

Nitrate in Drinking Water Study Update

March 5, 2024

2024 NRD Water Programs Conference

Presented by Bridger Corkill and Hillary Stoll, P.E.

NDEE

Goal of the 2023-2024 Water Quality Study

Provide an analysis and recommend viable solutions for nitrate-impacted drinking water including drinking water supply not regulated by the Safe Drinking Water Act (SDWA).



Project Partners

- Representatives from the NRDs
- UNL Extension
- DHHS Public Health Environmental Lab
- Olsson

Goals of the 2023-2024 Water Quality Study

- Obtain more domestic well data
- Analyze nitrate levels and trends
- Develop tools and guidance
- Assist public water systems and private well owners
- Risk-communication based outreach plan

Interim Analysis

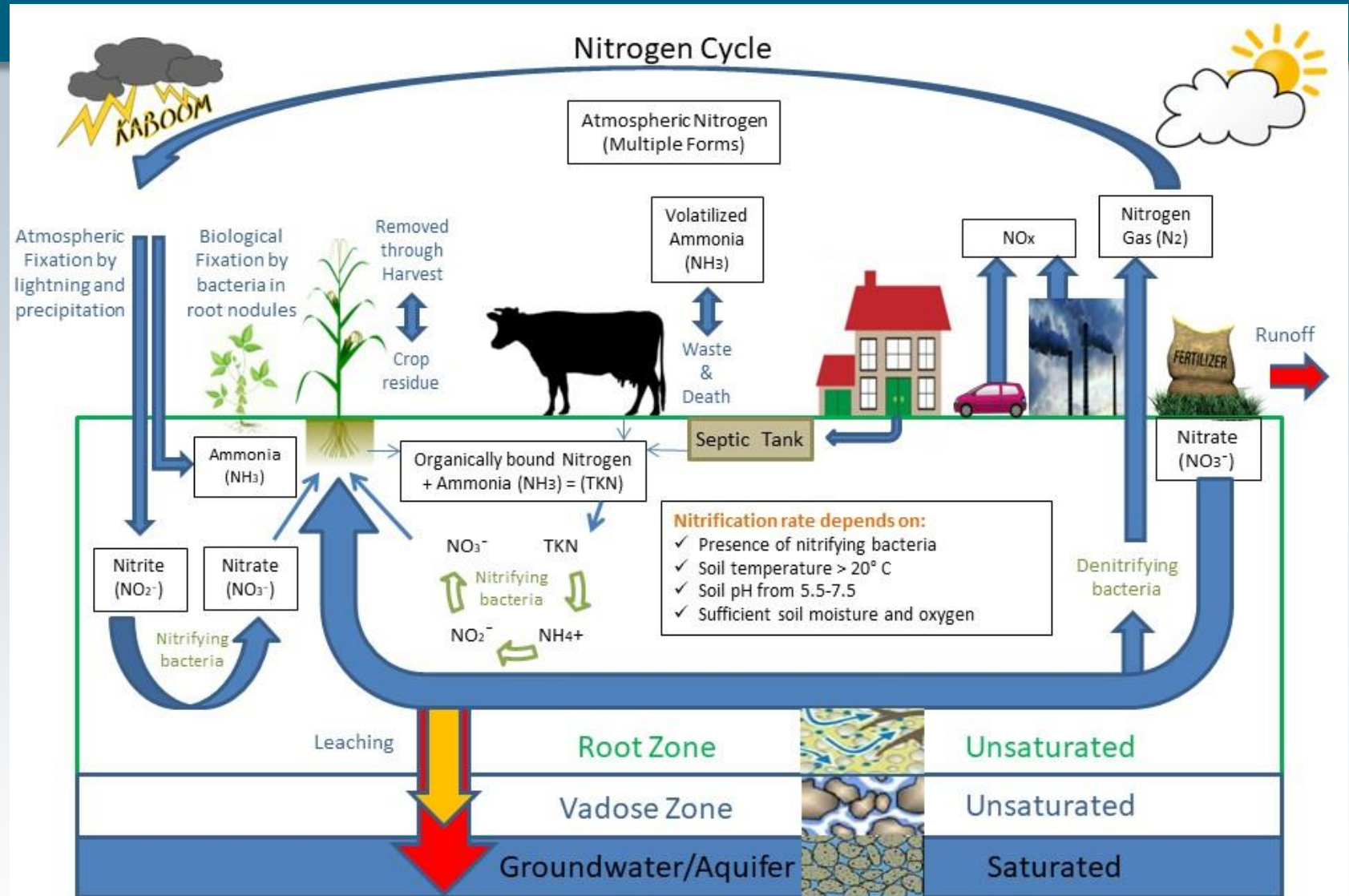
What has been done so far?

- Background information on nitrate in drinking water
- Study approach and data gaps
- Share interim findings
- Free nitrate test kits for private well owners

Background: Nitrate in Groundwater

Nitrogen Cycle

- Nitrogen comes from organic and inorganic sources
- Excess nitrogen in the soil can leach past the root zone and vadose layer to impact groundwater



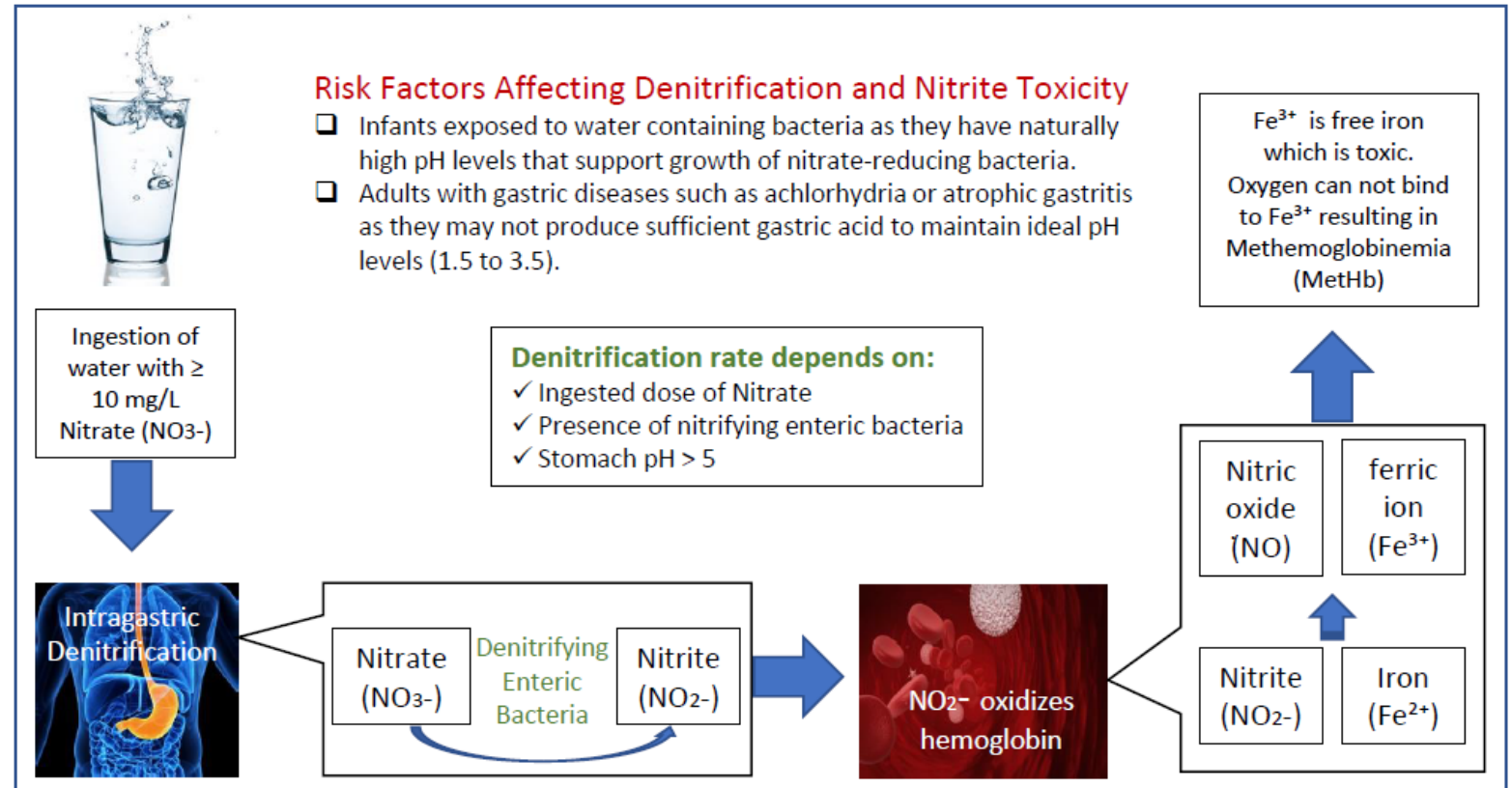
Nebraska Department of Environment and Energy, 2024

