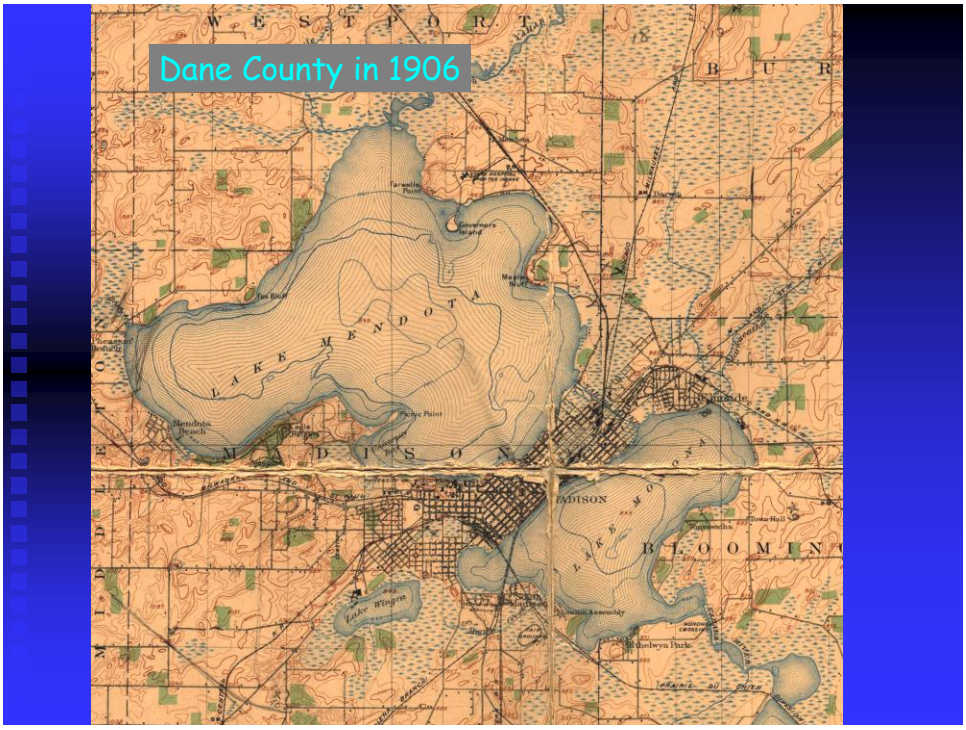
Dane County's Groundwater: Where it comes from, where it goes

Ken Bradbury
Wisconsin Geological and Natural History Survey,
UW Extension

Cooperative Extension
Wisconsin Geological & Natural History Survey



Wisconsin State Journal

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WATER WORRIES

Growth in Dane County communities such as Fitchburg and Verona is lowering groundwater levels and affecting surface waters.

Photo by CRAIG SCHREINER - State Journal

The waters of Pheasant Branch Creek in Middleton would have been threatened by a municipal well near the water tower in the background. As a result, the city decided to build the well elsewhere.

HOUSES GO UP, AQUIFER GOES DOWN

By RON SEELY
rseely@madison.com
608-252-6131

For most of us, getting water is as simple as turning on the faucet.

But for Mike Frey, it's considerably more difficult. Frey, operations manager for Middleton's water utility, is charged with finding water for an ever-growing, thirsty city.

It's a task that has become increasingly more complicated because of the rapid growth that typifies Dane County's suburban communities.

That growth, experts say, means we are making more demands on the deep underground aquifer that supplies drinking water for all municipalities in the county — and affecting the lakes, streams and springs that make this such a pleasant place to live.

While Madison has struggled recently with water quality issues — high levels of manganese in some wells, for example, as well as industrial chemicals beneath the Isthmus — water quality reports from

Please see WATER, Page A4

A section of water main is lowered into a trench by Jeff McGee, holding pipe, and Dave Hunt, working along Targhee Street in Fitchburg. Development in cities such as Fitchburg and Middleton is increasing the demand for water, and that demand has led to noticeable impacts on surface waters such as wetlands and streams.

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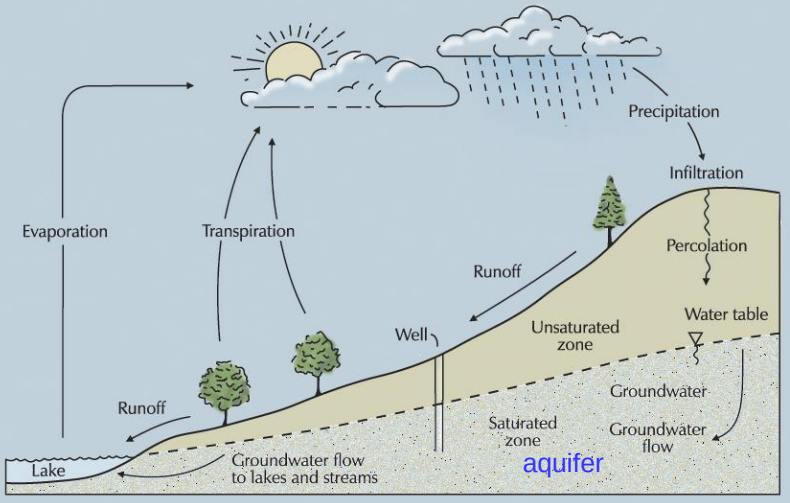
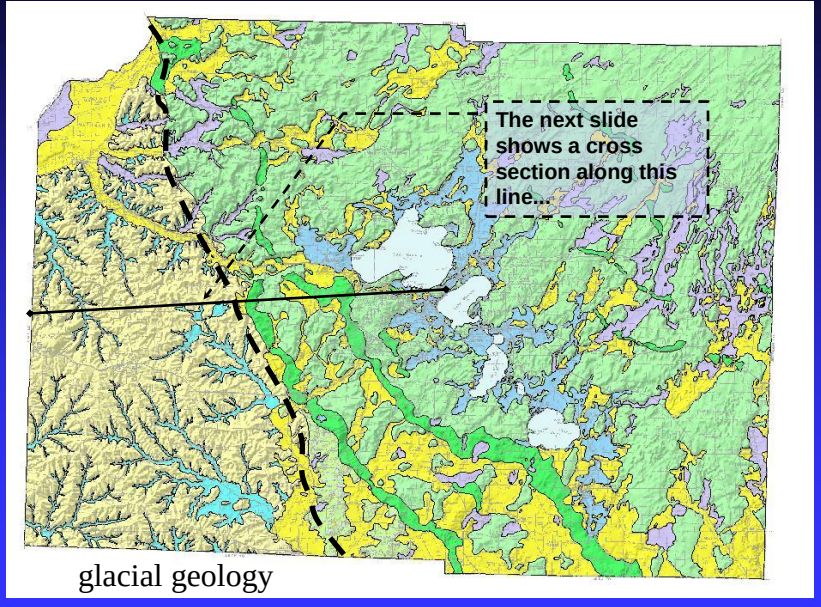
All water is part of the water cycle…



