Pepin County Well Water Quality Testing Overview

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Nitrate / Chloride

- Useful for understanding land-use impacts on groundwater

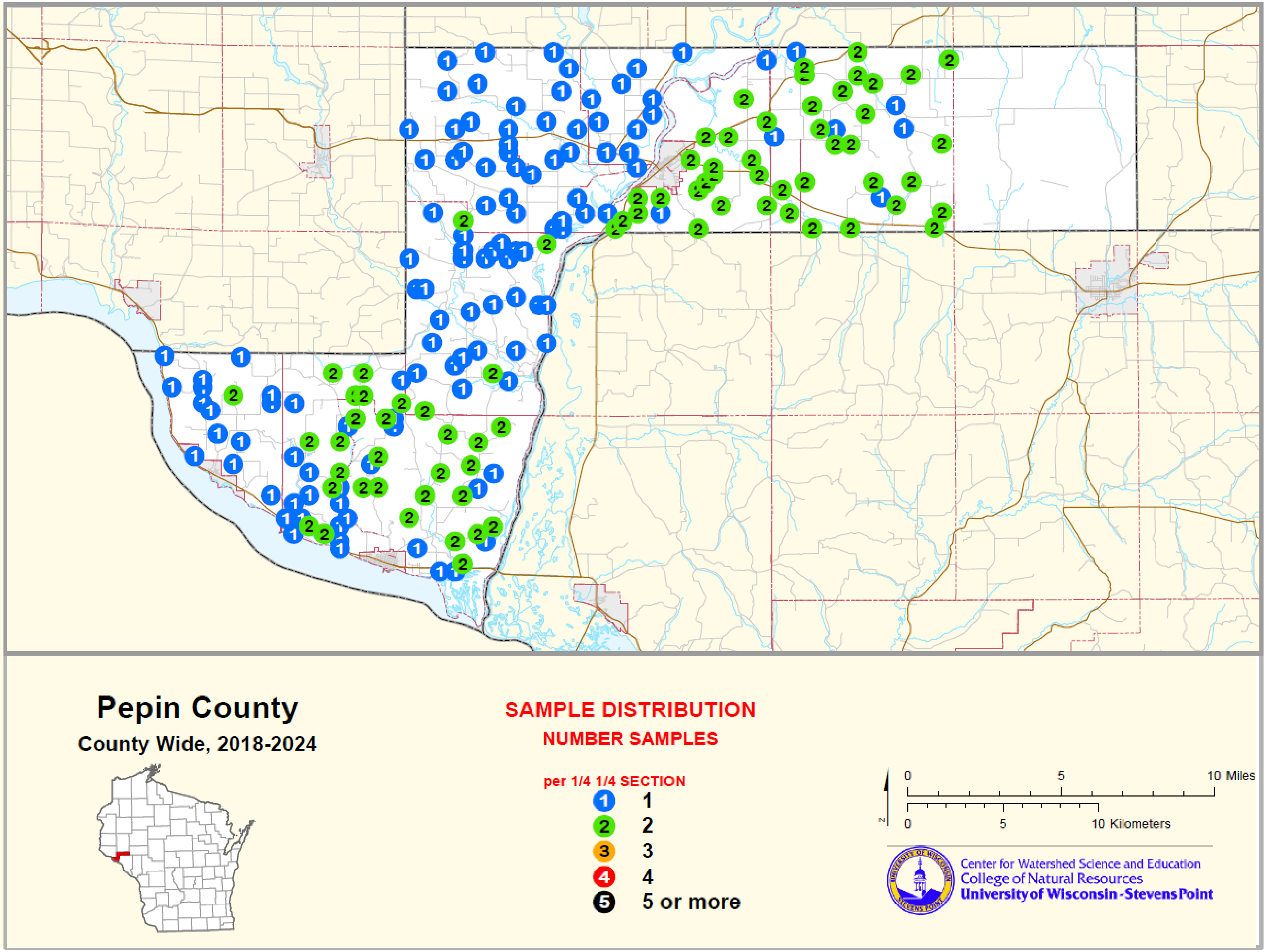
Conductivity

- Overall water quality, combination of both land-use, rocks, and soils

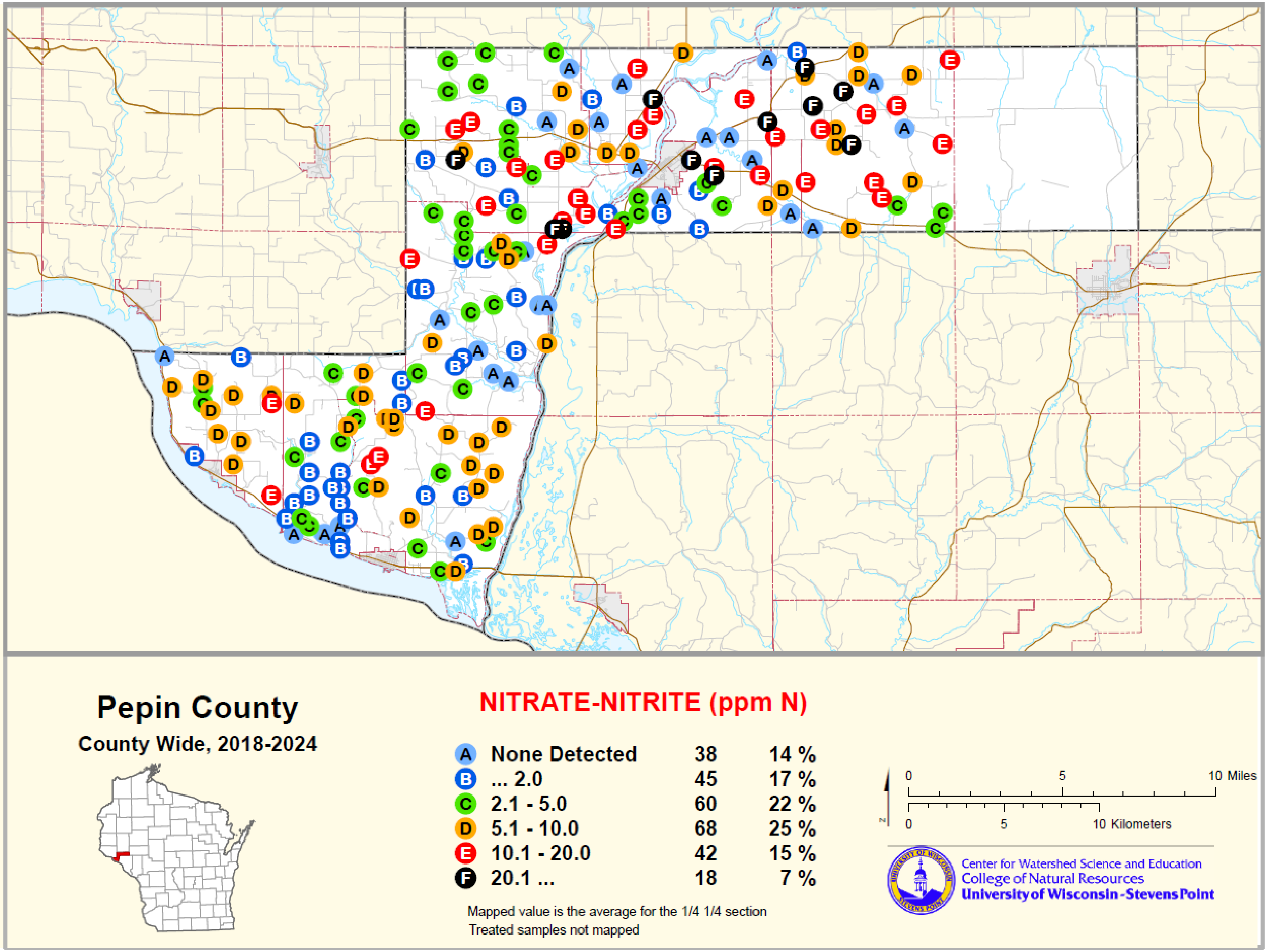
Total Hardness / Alkalinity / pH

- Help us understand how rocks and soils impact groundwater

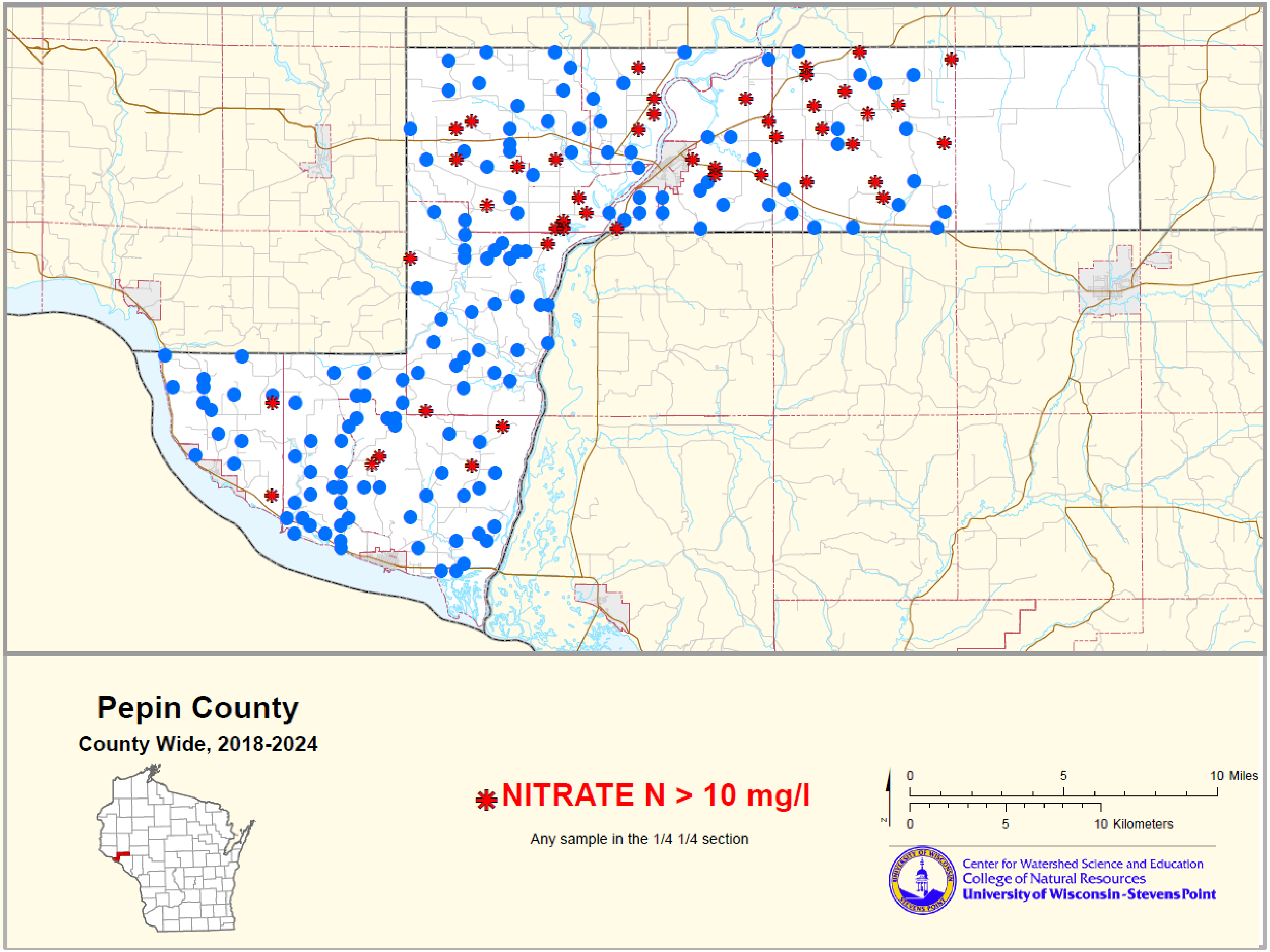
Pepin County Well Sampling Distribution



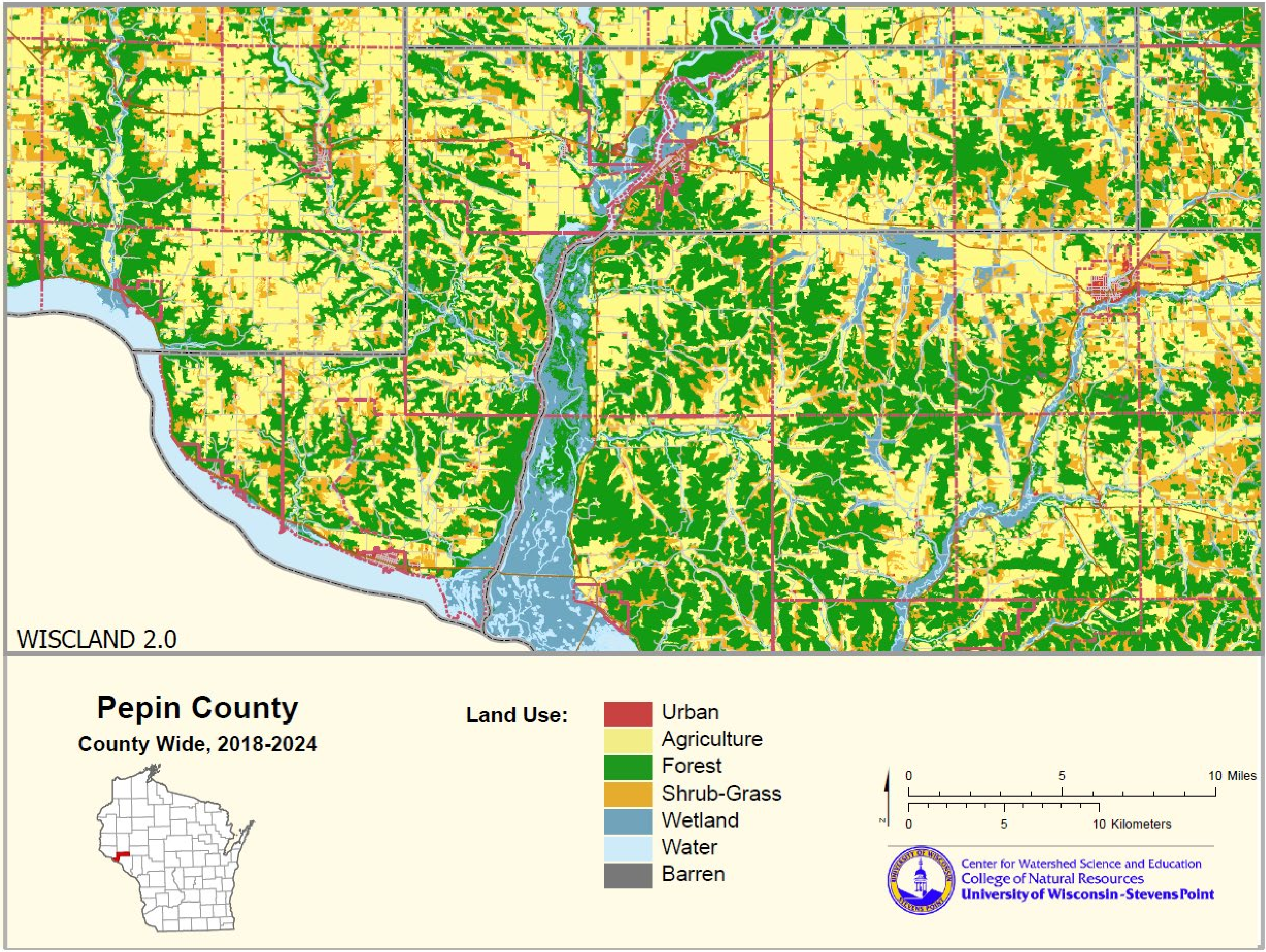
Pepin County Nitrate-N Concentration



Pepin County Nitrate-N Concentrations greater than 10 mg/L



Pepin County Land Cover



Chemical Source Summary