Internal Nitrogen Cycle

- Nitrate is a regulated contaminant under the Safe Drinking Water Act (SDWA)
- The Maximum Contaminant Level for nitrate in drinking water is 10 milligrams per liter (mg/L)

Nitrate Impairs Blood Oxygen Delivery

Nitrate toxicity is due to its conversion to Nitrite in the body



Nebraska Department of Environment and Energy, 2023

Tools for Private Well Owners to Address & Prevent Elevated Nitrate Levels

- Water treatment
- Well siting
- Well construction
- Connect to a rural water district



Source: <https://www.epa.gov/watersense/point-use-reverse-osmosis-systems>

Tools for Public Water Systems to Address Elevated Nitrate Levels

- Water Treatment
 - Reverse osmosis (most common)
 - Ion exchange
- Blending
- New Sources
- Consolidation with a Rural Water District or other PWS
- Long-Term Planning and Best Management Practices



State Assistance for Nitrate in Drinking Water

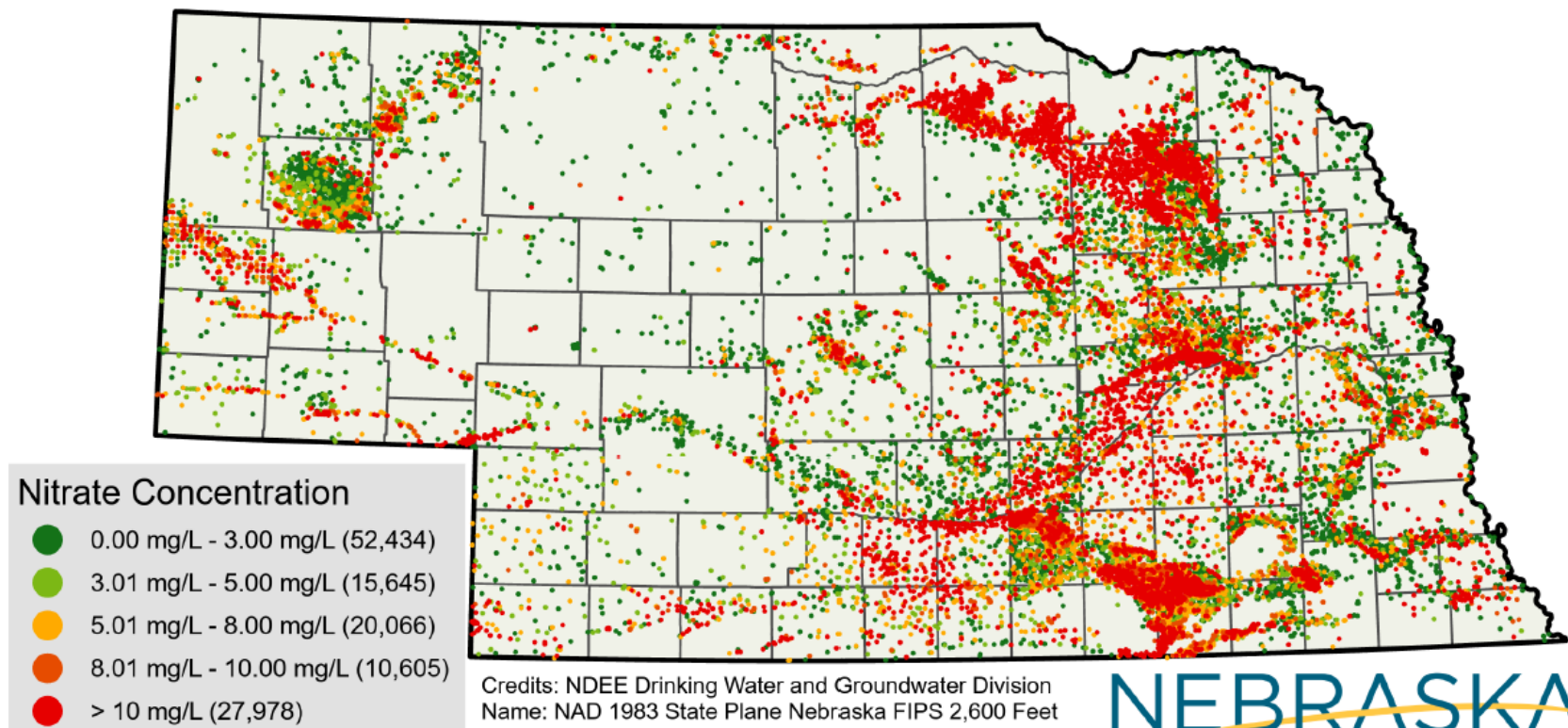
- Water/Wastewater Advisory Committee (WWAC)
- Nebraska Drinking Water State Revolving Fund
- Capacity Development Program & Technical Assistance
- Source Water Protection Program
- Wellhead Protection Program

Study Approach and Data Gaps

What data do we have?

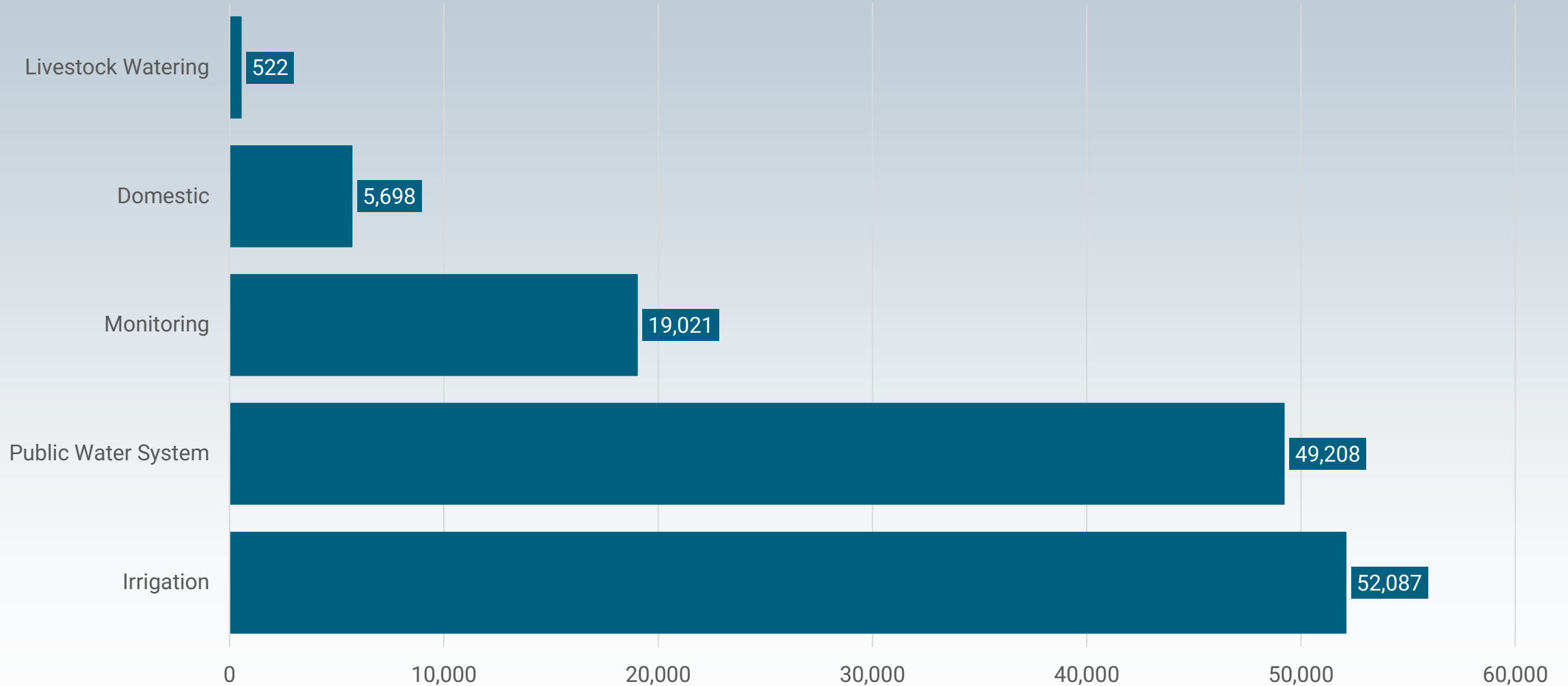
Clearinghouse.Nebraska.gov

126,728 Nitrate Well Samples from the Nebraska Groundwater Quality Clearinghouse: All Well Types 2003-2023

