

Ottawa County

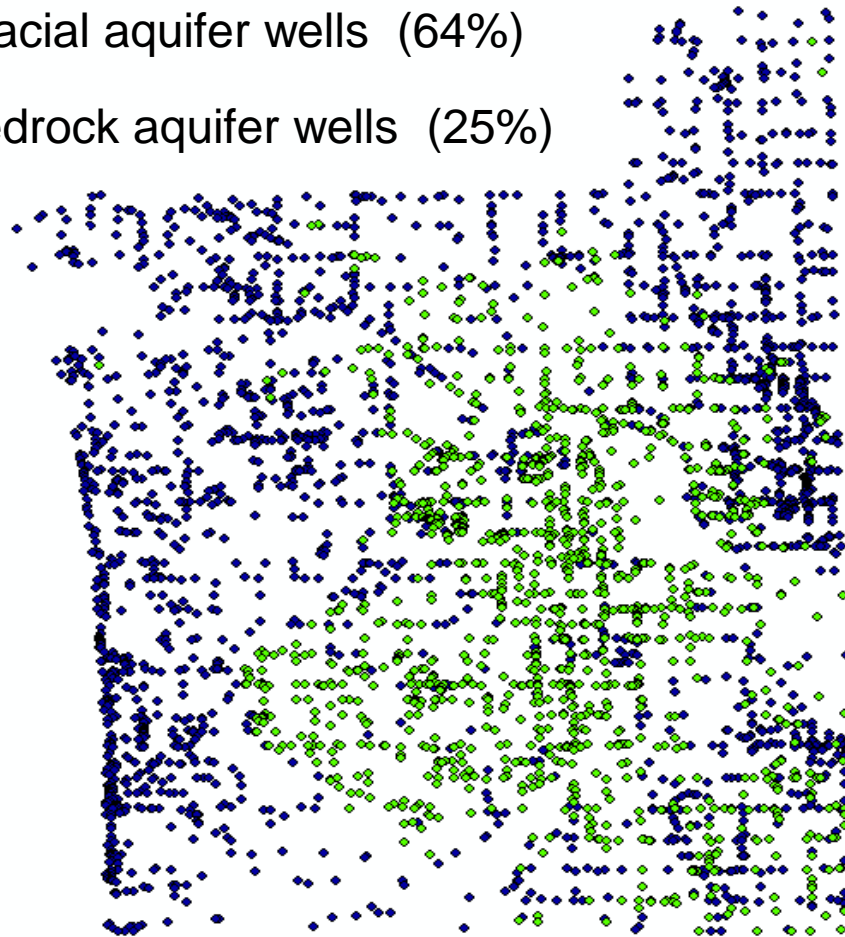
WATER RESOURCES STUDY

Dept. of Civil and Environmental Engineering
and
Institute of Water Research
Michigan State University

Data sets used:

□ MDEQ **Wellogig** Database

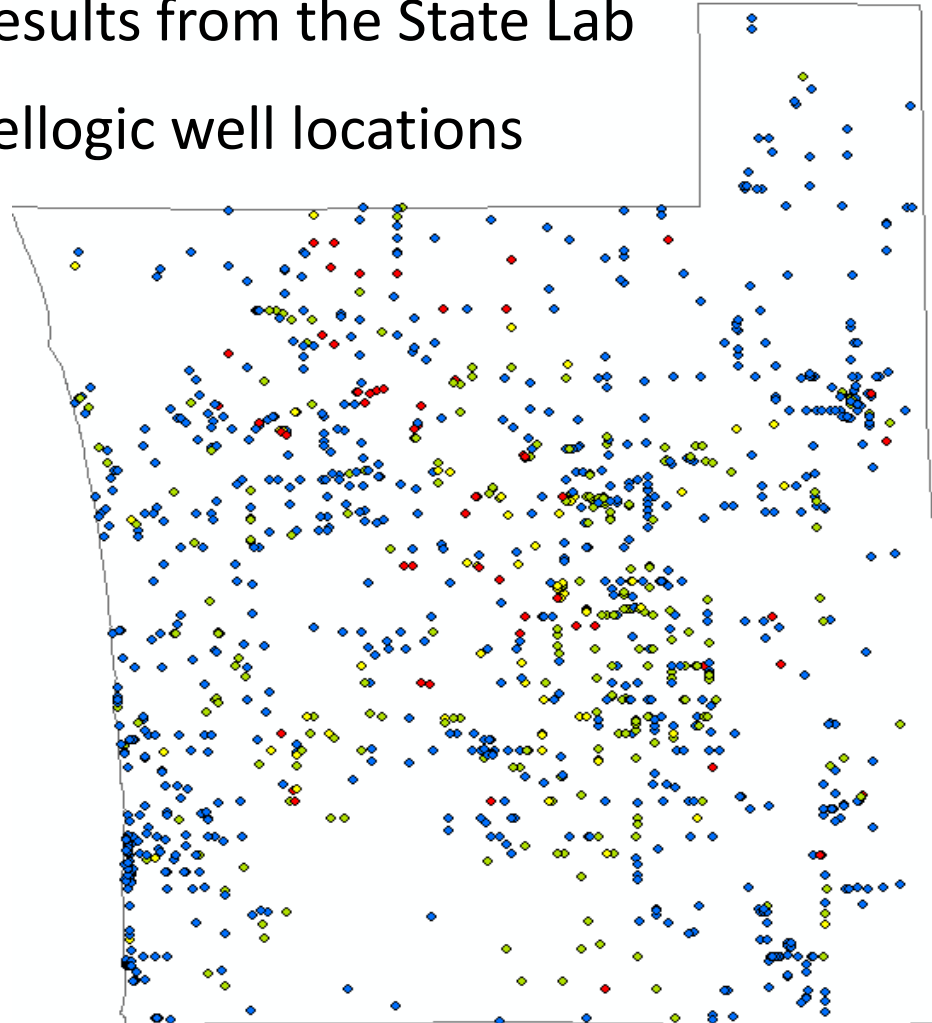
- 8,027 digital water wells records in Ottawa County
 - 5,152 Glacial aquifer wells (64%)
 - 2,018 Bedrock aquifer wells (25%)



Data sets used:

□ MDEQ **WaterCHEM** database

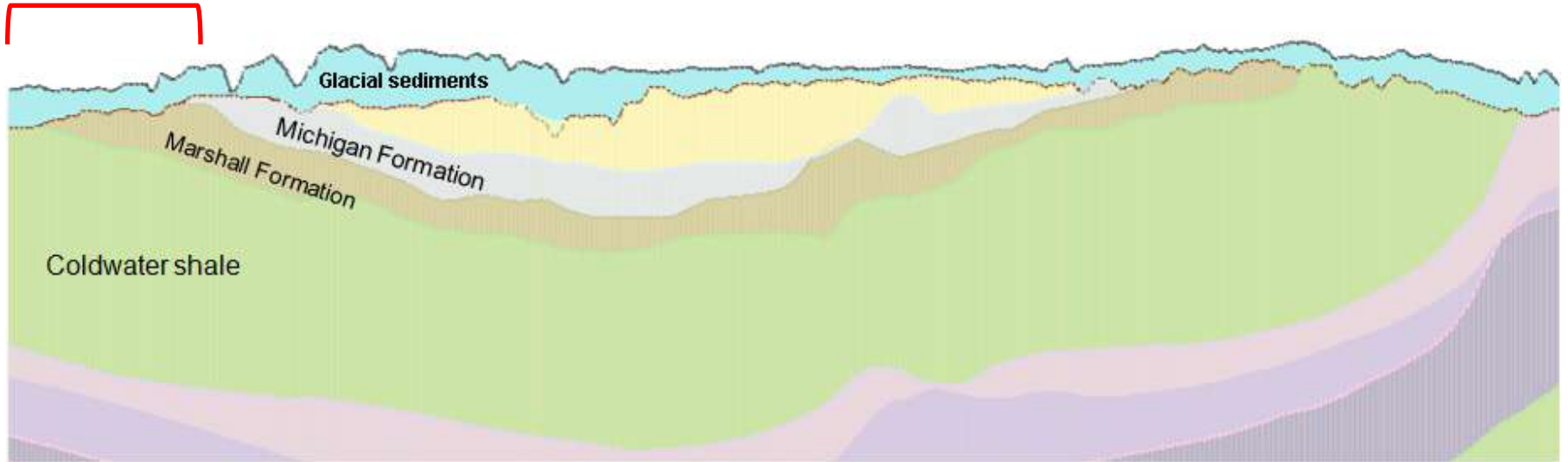
- 1983-2010 test results from the State Lab
- Spatial link to Wellogic well locations



