Attachment I
South Heartland District Water Quality Surveillance Report

Introduction

Water quality plays a critical role in safeguarding public health and sustaining community well-being. This Water Quality Surveillance Report (Attachment I) focuses on nitrate levels in public and private wells throughout the South Heartland District, which encompasses Adams, Clay, Nuckolls, and Webster Counties. Elevated nitrate concentrations in drinking water have been linked to health risks, particularly for infants (commonly referred to as "blue baby syndrome") and pregnant women, emphasizing the importance of ongoing monitoring and mitigation efforts.

In this report, we present data on nitrate concentrations across multiple sources, including free sampling. initiatives for private domestic wells, public community water systems, and irrigated agriculture wells. Each section provides a short summary, visual maps, and key takeaways regarding where and how nitrates may pose risks in our region. This information complements the broader Community Health Assessment (CHA) by highlighting specific environmental health challenges and underscoring the need for strategic interventions—such as wellhead protection, nutrient management, and community education—to protect drinking water quality over the long term.

Methods

Data Sources and Collection

1. **Nebraska Department of Environment and Energy (NDEE) Clearinghouse**
    - **Groundwater Quality Data:** We obtained historical nitrate concentration readings (2000–2020) for irrigation and domestic wells from the NDEE Groundwater Quality Clearinghouse. These datasets included both point-specific measurements (individual well tests) and median nitrate results aggregated at the township or county level.
    - **Public Water System Records:** NDEE data on community water systems (CWS) provided point-of-entry sample results, which were used to map average nitrate concentrations and identify areas nearing or exceeding the 10 mg/L Maximum Contaminant Level (MCL).
2. **Free Nitrate Sampling of Private Domestic Wells**
    - **2023–2024 Initiative:** Through a partnership program, private well owners in Adams, Clay, Nuckolls, and Webster Counties were offered free nitrate testing. Samples were either self-collected by homeowners under standard instructions or collected by project staff. Resulting data were compiled to highlight the proportion of wells exceeding 5 mg/L and 10 mg/L.
3. **EPA Safe Drinking Water Act (SDWA) Violations Data**
    - **Violation Logs (Q1 2020–Q2 2024):** Public water system violations for nitrate and coliform bacteria were drawn from the EPA's SDWA compliance records. Each instance was coded by date, type of violation (e.g., nitrate MCL exceedance), and the water system's name, allowing us to track frequency and severity of violations over time.

4. **Local Partner Surveys and Map Overlays**

    - **Wellhead Protection Area (WHPA) Data:** Geographic boundaries and average nitrate levels for 486 WHPAs were gathered from the NDEE Wellhead Protection Program. Local NRDs (Natural Resources Districts) seasonal reports data, shapefiles and up-to-date wellhead boundaries were obtained from publicly available data.
    - **Mapping and Visualization:** All point data (wells) and polygon data (counties, WHPAs) were obtained using and created from online publicly available data mapping tools.

Data Analysis and Interpretation

1. **Nitrate Thresholds**

    - **Key Benchmarks:** We used the federal drinking water MCL of 10 mg/L as the primary health risk threshold. Additional breakpoints of 5 mg/L and 8 mg/L were employed to visualize moderate and elevated nitrate ranges.

2. **Temporal Scope**

    - **Historical Trends (2000–2020):** Longitudinal data helped identify persistent “hot spots” and changes in nitrate concentrations over two decades.
    - **Recent Observations (2018–2024):** More recent CWS data, private well sampling, and violation logs provided insight into current conditions and urgent issues requiring intervention.

3. **Mapping Conventions**

    - **Color Gradients:** Maps used green or yellow tones to indicate lower nitrate concentrations (<5 mg/L), orange/red/purple tones to show medium to high concentrations (>5 mg/L and >10 mg/L). Where possible, we labeled numeric ranges on the legend for clarity.
    - **Spatial Aggregation:** Some figures present individual well data (dots), while others display median concentrations at the township or county level. These complementary views allow for both localized identification of high-nitrate wells and broader regional comparisons.

4. **Limitations and Data Gaps**

    - **Sampling Bias:** Private well results are limited to self-selected or volunteer participants. Areas without volunteer participation may be underrepresented.
    - **Reporting Gaps:** Not all wells are tested annually. Some data points are from older tests and may not reflect the most current nitrate levels.
    - **Analytical Methods**: Different labs may have slightly varying detection limits or reporting standards. However, all labs met NDEE or EPA accreditation requirements for analyzing nitrates in drinking water.