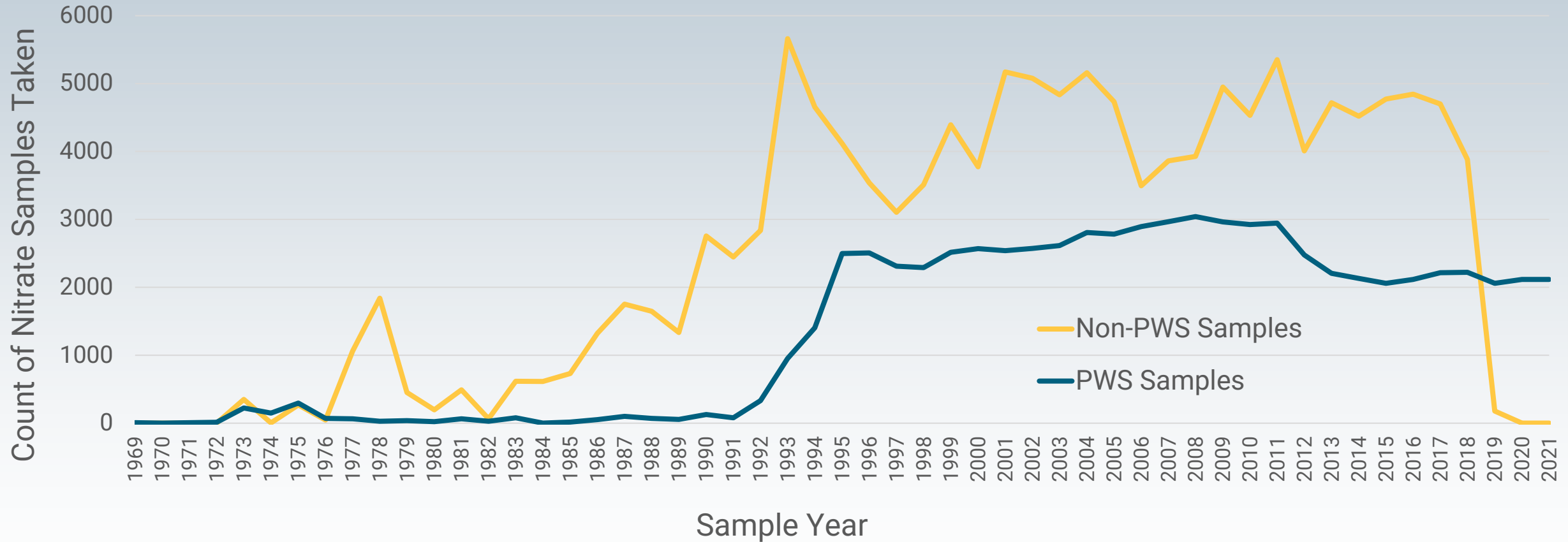


Credits: NDEE Drinking Water and Groundwater Division
 Name: NAD 1983 State Plane Nebraska FIPS 2,600 Feet
 Datum: North American 1983
 Projection: Lambert Conformal Conic

