Verndale DWSMA Groundwater Protection Rule Summary

Groundwater, Nitrogen Fertilizer Management, and Nitrogen Loading Analysis

Published: 5-24-2023; Addendum added 5-15-2025

Introduction

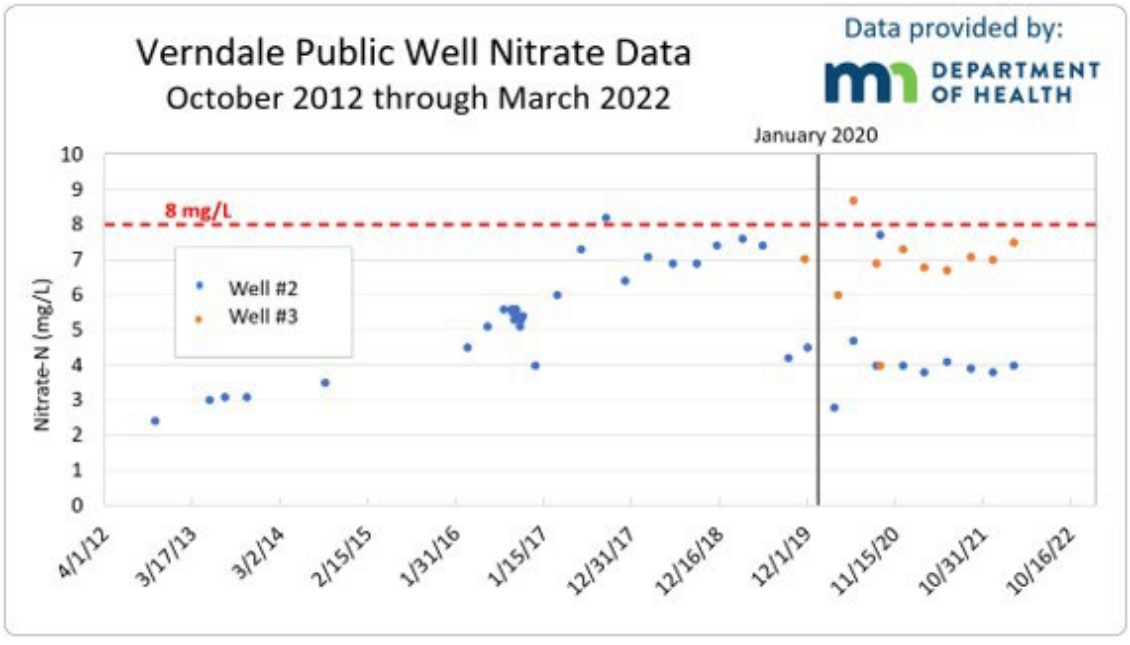
This document summarizes the Minnesota Department of Agriculture's (MDA) current understanding of the Verndale Drinking Water Supply Management Area (DWSMA), public well nitrate-nitrogen levels, and nitrogen management information. Also included is a summary of the MDA's analysis of nitrogen loss below cropland within this DWSMA. This summary provides the detail the MDA considered to determine whether the proposed list of nitrogen fertilizer Best Management Practices (BMPs) and Alternative Management Tools (AMTs) will be protective of groundwater.

Verndale DWSMA Vulnerability Designated by the Minnesota Department of Health (MDH)

DWSMA and Public Well Nitrate-Nitrogen Data

The DWSMA boundary defined by the Minnesota Department of Health (MDH) for the City of Verndale public wells includes 478 acres. The MDH defines the groundwater below this DWSMA as highly vulnerable. Of the 478 acres in the DWSMA, 311 acres meet the definition of cropland in the Groundwater Protection Rule (GPR). The GPR applies to the 311 acres of cropland within this DWSMA.

The MDA relies on the water quality data provided by the MDH to evaluate nitrate-nitrogen levels in the public water supply. The public well data provided for Verndale is shown in the graph below. Nitrate-nitrogen levels have exceeded 8 mg/L in both of the Verndale public wells within the past ten years.



At the end of 2019, Verndale well #3 was installed nearby well #2. Well #3 is located upgradient of well #2, has a larger in casing diameter and is shallower in depth (Table 1). The placement of well #3 may be an influence on the change in nitrate levels measured in well #2. There were no substantial changes in cropland management that occurred at that time that might help explain the change in well #2 nitrate levels.

Table 1. City of Verndale public well information.

