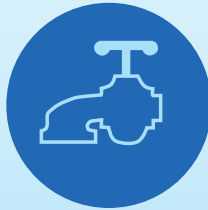


Groundwater:

Powering Wisconsin's Economy



Powering Wisconsin's economy

Walking on water

Below your feet, at this very moment, lies one of Wisconsin's most valuable resources: **groundwater**! Every day we rely on clean, abundant supplies of groundwater for the water we drink, use to grow our food, boat on and fish in. It powers our economy, sustains fish and wildlife habitat and keeps us healthy. We may not be able to see the groundwater beneath our feet but the environment and our quality of life depend on how we take care of this valuable and limited resource.

Wisconsin is continuously making progress in groundwater protection by improving our understanding of the science and acting on it through legislation, education and incentive programs for industry, businesses and individuals.

In these pages, you will learn about some of the challenges Wisconsin faces in protecting groundwater and providing clean, safe drinking water to maintain our economy,

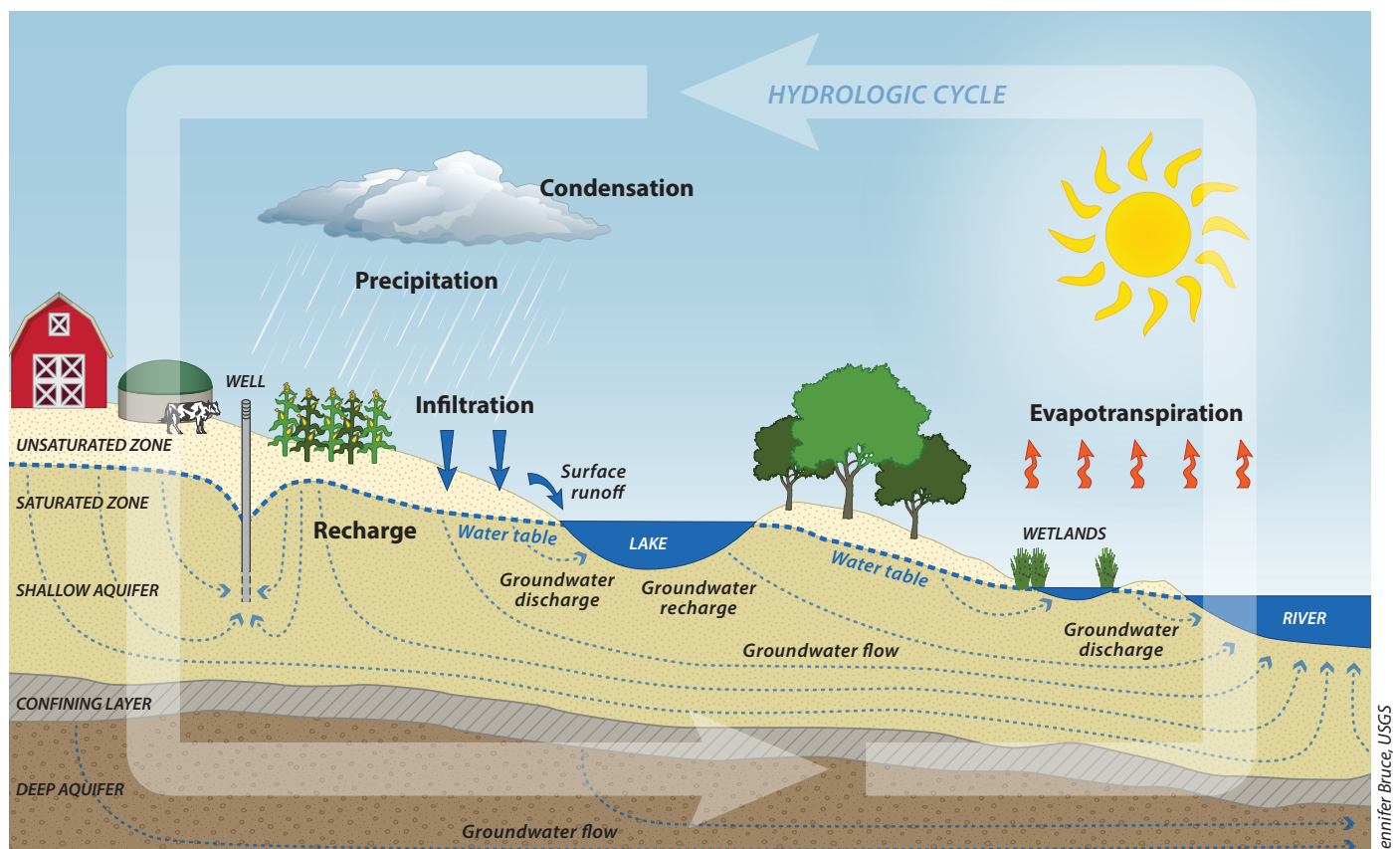
environment and health. You will also read about business owners from across Wisconsin working to understand and manage groundwater in innovative ways. Good stewardship requires more than understanding the science. It requires that agencies, businesses and individuals commit to protecting our groundwater now and into the future.

