in the glacial deposits and dolomite of southeastern Wisconsin.

In northern Wisconsin sulfide and arsenopyrite minerals can be found in the Precambrian granitic bedrock, and arsenic bearing iron oxides can be in the end moraine deposits of various glacial advances. Across the northern counties there are arsenopyrites in the Precambrian Bedrock associated with shear zones and other structures from Taylor to Florence County. Also, arsenic released from iron oxides are common in the glacial moraine tills in this area.

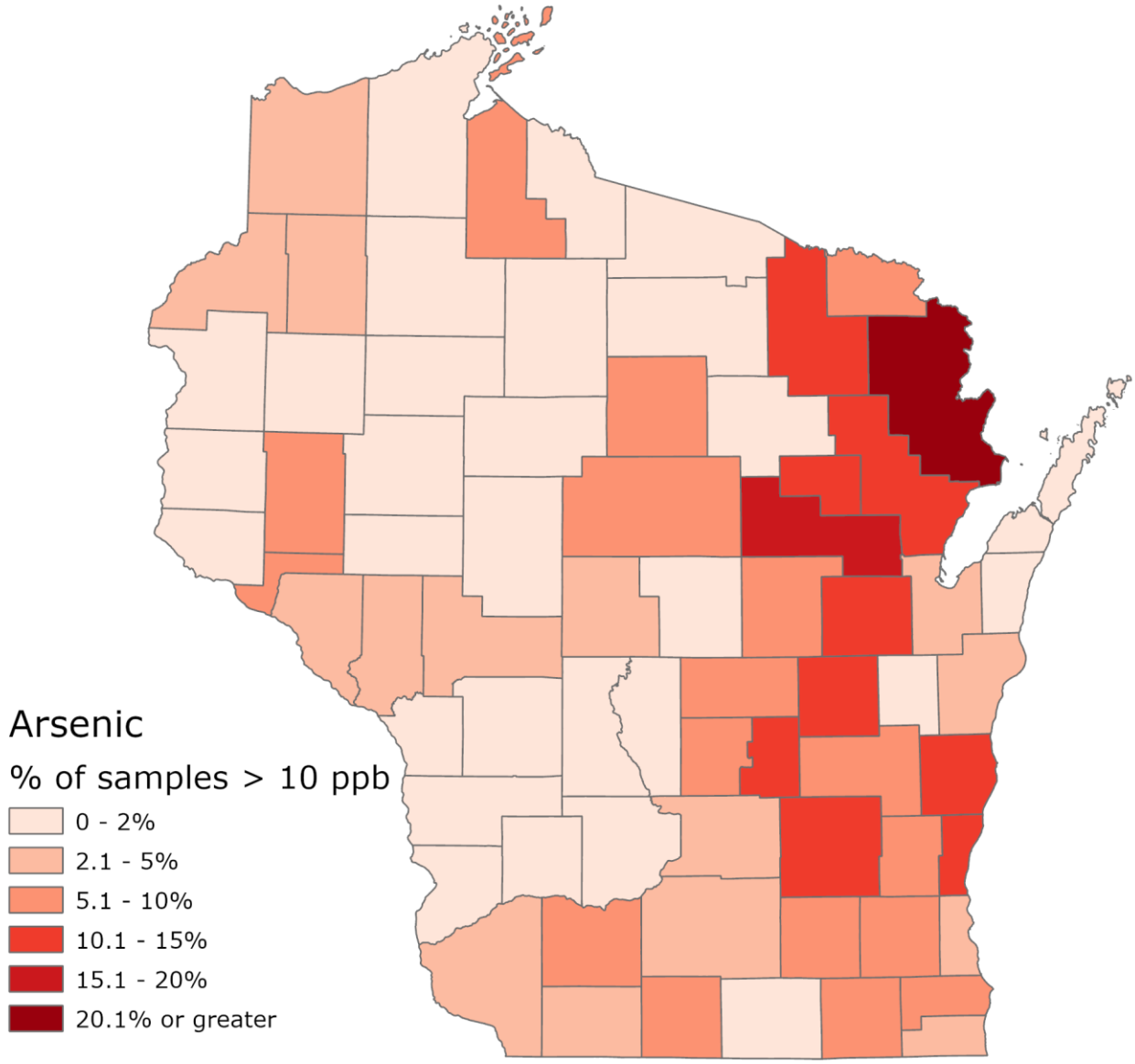
Arsenic-rich minerals, such as arsenic-rich pyrite (pictured), are natural sources of arsenic in groundwater in Wisconsin. *Photo: JJ Harrison.*

In southwestern Wisconsin sulfides associated with the lead-zinc district have contaminated a number of wells. Further north, sulfides in the Tunnel City formation have forced the replacement of at least a dozen wells from La Crosse to Barron counties. A report by Zambito et. al.[1] explains the occurrence of arsenic and metal bearing sulfides. Other metals commonly associated with arsenic are nickel, cobalt, copper, aluminum and vanadium.