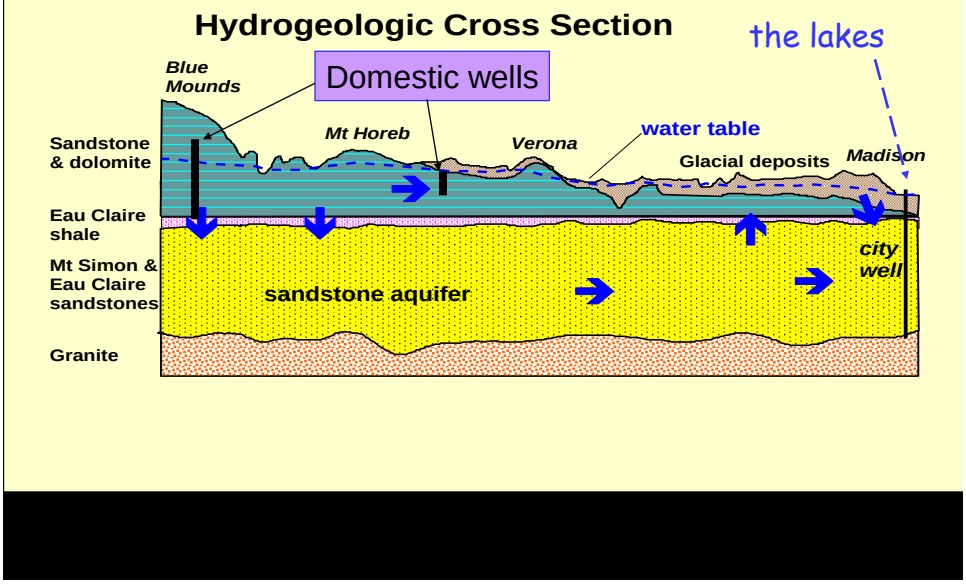
Aquifers are geologic units (sand and gravel, sandstone, etc) that can store and transmit significant quantities of groundwater

Dane County geology...



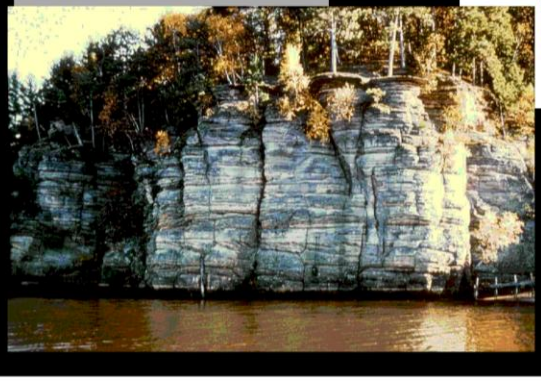
glacial geology

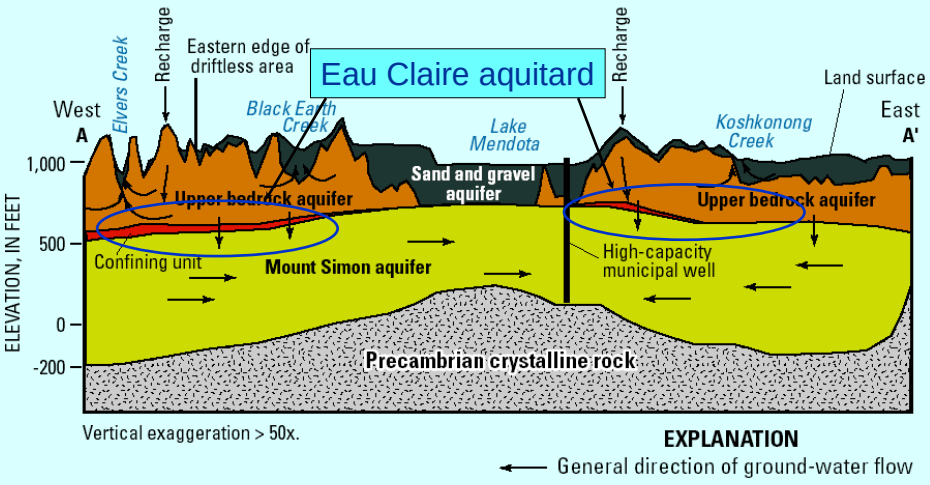
Groundwater moves downward and laterally through Dane County's aquifers...



"Sandstone" aquifer:

-sandstone, dolomite
-regionally extensive
-excellent aquifer
-porous flow
-most high-capacity wells
-occurs beneath shale in east





West-East cross section showing the upper aquifers and the lower (Mount Simon) aquifer. Schematic flow-lines also are included to illustrate the local and regional ground-water flow that occurs in the county.

