Door County Well Monitoring Program - Fall 2020 Summary

UW Oshkosh
Environmental Research and Innovation Center

December 1st, 2020

UWO | UNIVERSITY OF WISCONSIN OSHKOSH

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

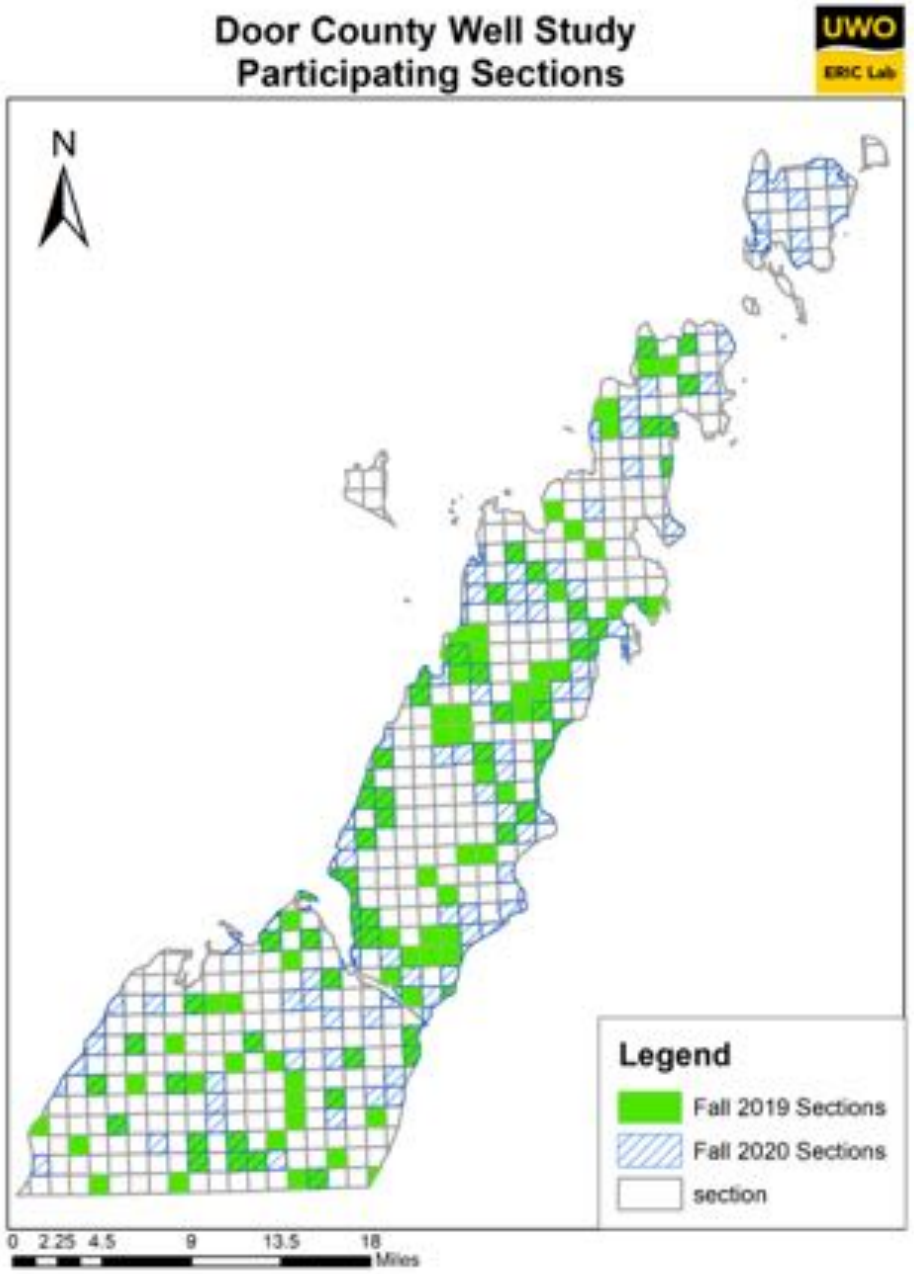
Program Goals

- Provide continued education on water resources in Door County, WI
- Provide avenue for residents and guests to have the most accurate information on their drinking water quality
- Provide reliable information to guide county resources for the protection and maintenance of drinking water resources
- Be proactive with respect to drinking water resources, rather than reactive
- Create a groundwater water quality database for Door County
- Establish trends in groundwater data over time

UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

- Target is <u>at least</u> one well per section (square mile) of Door County
- Spatially distributed data to look for trends and relationships
  - Soil type
  - Depth to bedrock
  - Water table depth
  - Land use



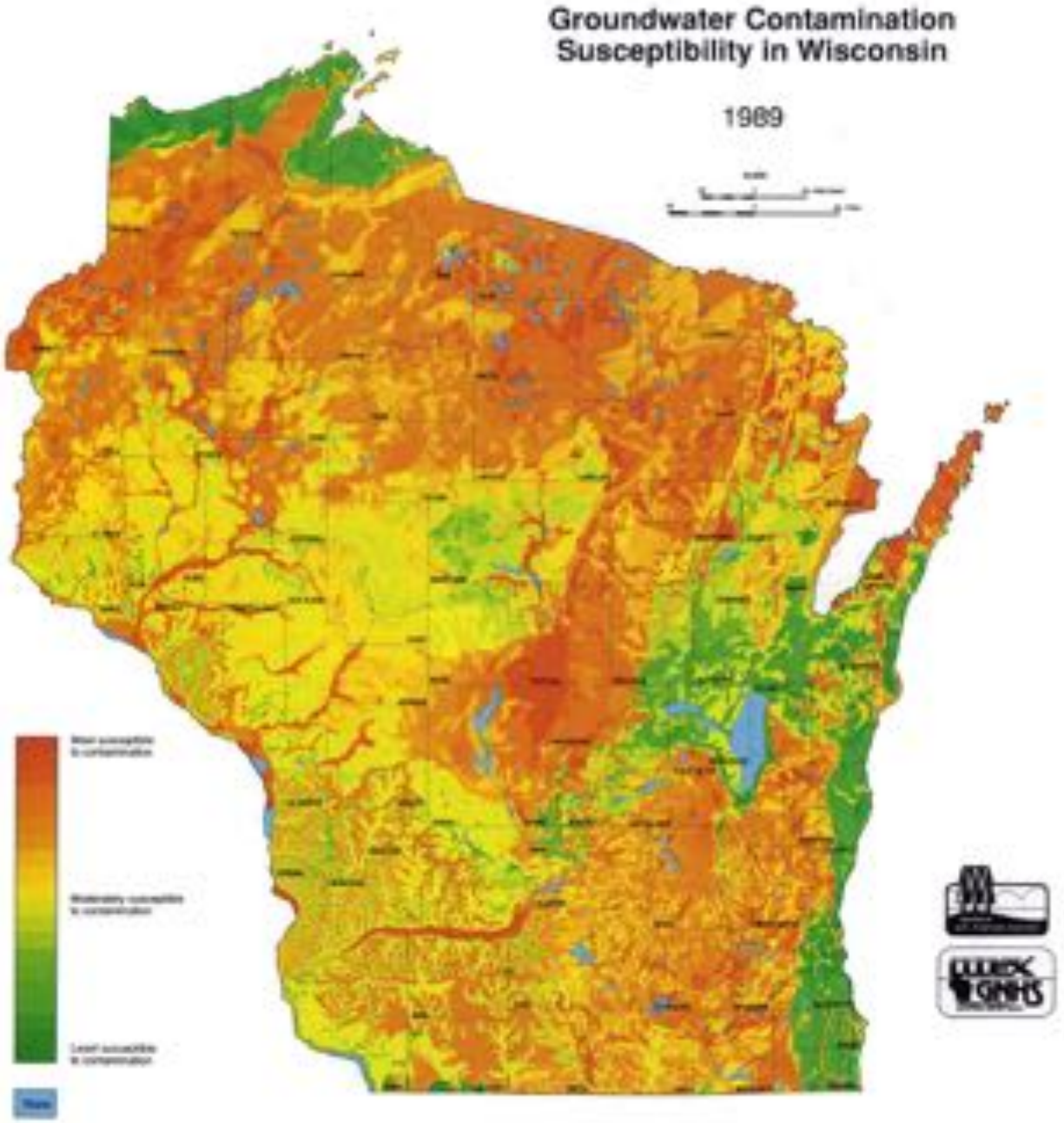
Karst Geology & Groundwater Susceptibility

UNIVERSITY OF WISCONSIN OSHKOSH

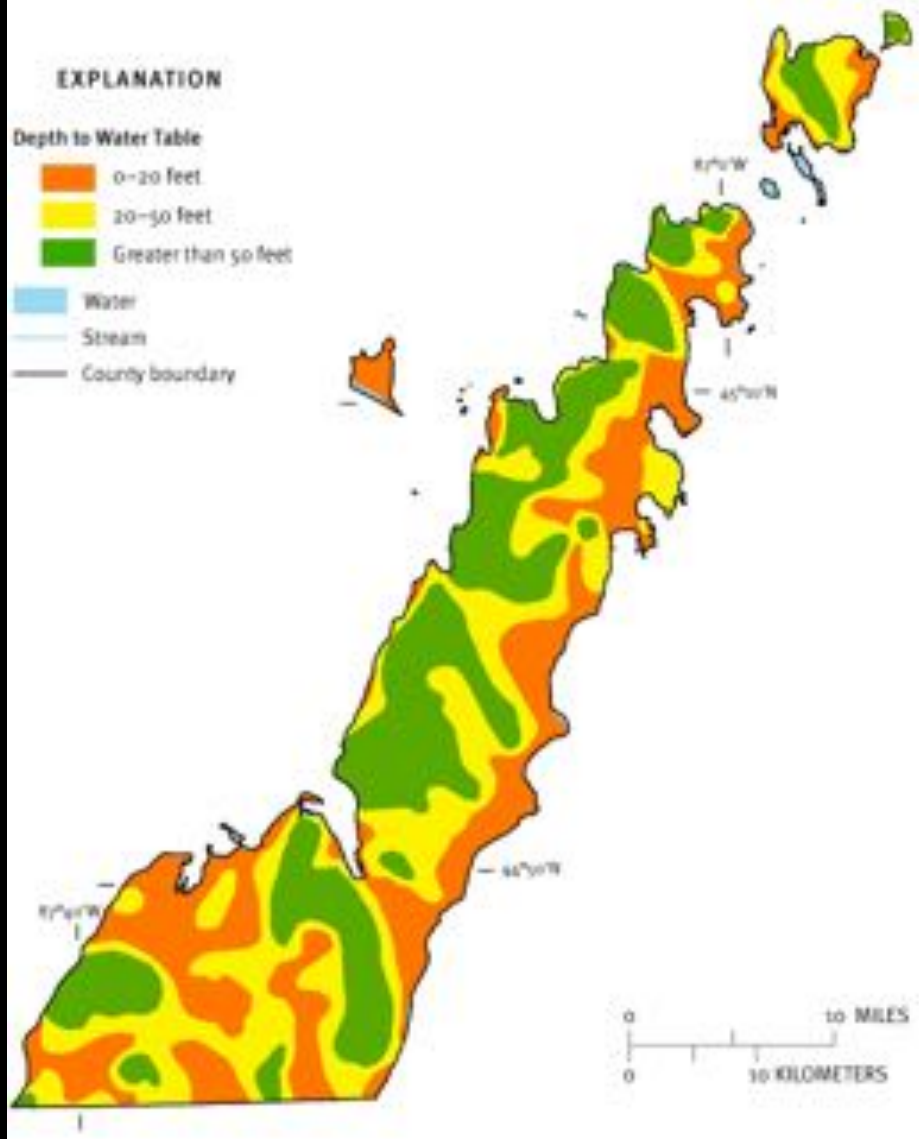
UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

- Based on factors such as: bedrock depth, soil type, depth to water table, etc.



Door County – Depth to Water Table

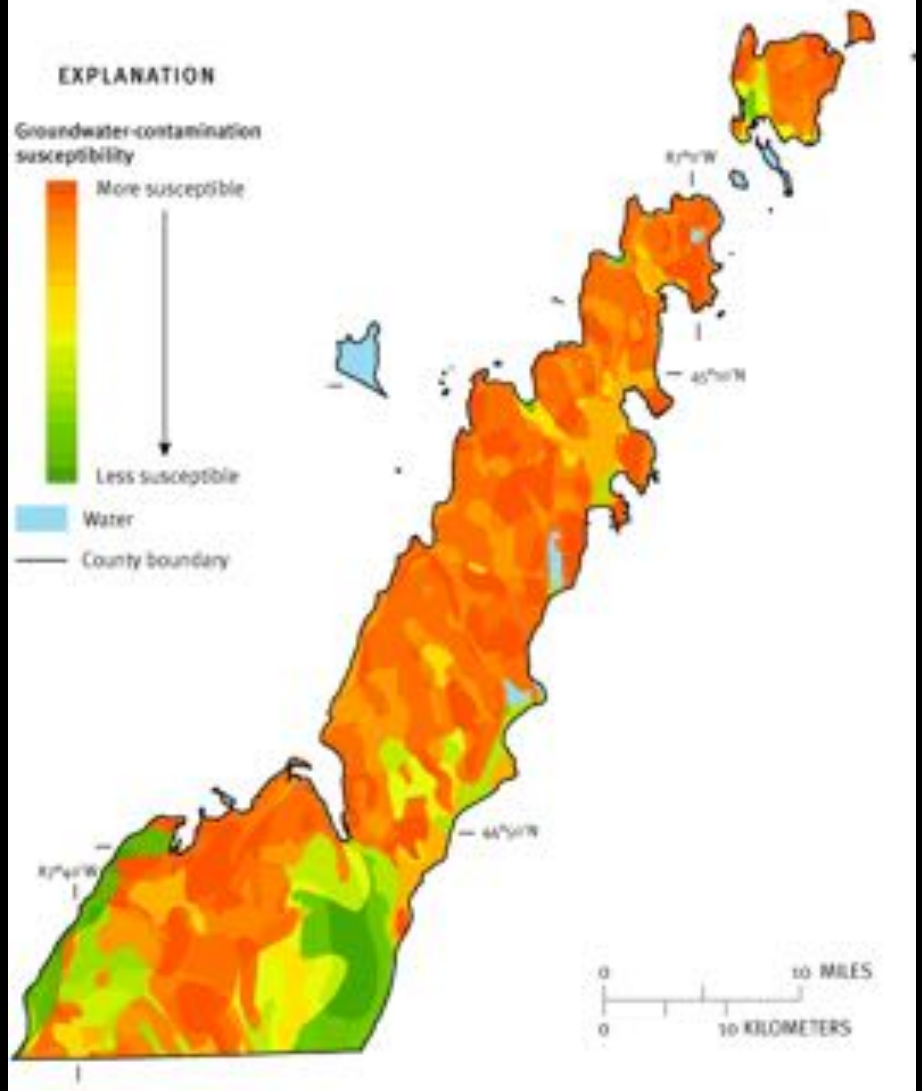


This resource characteristic map was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2003. http://wi.water.usgs.gov/gwcomp/

Door County – Groundwater-Contamination Susceptibility Analysis



This groundwater-contamination susceptibility map is a composite of five resource characteristic maps, each of which was derived from generalized statewide information at small scales, and cannot be used for any site-specific purposes.