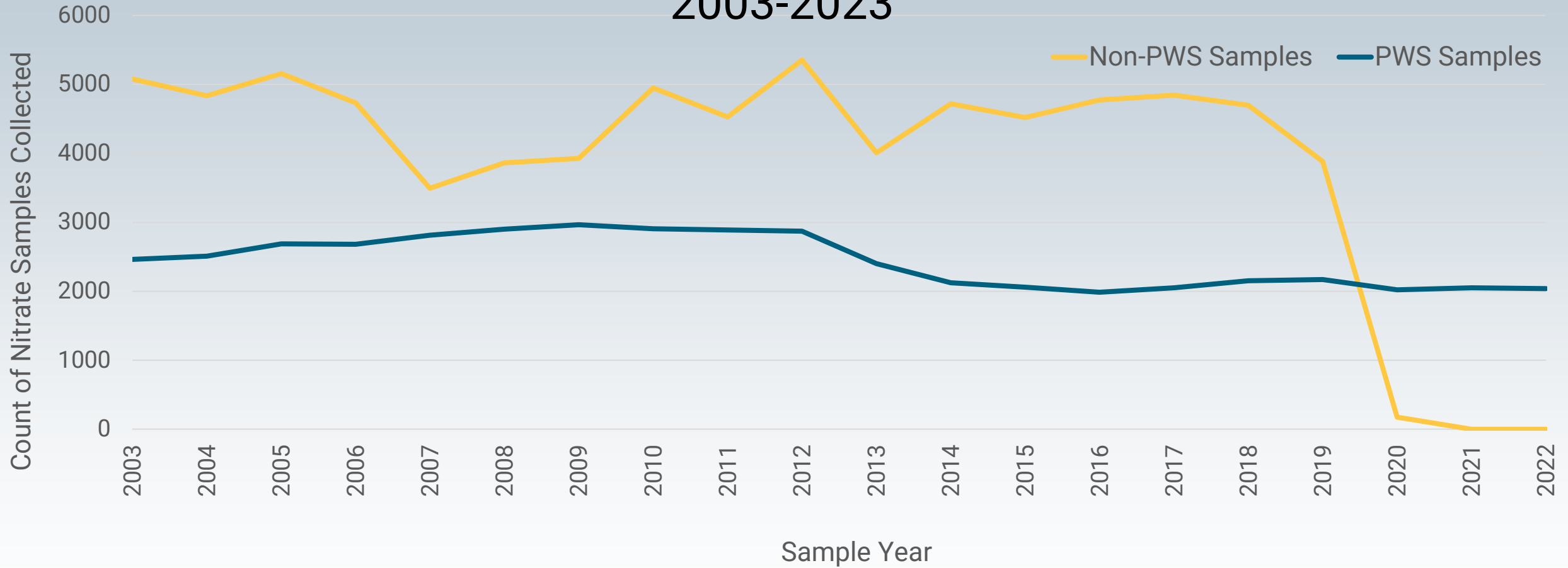
CLEARINGHOUSE NITRATE SAMPLE COUNT BY WELL TYPE 2003-2023



NITRATE SAMPLES IN THE CLEARINGHOUSE TAKEN FROM PWS & NON-PWS WELLS 1969-2023



NITRATE SAMPLES IN THE CLEARINGHOUSE COLLECTED 2003-2023



Let's Do the Math

360,000 Nebraskans not on a PWS

Divided by 2.5 people/household =

Estimated 144,000 private domestic wells

- 34,700 registered wells

- 109,300 unregistered wells

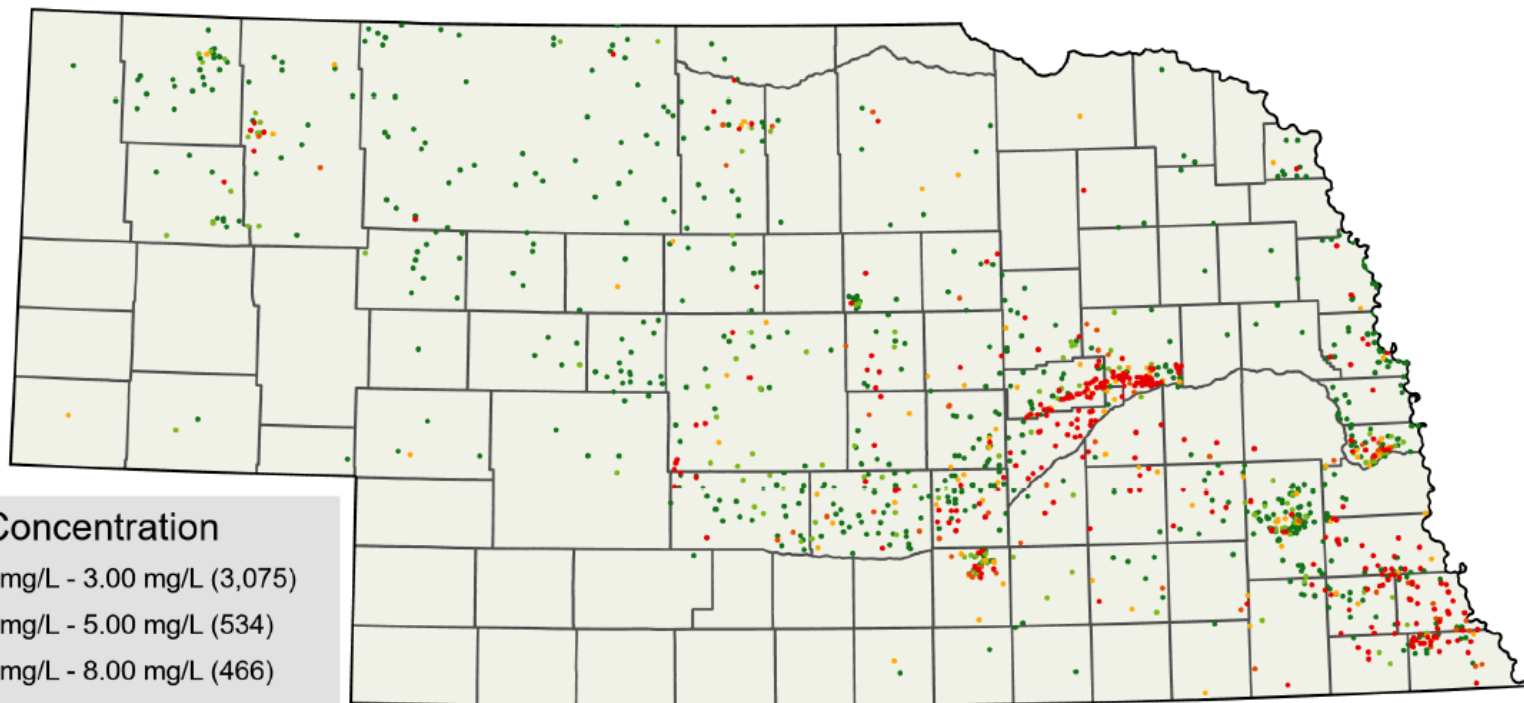
Data for 4,493 domestic wells since 2010

We do not have data for approximately 140,000 private domestic wells



What data do we have?

5,693 Nitrate Well Samples from the Nebraska Groundwater Quality Clearinghouse: Domestic Wells 2003-2023



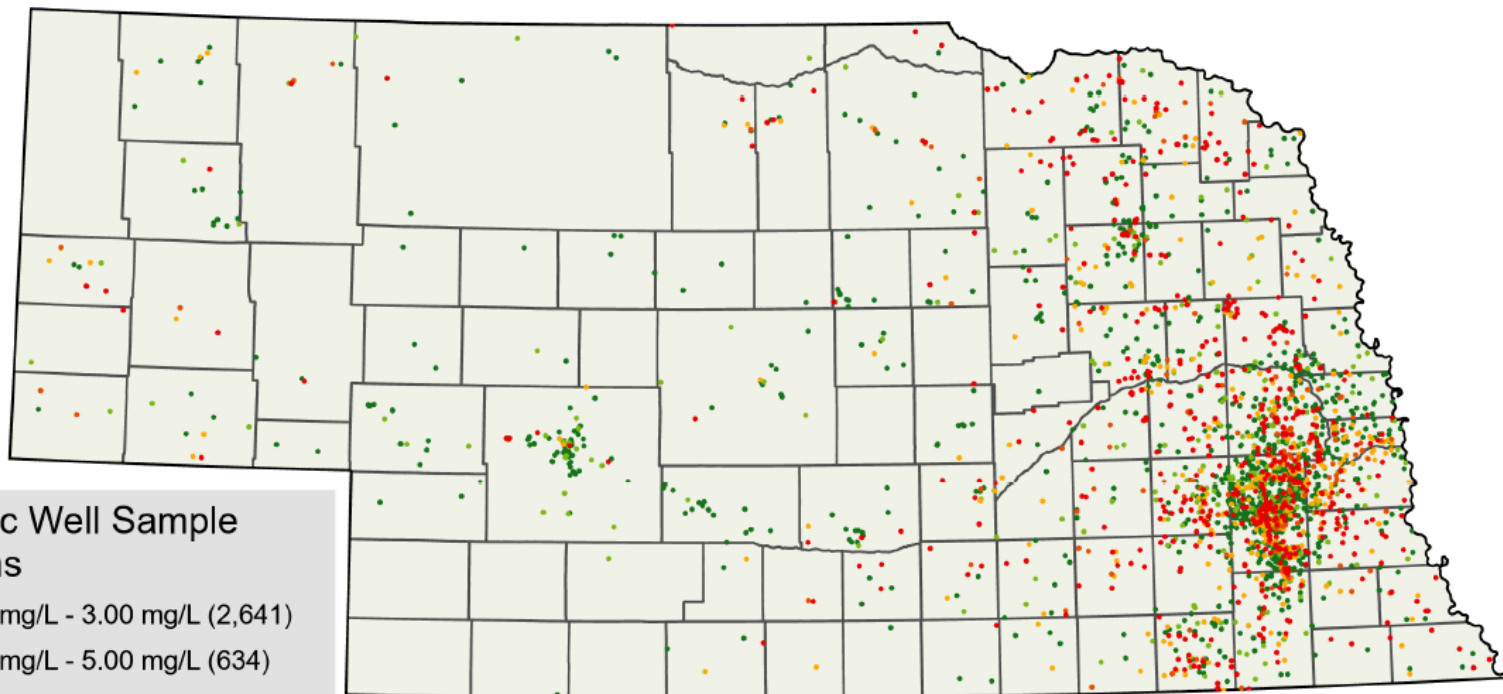
Nitrate Concentration

● 0.00 mg/L - 3.00 mg/L	(3,075)
● 3.01 mg/L - 5.00 mg/L	(534)
● 5.01 mg/L - 8.00 mg/L	(466)
● 8.01 mg/L - 10.00 mg/L	(237)
● > 10 mg/L	(1,381)

Credits: NDEE Drinking Water and Groundwater Division
 Name: NAD 1983 State Plane Nebraska FIPS 2,600 Feet
 Datum: North American 1983
 Projection: Lambert Conformal Conic

What data do we have?

5,082 Nitrate Well Samples from the Nebraska Department of Health and Human Services (NDHHS): Private Domestic Wells 2010-2022



Domestic Well Sample Locations

- 0.00 mg/L - 3.00 mg/L (2,641)
- 3.01 mg/L - 5.00 mg/L (634)
- 5.01 mg/L - 8.00 mg/L (689)
- 8.01 mg/L - 10.00 mg/L (261)
- > 10 mg/L (857)

Credits: NDEE Drinking Water and Groundwater Division
 Name: NAD 1983 State Plane Nebraska FIPS 2,600 Feet
 Datum: North American 1983
 Projection: Lambert Conformal Conic

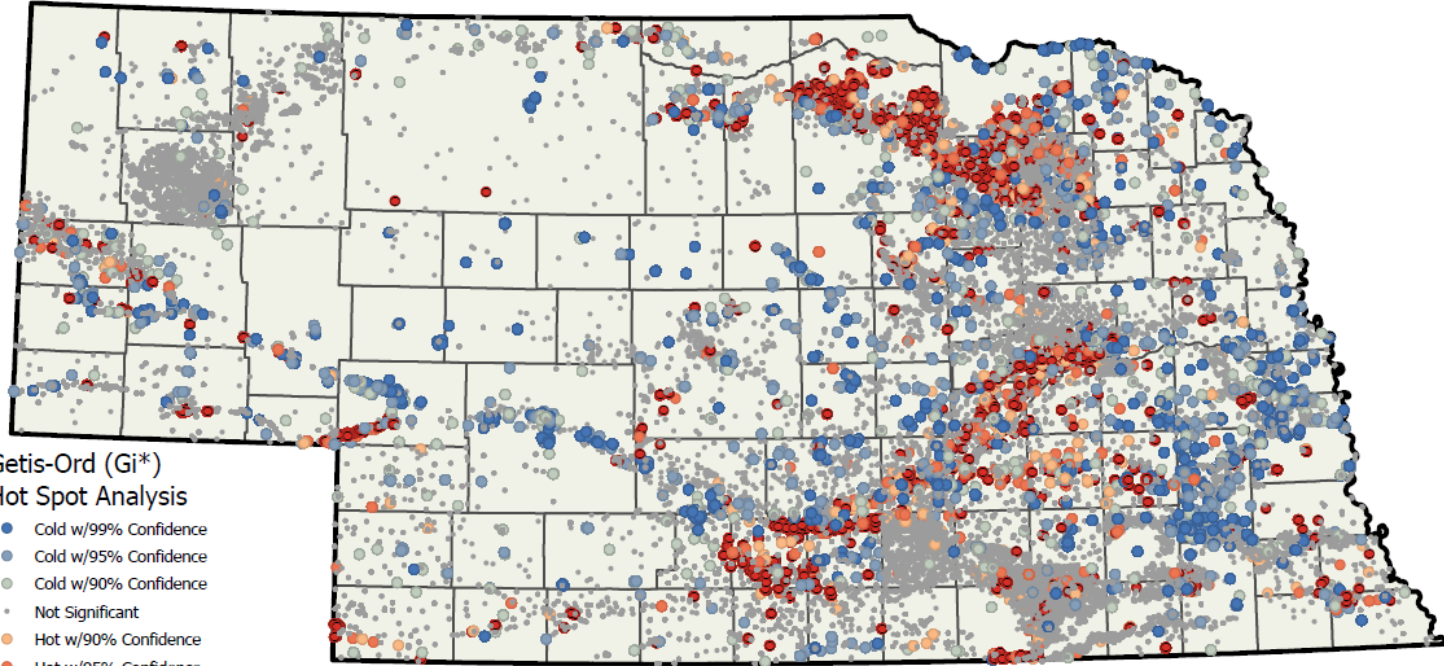
What's Missing?