Two aquifers in Ottawa County:

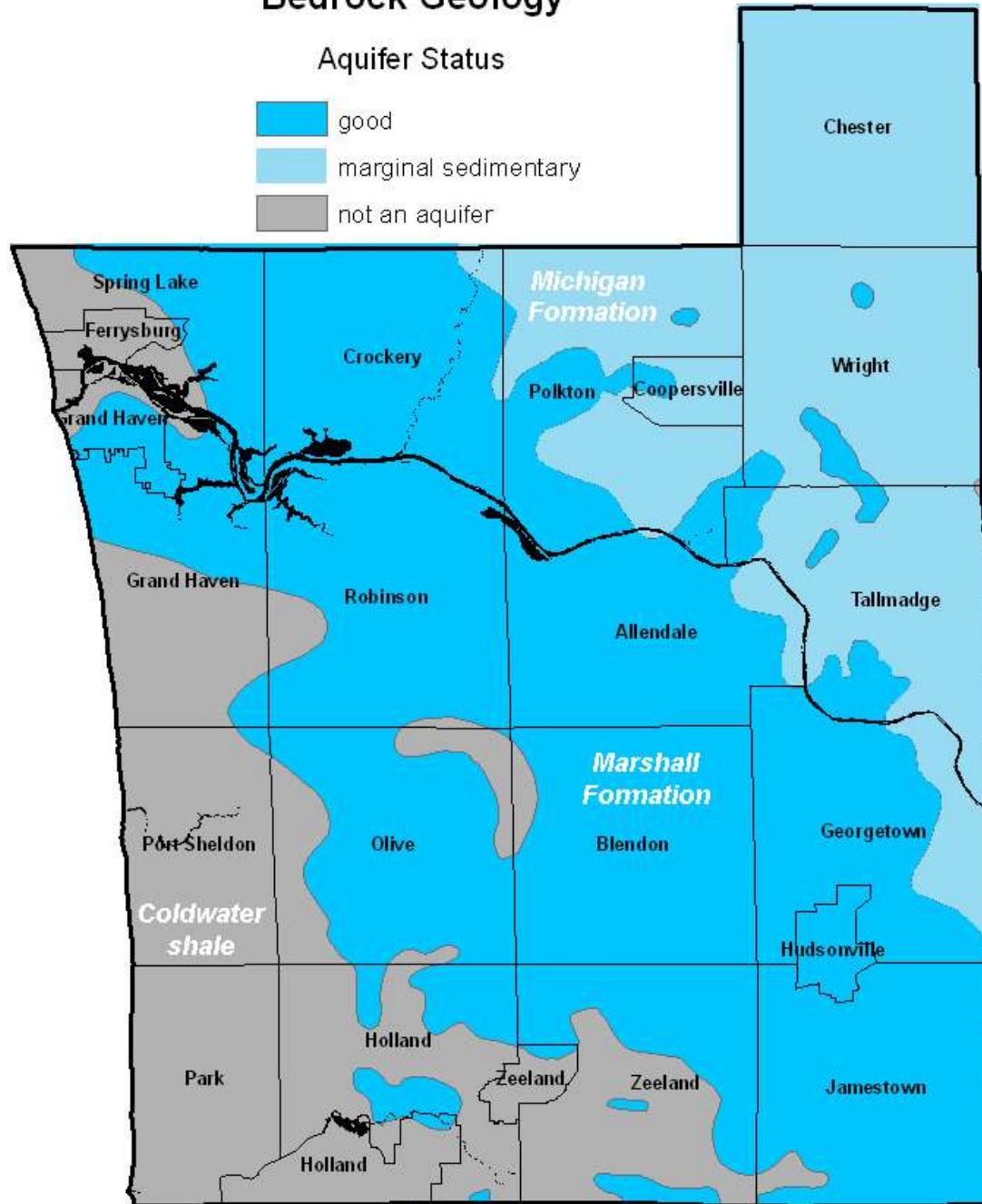
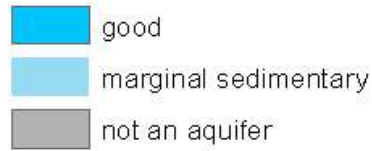
- ❑ Upper, glacial aquifer
- ❑ Deep, bedrock aquifer

Ottawa Co.