Acesulfame	Alachlor ESA	Alachlor OA	Carbamazepine	Metolachlor ESA	Metolachlor OA	Sucralose	Sulfamethoxazole	Deethylatrazine	AG	WASTEWATER	SUMMAY
44.1	0	0	0	0.5	0	83.3	0	0	1	2	BOTH
0	0.3	0	0	0	0	0	0	0	1	0	AG ONLY
0	0	0	0	0.75	0	0	0	0	1	0	AG ONLY
0	0.44	0	0	0.21	0	0	0	0	2	0	AG ONLY
0	0.53	0	0	2.34	0	0	0	0	2	0	AG ONLY
0	0.4	0	0	0	0	0	0	0	1	0	AG ONLY
19.3	0.23	0	0	0.26	0	137	0	0	2	2	BOTH
0	0	0	0	0	0	0	0	0	0	0	NONE
0	0	0	0	0.62	0.16	0	0	0	2	0	AG ONLY
0	0.15	0	0	1.67	0.58	0	0	0	3	0	AG ONLY
25.3	0	0	0	0	0	42.9	12.3	0	0	3	WASTEWATER ONLY
154	0.11	0	0	0.5	0.13	821	33.4	0	3	3	BOTH
0	0.22	0	0	0.34	0.11	0	0	0	3	0	AG ONLY
0	0.33	0	0	0.59	0	0	0	0	2	0	AG ONLY
14.5	0.33	0	0	0	0	0	0	0	1	1	BOTH
78.7	0.42	0.08	0	0.79	0.11	65.6	0	0	4	2	BOTH
0	0.21	0.1	0	7.42	5.29	0	0	0	4	0	AG ONLY
25.2	0.92	0	0	2.48	0.11	0	0	0	3	1	BOTH