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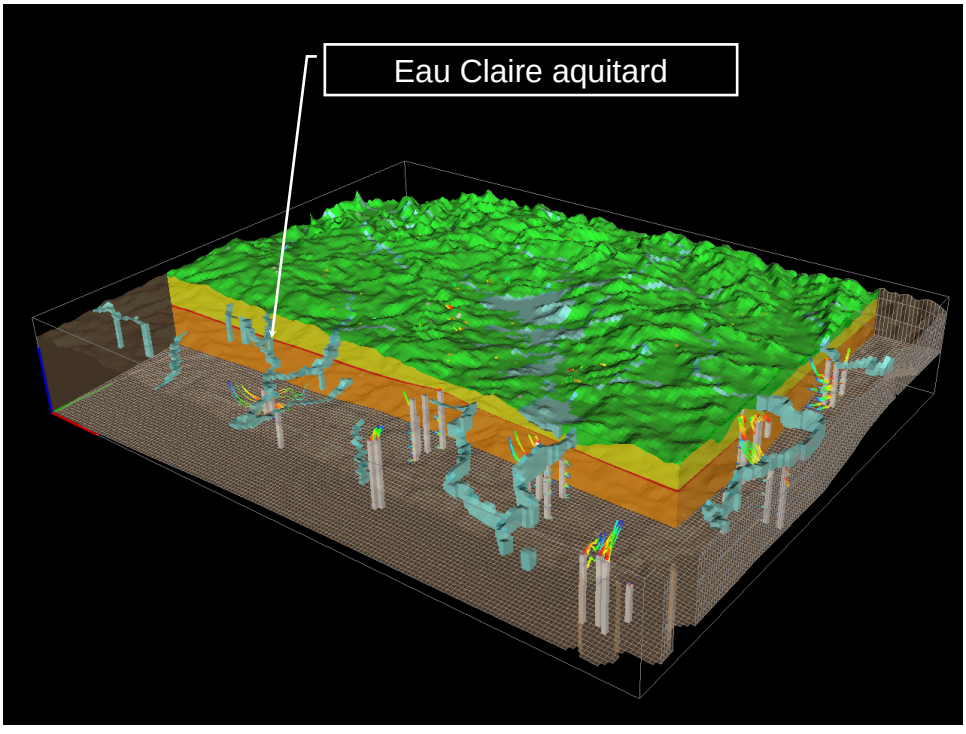
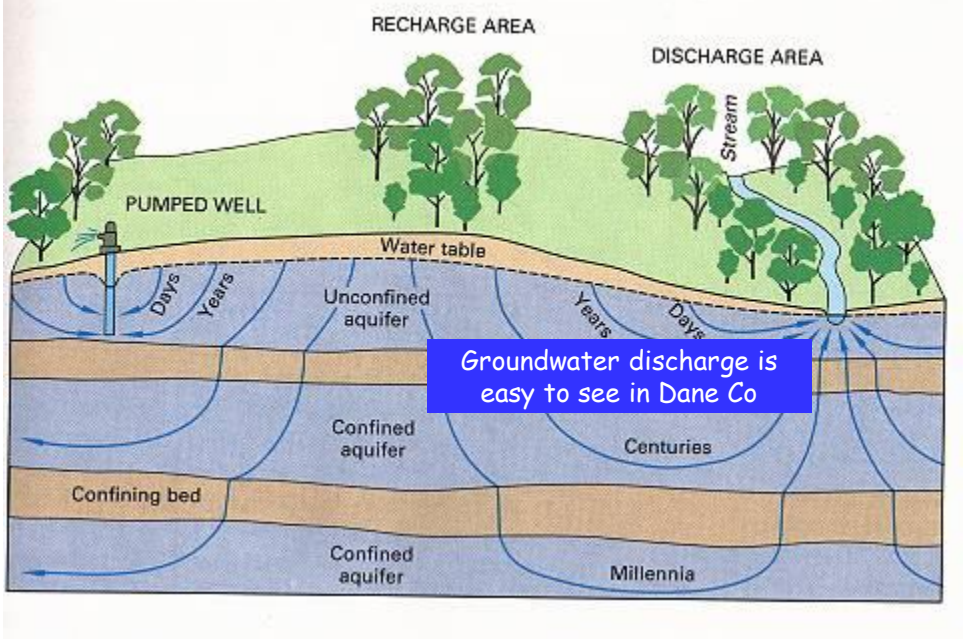