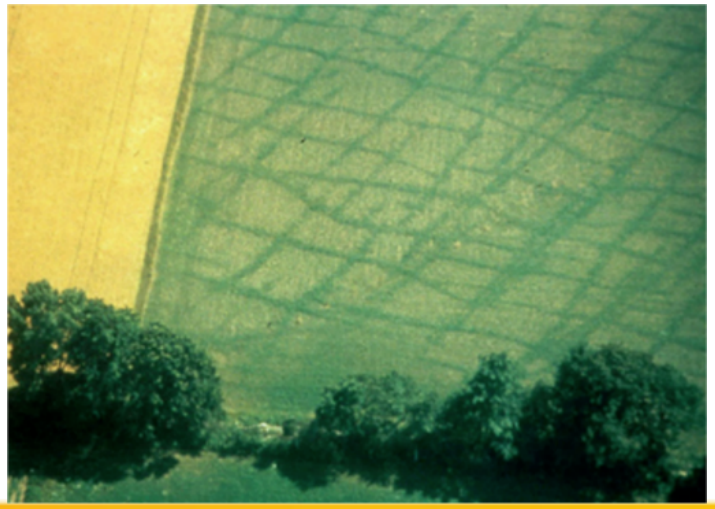
Map source: Schmidt, R.R., 1987, Groundwater contamination susceptibility map and evaluation: Wisconsin Department of Natural Resources, Wisconsin's Groundwater Management Plan Report 5, PUBL-WR-177-87, 27 p.

Figure created for the "Protecting Wisconsin's Groundwater Through Comprehensive Planning" web site, 2003. http://wi.water.usgs.gov/gwcomp/

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

What is Karst Geology?

- A landscape created when water dissolves rocks
- Made of dolomite and limestone

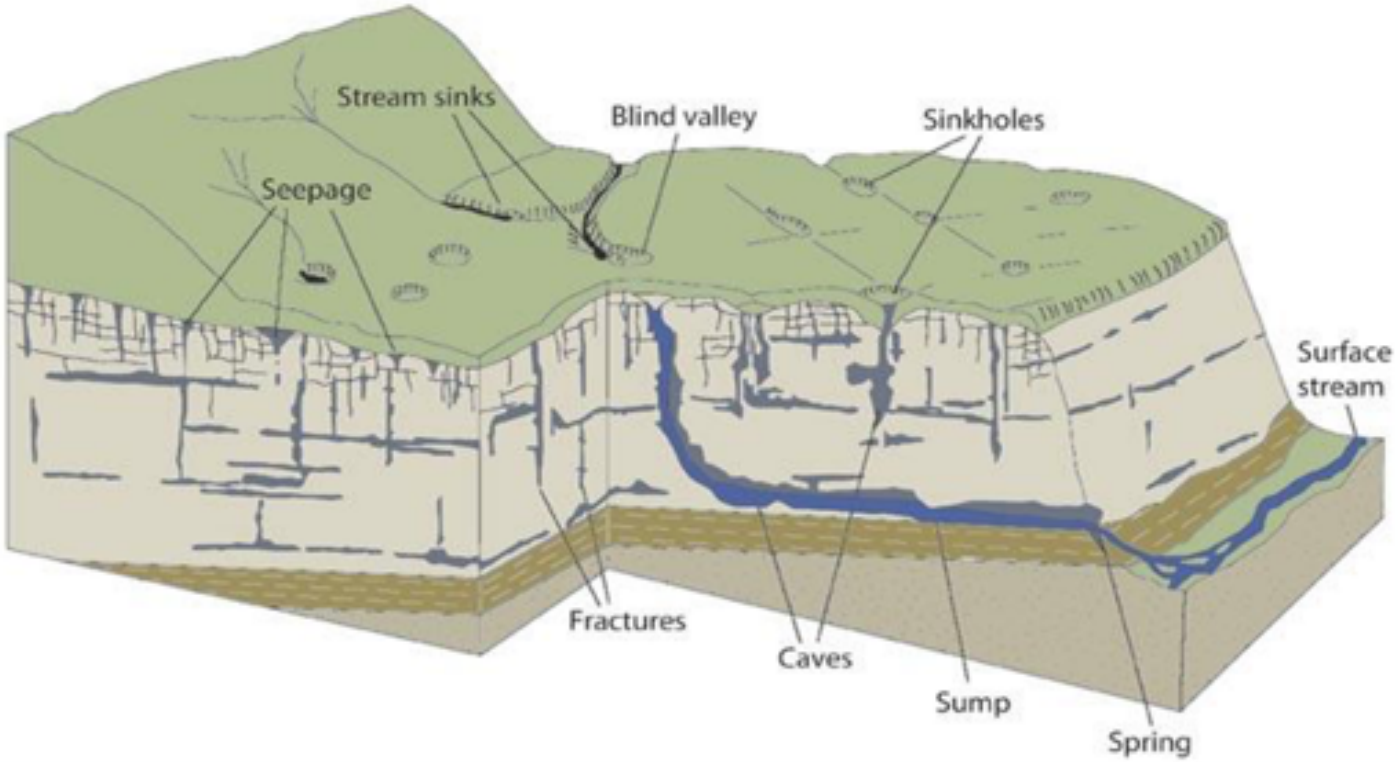


UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Karst Geology and Impact on Well Water

Karst features create direct conduits to groundwater



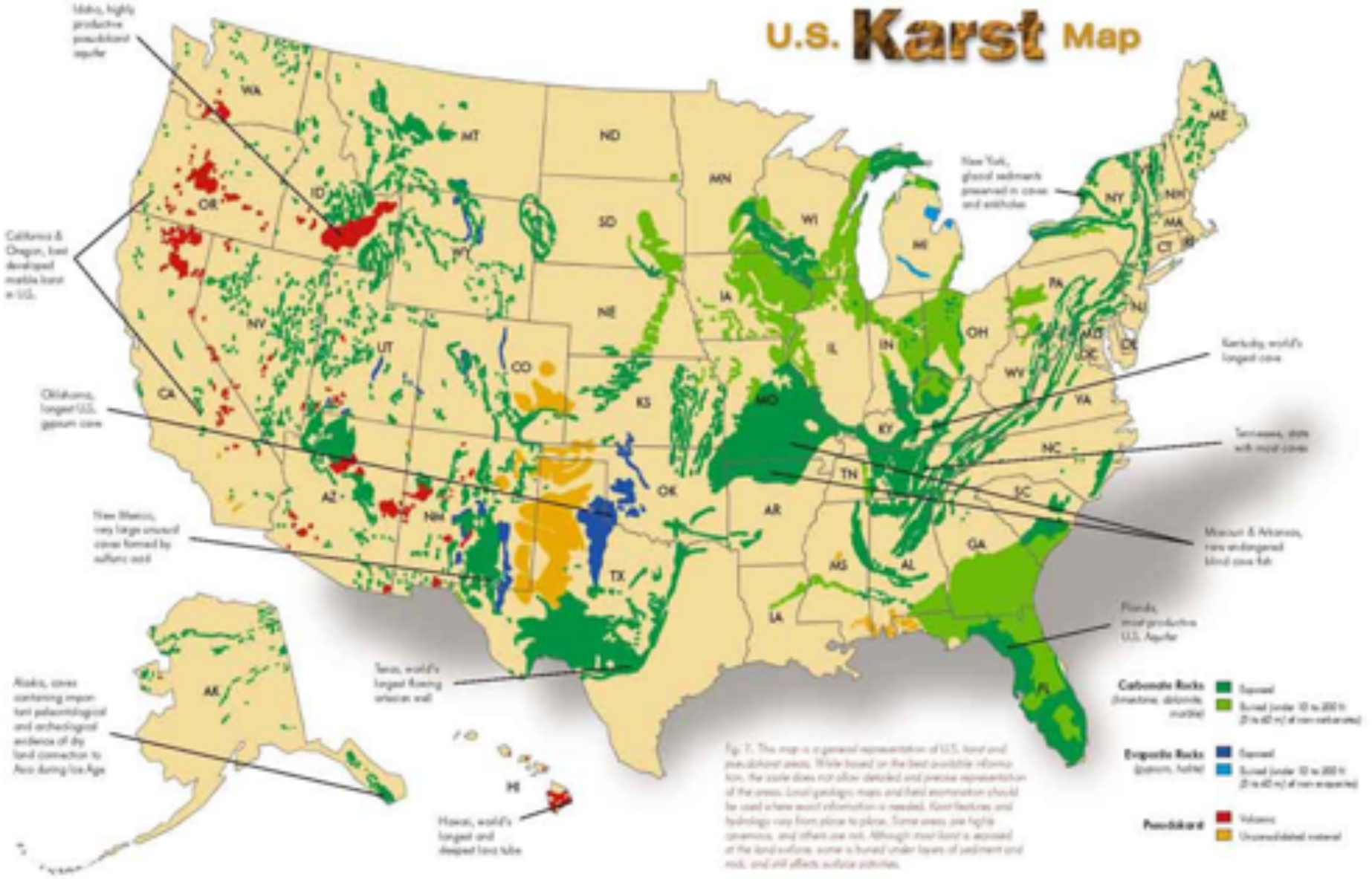


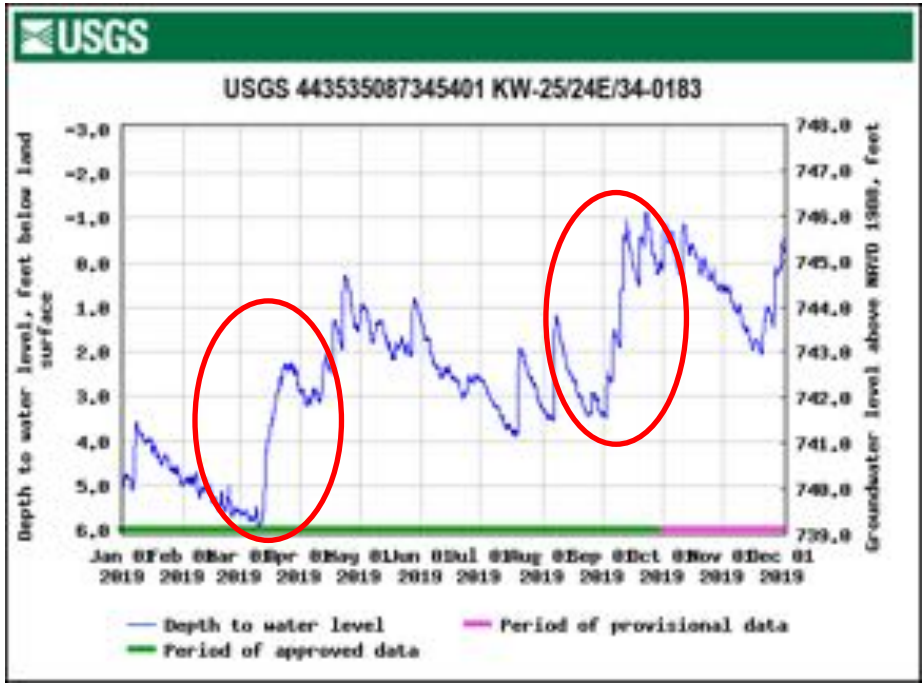
Fig. 1. This map is a general representation of U.S. karst and pseudokarst areas. While based on the best available information, the scale does not allow detailed and precise representation of the areas. Local geologic maps and field examination should be used where exact information is needed. Karst features and hydrology vary from place to place. Some areas are highly carbonkarst, and others are not. Although most karst is exposed at the land surface, some is buried under layers of sediment and rock, and still affects surface activities.

UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Groundwater Recharge

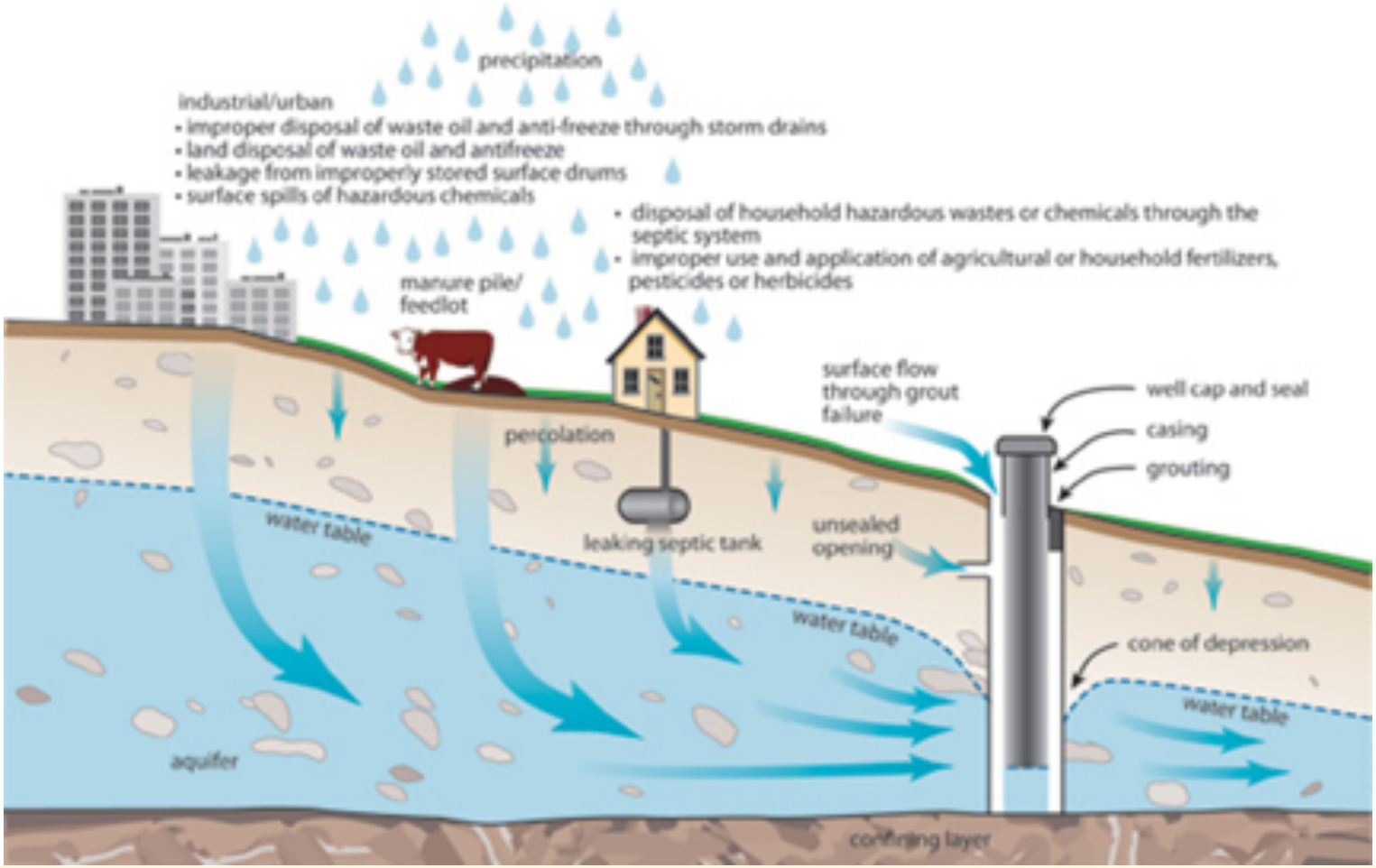
- Samples are collected in a narrow window of time (~30 hours) - **Why?**
  - Weather conditions
  - Groundwater conditions – dry period or recharge?
  - Greater effect with karst geology



UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Sources of Contamination



UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

Bacteria

- Feces contain millions of microorganisms/gram
- Pathogens (disease-causers) usually found in low numbers
- Pathogens are usually more difficult to identify in the lab than indicator organisms
- Pathogens can be bacteria (*E.coli*), viruses (Norovirus), or protozoans (*Cryptosporidium*)
- We look for fecal indicator organisms that “indicate” that a recent contamination has occurred (and that pathogens also are likely present)

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

Positive Bacteria Result

- Sources
  - Improperly constructed well
  - Older or damaged well
  - Distribution system issue (cracked pipe, dead end, etc)
  - Outside source of bacteria (agriculture, animal waste, human waste)

UNIVERSITY OF WISCONSIN OSHKOSH

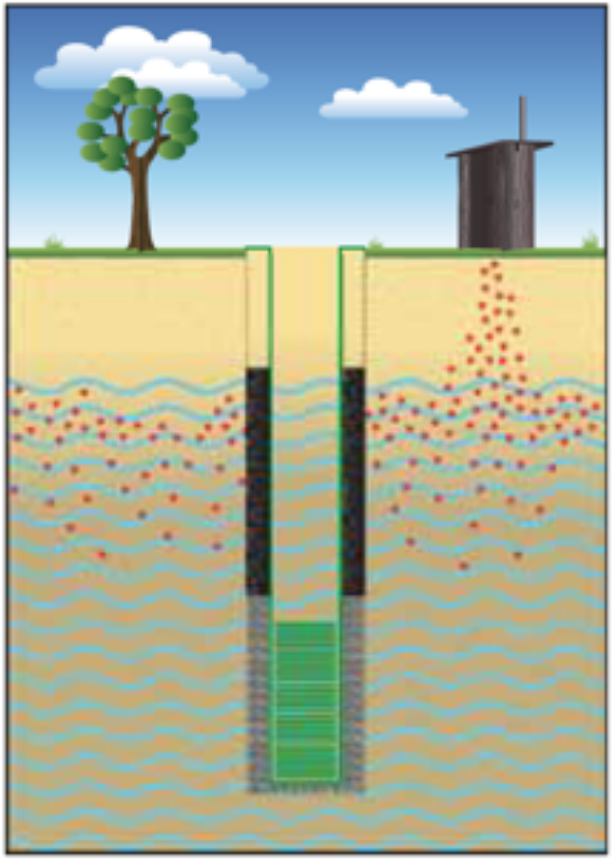
Department of Engineering Technology

Positive Bacteria Result

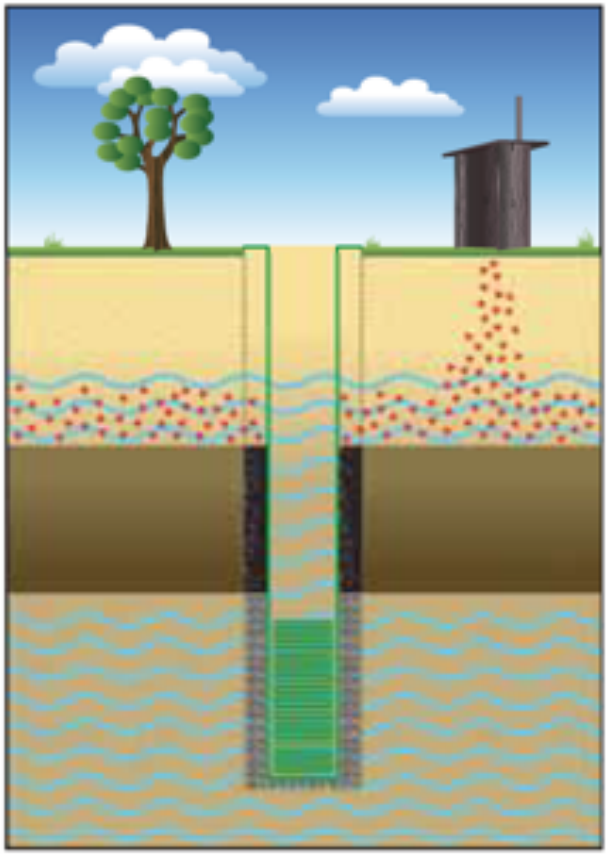
UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Properly Constructed Wells

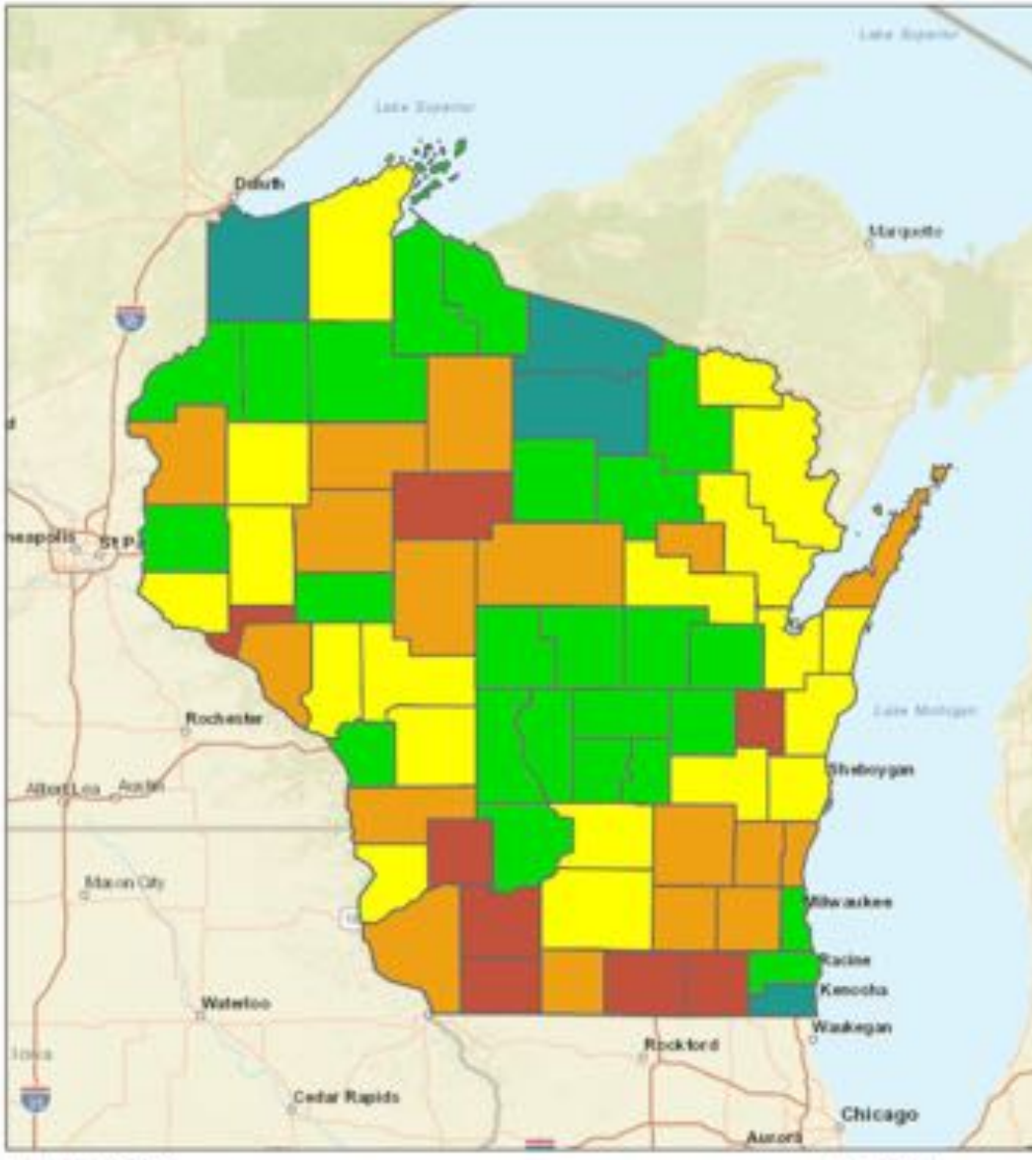


Single Aquifer Sanitary Seal



Multiple Aquifer Sanitary Seal

% Positive Bacteria

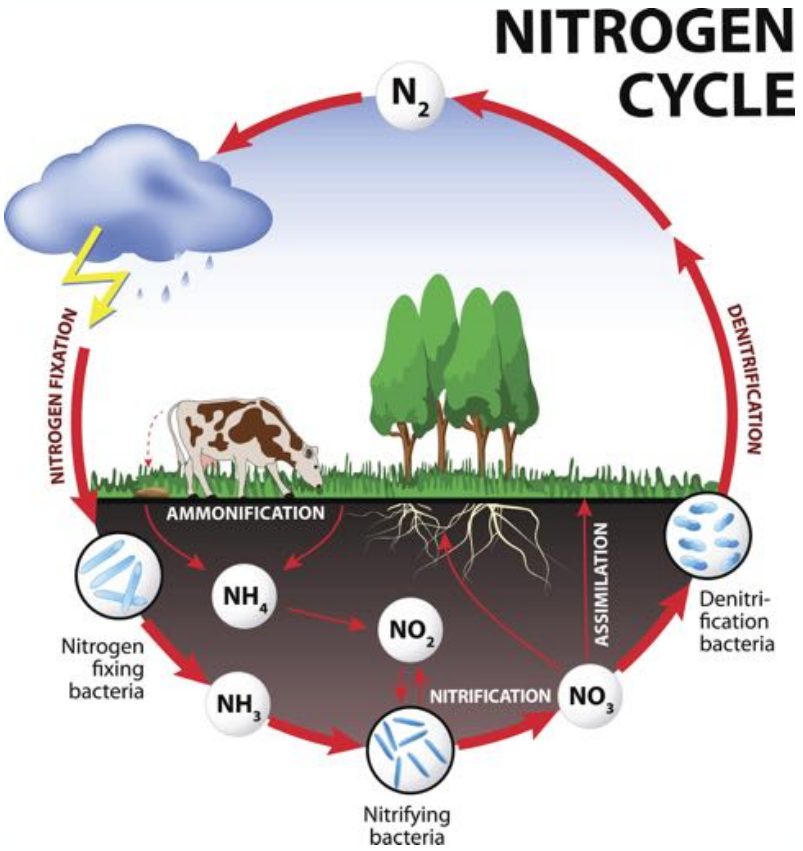


UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Nitrate

- Formed when nitrogen from ammonia or other sources combines with oxygen in water
- Soluble in water – runoff