5. **Quality Assurance**

- **Cross-Checking Data:** Where possible, we compared well test results from multiple sources (private vs. public records) for consistency. Any anomalies (e.g., unusually high readings with no historical precedent) were flagged and reviewed in consultation with local NRD or NDEE staff.
- **Validation of Map Layers:** GIS shapefiles were validated against official county boundaries, wellhead protection area definitions, and NDEE's well location coordinates to ensure accurate representation using R programming.

Report Organization

Following these methods, the Results sections in this attachment are organized by figure, each containing a data-driven summary, key findings, and implications for public health and resource management. The final sections synthesize overarching trends and provide recommendations for local stakeholders—ranging from private well owners to public water system operators—to consider when addressing nitrate contamination and protecting community water supplies.

Figure 1: Nitrate Concentrations in Ground Water Wells

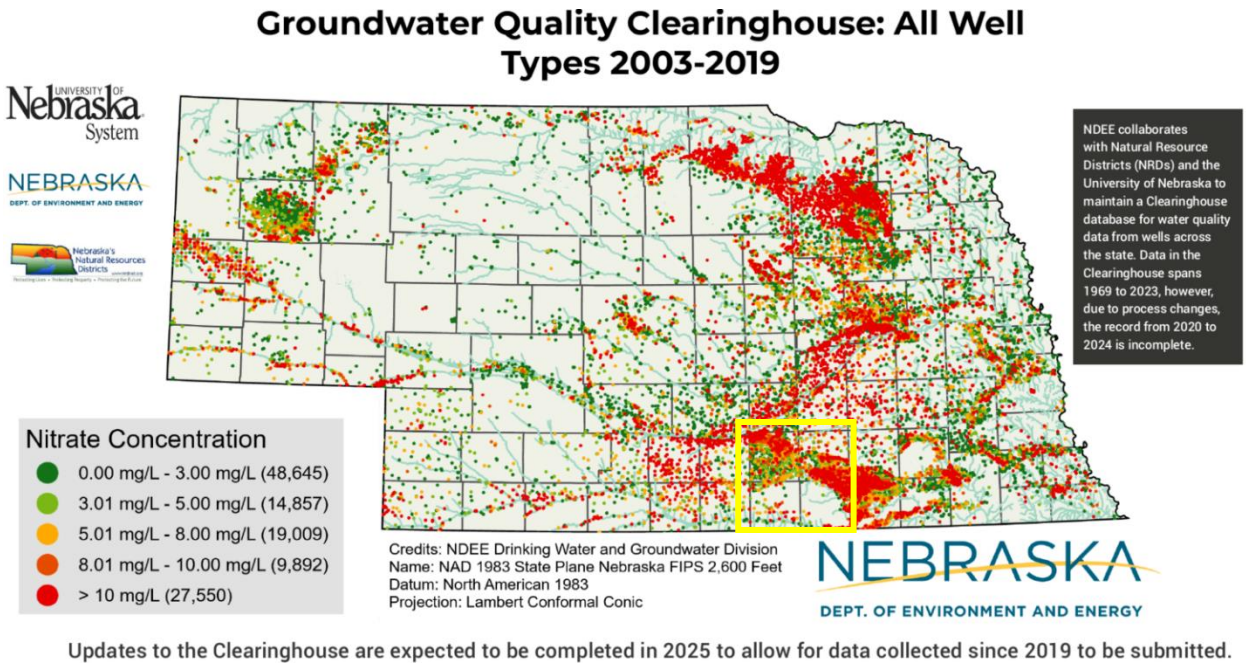

Figure 1 Summary: In the South Heartland District (outlined by the yellow box), a notable number of wells show moderate to high nitrate levels—often above 5 mg/L. Some areas are approaching or even exceeding the 10 mg/L federal drinking water standard. This cluster of elevated nitrate readings underscores the need for continued monitoring and proactive management to safeguard drinking water supplies in these four Counties.

