NEBRASKA NITRATE IN DRINKING WATER STUDY UPDATE

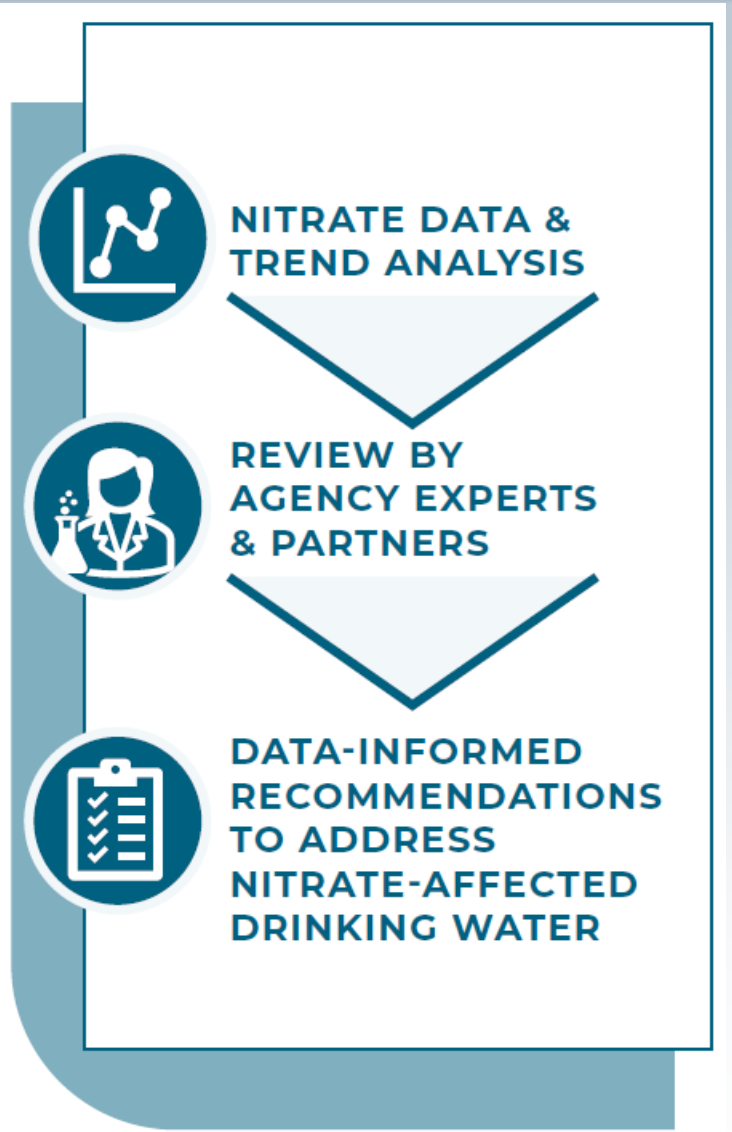
October 10, 2024

Presented by Bridger Corkill

Engineer – Permitting and Engineering Division

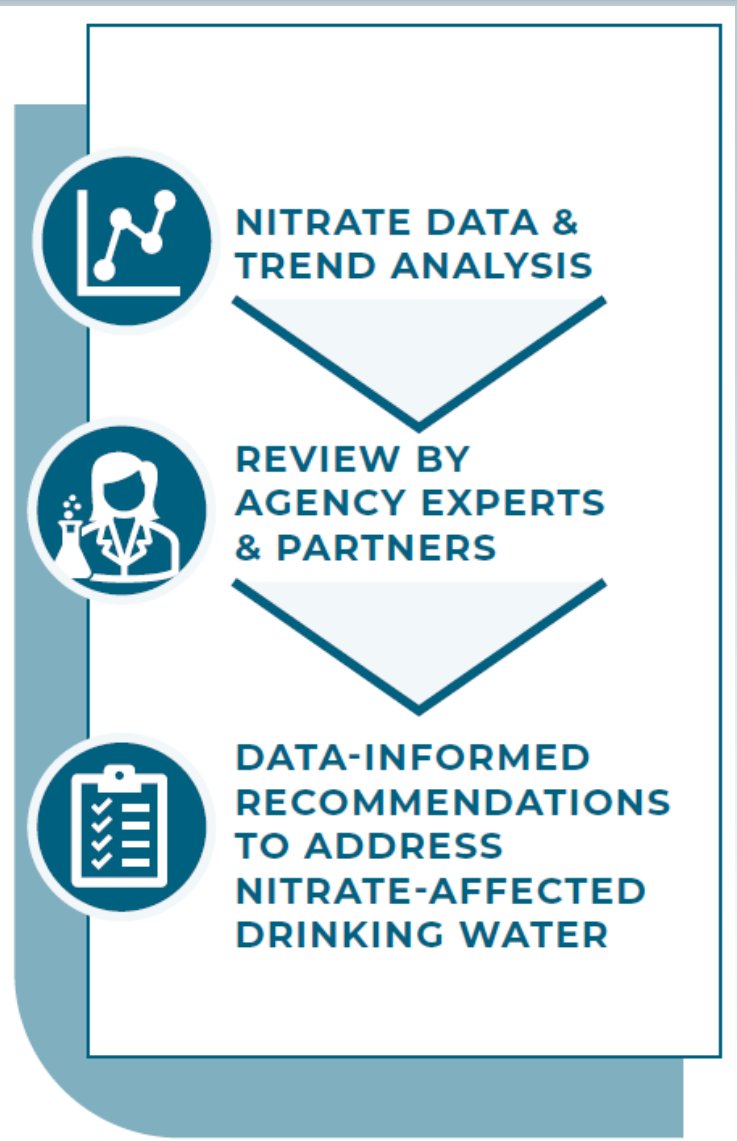
Overall Objective:

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).

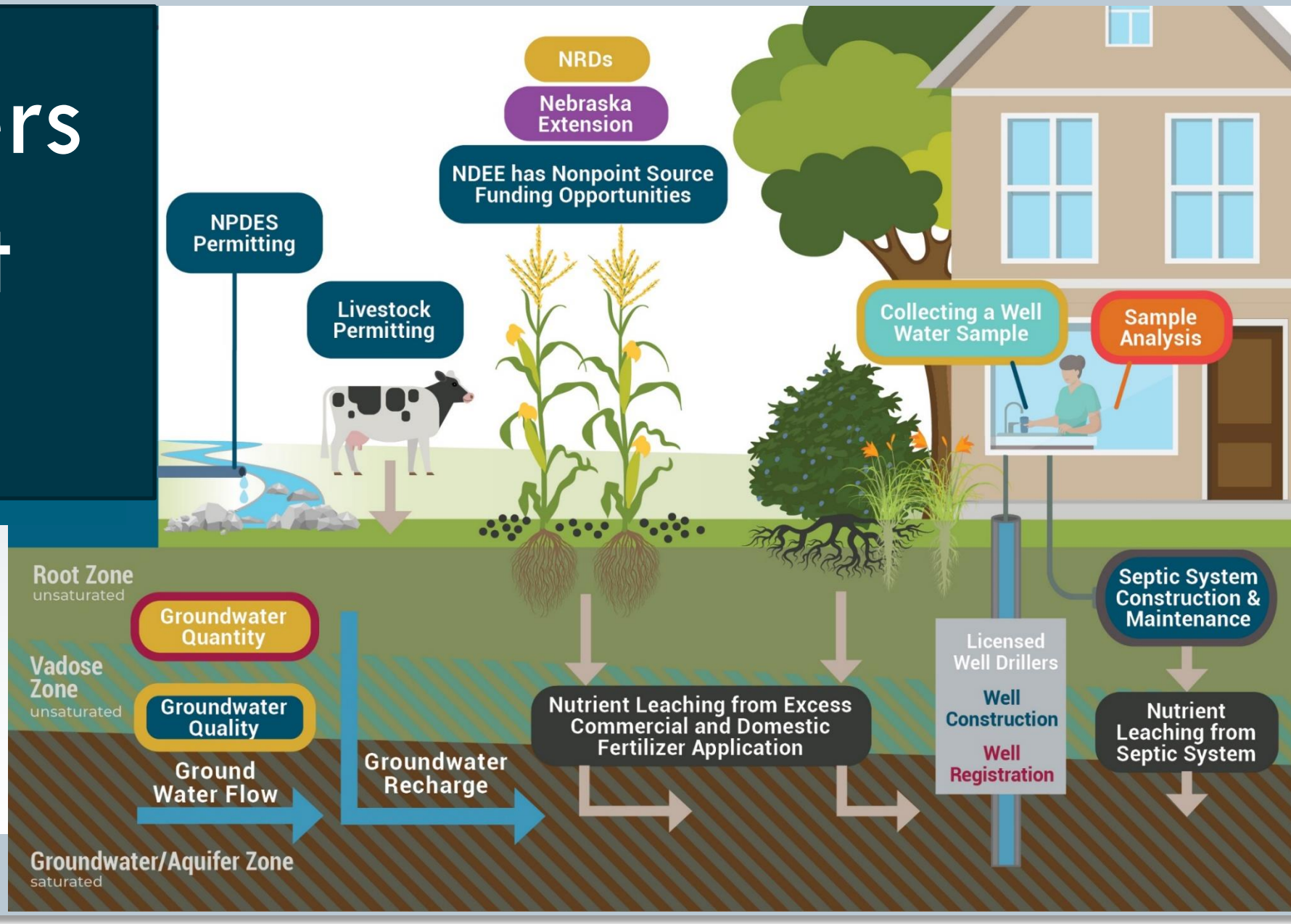


Elements of the Nitrate Study

- Analysis & Data Collection
- Guidance & Tools
- Reports & Communication Materials



Stakeholders and Project Audiences



Project Partners

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Nebraska's Natural Resources Districts
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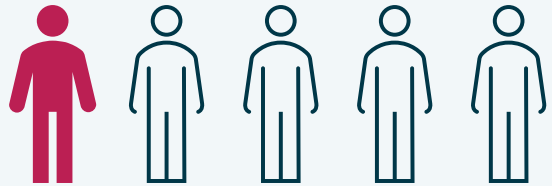
THE SAFE DRINKING WATER ACT (SDWA)

- NDEE Enforces
- Applies to Public Water Systems (PWSs)
- Establishes Water Quality Standards
- Maximum Contaminant Levels (MCLs)
- The Nitrate MCL is 10 mg/L

PRIVATE DOMESTIC WELLS ARE NOT REGULATED BY THE SAFE DRINKING WATER ACT



ONE IN FIVE NEBRASKANS RELY ON A PRIVATE DOMESTIC WELL FOR THEIR DRINKING WATER

PWSs THAT REPEATEDLY VIOLATE THE MCL FOR NITRATE:

Must notify customers and provide water for vulnerable populations.

Can be legally compelled to provide SDWA compliant drinking water. May mean a treatment plant or new well.

