water resources

Arsenic

Director Anders W. Andren
Phone (608) 262-0905 Web www.wri.wisc.edu

Arsenic contamination of groundwater is becoming an issue of increasing concern in Wisconsin. Ninety-seven percent of the state's inland communities—70 percent of the state's population—depends on groundwater for their drinking water. In densely populated areas, the pumping of increasingly high volumes of groundwater has resulted in a lowering of the water table and the drilling of deeper wells. This combination of lower water tables and deeper wells is contributing to elevated levels of arsenic in drinking water, particularly in northeastern and southeastern parts of the state.

While modern water treatment methods are extremely efficient at removing pathogens and many toxic trace metals, most treatment techniques do not effectively remove the toxic inorganic forms of arsenic from drinking water.

Arsenic contamination of groundwater supplies is an emerging problem not only in Wisconsin, but in other parts of the United States and other areas of the world. Effective in 2006, the permissible amount of arsenic in U.S. drinking water systems will be reduced by 80 percent, to 10 parts per billion (pbb). Recent studies in Wisconsin, Minnesota, Michigan and four other states indicate groundwater arsenic concentrations exceeding 10 pbb are more common and widespread than previously recognized.

About Arsenic

Arsenic is a naturally occurring element found in soil, minerals and water. It dissolves into groundwater and surface waters as part of the normal geochemical cycling of elements. Arsenic concentrations in groundwater in the United States typically range from one to 50 ppb.

Arsenic in the environment can exist in a variety of chemical forms, both organic and inorganic. The inorganic forms are far more toxic than the organic species of arsenic. Of greatest concern are two species of inorganic arsenic—As(III) and As(V)—which and usually exist as trace constituents in minerals, soils and rocks. As water flows through aquifers, varying amounts of inorganic arsenic are dissolved.

Arsenic has been detected in well water samples in every county in Wisconsin, but the area of greatest concern is parts of Brown, Outagamie, Shawano and Winnebago counties, where 20 percent of drinking water supplies have arsenic concentrations higher than 10 ppb.

ISSUES

- **Long-term chronic exposure to arsenic in drinking water has been linked to cancer of the skin, bladder, prostate, lungs, nasal passages, kidneys and liver.**
- **Elevated levels of arsenic have been detected in public and private drinking water systems in 30 of Wisconsin's 72 counties.**
- **Effective in 2006, the permissible amount of arsenic in U.S. drinking water systems will be reduced by 80 percent, to 10 parts per billion.**
- **Meeting the new 10 ppb standard could place heavy financial burdens on small public water utilities. For community water systems serving fewer than 10,000 people, the expected annual increase in cost ranges from $38 to $327 per household.**
- **The University of Wisconsin Water Resources Institute supports a comprehensive package of research that addresses the sources, release mechanisms, public health effects, and treatment and removal of arsenic in groundwater.**

Addressing the Problem of Arsenic

The **University of Wisconsin Water Resources Institute** (WRI) supports a comprehensive package of projects that address the sources, release mechanisms, public health effects, and treatment and removal of arsenic in groundwater.

The WRI is part of the **Water Resources Research Institute Program**, a federal-state partnership of research, outreach and education administered by the U.S. Geological Survey. Additional funding comes from the **UW System Groundwater Research Program**, part of Wisconsin's **Groundwater Research and Monitoring Program** (GRMP).

Guided by the Wisconsin Groundwater Coordinating Council, the GRMP provides a mechanism for the UW System and the state departments of Natural Resources, Commerce, and Agriculture, Trade & Consumer Protection to pool limited state and federal resources to support a coordinated, comprehensive and multidisciplinary response to the arsenic problem as well as other critical issues in groundwater research and management. >

Identifying Arsenic Sources

Arsenic contamination in groundwater is widespread in the northeastern and the southeastern parts of Wisconsin. The GRMP is supporting studies aimed at determining the mechanisms responsible for the release of arsenic in these two locations. Current studies indicate the geologic and hydrogeologic conditions contributing to arsenic contamination in southeast Wisconsin differ from those in the Fox River Valley.