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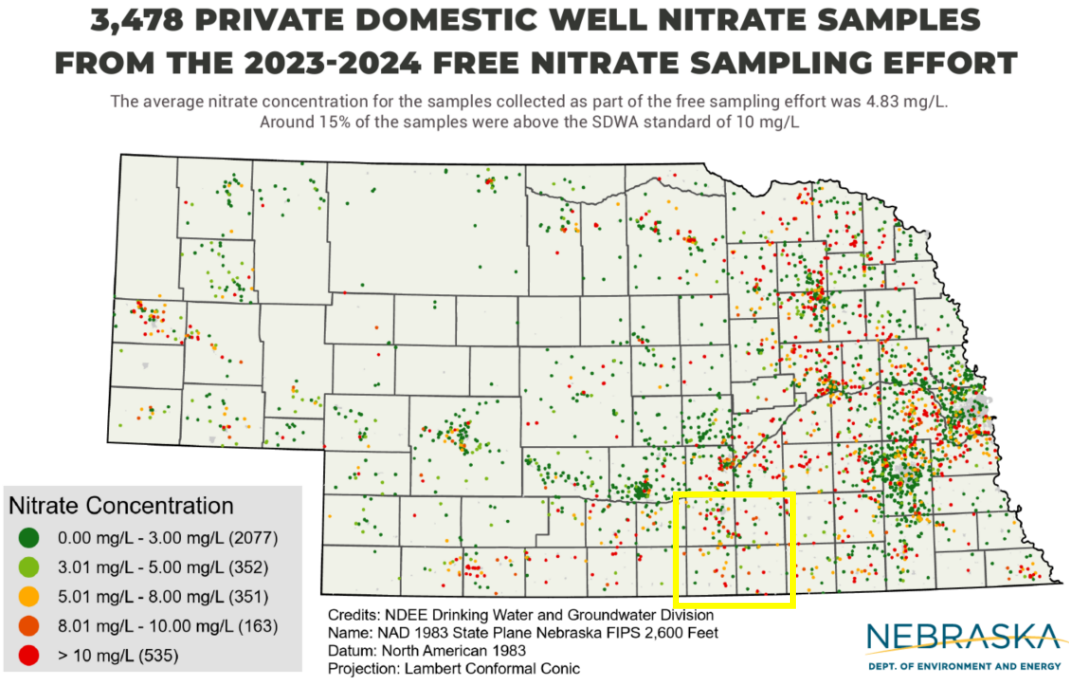

Figure 2: Nitrate Concentrations in Free Sampled Private Domestic Wells, 2023-24

Figure 2 Summary: Recent 2023–2024 free sampling of private domestic wells in the South Heartland District shows that a noteworthy portion of wells are registering elevated nitrate levels. Although the statewide average among sampled wells is around 4.83 mg/L, about 15 percent exceed the 10 mg/L SDWA limit—indicating a potential health risk. Within Adams, Clay, Nuckolls, and Webster Counties, clusters of wells appear in the higher range (above 5 mg/L), emphasizing the importance of continued testing and targeted intervention to reduce nitrate inputs at their source. Efforts such as improved fertilizer application practices, wellhead protection initiatives, and ongoing education of private well owners remain critical to safeguarding local water quality and public health.

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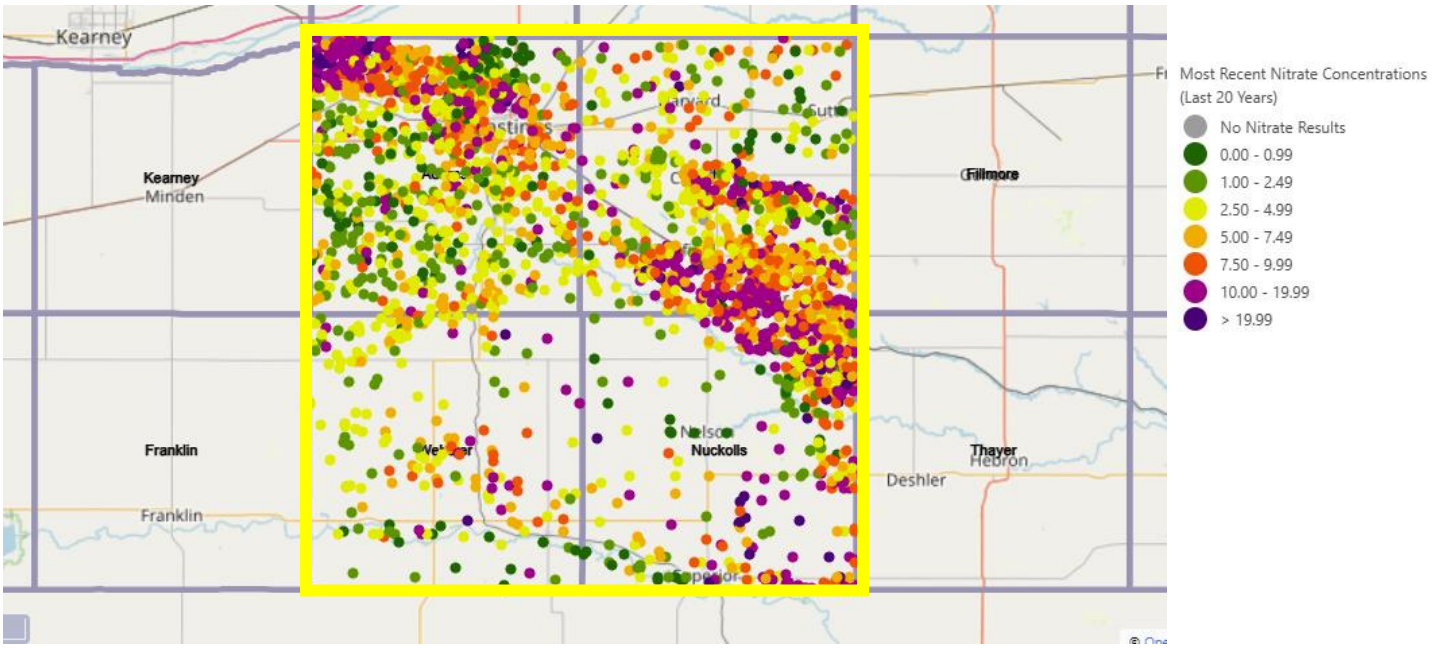

