water resources

Groundwater Drawdown

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Groundwater is a critically important resource. Seventy percent of Wisconsin's population depends on it for drinking water. It is essential to many manufacturing processes; it is used to irrigate potato, corn and many other crops. Groundwater sustains springs, streams, lakes and wetlands, providing essential habitat and drinking water for wildlife.

Wisconsin's 1.2 quadrillion-gallon groundwater endowment may seem inexhaustible. But this vast amount of water is not stored in a simple underground reservoir, readily available for our use. It is stored within complex layers of rock, shale, sand and other sediment.

Wisconsin's 12,000 public drinking water systems, 800,000 private wells and 12,000 high-capacity industrial and agricultural wells are drawing about 760 million gallons of groundwater per day, and large-scale withdrawals of groundwater are adversely affecting the environment, economy and public health in large areas of the state.

About Drawdowns

An underground formation that holds a large amount of water is called an aquifer. Water moves very slowly through aquifers—so slowly that wells pumping large amounts of water from an aquifer can cause a long-term, cone-shaped depression in the groundwater level called a drawdown. Large drawdowns can cause the water level in wells, streams and wetlands to drop or cause them to dry up entirely. Drawdowns can also cause the levels of arsenic, radium (the precursor to radon) and salinity in drinking water to increase.

Reduced flow from groundwater into streams, wetlands and lakes can have far-reaching impacts on ecosystems and wildlife. Without cooling groundwater, a first-class trout stream becomes a troutless stream. Up to 70 percent of the water in some wetlands flows from groundwater. Because most species of wildlife depend on wetlands during some stage of their life cycle, groundwater drawdowns can severely affect critical habitat for many birds, fish and mammals.

In Wisconsin, the most severe drawdowns are occurring in the Lower Fox River Valley and Lake Winnebago watershed, in southeastern Wisconsin, and in central Dane County.

ISSUES

- **Seventy percent of Wisconsin's population depends on groundwater for drinking water.**
- **Large-scale pumping of groundwater has caused large drawdowns—long-term drops in groundwater levels—in the Lower Fox River Valley, southeastern Wisconsin and Dane County.**
- **Drawdowns can cause serious economic, health and environmental problems: wells run dry and must be drilled deeper; concentrations of arsenic, radium, salts and other naturally occurring substances can reach unhealthy levels; streams, lakes and wetlands lose water or dry up completely, depriving fish, birds, amphibians and mammals of vital habitat.**
- **The University of Wisconsin Water Resources Institute supports a comprehensive package of research to better understand and manage the causes and consequences of groundwater drawdown, and minimize adverse effects on the environment, the economy and public health.**

Lower Fox River and Lake Winnebago Watershed. Municipal and industrial wells tapping a deep sandstone aquifer in the Green Bay area caused a 400-foot-deep drawdown, forcing the city of Green Bay to abandon the aquifer in 1957 and build a pipeline to Lake Michigan to obtain water. Today, groundwater levels in the area are still over 300 feet below their original levels (see map), imposing the high costs of drilling deep wells on homeowners, businesses and municipalities alike. Several other communities in Brown County are considering building a pipeline to Lake Michigan—a highly expensive option that by law is open only to those who reside within the Lake Michigan watershed.

Drawdowns also appear to be increasing the amount of arsenic in the drinking water of the Lower Fox River Valley and other areas of the state as well. Arsenic is a naturally occurring element found in soil, minerals and water. However, drawdowns expose arsenic-bearing sulfide minerals in the area's sandstone aquifer to oxygen, causing a chemical reaction that makes the arsenic water-soluble.

Southeastern Wisconsin. Southeast Wisconsin has experienced the state's deepest drawdowns. Groundwater pumping since the 1880s has reduced groundwater levels more than 450 feet around Milwaukee and Waukesha. >

Besides the problems and costs associated with digging deeper wells, these drawdowns have reversed the flow of groundwater in some places. Where groundwater used to flow into Lake Michigan, water is now being drawn from the lake into the aquifer.

