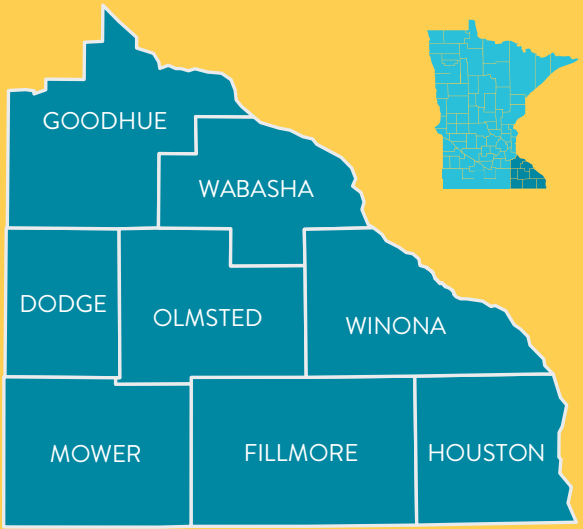
Southeast Minnesota Nitrate Strategies Collaborative Work Group

Report of Recommendations

Protecting groundwater resources in this unique geologic region.



Authors

Aaron Bishop, Fillmore
Jan Blevins, Olmsted
Doug Cieslak, Winona
Andrea Eger, Houston
Warren Formo, Goodhue
Glen Groth, Winona
Bonnie Haugen, Fillmore
Beau Kennedy, Goodhue/Wabasha
Martin Larsen, Olmsted
David Mensink, Fillmore
Jeff Pagel, Olmsted
Thomas Pyfferoen, Dodge
Henry Stelten, Goodhue
Mark Thein, Olmsted
Mary Thompson, Houston
Rita Young, Winona

Contributors/acknowledgements

Shaina Keseley, MPCA
Katie Pratt, Office of Collaboration and Dispute Resolution
Tannie Eshenaur, MDH
Christopher Schaupp, MDH
Michael Cruse, Minnesota Department of Agriculture
Scott Hanson, Minnesota Department of Health
Justin Watkins, Minnesota Pollution Control Agency

Editing and graphic design

Sara Thurin Rollin
Scott Andre

Thanks to Martin Larsen for photo contributions

MINNESOTA

Contents

Foreword

Photo: Martin Larsen

Dear reader,

As residents of southeast Minnesota, we are proud of the unique landscape we call home. From bluffs and river valleys, fields and forests, to towns and cities, there is not another place on the planet like our corner of Minnesota. Regardless of where we work, live, and play in the region, the water that flows here connects us all. The importance of clean drinking water is a value we hold in common and a value that was core to the Southeast Minnesota Nitrate Strategies Collaborative Work Group.

We came together as a work group in July of 2024 to learn together and develop recommendations that we hope will address the complex challenge of nitrate contamination in our groundwater. The karst geology of southeastern Minnesota is uniquely susceptible to leaching from land practices, which can result in problems for our private wells and community water supplies. Many important practices are needed to keep drinking water safe, but reducing the leaching of nitrate over the long-term—stopping the problem at the source—is a crucial part of the solution.

Our work group met for a full year to discuss and deliberate. A wide range of perspectives were represented, and experts were brought in to share information. A lot of thought and consideration was put into the recommendations in this report. We did not agree on all aspects of the problem and at times disagreed on the proposed solutions. In the end, these recommendations get to the core of what we all agreed could realistically be done to effectively reduce nitrate in water. Not all these ideas are new, but continued emphasis on practices that are working from the people who live in this region keeps building momentum for change.

Leaders from industry, community, and all levels of government have a responsibility to help move these ideas forward. We urge residents to share information in this report with their colleagues, neighbors, friends, and family. It will take long-term vigilance, care, monitoring, and financial support to mitigate and reduce nitrate concentrations in water. The recommendations in this report are not spelled out in every detail. The work group recognized that the complexity of nitrate contamination means that agency experts, lawmakers, scientists, and advocates will need to do additional program and policy development, and continue conversations with subject matter experts, to implement the ideas.

Despite the challenges of the nitrate issue, our work group found much to be hopeful about. First, many farmers are thinking outside of the box, embracing new crops, keeping roots in the ground for more of the year, and striving for more diversified agricultural economies. Second, there are many solutions to improving our water quality that have been shown to be effective that now need to be adopted consistently on a wider scale. Third, we have sophisticated testing, data, and analysis to help the cause. This technology is evolving rapidly, and we have more tools than ever to help us deploy solutions strategically. We felt that rhetoric on the issue is not always a fair representation of the problem or solutions. It is possible to put reasonable steps in place that protect water, protect our health, and allow communities, business, and agriculture to thrive. Working together, we can get it done.

Sincerely,

Work Group Members

Strategies for keeping nitrate out of groundwater in southeast Minnesota

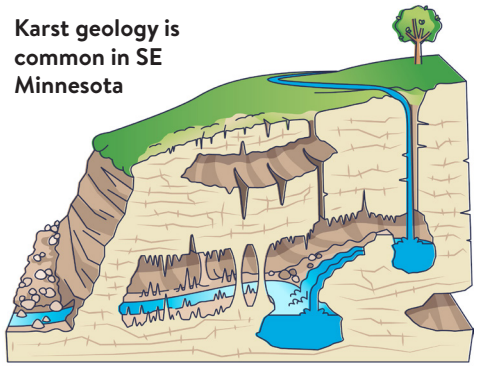
Overview of recommendations from the Southeast Minnesota Nitrate Strategies Collaborative Work Group

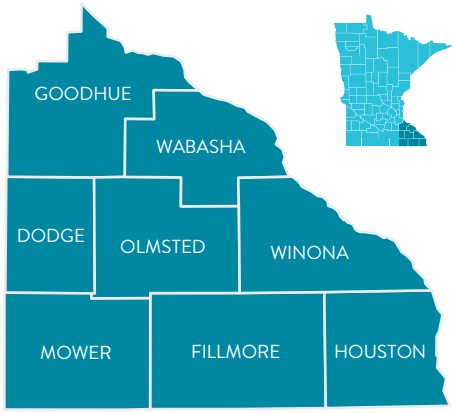
Safe drinking water is essential for the health and well-being of all Minnesotans. In southeastern Minnesota, approximately 300,000 people rely on 93 community water systems that all rely on groundwater as a source and more than 93,000 rely on private wells. The Minnesota Departments of Health (MDH), Agriculture (MDA), Natural Resources (DNR), and the Pollution Control Agency (MPCA), along with local governments, work together to protect drinking water supplies from nitrate and other pollutants.

Nitrate in groundwater and drinking water has been a decades-long subject of water planning in southeast Minnesota, with some of the earliest county water planning efforts focused on reducing nitrate levels. Currently, there are extensive efforts to address nitrate contamination underway in Minnesota and specifically in the southeast region. These programs require coordination across state agencies and with local governments and community partners. Despite these efforts, challenges remain in ensuring water supplies are below safe drinking water regulatory limits and environmental and human health is protected for the long term.

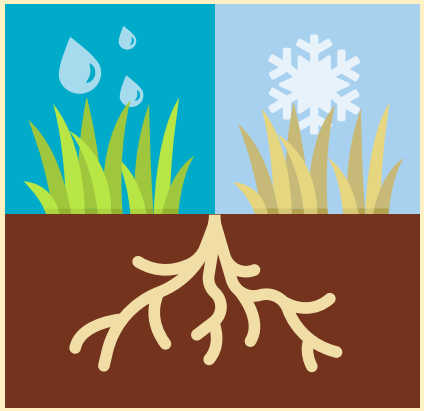
Karst is the most common type of geology found in southeast Minnesota and is made up of limestone that is prone to cracks, sinkholes and caves. Due to this and the limited soil depths in this area, surface water can make its way into ground water in hours or days as opposed to weeks or years in areas with other geology and deeper soils which act as a filter. That means water in southeast Minnesota is particularly vulnerable to nitrates and other contaminants. Row crop agriculture is the main source of nitrate in southeast Minnesota.

Karst geology is common in SE Minnesota





Recommendations



More living roots on the ground for longer periods

Support alternative crops and land uses

Support and increase implementation of nitrogen Best Management Practices

Education and outreach

In April of 2023, a petition was filed to the EPA asking them to address nitrate contamination posing a risk to human health of the residents in the eight counties in the southeastern corner of Minnesota. Three state agencies, the MDH, MDA, and MPCA, responded to the EPA with a three-phase work plan outlining actions they intended to take to address this nitrate issue. As part of Phase 3, long-term nitrate strategies, a work group was formed comprised of local leaders in the region. This work group of 19 members represented more than 25 organizations and met monthly for one year. They built a shared understanding of the challenges and opportunities of addressing nitrate pollution in southeastern Minnesota, then deliberated and built consensus on ways to strengthen the long-term nitrate reduction strategies and finally developed this report that outlines recommendations for improving, prioritizing, and implementing strategies to accelerate nitrate prevention and mitigation activities.

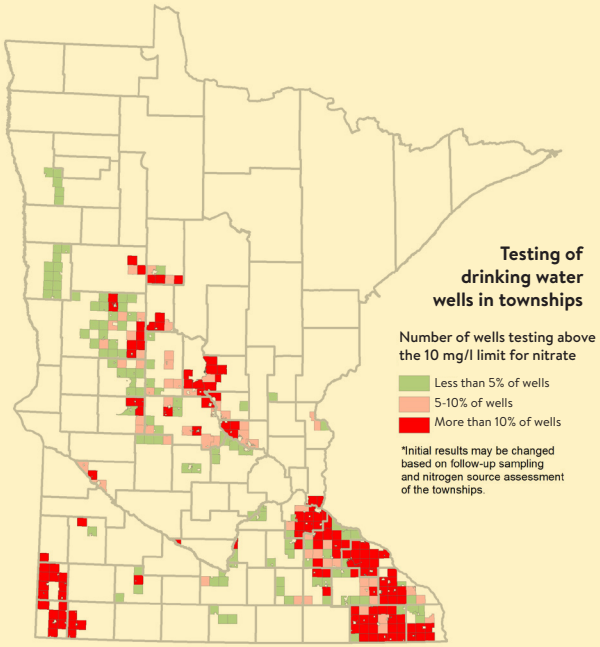
Four recommendations were developed by the work group with corresponding actions. These recommendations and actions received consensus support of work group members, meaning all work group members endorse the set of recommendations as important steps for addressing nitrate contamination, and they do not oppose the recommendations even if they do not agree on all aspects.