Water – our most recycled resource

The amount of water on Earth doesn't change over time. The water you drink and that falls as rain today, is the same water that froze in glaciers when mastodons roamed the earth. The distribution of water on our planet does change. Solar energy and gravity move water around the earth in a cycle. Vapor in clouds turns to rain. Once rain or snow hits the ground it either percolates through soils to groundwater or runs off the land to fill surface water bodies like lakes,

streams and wetlands. Groundwater discharges slowly to surface water. Evaporation from surface water or transpiration from plants releases water vapor back into the air where the cycle starts again.

In Wisconsin, the quality and quantity of groundwater varies from place to place. The difference is caused by a combination of geology, rainfall amount and water use. For example, cities and towns in the north central and northeastern third of the state receive the most rainfall but are located above crystalline bedrock, a type of rock notorious for storing and yielding only small quantities of water. There is plenty of rain but finding the groundwater to supply cities in this area can be difficult. In the central part of the state, you can drill a well in permeable sandstone and get plenty of water for homes and manufacturing but you have to keep an eye on quality due to the nature of the soil.

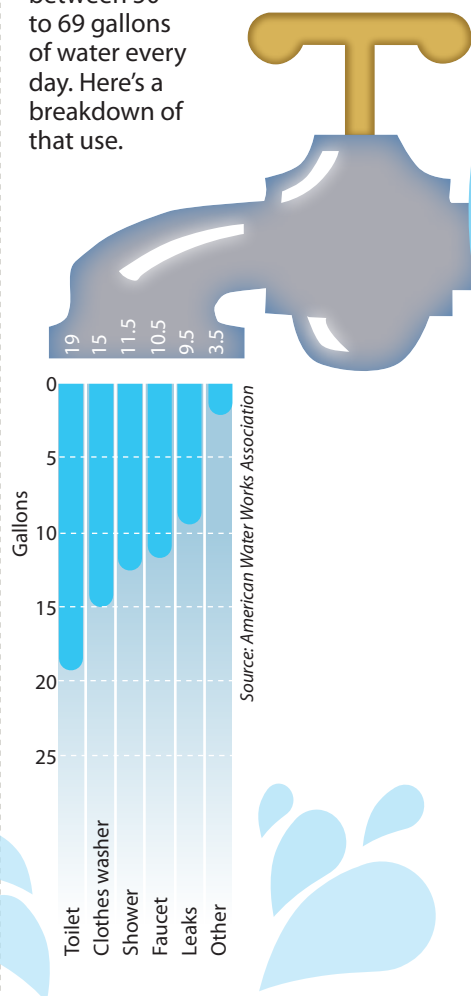


Jennifer Bruce, USGS

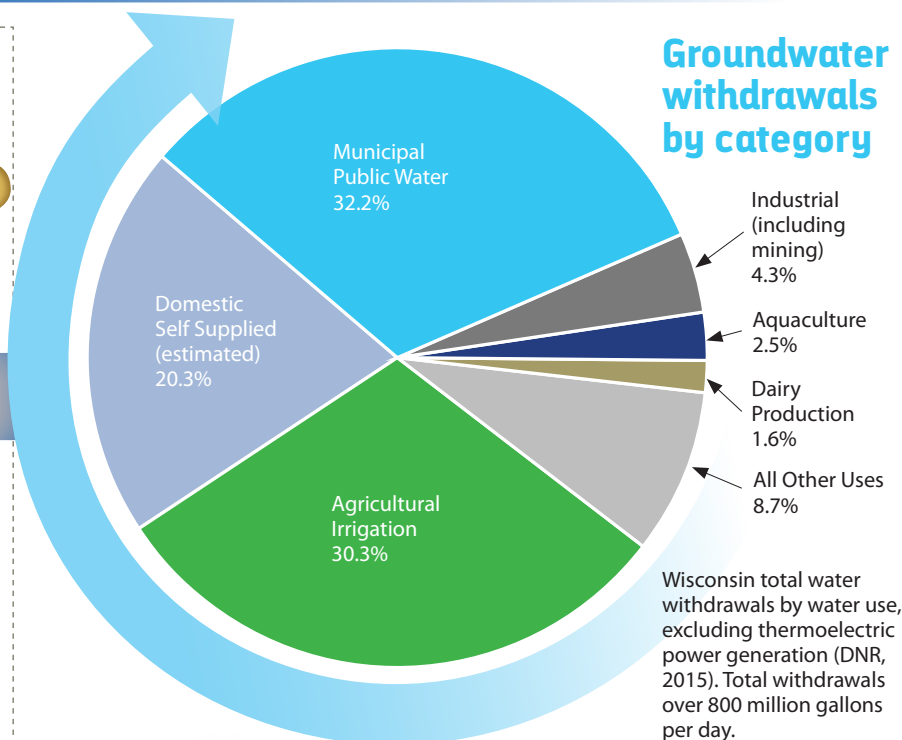
Groundwater by the numbers

Personal water use

Each of us uses between 50 to 69 gallons of water every day. Here's a breakdown of that use.