Drawdowns in southeastern Wisconsin are also changing the nature of the groundwater available there. As wells are drilled deeper to reach declining groundwater levels, they reach older water that has been in contact with rock formations for hundreds, perhaps thousands, of years. Such contact times are long enough for substantial amounts of naturally occurring radium, arsenic, salts and other minerals to have dissolved into the water—a matter of increasing concern in that part of the state.

Dane County. Drawdowns in Dane County were estimated at nearly 60 feet in the early 1990s. The main effects of the drawdown have been increased pumping costs and decreased groundwater discharges to springs, streams and wetlands in the area. While groundwater beneath Madison used to flow into the area's lakes, drawdowns have caused that flow to reverse in some areas, so that lake water is now being drawn into the aquifer. As a result, nearly a third of the water drawn by some wells is not groundwater, but lake water.

Addressing Drawdown Issues

The **University of Wisconsin Water Resources Institute** (WRI) supports a comprehensive package of projects that address issues related to groundwater drawdown and other water issues throughout Wisconsin.

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 University of Wisconsin 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 cross-disciplinary response to groundwater drawdown as well as other critical groundwater research and management issues.

Examples of Recent Research

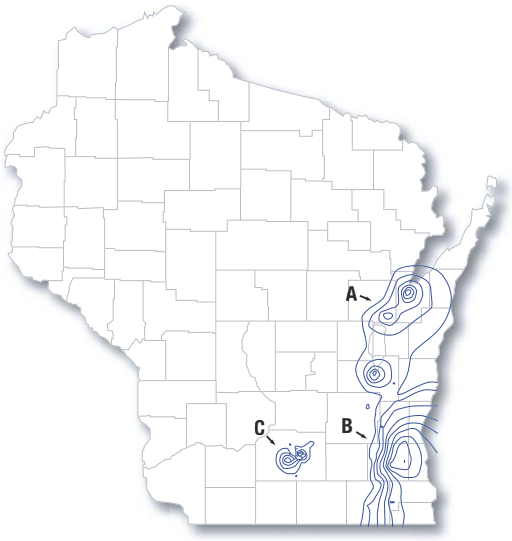
As Wisconsin communities engage in comprehensive "smart growth" planning, they frequently consider the *quality* of their water supply but often lack expertise and advice on protecting its *quantity*. This is a particular problem in populous southeastern Wisconsin, where the demand for groundwater can exceed the aquifer's ability to supply it.

WRI-supported research is using groundwater information and groundwater flow models developed at a regional scale and adapting it for use at a local level. In Washington County, WRI researchers are working with the city of Richfield to develop a protocol for quantifying its groundwater budget. That information will be coupled with projected changes in land use and pumping demand to define the effects of several development scenarios on the community's water supply. Once developed, this protocol will enable other communities to decide how to best protect vital groundwater recharge areas, where precipitation replenishes local aquifers. This will also help communities examine how changes in groundwater levels will affect local streams, lakes and wetlands.

Another WRI project is investigating the sources of high salinity and radium in the deep sandstone aquifer that supplies water to residents of eastern Wisconsin. This project is examining in detail the chemistry of the groundwater and the rock formations of this complex aquifer and determining whether high pumping rates are raising salinity and radium levels. This will help city planners and water utility directors better understand the relationship between well operations and water quality in this region. It will also allow planners to account for the effects of urban growth on water supplies.

Other WRI research is investigating the viability of aquifer storage and recovery (ASR) for Wisconsin, a technology already accepted in other parts of the country, where excess water is stored in aquifers when demand is low and withdrawn for use when demand increases. Computer models of groundwater flow and transport in ASR systems are being developed for three representative groundwater systems in Wisconsin. A better understanding of pumping rates, storage times and other factors that affect recovery efficiency of ASR systems will help guide future decision-making about using these systems in Wisconsin.

Simulated Drawdown in the Sandstone Aquifier (1998–2000)



Map adapted with permission from U.S. Geological Survey and Wisconsin Geological & Natural History Survey.

In Wisconsin, pumping groundwater has produced large drawdowns in (A) the Lower Fox River Valley/Lake Winnebago Watershed (max. 336 ft.), (B) southeastern Wisconsin (max. 458 ft.), and (C) Dane County (max. 59 ft.). Contour intervals = (A) 50 feet, (B) 50 ft., (C) 10 ft.