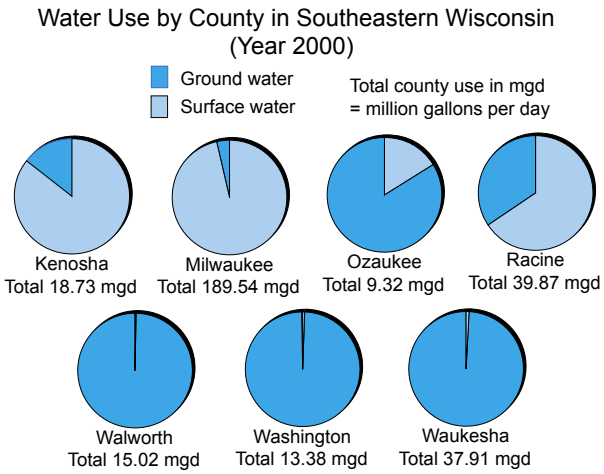
OUR WATERS

The waters of Southeastern Wisconsin are vast but vulnerable.
We depend on our waters for drinking water, irrigation, industry, transportation, power production, recreation and scenic beauty.
Understanding our region's water-related issues and future challenges can help us protect clean, abundant water for generations to come.

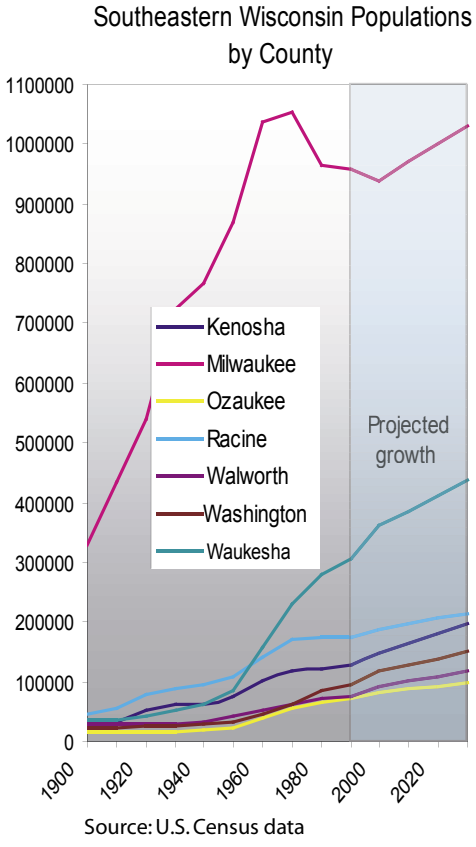
Regional Water Supply

Ground water provides drinking water, irrigation for crops and water for industries. It is also connected to surface waters, and maintains the flow of rivers and streams and the level of wetlands and lakes. Communities in Southeastern Wisconsin first tapped aquifers nearly 150 years ago. With the exception of those along Lake Michigan, most communities, farms and industries still rely on ground water wells for their water supply.



Source: Southeastern Wisconsin Regional Planning Commission and U.S. Geological Suvery data

The seven counties of our region cover five percent of Wisconsin's land area, but are home to more than a third of the state's residents. We are already straining our ground water supplies, and populations across our region, along with water demands, are projected to rise in coming decades. Much of the growth will occur in ground water dependent suburbs like those in Waukesha County.



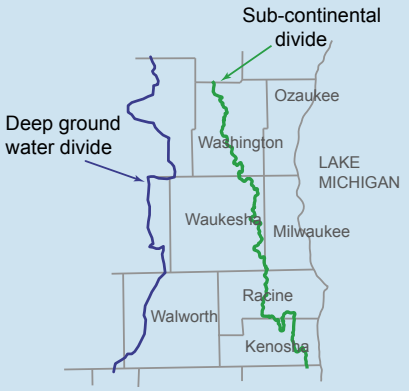
Source: U.S. Census data

Ground water is a hidden resource. We don't see the impacts of our wells and water use, so we have managed ground water as though it is infinite and disposable. Most of us water our lawns or run the tap until our water is hot without a second thought. And many communities practice "pump and dump" ground water use. In these systems ground water is pumped to residents' taps, showers and toilets. After one use, the water runs down the drain, is treated, and is dumped into rivers that flow out of our region. Although rain and snowmelt seep underground to replenish ground water, we are using it too fast for nature to keep up.