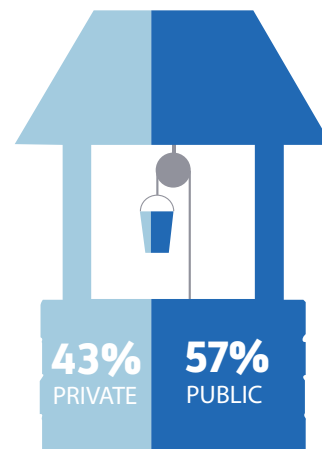
Groundwater withdrawals by category



294 ft.

Drinking water use

Over 67% of Wisconsin residents get their drinking water from groundwater, either from private or public wells.



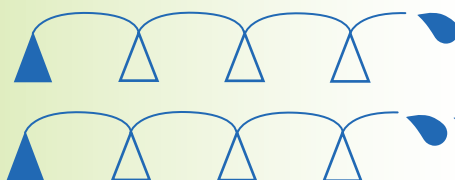
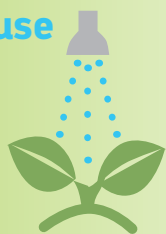
If you were to take all of the groundwater in Wisconsin and pump it to the surface, the entire state would be 100 feet under water and one-third of the state capitol building would be submerged.

100 ft.

Agricultural use

97%

of irrigation water comes from groundwater.



In 1964, there were 62,000 acres of irrigated land in Wisconsin.

In 2012, there were 473,000 acres of irrigated land in Wisconsin.

Powering Wisconsin's economy

Wisconsin's economy and groundwater

Groundwater is vital to Wisconsin's economic health. Some of our most important industries — cheese making, fruit and vegetable processing, dairy farming, meat processing and brewing — require clean, abundant groundwater to make the goods that make Wisconsin famous. Other businesses, like restaurants, water parks and resorts, need this valuable resource as well.

In Wisconsin, groundwater makes up more than one-third of the water used for commercial and industrial purposes. Groundwater also sustains all of the state's lakes, rivers and streams whose shores and waters draw visitors from near and far. This makes groundwater a silent but important partner in Wisconsin's economy.

Read on for profiles of industry leaders and how they are conserving and protecting groundwater.

Groundwater sustains Wisconsin's lakes, rivers and streams, drawing visitors from near and far.



Dairy farming is just one of Wisconsin's important industries that rely on clean, abundant groundwater and accounts for 1.6% of total withdrawals.

Dairy Business Association



DNR Files



Groundwater beneath our feet keeps us healthy, sustains fish and wildlife habitat, helps grow our food and powers our economy.

Will Allen



Tom Porter, Lake Louie Brewing

"Water is at least 98 percent of every beer made," says Tom Porter, owner of Lake Louie Brewing in Arena. Put another way, "quality water is essential to producing quality beer."

At Lake Louie, good stewardship of water resources just makes sense. Porter explains, "We here at Lake Louie are not on a city well or city sewer. All of the water needed to make Lake Louie beers comes from the groundwater directly beneath the brewery property. My home is also on the property, so all of the domestic water also comes from a private well. If we don't do a good job of keeping the water supply clean, it not only affects my business, it also affects my personal water usage. Can't get much more important than that!"



Photo courtesy of Lake Louie Brewing

Improvements in the brewing industry mean it now takes as little as 4 or 5 gallons of water to make 1 gallon of beer.

For a state that has nearly 150 breweries and produces over 10 million barrels of beer each year, that adds up to a lot of water. But the water you drink is not the only water needed to make that draft. Growing grains, pasteurizing, cleaning kettles — water is used every step along the way.

"The industry standard back in the 70s and 80s was 10 gallons of water needed to produce 1 gallon of beer," says Porter. But thanks to great strides taken by the industry, that ratio is now down to as little as 4 or 5 gallons of water per gallon of finished beer.



Cedar Grove Cheese uses a self-contained ecosystem of microbes, tropical plants, leeches and snails to clean their wastewater.

Photo courtesy of Cedar Grove Cheese

Bob Wills, Cedar Grove Cheese

"I not only want a business that will survive, I want an environment that will survive for my kids," says Bob Wills, owner of Cedar Grove Cheese in Plain. "Clean, drinkable water is absolutely necessary for humans to live."