- Private Domestic Well Data
- Clearinghouse Updates

Interim Analysis

Where are the
nitrate hot spots in
the state?

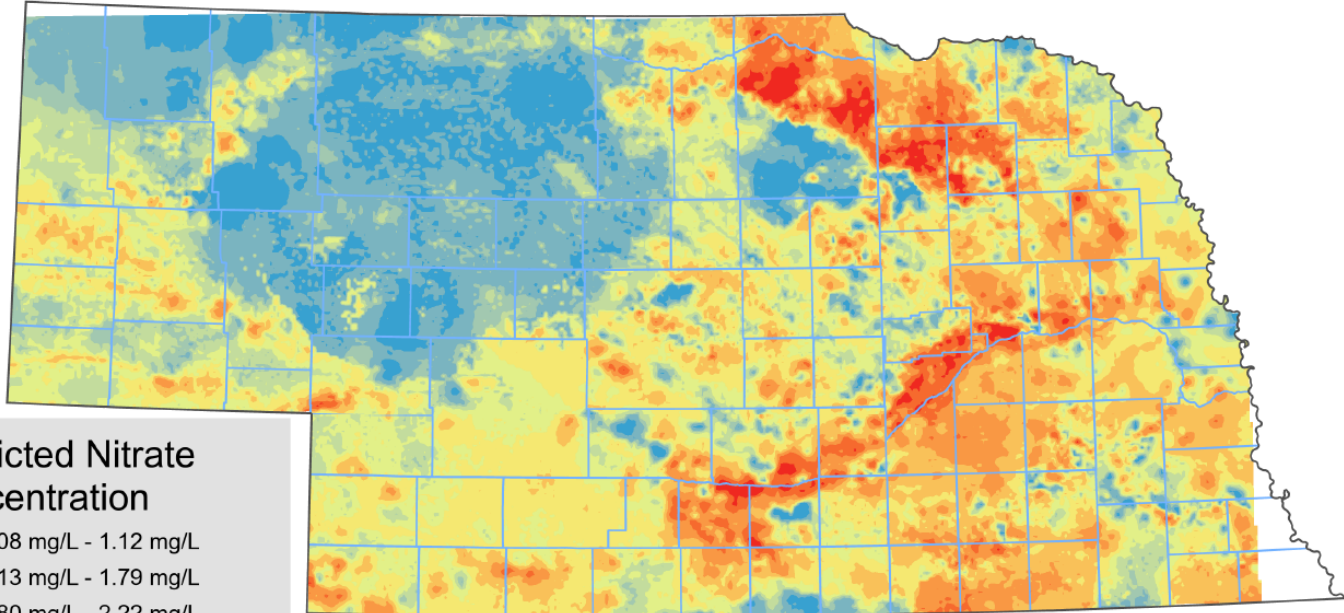
Getis Ord (Gi*) Hot Spot Analysis for Nitrate Well Samples in the Nebraska Groundwater Quality Clearinghouse 2003 - 2023



What predictions can we make about nitrate levels?

Predicted Nitrate Levels in Nebraska

Note: Predicted values are an estimate based on nitrate sample data from the groundwater clearinghouse, historic land use, soil vulnerability, and well density. Results were modeled in ArcPro using Empirical Bayesian Kriging with Regression Prediction. Predictions have a mean error of approximately +/- 3 and are not intended to represent definite values at any one location. Results provided for illustrative purposes. Final results will accompany the final report.



Predicted Nitrate Concentration

0.08 mg/L - 1.12 mg/L
1.13 mg/L - 1.79 mg/L
1.80 mg/L - 2.22 mg/L
2.23 mg/L - 2.90 mg/L
2.91 mg/L - 3.94 mg/L
3.95 mg/L - 5.57 mg/L
5.58 mg/L - 8.08 mg/L
8.09 mg/L - 11.99 mg/L
12.00 mg/L - 18.06 mg/L
18.07 mg/L - 27.48 mg/L

Credits: NDEE Drinking Water and Groundwater Division
 Spatial Reference Name: NAD 1983 State Plane Nebraska FIPS 2,600 Feet
 Datum: North American 1983
 Projection: Lambert Conformal Conic

Trends in Drinking Water Nitrate Levels

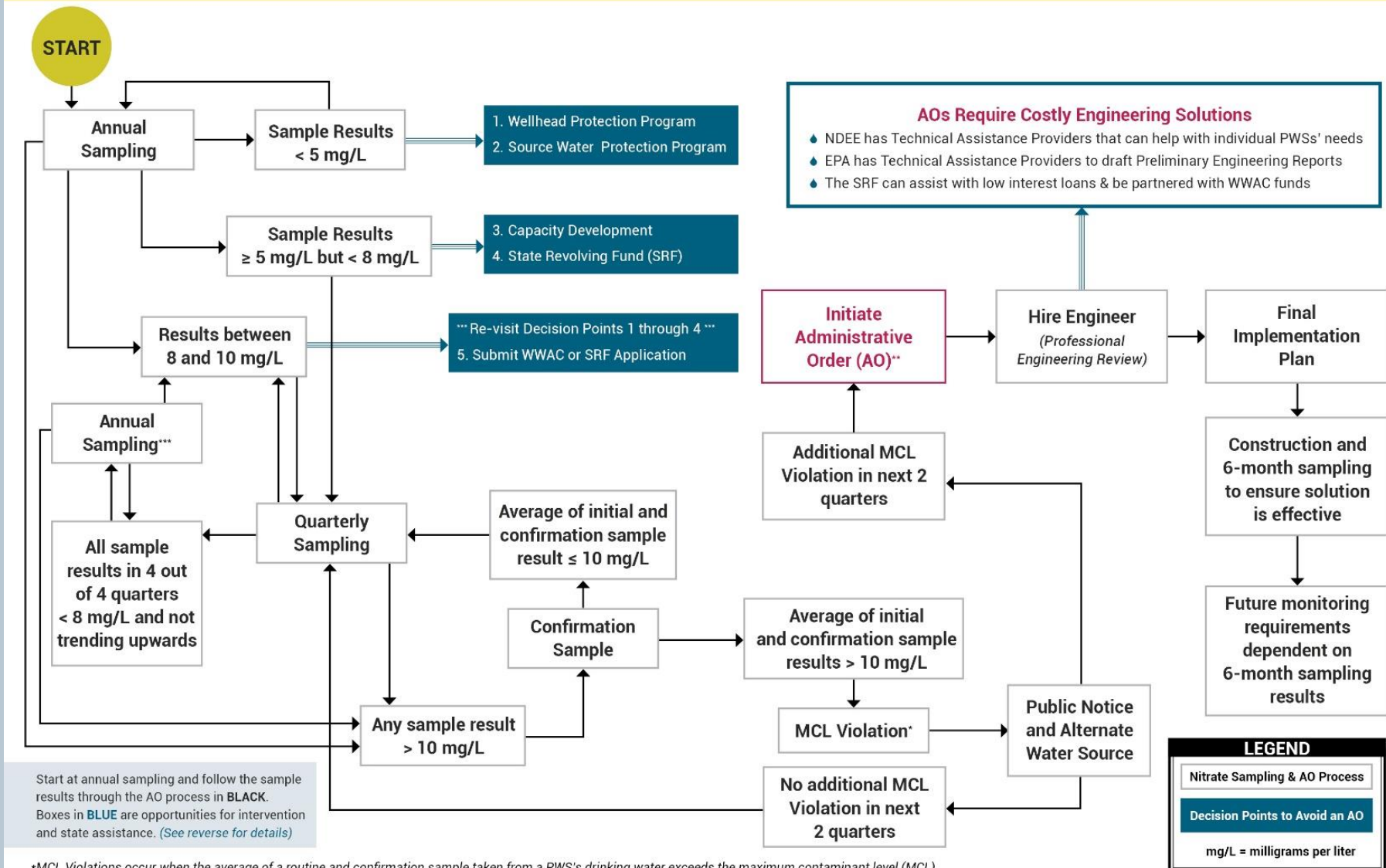
- For public water systems
- For different regions of the state

How do we turn study results into something actionable?

