Managing Chippewa County's groundwater—today and tomorrow

Evaluating the impacts of industrial sand mines and irrigated agriculture on the county's water resources

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Factsheet 07 | 2013

Groundwater is an important natural resource that is fundamental to our environment and quality of life.

In western Wisconsin, groundwater serves as the source of our drinking water supply and is used extensively by agriculture and industry to grow and manufacture products that are vital to the economy.

Wisconsin's groundwater is plentiful but supplies are finite.

Understanding and managing this resource is critical to ensuring continued availability for future generations. Careful management is particularly important in areas that are experiencing increased demand for groundwater.

The expansion of industrial sand mines and irrigated agriculture will require large volumes of water and will place additional long-term demands on available water resources.

To sustainably manage groundwater resources, Chippewa County has taken a proactive approach. In 2012, the county commissioned the Wisconsin Geological and Natural History Survey (WGNHS) and the United States Geological Survey (USGS) to conduct a 5-year study of groundwater resources in western Chippewa County (fig. 1).

The goal of the study is to answer two important questions:

1. How does pumping of high-capacity wells (wells capable of pumping more than 70 gallons of water per minute) affect water levels in nearby wells and flows in streams today?

2. How might changes in pumping rates, placement of new high-capacity wells, and changes to the landscape affect wells and streams in the future?

To answer these questions, scientists at the WGNHS and USGS will prepare

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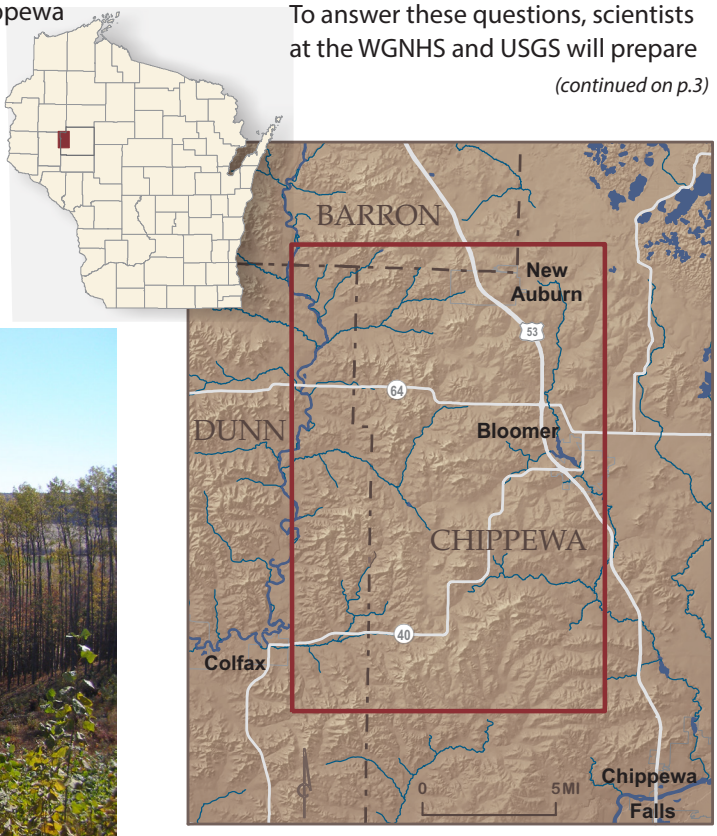


Figure 1. Map of the study area in western Chippewa County.

UW Extension

WATER FLOW BASICS

Due to the focus of this study, it is important to learn some of the terms that are commonly used to describe groundwater systems. Familiarity with these terms will aid in understanding the issues involved. This section briefly explains a few key concepts.

Water cycle. The water cycle describes the movement of water from the air to the earth's surface, down into the ground, and back again (fig. 2). In the cycle, water reaches the land surface as precipitation (rainfall and snowmelt). Some of the water flows downhill in streams or as runoff, some seeps into the ground to become groundwater, and some goes back into the atmosphere through evaporation and transpiration through plants. Eventually the water returns to the atmosphere to begin the cycle again.

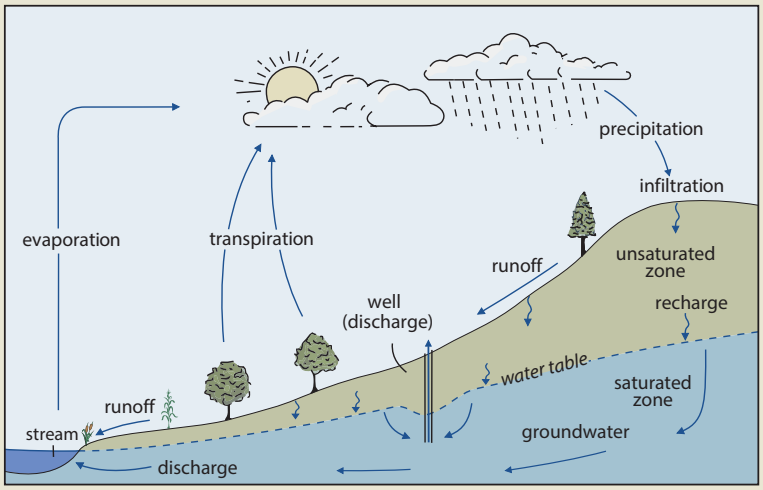


Figure 2. Water cycle.