Work group members spent many meetings learning more about the actions and efforts already underway to address the issue of nitrate in water in the region. This photo shows them on a farm tour in Olmsted County in September of 2024.

Nitrate pollution is a threat to clean groundwater.

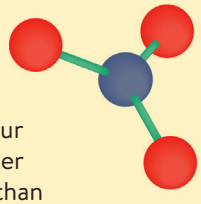
Polluted wells

Many private wells, especially in southeast Minnesota are above the health risk limit, 10 milligrams/liter, for nitrates.



Testing done by Minnesota Dept. of Agriculture. Updated June 2019.
This was initial testing. Results may change based on further sampling.

What is nitrate?



Nitrate-nitrogen (referred to as nitrate) is a compound made up of nitrogen and oxygen. It can occur naturally in groundwater at levels typically less than one part per million (ppm). Above 3 ppm is considered elevated, and above 10 ppm is considered unsafe.

Why is it bad?

Nitrate can interfere with your blood's ability to carry oxygen. The risk is highest for bottle-fed infants, and adults with certain health problems. To protect vulnerable groups, the health limit for drinking water is 10 parts per million.

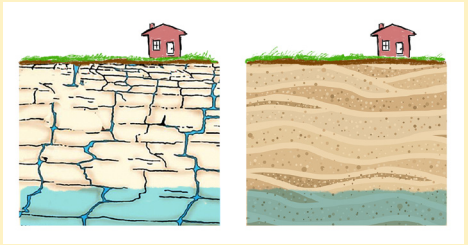
Where does the pollution come from?

High levels of nitrate in water can come from fertilized soil, wastewater, landfills, feedlots, septic systems, or urban drainage. A major contributor in rural areas is nitrogen fertilizer that moves deeper than the crop root zone.

Photo: Martin Larsen

Where is nitrate pollution most common?

Contamination is most often found in areas that have sandy or coarse soils, shallow bedrock, or karst geology (such as in southeast Minnesota). Areas with heavy row crop agriculture and vulnerable groundwater are especially at risk.



Karst geology Sandy soils

Work group members take a moment to pose together with farmers who took them on a tour of their farm to see first hand practices being implemented on the landscape to help address nitrate in groundwater.

Work group context

On April 24, 2023,a group of petitioners requested that the U. S. Environmental Protection Agency exercise its emergency powers under Section 1431 of the Safe Drinking Water Act (SDWA) to address groundwater nitrate contamination that presents a risk to the health of the residents in eight counties of the southeast Karst Region of Minnesota.

On January 12, 2024, the Minnesota Department of Health (MDH), the Minnesota Department of Agriculture (MDA) and the Minnesota Pollution Control Agency (MPCA) submitted to the U.S. Environmental Protection Agency (EPA) a workplan outlining next steps. There are three phases to this workplan: Phase 1 – immediate response (led by MDH); Phase 2 – public health intervention (led by MDH); Phase 3 – long-term nitrate strategies (led by MPCA and MDA).

As part of Phase 3 of the workplan, the MPCA and MDA jointly convened (with MDH and the Minnesota Board of Soil and Water Resources partnering in the effort) a work group to address nitrate in southeast Minnesota. The work group consisted of residents and local leaders from the southeastern Minnesota counties of Dodge, Fillmore, Goodhue, Houston, Mower, Olmsted, Wabasha, and Winona. Organizational affiliations of the members included: Minnesota Farm Bureau, Minnesota Farmers Union, Minnesota Soybean Growers, Minnesota Corn Growers, Minnesota Milk Producers, Grazing Advisory committee of the U.S. Department of Agriculture's Natural Resources Conservation Service (NRCS) State Technical Committee, Three River Cattlemen, Land Stewardship Project, Sustainable Farmers Association, Practical Farmers of Iowa, Driftless Area Agriculture Alliance, Agriculture Fertilizer Research and Education Council, Minnesota Caving Club and Karst Preserve, National Speleological Society, American Cave Conservation Association, Geological Society of America, Responsible Agriculture in Karst Country, Minnesota Well Owners Organization, Goodhue and Olmsted County Soil and Water Conservation Districts, Winona County, and the Prairie Island Indian Community. The following were the 19 members of the work group:

Aaron Bishop, Fillmore
Jan Blevins, Olmsted
Doug Cieslak, Winona
Andrea Eger, Houston
Warren Formo, Goodhue
Glen Groth, Winona
Bonnie Haugen, Fillmore
Beau Kennedy, Goodhue/Wabasha
Martin Larsen, Olmsted
David Mensink, Fillmore
Jeff Pagel, Olmsted
Thomas Pyfferoen, Dodge
Henry Stelten, Goodhue
Mark Thein, Olmsted
Mary Thompson, Houston
Rita Young, Winona

Ex-officio contributors:
Michael Cruse, *Minnesota Department of Agriculture representative*
Scott Hanson, *Minnesota Department of Health representative*
Justin Watkins, *Minnesota Pollution Control Agency representative*

From July 2024 to June 2025, the work group met once per month, for day-long, in-person meetings. The purpose of the work group was to:

- build a shared understanding of the challenges and opportunities of addressing nitrate pollution in southeastern Minnesota.
- deliberate and build consensus on ways to strengthen the long-term nitrate reduction strategies.
- develop recommendations for improving, prioritizing, and implementing strategies, including strengthening communication and engagement activities, policy or funding proposals, or collaborative strategies to accelerate prevention and mitigation activities.

The outcome of the work group was this report, which outlines recommendations and background information.

Work group process

Work group members met between July 2024 and June 2025. They had a total of 12 in-person, day-long meetings. The work group used a collaborative problem-solving process to develop the consensus recommendations presented in this document. Work group members engaged in structured work sessions that included the following elements:

- Learning about the theory and practice of collaborative problem-solving.
- Sharing with one another from their lived experiences in southeastern Minnesota and from their unique areas of expertise.
- Fact-finding about science, policy, economics, and land practices related to nitrate water pollution prevention and management.
- Generating shared principles and approaches.
- Developing draft recommendations for the long-term reduction of nitrate in groundwater.
- Deliberating on options.
- Developing consensus recommendations.

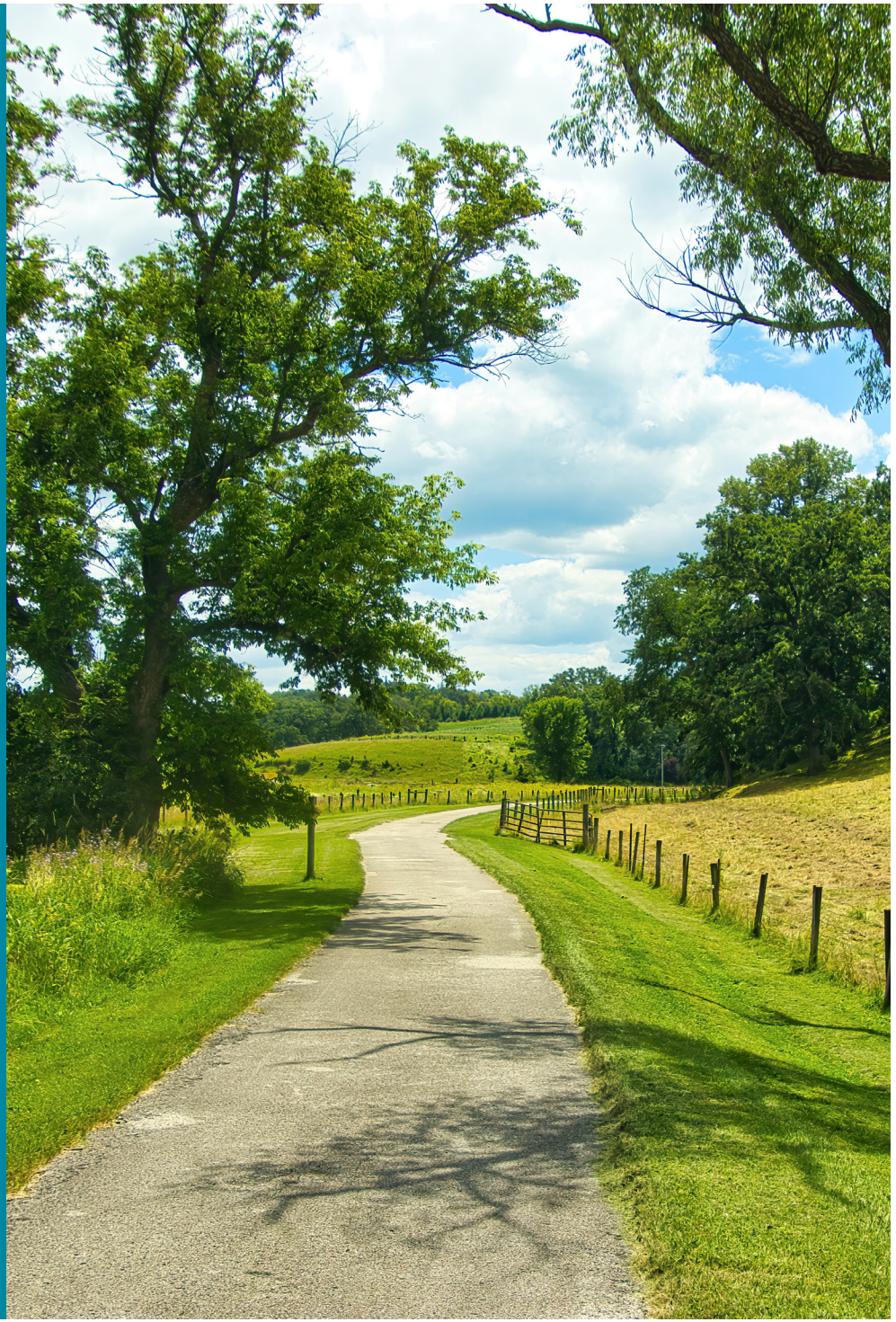
- Discussing barriers and opportunities for the implementation of their recommendations.