0	2.25	0.09	0	2.26	1.04	0	0	0	4	0	AG ONLY
0	0.76	0	0	1.51	0.78	0	0	0	3	0	AG ONLY
0	0	0	0	0	0	0	0	0	0	0	NONE
175	1.39	0.2	15.3	0.89	0	52.7	0	0.41	4	3	BOTH
0	0.46	0	0	0.43	0	0	0	0	2	0	AG ONLY
1550	0	0	0	0	0	2570	20.2	0	0	3	WASTEWATER ONLY

- 20/24 (83%) contained one or more Ag Tracers
- 13/24 (54%) contained only Ag Tracers
- 9/24 (38%) contained one or more Wastewater Tracers
- 7/24 (30%) contained both Ag & Wastewater tracers
- 2/24 (8%) contained only Wastewater tracers
- 2/24 (8%) contained detected no tracers

Source Identification

- **Chemical Source Tracing** (Ag vs. Wastewater)
  - Agricultural pesticides (metolachlor ESA, alachlor ESA) and compounds common to human wastewater (sucralose, acesulfame, caffeine, etc.) used to determine whether nitrate is coming from row crop agricultural systems or septic drainfields
  - When both are present, cannot easily determine the percentage from each source
  - In the case of agricultural nitrogen does not distinguish nitrate from fertilizer versus manure
  - When only wastewater tracers are present nitrate concentrations were lower
- **Isotope Testing** (Fertilizer vs. Manure)
  - Nitrogen from fertilizers, nitrification of commercial fertilizers/soil nitrogen, and manure/septic effluent have unique isotopic compositions that can be used to understand source
  - Because nitrogen cycles within the soil, is often difficult to interpret
  - More utility in in-field or edge of field monitoring where the isotopic signature is strongest