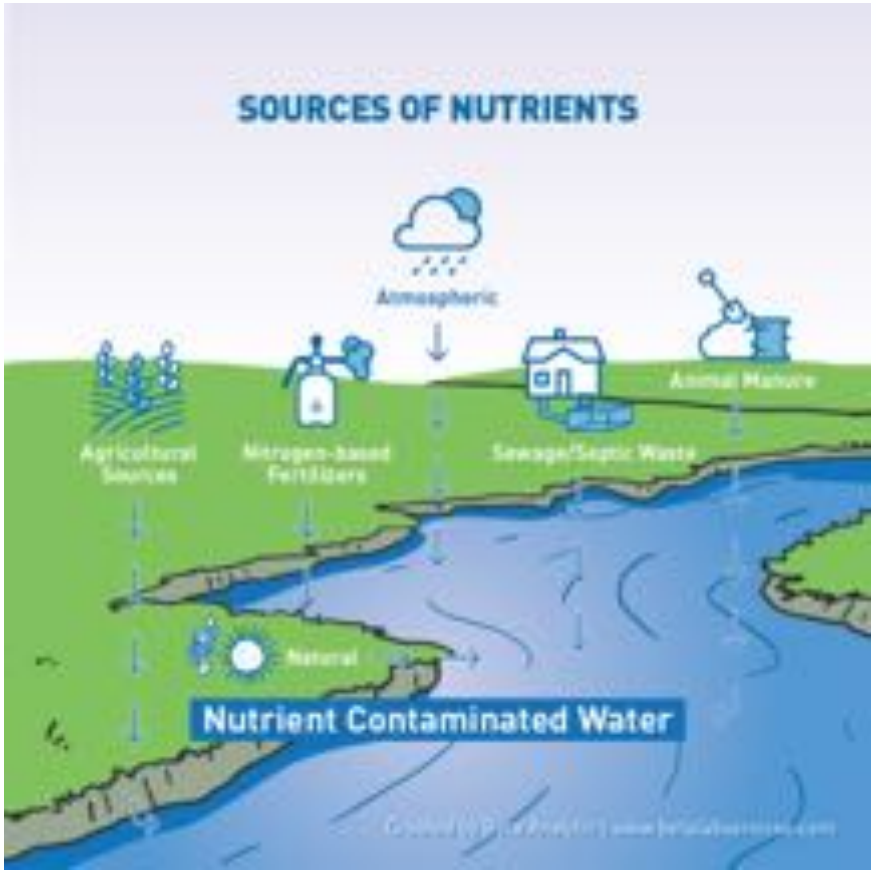


UNIVERSITY OF WISCONSIN OSHKOSH

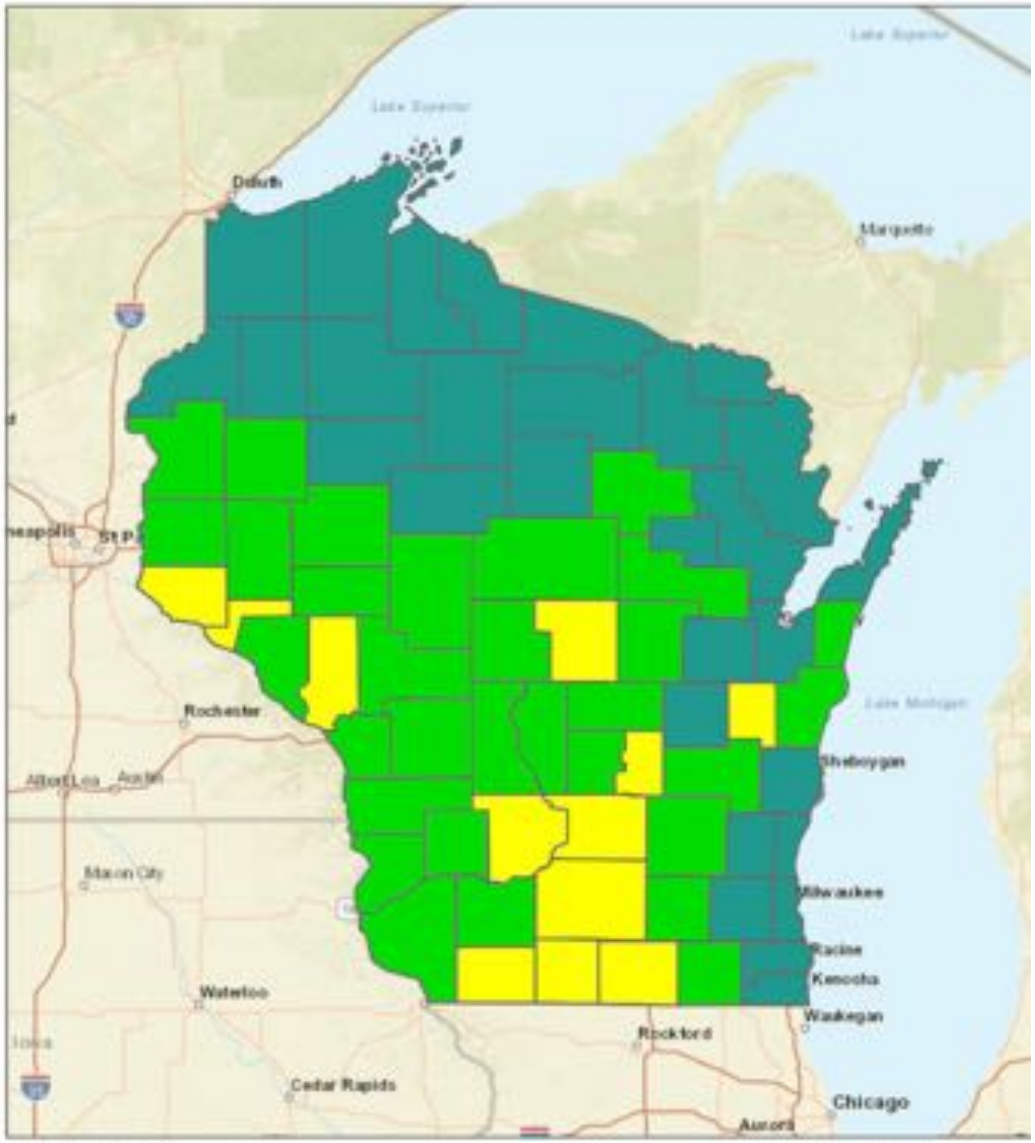
Department of Engineering Technology

Nitrate

- Sources
  - Agriculture (manure and/or fertilizer)
  - Sewage/Septic
  - Animal waste
  - Atmospheric (trace amounts)
  - Lawn care (fertilizer)
  - Very low naturally occurring nitrate



Average Nitrate



November 26, 2019

Nitrate - mg/l N - Average by County

- ... 2.0 mg/l as N
- 2.1 - 5.0
- 5.1 - 10.0

1:4,622,324

0 25 50 100 mi

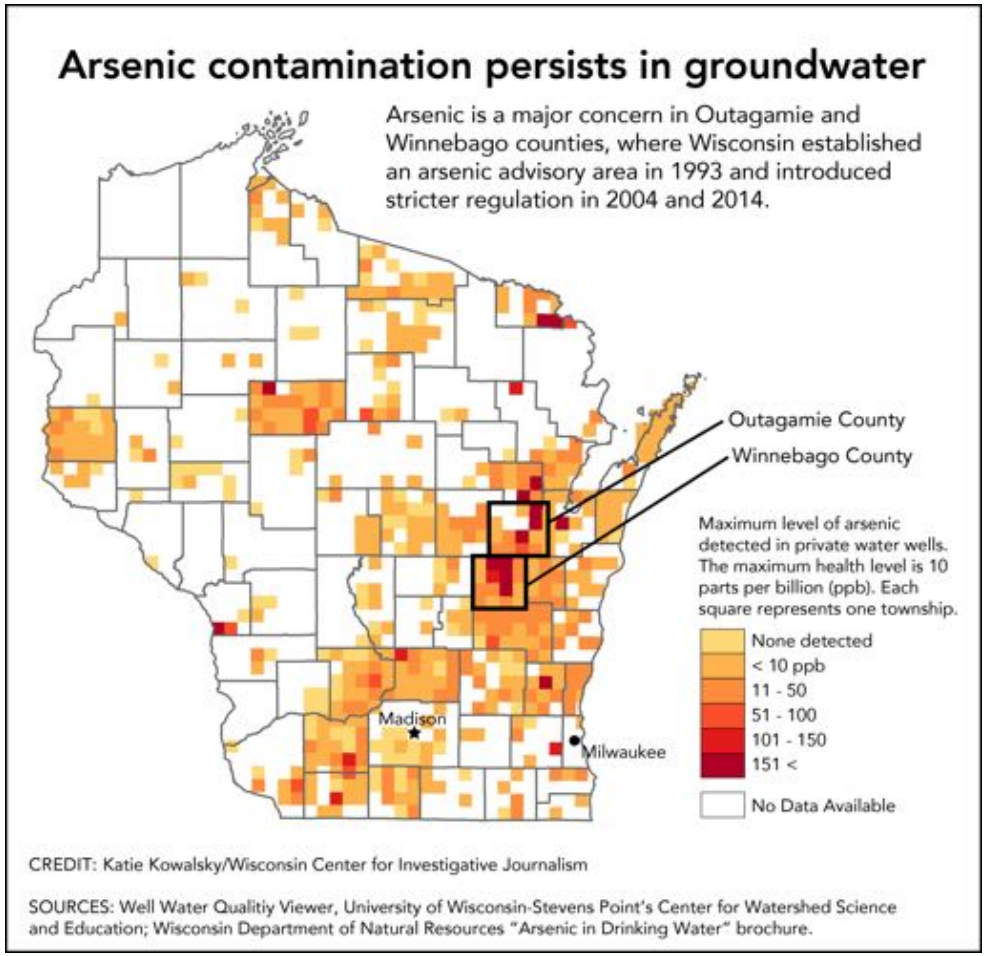
0 40 80 160 km

UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Arsenic

- Sources
  - Most naturally occurring in bedrock
  - Lead arsenate pesticides were used in orchards from 1890s-1960s (binds to soil, does not usually migrate into groundwater)



How to Interpret Results

UNIVERSITY OF WISCONSIN OSHKOSH

How much is one part per ...

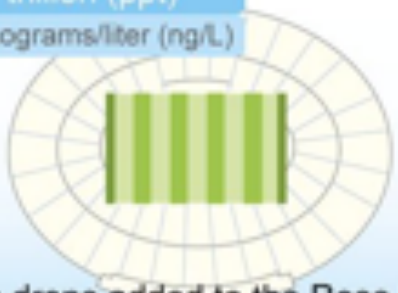
million (ppm)
milligrams/liter (mg/L)

= three drops added to a 42-gallon barrel

billion (ppb)
micrograms/liter (µg/L)

= one drop added to a large tanker truck

trillion (ppt)
nanograms/liter (ng/L)



= ten drops added to the Rose Bowl (filled with water)

quadrillion (ppq)
picograms/liter (pg/L)

= two teaspoons added to the Great Salt Lake of Utah

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

How to Interpret Results

Bacteria

- Tested for Coliform and *E. coli*
- Negative or 0: no bacteria present in the sample, safe to drink
- Positive or any #: bacteria present in the sample, unsafe to drink

Nitrate

- ND: nitrate was not detected in the sample
- Between 0-10 mg/L: nitrate was detected in the “safe” range
- Over 10 mg/L: nitrate was detected over the “safe” range

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

How to Interpret Results

Arsenic

- ND: arsenic was not detected in the sample
- Between 0-10 µg/L: arsenic was detected in the “safe” range
- Over 10 µg/L: arsenic was detected over the “safe” range

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

How to Interpret Results

Cumulative

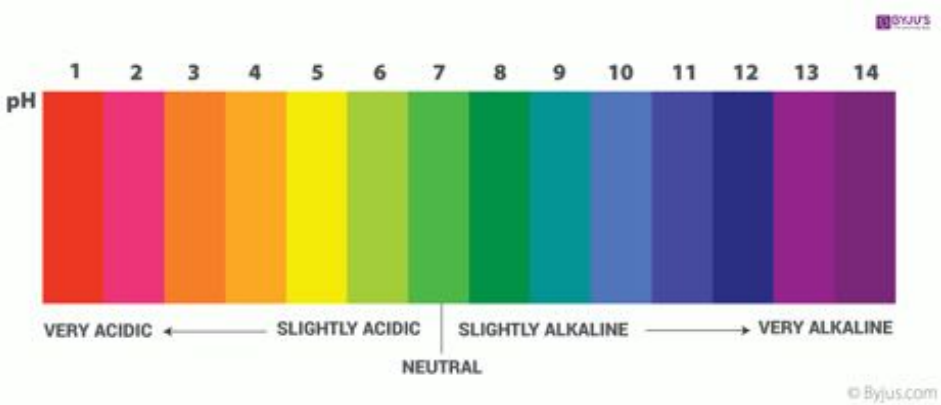
- pH: measure of the acid-base balance. Carbon dioxide concentration and an increase in temperature can decrease the pH of water.
- Iron: a metal element that makes up about 5% of the earth's crust. It is not considered hazardous to health.
- Hardness: water's ability to react with soap and produce a lather. Caused by ions such as calcium and magnesium. It is not considered hazardous to health.
- Alkalinity: water's ability to neutralize acids. Can be affected by natural deposits in the earth and industrial practices. It is not considered to be hazardous to health.

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

How to Interpret Results

Cumulative

- pH



- Iron: Recommended level is less than 0.3 mg/L

- Hardness

Water Hardness Scale		
Grains/Gal	**mg/L & ppm**	**Classification**
Less than 1	Less than 17.1	**Soft**
1 – 3.5	17.1 - 60	**Slightly Hard**
3.5 - 7	60 - 120	**Moderately Hard**
7 - 10	120 - 180	**Hard**
Over 10	Over 180	**Very Hard**

- Alkalinity: Recommended level is between 75-200mg/L

2020 Results

UNIVERSITY OF WISCONSIN OSHKOSH

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

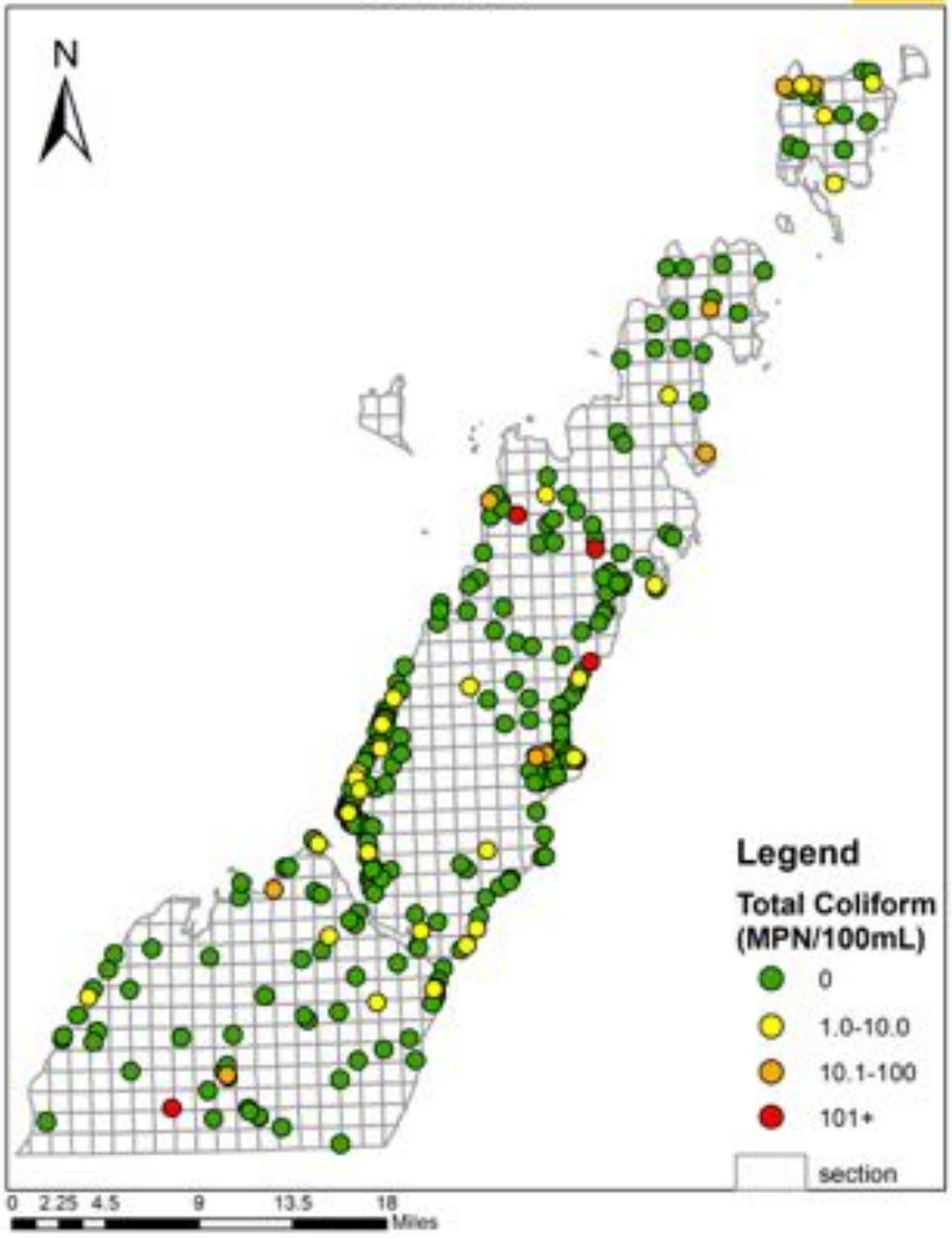
Fall 2020 Sampling Results

Coliform

Coliform Result (MPN/100 mL)	# Samples	% Samples
0	254	86
1-10	28	9
10-100	9	3
100+	4	1
n=295		