Work group meeting topics included:

- Key dates and events in the history of landscape change and water quality insoutheastern Minnesota
- Tour of Niagara Cave
- Understanding southeast Minnesota groundwater and hydrogeology
- Visits to local farms
- Farming practices and farmer experiences
- Nitrate reduction programs, activities, and funding sources
- Strategies of state government and their partners to address nitrate contamination
- Discussion with representatives of organizations that petitioned the U.S. EPA under the Safe Drinking Water Act
- Nitrate and health, and the work of the Minnesota Department of Health Water Policy Center
- Economic tradeoffs and consideration in nitrate management and regional economics in southeast Minnesota
- Minnesota Department of Agriculture's Township Testing Program and Nitrogen Fertilizer Management Plan

Members of the work group developed the following shared principles reflecting their common values in relation to addressing nitrate in southeastern Minnesota:

- Everyone needs clean drinking water.
- Focus on sustainability for future generations.
- Lift up locally driven community collaboration.
- Outreach, education, and building trust are important components of making systems change.
- Speak with one voice on the importance of testing wells and protecting health.
- Use the best available science and data.
- Agree that we have enough information about the causes of nitrate contamination to act.
- Recognize solutions require both taking responsibility and supporting those willing to take risks in the interest of change.
- Recognize that investment is needed at multiple scales for farming systems and markets to change.
- Structure programs to be simple to use – remove red tape.
- Embrace flexibility rather than a one-size-fits-all approach.
- Make sure affected groups are at the table.
- Drilling wells into deeper aquifers will not solve nitrate contamination in southeast Minnesota.
- Additional approaches are needed to address the nitrate issue in southeast Minnesota.



Land use of the eight southeast counties

The population of the eight southeast counties, as of 2024, was 388,134. In general, land use in the region has shifted from mostly pasture and hay to more acres used to grow cultivated crops (corn and soybeans) and more developed areas with homes, business, etc. (Figure 1). Underlying the land use on the surface are three types of karst: covered karst which is mostly on the western side of the southeast area, transition karst and active karst mostly on the eastern side up to the Mississippi River (Figure 2). Karst is a terrain with distinctive landforms and hydrology created primarily from the dissolution of soluble rocks. It is characterized by sinkholes, caves, springs, and underground drainage dominated by rapid conduit flow, conduits that are created by that dissolution of rock.

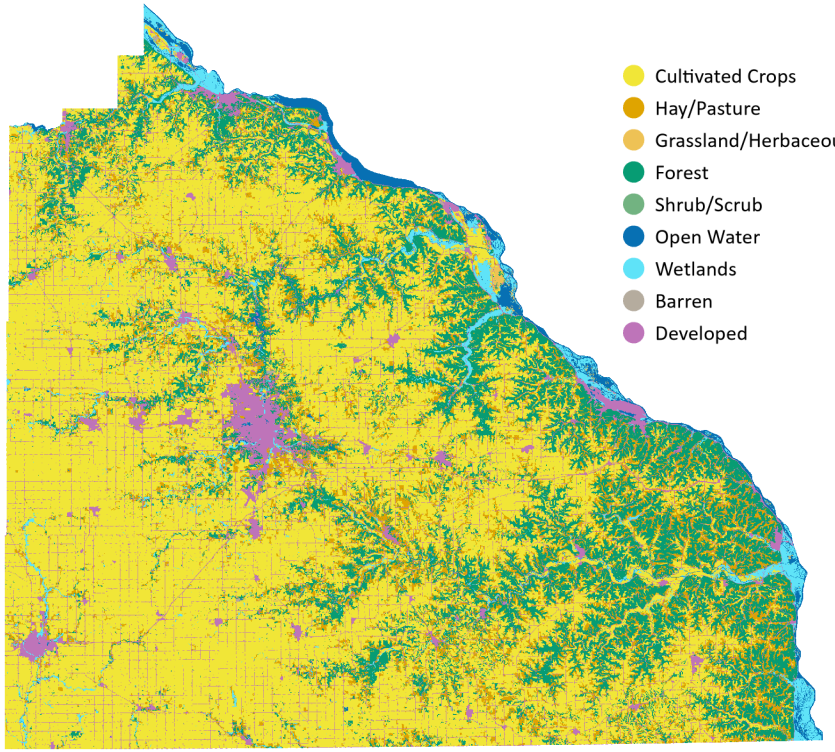
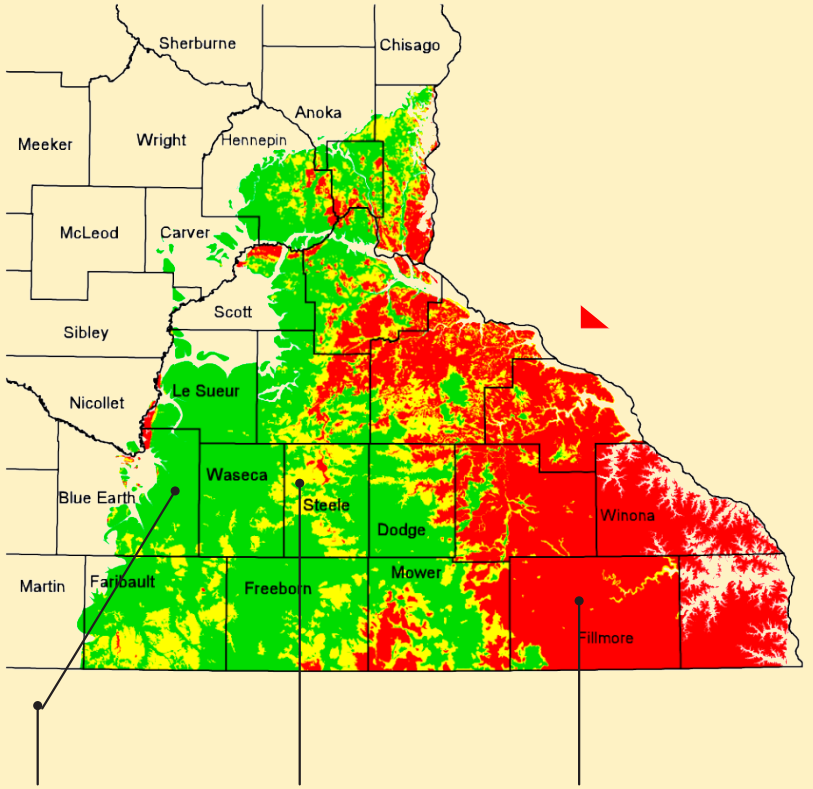


Figure 1. Land use in the eight-county southeast corner of Minnesota, 2020.

Figure 2.

Where is karst in Minnesota?



Covered karst: More than 100 feet of soil/sediment cover above bedrock

Transition karst: 50-100 feet of soil/sediment cover above bedrock

Active karst: Less than 50 feet of soil/sediment cover above bedrock (groundwater is most at risk here)

E. Calvin Alexander Jr., Yongli Gao, and Jeff Green

Harvested Crop Type Records in Southeast Minnesota

As of 2021, 65% of land in the eight southeast counties is considered cropland; that's 2,138,982 of the 3, 311,872 acres[2]. The long-term records of crop types harvested tell the story of agricultural changes. Three categories are tracked by County Agricultural Surveys collected by the National Agricultural Statistics Service (NASS): hay (Figure 3), small grains (Figure 4) and row crops (i.e. corn and soybeans) (Figure 5). The data is shown as percentage of total acres harvested and aggregated on 10-year increments, from 1930-2020 .

Figure 3. Percent of hay acres harvested per decade in the eight counties of southeast Minnesota.

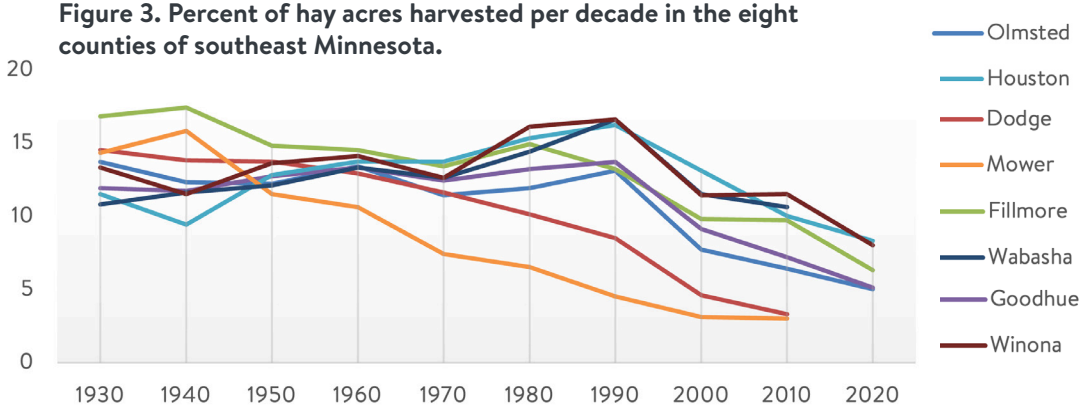


Figure 4. Percent of small grain acres harvested per decade in the eight counties of southeast Minnesota.