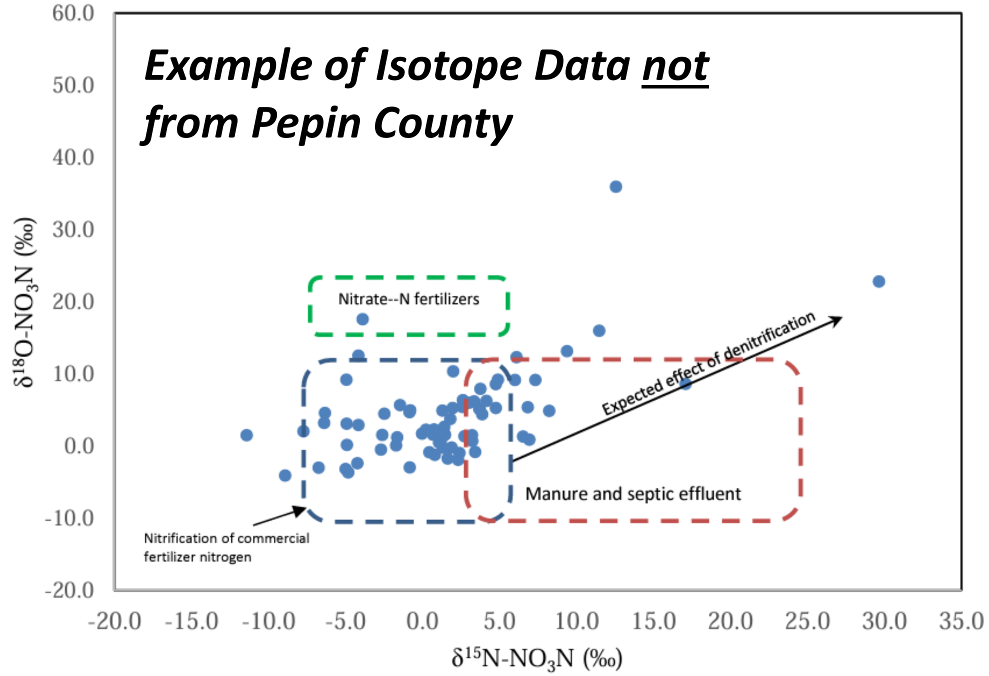


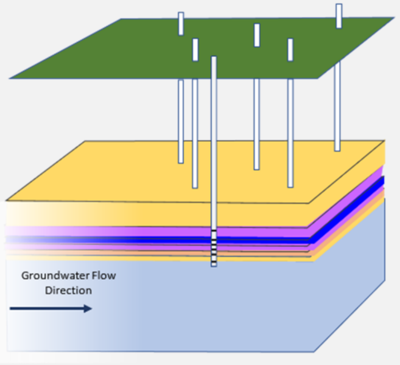
Figure 5. Measured δ^{15}N-NO_3N versus δ^{18}O-NO_3N compared to expected ranges from commercial fertilizer sources (dark blue dashed box), manure and septic sources (orange dashed box) and inorganic nitrate fertilizers (green box). Trend arrow of increasing δ^{18}O-NO_3N and δ^{15}N-NO_3N for enrichment due to denitrification. Ranges and arrow from (Kendall and Aravena, 2000).

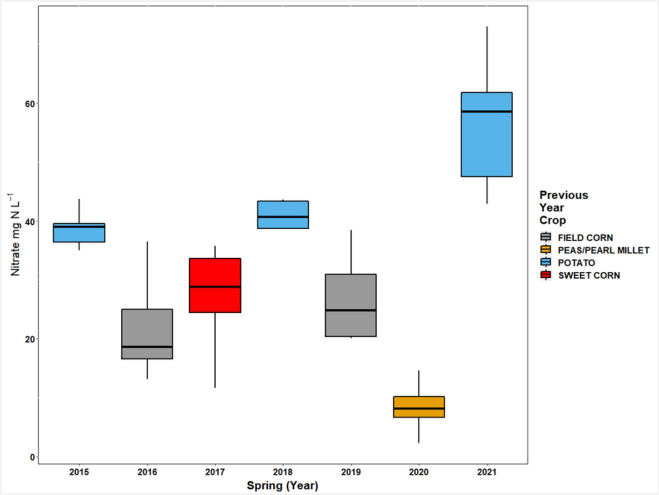
Data from 2018 EPA investigation in Town of Armenia, Jackson County, WI.
https://www.epa.gov/sites/default/files/2018-10/documents/isotope_study_report_erg_csd-may_june2018.pdf

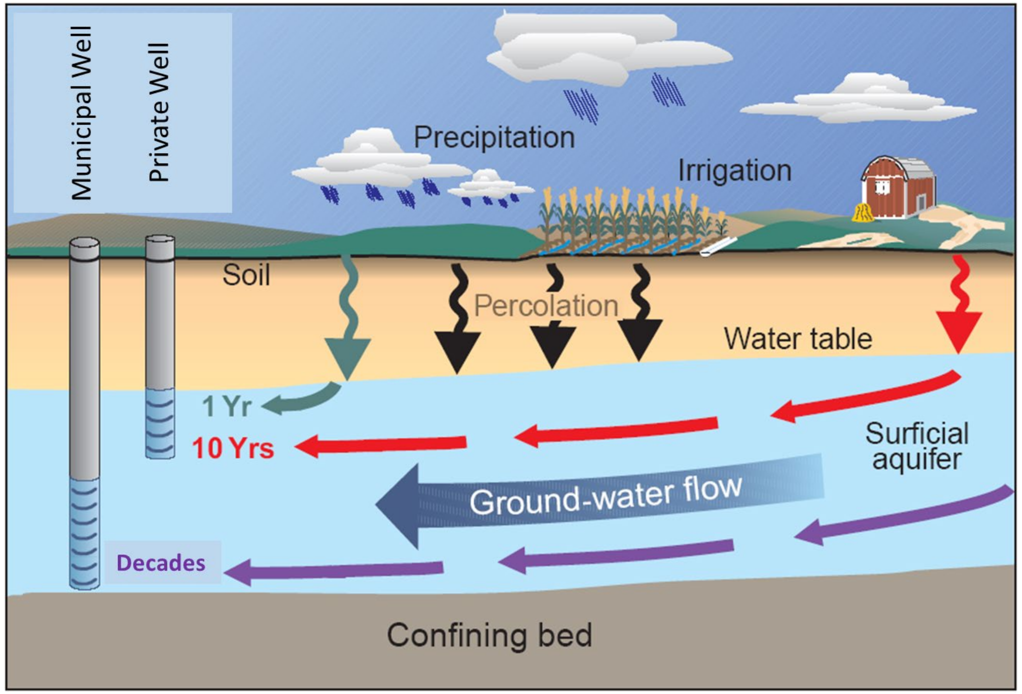
Observing water quality changes

- **How long does it take to observe water quality impacts below a field?**
  - Depends on soil type, geology, depth to water, when precip/snow melt happen (~Days to months)
  - Are able to detect annual changes in groundwater quality at the very top of the aquifer
- **How long does it take to observe water quality in surrounding private wells?**
  - Depends on distance, well/casing depth, geology, etc. (~1-10 years….educated guess)
  - A rule of thumb is that groundwater in sand/gravel aquifers might move 1 foot per day
  - The longer the water has to travel to reach a well the more potential mixing that occurs
    - Possibility of dilution from mixing with other land-uses
    - More difficult to interpret source tracing