Figure 3: Map showing Nitrate Concentrations Recent, Irrigation & Domestic Wells, 2000-2020

Figure 3 Summary of Recent Nitrate Concentrations (2000–2020); Within the highlighted region that encompasses Adams, Clay, Nuckolls, and Webster Counties, many monitored wells—both irrigation and domestic—indicate moderate to high nitrate concentrations over the past two decades. The color-coded points on the map illustrate a dense cluster of wells surpassing 5 mg/L, with some readings exceeding 10 mg/L or even 20 mg/L in certain areas. These findings highlight a persistent challenge in managing nitrate levels in the South Heartland District, emphasizing the need for regular testing, effective agricultural nutrient management, and proactive measures to protect both public and private drinking water supplies.

1. **What the Map Shows**
    - Each **dot** represents a single irrigation or domestic well tested sometime between 2000 and 2020.
    - The **dot's color** indicates how much nitrate was found (in milligrams per liter, mg/L).
        - **Green or yellow** tones mean lower nitrate levels (under roughly 5 mg/L).
        - **Orange, red, pink, or purple** signify higher levels (some above 10 mg/L, which is the EPA's drinking water limit).
    - Because it includes *domestic wells*, this map highlights potential health concerns for households whose private well water might have nitrate above recommended levels.
2. **Why It Matters**
    - **High nitrates** (above 10 mg/L) can pose health risks—especially for infants ("blue baby syndrome") and pregnant women.

- While **irrigation wells** may not directly provide drinking water, they share the same groundwater. If nitrate levels are high in irrigation wells, there's a chance nearby domestic wells could be affected.

3. **Key Takeaways**

   - The **clusters** of red, pink, and purple dots show where groundwater nitrate levels may need closer monitoring or management.
   - Green/yellow dots are generally safer, but it's still good for **well owners** to test periodically since conditions can change.
   - Communities in areas with many high-nitrate wells should consider **mitigation measures** (e.g., careful fertilizer use or wellhead protection) and **regular testing** of household wells.