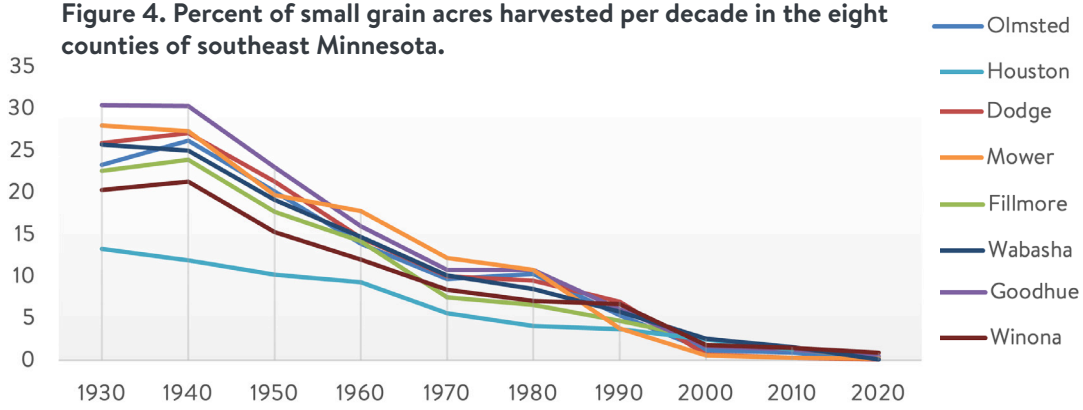
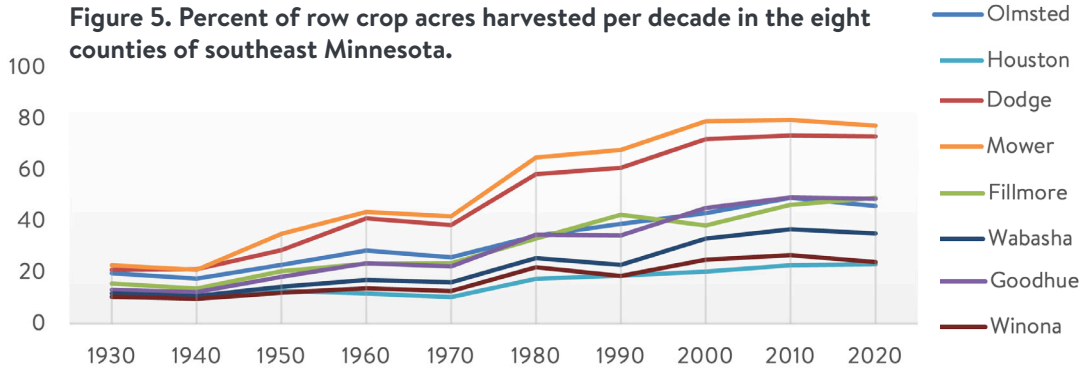


Figure 5. Percent of row crop acres harvested per decade in the eight counties of southeast Minnesota.



Nitrate in southeast Minnesota groundwater

Regional efforts to address nitrate

Millions of dollars and years of work in southeast Minnesota have served to reduce nitrate leaching loss from cultivated acres. However, data and research show that nitrate is still leaving the region's cropping systems and polluting groundwater. Therefore, new approaches and more work on the issue is needed.

Nitrate in groundwater/drinking water has been a decades-long subject of water planning in southeast Minnesota, with some of the earliest county water planning efforts being focused on reducing nitrate levels. The Southeast Minnesota Water Resources Board was formed largely to foster efforts to reduce leaching of nitrate to the region's groundwater; this Board was dissolved in 2019. Two major rules, MDA's Groundwater Protection Rule (Minn. R. ch. 1573, passed by the legislature in 2019) and the MPCA's Feedlot Rule (Minn. R. ch. 7020, in effect since the 1970s and currently open for amendment), were adopted and assist in the reduction of nitrate leaching to groundwater (Appendix).

There are extensive efforts to address nitrate contamination underway in Minnesota and specifically in the southeast region. These programs require coordination across state agencies and with local governments and community partners. Many also require the appropriation of funds from the state legislature. Key programs are listed in the Appendix.

Southeast Minnesota hydrogeology

Karst is the most common type of geology found in southeast Minnesota and is made up of limestone that is prone to cracks, sinkholes and caves. Due to this and the limited soil depths in this area, surface water can make its way into ground water in hours or days as opposed to weeks or years in areas with other geology and deeper, prairie soils which act as a filter. Due to this, water in southeast Minnesota is particularly vulnerable to nitrate and other contaminants.

The unique geological features of southeast Minnesota make management of the region's aquifers challenging. An aquifer is an underground body of permeable rock or sediment that holds water. These features dictate the speed and direction of water moving from the surface through

Photo: Martin Larsen

Moth Spring is an example of a dramatic karst feature which is one of the characteristics of the southeast karst region.

the layers of soil and rock below. This complex movement of water from the surface to aquifers below ground makes it vulnerable to contaminants like nitrate.

The layered sedimentary geology of southeast Minnesota includes both aquifers and confining layers known as aquitards. These aquitard provide geologic protection to deeper aquifers within the region. However, contributions to these deeper aquifers can sometimes be focused along the edges of these confining units where their thickness lessens. This interaction can cause a significant delay in the discharge to aquifers including surface contaminates. This mixed age of groundwater in certain aquifers within the region can make it difficult to evaluate the immediate impact of management practices occurring on the landscape.

A recent peer-reviewed study by the Minnesota Geological Survey, the Minnesota Department of Agriculture and the Minnesota Department of Natural Resources investigated groundwater residence time and how it affects nitrate trends in springs, wells and streams southeastern Minnesota, a region with agricultural and karst landscapes.

This study confirms that the uppermost groundwater has generally taken on the nitrate concentrations that we see leaving the root zones from the land surface above. This uppermost groundwater has reached a state of "equilibrium" in that concentration trends are generally not increasing. Most are flat and some are decreasing. However, these concentrations are still high and need reduction. The deeper groundwater has lower, but increasing levels of nitrate that have not yet reached that equilibrium and are increasing at a rate of about 1-2 mg/L every ten years[4] (Figure 6).

Nitrate sources, concentrations, and practices

Row crop agriculture is the main source of nitrate in southeast Minnesota. A comprehensive study completed in 2013 of nitrogen sources in the Lower Mississippi River Watershed in Minnesota (the basin covering most of southeast Minnesota) estimates that 89% of the nitrogen loading to surface waters originates from cropland, with a substantial portion moving downward through groundwater to surface waters (57%) and downward through tile drainage to surface waters (23%)[5] (Figure 7). Research also confirms that in the absence of human disturbance in a watershed, the nitrate concentrations at various points of measure (deep wells, baseflow of trout streams, springs) approach 0 mg/L nitrate. Other types of land use such as pasture and turf grass also contribute some nitrate, but at rates much lower than crop land[6] (Figure 8).

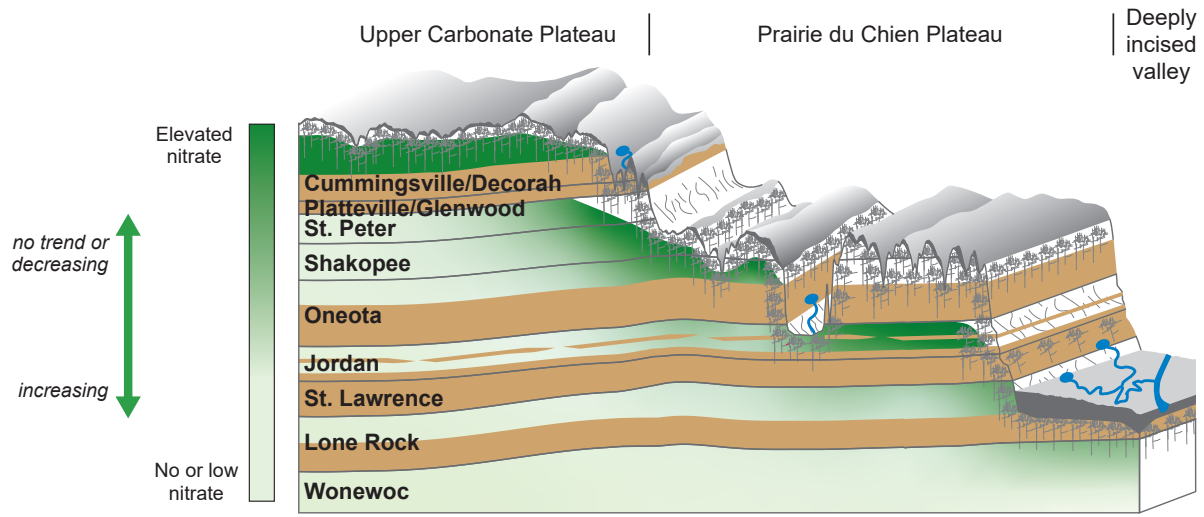


Figure 6. Cross-section example showing bedrock formations in southeast Minnesota and associated nitrate trends.

Once on the landscape, there are various land-use practices that can be used to address nitrate, with varying effectiveness. According to a literature review conducted as part of Minnesota's Nutrient Reduction Strategy, most practice efficiencies had a wide range of variability, influenced by site, soil, weather, crop management, and other factors. In field nitrogen management practices had average reductions of 4% to 21%, depending on the practice. Continuous living cover efficiency averages ranged from 17% to 94%, and drainage water management and treatment practices averaged 30% to 51%.