Part of a core of the Wonewoc sandstone

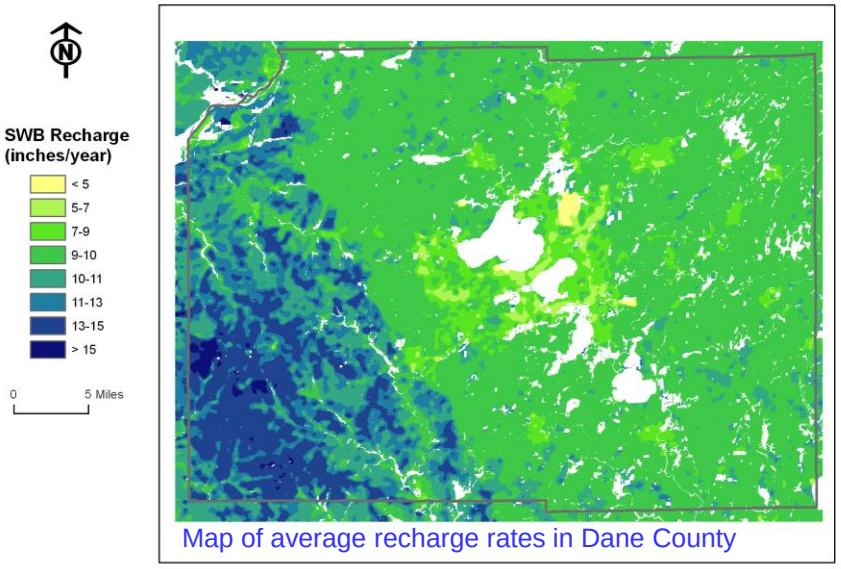
Core sample of the Eau Claire shale

Groundwater moves from recharge areas to discharge areas

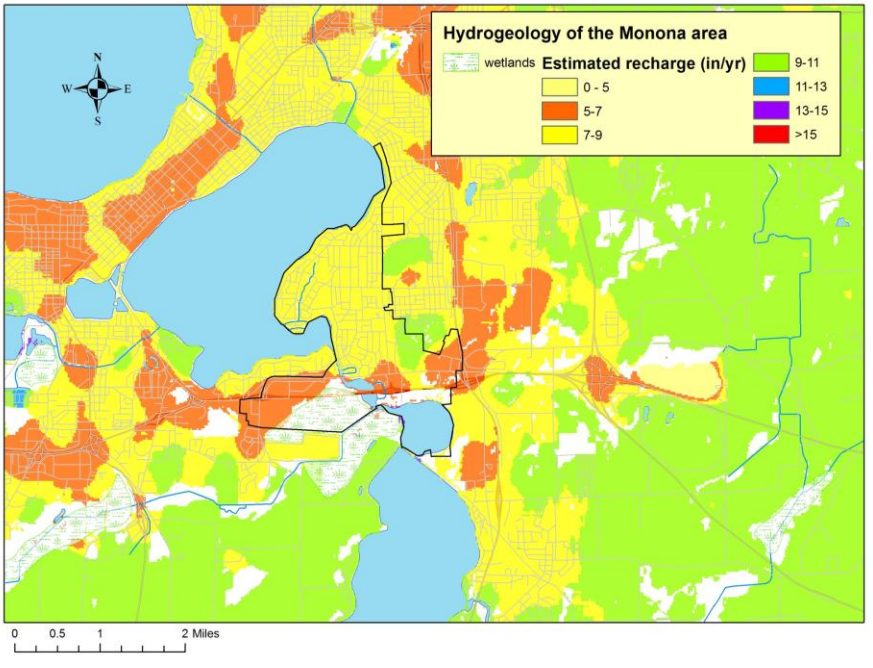


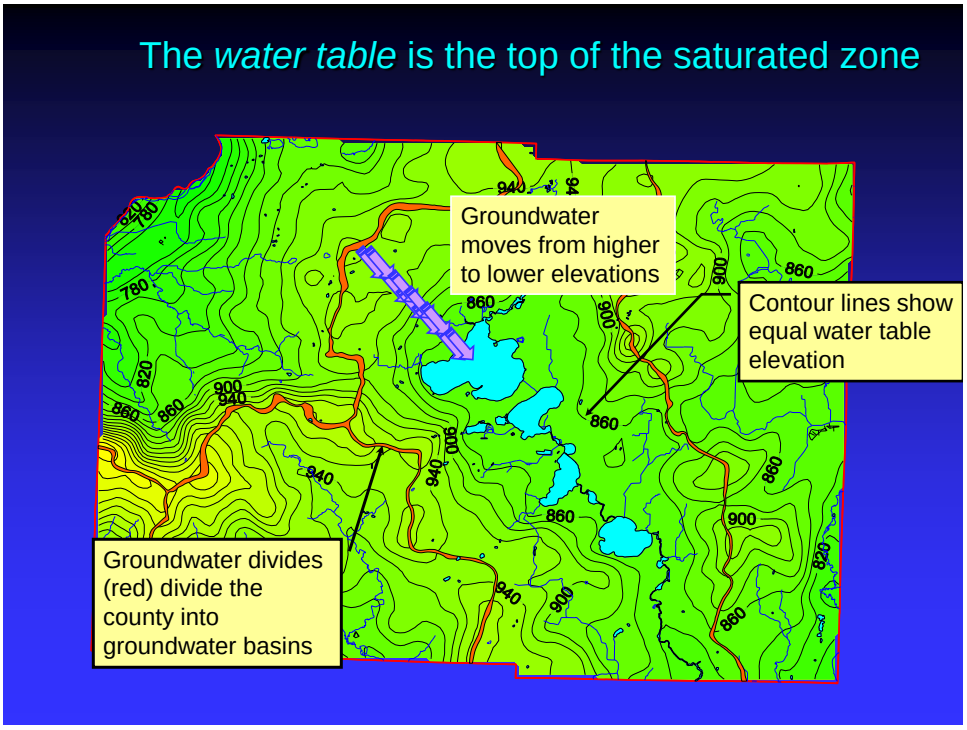
Groundwater discharge is easy to see in Dane Co

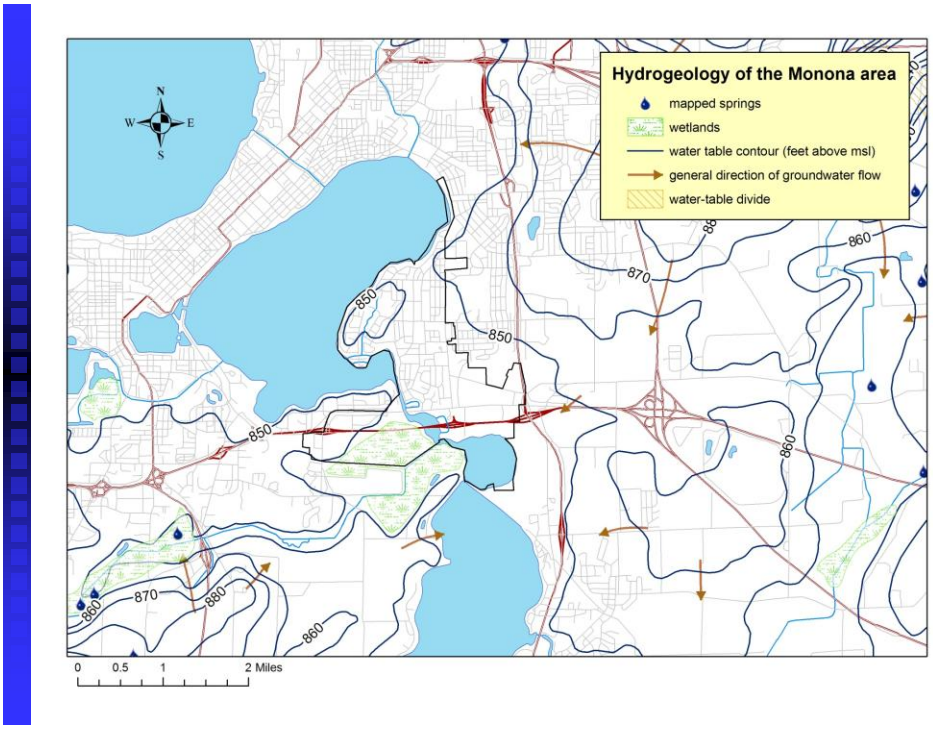
Recharge occurs everywhere



Map of average recharge rates in Dane County




The *water table* is the top of the saturated zone
Groundwater moves from higher to lower elevations
Contour lines show equal water table elevation
Groundwater divides (red) divide the county into groundwater basins


Hydrogeology of the Monona area
mapped springs
wetlands
water table contour (feet above msl)
general direction of groundwater flow
water-table divide
N
W
E
S
0
0.5
1
2 Miles


Pheasant Branch Springs


Flowing well at Nevin Fish Hatchery

Water use in Dane County

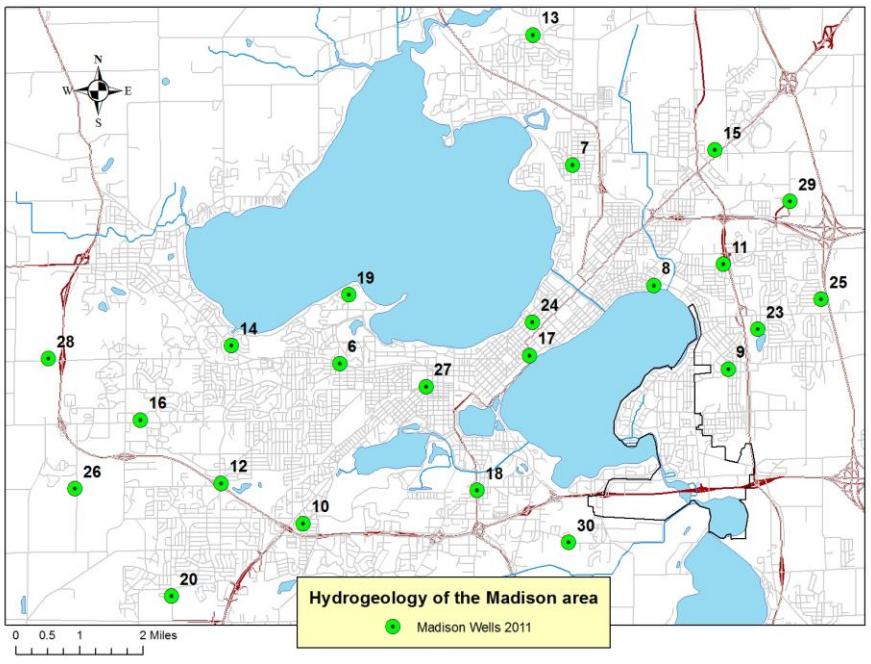
- 100% of drinking water comes from groundwater