In the cheese-making process, milk may be the most important

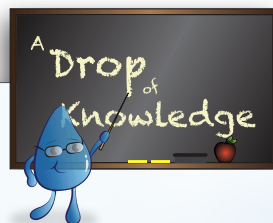
ingredient, but the water used in the process is also a big deal. In addition to the water used during production for cooling the curds, "we do a massive amount of cleaning," says Wills. "Every truck, every tank, pipeline, pasteurizer, all of the equipment, floors and walls need to be cleaned thoroughly every day to maintain a safe environment for food production."

Cedar Grove Cheese could send that wastewater through industrial treatment that is relatively chemical-heavy and energy-intensive. But they have a different solution: a living machine.

"It's a system designed based on how nature would clean water," Wills explains. "So there's a 3-day process in which the water goes through tanks loaded with microbes and tropical plants and some larger animals

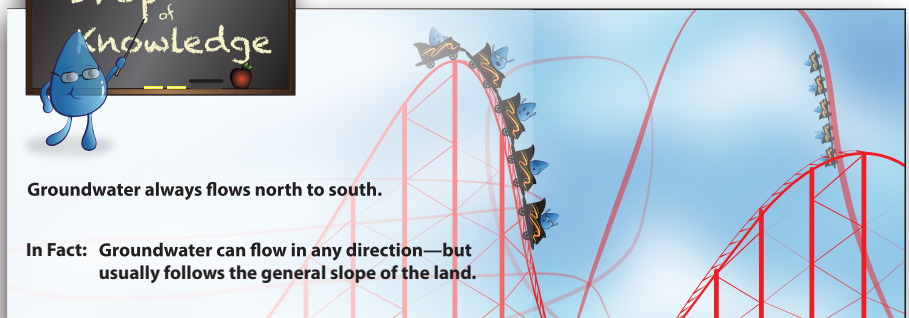
like leeches and snails. These self-contained ecosystems take care of most of the organics and suspended solids."

One of the aspects of this system, Wills appreciates, is the teaching opportunity it provides for employees and visitors alike. "For everybody, what goes down the drain is gone. It's not visible and it's not in their psyche. We have the water coming back and we're able to grow plants and have vegetables, so it becomes more apparent to everybody what the impacts of their decisions are."



Groundwater always flows north to south.

In Fact: Groundwater can flow in any direction—but usually follows the general slope of the land.



Mary Brazeau Brown, Glacial Lake Cranberries

It's no secret cranberries are Wisconsin's No. 1 fruit crop but you might not know another unique fact about the red berry.

"Cranberries were found growing wild here!" says Mary Brazeau Brown, owner of Glacial Lake Cranberries in the Central Sands area of the state. "This is where they're meant to grow."

As the name "Glacial Lake Cranberries" indicates, geology and groundwater are key. "We're on the north shore of the old Glacial Lake Wisconsin," says Brown. "When the glacial lake receded, or emptied, what was left was an area that's very flat with high water tables and acidic, sandy soils."

That is perfect for the native cranberries, as well as for the natural wetlands and upland forests that cover the region.

Brown, like others in the traditional cranberry growing area in the town of Cranmoor, is committed to preserving the natural harmony between cranberries and the rest of the native landscape. Of the 6,000 acres owned by Glacial Lake Cranberries, about 3,000 acres of water reservoirs support 330 acres of cranberry vines. Another 2,200 acres are in a forestry management plan, managed primarily for natural succession and wildlife.

With so much contiguous area devoted to conservation, it is not

surprising the property is teaming with diverse wildlife including trumpeter swans and other migrating bird populations.

"Diversity is stability," Brown says. "There are already naturally existing complementary relationships between flora and fauna and I firmly believe it's my responsibility to perpetuate that."

This sustainable approach is working out for them. At Glacial Lake Cranberries, the native plant has been in continuous commercial production for over 140 years on essentially the same footprint — in what is still considered the heart of America's cranberry country.



DNR Files

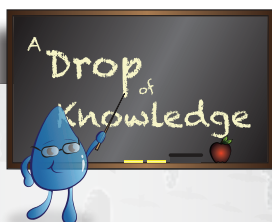
Cranberries are native to Wisconsin and are the state's leading fruit crop, both in acreage and value.

Steve and Andy Diercks, Coloma Farms

According to Andy Diercks, fourth generation potato grower, "Our greatest challenge in the foreseeable future, is one faced by all Wisconsin potato and vegetable growers in the Central Sand area of the state. How can we best protect the water resources we all rely on? Coloma Farms is doing this by implementing practices that conserve water in every possible way."

Like many potato growers in Wisconsin, Coloma is a family farm. Each year eight to 10 different varieties of potatoes are grown on over 700 acres. Crop fields are rotated between potatoes, field corn, soybeans and vegetables. This crop rotation limits pest problems and reduces pesticide use.

"All of our crops are irrigated with groundwater so it is our job to do everything we can to protect it. Our



Groundwater flows in underground caverns and rivers.