In the Fox Valley, the main cause of elevated arsenic levels is the drawdown of groundwater levels from pumping for drinking water. This lowering of the water table exposes arsenic-bearing sulfide minerals common in the area's sandstone aquifer to oxygen, causing a chemical reaction that makes the arsenic water-soluble. Preliminary research results from the southeastern region, however, suggests that the elevated arsenic levels there are due to a lack of oxygen in the water, which causes a chemical reaction that dissolves the arsenic from iron oxides on glacial deposits in the area's sand and gravel aquifers.

Understanding the geological sources and geochemical mechanisms of arsenic release can help us develop water well siting and construction techniques to minimize arsenic contamination of well water.

Defining the Public Health Effects

Research has shown that people who drink water containing high levels of arsenic over a period of several years have a higher risk of developing cancers of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Drinking arsenic-contaminated water can also contribute to cardiovascular and pulmonary disease, immunological and neurological disorders, and adult-onset diabetes.

A recent GRMP study supported by the Wisconsin DNR and conducted by the state Department of Health & Family Services evaluated arsenic exposure and the health of residents in rural Outagamie and Winnebago counties. More than 2,000 families participated in the study by submitting a water sample for arsenic analysis and completing a questionnaire regarding family water use and health history.

The study found that people who consumed water that contained arsenic levels above 5 ppb for 10 years or longer were more likely to report a diagnosis of non-melanoma skin cancer than others. People with a history of cigarette smoking who also consumed water from an arsenic-contaminated well for at least 10 years were three times more likely to report skin cancer than non-smokers whose water contained no detectable arsenic. These results, along with those from earlier studies, underscore the importance of testing private wells for arsenic and closely following water-use advisories.

Removing Arsenic from Water Supplies

Effective in 2006, the U.S. Environmental Protection Agency has mandated an 80 percent reduction, to 10 ppb, in the permissible amount of arsenic in U.S. drinking water systems. However, traditional water treatment methods do not remove appreciable quantities of arsenic. Reverse osmosis is currently the only effective method that is commercially available, but it is expensive. This has created an urgent need for a highly effective, reliable and economical arsenic removal technique, especially for small public water utilities and private well owners.

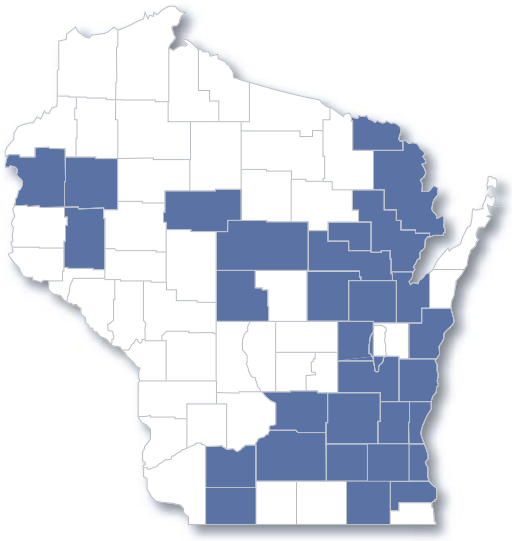
WRI-supported researchers are currently developing and testing inexpensive, high-performance photoactive adsorption media for simultaneously removing two toxic arsenic species—As(III) and As(V)—from groundwater using thin, UV-irradiated photoactive films. This technique offers a simple, effective means of removing both arsenic species without requiring pH adjustment or the addition of other chemicals, which could prove especially beneficial to small water systems as well as point-of-use and at-the-tap devices for private well owners.

Other GRMP research has determined that how a well is constructed and used can be critical to reducing arsenic concentrations. Designing a well to reduce the volume of water stored over time and to allow the mixing of water from different levels in the aquifer—along with fully purging the well before using the water—can result in lower concentrations of arsenic coming out of the tap.

Disseminating Arsenic Information

The WRI serves as the primary distribution point for GRMP project summaries and final reports. The results of all Wisconsin groundwater research and monitoring projects are communicated through the WRI Web site (*www.wri.wisc.edu*) and the UW-Madison Water Resources Library (*wri.wisc. edu/library*), which houses a nationally unique collection of more than 30,000 documents covering all major topics in water resources. This makes arsenic and other groundwater research results readily available on a timely basis to water scientists, resource managers, policy makers, faculty and students, and citizens nationwide.

Counties Where Public and/or Private Wells Have Arsenic >10 pbb



Adapted from Wisconsin Department of Natural Resources maps.