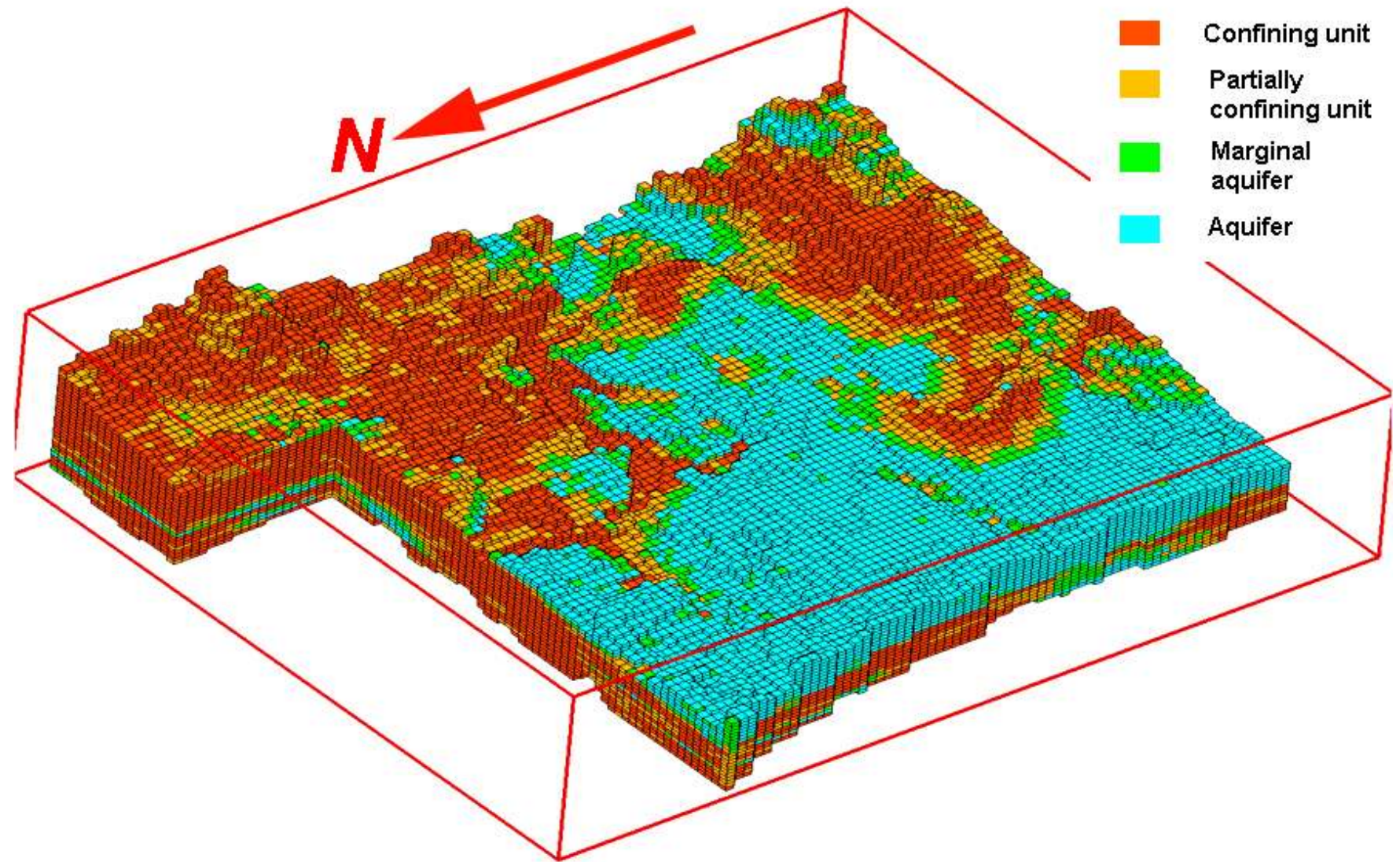
Bedrock Geology

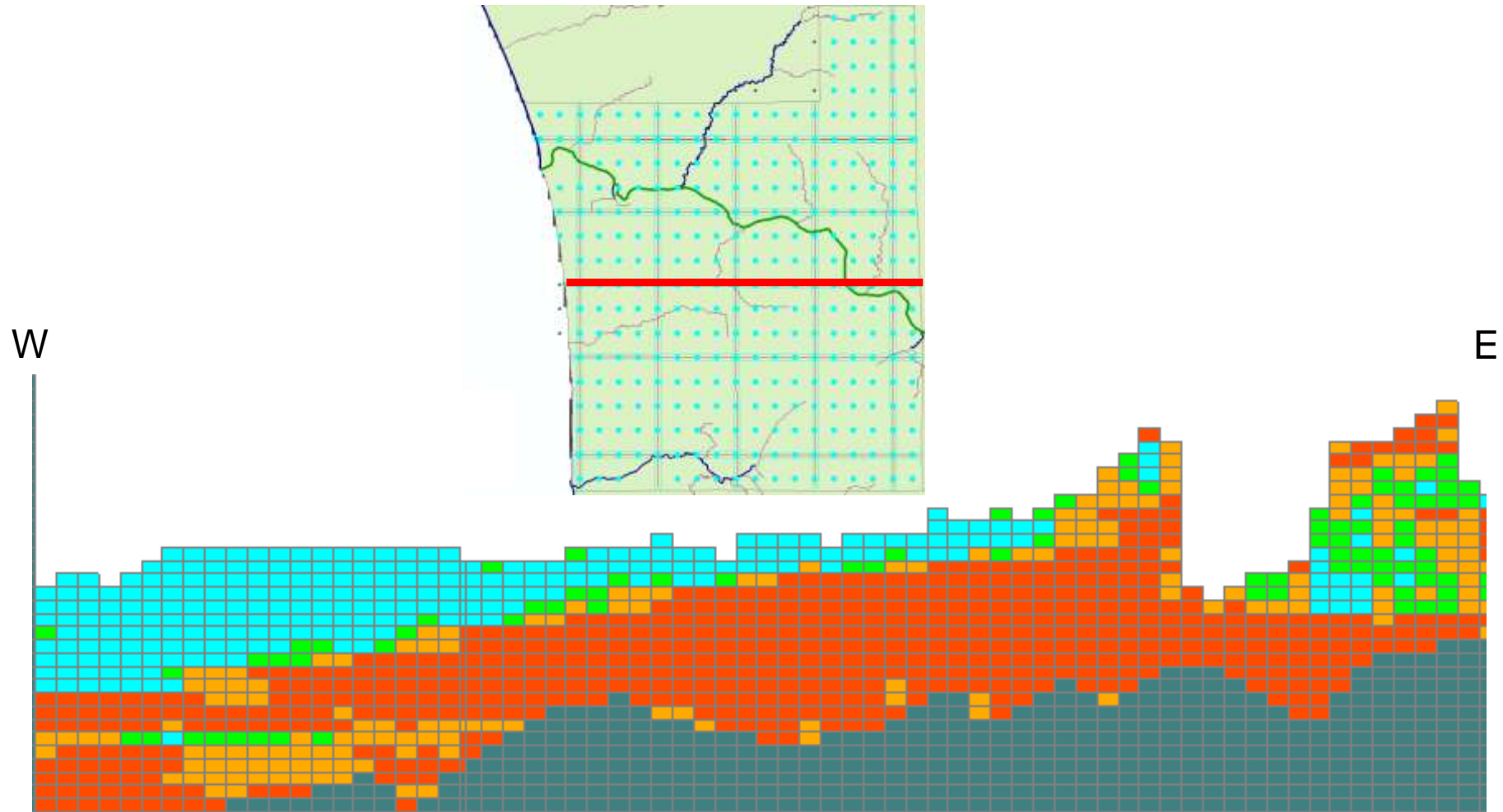
Aquifer Status

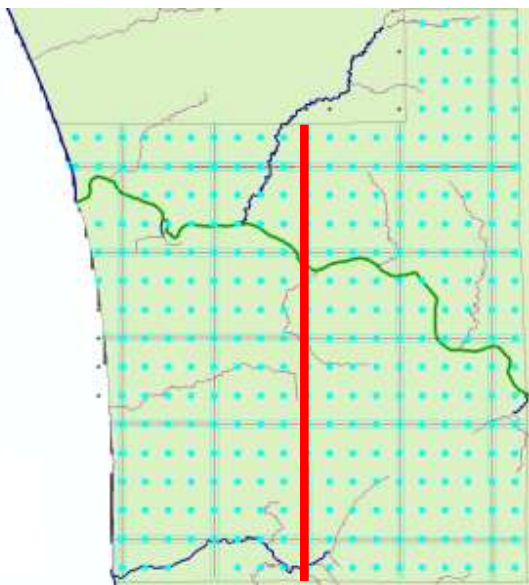


Summary of results:

- An **extensive, thick clay layer** underlies most of Ottawa county.
- Numerous, thinner clay confining layers, interspersed with thin, discontinuous aquifer materials, dominate the glacial deposits within the eastern townships of the county.
- The glacial aquifer system is composed of a **single, unconfined aquifer with moderate to low hydraulic conductivity**.
- A lower, thin and very patchy glacial aquifer occurs beneath the thick confining layer, but its yield is coupled to the availability of water in the underlying bedrock (*i.e.*, restricted to areas in contact with the Marshall Formation).