In Fact: Groundwater flows through cracks and pores in soil and rocks.



goal is to make the most efficient use of every gallon put through the irrigation systems," says Diercks.

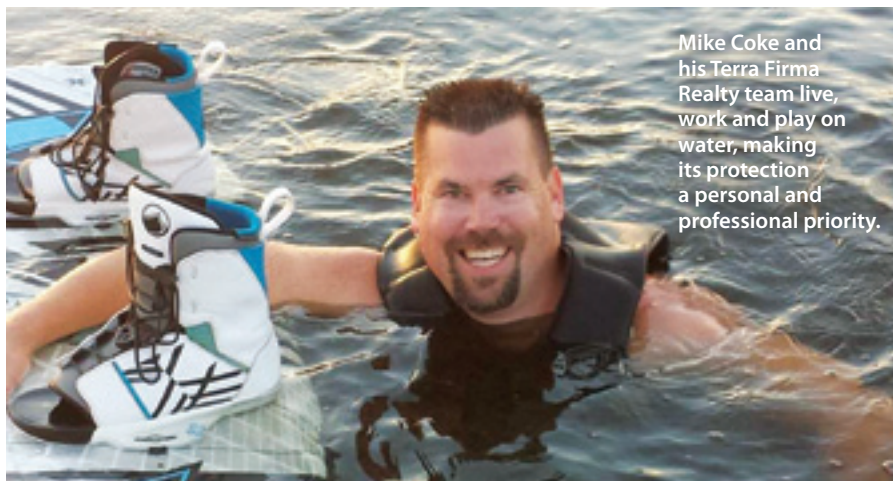
To achieve their goal, they work closely with University of Wisconsin researchers to find ways to use the groundwater more efficiently. A computer-based model, using soil moisture data, makes sure every drop of water applied is needed.

"When the fall harvest is over, our work is still not done," says Diercks. "Farming means finding new and better ways to produce healthy food while balancing the environmental, social and economic challenges we face on the farm. We consider the consequences of our farming practices on the environment, our employees and our neighbors."

Steve (left) and Andy Diercks work closely with UW researchers to find ways to use groundwater efficiently.



Photo courtesy of Coloma Farms



Mike Coke and his Terra Firma Realty team live, work and play on water, making its protection a personal and professional priority.

Photo courtesy of Mike Coke

Mike Coke, Terra Firma Realty

Growing up near the Madison lakes as a water skier on the Capitol City Water Ski Team and an active scuba diver, Mike Coke has always had a passion for water. As the owner of Terra Firma Realty, a real estate brokerage specializing in waterfront properties, he gets to combine this enthusiasm with his other passion: real estate.

Selling waterfront properties requires a different approach than marketing traditional residential real estate.

"We have to reach buyers in Chicago, Milwaukee, Iowa and Minnesota who may be looking to purchase a Wisconsin lake home," explains Coke. Furthermore, those buyers tend to have concerns that are unique to waterfront homes.

"In the residential market for instance, the buyer may have questions about the schools, but our clients are more concerned with the quality of the lake and the fishing or recreational opportunities," says Coke. In Wisconsin, those lake characteristics are often strongly dependent on the quality and quantity of the

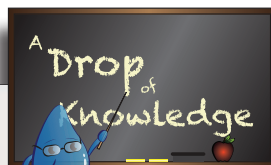
groundwater sustaining them.

This is something the Terra Firma Realty team understands well, since most of them live on a lake themselves.

Coke points out, "We live, work and play on water. Protecting these waters is very important to us for personal and professional reasons."

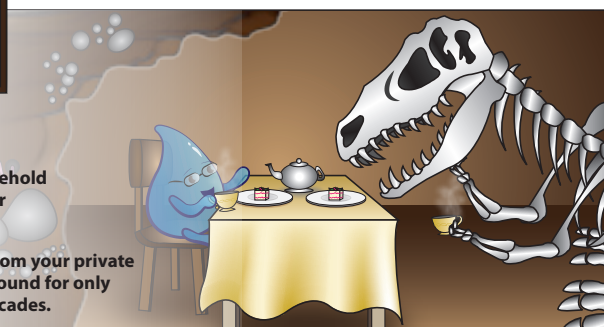
To this end, Terra Firma team members have helped create or lead several area organizations, including the Blue Water Business Consortium, Petenwell and Castle Rock Stewards and the Lake Wisconsin Alliance.

Coke sums up his philosophy in this way: "If we don't reverse the continued degradation of water quality we will lose our precious resource that many of us rely on for our livelihood and personal pleasure. Without change, algae blooms will worsen, our fisheries will be destroyed, wildlife as a whole will suffer, businesses will go belly up and our drinking water will be contaminated. Improving water quality is not just something we should talk about doing, it's something we should act on. It's the right thing to do!"



Groundwater drawn from household wells has been underground for thousands of years.

In Fact: The water you pump from your private well has been underground for only a few years to a few decades.