Figure 4: Nitrate Concentrations, Irrigation & Domestic Wells, 2000-2020

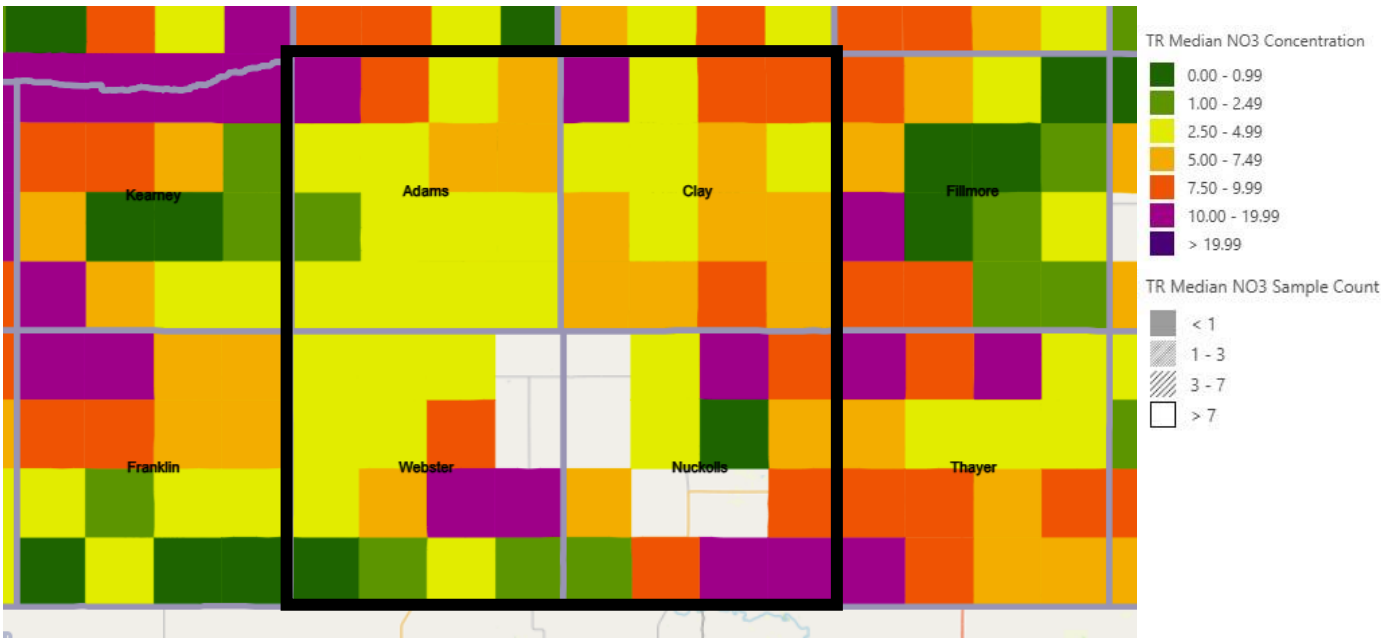

Figure 4 Summary of Median Nitrate Concentrations (2000–2020): Across much of Adams, Clay, Nuckolls, and Webster Counties, township-level data reveal consistently elevated median nitrate readings in both irrigation and domestic wells. Many sections are classified in the 2.5–4.99 mg/L range (yellow) or 5–9.99 mg/L range (orange/pink), with portions exceeding 10 mg/L (magenta/purple). These findings highlight a persistent regional issue requiring ongoing well monitoring, strategic nutrient application, and focused wellhead protection measures to safeguard local water supplies.

1. **What the Colors Represent**

   - Each **county-sized square** is shaded based on the **median** (middle) nitrate result from all irrigation and domestic wells tested there over the 20-year span.

- **Green** indicates a median level below 1 mg/L, while **purple** can indicate medians above 20 mg/L—which is substantially high.

2. **Striping and Shading (Sample Counts)**
    - The **patterns** (gray or striped) show how many total samples were used to calculate that county's median.
    - More shading or striping = **fewer data points** (less certainty).
    - Solid color (no shading) = **more samples** (stronger data).
3. **Implications**
    - Counties with **orange, red, pink, or purple squares** have had **consistently higher nitrate levels** over time and may require further attention.
    - In counties with heavy shading (fewer samples), **more well tests** could help clarify local nitrate trends.
    - This median-based approach gives an **overall snapshot** of long-term nitrate conditions, complementing the individual well view in Figure 1.
4. **Community Significance**
    - **Domestic well owners** in counties with higher median nitrates should test their water regularly.
    - **Farmers and land managers** in those areas might explore **best management practices** (e.g., optimizing fertilizer) to help reduce nitrate infiltration into groundwater.
    - Identifying "hot spots" can guide **targeted outreach** and **funding** for well protection or remediation efforts.

These maps together illustrate both the **individual well data** (Figure 1) and the **overall county trends** (Figure 4) for nitrates in irrigation and domestic wells, helping the South Heartland District better understand and address groundwater quality concerns.