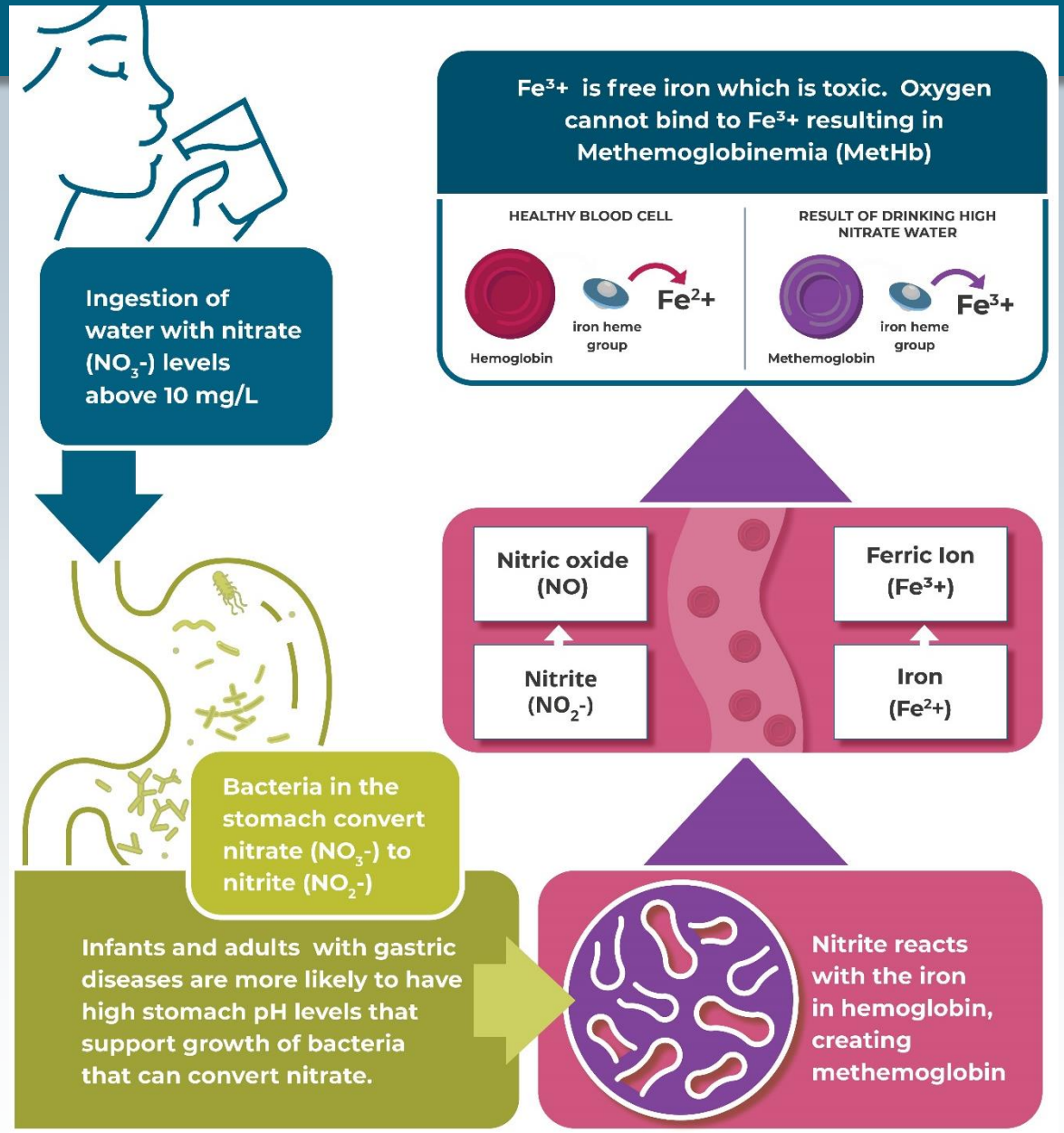
Engineered solutions are costly, especially for small communities.

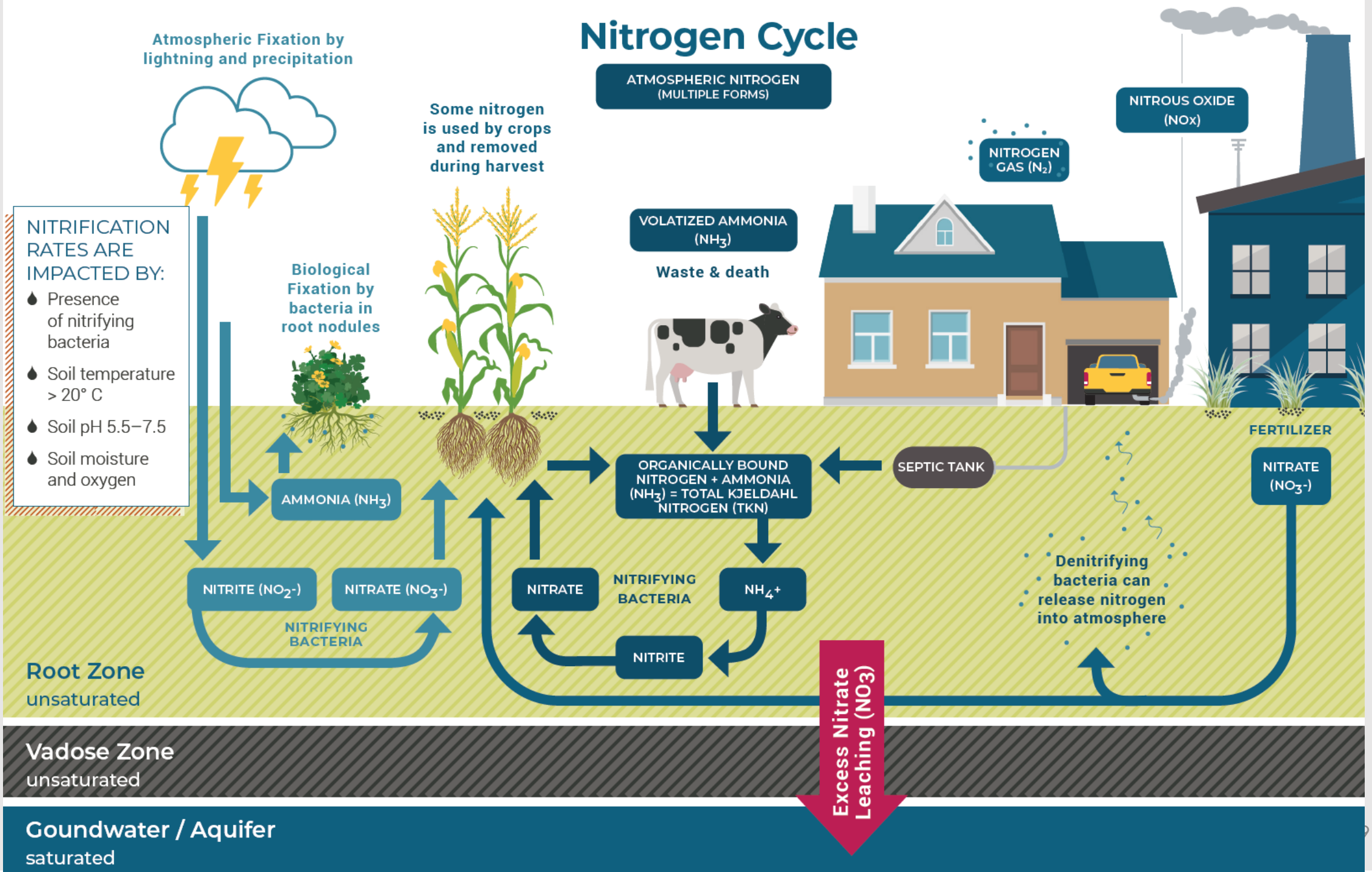
Note: The public can access water quality data for their community at https://drinkingwater.ne.gov.

Nitrate Impairs Blood Oxygen Delivery

Nitrate toxicity is due to its conversion to nitrite in the body.

Infants are particularly vulnerable to nitrate in drinking water above the SDWA Limit of 10 milligrams per liter (mg/L).