Ongoing work shows groundwater quality below potato years to have the greatest nitrate concentrations compared to other crops in the rotation



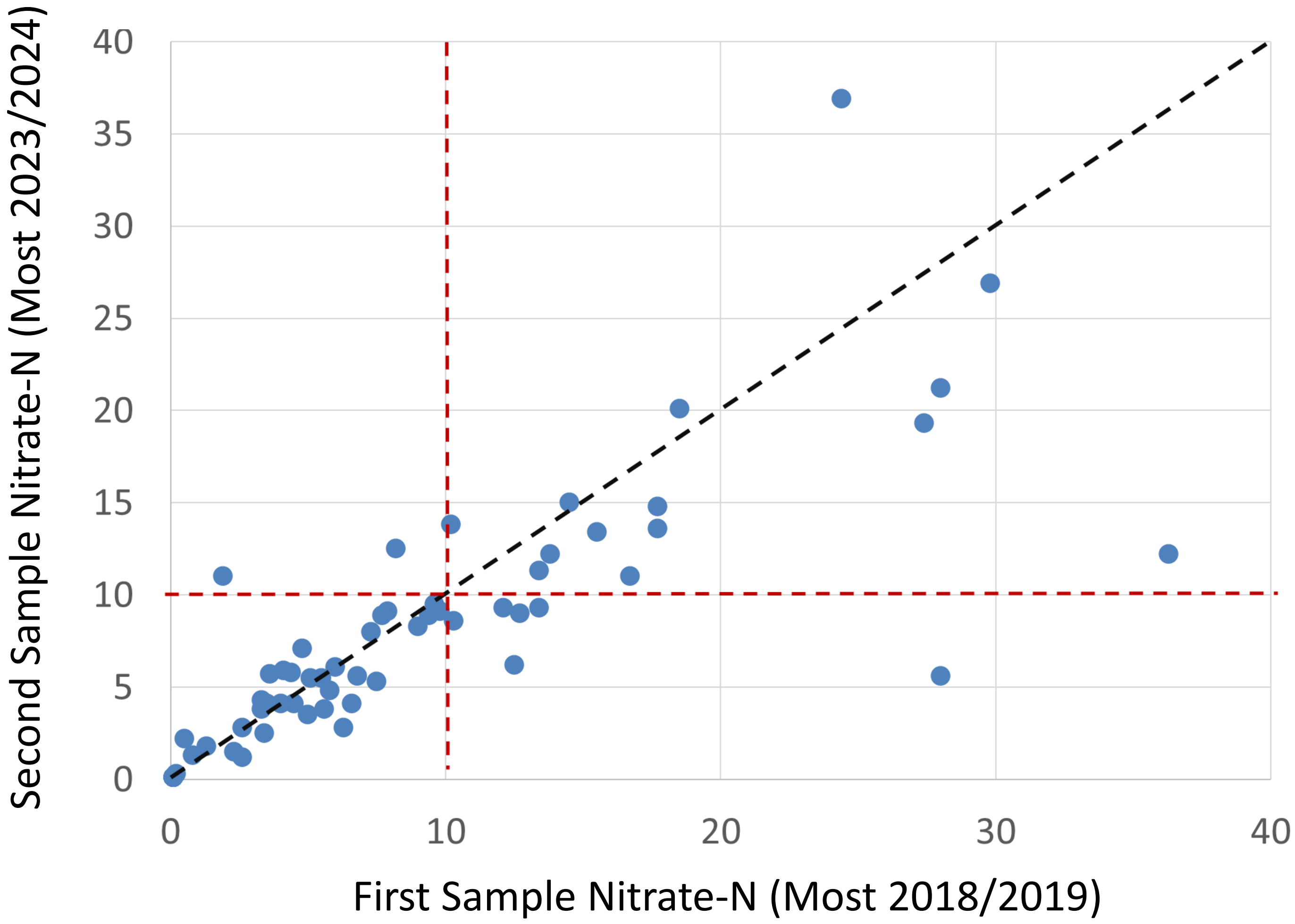




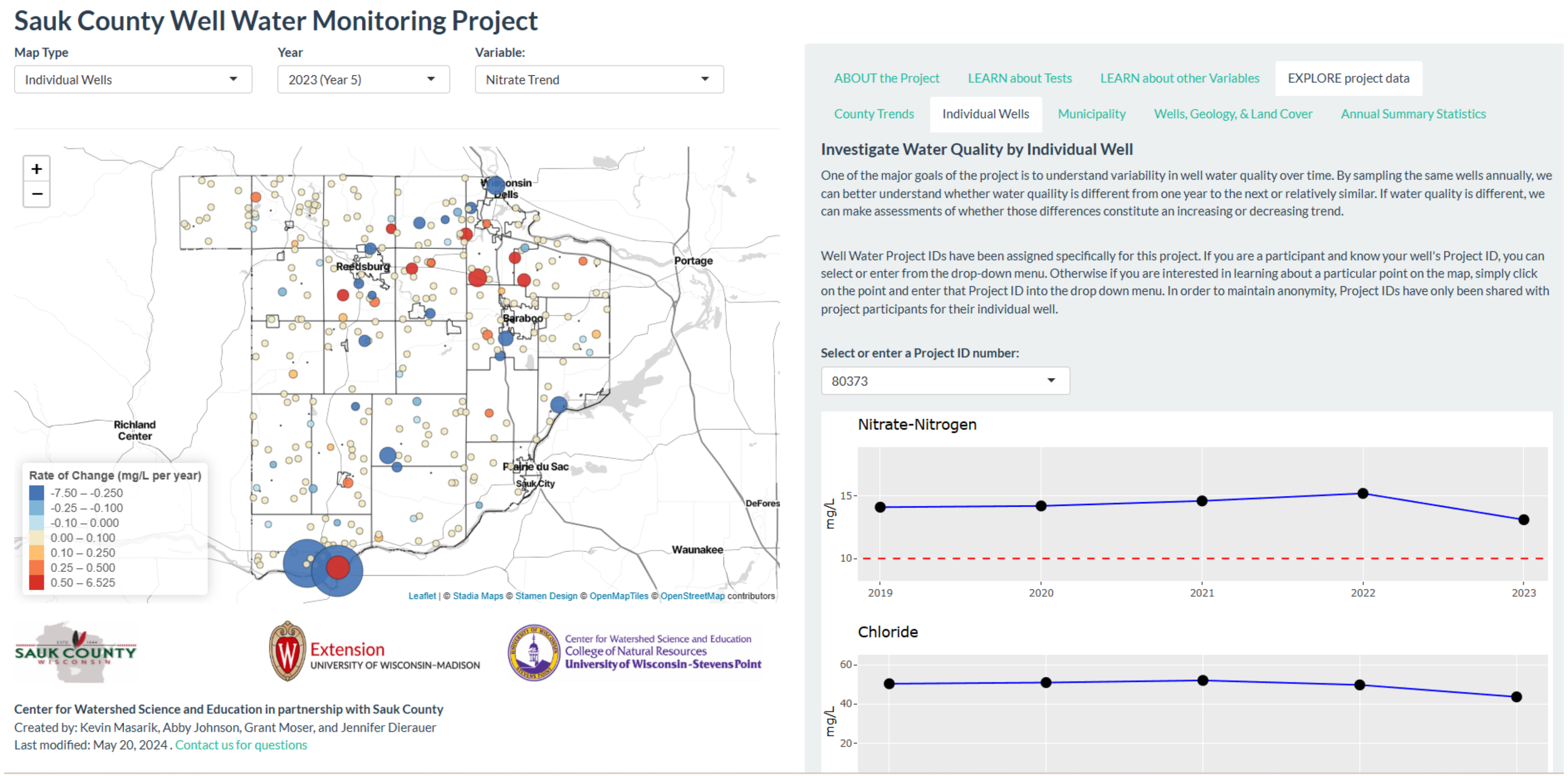
Pepin County Preliminary Data Repeat Samples