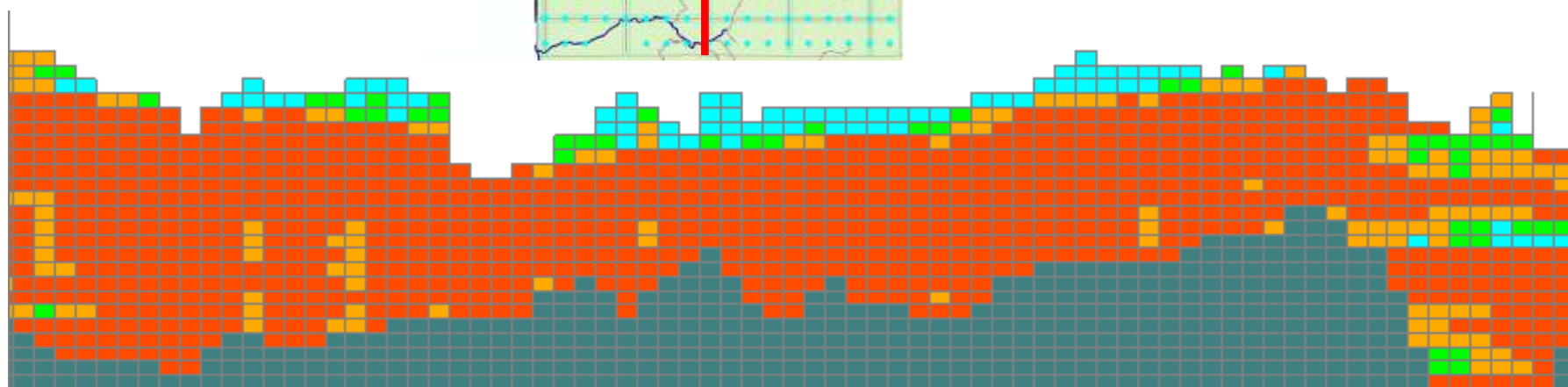






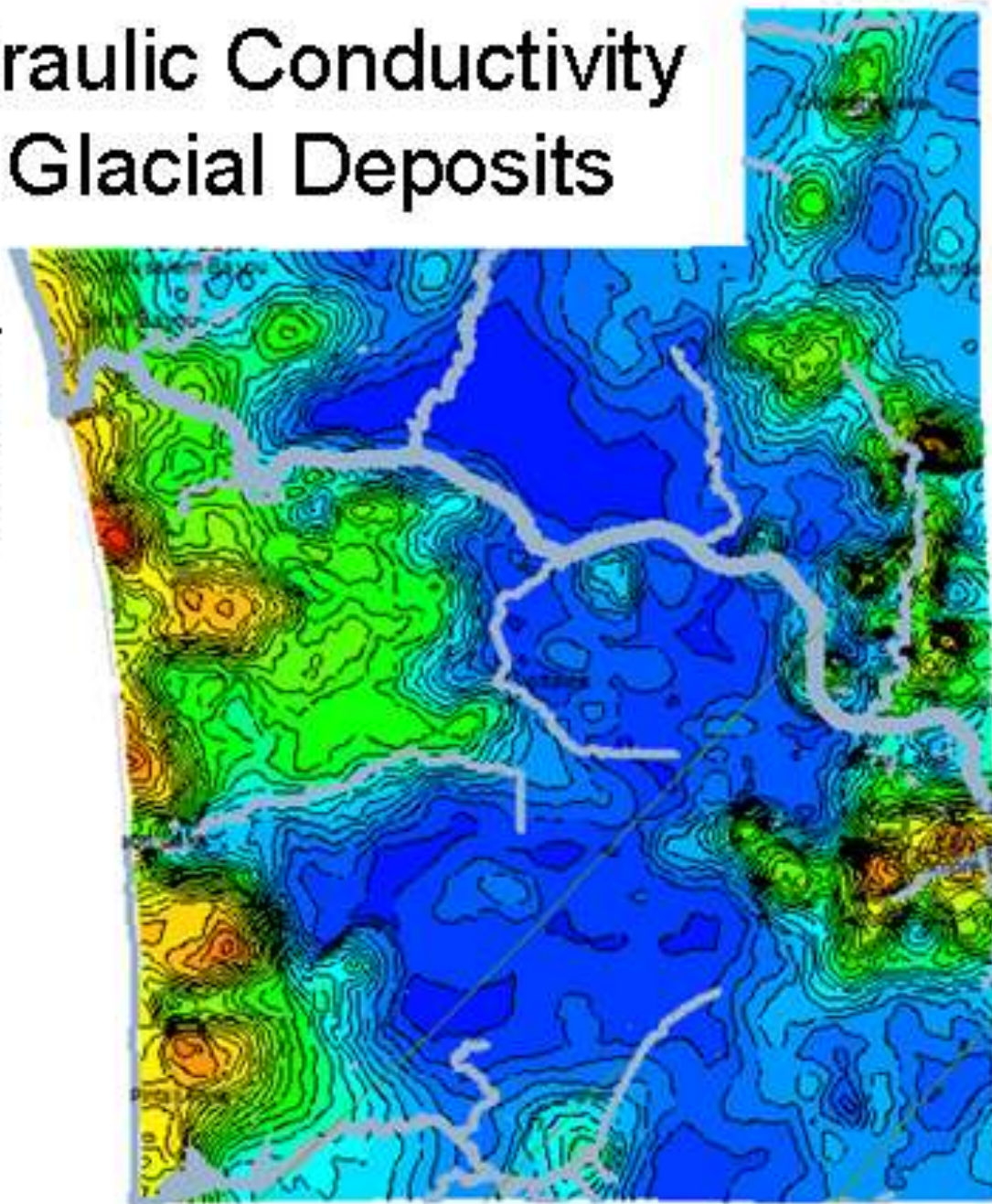
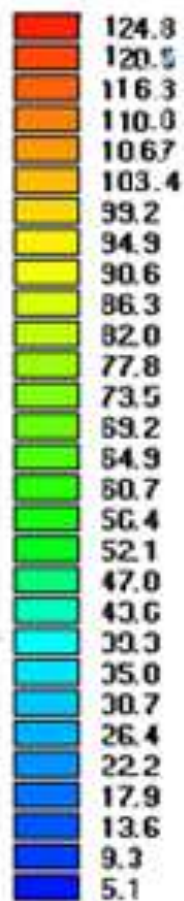
N

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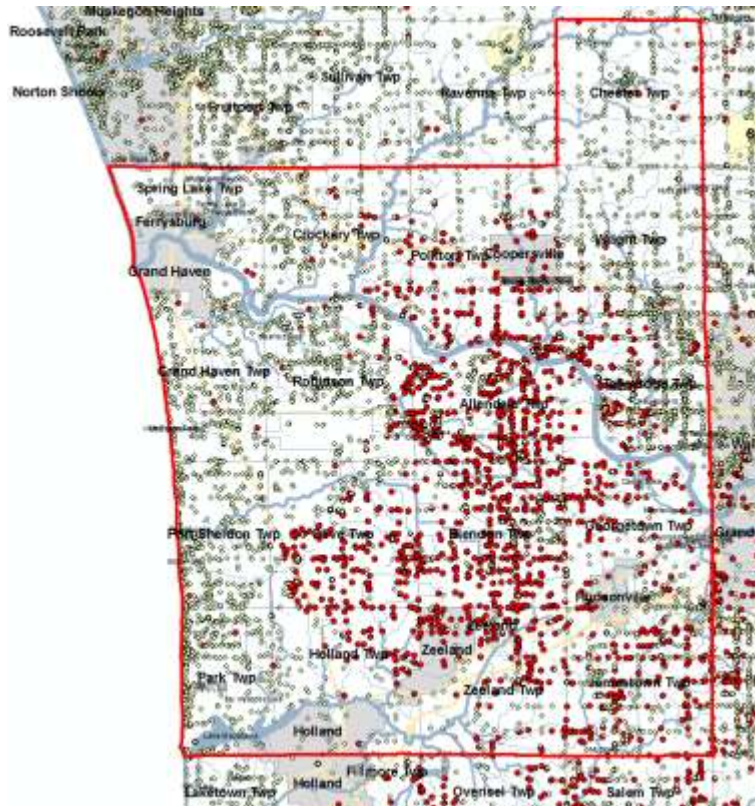
Hydraulic Conductivity in Glacial Deposits

Ft. per day



Summary of the study results:

- The Marshall Formation is the only productive bedrock aquifer beneath Ottawa County. Some bedrock wells pierce the Michigan Formation, but their yield comes from the underlying Marshall Formation.

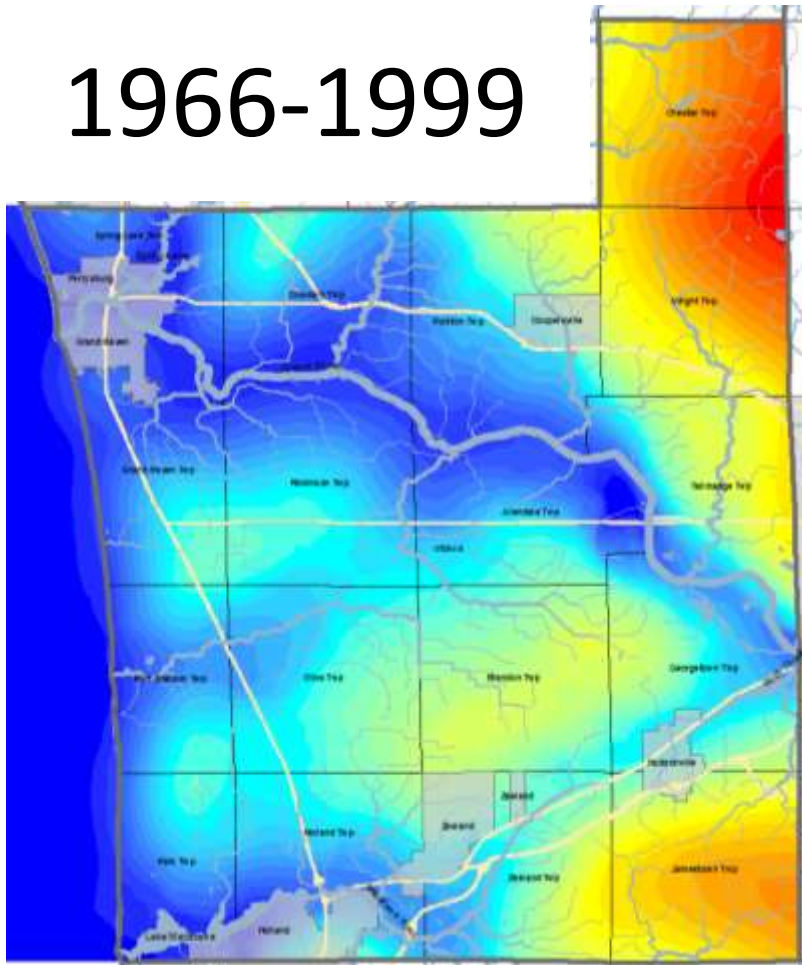


Summary of the study results:

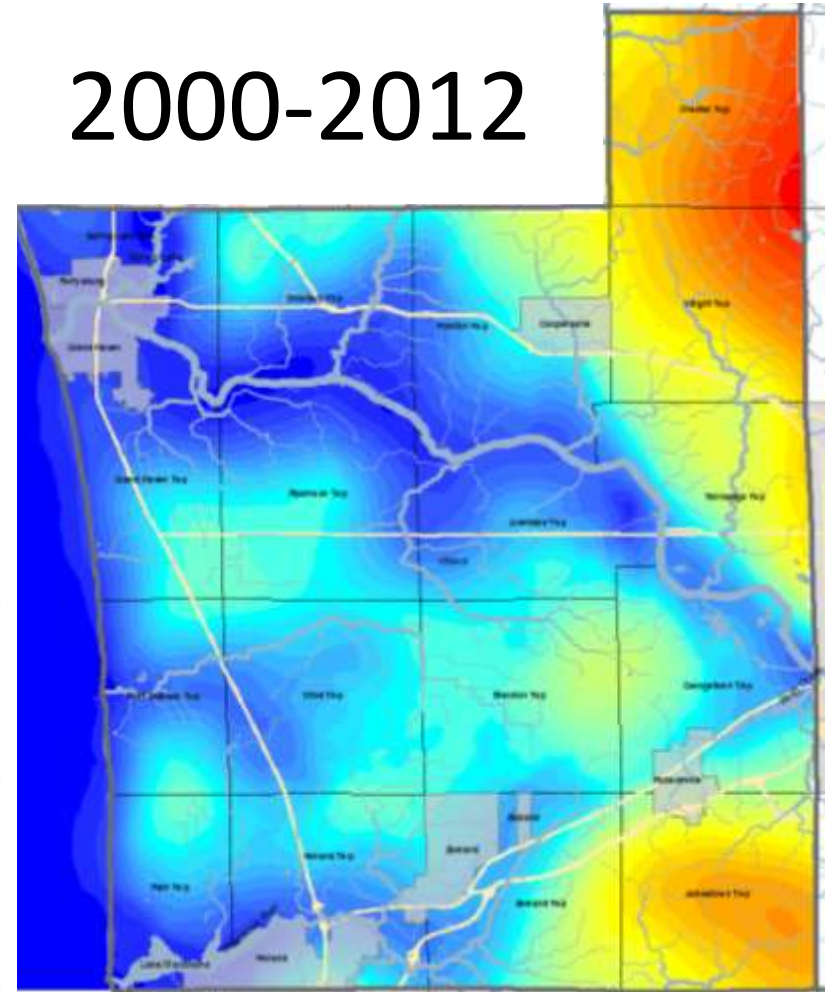
- Since 1999, the **static water levels in both the glacial and the bedrock aquifer** have modestly, but significantly, **declined**.
- This documents that **the current volume of groundwater withdrawals in Ottawa County is not sustainable in the long run**.
- Further study will be necessary in order to forecast the duration of available groundwater.