Door County Total Coliform Results: Fall 2020

UWO
ERIC Lab



UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

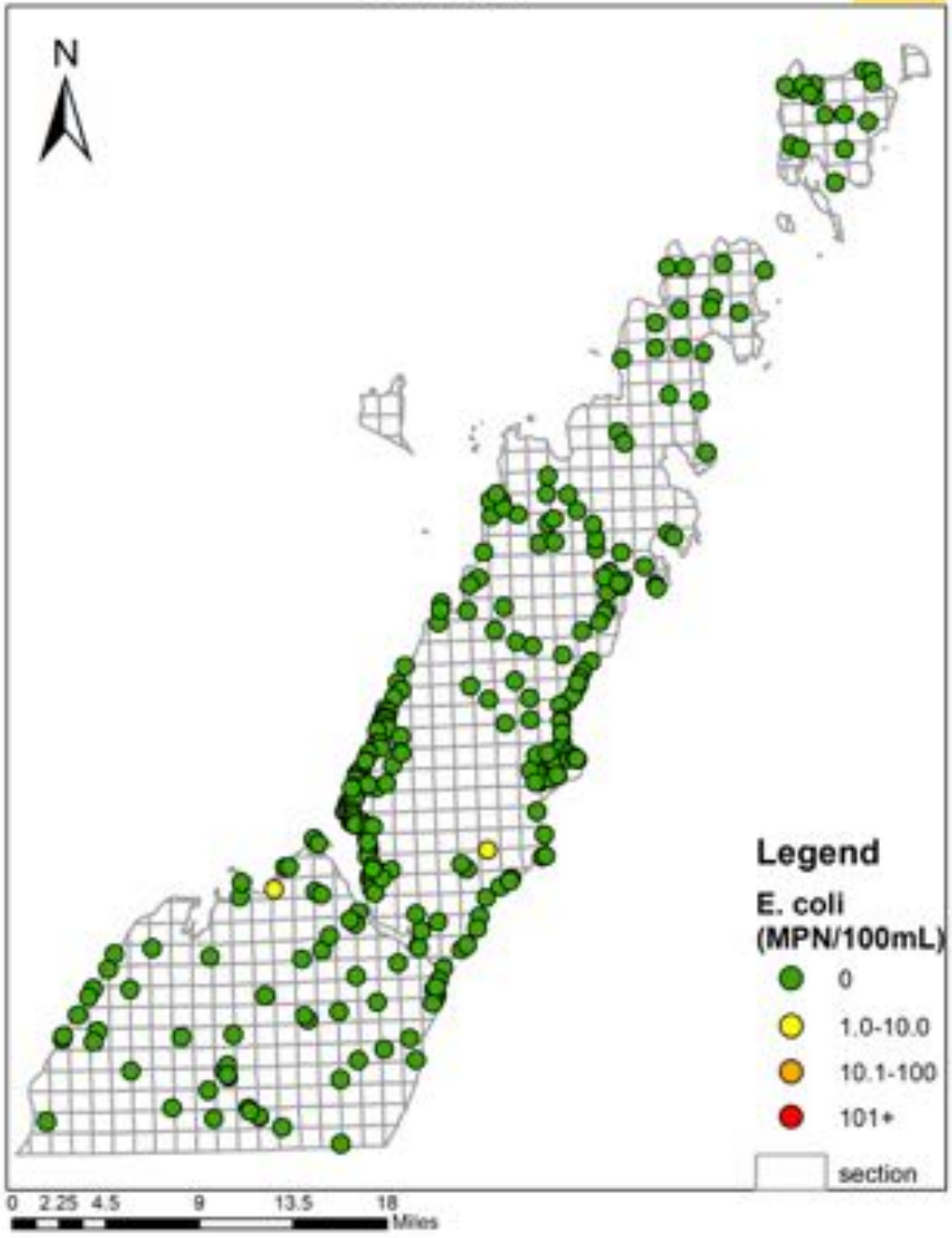
Fall 2020 Sampling Results

E coli

E coli **Result (MPN/100 mL)**	**# Samples**	**% Samples**
0	293	99
1-10	2	1
10-100	0	0
100+	0	0
n=295		

Door County E. coli Results: Fall 2020

UWO
ERIC Lab



UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

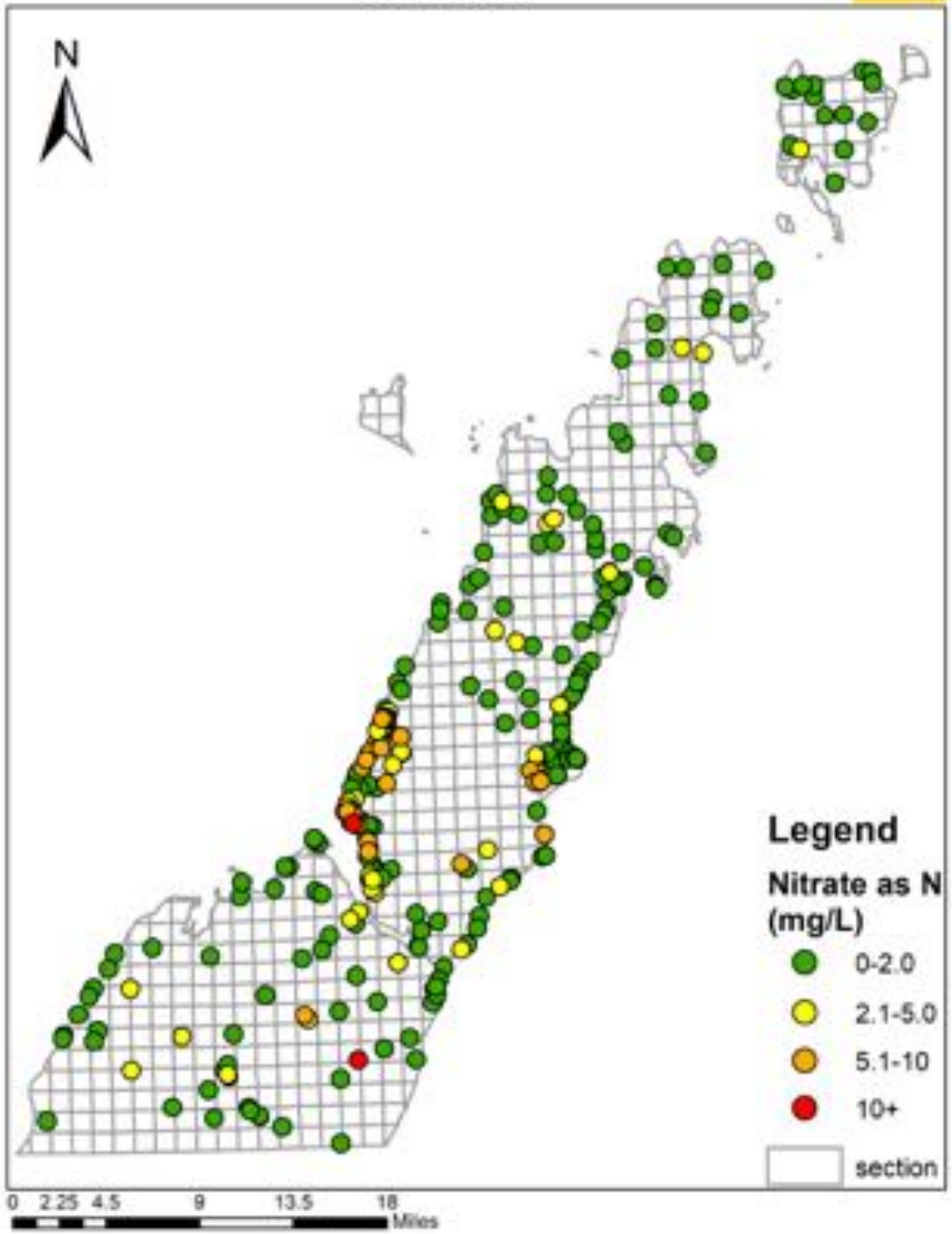
Fall 2020 Sampling Results

Nitrate

Nitrate Result (mg/L)	# Samples	% Samples
Less than 2	206	72
2-5	46	16
5-10	34	12
10+	2	1
n=288		

Door County Nitrate Results: Fall 2020

UWO
ERIC Lab



UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

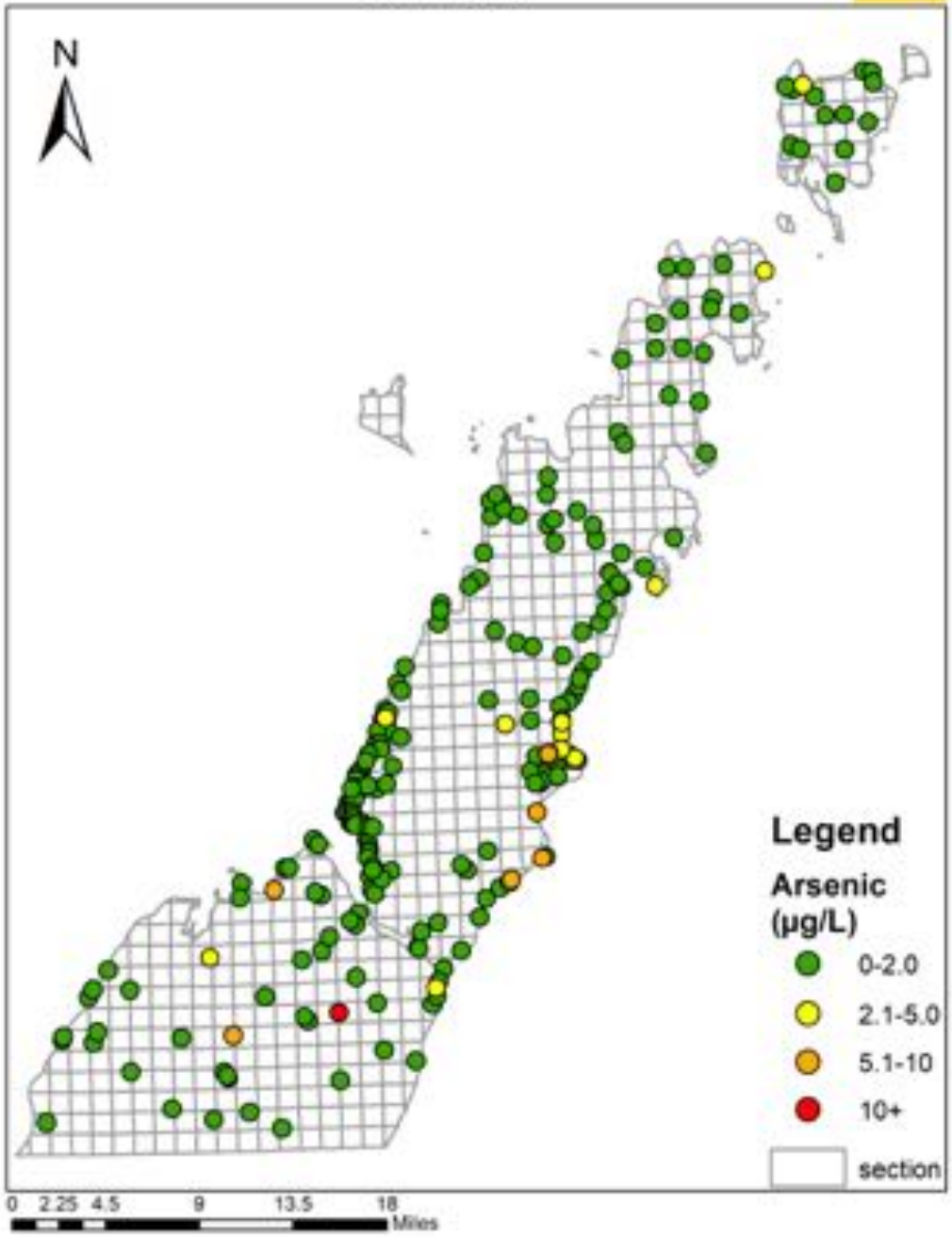
Fall 2020 Sampling Results

Arsenic

Arsenic Result (µg/L)	# Samples	% Samples
Less than 2	214	90
2-5	15	6
5-10	7	3
10+	1	<1
n=237		