Point sources that contribute nitrate can also manage what enters the landscape. As of 2024, permits for municipal and industrial wastewater dischargers with high concentrations of nitrogen will be required to develop and implement nitrogen management plans as a part of their permits, including an evaluation of the facility's influent reduction measures, effluent reduction measures, and nitrogen effluent concentration as well as a plan to implement the necessary nitrogen management and reduction measures over the permit term.[8]

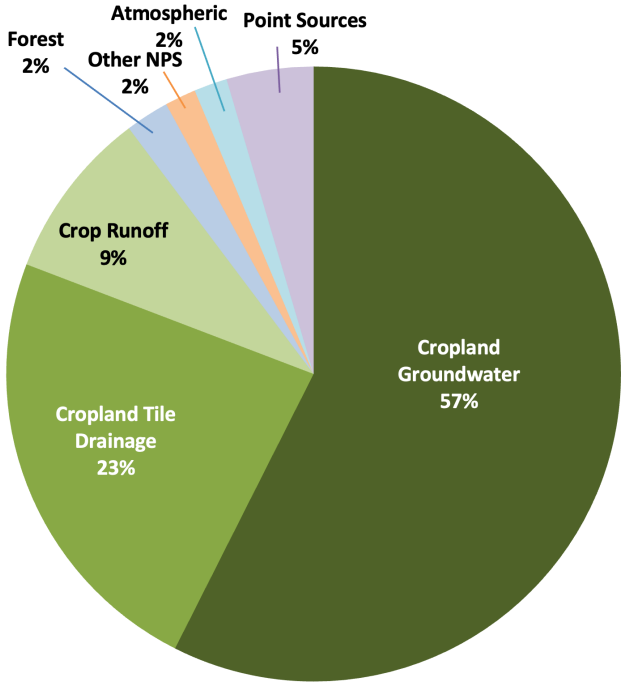
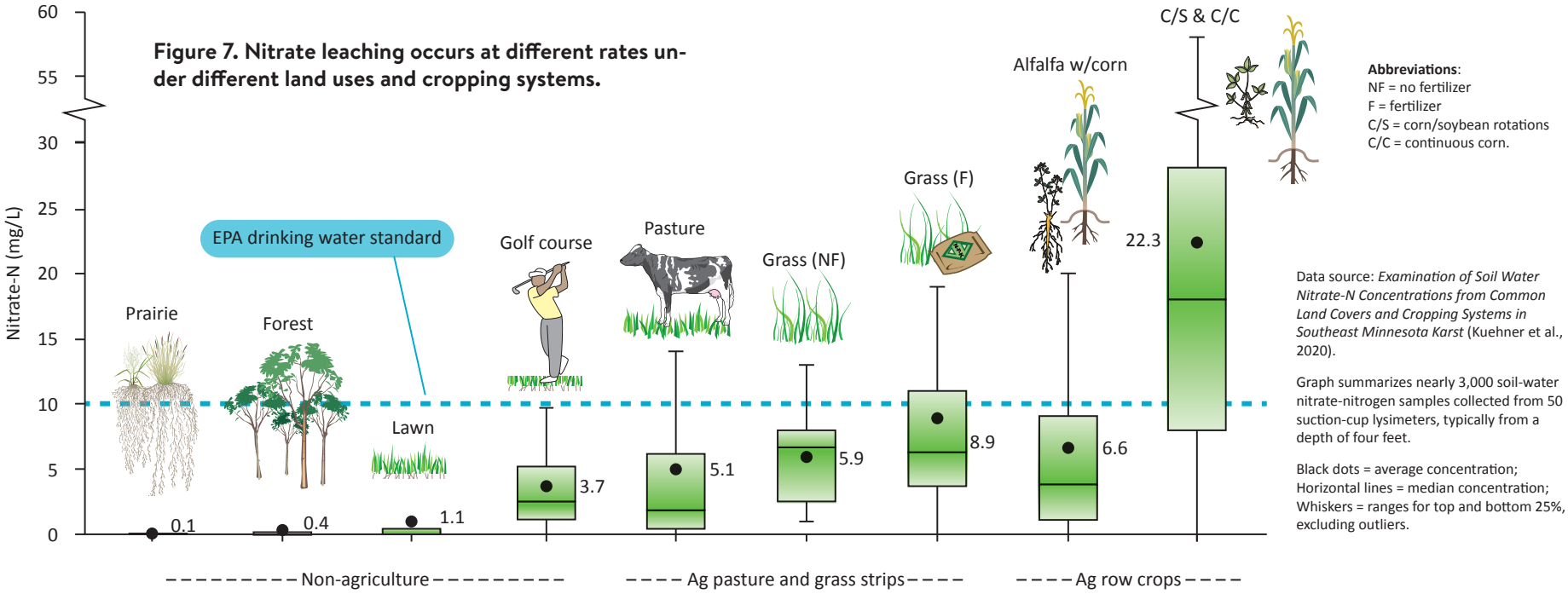


Figure 8. Nitrogen sources in the Lower Mississippi River Basin.

Figure 7. Nitrate leaching occurs at different rates under different land uses and cropping systems.



Abbreviations:
NF = no fertilizer
F = fertilizer
C/S = corn/soybean rotations
C/C = continuous corn.

Data source: *Examination of Soil Water Nitrate-N Concentrations from Common Land Covers and Cropping Systems in Southeast Minnesota Karst* (Kuehner et al., 2020).

Graph summarizes nearly 3,000 soil-water nitrate-nitrogen samples collected from 50 suction-cup lysimeters, typically from a depth of four feet.

Black dots = average concentration; Horizontal lines = median concentration; Whiskers = ranges for top and bottom 25%, excluding outliers.

Drinking water in southeast Minnesota

The source of drinking water for the eight-county southeast region is solely groundwater. In this region, a population of about 300,000 people rely on 93 community water systems with the remaining 93,805 people relying on their own private well. Those relying on community water systems can be confident their water utility regularly tests and treats for nitrate, with water required to be below the maximum contaminant level (MCL). An MCL, or maximum contaminant level, is a legally enforceable standard for a specific contaminant allowed in public drinking water, according to the federal Safe Drinking Water Act (SDWA). Of these private well users, an estimated 9,218 people are at risk of consuming water with nitrate at or above the MCL of 10 mg/L. Nitrates are an issue in the aquifer occurring in both public water supplies and private wells.

Public water supply

The SWDA is in place to provide protection for public water supplies. The Safe Drinking Water Act sets the Maximum Contaminant Level (MCL) for nitrate-nitrogen at 10 mg/l, often stated as 10 parts per million. The 1996 amendment to the SDWA required MDH to produce Source Water Assessments for all Minnesota public water systems by 2003. MDH developed the assessments using existing data such as water sampling results, water system surveys, and well records. These assessments automatically update as new information is added to MDH's databases. Groundwater is the source of drinking water for public water suppliers across the eight-county southeast petition area[10]. Southeast Minnesota has historically had nitrate levels in the upper carbonate formations that have exceeded this level. Several communities have drilled deeper wells to meet the 10mg/l MCL standard.

Private wells

For private wells, the only current requirement for testing is when the well is constructed. There are no state or federal rules in place governing the use of private wells even when the 10 mg/L threshold is exceeded.

Existing rules governing the construction and siting of wells has helped to mitigate some issues with nitrate, however degradation of the aquifer(s) based upon the impacts of land use decision has continued to occur. Homeowners are responsible for regularly testing their well water. The Minnesota Department of Health recommends laboratory analysis for bacteria and nitrate-nitrogen annually .

According to a report from the Minnesota Department of Agriculture (MDA), once nitrate is measured in a well above 3 mg/L, there is a higher probability of detecting a pesticide in that same well and when the nitrate concentration goes above 10 mg/L, that likelihood increases even more.

The MDA completed an assessment of private wells in areas with a dominance of agricultural land use in the region from 2013 to 2019 and found that 14% of the sampled wells (8,837) exceeded the United EPA nitrate drinking water standard of 10 mg/L .

Health effects of nitrate

There is a well-known link between infant methemoglobinemia (blue baby syndrome), an acute adverse health effect, and nitrate in drinking water. The federal maximum contaminant level (MCL) of 10 mg/L was set in response to this risk. The establishment of this standard, in combination with targeted education efforts, has resulted in blue baby syndrome rarely being reported in Minnesota and the United States today. It should, however, be noted that blue baby syndrome is not a reportable disease.

The human health effects of chronic exposure to nitrate in drinking water (even at concentrations below 10 mg/L) is the subject of ongoing scientific study. In 1991, when the current MCL for nitrate in drinking water was made widely known, there was little information on the effects of chronic nitrate exposures. Recent epidemiological research has provided increasing evidence for associations between longer-term exposures to nitrate in drinking water and a multitude of adverse health effects, including gastrointestinal cancers, thyroid dysfunction, birth defects, and adverse reproductive outcomes (e.g., pre-term delivery). The most consistent associations have been observed for colorectal cancer and neural tube defects. It can be challenging to determine which health conditions are caused specifically by exposure to nitrate in drinking water as opposed to other lifestyle variables or interactions with other chemicals that humans are exposed to in their environment. Continued research will be important for better understanding the nature and the severity of the human health risks, and for implementing an effective response.

At the same time, it is well known that nitrate is not the only contaminant in drinking water. As nitrate concentrations increase, the likelihood of other contaminants or pathogens being in the drinking water also increases. Drilling wells to tap into deeper aquifers may lead to exposure to high levels of other contaminants that come from the geology and are also harmful to health. Deciding how to best use public funding to maximize safe water and the protection of health of Minnesotans is a complex challenge.

Economics of nitrate and clean water

The economic costs and benefits of nitrate use and of clean water are complex, far reaching, and difficult to measure. Moreover, costs and benefits are separated in time and space making accounting difficult. To achieve the goals of cleaning up the upper aquifers of the region to less than 5-10 mg/L nitrate, investments are needed in vegetative solutions, which can be quite costly.

The inertia of the current system including federal crop insurance programs, lender rules, existing markets, financing, and policy can significantly impact the adoption of needed practices. Passing costs down to consumers is one way to deal the costs of changing cropping systems. While consumers will often be willing to pay more for food grown sustainably, making changes on a regional basis makes it hard to pass those costs along to the consumer. A long-term, comprehensive approach that considers both state-level and broader societal factors is essential to achieve sustainable agriculture and water quality.

It was beyond the scope of the workgroup to comprehensively examine the economic tradeoffs of nitrate use and clean water. That said, some themes that came up in conversation included:

- Recent economics have not been favorable for most farmers in southeast Minnesota. Adding increased costs to farmers may have a negative impact on their economic sustainability.
- Farming plays an important role in economic processes at local, regional, and global scales.
- There are costs to individuals and governments for cleaning up contaminated water.
- Health impacts of drinking nitrate contaminated water may have costs for individuals, the healthcare system, and the broader economy.
- Clean water plays an important role in economic processes at local, regional, and national scales.

Clumps of trees mark and protect the openings of sinkholes in the karst farmland of southeastern Minnesota.

Photo: Martin Larsen

Recommendations

Shared responsibility for recommendations

A consistent theme in work group conversations was that addressing nitrate in groundwater requires system change. No single group or action can solve the issue. It will take many coordinated activities to reverse trends and create durable change. Increased alignment, participation, and coordination across entities and sectors will help move the goals forward more quickly. The recommendations were created with this reality in mind and with the hope that many hands will make many changes to address the nitrate issue of the region.