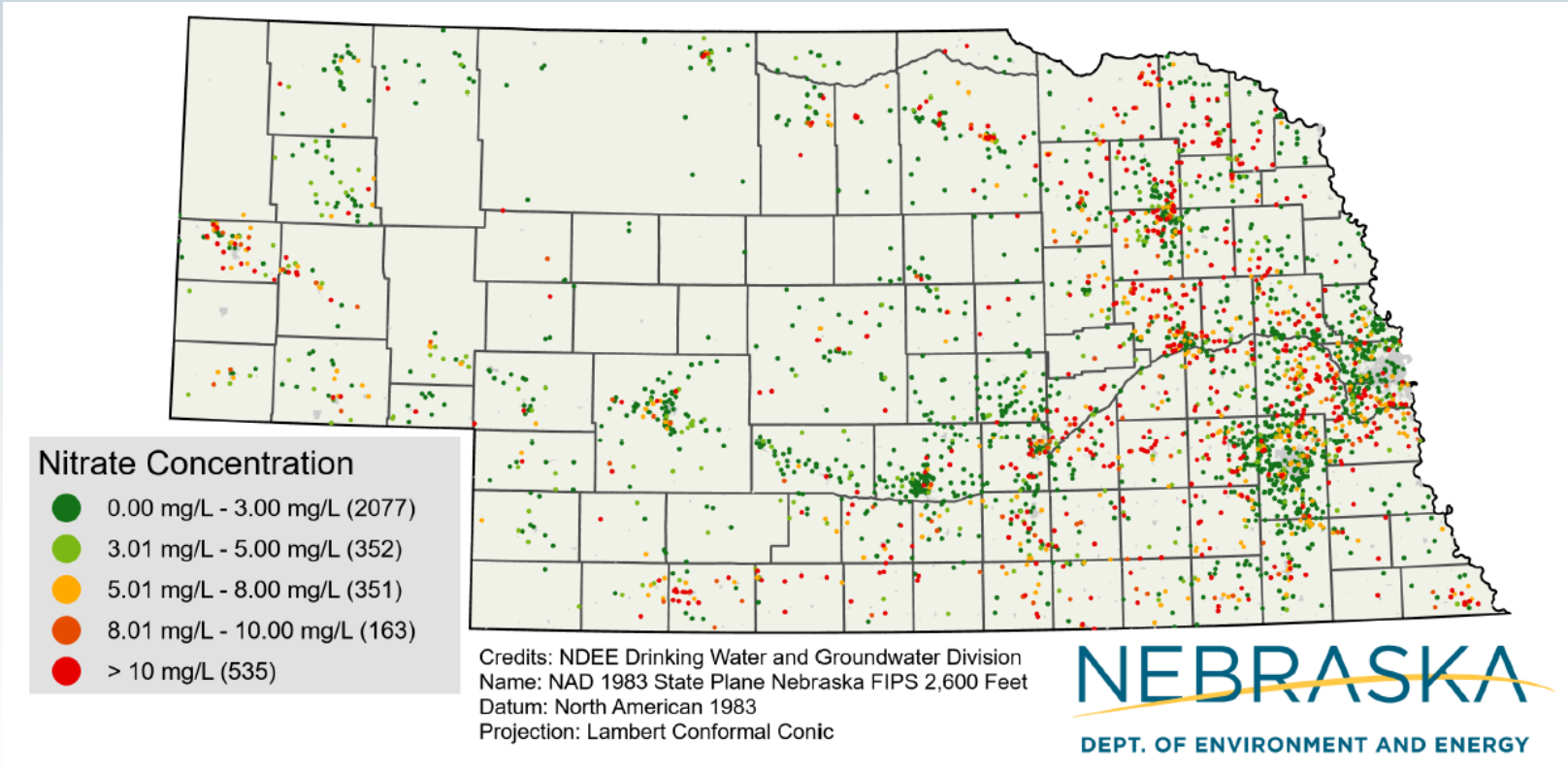

Nitrogen Cycle
ATMOSPHERIC NITROGEN (MULTIPLE FORMS)
Atmospheric Fixation by lightning and precipitation
Some nitrogen is used by crops and removed during harvest
NITROUS OXIDE (NOx)
NITROGEN GAS (N_2)
VOLATIZED AMMONIA (NH_3)
Waste & death
Biological Fixation by bacteria in root nodules
NITRIFICATION RATES ARE IMPACTED BY:
Presence of nitrifying bacteria
Soil temperature > 20° C
Soil pH 5.5–7.5
Soil moisture and oxygen
AMMONIA (NH_3)
ORGANICALLY BOUND NITROGEN + AMMONIA (NH_3) = TOTAL KJELDAHL NITROGEN (TKN)
SEPTIC TANK
FERTILIZER
NITRATE (NO_3-)
NITRITE (NO_2-)
NITRATE (NO_3-)
NITRIFYING BACTERIA
NITRATE
NITRIFYING BACTERIA
NH_4^+
NITRITE
Denitrifying bacteria can release nitrogen into atmosphere
Root Zone
unsaturated
Excess Nitrate Leaching (NO_3)
Vadose Zone
unsaturated
Goundwater / Aquifer
saturated

Free Private Domestic Well Sampling Effort

NDEE Oversaw the Largest Private Domestic Well Sampling Effort in State History

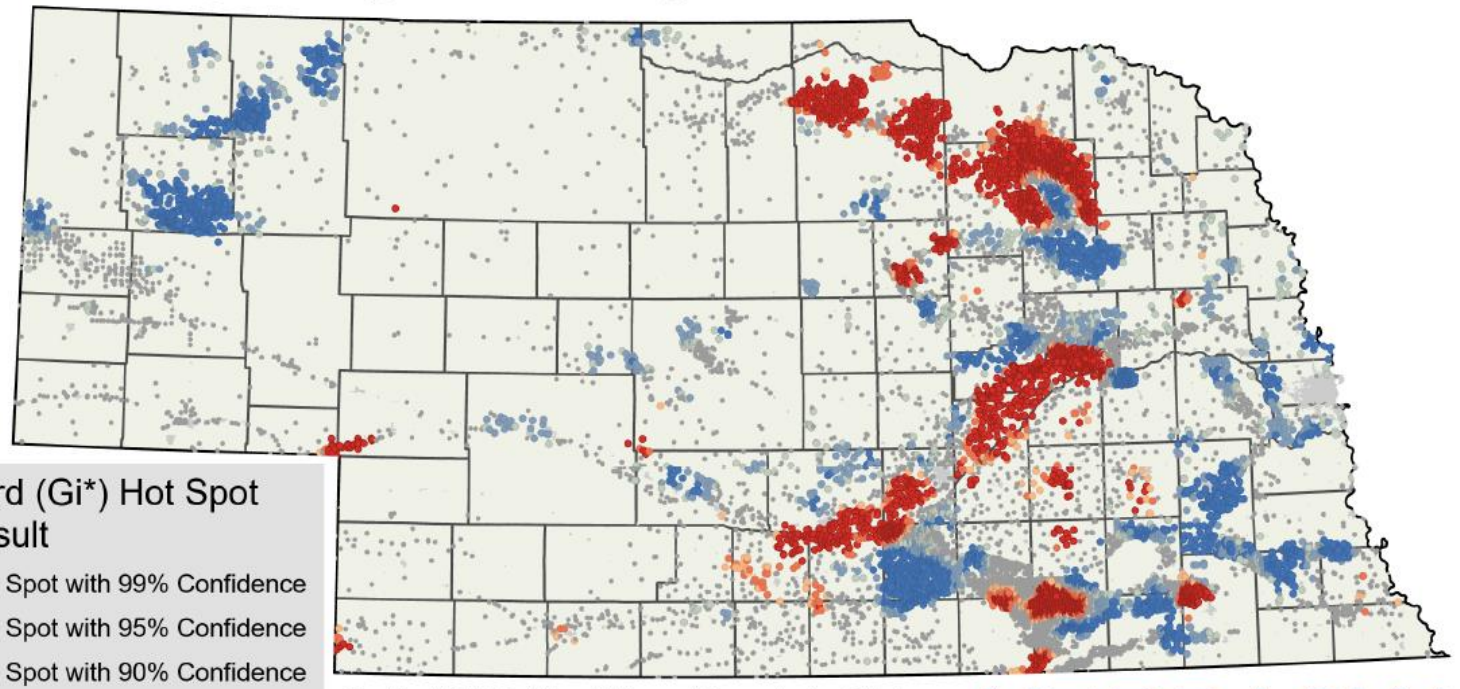
Over 3,400 Samples Analyzed

Mean Nitrate Concentration 4.83 mg/L



Statistical Analysis to Identify Hot Spots and Trends in Nitrate Concentrations

Getis Ord (Gi*) Hot Spot Analysis: Nitrate Samples from the Nebraska Groundwater Quality Clearinghouse 2003-2019



Getis Ord (Gi*) Hot Spot Test Result

- Cold Spot with 99% Confidence
- Cold Spot with 95% Confidence
- Cold Spot with 90% Confidence
- Not Significant
- Hot Spot with 90% Confidence
- Hot Spot with 95% Confidence
- Hot Spot with 99% Confidence

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

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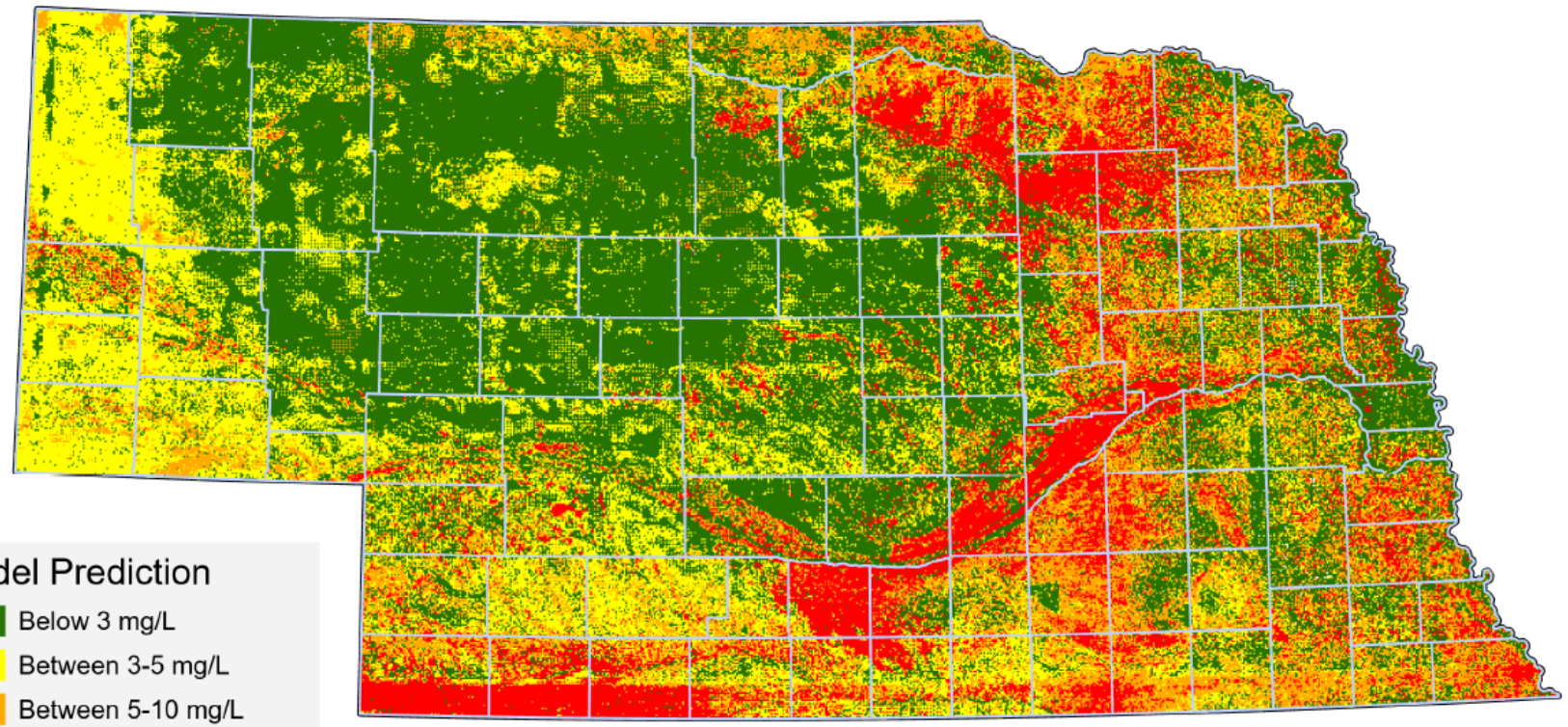
Modeling to Supplement Private Domestic Well Owner GIS-Tool

Predictive Nitrate Model Results: Composite Layer for the Private Domestic Well Owner Risk Assessment Tool



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

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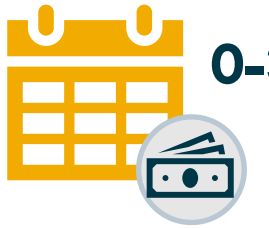
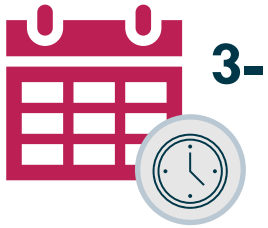
Results and Recommendations Relating to Public Water Systems (PWSs)

Why Analyze Trends in PWS Nitrate Concentrations?



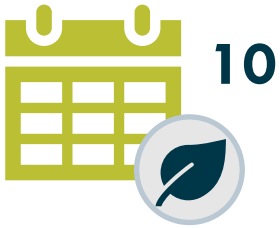
0-3 Years

Short-term Engineered Solutions, like new wells or treatment.



3-10 Years

Mid-term Technical Assistance and capacity building.



10+ Years

Long-term Wellhead and Source Water Protection.