Water Talk

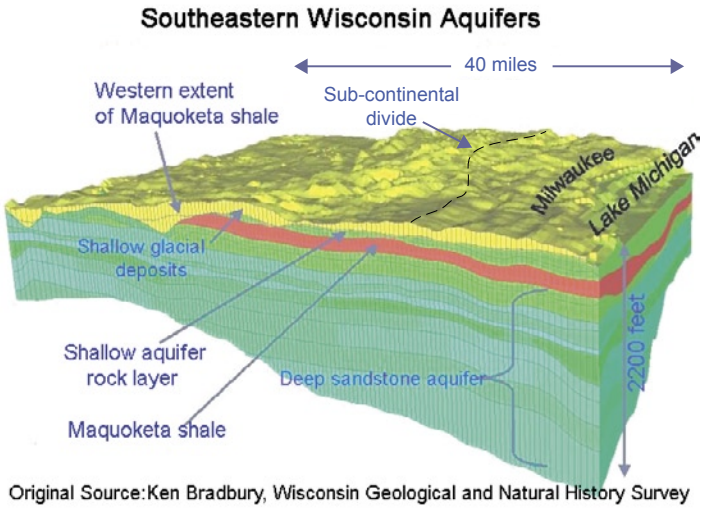
A few basic terms can help us understand regional water issues:

- An *aquifer* is an underground storage area that holds water in layers of porous rock or sediment.
- A *watershed* or *basin* is an area from which all surface waters (rivers, streams and runoff) flow toward the same river, lake or ocean.
- *Recharge* or *replenishment* is water added to an aquifer by rainfall, snowmelt, or exchange with surface waters.



- The *sub-continental divide* is a subtle ridge that separates two important watersheds. East of the divide surface waters flow to Lake Michigan; west of the divide they join tributaries to the Mississippi River.
- The *deep ground water divide* is the underground boundary that marks whether ground water flows through, or is stored in, aquifers to the east or to the west.

Ground Water Basics



Original Source:Ken Bradbury, Wisconsin Geological and Natural History Survey

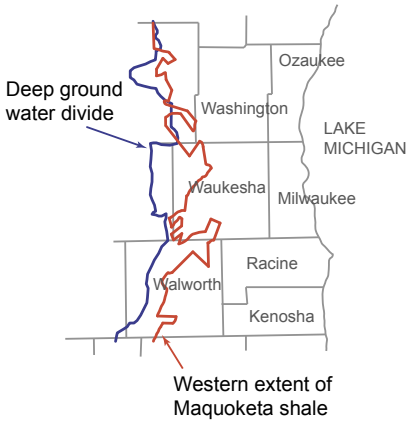
Our region pumps ground water from two main aquifers:

•The ***shallow aquifer*** is made up of sand, gravel and clay left behind by glaciers. In some areas it includes an under-layer of rock.

•The ***deep aquifer*** is made up of thick sandstone layers. This aquifer extends as far as 2000 feet underground.

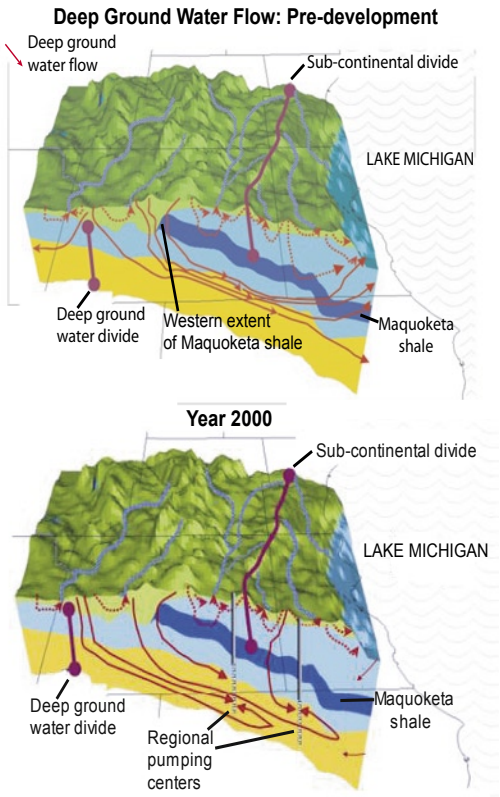
In the western edge of our region, these aquifers are connected. Rainwater that seeps underground cycles freely between them. After circulating for a few decades or centuries it is drawn in by a well or flows into a local lake, stream or wetland.