The work group recognizes that the recommendations advanced in this report may require additional steps beyond what is outlined below before they can be fully implemented. For example, some recommendations may require legislative action, funding, additional stakeholder conversations, or operational development. Work group members urge continued collaboration and engagement by many parties to help move these ideas forward.

Developing consensus

The recommendations in this report were arrived at by consensus. All work group members endorse the recommendations as important steps for addressing nitrate contamination, and they do not oppose the set of recommendations. Many other recommendation ideas were generated during the work group process, but after deliberation, they did not receive support from all work group members and were removed. Work group members do not agree on all aspects of this complex issue, but they found many areas of common ground. The effort to build consensus around a core set of actions represents a significant shared commitment to solutions that meet many important needs in southeast Minnesota.

Note on the organization of the recommendations

The recommendations below are listed in no order. The structure is set up with an overarching statement, a recommendation, and actions that could be taken to implement the recommendation. At the end of this section, there is a list of related recommendations which are activities that work group members wanted to highlight that are less directly tied to long-term nitrate reduction than the four core recommendations.

More living roots in the ground for longer periods.

More living roots in the ground for longer periods will incrementally reduce nitrate in southeast Minnesota water. Other best management practices (BMPs) that reduce nitrate will help as well, but the longer roots are in the ground the more impact on nitrate reduction in groundwater quality.

Recommendation 1

Continue to promote and incentivize policy and programs with the goal of increasing living cover. Many options of BMPs exist to increase the amount of living cover on the landscape.

ACTIONS

a. Replicate programs like the Olmsted County Groundwater Protection and Soil Health Program model to other counties throughout the region. The program should have these core principles: locally led, flexible, streamlined implementation, and outcome-based/tiered payments.

b. Support federal and state programs that enroll more acres in conservation and rotational grazing programs.

c. Increase means to incentivize hay, pasture, and grazing through the concept of 'working lands' BMPs and efforts, like the work led by the Minnesota Board of Water and Soil Resources. Also, increase technical assistance for the development of grazing plans and funding for fencing and water systems.

d. Find ways to increase hay pasture-based livestock systems and support these systems because perennial cover is proven to reduce nitrate leaching to groundwater.

Photo: Martin Larsen

Support alternative crops and land uses

Infrastructure and market support for crops other than corn and soybeans, like small grains, perennials and pasture, is the path to profound change in the groundwater quality of southeast Minnesota. Cover crops and nitrogen BMPs work to reduce nitrate moving to groundwater and will make incremental reductions of nitrate leaching loss over time. But to "move the needle" faster and further, Minnesota must invest money and write policy that will support alternative crops in the region.

Recommendation 2:

Promote viable market opportunities for small grain farmers as well as hay and pasture-based livestock producers.

ACTIONS:

a. Incentivize first purchasers and end-users of small grains to purchase small grains grown in Minnesota. This may include millers, grain elevators, feed and food mills.

b. Creation of market opportunities for both human grade food and livestock feed companies to source local grains. The University of Minnesota and/or Agricultural Utilization Research Institute (AURI) could play a role.

c. Provide mid-tier marketing grants (similar to the USDA's Resilient Food Systems Infrastructure program grants) to support lower nitrogen demand alternatives to soy/corn; e.g. small grain mills, local meat markets, hemp/flax fiber and processing, etc.

d. Explore something like the structure of the federal economic opportunity zones in southeast Minnesota. Use the resources that flow from such a designation to encourage private investment in mills for oats and research stations for uses of other small grain commodities. Use this same program to guarantee a specified return per acre on farmers who enroll acres in exploratory programs on emerging commodities.

e. Support the use of alternative crops (other than corn and soybeans) for Sustainable Aviation Fuel and other biofuels.

f. Facilitate engagement with companies that emphasize local sourcing of products, such as oats grown in Minnesota. This would highlight market and water quality improvement.

Support and increase implementation of nitrogen Best Management Practices

Research and science confirm that nitrogen BMPs do reduce nitrate leaching loss to groundwater. In addition to reducing nitrate leaching loss, source control BMPs can save producers money because they typically include reduced fertilizer inputs to cultivated acres. Academic reviews of nitrogen BMPs summarized in the draft 2025 Minnesota Nutrient Reduction Strategy update notes that "fertilizer efficiency practices" are a "cost savings."

Recommendation 3

Utilize existing programs by expanding access and tailoring to promote nitrate reduction.

ACTIONS:

a. Increase access to conservation agronomy expertise.
b. Establish a conservation agronomist certification program.
c. Develop a program for cost-sharing to install filter strips to slow down and filter runoff around sinkholes.
d. Require certification of agricultural retailers in the 4R program. Currently, this is an established voluntary program that encourages agricultural retailers and crop consultants to promote the adoption of nutrient BMPs and that supports those retailers and consultants through education, accountability, and coordination efforts.
e. Enhance and expand Minnesota Agricultural Water Quality Certification Program (MAWQCP) with a groundwater endorsement for farms in the southeast karst region with vulnerable soils. Increase the number of staff to deliver the program to more landowners awaiting certification.
f. Support MDA's implementation of the Nitrogen Fertilizer Management Plan, which is the state's blueprint for preventing and

minimizing the impacts of nitrogen fertilizer on groundwater, including:

- Reinstate testing through the Township Testing Program run by MDA.
- Enhanced use of field-scale mapping to improve methods to identify areas of groundwater sensitivity, invest in organizations that can complete this work so mapping can increase, and prioritize funding to ensure state agencies are incorporating the data produced into programs.

g. Increase funding and simplify processes to improve manure storage.

- Proper manure storage for nine or more months in duration is needed to agronomically utilize manure as a valued product, providing nutrients to the field when conditions are right and when the plant can utilize those nutrients.
- In addition to following MPCA's guidance document titled "Liquid Manure Storage Areas," additional requirements of using geophysics, maximum cell size that limits the volume of liquid manure held in a storage facility, and careful siting of the location of storage facilities should be required.

h. In vulnerable areas of the southeast karst region, the following is recommended:*

- As part of their current commercial nitrogen fertilizer sales requirement, reporting of nitrogen fertilizer application rates from responsible parties (e.g. crop retailers) to MDA should be required, in phases. The scale of reporting should be progressively finer scaled, potentially moving from township to tract to field scale. Responsible parties should report application rates for sales made to individuals who apply their own fertilizer. When developing this reporting system, crop retailers and other responsible parties should be included in the process.
- Nutrient management plans should be encouraged for all cropland farmers, like what is required of livestock farmers and Manure Management Plans by MPCA.

Photo: Martin Larsen

- Expand reporting of manure to include more producers, not only livestock farmers with 300 animal units (AUs) or more that MPCA currently requires. This would allow for accounting of all manure being applied on the landscape.
- Replicate, at a high density in the southeast region, Ag Retail Surveys conducted by industry groups. The first Ag Retail survey in Minnesota will be in the summer of 2025 and was modeled after the work done in both Iowa and Illinois. The Minnesota Ag Retail Survey will survey randomly selected retailers and farm fields across the state and use the data collected to generate actionable trendlines for Minnesota growers, support Minnesota Crop Production Retailer's (MCPR) advocacy efforts, provide additional information for the Minnesota Nutrient Reduction Strategy, and can be compared with similar initiatives in Iowa and Illinois. This work is being done by a partnership between MCPR and the Minnesota 4R Nutrient Stewardship Council (MNSC).
- Data overlap should occur between commercial nitrogen

fertilizer application and expanded manure application reporting to ensure proper crediting of all nitrogen sources occurs. The data MDA collects from responsible parties on commercial application would be aggregated to protect identification of individuals. Heat maps could then be made to highlight areas with higher overall application rates.

- The University of Minnesota's (or from states contiguous to Minnesota) recommended nitrogen application rates should be followed, with allowances for reasonable exemptions like weather extremes. If found to be not following recommended rates (with exemptions), an enforcement process should be started with an escalating approach that would end in financial penalties to appropriate parties.

* **Note about recommendation 3h.** The intent of this action is two-fold. First, the goal is to collect more frequent and higher resolution data about nitrogen application to better understand the effects on water quality in the karst region. Second, the intent is to create an accountability mechanism for instances of the overapplication nitrogen. This is not to penalize farmers who are making sound nitrogen application decisions, reduce the economic viability of businesses, or reduce the ability of farmers to adapt to challenges and variability.

The 2023 drought in southeastern Minnesota revealed complex networks of "crop lines" or "karst lineations" in agricultural fields, primarily alfalfa. These lines, characterized by denser, taller, and greener plants, are a direct result of drought conditions combined with thin soil over the highly fractured carbonate bedrock, where plants access moisture from within these bedrock crevices.

Photo: Dennis DeKeyrel

Photo: Martin Larsen

Education and outreach

Strategic communication and public awareness are needed to foster a community-wide understanding of the nitrate water contamination issue and therefore promote change. Education and outreach should be connected to research to keep current information at the forefront.

Recommendation 4

Work at multiple levels in the education system, coordinate messaging and communicate with those that impact nitrate levels.

ACTIONS:

a. Promote the University of Minnesota Extension County educator model that could in turn promote:
   - Farmer-led discussions to encourage information sharing and community building.
   - Toolkits that champions can use to talk to community groups about the nitrate issue.
   - Increase technical assistance and education for production and use of small grain crops.

b. Coordinated outreach from MDA, MPCA, and MDH about nitrate sources, transportation through karst, and its role in contaminating aquifers and drinking water.

c. Build awareness of the critical need for ongoing funding, including Clean Water Fund renewal that must be completed by 2033, and continuation of the Environment and Natural Resource Trust Fund (ENRTF) administered by the Legislative Coordinating Commission on Minnesota's Resources. In 2024, Minnesota voters approved renewal of the ENTRF, which is funded by lottery proceeds, until 2050.

d. Integration of conservation into agronomy studies.
   - Work with universities to include and enhance conservation agronomy in existing (or new) programs.

e. Provide funding support for conservation-focused agronomy programming. Example: Northeast Iowa Community College.

f. Public education:
   - Utilize the YouTube videos on karst produced by the MDA, MPCA, MDH[13].
   - Field days available for students or teachers that could include speakers with backgrounds in hydrology/geology with an emphasis on water and contaminant movement and residence times.