Data Analysis to Prioritize State Assistance

NITRATE DATA & TREND ANALYSIS

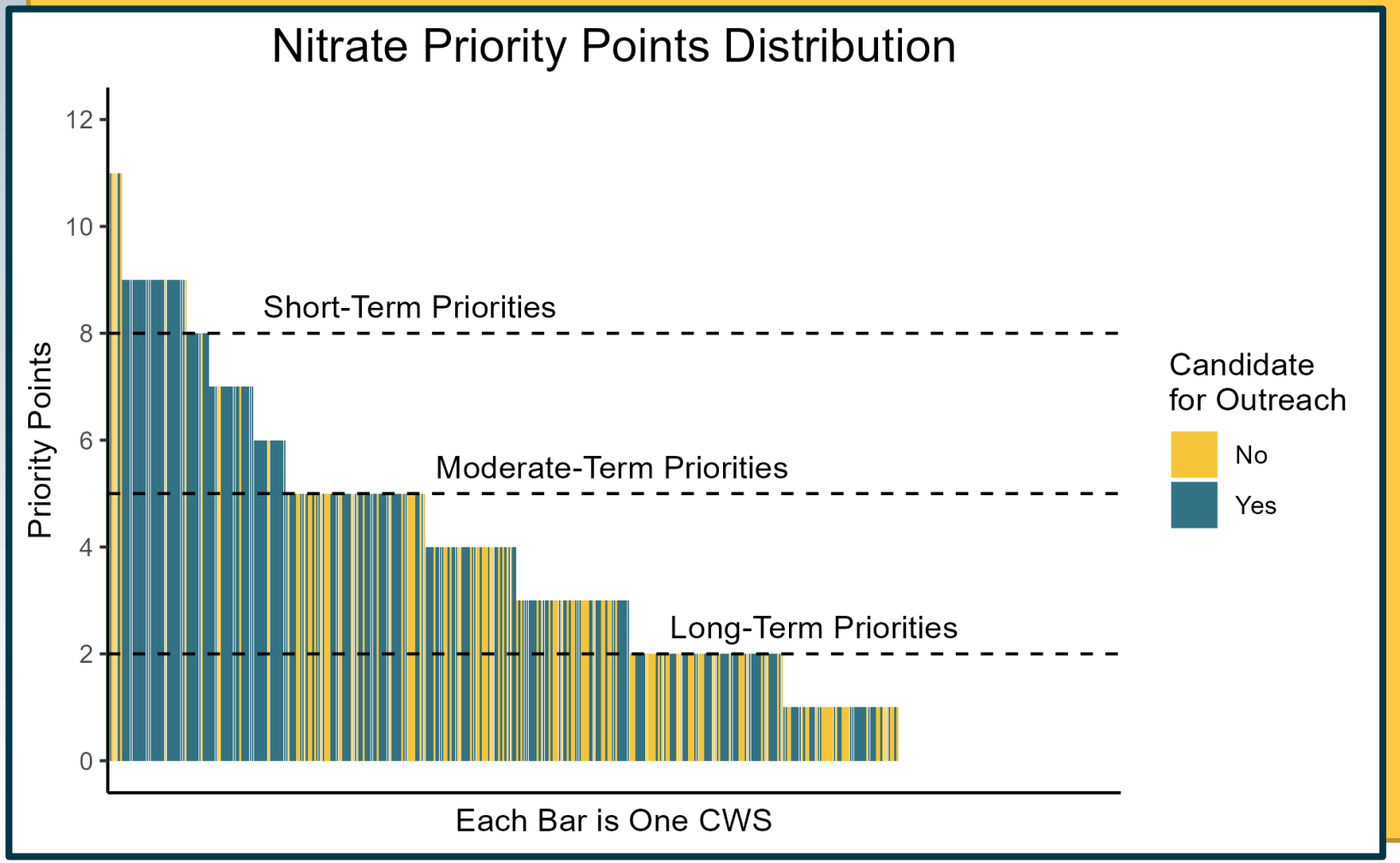
PRIORITY POINTS CALCULATIONS

RANKING BY TOTAL POINTS

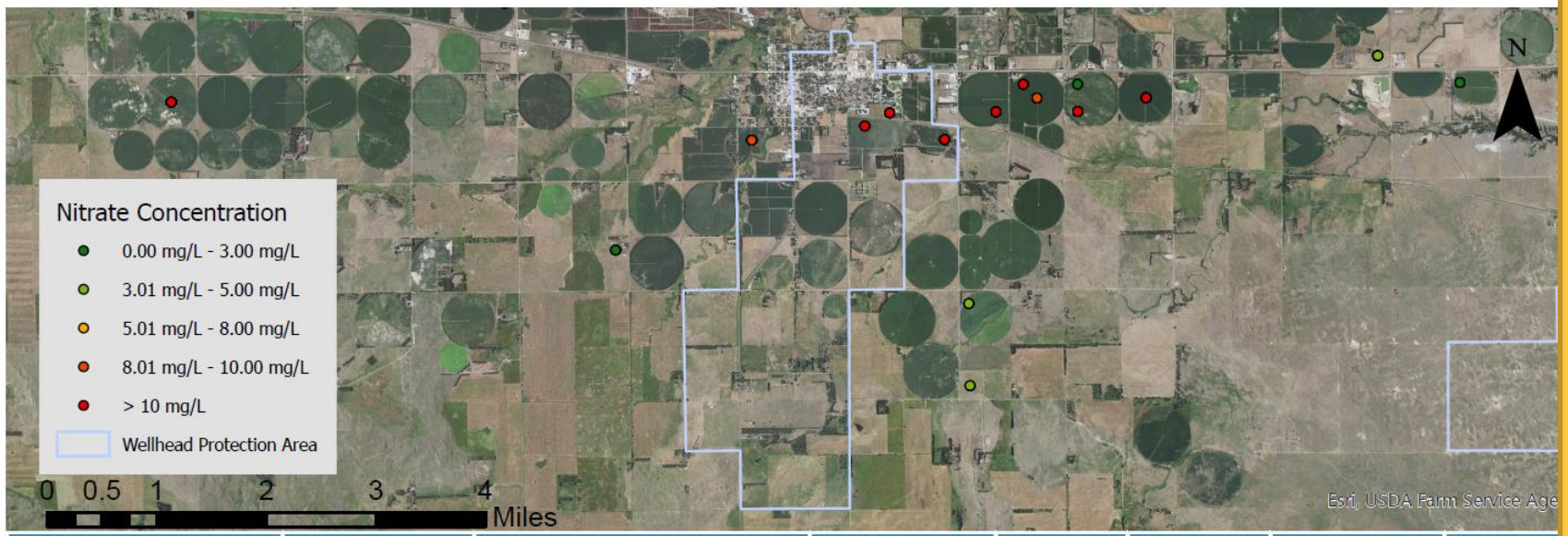
1. SHORT-TERM PRIORITIES
2. MID-TERM PRIORITIES
3. LONG-TERM PRIORITIES

PWS Nitrate Priority Points System

A planning tool NDEE can use to better target medium and long-term assistance programs that prevent expensive, mandated solutions for small communities to comply with the SDWA.

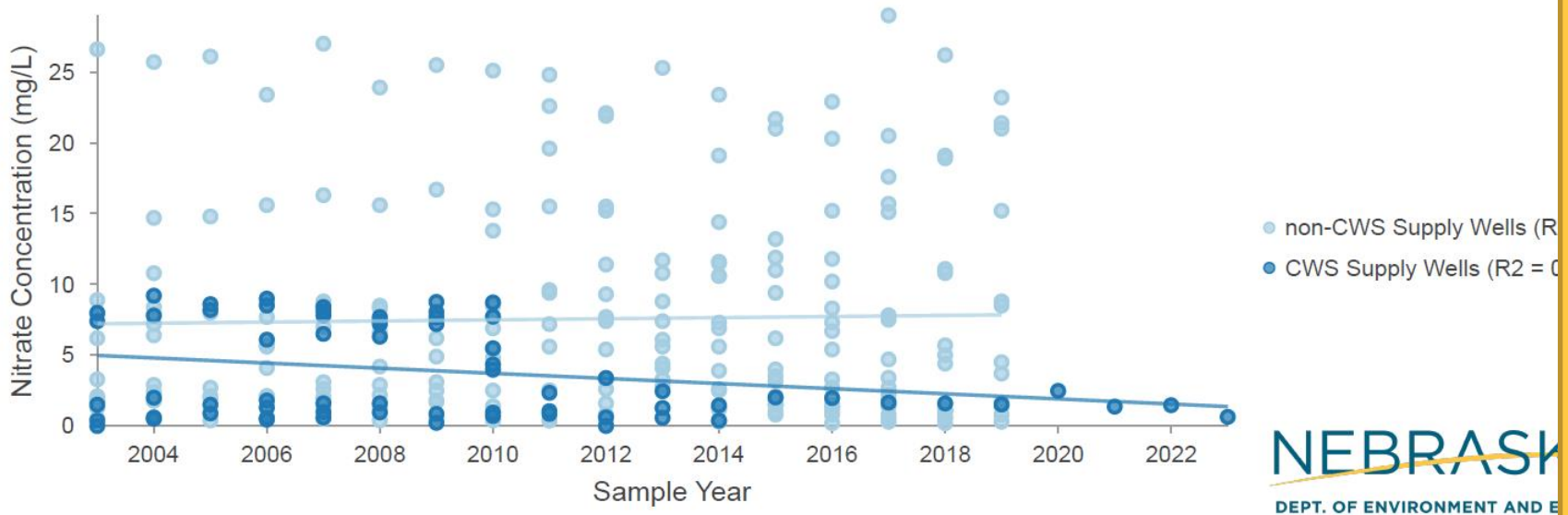


Water System: AINSWORTH, CITY OF



PWS_Name	NRD	Mean Nitrate Concentration	Priority Points	MK Score	TSC Score	LogLin Score	Sample S
AINSWORTH, CITY OF	Middle Niobrara	1.16	2	0	1	0	1

Groundwater Nitrate Samples 2003-2023 Inside the Map Frame



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PWS System Summary Reports

Personalized study results for each community water system in Nebraska.

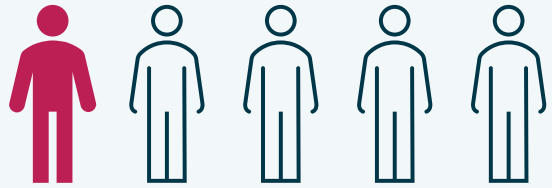
Key Recommendations Related to PWSs

Encourage voluntary best management practices as a way of preventing elevated nitrate concentrations in drinking water.