In most of our region, however, a thick sheet of rock called the Maquoketa shale separates the two aquifers. It restricts flow down from the shallow aquifer, so ground water enters this part of the deep aquifer from beyond the shale's western edge. The shale layer also slows movement in the deep sandstone. It can take ground water thousands of years to flow a mile under the shale, so the water supply in the deep aquifer is very slow to replenish.



Changes Underground

For over 10,000 years, water in our deep aquifer has been creeping steadily east to Lake Michigan. As we pump ground water out of the deep sandstone, however, surrounding waters must flow in to replace it. In just 150 years of pumping we have rerouted deep ground water and altered age-old flow.



Original Source: "Ground Water in the Great Lakes Basin: the case of Southeastern Wisconsin," Feinstein and others, at http://w ater.usgs.gov/glpf/cs_pmp_src.htm

Our wells have increased the flow of shallow ground water down to the deep sandstone. This reduces the natural ground water flow to lakes, streams and wetlands.

Intense pumping has shifted the natural deep ground water divide ten miles west. From this newly gained territory, ground water that would have fed streams flowing toward the Mississippi River is diverted toward our wells.

We have also reversed deep flow east of our wells. Deep ground water that has spent millennia following eastward is backtracking toward our pumping centers, the largest of which is in eastern Waukesha County. This has eliminated deep ground water flow from our region to Lake Michigan. Losing this small ground water contribution won't impact the lake, but it marks a dramatic change in regional flow.

Where does our water come from?

Most municipal and industrial wells in our region tap the deep sandstone aquifer, although Ozaukee and Washington Counties pump mainly from shallow aquifers.

The water we pump from the deep aquifer did not come from Lake Michigan. Your glass of ground water started its journey to your tap during the last advance of Pleistocene Ice, over 12,000 years ago. It seeped under the obstacle of the Maquoketa shale miles west of our wells, in western Waukesha or Walworth County, or eastern Dodge or Jefferson County.

From there it flowed slowly east. Several millennia of slow flow later, it was drawn in to your municipal well.

The Ground Water Deficit

Managing our water supply should be similar to managing money. Most of us don't question the need to budget according to our income, or save money for the future. With water, however, we've forgotten these basics.

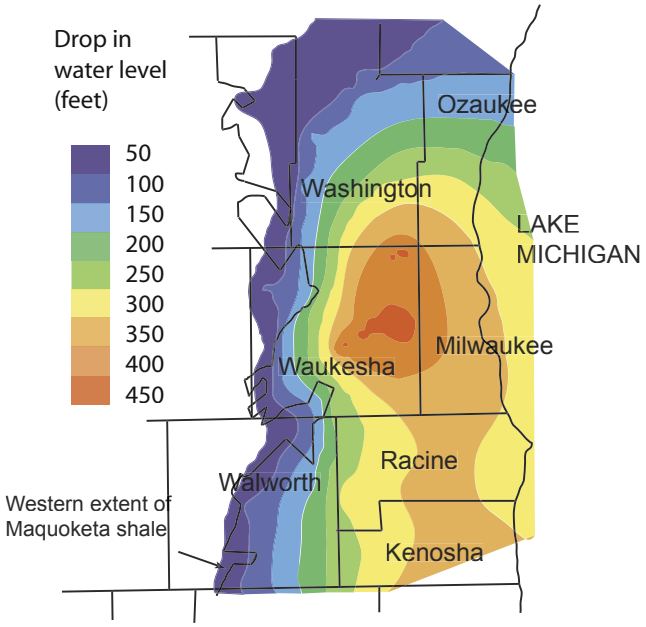
Think of the deep sandstone aquifer as a bank account we draw from to meet our daily needs. Our income is rain and snow that seeps underground and beneath the western edge of the Maquoketa shale to replenish these assets. As a region, we have been withdrawing groundwater much faster than our income is deposited. Each year we draw the balance – the water level – in this account down about seven feet. We are living beyond our means, pumping deep ground water without accounting for its slow replenishment.