- Development of curriculum that teaches students the basic geology of their area, so they understand the relationship between land use and water quality.

g. Continue to build out the database of sinkhole locations, like how individuals can report spring locations through the Minnesota DNR's online spring inventory.[14]

Related recommendations

The core charge of the work group was to develop recommendations for strengthening long-term nitrate reduction strategies. However, there are related activities that work group members also wanted to highlight in this report that are less directly tied to long-term nitrate reduction. The following recommendations are supported by work group members as important activities for addressing clean water and human health in southeast Minnesota.

Research

- More toxicology research around implications of nitrates on human health.
- Continue developing technological solutions to high nitrate in drinking water.
- Increase the amount of observation wells throughout the region that monitor the quality and trends of aquifers.
- Support further research into understanding and mapping all significant karst features.
- Fund installation of more lysimeters, a device that measures water movement through soil.

Private well water testing

- Provide free annual private well water testing to southeast Minnesota residents.
  - Include an educational component about remediation options for private well water.

- Require testing of private wells at point of sale across karst, 8-county region.
- Train community health workers and local public health offices to communicate the importance of testing private wells and have them organize well-water sampling opportunities.
- Expand the Minnesota Colleges and Universities rural health program.
- Build drinking water awareness into health-care screening practices for adult and children's annual check-ups and expectant mother screenings, medical care.

Addressing problematic wells

- Fund the permanent sealing of any multi-aquifer well and provide low/no interest loans for those same landowners to drill wells that meet today's standards. An example is MDA's Ag Best Management Practices loan program where well sealing is an approved practice.
- Develop a revolving loan fund that provides low interest loans for applicable well owners with nitrate levels of10 ppm or more. Make allowances to fund similar loans for wells with 5 ppm nitrate, over time. Reassess severity of nitrate level on a regular basis.
- Cost share program for well treatment.

Maps, measurements and accountability

[Healthier watersheds: Tracking the actions taken | Minnesota Pollution Control Agency][15]

Find out what's being done in Minnesota's watersheds to protect and improve water quality. We will update the information each July, based on data from the previous year.

[Source Water Protection Web Map Viewer | MN Department of Health][16]

This map viewer features several types of source water protection areas. You can see where communities source their drinking water and identify whether you are in a protection area. You can also learn how vulnerable a drinking water source is to outside contamination.

[Monitoring Nitrate in Groundwater | Minnesota Department of Agriculture][17]

This website is a landing page for a variety of information relating to nitrate, from plans to rules to testing programs.

Conclusion

Nitrate in the southeast region of Minnesota is, and has been, a cause for concern for many years. To date, a lot of time and money have been invested to reduce nitrate leaching loss from cultivated acres. Those efforts should not go unnoticed and can be attributed to why the situation isn't in an even worse state. However, data and research show that nitrate is often leaving the region's cropping lands, at a concentration twice the federal safe drinking water standard. As such, continued work and new approaches are needed.

The recommendations outlined in this report lay out actions that can be taken to address excess nitrate in water. For these recommendations to be implemented, there needs to be an understanding and realization that there is no single group or action that can solve the issue. It will take many coordinated activities to reverse trends and create durable change. It will take willingness to think outside the traditional boxes of how the system works to create the system change that is necessary. Increased alignment, participation, and coordination across entities and sectors will move these recommendations, and therefore progress on reducing nitrate, forward more quickly.

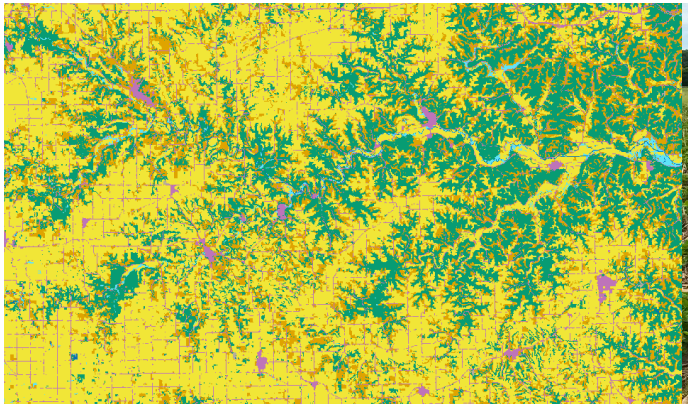


Photo: Martin Larsen

Appendix: Current programs administered by state agency to address nitrate[18]

Editor's note: This appendix was provided by the State of Minnesota's Interagency Coordination Team/Committee on Nitrate as a background resource that describes Minnesota state government responsibilities for nitrate in water.

Board of Water and Soil Resources

The Minnesota Board of Water and Soil Resources (BWSR) functions as the state soil and water conservation agency and is authorized to direct private land soil and water conservation programs through the action of soil and water conservation districts (SWCDs), counties, cities, townships, watershed districts, and watershed management organizations. The BWSR board is appointed by the governor, and it includes citizens, commissioners of the MDA, MDH, DNR, MPCA, local governments, and the University of Minnesota.

BWSR is the primary source of guidance, oversight, and on-the-ground project funding for local governments, private landowners, and other partners on local water plans, wetland protection efforts under the Wetland Conservation Act, and soil and water conservation programs.

Easements

- Reinvest in Minnesota (RIM) Reserve in Wellhead Protection Areas focuses on land use protection in wellhead protection areas.
- Conservation Reserve Enhancement Program (CREP) in Wellhead Protection Areas ensures land use in area enrolled protects wells. CREP is a voluntary, federal-state funded natural resource conservation program that uses a science-based approach to target environmentally sensitive land in 54 counties in southern and western Minnesota. This is accomplished through permanent protection by establishing conservation practices via payments to farmers and agricultural landowners.

Grants

- Partner Protection Grants in Wellhead Protection Areas provide an array of protective choices for land use that may be more flexible and attractive for landowners.
- Watershed Based Implementation Funding is intended to provide local governments throughout Minnesota with efficient, transparent and stable funding.
- SWCD Conservation Delivery grants provide each SWCD with funds for the general administration and operation of the district. The grants are intended to provide districts a certain degree of funding stability.
- Clean Water Fund Projects and Practices Grant focuses on the implementation of projects and practices to protect soil and water resources.

Water planning

- One Watershed, One Plan focuses on local water planning on major watershed boundaries with state strategies toward prioritized, targeted, and measurable implementation plans. It is a voluntary program, but necessary if requesting funds from BWSR.
- Watershed management plans (metro and nonmetro) are required of watershed districts and water management organizations.
- Metro county groundwater plans allow counties to set priorities, address issues, and build local capacity for the protection and management of groundwater (voluntary).

Minnesota Department of Agriculture (MDA)

The MDA is statutorily responsible for the management of pesticides and fertilizer, other than manure, to protect water resources. The MDA implements a wide range of protection and regulatory activities to ensure that pesticides and fertilizers are stored, handled, applied, and disposed of in a manner that will protect human health, water resources, and the environment. The MDA works with the University

of Minnesota to develop pesticide and fertilizer best management practices (BMPs) to protect water resources. It also works with farmers, crop advisers, farm organizations, other agencies and many other groups to educate, promote, demonstrate, and evaluate nitrogen fertilizer BMPs, and promote vegetative cover and other advanced nitrogen fertilizer management practices.

Groundwater Protection Rule

The Minnesota Groundwater Protection Rule went into effect on June 24, 2019. It minimizes potential sources of nitrate pollution to the state's groundwater and protects drinking water. Minnesota's Groundwater Protection Rule includes two parts: 1) it restricts nitrogen fertilizer applications in the fall and on frozen soils in both vulnerable groundwater areas and Drinking Water Supply management Area (DWSMA) with elevated nitrate, and 2) a process to address community water supply wells with elevated nitrate, intended to take action to reduce nitrate levels. The rule combines voluntary and regulatory efforts designed to work with local farmers and their agronomists on solutions tailored to their specific situations. There are four mitigation levels in Part 2 of the rule. Levels 1 and 2 are voluntary, and 3 and 4 are regulatory. The response always starts at a voluntary level, only moving to a regulatory level if recommended practices are not adopted or the water quality worsens. Under mitigation levels 2, 3, and 4, the Commissioner of Agriculture will work with local advisory teams to consider appropriate recommended and required management practices for the area.

The MDA is working to ensure that DWSMAs with elevated nitrate are a high priority for implementation funds. The goal is that no additional municipal water supply wells will exceed the drinking water standard for nitrate. The MDA will work with a local advisory team in level 2 DWSMAs to promote the adoption of the nitrogen fertilizer BMPs and other practices, which may reduce nitrate levels in groundwater, such as precision agriculture, perennial crops, forages, cover crops, nitrification inhibitors, new hybrids, real-time sensors, or taking targeted land out of production. These other practices are collectively referred to as alternative management tools (AMTs).

Groundwater modeling of nitrate is underway to evaluate nitrate losses to groundwater from different cropland and nitrogen management scenarios. EPIC and SWAT models provide a predictive tool to estimate changes in nitrate loading based on changes in cropland use and a range of nitrogen management practices.

Nitrogen Fertilizer Management Plan

The MDA developed the Nitrogen Fertilizer Management Plan (NFMP) as the state's blueprint for preventing and minimizing the impacts of nitrogen fertilizer on groundwater. The MDA uses results from the Township Testing Program to prioritize areas of the state to implement the NFMP and protect private wells. The NFMP was developed using a multi-stakeholder advisory committee and a public review process. It emphasizes involving local farmers and agronomists in problem-solving for local groundwater concerns when nitrate from fertilizer is a key contributor.

The NFMP process includes supporting local advisory teams and promoting existing nitrogen fertilizer BMPs and AMTs. The MDA will work with local farmers and crop advisers to demonstrate and implement practices that can protect and mitigate the impact of nitrate on groundwater. This includes using computer modeling tools and surveys of practices to estimate reductions in nitrate loading to groundwater and conducting groundwater monitoring to determine actual changes in nitrate levels in groundwater over time.