Challenges and solutions

Bacteria in wells

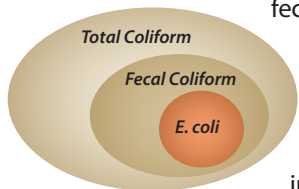
State law requires all new private wells to be tested for presence of bacteria. Well water must also be tested for bacteria following pump work and if a well is inspected at the time of a property transfer. The DNR recommends that private well owners test existing wells for bacteria every year, and whenever there is any change in the taste, odor or appearance of the water.

When a water sample from a private well is sent to a lab for bacteria testing, the lab will analyze the sample for total coliform and *E. coli* bacteria. Coliform bacteria are naturally occurring in soil, are found on vegetation and in surface waters and can be associated with various contamination sources. Most coliform bacteria do not cause illness in healthy individuals, however their presence in well water may indicate the well is at risk to other types of contamination. If your well water tests positive for total coliform bacteria, it is recommended you contact a licensed pump installer or well driller to disinfect your drinking water system.

Fecal coliform bacteria are microorganisms that inhabit the intestines of warm-blooded animals and are typically found in their fecal matter. Consumption of fecal bacteria can cause illnesses having symptoms such as nausea, vomiting, fever, diarrhea and even death.

E. coli bacteria are a subgroup of fecal coliform bacteria (which are a subgroup of total coliform bacteria) that labs routinely test for. If *E. coli* are detected in your well water,

immediately discontinue the use of your water for consumption and food preparation, and contact a licensed well professional to disinfect the system and assess your well's construction for defects that may need repair or replacement. You may also contact the Department of Natural Resources if you would like assistance in identifying the source of contamination. For more information, search on "bacteria in wells" on the DNR website (dnr.wi.gov).



Collaboration in Kewaunee County

Frequent detections of harmful bacteria in private wells led to conflicts between farmers and well owners in karst areas of northeastern Wisconsin. To assess landspreading practices for manure and contamination of groundwater and drinking water wells, DNR along with local, state and federal partners, convened a Groundwater Collaboration Workgroup. The workgroup, made up of farmers, manure applicators, citizens, agricultural and environmental groups, and county, state and EPA representatives, was established to

develop recommendations to reduce risk to groundwater quality and public health in Kewaunee County.

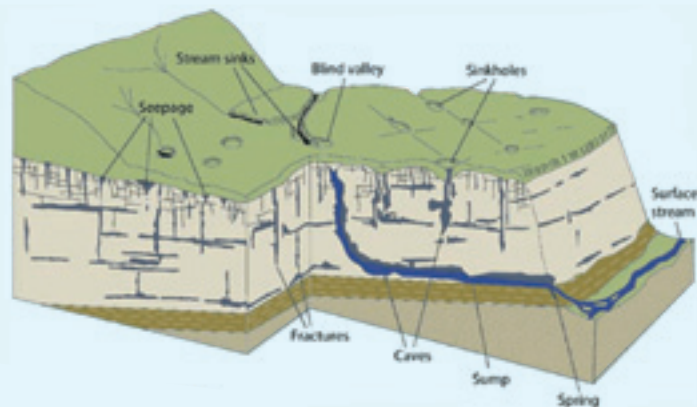
Final recommendations from the workgroup range from law changes to increasing recognition of vulnerable features on the karst landscape. Many of the recommendations can be applied to karst areas across Wisconsin. The DNR is already taking action on some of those recommendations that lie within its authority. The final report can be found by searching on "Groundwater Collaboration Workgroup" on the DNR website (dnr.wi.gov).

Karst topography

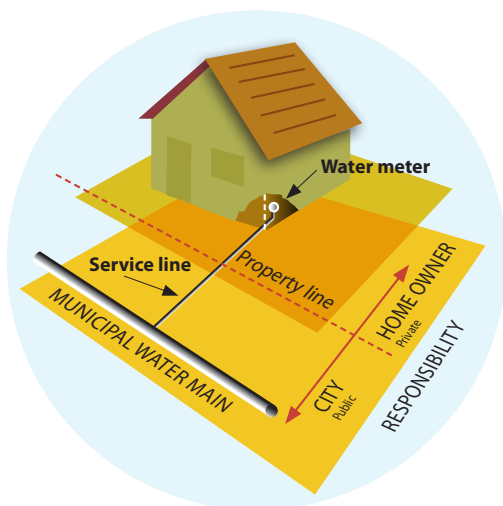
The geologic landscape known as karst has features that make manure spreading in some areas of the state challenging. Karst areas have dolomite and limestone bedrock (referred to as "carbonate" bedrock). Groundwater in karst areas is most vulnerable where crevices in the bedrock are exposed at the surface or where soils are thin and/or permeable. Once contaminants reach cracks in the bedrock they can move very quickly to groundwater.