We have created a serious deficit. Water levels in the deep aquifer have declined across our region. This makes pumping more costly and long term supplies uncertain. Under eastern Waukesha County, the location of today's greatest pumping, our withdrawals have outstripped our income by so much that water levels have fallen 500 feet.

Can we learn to budget water?

Scientists from the United States Geological Survey (USGS), the Wisconsin Geological and Natural History Survey (WGNHS) and University of Wisconsin-Milwaukee (UWM) have created a computer model that predicts impacts of our pumping on regional ground water and surface water supplies. Now the model is being put to use by Southeastern Wisconsin Regional Planning Commission (SEWRPC) to develop water management recommendations for our area, and by UWM scientists to help individual communities budget their ground water.

Water Level Declines in Deep Aquifer
Year 2000



Original Source: Wisconsin Geological and Natural History Survey Open-File Report 2004-1

Managing Ground Water For the Future

The choices that communities make to meet radium standards and reduce deep aquifer dependence will affect our regional supplies.

The choices include:

- Treating deep well water for radium
- Replacing deep well water with Lake Michigan water
- Replacing deep well water with water pumped from the shallow aquifer
- Blending deep well water with shallow well water to meet radium standards and allow deep aquifer recovery
- Applying science-based choices or combinations of the options above based on the water needs and resources of specific communities

It is a critical time for water management in Southeastern Wisconsin. Rising populations and concerns about natural radium and the ground water deficit in the deep aquifer are pushing communities to find new water sources. Some regional communities have taken temporary measures to bring their water supplies into compliance with EPA radium standards, but must still develop plans to meet the standards in the long term.

The water management choices made by each regional community affect our shared waters. It is important for communities to avoid rushing into short term fixes. If new sources are exploited without researching long term consequences, our aquifers, our streams and wetlands, and Lake Michigan are at risk.

Evaluating Choices

• Treating deep well water for radium

Continuing to over-pump deep aquifers may threaten water quality. Some communities will be able to budget deep ground water to meet their long term needs and treat their supply for radium. But communities that continue to over-consume will further deplete water levels in the deep sandstone. With continued deep ground water use in eastern Waukesha County, for example, USGS predicts water levels will drop another 125 feet before 2020. This severe depletion could allow air into the aquifer and trigger reactions in the ancient, mineral-rich water that release compounds like arsenic into supplies.

- **Replacing deep well water with Lake Michigan water**

Transferring our dependence to Lake Michigan creates long term risks. Since only one percent of Lake Michigan's water is replenished each year, over-exploiting this resource, especially with "pump and dump" practices that cause net loss to the lake, could impact the lake's ecosystem.

Rights to Lake Michigan water are based on geography. In Southeastern Wisconsin, the sub-continental divide marks the Lake Michigan watershed. Areas east of the divide can tap the lake because water that goes down the drain will follow rivers or pipelines back to the lake. Areas west of the divide must use other water supplies.

Current laws require all governors and premiers of Great Lakes states and provinces to approve diversions (transfers across watershed lines) of Great Lakes water out of the lakes' watershed. In late 2005, governors and premiers signed the ***Great Lakes Water Resources Compact*** to strengthen existing resource protection. The Compact bans most diversions and exports of water out of the Great Lakes watershed. It provides a process for communities or counties that straddle watershed boundaries to request a diversion.

Some communities inside the sub-continental divide can replace ground water supplies with Lake Michigan water. Parts of New Berlin and Menomonee Falls, for instance, that lie east of the divide now use lake water which they return through Milwaukee Metropolitan Sewerage District's (MMSD) system.

