High-Capacity Wells:
Impacts on groundwater and surface water

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Key concepts for groundwater policy

- Groundwater and surface water are connected, and comprise a *single resource*
- Confined and unconfined aquifers behave differently. Drawdown is a *poor indicator* of stress for unconfined aquifers
- All water comes from somewhere – understanding the *water balance* is critical for management decisions

Typical hydrogeology in SE Wisconsin
Lines Drawn in Battle for Water Rights

Sportsmen, Farmers Begin Snarling Over Bills Introduced in the Legislature

By LEWIS C. FRENCH
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Stevens Point, Wis.—There is a cat and dog fight going on in Wisconsin over water.

The snarling and barking, along with vocal scratching, broke out last week in this Portage county seat, with both sides lining up for a last ditch fight over pending bills in the Wisconsin legislature.

If there is going to be a feud, Stevens Point is as good a starting point as any.

Portage County Area Offers an Example of How Farmers, Sportsmen Differ

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tatoes and another 10,000 acres of snap beans plus the boom of other canning crops such as sweet corn and tomatoes with irrigation in and near Portage county alone.

The attempts to solve the friction between the farmers and the sportsmen has failed so far.

The irrigators welded together a state-wide organization—the Wisconsin Agricultural Water Conservation committee—to rally here Friday and raise a fund to “fight back,” pledging to seek the ear of every member of the legislature.

The naturalists have done the same thing.

What Will Happen?

And what a beating the all-inclusive term “conservation” may take as both sides swarm to the capital over three water bills which would, if passed, put the irrigators under tighter re-
What is groundwater?

Groundwater is water filling pores, cracks, fractures, and other voids in geologic materials beneath the earth’s surface.

Culver springs, Dane County, WI
In Wisconsin, shallow groundwater generally mirrors topography, and groundwater moves from higher to lower areas.
Groundwater moves in three dimensions.

Groundwater divide

Impermeable bedrock

Groundwater naturally discharges to surface water
Unconfined aquifers:
- Upper boundary is water table
- High storage
- Lower drawdown
- Best connection to surface water

Confined aquifers:
- Upper boundary is aquitard (clay, shale, etc)
- Lower storage
- Greater drawdown
- Less connection to surface water

Aquifer type matters – all aquifers are not alike
Example hydrographs...

**Unconfined**

Shallow sand and gravel well at Hancock, Wi; note seasonal fluctuations and gradual decline

**Confined**

Deep sandstone well in Kenosha County, shows long-term potentiometric drop due to pumping
What is a high-capacity well?

Section NR 812.07(53), Wisconsin Administrative Code, defines a high capacity well system as one or more wells, drillholes or mine shafts on a property that have a combined approved pump capacity of 70 or more gallons per minute. A property is defined as contiguous or adjacent land having the same owner.
What is a high-capacity well?

Important points:

1. If the capacity of several small wells, on one property, added together, is greater than 70 GPM then the property is considered a high-capacity property, and the high-cap rules apply.

2. The definition is based on pump capacity, not actual use.

3. Many wells pump far more than 70 GPM; discharges in the 1000’s of GPM are common.
Impacts of high-capacity wells

Essentially two impacts:
1. Drawdown, or lowering of groundwater levels near the well.
2. Reduction of groundwater flow to nearby surface water features (a reduction of natural groundwater discharge).
The size of the cone of depression depends, in part, on the length of time the well is pumped.
When wells are close to each other, their cones of depression can overlap, and the wells hydraulically interfere with each other.

Drawdown reduces well yield
Drawdown in central Dane County reaches about 60 feet.
Historic Water Levels

- **Circa 1900: Artesian Conditions in deep sandstone aquifer**

- **Water levels in deep sandstone were 90-100 feet above ground surface**

- **1886 – 1905 City of De Pere uses artesian pressure to supply water.**

- **By 1915 water levels 10 feet above surface (already 80-90 feet of drawdown)**
How bad is the problem? Regional declines in water levels:

Note the differences in drawdown among regions, even though pumping rates are similar. Differences are caused by the hydrogeologic settings.
Like a bank balance, a water budget includes all inflows and outflows of water.

Models inherently provide this water budget accounting.

In Wisconsin, the most obvious evidence of “deficit” in the water budget is decreased baseflow to streams, springs, lakes, and wetlands.
Pumping wells affect groundwater movement

The well causes a cone of depression

Well pumping can reduce flow to surface water

source: USGS
The impact on streams can be significant even if drawdown is small.

The “ecological reserve” refers to groundwater that discharges to and sustains streams, lakes, and wetlands. This is the first water to be “lost” from surface water features in areas of intense pumping.
Regional vs local issues

Regional

- Multiple wells impact each other and also impact regional water levels and discharges to surface water
- Impacts can be regional (10’s of miles)
- Effects of each individual well not necessarily obvious;
- More difficult to regulate...in theory...because no single well can be blamed for the problem

- Example: regional drawdown in Dane County
regional vs local issues

Local

- single well affects other nearby wells, or affects flows to or water levels in a lake, stream, spring, or wetland
- impacts limited in scope (less than a mile)
- effects of the individual well are clear
- easy to regulate…in theory

- example: the Lake Beulah case

Source: www.lakebeulah.org
Problem: GMA’s are primarily based on drawdown. But, drawdown is a poor measure of impacts. Water balance indicators are much more meaningful.
Springs in Wisconsin
-over 10,800 springs identified
-most have flow less than 1 CFS
-almost no springs have enough data for flow duration analysis

Technical consensus on 0.25 CFS as a reasonable flow criterion.

235 springs = 2% of total
Ending up...

- As water scientists, we have an obligation to be sure that legislators, regulators, and the public have the best possible technical information to inform their decisions.
- Modeling and quantitative analysis is now a standard of our profession; we need to communicate this to decision makers.
- Good data collection and hydrogeologic interpretation is essential for meaningful decision making.
- In the final analysis, science may contribute to the debate, but it almost never controls the final choice. Scientists must come to terms with this reality.