Results and Recommendations Relating to Private Domestic Wells

Private Domestic Wells Nitrate Background

- Not regulated by the Safe Drinking Water Act
- Construction is Regulated by NDEE (Title & Driller Certification)
- NRDs and Counties may set Additional Requirements



ONE IN FIVE NEBRASKANS RELY ON A PRIVATE DOMESTIC WELL FOR THEIR DRINKING WATER

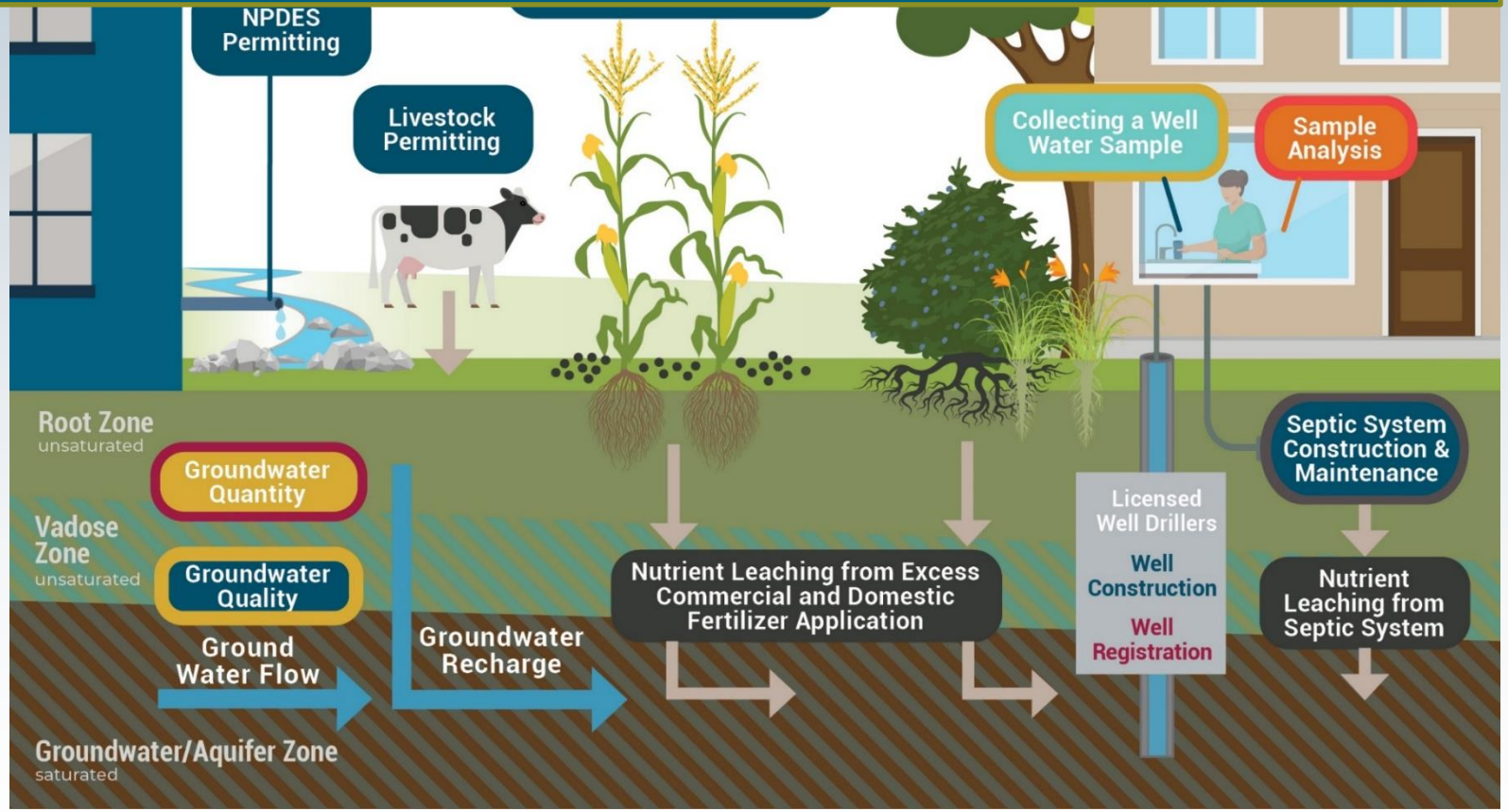
Private Domestic Wells Vulnerable to Nitrate

50-feet or Shallower

Located in Sandy Soils

High Groundwater Table

High Nutrient Loading at the Surface

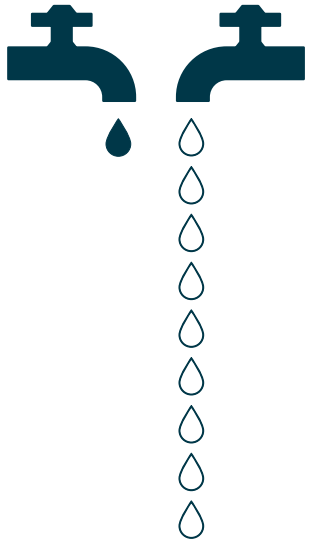


Limited Historic Data on Private Domestic Wells

NDEE estimates there are 110,000 unregistered private domestic wells in Nebraska.

Only an estimated one-in-ten are sampled annually for nitrate and bacteria, which NDEE recommends.

Data from private domestic wells is inconsistently reported to the State Groundwater Quality Clearinghouse



Fewer than 10% of domestic wells are sampled annually for nitrate.

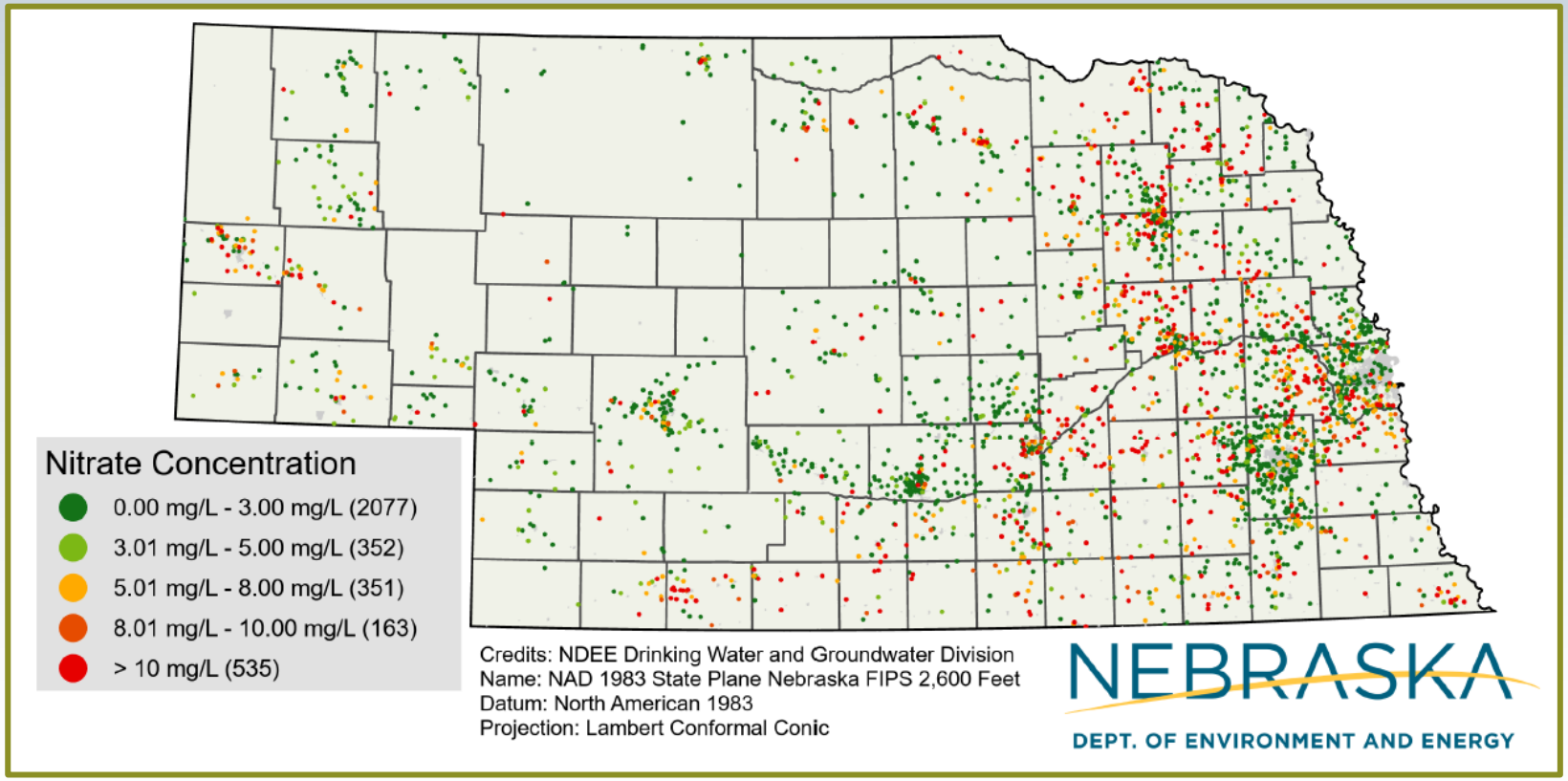
Free Private Domestic Well Sampling Effort

NDEE Oversaw the Largest Private Domestic Well Sampling Effort in State History

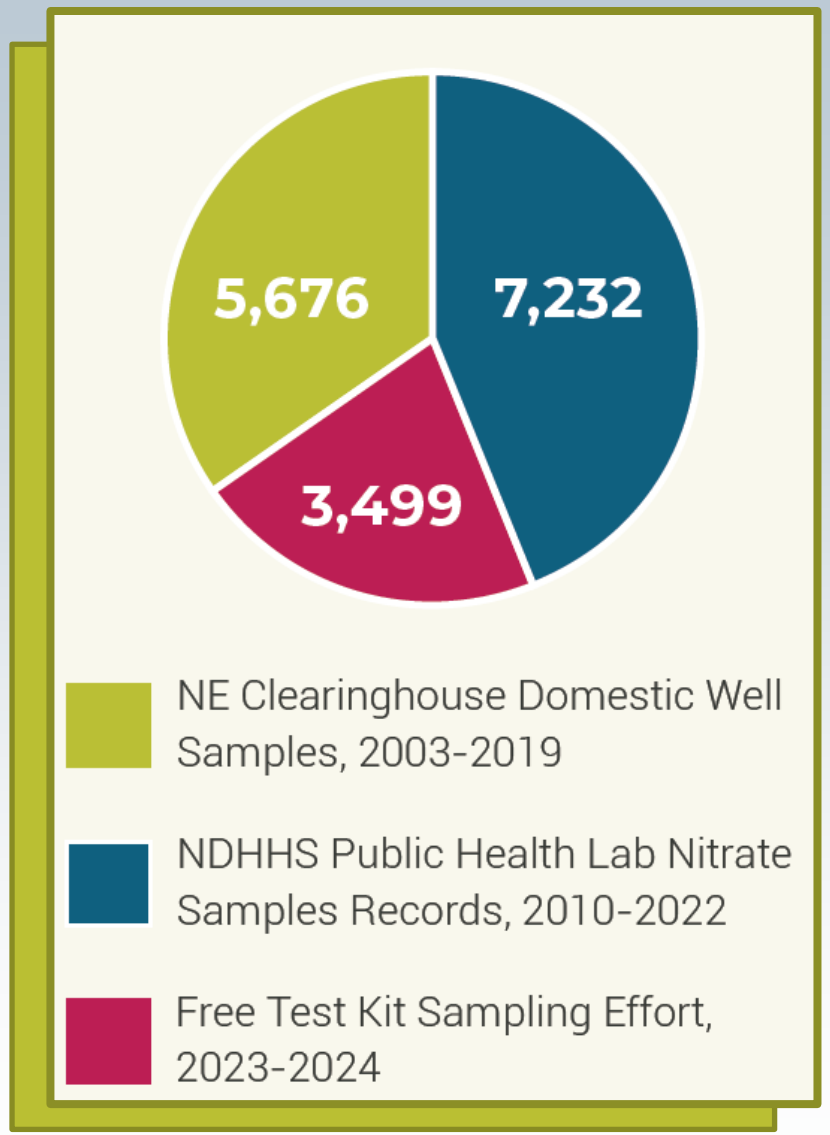
Over 3,400 Samples Analyzed

Mean Nitrate Concentration 4.83 mg/L

About 15% of the Samples were Above the SDWA Limit



The Free Sampling Effort adds significant data to the historic record, making up nearly a third of samples collected since 2003.