Saturated zone and water table. The saturated zone is the area where all of the empty spaces and cracks in the ground are filled with water. The top of this zone is called the water table. Water that infiltrates to the saturated zone is called groundwater; it continues to flow, generally very slowly, until it eventually discharges to lakes and streams in areas of lower elevation, or to wells (figs. 2 and 3).

Recharge. Water that reaches the water table is called recharge (fig. 2). Recharge replenishes groundwater that flows to wells, streams, lakes, springs, and wetlands. The amount of recharge an area receives depends on the amount and timing of precipitation, temperature, type of land cover, topography, and soil type. Large changes to the landscape, such as that caused by industrial sand mining and subsequent changes to how the land is used may change the amount of water that becomes recharge.

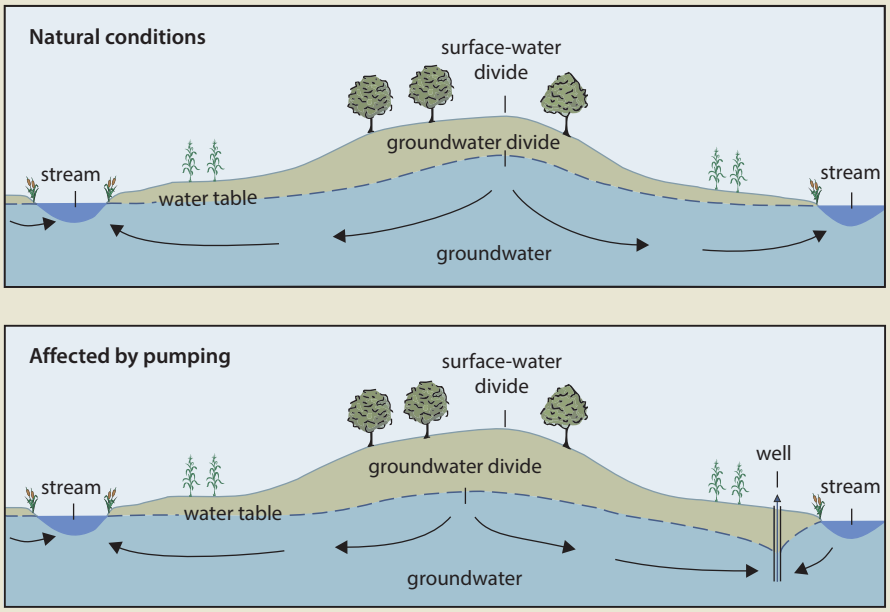


Figure 3. Groundwater flow under natural conditions and with pumping.
Source: *Adapted from USGS Water Resources Investigations Report 00-4008.*

Groundwater discharge. Groundwater can leave the subsurface through discharge to surface water or wells. Discharge to streams and other surface water occurs in places where the water table is higher than the elevation of the surface water. If the water table drops due to drought or pumping, water levels can drop in nearby wells, streams, and lakes.

Groundwater divide. A groundwater divide is a "ridge" in the water table that marks the boundary between groundwater basins (fig. 3). Groundwater, like surface water, flows away from divides, replenishing lakes and streams on opposite sides of the divide. Unlike surface water divides, the location of a groundwater divide may move as the water table rises and falls in response to changes in recharge or pumping. Shifting groundwater divides may affect the amount of groundwater available to discharge to streams and lakes.

To learn more about these terms, see *Groundwater: Wisconsin's Buried Treasure* (tinyurl.com/wi-groundwater)

computer models of the groundwater system. These models will serve as tools to evaluate the impacts of industrial sand mining and irrigated agriculture on groundwater resources in western Chippewa County both today and into the future.

At the completion of the study, public agencies, resource managers, technical consultants, and other interested parties will be able to answer questions such as "How much will stream baseflow decrease at this location if high-capacity wells are drilled at that location?" and "How might groundwater levels change during peak mining and after mining is finished?"

About the study area

Western Chippewa County (fig. 1) was selected as the study area due to the current and anticipated increased demand for groundwater from industrial sand mines and irrigated agriculture. It is also the headwaters of many high-quality trout streams, which rely on groundwater flow to maintain healthy habitats.

While the study site is focused on western Chippewa County, key insights gained from this study will be of use to communities in western Wisconsin with similar landscapes and geology. The information will help others anticipate what questions need to be answered to most effectively manage their groundwater resources.

About the tools

Hydrogeologists from the WGNHS and USGS will be developing two computer models for the study:

Soil-water balance model. This model simulates the infiltration of precipitation through the soil and into the groundwater system. Data used to build this model will include land surface elevation maps, soil maps, weather records (daily precipitation and temperature), and the type of land cover. The model will help evaluate how changes to the landscape during and after mining will affect groundwater recharge. It can also be used to simulate the effects of dry or wet years on recharge.