Local Well ID	MDH Status	Casing Diameter (in)	Casing Depth (ft)	Well Depth (ft)	Date Constructed
Well #2	Primary	6	27	35	1980
Well #3	Primary	8	20	30	2019

DWSMA Land Use and Potential Nitrate-Nitrogen Point Source Consideration

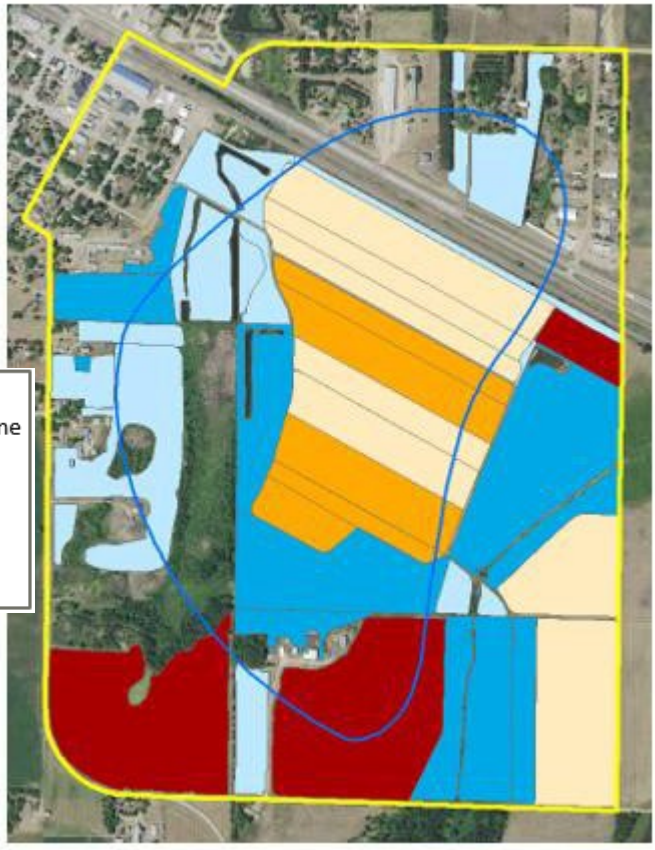
The MDA conducted a detailed review of potential contaminant sources to determine whether a point source of nitrogen could be the cause of the public well exceeding the criteria for mitigation level designation (Minnesota Statute 1573.0040, Subp. 3, C). In the Verndale DWSMA, the MDA review did not identify a potential point source for nitrate-nitrogen. With nitrate levels exceeding 8.0 mg/L within the past ten years and without a point source contribution, this DWSMA was designated at Mitigation Level 2 under Part 2 of the Groundwater Protection Rule in January 2020 (Minnesota Statute 1573.0040, Subp. 7, C, 2).

Part 2 of the Groundwater Protection Rule responds to DWSMAs which have elevated nitrate. The goal is to take action to reduce nitrate in groundwater before a public well exceeds the health standard for nitrate, 10 mg/L. For DWSMAs, like Verndale designated at Level 2, the MDA works with a local advisory team (LAT) including local farmers, agronomists, and others to get input on BMPs and AMTs that can reduce nitrate levels in groundwater.

The Groundwater Protection Rule defines cropland as land used primarily for the production or harvest of annual or perennial field, forage, food, fiber, or energy crops including pasture but excluding forestland. However, the evaluation of BMP adoption to determine if a mitigation level change is needed will exclude soybean acres.

A review of the publicly available USDA Cropland Data Layer (hosted on Crop Scape)[1] in the Verndale DWSMA shows that the land use here is predominately cropland. This is illustrated in the map to the right.

2021 Cropland within the Verndale DWSMA based on the USDA Cropland Data Layer



The Minnesota Department of Agriculture (MDA) has also surveyed agronomists and farmers to understand the nitrogen fertilizer management practices used in the Verndale area. Having current and accurate nitrogen fertilizer management data is critical to the discussion of BMPs and AMTs. With computer modeling the MDA compares

[1] National Ag Statistics Service (NASS) Cropland Data Layer (Feb 2022 release). Retrieved from https://data.nal.usda.gov/dataset/cropscape-cropland-data-layer?msclkid=7095cf4ca92d11ecb2a28bbba44507d5

nitrogen leaching loss below current nitrogen fertilizer management and under management changes proposed to protect groundwater. The farming practice information collected includes crop planting, harvest, and nitrogen fertilizer use information.

Due to the small number of operators farming within this DWSMA, the farming practice information MDA collected is not included in this document. Minnesota Statute 13.643 Subd. 7 protects the identities and location of producers who are cooperating with the MDA in an assessment of farm practices. If farm practice information could identify an individual, it is considered private information and cannot be shared by the MDA.

Farmers are doing an excellent job managing nitrogen fertilizer within the Verndale DWSMA and the practices they currently use are highly protective of groundwater. The nitrogen rates are appropriate and within University of Minnesota guidelines, all nitrogen sources are accounted for, split application of nitrogen is used, and nitrogen credits from previous legume crops and manure are taken. All of the BMPs recommended by the University of MN for the cropping rotation and soil types present within this DWSMA are currently being used. However, the soils and geologic conditions in this area make groundwater especially vulnerable to leaching and because of this it is challenging to improve groundwater quality.

Within the Verndale DWSMA the crops grown in 2021 included alfalfa, grass hay, pasture, corn, and soybeans. Small grains have also been grown in the DWSMA in five of the last ten years. In 2021 there were 201 acres of perennial crops (alfalfa, pasture, and grass hay) accounting for 65% of the cropland area. The remaining 35% of cropland acres in 2021 included 73 acres of corn and 37 acres of soybeans (Table 2).