Karst is formed when groundwater dissolves the carbonate bedrock to form caves and underground channels. When the bedrock is dissolved to the point where it can't support the rock and soil above it, these channels and caves are susceptible to collapse, creating sinkholes and buried sinkholes that give the landscape a bumpy, rough surface.

Wells in karst areas are vulnerable to bacterial contamination because sinkholes and solution fractures provide fast and direct routes from the ground surface, where wastes are applied for treatment, to groundwater sources of drinking water. Bacterial contamination of wells may occur without telltale changes to the color or taste of the water. For more information on testing your water and protecting your private well, please see the section entitled "How safe is my water?"



- "Karst" is a landscape created when water dissolves rocks.
- In Wisconsin, dolomite and some limestone are typical water-soluble rocks.



Lead pipes

Concern about high lead levels in drinking water recently made headlines when young children in Flint, Michigan began showing symptoms of lead poisoning. Lead poisoning can result in damage to a person's brain, kidneys, nervous system, red blood cells and reproductive system. Lead can enter drinking water in three ways: through corrosion of the lead service lines that connect a home to the utility's water main, corrosion of lead plumbing pipes still present in older homes and corrosion of the lead solder that holds together copper pipes and water lines. In Wisconsin, a 1984 law banned lead solder in homes.

Since water utilities cannot use ratepayer funds to pay for work on private property, many lead service lines were not being replaced. In 2015, DNR expanded the use of the Safe Drinking Water Loan Program to include financial assistance to municipalities to help homeowners pay for the replacement of lead service lines on private property. DNR has two years of funding available for this program. In the first year, DNR allocated \$14.5 million to replace lead service lines on private property. Thirty-eight communities applied for and will receive funding. DNR anticipates allocating \$7.5 million for the second year of the program.

For more information on lead pipe replacement, search "Drinking water and lead" on the DNR website (dnr.wi.gov).

How a well works

Wisconsin has had well regulations since 1936 and today is recognized as a national leader in well protection. Well drillers and pump installers must be licensed by the DNR to make sure wells are properly constructed and located.

The figure below shows one of many types of private wells constructed in the state. A pump is set inside a drilled and "cased" well at a depth several feet below the level of groundwater. When the pump turns on, water is drawn into the well through the screen and pushed through pipes to a pressure tank inside the house. The pressure applied by the tank insures pipes will be filled with water when you open the tap. Large municipal well systems work in a similar manner, but at a much larger scale. Large water towers use gravity to provide the pressure needed to make water flow into water mains and finally to service lines connected to homes.

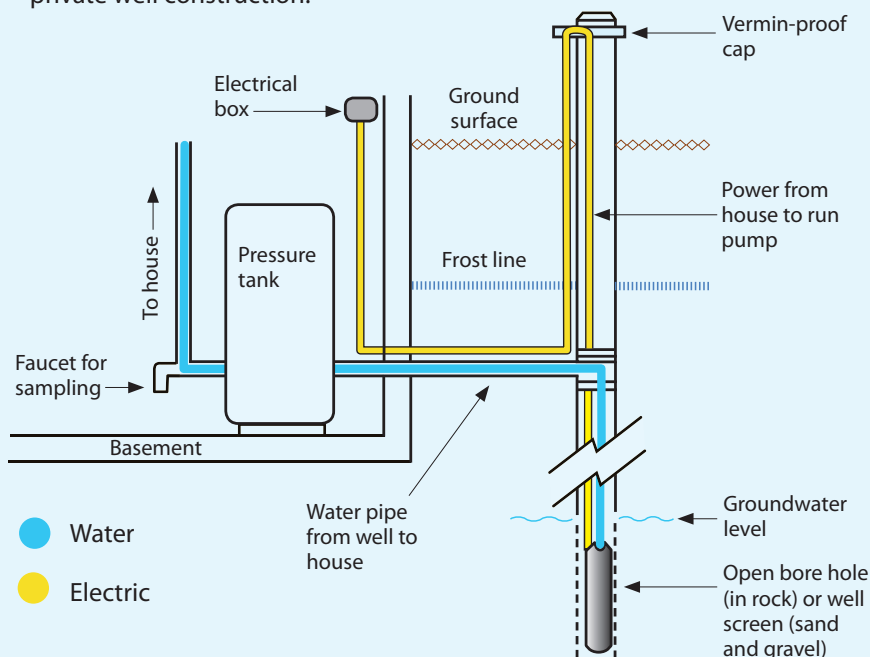
To protect public health, wells must be located far from sources of contamination. For example, a new private well cannot be constructed within 50 feet of an animal barn or within 1,200 feet of a landfill, without a variance.

Your well should be protected from mice, insects and flooding. Check to make sure the well cap is sealed and isn't broken. Make sure the conduit around the electrical wires to the pump is inserted tightly into the cap at the top and extends into the ground below. If your well is located in a pit below the ground surface or in a basement, have it inspected by a pump installer to make sure it is sanitary and safe from flooding. For more information on rules governing wells, check out the DNR website (dnr.wi.gov), search "private well construction."