Priorities for State Program Assistance

- Short-Term Engineered Solutions – Clean Water and Drinking Water State Revolving Funds
- Mid-Term Planning and Technical Assistance
- Long-Term Source Water and Wellhead Protection Planning and Aid

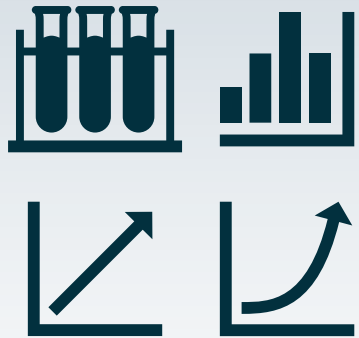
Public Water System (PWS) Nitrate Sampling Requirements and Decision Points to Avoid an Administrative Order (AO) Flowchart



*MCL Violations occur when the average of a routine and confirmation sample taken from a PWS's drinking water exceeds the maximum contaminant level (MCL).
 **Administrative Orders (AO) are enforcement actions issued by NDEE that require a PWS to take corrective action to address MCL Violations within a three-year time frame.
 ***Annual Sampling: After a PWS is required to conduct quarterly monitoring, when they meet the requirements to return to annual sampling, the new trigger point for returning to quarterly monitoring is 8 mg/L instead of 5 mg/L.

Community Water Systems Analysis

Sample Data and
Trend Analysis



Risk Index
Calculation

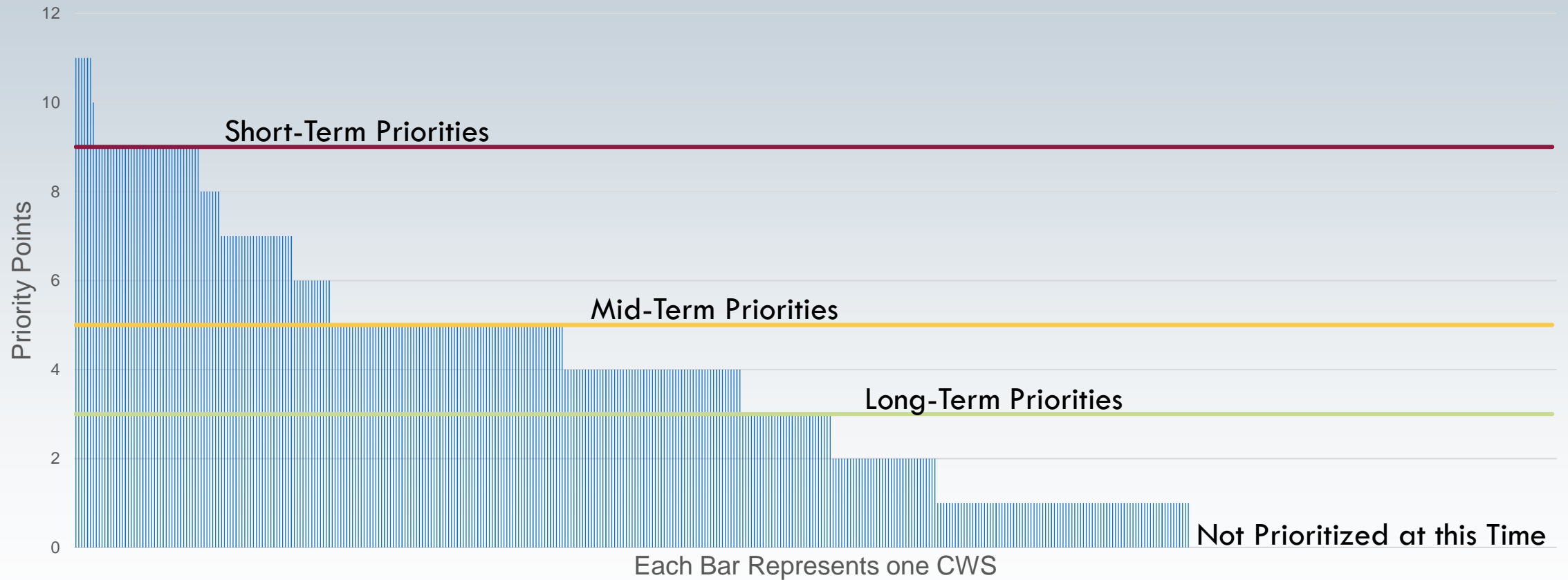


Ranking by Total Points

1. Short-Term Solutions
2. Mid-Term Solutions
3. Long-Term Solutions

Community Water Systems Analysis

CWS Priority Points Distribution and Cutoff Values

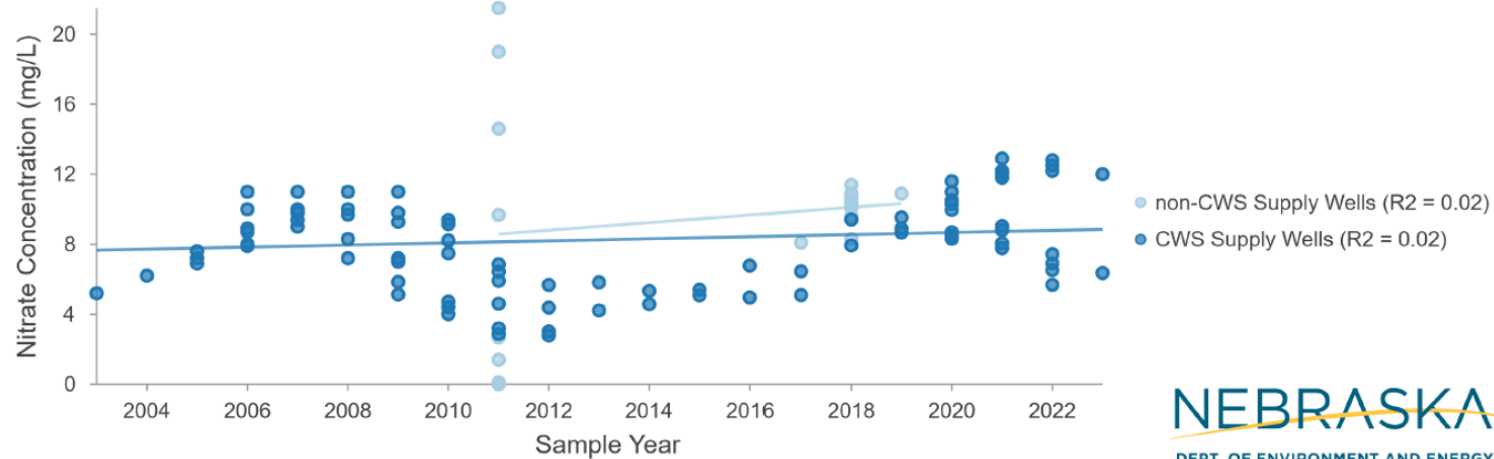


Water System: Nebraskaville, Village of

The map frame shows the WHPA boundary, aerial imagery, and the locations of all recorded nitrate samples nearby. These samples are plotted on the chart below separated by CWS and non-CWS samples. Study results are summarized by the table – which shows the total priority points and top-line results of the analysis. The reverse page of this map briefly summarizes each measure to help CWS understand what the water quality study findings mean for their system. CWS GPS information is not publicly available.

NE_ID	NRD	Mean Nitrate Supply Well C	Priority Points	Trend MK Score	Value Cluster Score	Linear Trend Score
		10.5 mg/L	9	0	1	2

Groundwater Nitrate Samples 2003-2023 Inside the Map Frame



What about private well owners?