Door County Arsenic Results: Fall 2020

UWO
ERIC Lab



UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

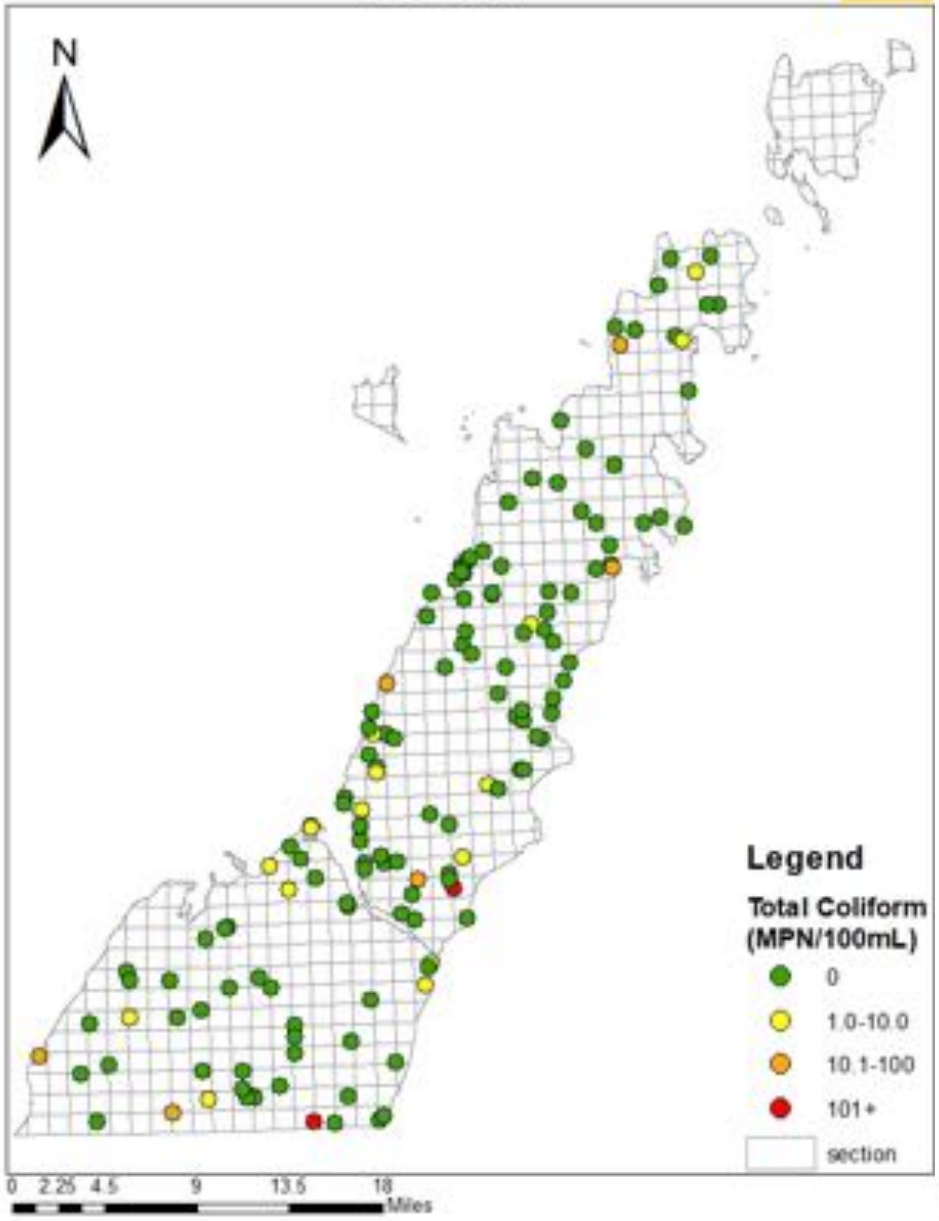
Previous County-Wide Efforts

Water Quality Standard	2020 Door County Results	2019 Door County Results	Previous Door County Results (Average)	Wisconsin**
Total Coliform (>0 MPN/100 ml)	14%	16%	18%	17%
E. coli (> 0 MPN/100 ml)	1%	0%	6%	5%
Nitrate (>10 mg/L)	1%	2%	2%	8%
Arsenic (>10 µg/L)	<1%	0%	3%	5%

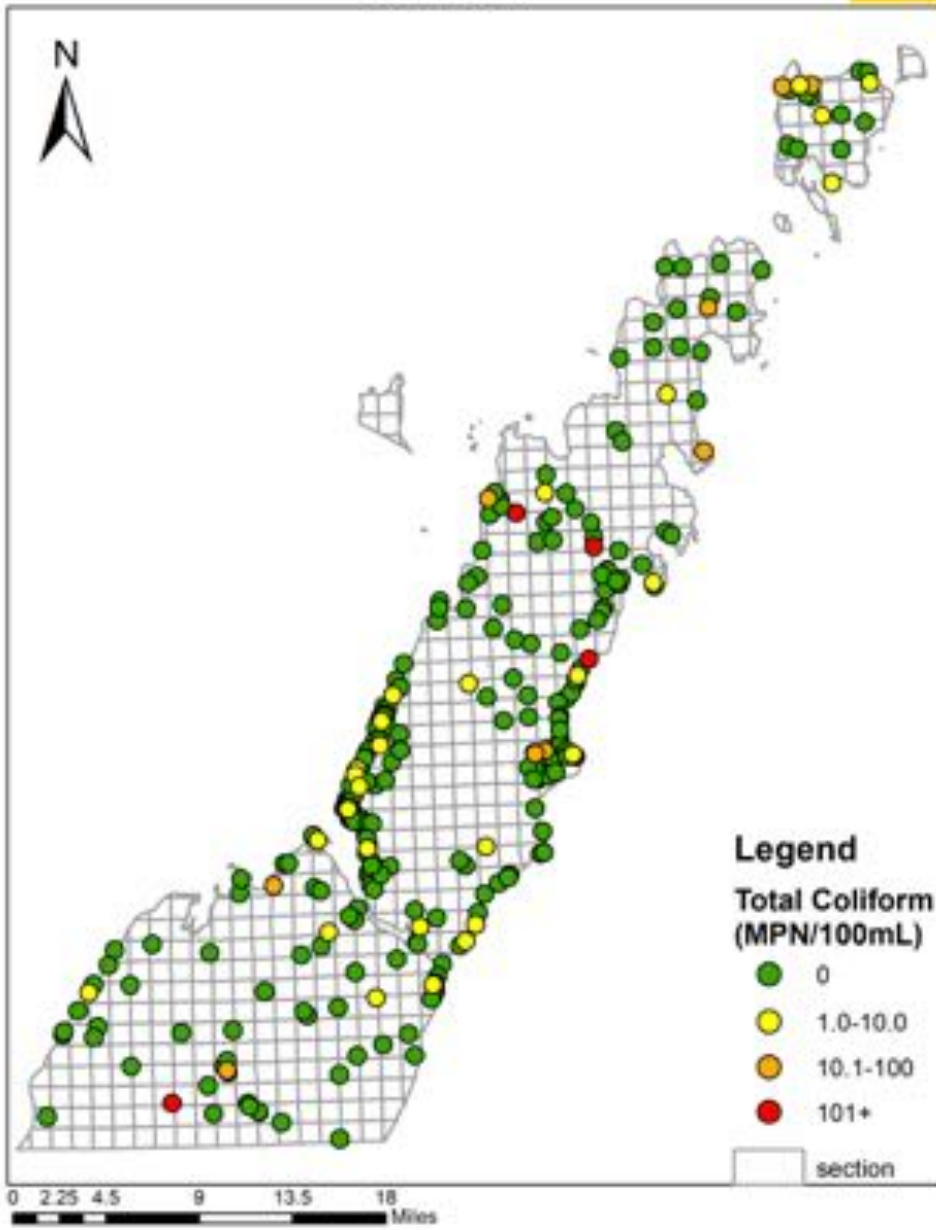
*Data derived from UWSP Well Viewer, UWO 2015 (480 samples) & 2016 (392 samples) community program,

**Data derived from the Wisconsin Groundwater Coordinating Council Report & UWSP Well Viewer

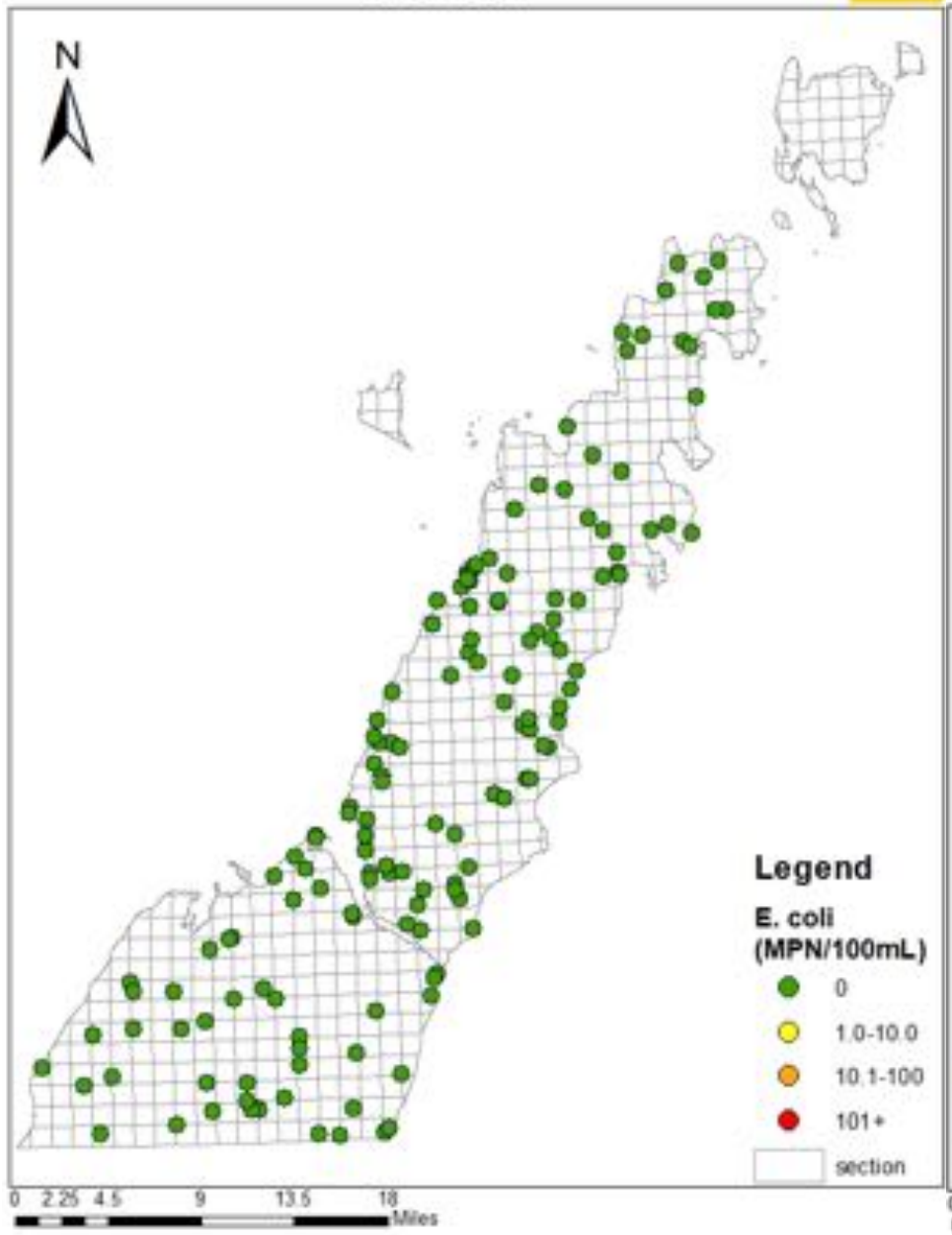
Door County Total Coliform Results: Fall 2019



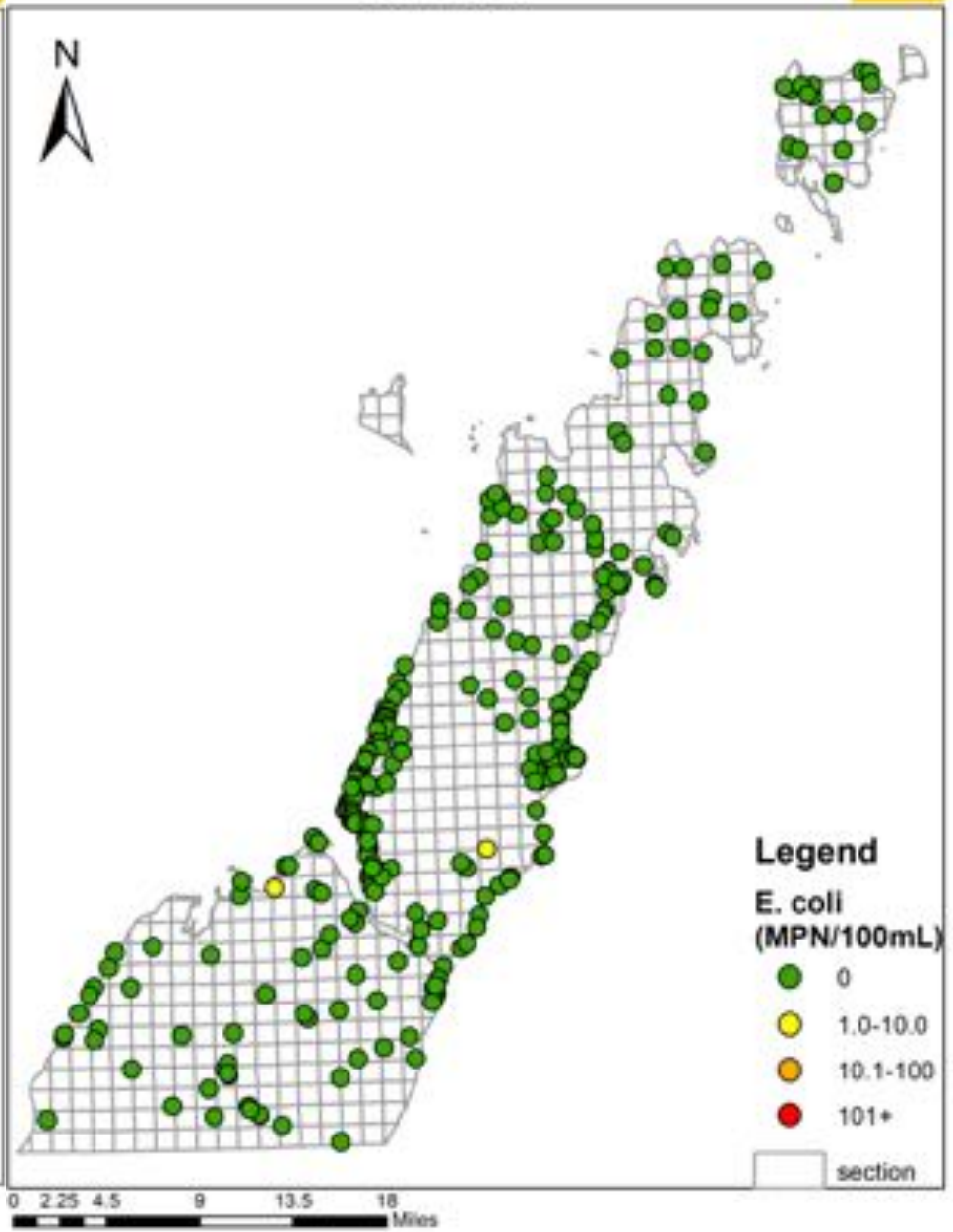
Door County Total Coliform Results: Fall 2020