Marty Nesman, WDNR

A properly constructed and maintained well has a vermin-proof cap and is located far from sources of contamination.



How safe is my water?

Many Wisconsinites, urban and rural, are concerned about the quality of the water they drink. If your water is supplied by a community public water system, the utility must complete a Consumer Confidence Report every year. The report includes information on the source of your drinking water, the treatment used to purify water, any contaminants that have been found in the system and the potential health effects of those contaminants. To find the Consumer Confidence Report for your water utility, search "Consumer Confidence Report" on the DNR website (dnr.wi.gov).

Private well owners should have their wells tested annually for bacteria and nitrate or if the color or odor of the water changes. Public and private certified laboratories test for contaminants such as bacteria, nitrate, pesticides and petroleum components. For more information on well testing, search "Test your private well water annually" on the DNR website.

If you notice changes to your private well water, use the checklists below to identify the symptoms. Then search "What's wrong with my water?" on the DNR website and click on the symptom. You'll get a detailed, printable explanation of the likely problem and how to fix it.

List of water symptoms

SYMPTOMS ABOUT SMELL AND APPEARANCE

MY WATER SMELLS

- ☐ Like manure
- ☐ Like gasoline
- ☐ Like rotten eggs
- ☐ Like sewage
- ☐ Like natural gas
- ☐ Musty
- ☐ Like a bog or swamp
- ☐ Like solvents or paint thinner
- ☐ Like fuel oil or diesel fuel

MY WATER APPEARS

- ☐ Rusty or red
- ☐ Cloudy
- ☐ To have white flakes
- ☐ Sandy or gritty
- ☐ Yellow
- ☐ Foamy
- ☐ Bubbly
- ☐ To have an oily or rainbow sheen

MY WATER STAINS

- ☐ Plumbing fixtures red or brown
- ☐ Plumbing fixtures blue or green
- ☐ Plumbing fixtures black or brown
- ☐ Laundry black
- ☐ Laundry red or brown

SYMPTOMS ABOUT TASTE AND FEEL

MY WATER TASTES

- ☐ Metallic
- ☐ Salty

MY WATER FEELS

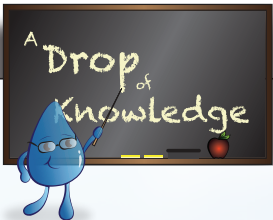
- ☐ Gritty
- ☐ As if it burns
- ☐ Like soap won't lather

MY WATER

- ☐ Spots my dishes
- ☐ Leaves slime in toilet tank
- ☐ Has changed in color, taste or odor

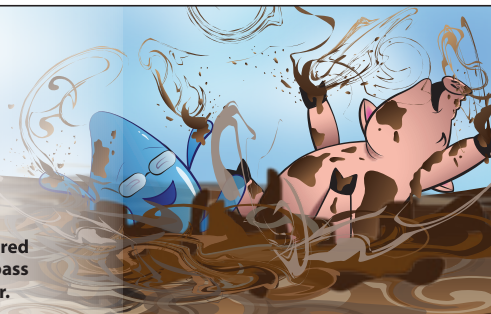


Thinkstock



Groundwater is always safe because soil filters out all impurities.

In Fact: Harmful bacteria in water *can* be filtered out by soil, but many chemicals can pass right through and reach groundwater.



Our shared resource

Groundwater protection isn't just the right thing to do, it protects your family and pets from accidental poisoning and exposure to hazardous chemicals. Your home will be safer and more attractive inside and out. Wildlife habitat and trout streams benefit when groundwater is conserved and protected. We all have a stake in protecting groundwater quantity and quality. You can do that in three ways: Prevent harmful substances from contaminating groundwater and surface water, keep water local by letting it soak into the ground where it falls and use water wisely. Water conservation is smart and saves you money. Groundwater protection is for everybody. To learn more about protecting our water, search "Better Homes and Groundwater" on the DNR website (dnr.wi.gov).



Anne Bartels, Education Specialist,
Marinette County Land & Water Conservation Division



Len Harris



DNR Files



UW-CALS

Good stewardship of Wisconsin's groundwater requires commitment from government, businesses and individuals now and into the future.



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Authors:
Carolyn Voter and Eric Verbeten

Editors:
Natasha Kassulke, Kathy Kahler and
Carlyn Brown

Contributors:
Mel Vollbrecht, Adam Freihoefer,
Kyle Burton, Liesa Lehman, Cathy
Wunderlich, Robin Schmidt, Dorie Turpin
and Laura Chern

Graphic design:
Thomas J. Senatori

Graphic design contributors:
Eric Verbeten and
Benjamin Pierson

Water drop graphics:
Kayleigh Oreschack

Printing:
Schumann Printers