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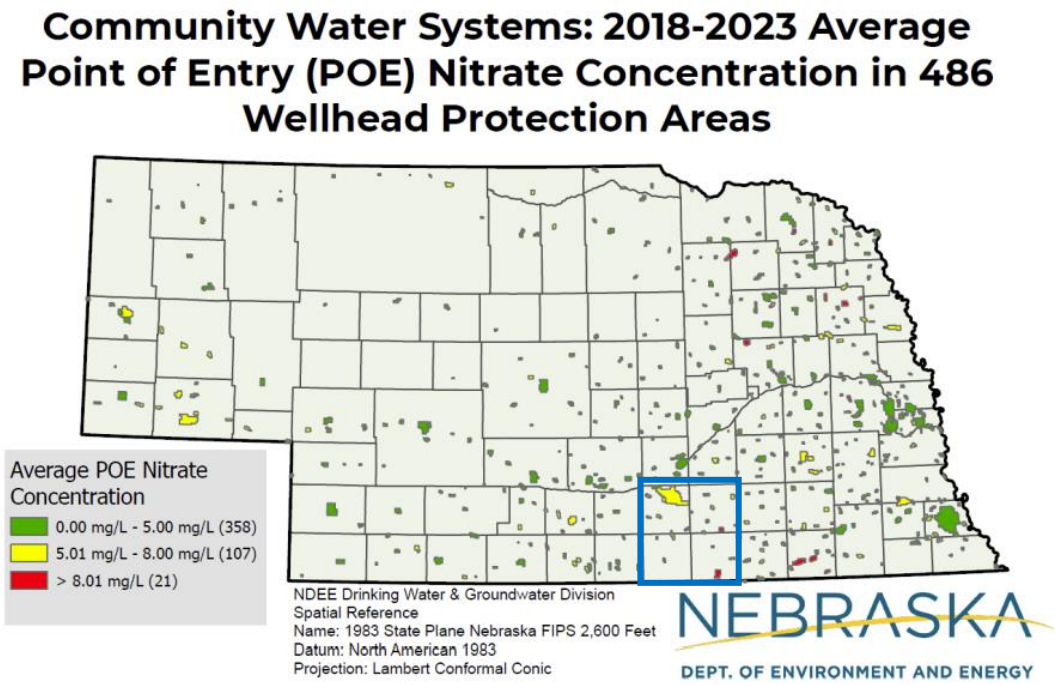
Figure 5: Nitrate concentrations in Community Water Systems, 2018-2023



Map B 8. Community Water System (CWS) Average Point of Entry (POE) Nitrate Sample Concentration in Wellhead Protection Areas (WHPAs). In the map, POE samples inside each WHPA were averaged over the last five years and symbolized in each WHPA. POE samples are representative of water that people are drinking but may not reflect untreated supply well nitrate concentrations.

Figure. 5 Summary of Community Water System Point-of-Entry Nitrate Levels (2018–2023) This map presents average nitrate concentrations at Community Water System (CWS) points of entry in 486 Wellhead Protection Areas (WHPAs). While a majority of WHPAs record levels below 5 mg/L (green), a significant subset (yellow) ranges between 5.01 and 8.0 mg/L, and a smaller group (red) exceeds 8.0 mg/L. Notably, in the South Heartland District (outlined in the blue rectangle), several WHPAs show elevated nitrate concentrations approaching these thresholds. These findings emphasize the importance of ongoing wellhead protection, consistent monitoring, and proactive strategies to mitigate nitrate risks.

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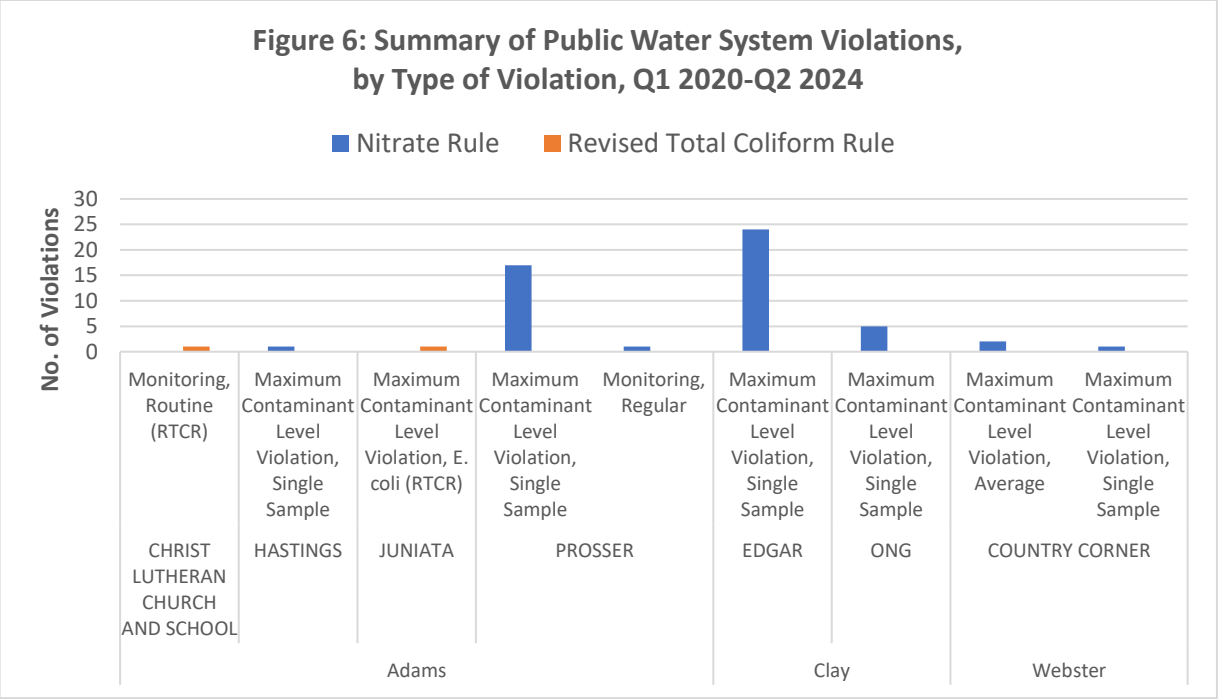