- **Replacing deep well water with water pumped from the shallow aquifer (which generally meets radium standards)**
- **Blending deep well water with shallow well water to meet radium standards and allow deep aquifer recovery**

For long term supplies, our region can research replacing or supplementing deep aquifer supplies with shallow ground water. Although less water is stored in the shallow aquifer than the deep sandstone, shallow ground water is replenished relatively quickly by rainfall and exchange with surface waters.

Especially for communities west of the sub-continental divide, pumping shallow ground water could reduce deep ground water use and allow the deep aquifer to rebound. The Village of Eagle has replaced deep aquifer supplies with pumping from two shallow wells. Blending shallow ground water with deep supplies, as the Village of Mukwonago does, also dilutes radium levels.

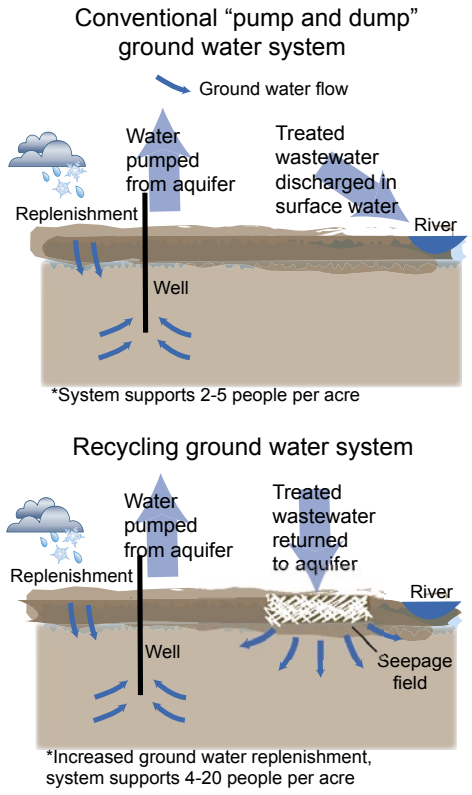
Transferring our needs to the shallow aquifer without adequate research, however, could impact ground water flow to lakes, streams and wetlands, affecting recreation and hunting.

- **Applying science-based choices or combinations of the options above based on the water needs and resources of specific communities**

Our region has valuable tools for developing future water management plants in ongoing research and a computer model that simulates ground water flow. Recommendations from SEWRPC's ongoing Water Supply Study, and UWM's water budgets can help individual communities develop sustainable water use plans. Basing water management on research will aid deep aquifer recovery, protect shallow ground water supplies and preserve natural areas. For communities developing shallow wells, plans may include measures to increase ground water replenishment and select responsible well sites.

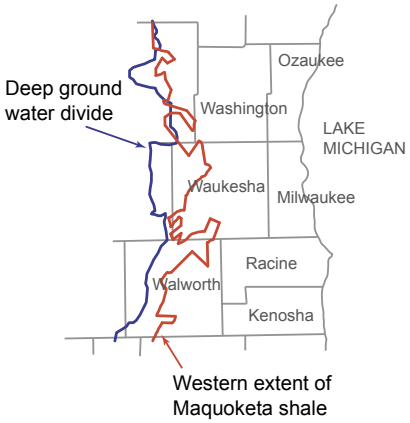
Municipal systems can boost aquifer replenishment by "recycling," returning treated wastewater to the aquifer instead of discharging it to surface waters. Research shows this can double, or potentially quadruple, the people a ground water system can support. Recycling systems are used by private well and septic owners and by communities like Lake Geneva. Communities can also aid ground water recharge by letting stormwater infiltrate underground and by preserving unpaved, open spaces. Home-owners can plant rain gardens to absorb rainfall, and disconnect downspouts so water seeps underground instead of flowing into sewers.

Communities can protect water supplies and surface waters by voluntarily investigating impacts of their planned shallow well sites and pumping rates (state regulations only require environmental assessments for wells within a quarter mile of a trout stream, large spring, or exceptional water resource). The City of Waukesha, Village of East Troy and Town of Richfield are among those that have used digital models or other scientific analysis to predict the effects of proposed new wells.