Goals for the Private Well Owner Risk-Assessment Tool

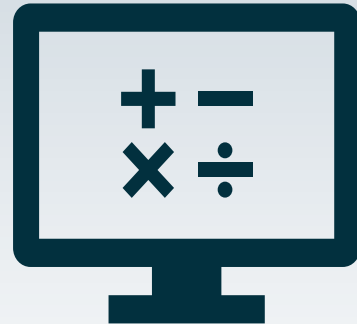
- Assist Owners in Evaluating Risk
- Provide Practical Steps to Address Concerns

Private Well Risk-Assessment Tool

Well Owner Enters
their Address

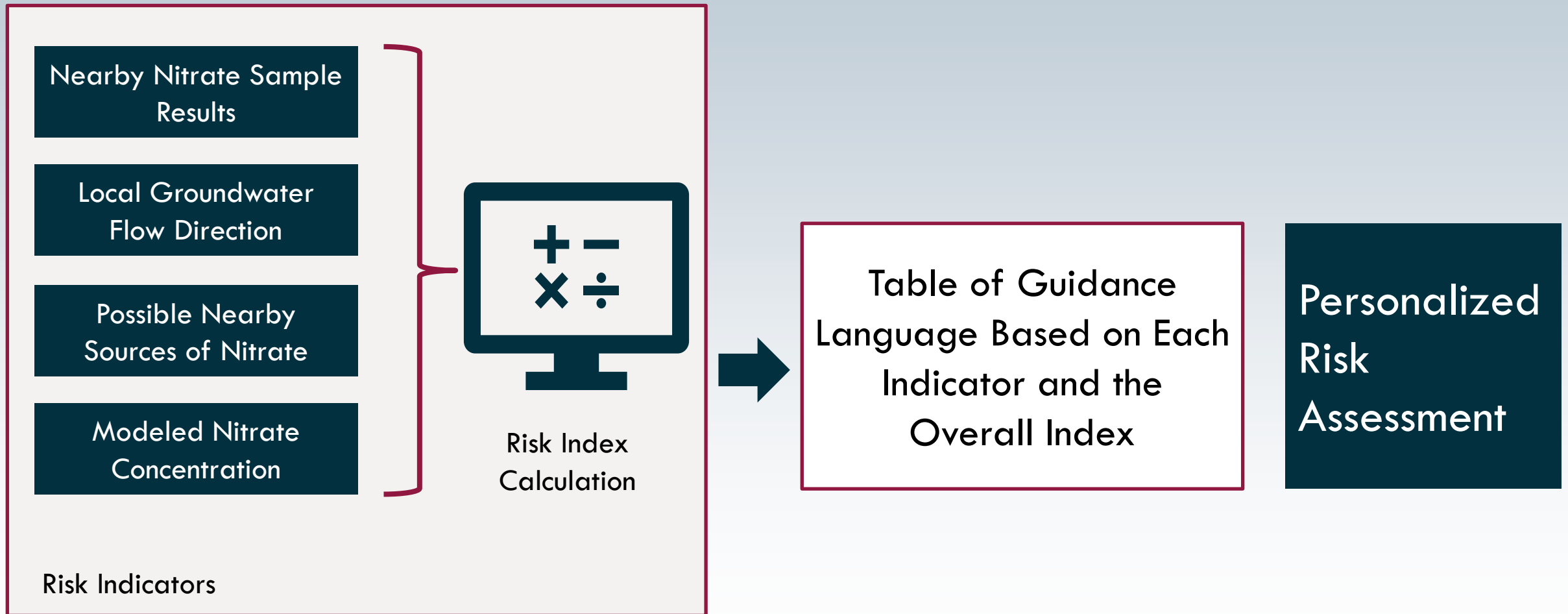


Risk Index
Calculation



Personalized
Risk
Assessment

Private Well GIS Risk-Assessment Tool



NITRATE IN DRINKING WATER

Nitrate is a compound that occurs naturally and has many human-made sources. Nitrate is in some lakes, rivers, and groundwater in Nebraska. You cannot taste, smell, or see nitrate in water. Consuming too much nitrate can be harmful—especially for babies.

Background Information

Nitrate occurs naturally and at safe and healthy levels in some foods (e.g., spinach and carrots) and comes from natural processes, like plant decay. Most nitrogenous materials in water tend to be converted to nitrate, so all sources of combined nitrogen, including organic nitrogen and ammonia, should be considered as potential nitrate sources. Primary sources of organic nitrate include human sewage and livestock manure. The primary source of inorganic nitrate is from fertilizers used on yards, gardens, golf courses, and crops. Certain industrial processes and leaks from fertilizer storage can also be a source of inorganic nitrate. Natural processes can cause low levels of nitrate in drinking water—usually less than 3 mg/L. The health concern is with levels of nitrate over 10 mg/L.

Nitrate in Nebraska Water

Nitrate has been found in groundwater across Nebraska. While nitrate occurs naturally, levels in groundwater above 3 mg/L are considered an indicator of human-driven contamination. Based on available data, there were 8,982 domestic well nitrate samples collected from 2010–2022. Of all the domestic wells sampled over this period, 4,284 (47.7%) of them were above 3 mg/L for nitrate and 1,855 (20.7%) of them were above 10 mg/L for nitrate. For more information about nitrate in Nebraska surface water and groundwater, see the Nebraska Department of Environment and Energy's (NDEE's) annual water program publications included in the Resources section.

Health Effects

Consuming too much nitrate can affect how blood carries oxygen and may cause methemoglobinemia (also known as blue baby syndrome). Bottle-fed babies under six months old are at the highest risk of getting methemoglobinemia. This illness can cause the skin to turn a bluish color and result in serious illness or death. Other symptoms connected to methemoglobinemia include decreased blood pressure, increased heart rate, headaches, stomach cramps, and vomiting.¹ Pregnant or nursing mothers should consult their doctor with questions about how elevated nitrate levels in drinking water may impact them. The following conditions may also put people at higher risk of developing nitrate-induced methemoglobinemia: anemia, cardiovascular disease, sepsis, glucose-6-phosphate-dehydrogenase deficiency, and other metabolic problems.²

How to Protect Yourself and Your Family

The U.S. Environmental Protection Agency (EPA) established the Maximum Contaminant Level (MCL) for nitrate in drinking water at 10 milligrams of nitrate (measured as nitrogen) per liter of drinking water (mg/L).^{*} Drinking water with nitrate above the MCL is acutely dangerous to infants under six months of age who may develop blue baby syndrome.

^{*}1 milligram per liter (mg/L) is equivalent to 1 part per million

If You Are on a Community Public Water System

Your public water system regularly tests for nitrate and makes sure levels meet the EPA standard. You can find the level of nitrate detected in the system serving where you live by reading the system's water quality report (also published in the paper as Quality on Tap). Call your water system to get a paper copy of your community's most recent report or find drinking water quality information about your system online at the Drinking Water Watch website. If you want to find the nitrate level in drinking water for a location other than your home, contact the public water system serving that location.

If You Have a Private Well

The following types of wells are the most vulnerable to nitrate contamination, especially if they are near or downgradient of septic tanks and absorption/leach fields, certain industrial areas, areas with agricultural activities, or other contamination sources:

- Shallow wells 50 feet or less in depth.
- Wells in sand aquifers.
- Dug wells or wells with casings that are not watertight due to damage or construction materials used.
- Wells in a pit.
- Improperly constructed wells.
- Wells constructed prior to the 1988 construction standards.

¹ Agency for Toxic Substances and Disease Registry (ATSDR). 2015. ToxFAQs™ for Nitrate and Nitrite (<https://www.atsdr.cdc.gov/toxfaq/toxfaq204.pdf>). Accessed October 2016.

² ATSDR. 2013. ATSDR Case Studies in Environmental Medicine. Nitrate/Nitrite Toxicity (https://www.atsdr.cdc.gov/cs/em/nitrate_2013/docs/nitrite.pdf). Page 37. Accessed October 2016.

Prevent Contamination

- **Construct your well in a safe spot.** Domestic wells constructed in Nebraska are required to adhere to setback distances and construction standards set in Nebraska Administrative Code (NAC) Title 178, Chapter 12. Ensure your installer is a licensed Water Well Professional using the NDEE website listed in the Resources section or by calling 402-471-0546.
- **Keep nitrate sources away from your well.** Sources may include fertilizer application and storage, fuel storage, septic systems, wastewater treatment facilities, and livestock facilities. See NAC Title 178, Chapter 12, Chart 1 for setback distances from common sources of well contamination.
- **Regularly inspect your well for damage.** And work with a licensed professional to take any corrective actions that may be needed. Water Well Professionals with a current license are listed on the NDEE website listed in the Resources section.
- **Test for nitrate every year.** You are responsible for regularly testing your well water. NDEE recommends using an accredited laboratory to test your well water. Well owners can request sample kits from the Nebraska Department of Health and Human Services (NDHHS) online at the website listed in the Resources section or by calling 402-471-3935. Additionally, the NDHHS's website has a list of other accredited laboratories. Contact the laboratory to get sample containers and instructions or ask your local Natural Resources District (NRD) or public health services if they provide well water testing services.