How is arsenic contamination trending over time?

Arsenic continues to be an issue for Wisconsin well owners. Since 2014, the DNR has required testing for arsenic when pump work is done on existing wells. The data is analyzed to determine if additional Special Well Casing Depth Areas should be developed.

Data from Jan. 2023 – June 2024 for new well and pump work showed that of the 10,431 arsenic samples taken, 573 (or 5.5%) were over the 10 ppb ch. NR 140 ES. The maximum level recorded was 14,800 ppb. About 34.4% or 3,592 samples were over the ch. NR 140 Preventive Action Limit (PAL) of 1 ppb. See Map 1 and Table 1 to see arsenic contamination by county.



Map 1. Map of Estimated Percent of Wells with samples over the Arsenic Standard (10 ppb) by County – January 2023 – June 2024. See tabular data by county below.

County	% > 10	County	% > 10
Adams	1.2	Marathon	9.5
Ashland	9.4	Marinette	21.9
Barron	0.7	Marquette	5.6
Bayfield	1.0	Menominee	14.8
Brown	3.4	Milwaukee	3.7
Buffalo	2.9	Monroe	0.0
Burnett	2.7	Oconto	14.4
Calumet	2.0	Oneida	0.6
Chippewa	0.9	Outagamie	10.8
Clark	0.0	Ozaukee	14.2
Columbia	2.7	Pepin	8.1
Crawford	0.0	Pierce	1.3
Dane	3.2	Polk	0.4
Dodge	14.2	Portage	0.0
Door	1.9	Price	0.0
Douglas	2.1	Racine	5.6
Dunn	7.5	Richland	0.0
Eau Claire	1.7	Rock	1.0
Florence	7.4	Rusk	1.9
Fond du Lac	9.7	St. Croix	0.9
Forest	11.4	Sauk	1.0
Grant	2.2	Sawyer	0.0
Green	8.1	Shawano	18.7
Green Lake	13.4	Sheboygan	12.3
Iowa	5.3	Taylor	0.0
Iron	0.0	Trempealeau	4.5
Jackson	2.8	Vernon	0.0
Jefferson	7.7	Vilas	0.0
Juneau	0.0	Walworth	8.2
Kenosha	2.5	Washburn	2.9
Kewaunee	0.0	Washington	7.6
La Crosse	1.6	Waukesha	5.8
Lafayette	3.7	Waupaca	8.9
Langlade	0.0	Waushara	7.4
Lincoln	7.3	Winnebago	13.1
Manitowoc	2.2	Wood	4.0

Table 1. Percent of wells over 10 ppb arsenic by county (January 2023 – June 2024).

Sampling and testing private wells remain important priorities for understanding and managing arsenic contamination in Wisconsin. To encourage private well sampling, local health departments continue to offer fee-exempt testing to low income families. DHS's new baby sampling program includes a metals screen developed at SLOH that looks for arsenic, co-contaminants and indicators for the possible source and release mechanism. The DNR and some county governments are also working to both promote well sampling programs and explore impediments to private well sampling.

In areas of the state known to be vulnerable to arsenic contamination, there is a focus on reducing exposure. Several communities have expanded the service area for public water systems and moved homes from private wells to public supplies. This expansion has been effective in reducing exposure in towns like Algoma in Winnebago County.

Discovery triggers geochemical questions and science improves understanding and helps GCC agencies better protect human health. This pattern is repeated by GCC agencies and researchers whenever natural contaminants are identified in groundwater in unexpected amounts in a new location. For example, ongoing investigations are exploring the occurrence of strontium near Green Bay and the presence of heavy metals in geologic formations near La Crosse, among others.

Further Reading

- DNR overview of arsenic in drinking water wells
- DNR special well casing depth areas for arsenic
- DHS overview of arsenic health effects
- WGNHS report on arsenic release due to well disinfection
- WGNHS report on preliminary investigation near Lake Geneva, Wisconsin
- DHS report on arsenic in Wind Lake Private Wells, Town of Norway, Racine County
- Wisconsin Natural Resource magazine article on arsenic in private wells
- Taylor, R.W. and G. Mursky. 1990. Mineralogical and geophysical monitoring of naturally occurring radioactive elements in selected Wisconsin aquifers. Wisconsin groundwater management practice monitoring project, DNR-051. Available at *http://digital.library.wisc.edu/1711.dl/EcoNatRes.TaylorMineral*

References

1. Zambito, J., Haas, L., Parsen, M., McLaughlin, P. 2019. Geochemistry and mineralogy of the Wonewoc–Tunnel City contact interval strata in western Wisconsin. Wisconsin groundwater management practice monitoring project, WR15R004. Available at *https://wgnhs.wisc.edu/pubs/wofr201901/*