Figure 6 Summary of Public Water System Violations (Q1 2020 – Q2 2024): The figure 6 shows the number and type of Safe Drinking Water Act (SDWA) violations recorded by selected public water systems in Adams, Clay, and Webster Counties. Most infractions fall under the Nitrate Rule (blue bars), typically involving maximum contaminant level (MCL) exceedances in single samples. Systems such as Prosser (Adams County) and Edgar (Clay County) show notably higher counts of nitrate MCL violations. Meanwhile, fewer communities report Revised Total Coliform Rule (RTCR) infractions (orange bars), which include routine monitoring lapses or E. coli detections. These data underscore ongoing challenges in managing nitrate levels and maintaining regular monitoring to safeguard drinking water quality.

1. Purpose of the Chart

This chart shows how often local public water systems (listed along the bottom) had **violations** of health rules between 2020 and mid-2024. The **blue bars** represent violations related to **high nitrate levels**, and the **orange bars** represent violations related to **coliform bacteria** (including E. coli) or monitoring issues.

2. What the Violations Mean

- **Nitrate Rule Violations (Blue Bars):** If nitrate levels in drinking water go over 10 milligrams per liter (mg/L), it can pose health risks—particularly for babies and pregnant women (e.g., "blue baby syndrome"). Systems with higher or repeated nitrate violations need closer attention to reduce those levels.
- **Revised Total Coliform Rule (Orange Bars):** Coliform bacteria come from the environment (or in some cases, fecal contamination). Having these bacteria—or missing routine testing—can be a sign of possible contamination and can affect overall water safety.

3. Key Takeaways

- Some water systems show only a few violations, suggesting issues were relatively **limited** or **short-term**.
- Others, like **Prosser** or **Edgar**, have taller blue bars indicating **more frequent or repeated nitrate problems** that need more thorough follow-up.
- Systems with orange bars—like **Christ Lutheran Church and School**, **Hastings**, and **Juniata**—had **bacterial or monitoring violations**, highlighting the need for improved regular sampling or bacterial contamination control.

4. Why It Matters

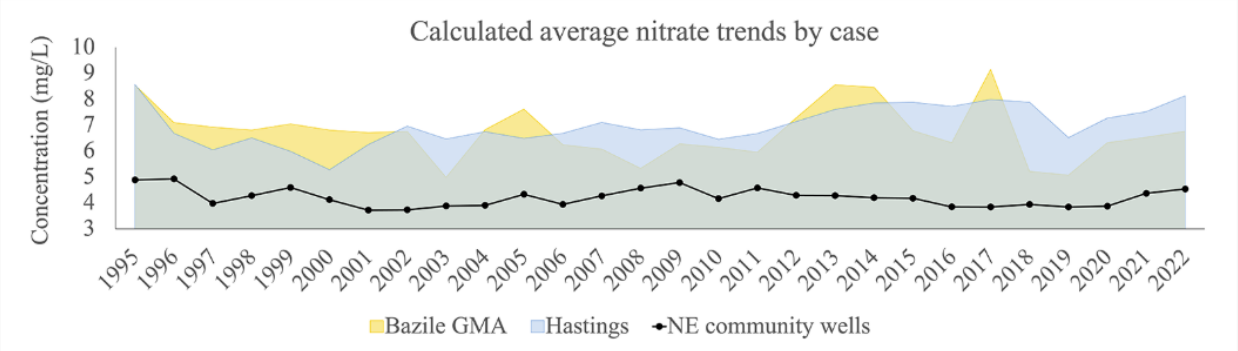
These violations can **directly impact community health** if not corrected. Ensuring safe drinking water reduces risks such as stomach illnesses from bacteria or long-term health problems from consistently high nitrates.