➢ Consequences of groundwater use…

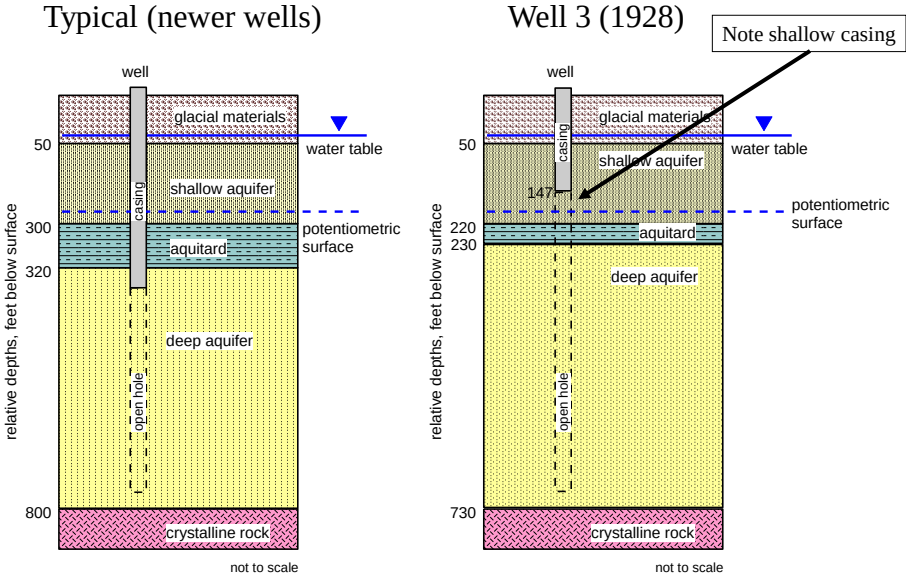
- Drawdown – lowering water levels
- Alteration of groundwater flow paths
- Effects on surface water
- Effects on water quality

Groundwater use in Dane County

- Municipal and Industrial water use:
  - About 50 million gallons per day (MGD)
  - 0r…about 75 cubic feet per second (CFS)
- For comparison:
  - Wingra Creek at Beld St: ~2 CFS
  - Badger Mill Creek at Verona: ~13 CFS
  - Black Earth Creek at Black Earth: ~27 CFS