Minnesota Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) is designed to accelerate adoption of on-farm practices that protect Minnesota's waters. MAWQCP is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water. Trained conservationists conduct comprehensive risk assessments to identify all risks to water quality, including nitrate leaching and runoff. If a risk exists, in field and edge of field mitigation measures are implemented as part of the certification agreement. A farmer certified

through the MAWQCP is deemed to comply with the Groundwater Protection Rule for the duration (10 years) of the ag producer's water quality certification.

Minnesota Department of Health (MDH)

MDH follows up with owners of unused wells to have them put back into use or sealed. Unsealed wells can become pathways for nitrate and other surface or shallow contaminants to reach groundwater aquifers. Ensuring unsealed wells are located and permanently sealed with approved grout reduces the amount of nitrate and other contaminants in groundwater.

MDH regulates the construction of new wells through the Minnesota Well Code. The Minnesota Well Code contains well construction requirements directed at stopping the movement of shallow groundwater that may contain elevated nitrate to deeper groundwater aquifers. Examples of well construction requirements include sealing the annular space around and between well casings during well construction and prohibiting well construction that connects aquifers separated by less pervious clay and bedrock layers (confining layers).

Safe Drinking Water Act (SWDA)

The federal SDWA gives MDH the authority to enforce water quality standards that prevent public water systems from delivering drinking water with nitrate levels over 10 mg/L. To prevent exposure to drinking water above the established limits, MDH administers compliance monitoring at public water systems around the state. These data are used to prevent the use of drinking water sources or the operation of systems that may result in the public's exposure to drinking water with nitrate contamination above the limit of 10 mg/L. Should levels rise above that level, MDH staff work with public water systems to implement strategies to bring the system back into compliance with the water quality standards. Approaches can involve developing new sources of supply, avoiding the use of specific wells, and treatment. Public notification and communication are a key part of the required response.

Compliance monitoring is done regularly for all public water systems in the state. Therefore, MDH has good information on nitrate occurrence and trends for individual systems. It is common that MDH staff are engaged with public water system staff anytime its nitrate levels are above 5 mg/L. Early interventions often help to avert compliance or enforcement situations that are disruptive and expensive to resolve.

Minnesota Pollution Control Agency (MPCA)

The MPCA is responsible for implementing much of the federal Clean Water Act in Minnesota, including establishing state water quality standards, assessing the quality of all waters, identifying waters that fail to meet state water quality standards, and administering the federal National Pollutant Discharge Elimination System (NPDES) permitting program.

The MPCA is required to develop total maximum daily loads (TMDLs), Watershed Restoration and Protection Strategies (WRAPS), and WRAPS Updates, which provide an allowable pollution budget for each impaired water body segment that results in the waterbody not being impaired and a plan for achieving the identified goals. The MPCA issues and manages wastewater permits for municipal and industrial users; stormwater permits for municipal, construction, and industrial activities; and works with local units of government to implement a statewide Subsurface Sewage Treatment System program. The MPCA also regulates the collection, transportation, storage, processing, and disposal of animal manure and other livestock operation wastes.

Water quality standards

The MPCA designates all groundwater and some surface waters as "Class 1 waters" that need to be protected so they can be used as a source of drinking water. The federal drinking water MCL of 10 mg/L nitrate applies to these waters. The MPCA is considering whether more surface waters should be designated as Class 1 waters, including surface waters that may directly impact groundwater. The MPCA is working on this as part of a rulemaking to update the Class 1 water quality standards.

The MPCA has also developed a draft of a technical support document for a new nitrate water quality standard to protect aquatic life. The agency is pursuing a holistic, stepwise approach to reduce nitrogen levels statewide before adopting this new standard. The first step, developing a detailed Wastewater Nitrogen Reduction and Implementation Strategy with targeted actions to reduce nitrogen from wastewater treatment plants (WWTPs) to protect drinking water and aquatic life and meet the Nutrient Reduction Strategy's point source goals, is complete. Since April 1, 2024, WWTP designs must include the treatment units and hydraulic capacity necessary to achieve future nitrogen effluent limits to maximize the benefits of impending investments and achieve nitrogen reductions as soon as possible. The second step is completing a 10-year update to the Minnesota Nutrient Reduction Strategy (NRS),with enhanced strategies and actions designed to achieve reductions in nonpoint and point sources of nitrogen and phosphorous. The 2025 update to the Minnesota NRS is set for release in 2025. Following its completion, the MPCA plans to restart its work moving forward with the proposed nitrate standard. An updated review of toxicity information and a revision to the technical support document will be completed prior to publishing a Request for Comments on the proposed nitrate standard.

Feedlot rules and permitting

The MPCA is responsible for ensuring the implementation of the Feedlot and Manure Management Rules (Minn. R. Ch. 7020). Fifty delegated counties implement rules and regulations for non-concentrated animal feeding operations throughout much of the livestock/poultry-intensive regions of the state. Because proper land-spreading of manure is particularly important for minimizing nutrients in waters, the Minnesota feedlot program has continued to conduct inspections of land application of manure practices, including land application records reviews with every facility compliance inspection and numerous in-field inspections.

Animal feedlots and land application of manure are likely one of many sources of nitrate contamination. In 2025, nitrate BMPs designed to reduce nitrate leaching were added to general NPDES and State Disposal System (SDS) feedlot permits. These permits are issued to the state's largest feedlots. Please visit the MPCA Feedlots webpage for further information.

Septic system programs

The 2014 Minnesota Nutrient Reduction Strategy also noted septic system upgrades as a needed area of continued work through the ongoing state program. The fraction of septic systems with direct outlets to the land surface has continued to decrease and now represents less than 5% of all septic systems (down from 11% in 2008). Please visit the MPCA's septic system website for more information.

Point-nonpoint trading

Water quality trading is a market-based tool for achieving improved water quality. To offset its pollutant discharges, an entity required to control a pollutant in a watershed can trade water quality credits with another entity in the same watershed to lower its pollution-control costs. Water quality trading can enhance pollution reduction efforts while offering flexibility and cost savings to regulated municipalities and industries. Point-nonpoint trading continues throughout Minnesota, with 13 permittees utilizing water quality trading. Current trading projects focus on phosphorus, but new nitrogen NPDES permit conditions are expected to generate interest in nitrogen trading. This expected demand for nitrogen credits could provide additional reduction incentives beyond voluntary implementation from nonpoint sources. Demand will likely focus on areas of interest to National Pollution Discharge Elimination System (NPDES) permittees, such as wastewater, Municipal Separate Storm Sewer System (MS4), and DWSMA entities. Please visit the MPCA's Water quality trading website for further information.

Endnotes

1. U.S. Geological Survey (USGS), 2024, Annual NLCD Collection 1 Science Products: U.S. Geological Survey data release, https://doi.org/10.5066/P94UXNTS.
2. United States Department of Agriculture (USDA), National Agricultural Statistics Service (NASS), Research and Development Division (RDD), Geospatial Information Branch (GIB), Spatial Analysis Research Section (SARS), 2022, 2021 Minnesota Cropland Data Layer.
3. Minnesota Department of Natural Resources. "Watershed Health Assessment Framework: Land Cover." https://arcgis.dnr.state.mn.us/ewr/whaflanduse/. Accessed May of 2025.
4. Kuehner, K., A. Runkel, J. Barry, 2025, Informing nitrate concentration trends: estimating groundwater residence time in a karstic, multiaquifer system using anthropogenic tracers (Minnesota, USA). Hydrogeology Journal 33:167-192.
5. Minnesota Pollution Control Agency, University of Minnesota and US Geological Survey, 2013, Nitrogen in Minnesota surface waters: conditions, trends, sources and reductions. Document no. wq-s6–26a, 211 pp. https:// www.pca.state.mn.us/sites/default/ files/wq- s6-26a. pdf.
6. Kuehner et. al. 2025.
7. Minnesota Pollution Control Agency, 2025, Nutrient Reduction Strategy DRAFT (to be finalized by 2026).
8. Minnesota Pollution Control Agency, Nitrogen Management plans, https://www.pca.state.mn.us/business-with-us/nitrogen-management-plans. Accessed May of 2025.
9. Kuehner KJ, Dogwiler T, Kjaersgaard J, 2020, Examination of soil water nitrate-N concentrations from common land covers and cropping systems in southeast Minnesota karst. Minnesota Digital Water Research Library. https://wrl.mnpals.net/islan dora/object/WRLrepository%3A3654.
10. Minnesota Department of Health, Source Water Assessments, https://www.health.state.mn.us/communities/environment/water/swp/swa.html. Accessed May of 2025.
11. Minnesota Department of Health, Owner's Guide to Wells, https://www.health.state.mn.us/communities/environment/water/wells/waterquality/test.html . Accessed May of 2025.
12. Minnesota Department of Agriculture, 2006, Analysis of the Co-occurrence of Nitrate-Nitrogen and Pesticides in Minnesota Groundwater, https://www.leg.mn.gov/docs/2008/other/080926.pdf
13. Minnesota Department of Agriculture, Southeast Minnesota Groundwater Resources. https://www.mda.state.mn.us/segwresources
14. Minnesota Department of Natural Resources. Minnesota Spring Inventory. https://www.dnr.state.mn.us/waters/groundwater_section/mapping/springs-msi.html
15. Minnesota Pollution Control Agency. Healthier watersheds: Tracking the actions taken. https://www.pca.state.mn.us/business-with-us/healthier-watersheds-tracking-the-actions-taken
16. Minnesota Department of Health. Source Water Protection Web Map Viewer. https://www.health.state.mn.us/communities/environment/water/swp/mapviewer.html
17. Minnesota Department of Agriculture. Monitoring Nitrate in Groundwater. https://www.mda.state.mn.us/pesticide-fertilizer/monitoring-nitrate-groundwater
18. Clean Water Fund Interagency Coordination Team – Drinking water/ground water subteam, 2025, Interagency Coordination on Nitrate: Working together to protect Minnesota's waters from nitrate. Posting on MPCA nitrate website is pending.

MINNESOTA