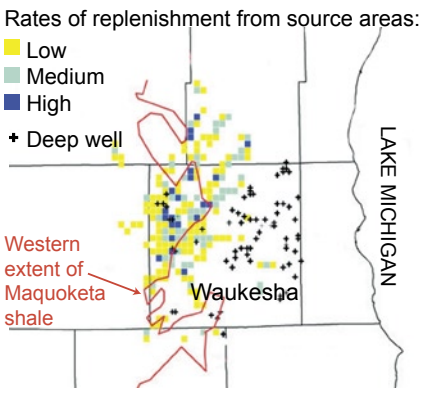
Deep Well Sources

Our region's deep well water can be traced back to a general area, a source strip between the deep ground water divide and the western edge of the Maquoketa shale. Here the deep sandstone aquifer is connected to the shallow aquifer, so replenishment can seep down to the deep aquifer and flow under the shale toward our wells.



Digital models allow scientists to trace the paths of flow to deep wells, here, to those in eastern Waukesha County.

Source Areas For Deep Wells in Waukesha County



Original Source: "Ground Water in the Great Lakes Basin: the case of Southeastern Wisconsin," Feinstein and others, at http://wi.water.usgs.gov/glpf/cs_pmp_src.htm

Key Regional Issue: Waukesha's Water

Faced with growing populations, radium contamination and a ground water deficit, officials in the growing City of Waukesha believe a new water supply will be needed to meet future demands. For now, Waukesha is meeting radium standards by blending supplies from existing deep wells with water from two new shallow wells, and by treating some deep ground water to remove radium.

The city predicts that by 2020 its average water use will rise from 8.2 to 10.3 million gallons per day (mgd), and maximum daily pumping from 13.5 to 17 mgd*. Officials are exploring two main options to replace current sources: a Lake Michigan diversion of 20 to 24 mgd, and the development of western well fields.

Another alternative, proposed by UWM scientists, highlights more efficient shallow aquifer use. This option, called "river bank filtration," is commonly used in Europe. It would involve Waukesha returning some treated wastewater to seepage fields or the Fox River upstream of the city (treated wastewater is now discharged to the river downstream of the city). This would replenish the shallow aquifer or the river's flow, so wells placed along the river (downstream from discharge areas) could supply much of the city's water. This process requires good treatment of both wastewater and well water to avoid quality problems, but it increases the quantity of available water through recycling. Some deep aquifer wells could be maintained to augment the river bank wells in dry weather.

**Source: Waukesha Water Utility website, www.ci.waukesha.wi.us/WaterUtility/Communitygrowthandwaterneeds.html.*

The Great Lakes Compact

The Great Lakes Water Resources Compact would regulate future withdrawals of Great Lakes water, and prohibit most diversions and exports of water out of the lakes' basin. The Compact has been passed in Minnesota, but has yet to be ratified by the remaining states and Congress. Wisconsin has convened a legislative council committee to develop legislation to pass the Compact.

In Southeastern Wisconsin the Compact would limit Lake Michigan water use to areas east of the sub-continental divide. It would, however, establish a process for communities that straddle the divide, or are within counties that straddle the divide, to request diversions.

Since Waukesha County straddles the divide, the City of Waukesha could apply for a diversion. The city would need to prove it has "no reasonable water supply alternative" to lake water, including conservation. And all treated wastewater would need to be returned to Lake Michigan. (The exception to this return rule is the century-old Chicago diversion.)

The city of New Berlin, which straddles the divide, has already applied for 1.83 mgd of Lake Michigan water for parts of the community outside the divide.

Concerns have been raised that the Compact limits water supply options for our region. But while it may regulate which communities can access Lake Michigan water, our region's advanced ground water science can provide a broad range of options to help all communities meet their needs sustainably.