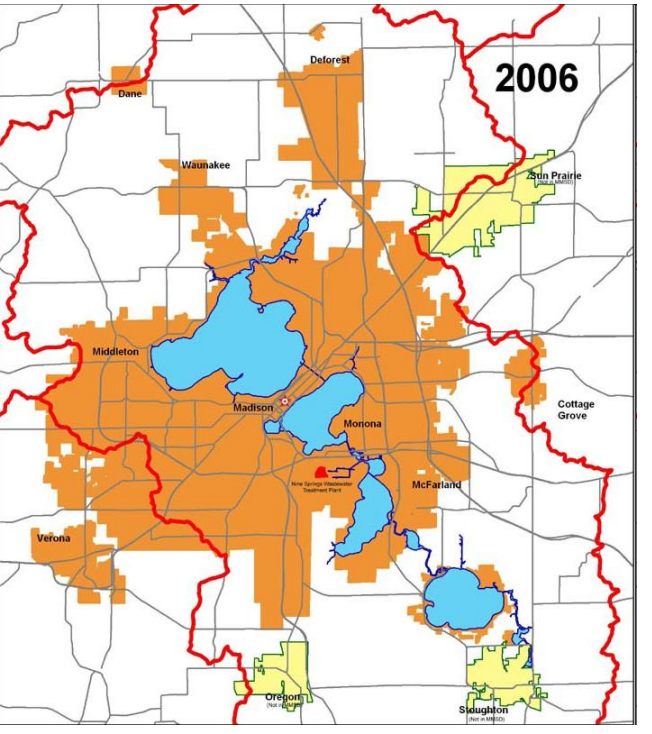


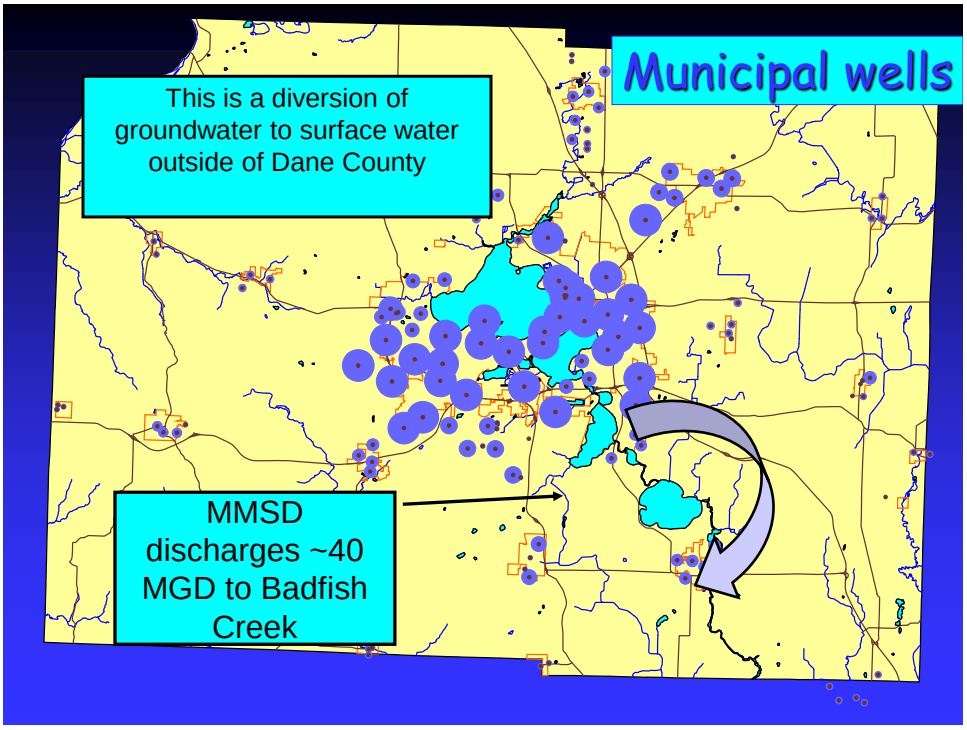
Construction of Madison supply wells



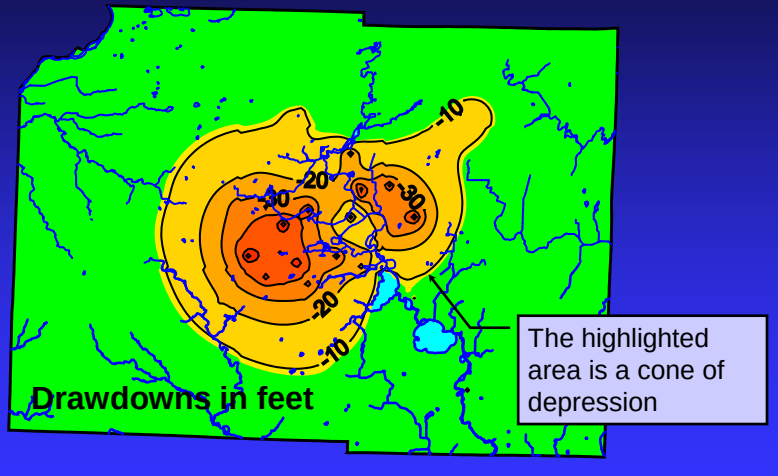
Madison's wastewater is treated at the MMSD plant at Nine Springs

MMSD also takes wastewater from other nearby communities

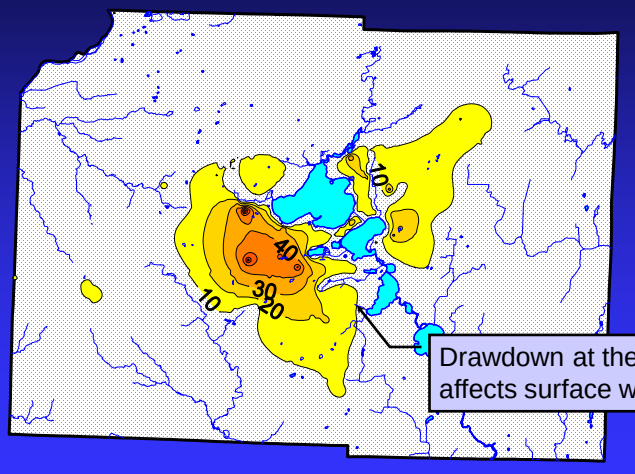


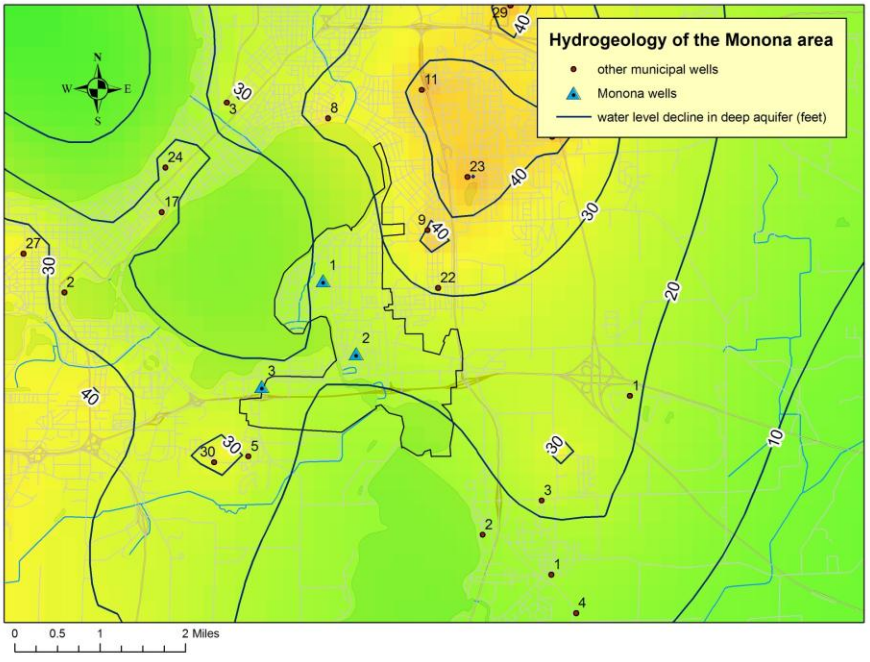


Municipal water use in the Madison area causes significant drawdown, or lowering of water levels, in the deep sandstone aquifer...



Drawdowns in the deep aquifer can affect the water table…reducing flow in streams and water levels in wetlands

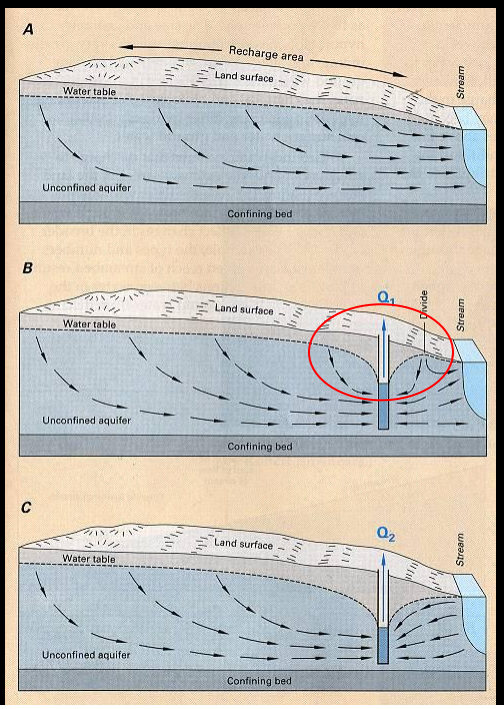




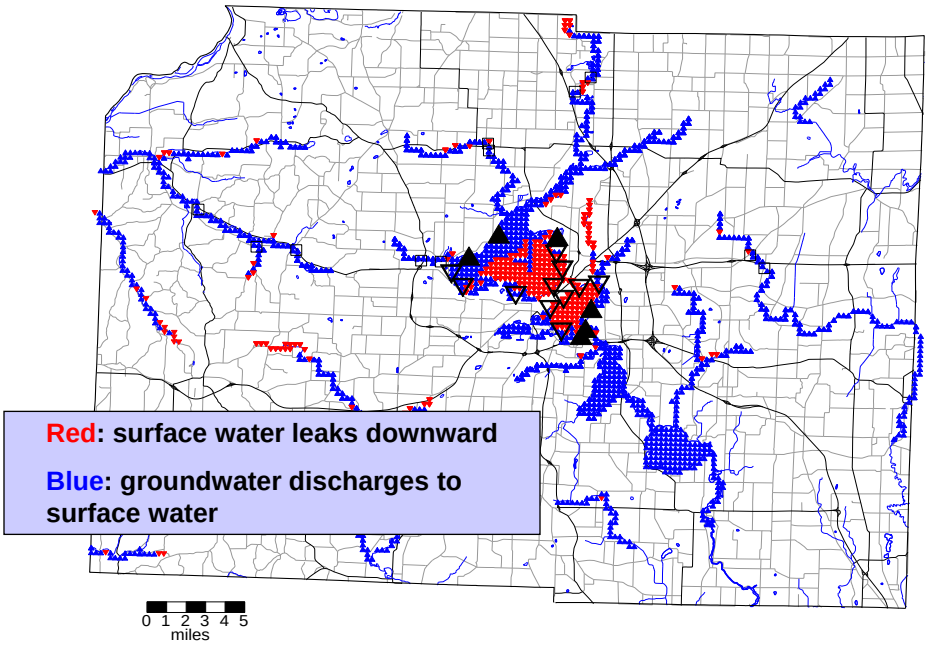
Pumping wells affect groundwater movement