Glacial Static Water Level

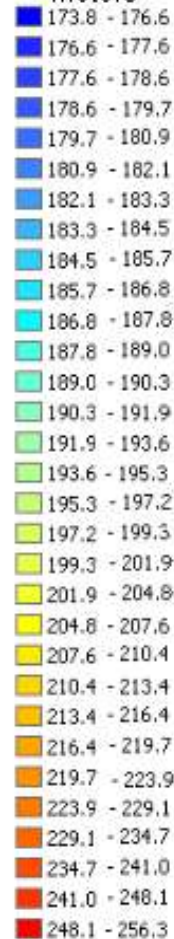
1966-1999



2000-2012

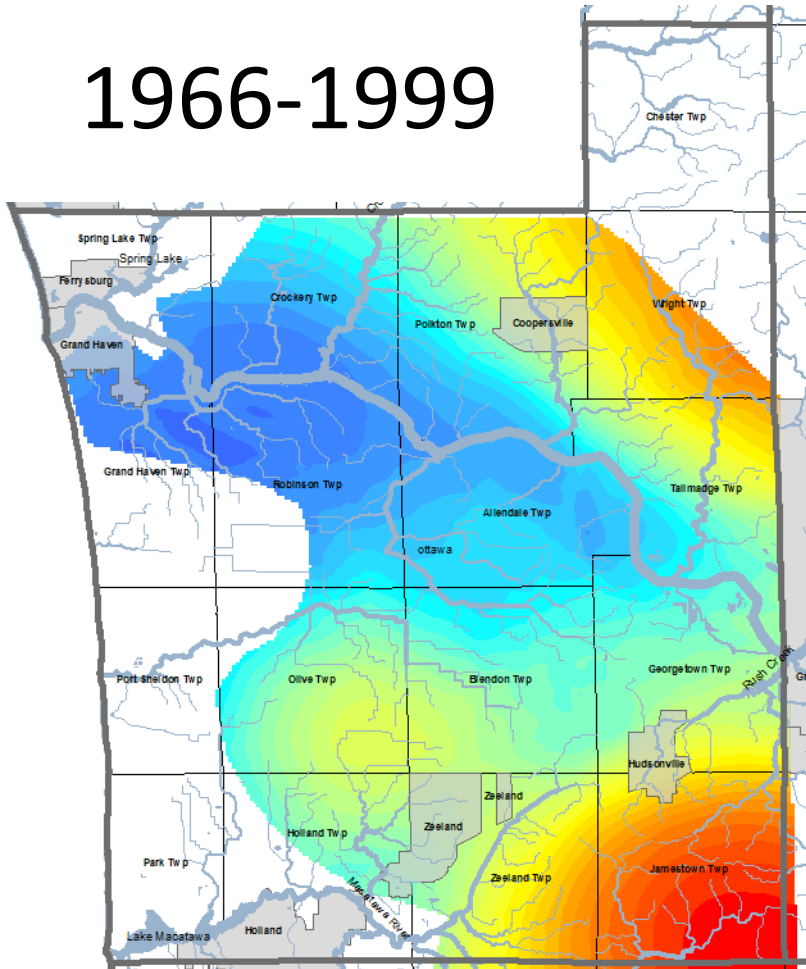


meters

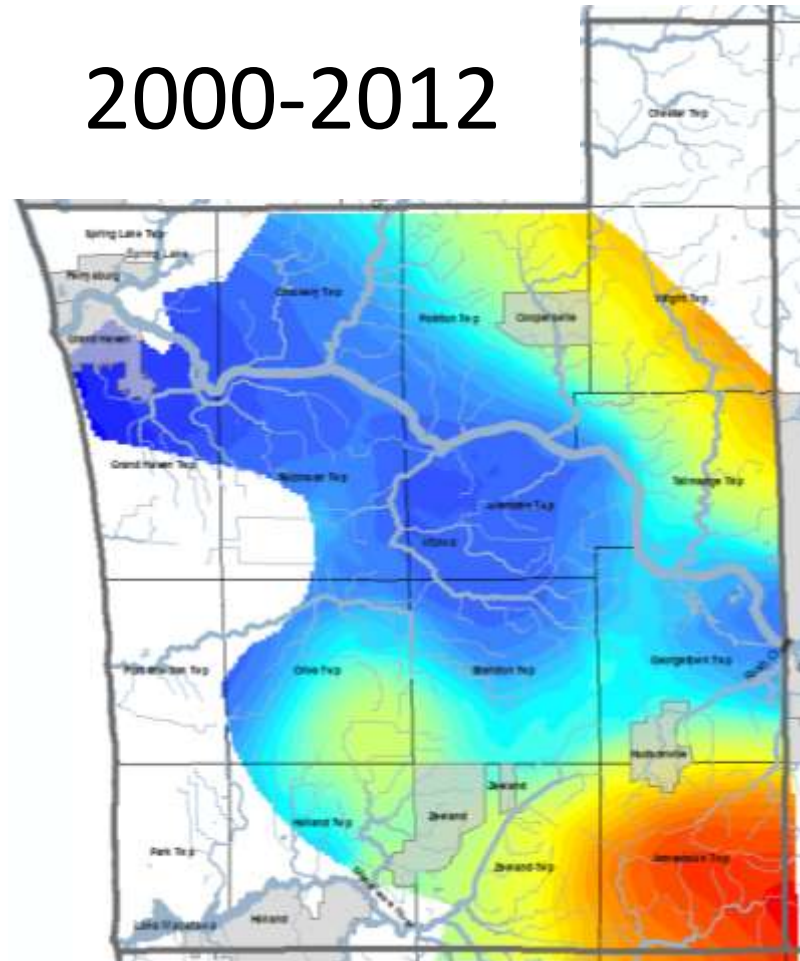


Bedrock Static Water Level

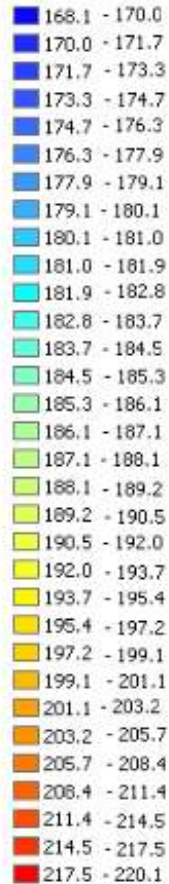
1966-1999



2000-2012

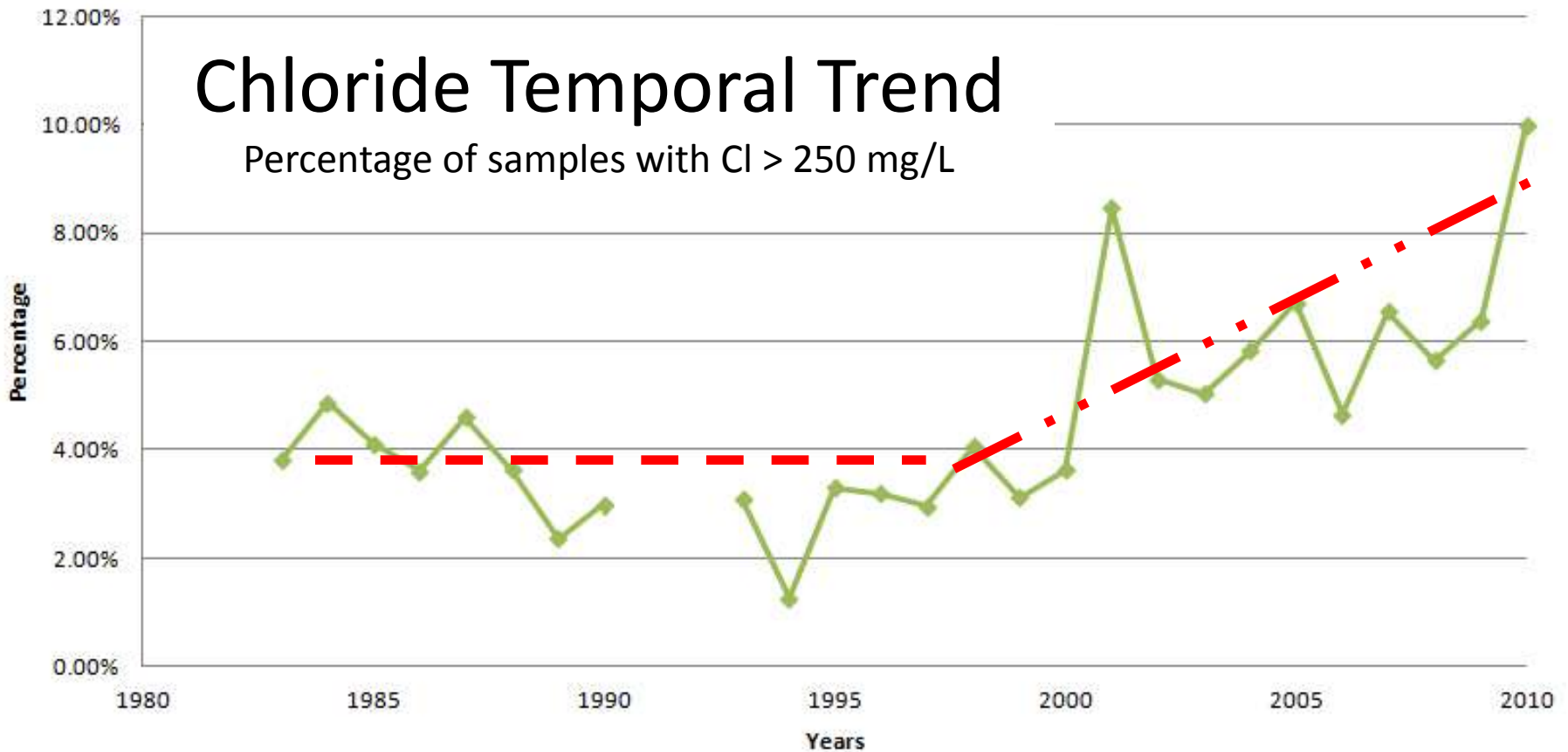


meters



Summary of the study results:

- The **groundwater in the bedrock aquifer is becoming more saline** as shown by increasing chloride concentrations through time.



Summary of the study results:

- The chloride concentration increases in the bedrock aquifer are NOT a surface contamination problem (*e.g.*, road salt).

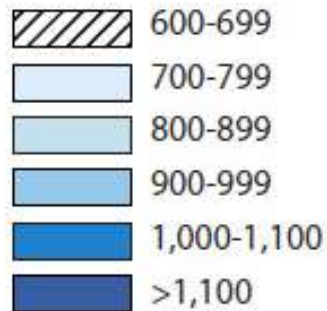
Hypersaline groundwater is upwelling within the Marshall Formation.

- It is likely that increasing withdrawals from the bedrock aquifer over time have allowed hypersaline groundwater from deeper in the Marshall Formation to migrate upward toward the **master discharge point beneath central Ottawa County.**

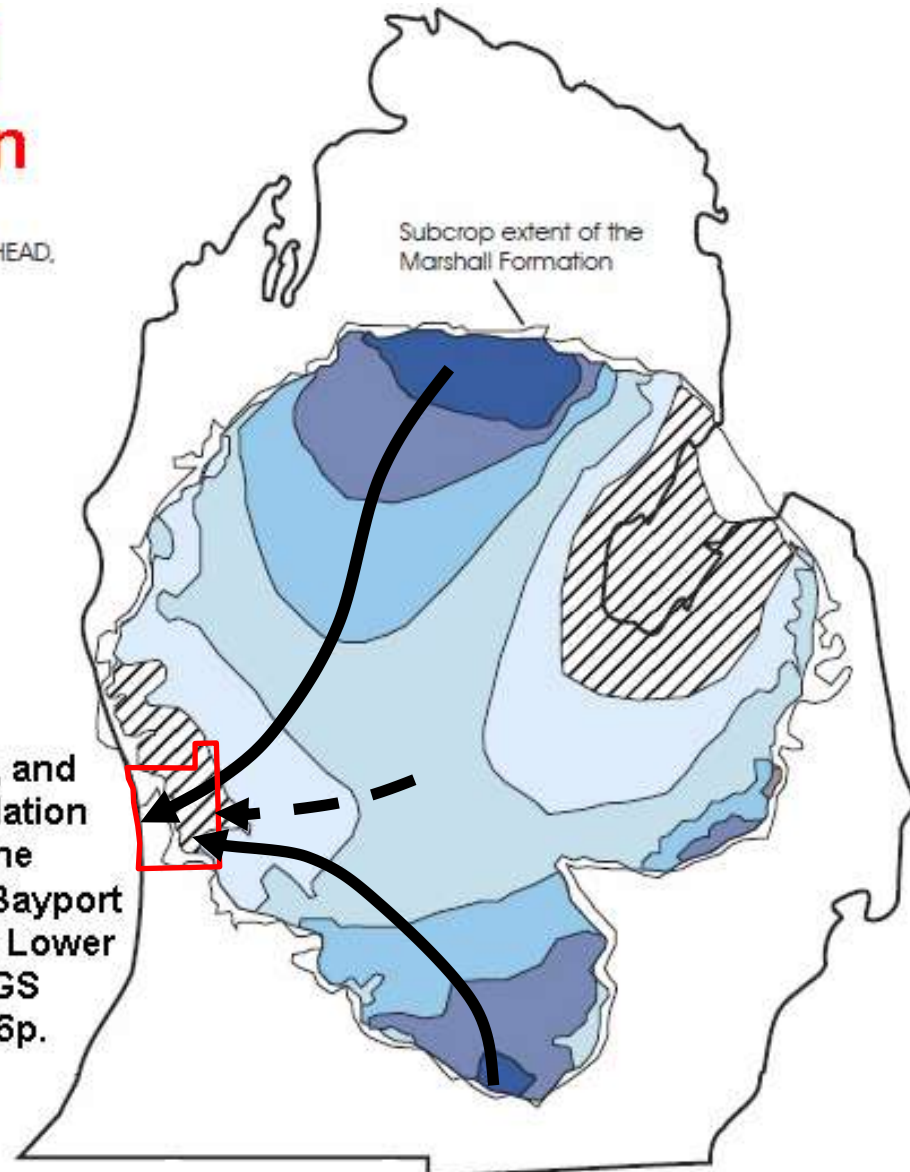
Ottawa County is part of the master discharge zone for the Marshall Formation