Address Contamination

If nitrate is detected in your water at levels above 10 mg/L, follow these steps:

- **Get your drinking water from a safe source,** such as bottled water, or a public water system including rural water districts. This is especially important if babies under six months old drink the water or formula is made with the water. Pregnant or nursing mothers should consult with their doctor about how elevated nitrate levels in drinking water may affect them. Boiling water is not a solution for elevated nitrate levels as it causes evaporation and concentrates the nitrate in the water.

- **Consider testing the well for other contaminants that commonly occur with nitrate such as bacteria and uranium.** Sample test kits for other contaminants, such as bacteria and uranium may be requested from the Nebraska Department of Health and Human Services online at the website listed in the Resources section or by calling 402-471-3935.
- **Consider a Point of Use (POU) treatment device to remove nitrate from drinking water.** NDEE currently provides a rebate of up to \$4,000 for installation of a reverse osmosis (RO) treatment system. If your well tests above 10 mg/L for nitrate, you may be eligible for the RO rebate program. Visit the NDEE website in the Resources section or call 402-471-4200 for more information.
- **Contact a local rural water district.** Connection to the rural water district-supplied water may be an option in your area.

Resources

- Drinking Water Watch <https://drinkingwater.ne.gov>
- NDEE Annual Report to the Legislature <http://dee.ne.gov/publica.nsf/pages/NDEE033>
- NDEE Groundwater Quality Monitoring Report <http://dee.ne.gov/publica.nsf/pages/23-022>
- NDEE (RO) Rebate Program <http://dee.ne.gov/Publica.nsf/pages/22-051>
- NDEE Water Well Professionals Licensee lookup <http://dee.ne.gov/NDEEQProg.nsf/OnWeb/Licenses1>
- NAC Title 178 (Chapter 12 Setback Distances) <https://rules.nebraska.gov/rules?agencyid=37&titleid=107>
- NDDHS Water Sampling Test Kit Request <https://www.nebraska.gov/dhhs/water-test-kits/private.html>
- NDDHS Certified Labs <https://dhhs.ne.gov/Pages/Lab-Certification-Requirements.aspx>
- EPA Fact Sheet <https://archive.epa.gov/water/archive/web/pdf/archived-consumer-fact-sheet-on-nitrates-and-or-nitrites.pdf>
- UNL Water: Nitrate in Drinking Water <https://water.unl.edu/article/drinking-water-wells/nitrate-drinking-water>

Nebraska Department of Environment and Energy
402-471-2186
ndee.moreinfo@nebraska.gov

FREE DRINKING WATER NITRATE TESTING

Learn more about how to request your
free private domestic well sample kit



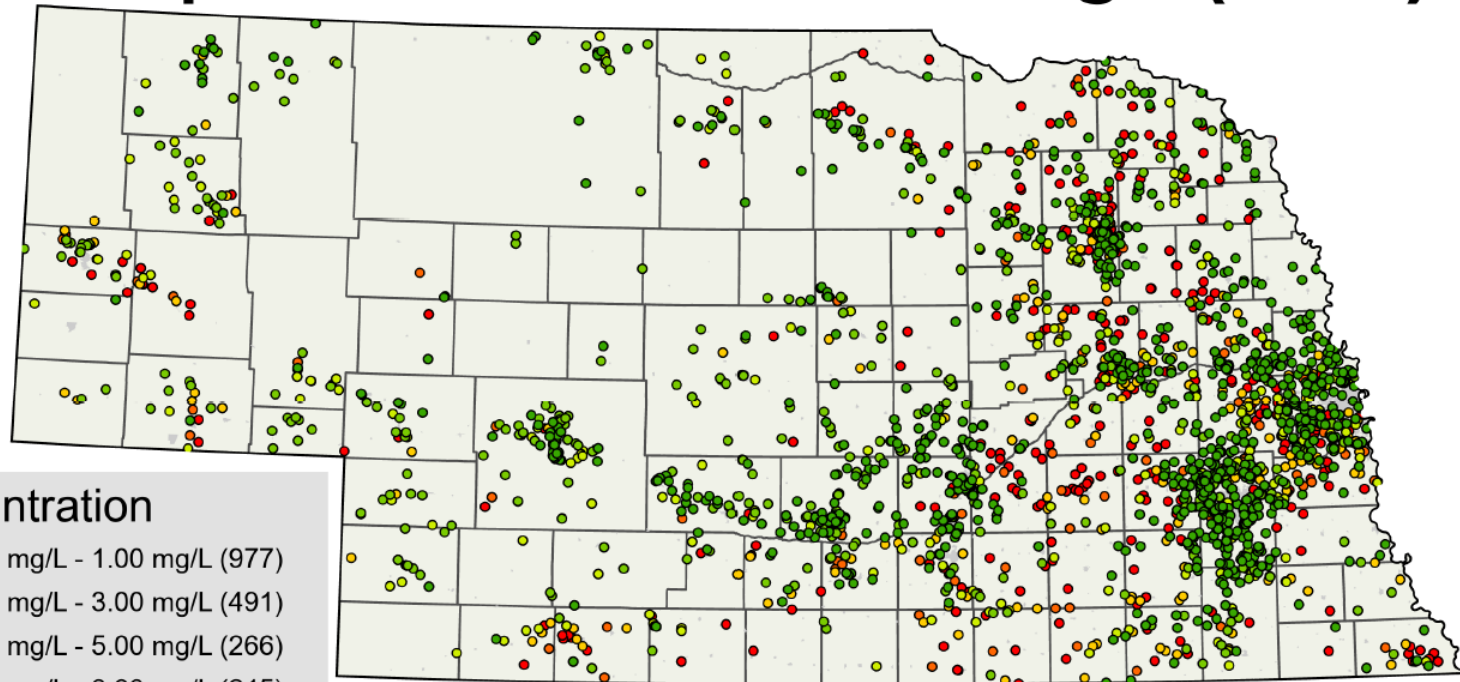
NEBRASKA

DEPT. OF ENVIRONMENT AND ENERGY

Free Nitrate Test Kits for Private Domestic Wells

- Over 4,500 free kits requested
- Increase the total domestic nitrate samples since 2010 by 50% (assuming all kits are returned)
- Over 4x the number of domestic nitrate samples in any year on record (peak of 900 after the 2019 flooding events)
- Deadline to request a kit was March 1

DRAFT NDEE 2,453 Free Domestic Nitrate Sample Results as of 02/29/2024 DRAFT 360 Sample Results are Above 10 mg/L (14.6%)



concentration

- 0.05 mg/L - 1.00 mg/L (977)
- 1.01 mg/L - 3.00 mg/L (491)
- 3.01 mg/L - 5.00 mg/L (266)
- 5.01 mg/L - 8.00 mg/L (245)
- 8.01 mg/L - 10.00 mg/L (107)
- > 10.01 mg/L (360)

NEBRASKA

DEPT. OF ENVIRONMENT AND ENERGY

Credits: NDEE Drinking Water and Groundwater Division
 Geo-reference: NAD 1983 State Plane Nebraska
 FIPS 2,600 Feet
 Datum: North American 1983
 Projection: Transverse Mercator

Reverse Osmosis System Rebate Program

- Tentative deadline to apply is June 30, 2024 and tentative deadline to have the system installed is September 30, 2024
- Instructions to apply are available at dee.ne.gov
- Well must be registered and you must be approved for the rebate prior to installation of the system
- Rebate is worth up to \$4000 for each private well
- Approximately \$650,000 remaining in the fund

Remaining Work

- Close Data Gaps
- Finalize Analysis
- Develop Interactive GIS Tool
- Finish Developing and Implement Outreach Plan

Questions?

Contact Information:

Hillary Stoll – hillary.stoll@nebraska.gov

Bridger Corkill – bridger.corkill@nebraska.gov

Feedback Wanted!

- How can we get this information to people who need it?
- Are there any pieces that seem missing?
- Would you use the private well risk-assessment tool to evaluate your well?

Email address: ndee.moreinfo@nebraska.gov