67 with repeat samples

- 33 decreased
- 11 no change
- 24 increased



Trend analysis requires at least 4 samples, the more the better



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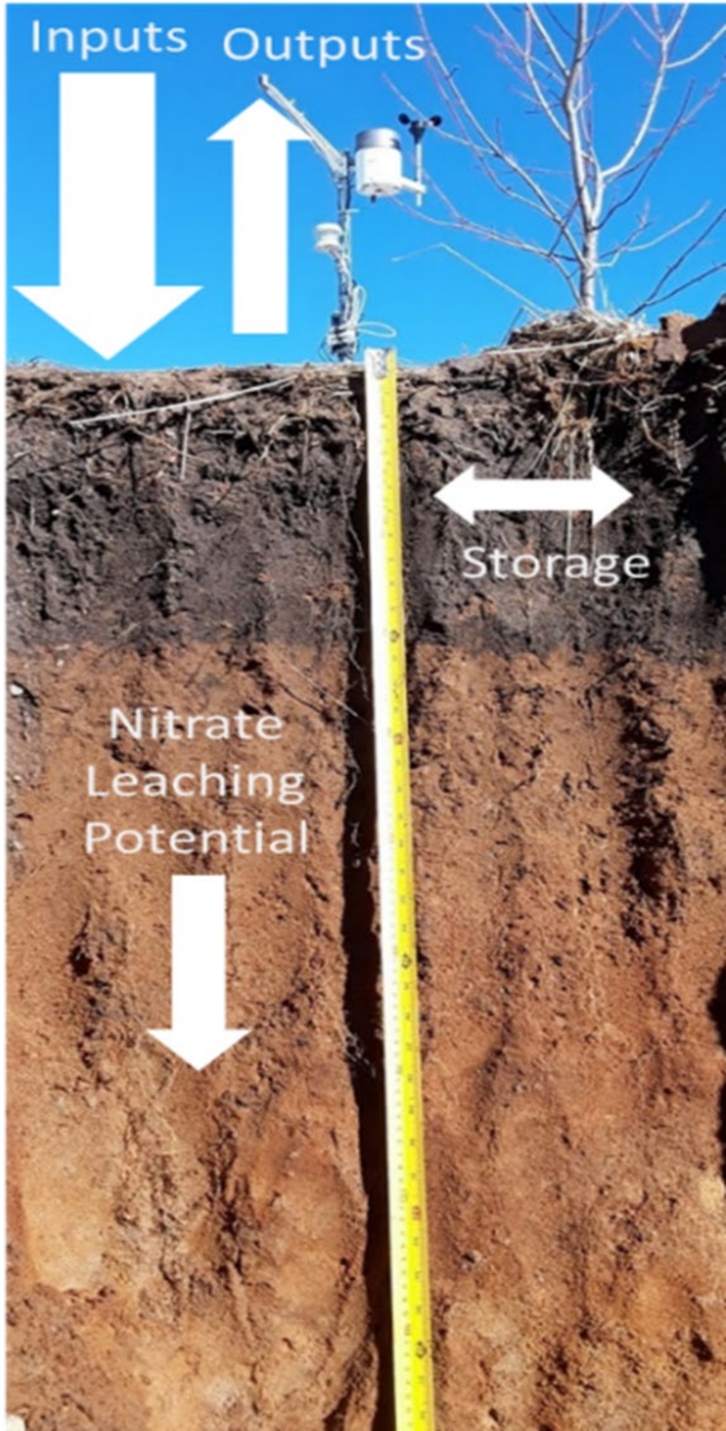
Potential reduction in nitrate-N concentration

	Nitrate-Nitrogen Concentration (mg/L)									
	1	2	3	4	5	10	15	20	30	40
Water in inches	lbs of Nitrogen per acre									
1	0.2	0.5	0.7	0.9	1.1	2.3	3.4	4.5	6.8	9.0
2	0.5	0.9	1.4	1.8	2.3	4.5	6.8	9.0	13.6	18.1
3	0.7	1.4	2.0	2.7	3.4	6.8	10.2	13.6	20.4	27.1
4	0.9	1.8	2.7	3.6	4.5	9.0	13.6	18.1	27.1	36.2
5	1.1	2.3	3.4	4.5	5.7	11.3	17.0	22.6	33.9	45.2
6	1.4	2.7	4.1	5.4	6.8	13.6	20.4	27.1	40.7	54.3
7	1.6	3.2	4.7	6.3	7.9	15.8	23.7	31.7	47.5	63.3
8	1.8	3.6	5.4	7.2	9.0	18.1	27.1	36.2	54.3	72.4
9	2.0	4.1	6.1	8.1	10.2	20.4	30.5	40.7	61.1	81.4
10	2.3	4.5	6.8	9.0	11.3	22.6	33.9	45.2	67.8	90.5
11	2.5	5.0	7.5	10.0	12.4	24.9	37.3	49.8	74.6	99.5
12	2.7	5.4	8.1	10.9	13.6	27.1	40.7	54.3	81.4	108.5
13	2.9	5.9	8.8	11.8	14.7	29.4	44.1	58.8	88.2	117.6
14	3.2	6.3	9.5	12.7	15.8	31.7	47.5	63.3	95.0	126.6
15	3.4	6.8	10.2	13.6	17.0	33.9	50.9	67.8	101.8	135.7

Groundwater recharge measured by lysimeters

Strategies to reduce nitrate in groundwater

- Applying fertilizer at the ***right rate, time, source, place will maximize profitability and minimize*** *excessive losses* of nitrogen to groundwater; additional practices may be needed to improve water quality in areas with susceptible soils and geology
- You may not need as much nitrogen fertilizer as you think, ***conduct your own on-farm rate trials to develop customized fertilizer response curves for your farm***
- Utilize conservation incentive programs to ***take marginal land or underperforming parts of fields out of production***
- ***Diversify cropping systems*** to include less nitrogen intensive crops in the rotation
- ***Explore and experiment with the use of cover crops, perennial cropping systems, or managed grazing to reduce nitrate losses to groundwater***



Long-term nitrogen reduction strategies for agricultural areas

	Practice	Details	% Nitrate-N Reduction (StDev)	Reduction potential	Uncertainty
Good	Timing	Fall to Spring Pre-plant	6 (25)	Low	High
		Spring pre-plant/sidedress 40-60 split compared to fall applied	5 (28)	Low	High
		Sidedress – Soil test based compared to pre-plant	7 (37)	Low	High
	Nitrification Inhibitor	Nitrapyrin – Fall – Compared to applied w/out nitrapyrin	9 (19)	Low	Medium
Better	Cover Crops	Rye	31 (29)	Medium	Medium
		Oat	28 (2)	Medium	Medium
Best	Perennial	Biofuel Crops (ex. switchgrass, miscanthus)	72 (23)	High	Medium
		Conservation Reserve Program	85 (9)	High	Low
	Extended Rotations	At least 2 years of alfalfa or other perennial crops in a 4 or 5 year rotation	42 (12)	Med-High	Low

Iowa Nutrient Reduction Strategy, 2014