5. Next Steps

- **For Higher-Violation Systems:** More rigorous follow-ups (e.g., improved water treatment, consistent sampling) to prevent further issues.
- **For the Public:** Stay informed about your local water system's testing results, and contact local health officials if you have concerns regarding water taste, odor, or reported violations.

In summary, figure 6 helps highlight where **improvements** or **additional support** may be needed so that every South Heartland resident has access to **safe, reliable drinking water**.

Figure 7: Average Nitrate Levels Comparison, 1995-22



Note: Calculated average nitrate levels by case. Bazile GMA and City of Hastings WPA wells against the average Wellhead Protection Areas (WPA) nitrate trend. **Source:** Nebraska Groundwater Quality Clearinghouse

Figure 7 Summary of Nitrate Trends: The figure 7 compares average nitrate levels in the Bazile Groundwater Management Area (GMA) and the City of Hastings Wellhead Protection Area (WPA) to the overall statewide WPA trend. Although the current statewide average for nitrate in Nebraska community water systems remains below the Maximum Contaminant Level (MCL) of 10 mg/L, localized areas—particularly the City of Hastings—consistently trend closer to 7 mg/L. Figure 7 illustrates that while overall water quality management efforts are underway in these areas, the data suggest that post-contamination interventions alone may be insufficient in maintaining lower nitrate levels. Instead, strategies aimed at

reducing nitrate inputs at the source appear to have greater potential for effectively lowering contamination in groundwater used for public drinking supplies.

Despite years of effort to control nitrate pollution, groundwater used for drinking in many parts of Nebraska is showing rising nitrate levels. This trend persists even with significant investments of time and money in water protection programs.

Why Filtration Is Complicated

- **Cost of Specialized Systems:** Removing nitrates often requires reverse osmosis (RO) or ion exchange (IX), which both cost more than typical carbon filters.
- **Increased Water Needs:** RO or IX treatments use at least 15% more water to meet the same demand, so communities must pump additional water.
- **Wastewater Disposal:** These systems also produce **wastewater**, which must be **properly managed** and disposed of—a big challenge for local utilities.

What It Means for Communities

- **Complex Decisions Ahead:** Local leaders must weigh the costs, benefits, and long-term impacts of various strategies. Preventing nitrate from entering groundwater in the first place is often more cost-effective than treating it afterward.
- **No One-Size-Fits-All Solution:** Each area must consider its unique hydrology, agricultural practices, and community needs when determining how best to prevent or reduce nitrate contamination.

Managing nitrates is a long-term challenge that can't be solved overnight. Ultimately, the best strategies often combine preventive actions (like responsible fertilizer use and land management) with targeted treatment solutions when necessary. By staying informed and working together, communities across Nebraska can find sustainable ways to protect their drinking water for future generations.

Conclusion

The findings presented in this Water Quality Surveillance Report demonstrate the presence of elevated nitrate concentrations in both public and private wells within the South Heartland District. Numerous samples exceed the 10 mg/L federal threshold, emphasizing the need for consistent monitoring and proactive measures. High nitrate levels, particularly in hot spot areas, raise concerns about potential health risks for infants and pregnant women, as well as the sustainability of local groundwater supplies.

Moving forward, it is recommended that private well owners continue to test annually, especially in regions with persistently high readings. Public water systems should prioritize targeted sampling protocols and explore options for infrastructure improvements when repeat violations occur. Preventive strategies, such as optimized fertilizer application, wellhead protection, and robust community outreach, may significantly reduce nitrate infiltration at its source. Through strengthened coordination among local health departments, municipalities, Natural Resources Districts, and state agencies, the South Heartland District can enhance its capacity to safeguard drinking water quality and protect public health.

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Data Sources:

1. Nebraska Department of Environment and Energy (NDEE) – Clearing House
- NDEE – Poster Nitrate in Nebraska Groundwater
- NDEE – Poster Public Water Systems
- NDEE – Poster Free Nitrate Sampling for Private Domestic Wells
- NDEE – Factsheet Water Contaminant Factsheet

2. Environmental Protection Agency (EPA) – Drinking Water Violations data
3. Jayasekera, Harshanee. "Nitrate Management in Nebraska Community Water Systems Is a Complex Issue." *Waterforfood.nebraska.edu*, 1 Sept. 2023, waterforfood.nebraska.edu/news-and-events/news/2023/08/nitrate-management-in-nebraska-community-water-systems-is-a-complex-issue.