Groundwater flow model. This model builds on recharge estimates from the soil-water balance model. It is used to simulate the flow of groundwater and its connection to surface water. The model will incorporate data about the depth and thickness of geologic layers, locations of wells and their pumping rates, and locations of streams and lakes. It will be calibrated (adjusted) so that simulated water levels and stream flows closely match conditions measured in the field. The model will allow resource managers to anticipate how a proposed new high-capacity well would affect nearby streams, lakes, springs, and existing wells. It will also provide insights on how changes to groundwater recharge might affect stream flow or groundwater levels.

AGRICULTURAL IRRIGATION

Connection to groundwater & recharge

Irrigation is used by growers to ensure a consistent supply of water available to crops for larger yields. Groundwater is the most common source of water for irrigation. Nearly all of the water used in irrigation is used by plants or evaporates and does not return to surface waters or groundwater. It is anticipated that the use of groundwater for irrigation in the study area will increase.

INDUSTRIAL SAND MINING

Connection to groundwater & recharge

The rise in demand for frac sand, used in the production of gas and oil wells in other regions of the United States, has led to the development of numerous industrial sand mines in western Wisconsin.

To extract industrial sand, mining operations in Chippewa County remove the overlying vegetation, soil, and unwanted rock layers (overburden). The overburden materials are set aside in large stockpiles for reuse during mine reclamation. The target sandstone is mined from the side of the hill and crushed to break apart the individual grains of sand.

Water supplied by wells is commonly used to transport, wash, and sort sand at mine sites. Although many sites recycle their water, additional groundwater is regularly pumped to replace water that is lost to evaporation and infiltration.

As mining is completed, the stockpiled materials are used to cover the exposed surfaces of the recently mined land and the site is replanted. The amount of water that reaches the water table (recharge) following reclamation may be different from what it had been prior to mine development for a variety of reasons. Disruption and remixing of the soil and shallow bedrock, changes to the shape of the land, the type of plants present, and final land uses will alter infiltration and may cause recharge to increase or decrease.

Putting the models to work

The models developed for western Chippewa County will be used to demonstrate how the groundwater system behaves today.

The models will also be used to test two hypothetical scenarios—during peak mining and following mine reclamation—to predict how changes in water use or recharge may affect the system in the future.

Both models will be made publicly available for county and state officials, consultants, and industry to perform additional groundwater evaluations.

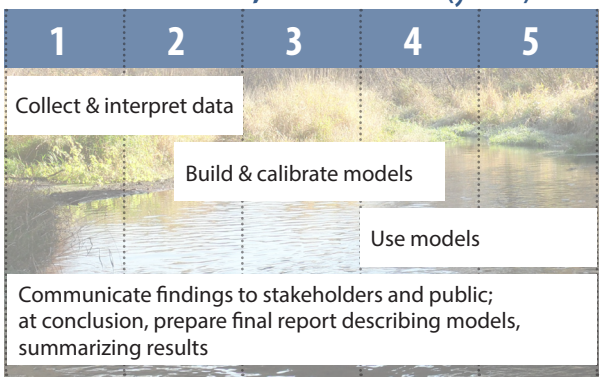
Stakeholders

A stakeholders group was formed to provide technical feedback regarding the study. Stakeholders will participate in annual meetings, collect and supply groundwater data, and help communicate study findings to their representative groups and the general public.

The stakeholders group consists of representatives from the following:

- All industrial sand mining companies in the study area: *Chippewa Sand Company, EOG Resources, Preferred Sands, Superior Silica Sands, Taylor Creek Transit, and West Wisconsin Sand Company*
- Local citizens
- Trout Unlimited
- Wisconsin Department of Natural Resources
- Wisconsin Farmers Union

STUDY TIMELINE, 2012–2017 (years)



More information

To learn more about the study, visit co.chippewa.wi.us/lcfm and click on the tab "Chippewa County Groundwater Study." PDFs of the study proposal, presentations, and this fact sheet are available on this page.

Specific questions about the study

- **Mike Parsen**, hydrogeologist, Wisconsin Geological and Natural History Survey (mjparsen@wisc.edu, 608-262-9419)
- **Dan Masterpole**, county conservationist, Chippewa County Department of Land Conservation and Forest Management (dmasterpole@co.chippewa.wi.us, 715-726-7920)

Background information

Agricultural irrigation: U.S. Geological Survey, ga.water.usgs.gov/edu/wuir.html

Groundwater and land-use planning: UW–Extension Center for Land Use Education and U.S. Geological Survey – Wisconsin Water Science Center, wi.water.usgs.gov/gwcomp

Groundwater and geological maps and publications: Wisconsin Geological and Natural History Survey: WisconsinGeologicalSurvey.org

Industrial sand mining and regulations: Wisconsin Department of Natural Resources, dnr.wi.gov/topic/mines/silica.html (includes link to a comprehensive report on silica sand mining)

State regulations regarding water use and wells: Wisconsin Department of Natural Resources, dnr.wi.gov/topic/groundwater

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