Marshall Formation

EQUAL ALTITUDE OF SIMULATED HYDROLOGIC HEAD, IN FEET ABOVE SEA LEVEL



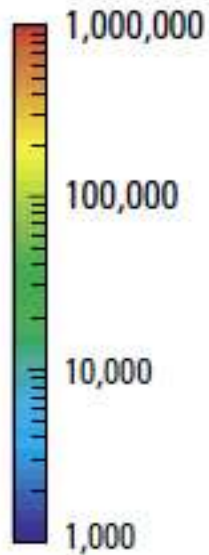
J.R. Hoaglund, G.C. Huffman, and N.G. Grannemann. 2002. Simulation of Ground-Water Flow in the Glaciofluvial, Saginaw, Parma-Bayport and Marshall Aquifers, Central Lower Peninsula of Michigan. USGS Open-File Report 00-504, 36p.



Increased withdrawals from the Marshall Formation = upwelling saline groundwater



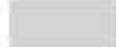
EXPLANATION

Total dissolved-solids concentration,
in milligrams per liter

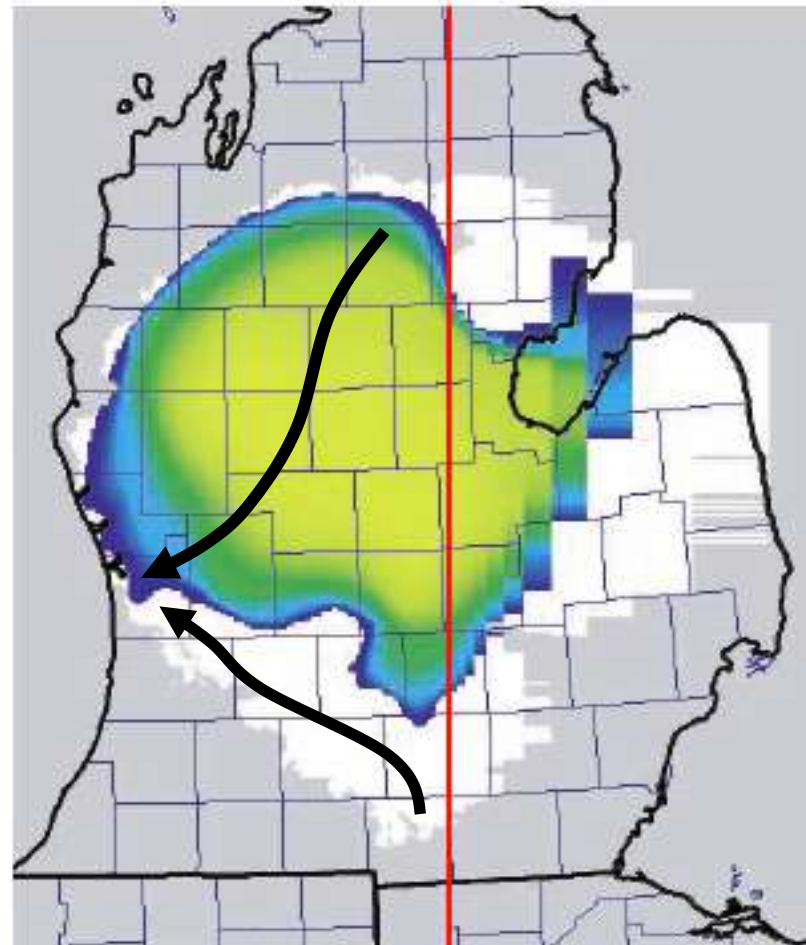


**Marshall
Formation**

Area not colored if less than
1,000 milligrams per liter

-  Innermost model domain
-  Model boundary
-  Hydrogeologic unit not present

Lampe, D.C., 2009, Hydrogeologic framework of bedrock units and initial salinity distribution for a simulation of groundwater flow for the Lake Michigan Basin: U.S. Geological Survey Scientific Investigations Report 2009-5060, 49 p.



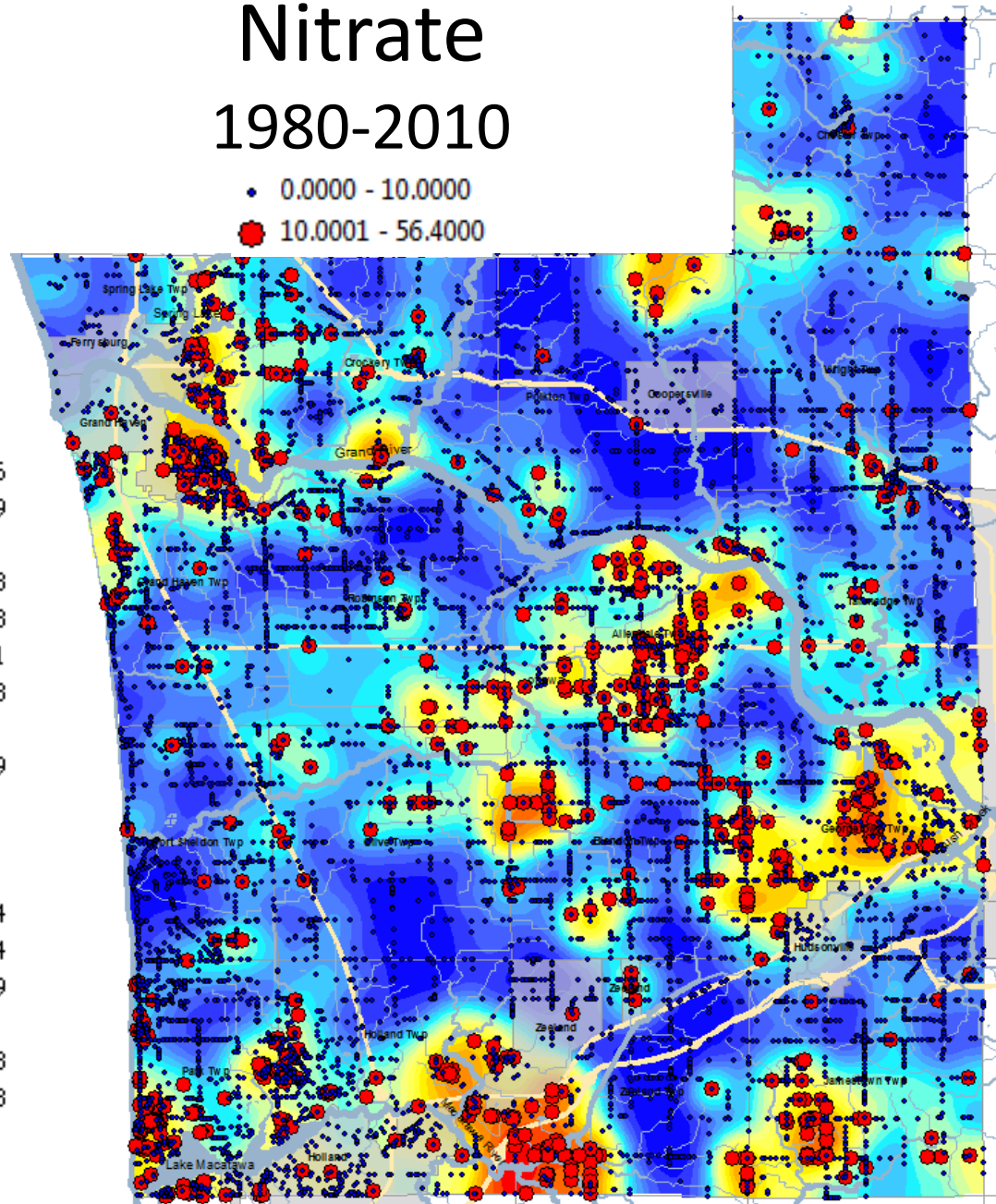
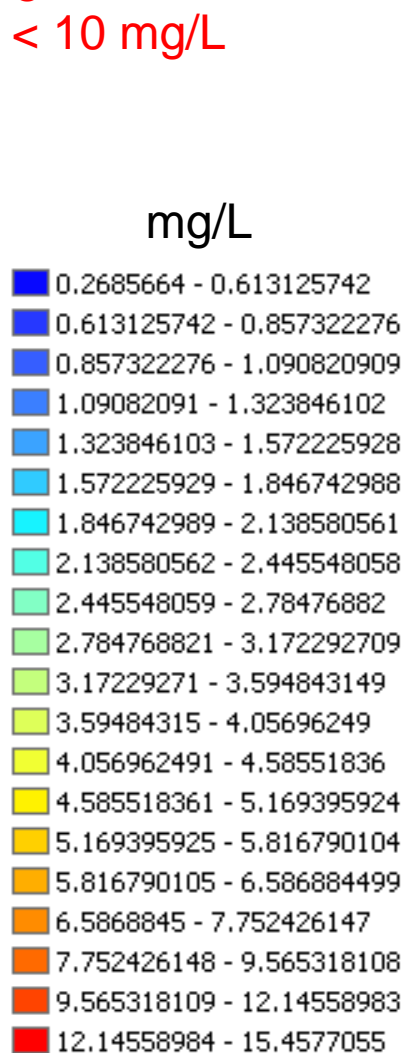
Summary of the study results:

- **Nitrate concentrations are elevated (> 3 mg/L) in many areas** of the county. There are numerous hotspots throughout the county, especially in the areas
 - just east of Ferrysburg and Grand Haven
 - south and SE of Zeeland
 - in central and western Allegan Twp
 - in central Georgetown Twp
 - in SW Jamestown Twp.
- In many of these hotspots, the nitrate concentrations are 2 - 5 times the drinking water standard of 10 mg/L!
- There is **no strong temporal trend** of nitrate concentration variations.

Nitrate

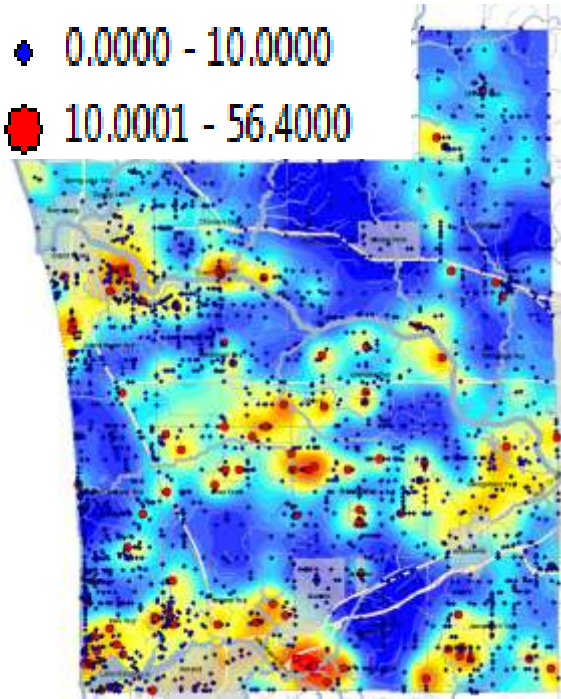
1980-2010

Drinking water standard
< 10 mg/L



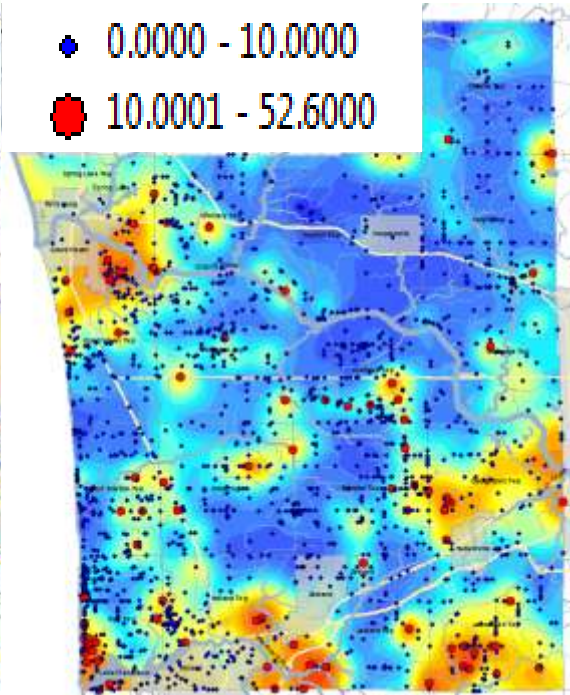
1980-1999

- 0.0000 - 10.0000
- 10.0001 - 56.4000



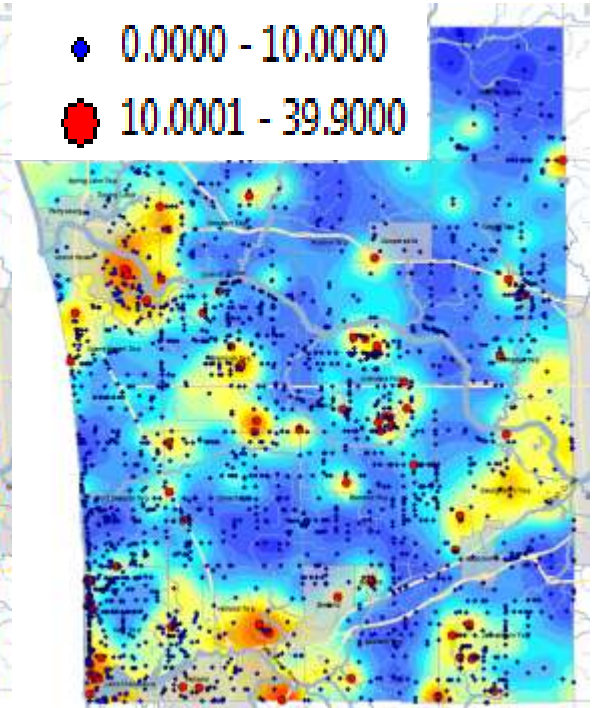
2000-2004

- 0.0000 - 10.0000
- 10.0001 - 52.6000

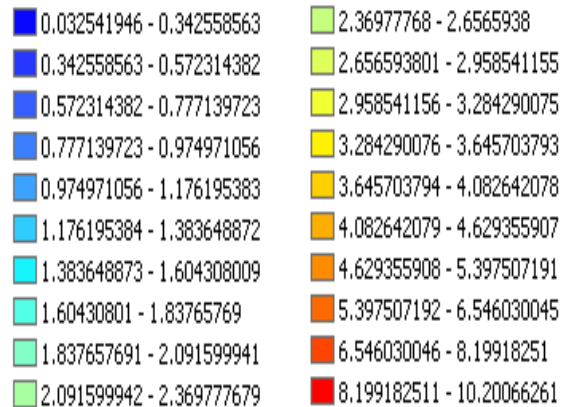


2005-2010

- 0.0000 - 10.0000
- 10.0001 - 39.9000



mg/L



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