The well causes a cone of depression

Well pumping can reduce flow to surface water

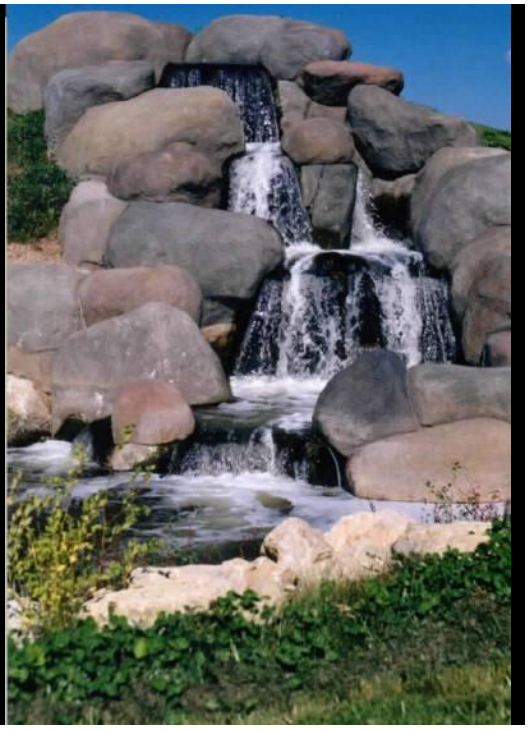


Groundwater discharge to lakes and streams



Drawdown could be alleviated, in part, by returning water to the basin

Treated effluent return flow to Badger Mill Creek near Verona



Viruses Found In Madison Wells

But Threat To Humans Isn't Considered Great Because Madison Chlorinates Its Water.

Wisconsin State Journal :: FRONT :: A1

Sunday, October 19, 2008
By RON SEELY rseely@madison.com 608-252-6131

Human viruses are probably present in most of Madison's drinking water wells and sometimes are infectious enough to cause illness were the city not treating its water with chlorine, according to research released last week.

The study was conducted by researchers from the Wisconsin Geological and Natural History Survey and Marshfield Clinic. It was a more complete follow-up to an earlier study by Mark Borchardt, a researcher at Marshfield Clinic. In that research, Borchardt found viruses in two of three wells he tested.

But this study was much more extensive and tested six of the city's wells every month between September 2007 and September 2008. Viruses, including gastrointestinal and respiratory viruses, were found at least twice in every well, though no well tested positive in every sampling round. Samples were taken from the wells prior to treatment with chlorine.

The findings are important, according to researchers, because neither the federal nor state government set standards for viruses and communities are not required to treat for them. Because Madison chlorinates its water, experts say, the health risk is minimal. But hundreds of communities across Wisconsin do not treat drinking water, according to Ken Bradbury, a hydrogeologist with the Wisconsin Geological and Natural History Survey who helped conduct the study.

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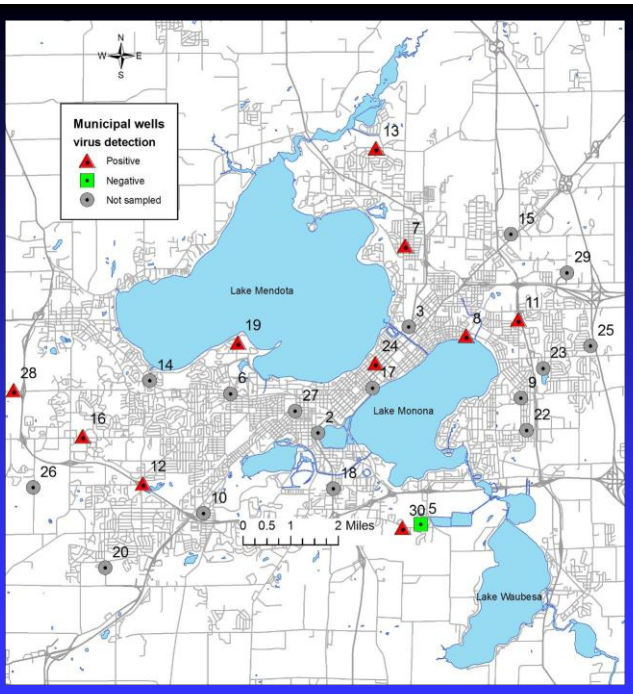
Wells sampled 2007-2008

We began with 10 wells in a variety of locations to be sure we had virus-positive wells to work with.

We later reduced the sampling to 6 wells due to budget and logistic considerations.



Take-home points from our virus sampling

- Human viruses are present in water pumped from the Madison wells; we assume other wells in the area would be similar
- Chlorination by the water utilities disinfects the water
- The virus presence shows us that water from these deep wells is vulnerable to contamination from land surface activities