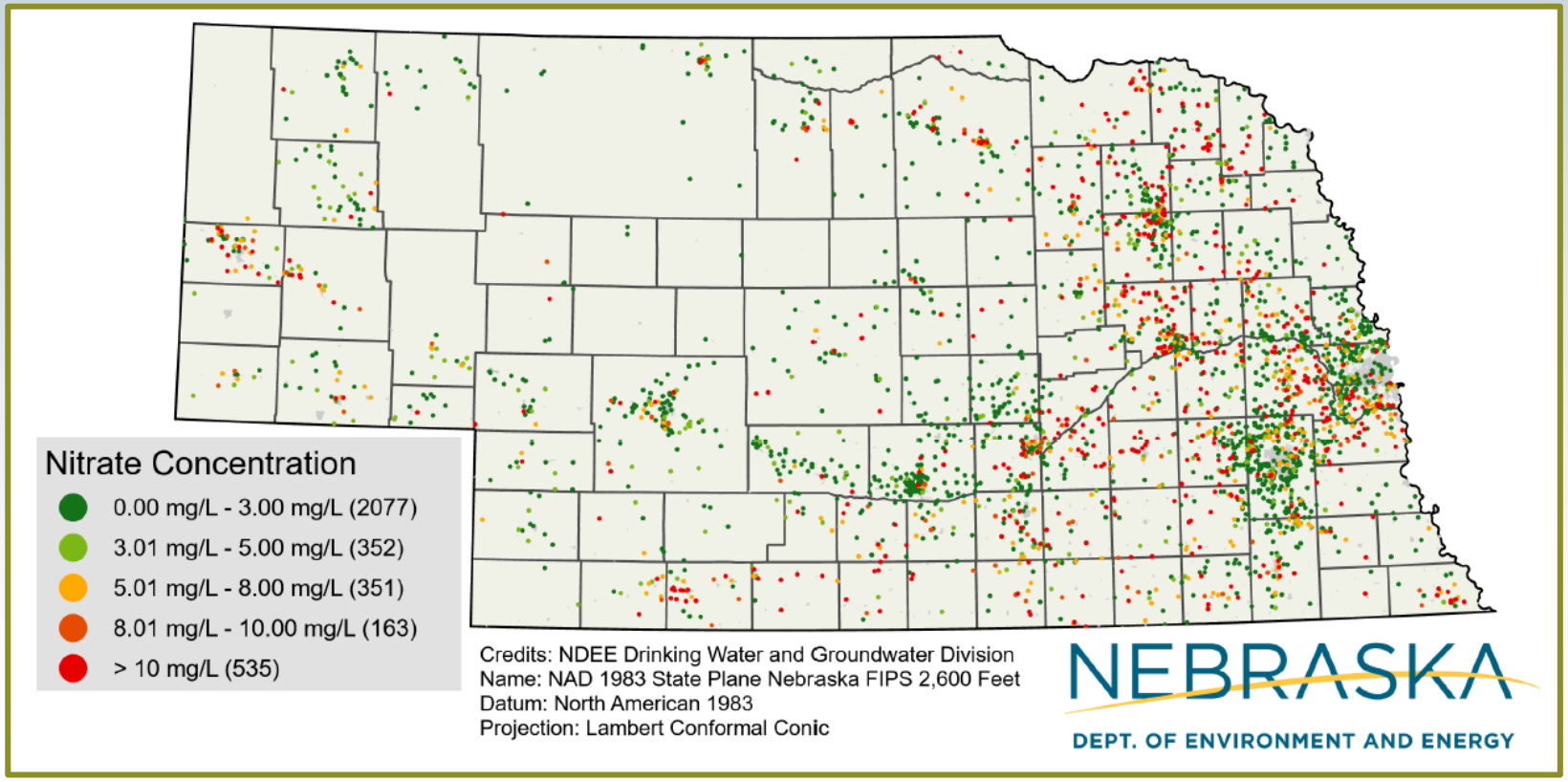


Free Private Domestic Well Sampling Effort

Invaluable Snapshot that Betters our Understanding

Over 2,500 Calls Fielded by Department Staff

Direct Public Education and Outreach on Nitrate

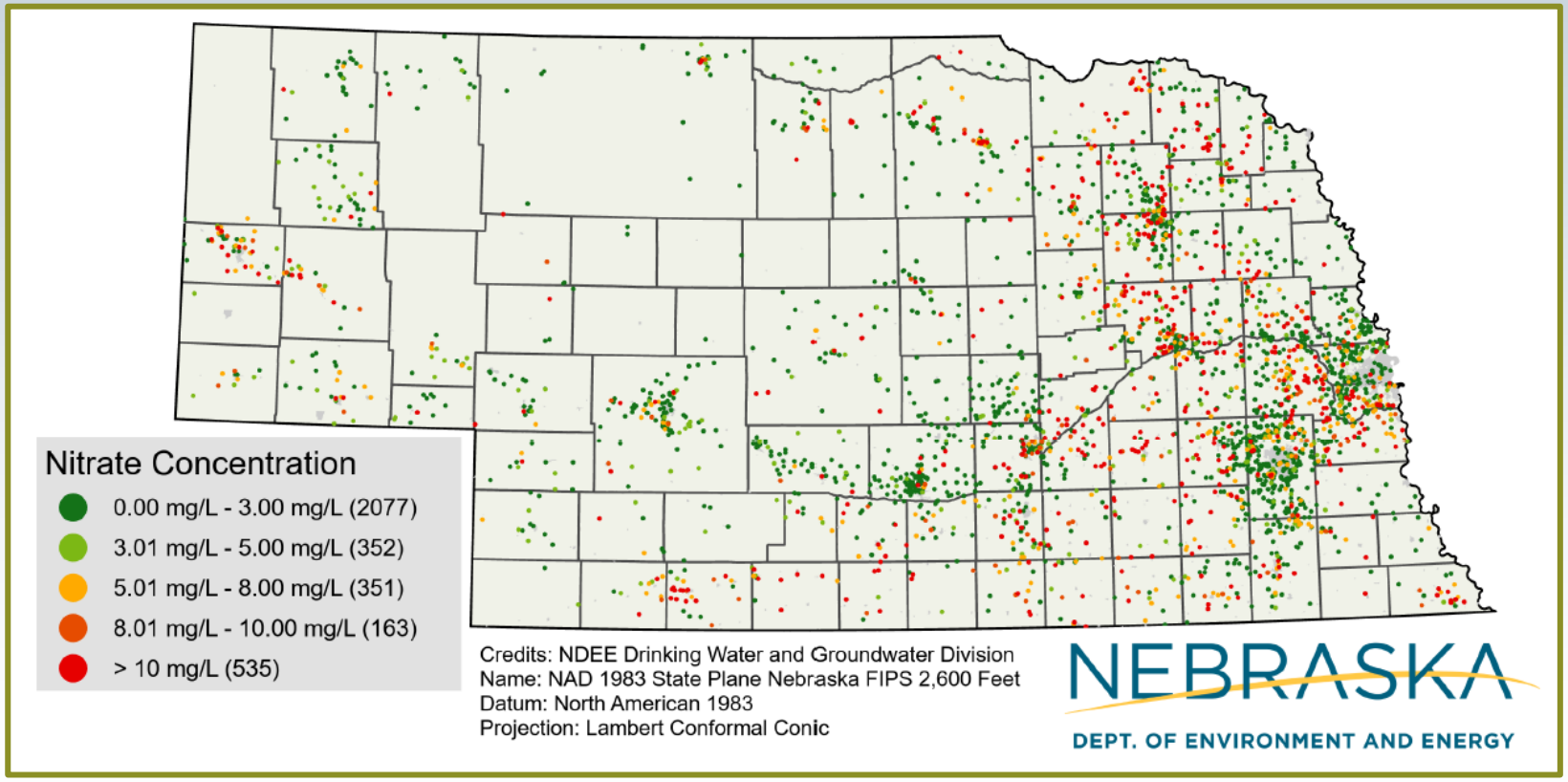


Free Private Domestic Well Sampling Effort

Guidance on Taking Samples

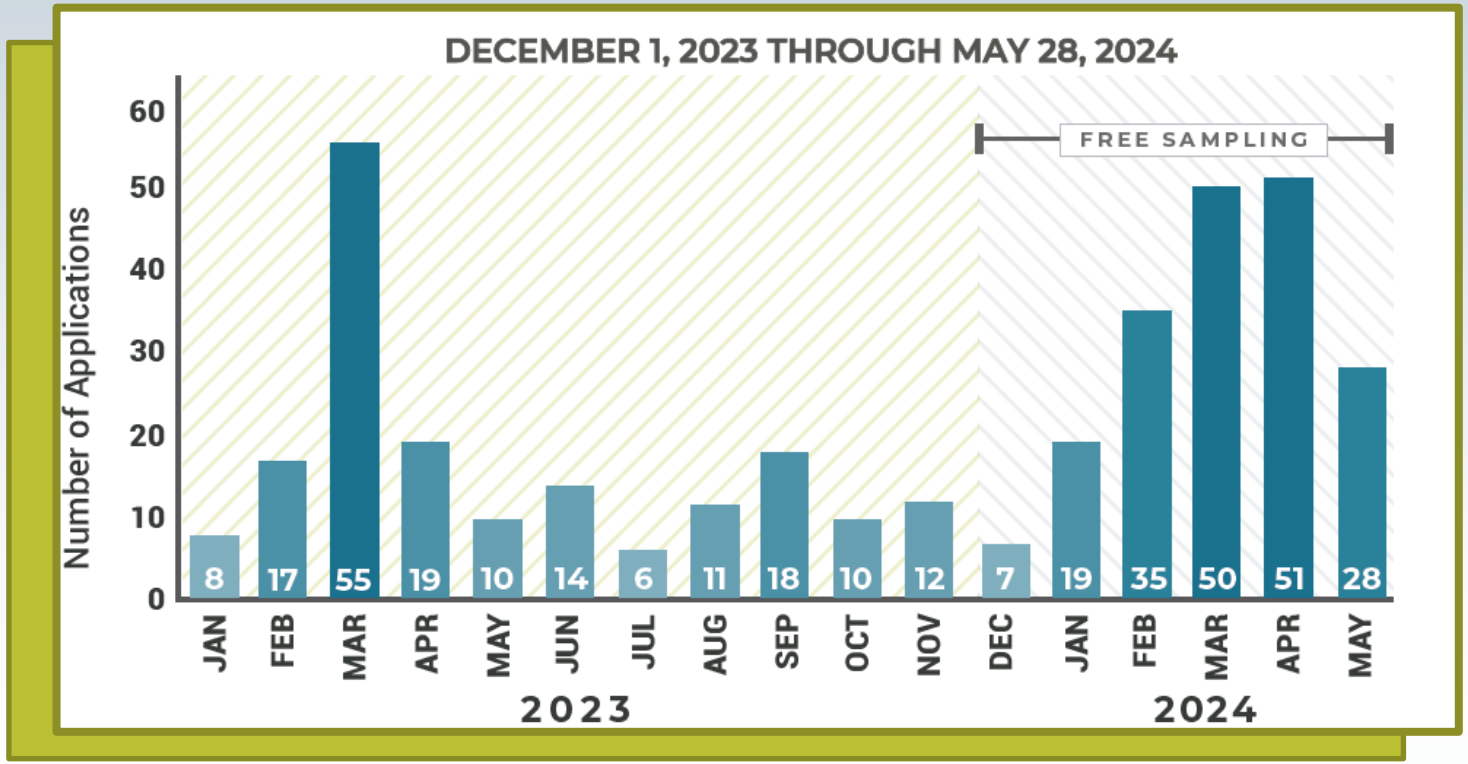
Guidance on Interpreting Results

Direct Outreach to all Samples Above 10 mg/L



Free Sampling and the Reverse Osmosis (RO) Rebate Program

Direct outreach and promotion of the free domestic well sampling effort improved the participation in the rebate program.