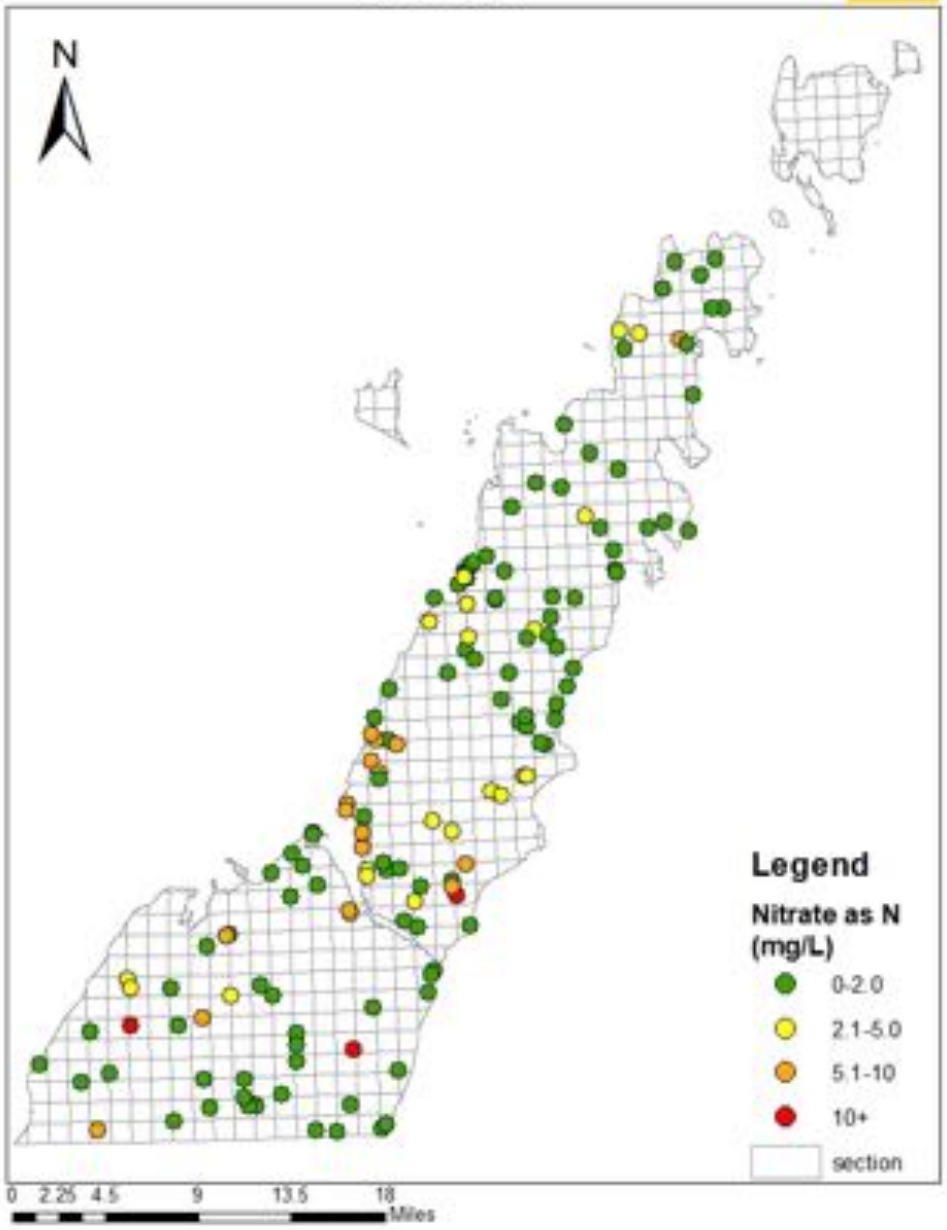
Door County E. coli Results: Fall 2019



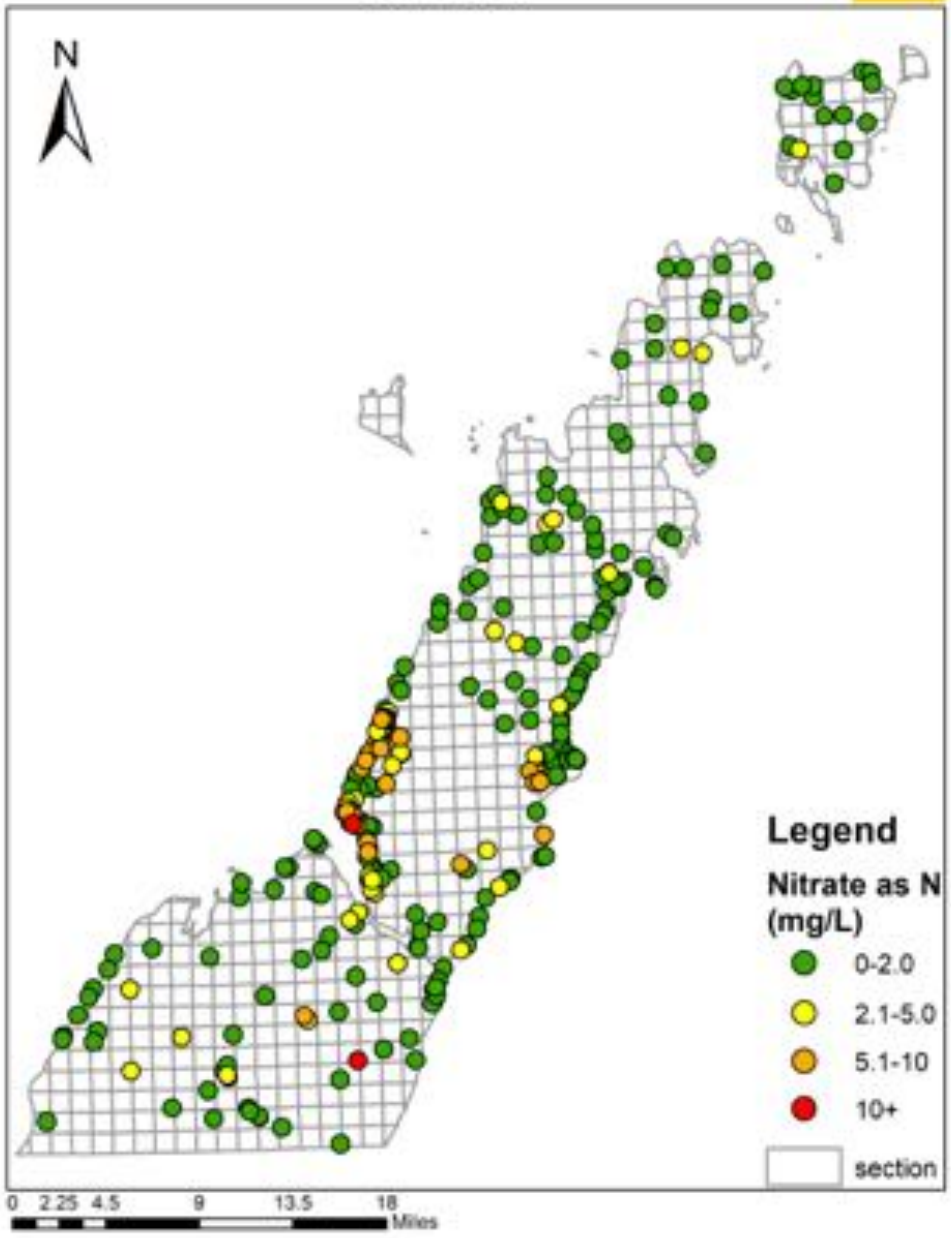
Door County E. coli Results: Fall 2020



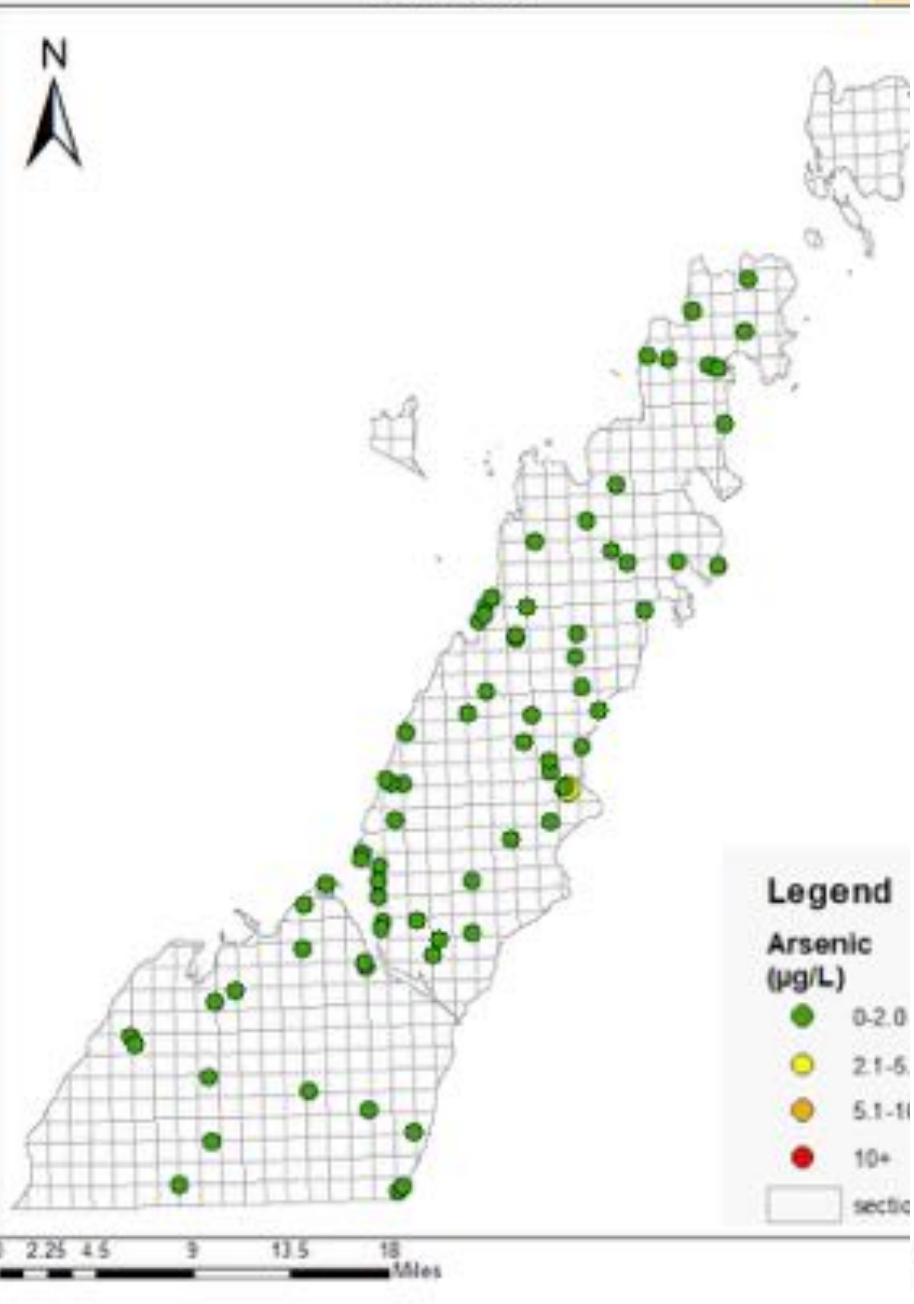
Door County Nitrate Results: Fall 2019



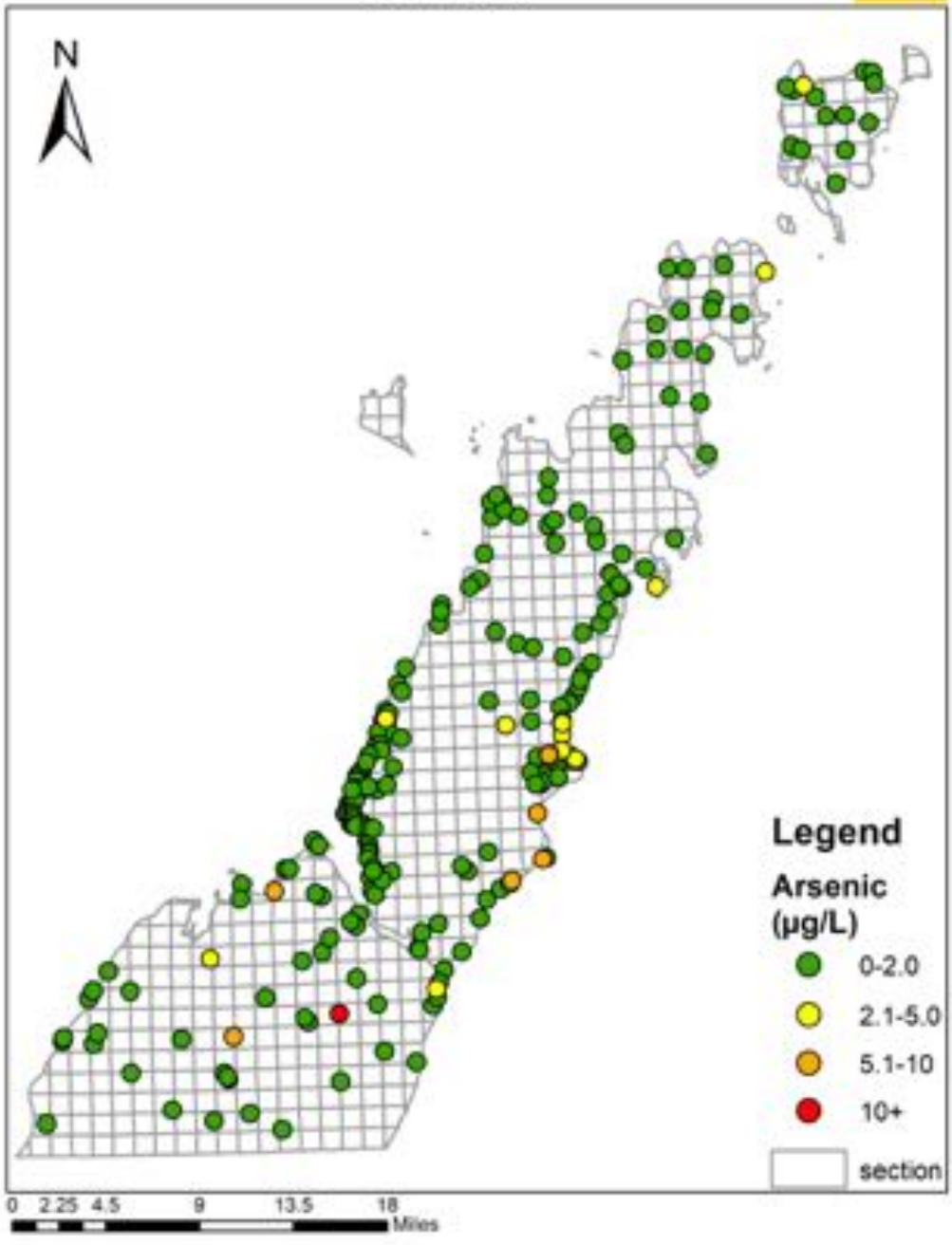
Door County Nitrate Results: Fall 2020



Door County Arsenic Results: Fall 2019

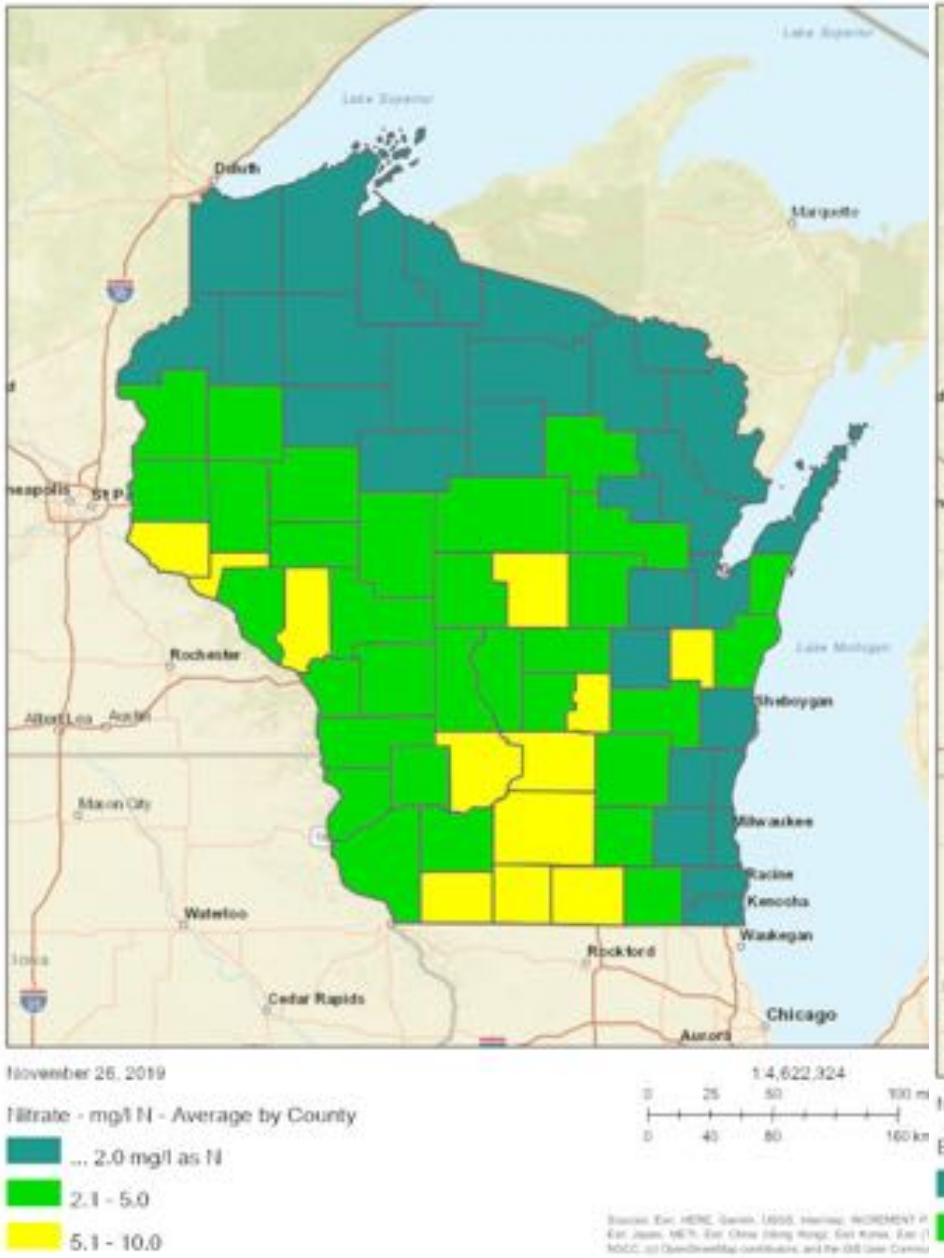


Door County Arsenic Results: Fall 2020

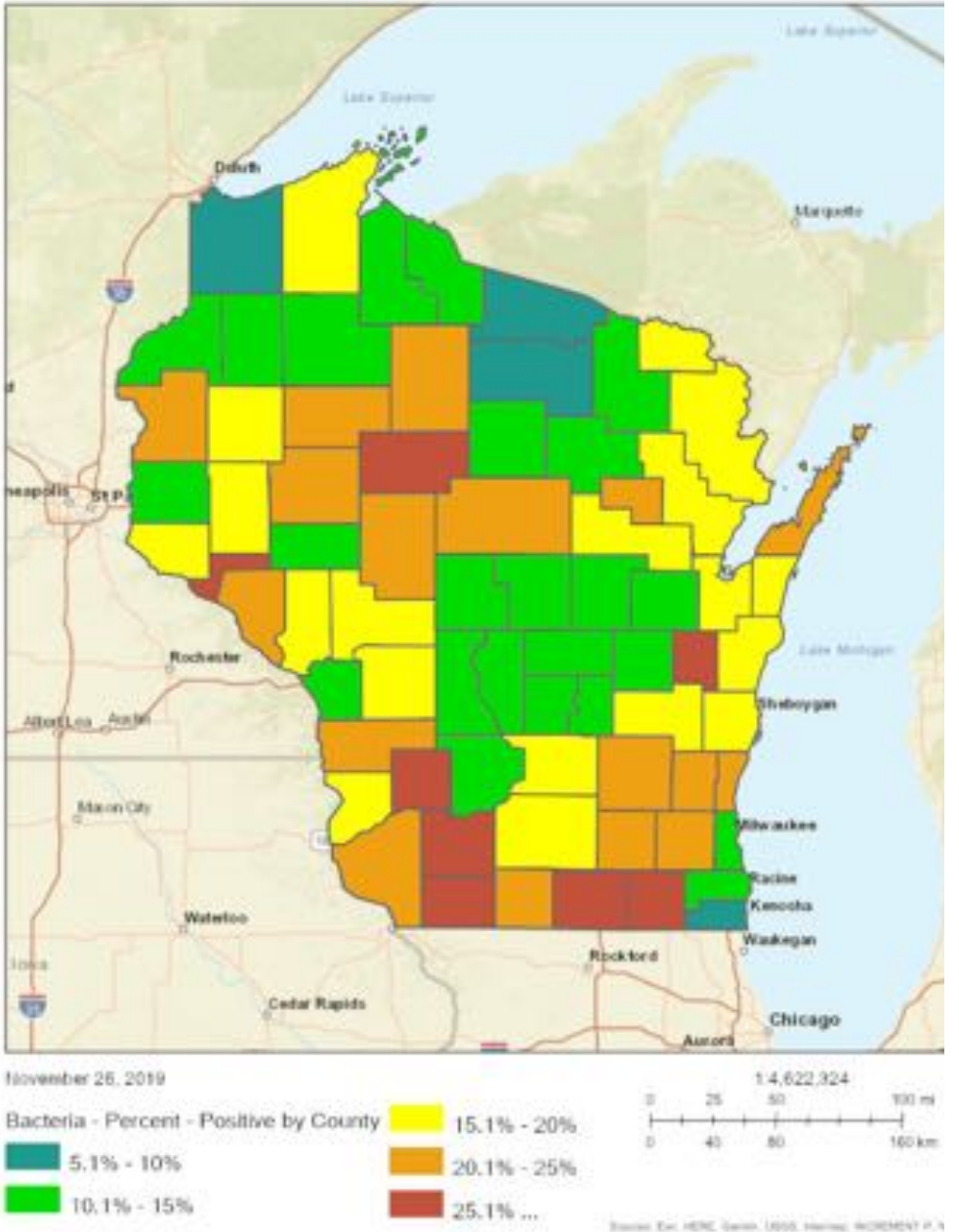


Statewide Private Well Data

Average Nitrate



% Positive Bacteria

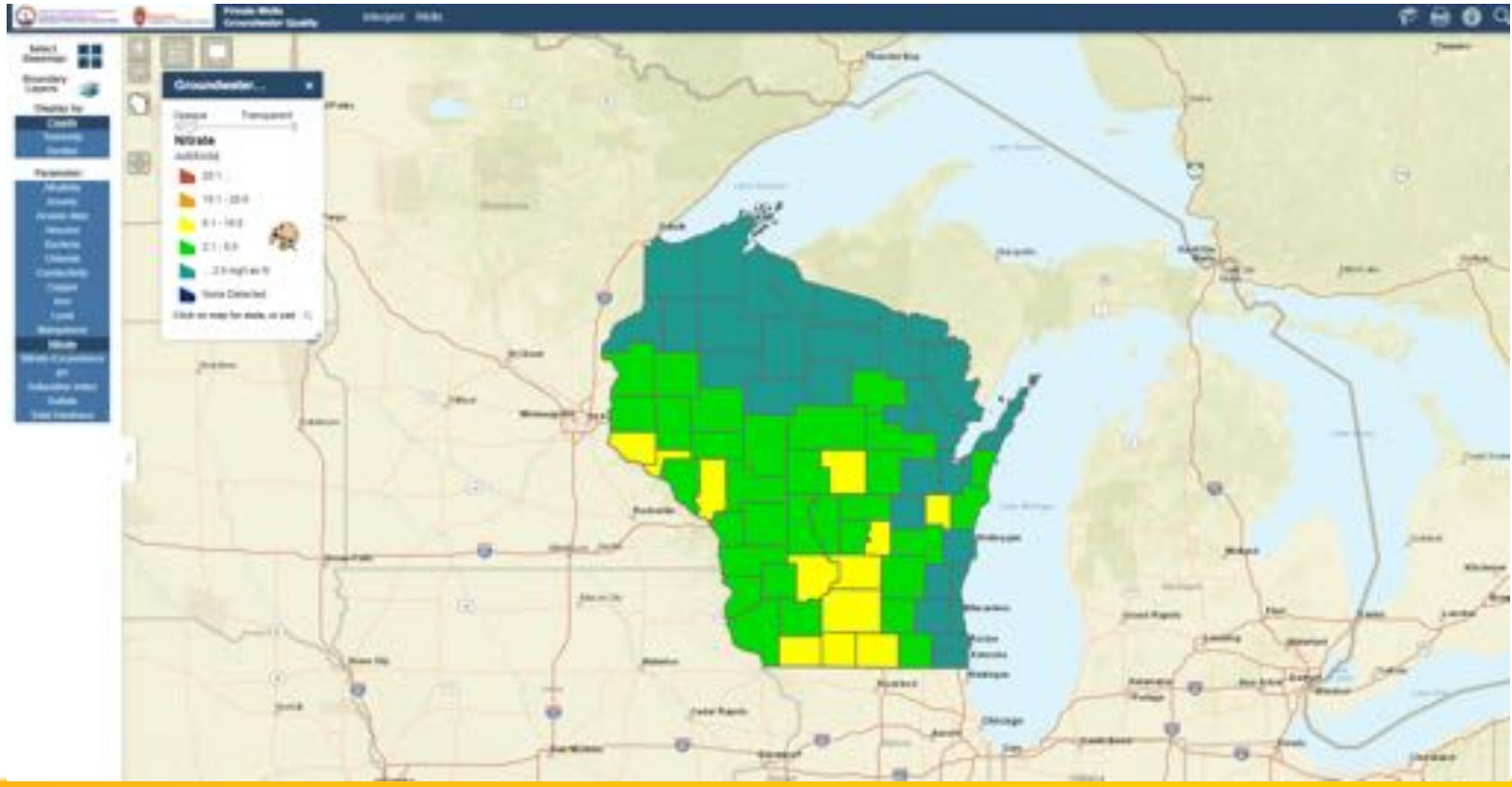


UNIVERSITY OF WISCONSIN OSHKOSH

Department of Engineering Technology

Where is the data going?

- UWSP Well Water Data Viewer https://www.uwsp.edu/cnr-ap/watershed/Pages/WellWaterViewer.aspx



UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

Further Research & Plans

- 2021 – targeted sampling in spring, summer, and/or fall
- Recruiting same volunteers for 2021 plus additional wells in other sections across county
- Continuation as a long-term study in future years will require additional funding

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

Take Home Messages

- Karst geology makes Door County groundwater highly vulnerable to contamination
- Sample your well annually for bacteria and nitrate, or more often if changes or problems observed
- Results from fall 2020 are consistent with previous sampling efforts in Door County and statewide
- Repeated sampling in 2021 will help identify seasonal changes in groundwater quality

UNIVERSITY OF WISCONSIN OSHKOSH
Department of Engineering Technology

Resources

- Door County Soil and Water Dept
- Door County Public Health
- WI DNR
- Presentation & recording available online at uwosh.edu/eric

Thank you!

We can't do this without you!

Questions?
Contact us at
eric@uwosh.edu
or (920) 424-3148

UWO | UNIVERSITY OF WISCONSIN OSHKOSH