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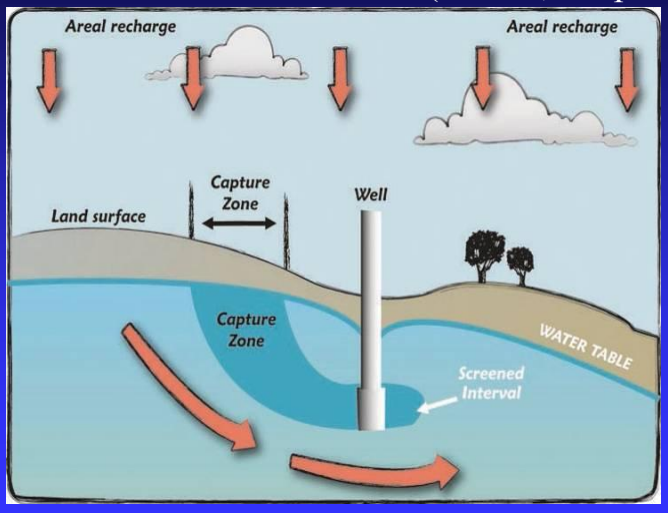
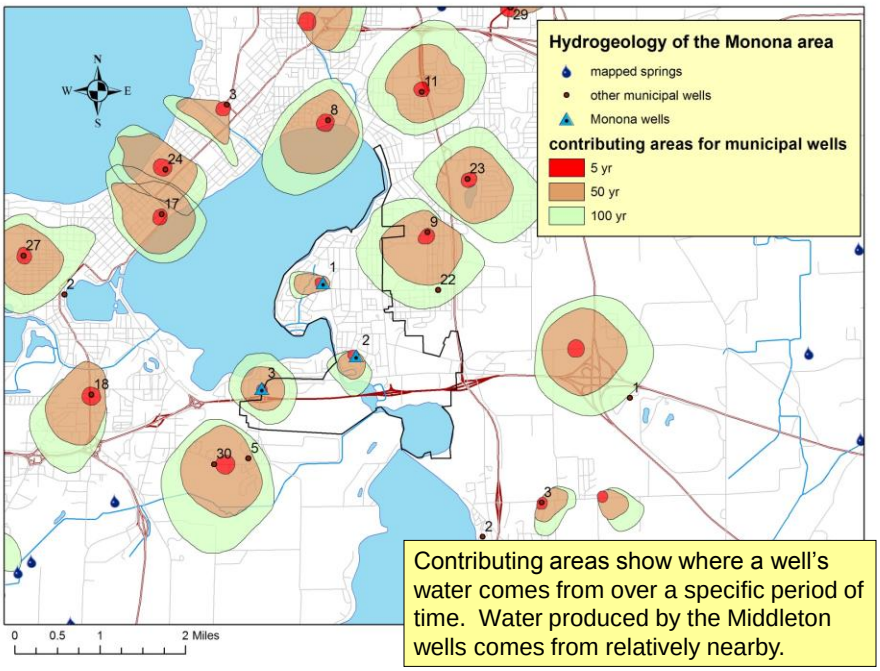
Capture zone, or contributing area: land surface over which precipitation and snowmelt infiltrate to the water table and flow to the well (or lake, or spring…)





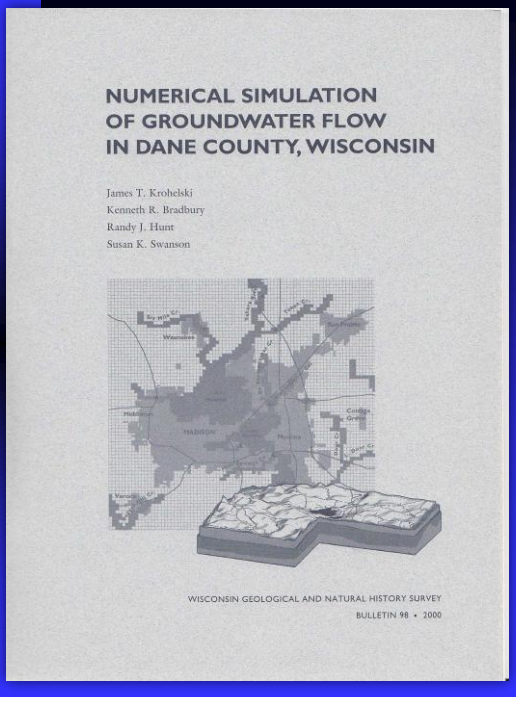
Contributing areas show where a well's water comes from over a specific period of time. Water produced by the Middleton wells comes from relatively nearby.

What is a groundwater flow model?

- Computers are used to solve mathematical equations describing groundwater flow
- Complex geology, wells, and surface water features are simulated using a three-dimensional grid
- Such models are powerful tools for interpreting the past and predicting future conditions

Typical modeling objectives

- Understand present GW system
- Study current and future impacts of groundwater use
- Simulate alternative management options
- Delineate contributing areas for wellhead protection
- Provide a framework for site-specific models and studies



The current model…

Project began in 1992;

completed in 1996;

published as WGNHS Bulletin in 2000

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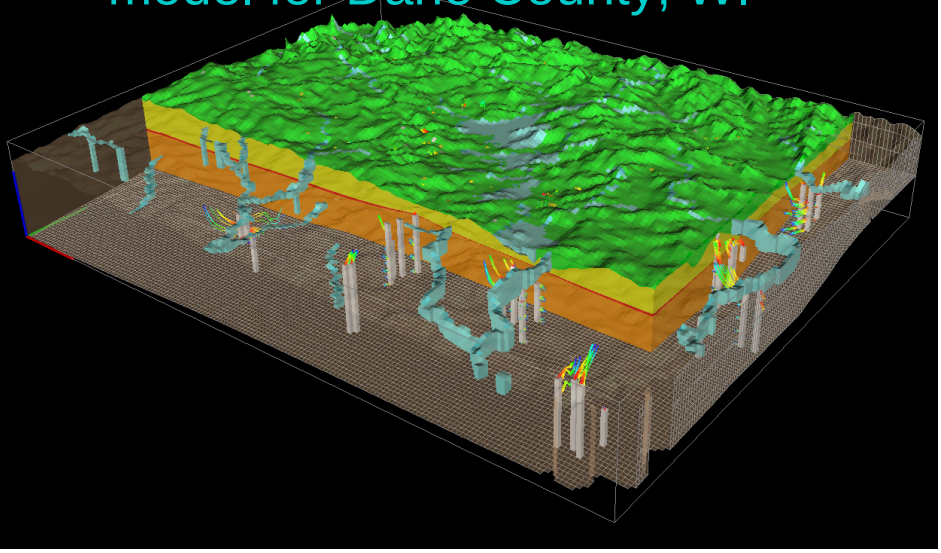
Complex 3-dimensional flow model for Dane County, WI



Why a new model?

- existing groundwater flow model was constructed in 1994
- steady state only, fixed lake and stream levels
- since then, pumping rates of municipal wells have been updated and some recalibration has occurred
- model is in regular use today, but is not adequate for many questions
- we know many current predictions may not be reliable

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Project scope/deliverables

- Re-evaluation and update of county hydrogeology
- Preparation of GIS coverages and database
- Construction of transient, improved resolution model
- Calibration using state-of-the-art inversion methods
- Predictive runs to address specific issues

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Project funding/administration

- 2 years, beginning July 2010
- WGNHS/USGS team with CARPC assistance
- Cost about $319,000, or ~$160,000 per year
- Cost shared among cooperators
- USGS provides Federal match; WGNHS provides in-kind contributions

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Summary

- Everyone in Dane County uses groundwater, and this water use has consequences for all
- The water we use originates as recharge in Dane County
- Our wells are vulnerable to contamination from surface activities
- Pumping is influencing *lake and surface water budgets*
- Long-term water management should emphasize returning effluent to the basin and promoting groundwater recharge

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