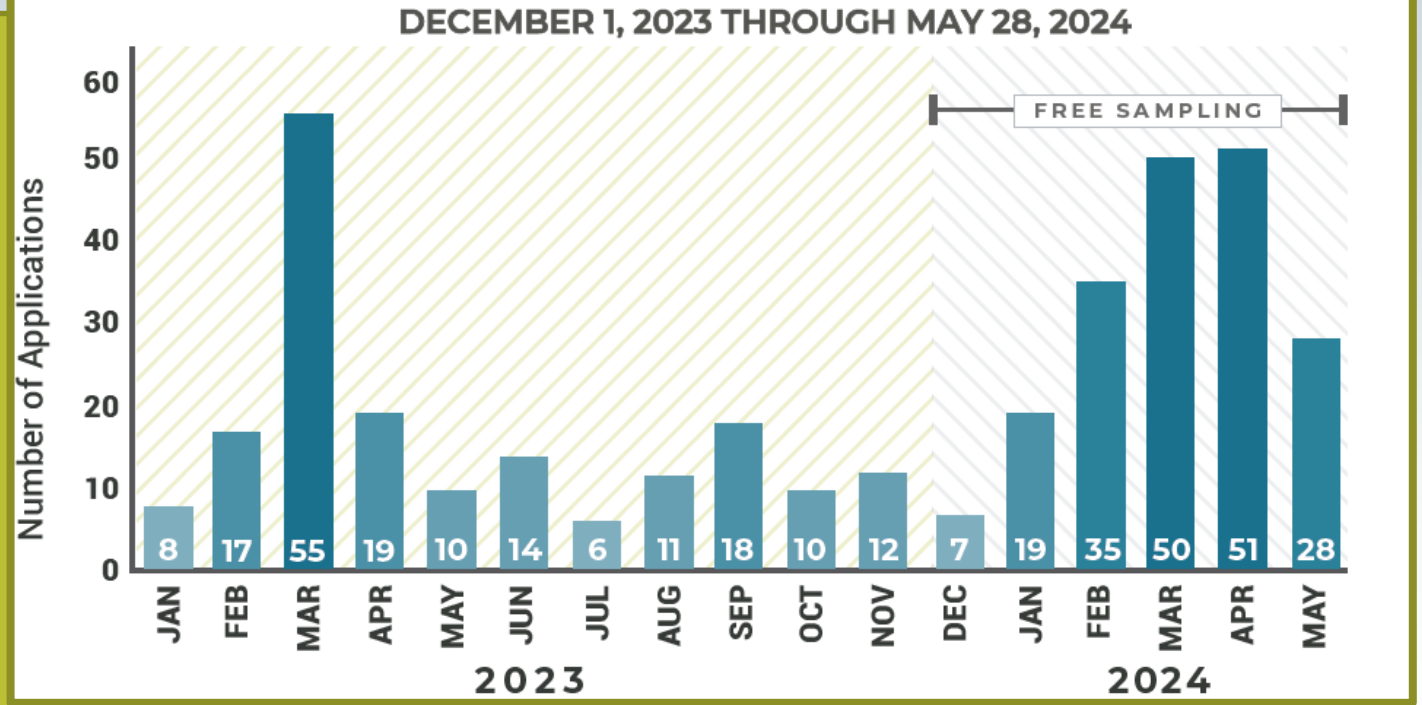


Free Sampling and the Reverse Osmosis (RO) Rebate Program

$4,000 Rebate

480 Applications Accepted

$2,083 Avg Cost



Reverse Osmosis System Tax Credit Act

50% of System Cost up to $1,000

Nitrate, Uranium, and PFAS

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

Private Domestic Well Owner GIS Risk Assessment Tool

FLOW CHART FOR THE GIS RISK ASSESSMENT TOOL DEVELOPED DURING THE WATER QUALITY STUDY.

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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. 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. Common sources of organic nitrate are human and animal waste.

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 16,403 domestic well nitrate samples collected from 2003-2024. Of all the domestic wells sampled over this period, 6,468 (39.4%) of them were above 3 mg/L for nitrate and 2,775 (16.9%) 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

HUMANS: 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 NO3-N).

Drinking water with nitrate above the MCL 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 women are also a high-risk group and should not consume water with nitrate above the MCL.[2] The following conditions may also put people at higher risk of developing nitrate-induced methemoglobinemia: anemia, cardiovascular disease, sepsis, glucose-6-phosphate- dehydrogenase deficiency, gastrointestinal diseases and other metabolic problems.[2, 3]

The EPA standard was set based on immediate health effects of consuming nitrate above 10 mg/L. There is additional research being done by others, including the University of Nebraska-Lincoln (UNL), on other potential health effects, including chronic health effects. Chronic health effects occur from ingesting a contaminant over a long period of time.

For more information about other potential health effects, visit the UNL websites located in the Resources section.

LIVESTOCK: It is recommended to not allow livestock to drink water with a nitrate level above 100 mg/L. Nitrate can affect livestock similarly to how it affects humans.[4] Additionally, nitrate levels above 100 mg/L may cause reproductive problems in adult cattle and reduce growth rates in replacement heifers.[5] It is recommended that you consult with a veterinarian if you have questions about an acceptable nitrate level in drinking water for other species of animals.

How to Protect Yourself and Your Family

IF YOU ARE ON A 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 your public water system by reading the system's Consumer Confidence Report (CCR) which is a water quality report that is required to be provided to water customers annually. 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 listed in the Resources section.

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 areas with known high concentrations of nitrate in groundwater:

- 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/toxfaqs/tfacts204.pdf). Accessed April 2024.

[2] ATSDR. 2013. ATSDR Case Studies in Environmental Medicine Nitrate/Nitrite Toxicity (https://www.atsdr.cdc.gov/csem/nitrate_2013/docs/nitrite.pdf). Page 37. Accessed April 2024

[3] U.S. Environmental Protection Agency. 1991. Integrated Risk Information System (IRIS) Chemical Assessment Summary (https://iris.epa.gov/static/pdfs/0076_summary.pdf). Accessed April 2024.

[4] Rasby, R. & Walz, T. 2011. Water Requirements for Beef Cattle. University of Nebraska-Lincoln Extension. (https://extensionpubs.unl.edu/publication/g2060/html/view). Accessed May 2024.

[5] Kononoff, P. & Clark, K. 2017. Water Quality and Requirements for Dairy Cattle. University of Nebraska-Lincoln Extension. (https://extensionpubs.unl.edu/publication/g2292/html/view). Accessed May 2024.

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. Consult with a Certified Onsite Wastewater Treatment (OWT) Professional if you have concerns about the location or condition of your septic system in relation to your well. A link to find a Certified OWT Professional is listed in the Resources section.
- **Get your well inspect** professional to take an needed. Water Well Pr are listed on the NDEE section.
- **Test for nitrate and b** responsible for regular recommends using an well water. Well owner Nebraska Department (NDHHS) online at the section or by calling 40 NDHHS's website has laboratories. Contact t containers and instruct Resources District (NR provide well water testi finding your local NRD Resources section.
- **Consider your well construction.** If your existing well is poorly constructed or is located near a contamination source such as a septic system, drilling a new well or rehabilitating your well may be an option. However, this can be costly and is not a guarantee that the new or modified well will have nitrate below 10 mg/L. Water Well Professionals with a current license that can help drill a new well or rehabilitate an existing well are listed on the NDEE website listed in the Resources section.
- **Consider a Point of Use (POU) or Point of Entry (POE) treatment system to remove nitrate from drinking water.** POU treatment systems treat water at one tap while POE treatment systems treat all the water that enters your home. Reverse osmosis, ion exchange, or distillation filtration systems are the typical types of treatment systems used to remove nitrate from drinking water. These systems require regular maintenance and testing to ensure they are working correctly and must be

Address Contam

If nitrate is detected in you mg/L, follow these steps:

- **Get your drinking wat** such as bottled water, including rural water dis important if babies und water or formula is mad or nursing mothers sho about how elevated nitr may affect them. Boilin elevated nitrate levels a and concentrates the n
- **Consider testing the commonly occur with uranium.** Sample test as bacteria and uraniu Nebraska Department online at the website lis by calling 402-471-393 other potential contami NebGuides link under t
- **Contact a local rural** the rural water district-s option in your area.

Enduring tool to help private well owners evaluate and address elevated nitrate in drinking water.

Key Recommendations Related to Private Domestic Wells

Update and maintain the State Groundwater Quality Clearinghouse, a valuable resource to many stakeholders. Currently there's a 3-year backlog in the data.

Key Recommendations Related to Private Domestic Wells

Make data collected during the study public. Identify funding opportunities to continue private well sampling and treatment programs.

Key Recommendations Related to Private Domestic Wells

Work with partner agencies to identify and reduce obstacles to well registration.

Overall Objective:

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).