If our region grants new diversions of Lake Michigan water before the Compact is passed or without following its standard process, we could derail this effort to protect the lakes. And if we threaten or oppose the Compact so our communities might gain Lake Michigan water, despite many other options, we will set a risky precedent. It could become hard to deny Great Lakes water to other areas of Wisconsin or Illinois. And as water demands in the High Plains and dry Southwest continue to outstrip supplies, it's not unimaginable that even western states will line up for a drink.

Lake Geneva Gives Back to Ground Water

In Lake Geneva, Utility Commission director Dan Winkler stresses that the city's wastewater utility, which recycles ground water, is not new. It was built in 1985. "What's new," says Winkler, "is that people are catching on." Systems like Lake Geneva's, which return treated water to the aquifer instead of discharging it into surface waters, augment natural ground water replenishment and can stretch regional supplies.

Behind the quaint red brick structure of the Lake Geneva Water Commission is the city's drinking water well field. The population of just over 7,000, which can swell to 30,000 on summer weekends, pumps from four wells less than 200 feet deep in the shallow aquifer. "We've had no problems with water levels, even during drought," says Winkler.

Residents' water flows down the drain to the wastewater treatment facility on the banks of the diminutive White River, a tributary of Lake Geneva that was the city's previous wastewater discharge site. At the treatment facility, standard processes remove debris, break down wastes and clarify the water.

The treated water is pumped to a holding pond at the east end of town and discharged into one of seven adjacent "seepage cells," which look like sunken gravel football fields. The water permeates the sand and gravel, reentering the shallow aquifer about a mile from its source.

The independent Lake Geneva Environmental Agency monitors ground water quality near the seepage cells, testing for a long list of compounds. They have found only elevated levels of chlorides which the city aims to reduce with incentives for home-owners to install efficient water softeners (one source of chlorides in wastewater).

This type of system isn't an option for every community. "You need a porous geological site," Winkler explains, so the water can filter into the aquifer. "And in a highly urbanized environment, you'd have difficultly securing this much land." He estimates Lake Geneva's holding pond and seepage cells cover 30 to 40 acres.

From the gravel fields Winkler says wastewater flows south through the shallow aquifer. The city's wells are northwest of the fields, so residents probably don't drink the recycled wastewater, but this doesn't diminish the benefits of the system. The seepage cells replenish the local aquifer, minimizing human impacts and maintaining ground water levels that feed lakes, streams and wetlands.

A Cross-County Look at Ground Water

Many regions of the United States are dealing with the consequences of ground water mismanagement: declining water quantities and qualities, land subsidence, or settling, in areas of depleted water, and loss of springs, streams and wetlands once fed by ground water.

In Chicago, pumping had reduced deep aquifer water levels 800 feet by 1980. With more use of Lake Michigan water, parts of the aquifer have begun to recover.

The vast High Plains aquifer, which underlies parts of eight states from South Dakota down to Texas, has been pumped intensely for agricultural irrigation. In 1999, water levels in southwestern Kansas, and parts of Texas and New Mexico were 175 feet lower than pre-development levels.

In the early 1900's areas of California's San Joaquin Valley settled 30 feet due to ground water depletion. Less dramatic subsidence around the southwest has left cracks in the earth, damaged buildings, roads and pipelines and increased flood concerns in San Jose, CA, and Houston, TX.

In south-central Arizona, ground water levels have dropped as much as 500 feet, and in parts of California and Nevada, by 300 feet. Much of the Southwest supplements or has replaced ground water with imported surface water, a practice with its own environmental and political issues.

Water levels are declining along the Atlantic coast, and in many areas, saltwater is being drawn into the aquifer to replace what has been pumped. This can contaminate ground water; one county in New Jersey has abandoned 120 wells to saltwater intrusion. Areas are working to improve management with plans that regulate water use and increase replenishment.

The "Our Waters" series is published by the University of Wisconsin-Milwaukee and the Great Lakes WATER Institute with support from the Brico Fund.

Find more information online at **www.glwi.uwm.edu/ourwaters** or e-mail **our-waters@uwm.edu.**

Look for future topics connected to regional water supplies and ground water, including:

- Great Lakes Water Balance
- Diversions of Great Lakes Waters
- Urbanization

Fact sheet updated 04/2007