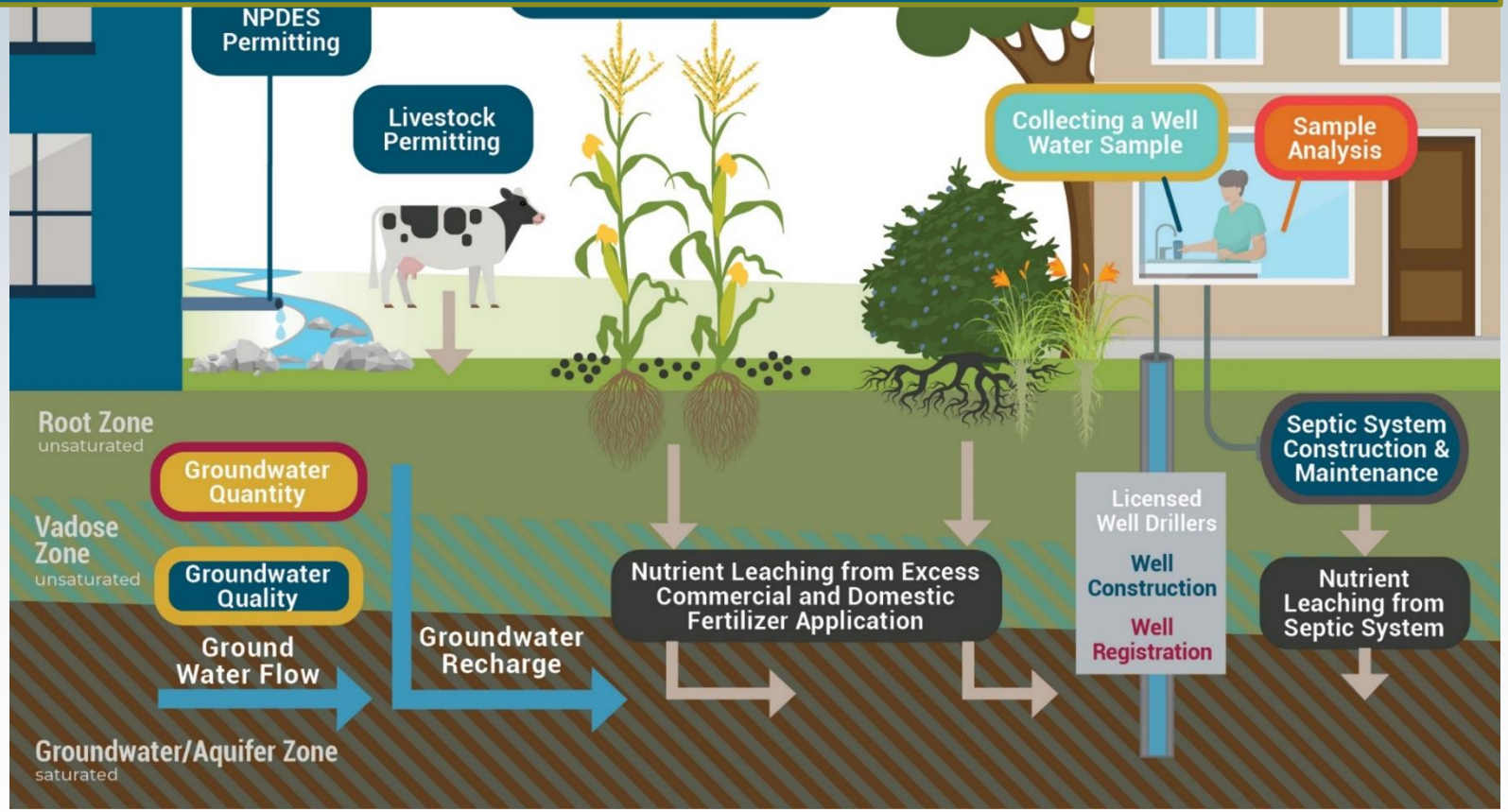
Questions?

Contact Information:
Bridger Corkill – bridger.corkill@nebraska.gov
Engineer, Permitting and Engineering Division

Private Domestic Wells: A Curious Case

Initial Sample: 155 mg/L

Confirmation Sample: 240 mg/L



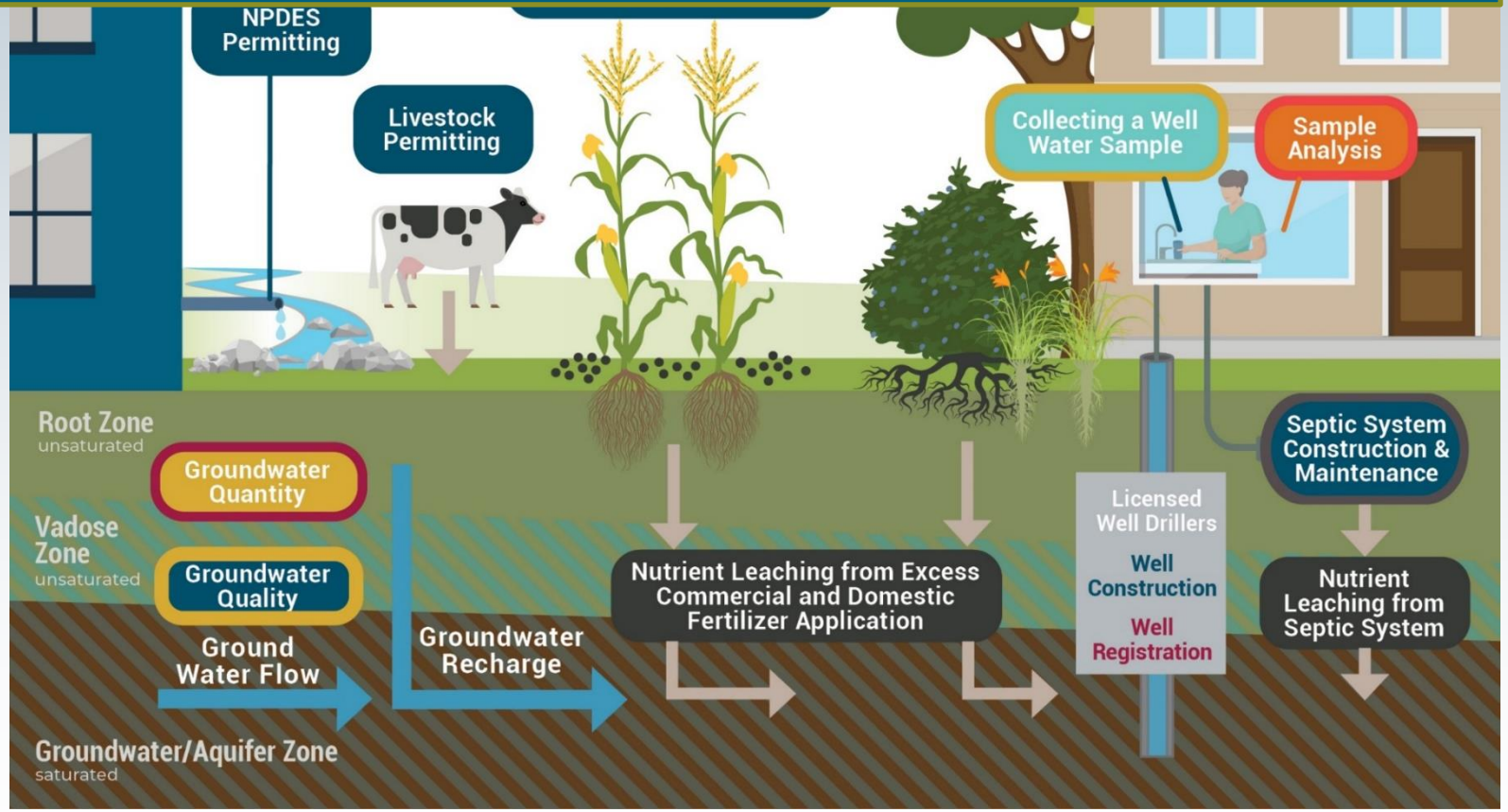
Private Domestic Wells: A Curious Case

Relatively New (2017)

Well Depth: >500 ft

Screen: >400 ft Below Ground Surface

Over 400 feet of Bentonite Seal

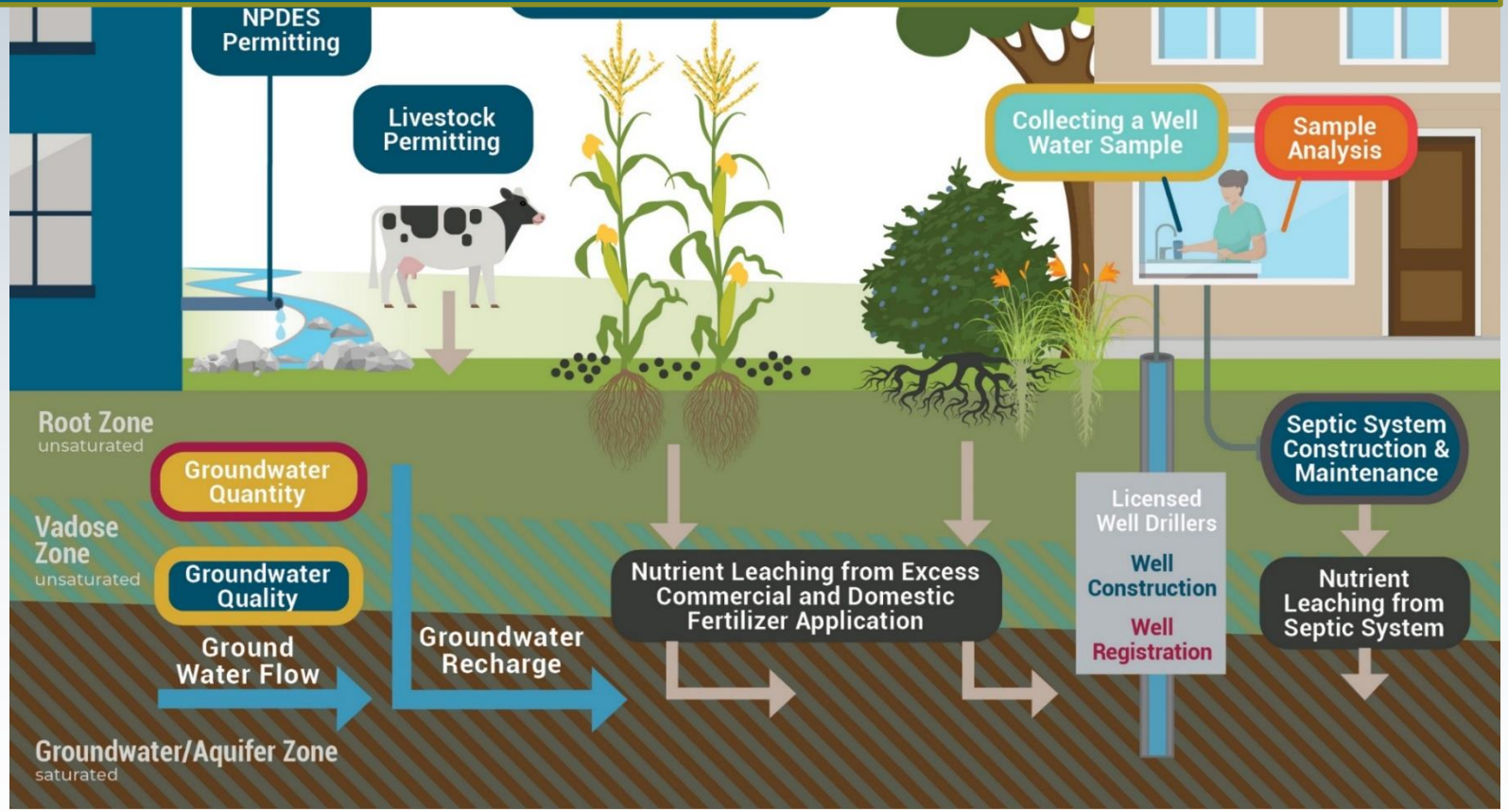


Private Domestic Wells: A Curious Case

CCTV Investigation

Separated Pitless Adapter

Perched Groundwater



Private Domestic Wells: A Curious Case

NRD Assistance

UNL Water Center Isotope Testing