Table 2. 2021 Verndale DWSMA Cropland Cover

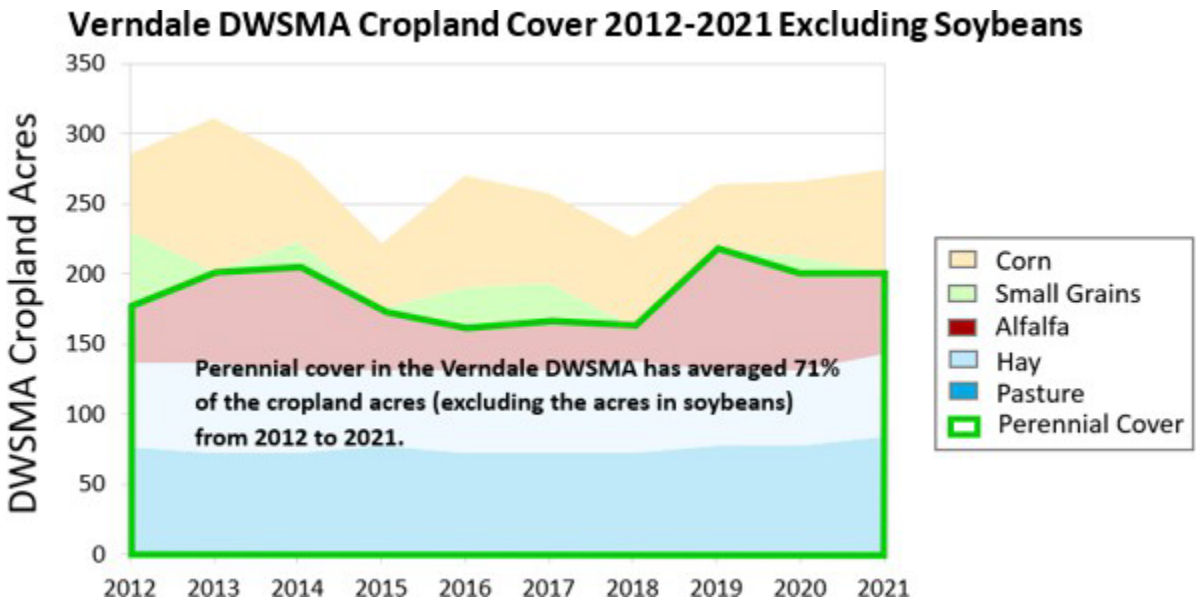
Crop Type	Acres	% of Cropland (311 acres total)
Alfalfa	59	19%
Pasture	84	27%
Grass Hay	59	19%
Corn	73	23%
Soybean	37	12%

The MDA has also reviewed the USDA Cropland Data Layer[1] over the past 10 years in Verndale's DWSMA. During this time, the perennial cover on cropland, excluding soybeans, has ranged between 60-83% of the cropland area (Table 3).

The crop rotations between corn and soybeans and alfalfa and corn are the reason that perennial cover varies from 60-83% within the Verndale DWSMA. As alfalfa stands decline, annual crops replace alfalfa in those fields for two years or more. When soybeans are planted and excluded from the calculation, the denominator is reduced and the percentage of perennial cover during those years is accordingly higher.

Table 3. Verndale DWSMA cropland crop history excluding soybeans

	Perennial Cover (Alfalfa, Pasture & Grass Hay)		Corn		Small Grains	
Year	Acres	% of Cropland	Acres	% of Cropland	Acres	% of Cropland
2010	178	62	56	20	52	18
2011	202	65	109	35		
2012	205	73	58	21	17	6
2013	175	79	46	21		
2014	163	60	80	30	27	10
2015	167	65	64	25	27	10
2016	163	72	63	28		
2017	218	83	46	17		
2018	201	76	54	20		
2019	201	73	73	27		
2020	178	62	56	20	10	4
2021	202	65	109	35		



DWSMA Nitrate-Nitrogen Loss Below Cropland

Using a crop and soil computer simulation model called EPIC[2], the MDA has estimated the nitrogen loss below the root zone in the Verndale DWSMA comparing the nitrogen management practices used in the recent past with the nitrogen loss below alternative nitrogen management practices within this DWSMA. The table below shows the modeled nitrogen loss below current nitrogen management practices. The model estimates an area weighted average of 5.2 lbs. N/acres are lost below the cropland rootzone within the DWSMA (Table 4).

Table 4. Verndale DWSMA nitrate-nitrogen loss estimates below cropland. Modeled nitrogen loss below cropland following current nitrogen management practices

Crop Rotation	Cover Crop	2021 Acres Within the DWSMA	Fraction of DWSMA Cropland	Area Weighted Average Nitrogen Leaching (lbs. N/ac)
Corn-Corn or Corn-Soybean	None	90	0.29	**5.2**
Corn-Soybean	After Soybeans	20	0.06	**5.2**
Alfalfa (x3)-Corn(x2)	None	64	0.21	**5.2**
Grass Hay	---	60	0.19	**5.2**
Pasture	---	77	0.25	**5.2**

With nitrogen fertilizer BMP adoption already in place within this DWSMA, the MDA modeled AMT possibilities that go above and beyond BMPs to further reduce nitrogen loss below the cropland root zone. In consultation with the Local Advisory Team, the MDA modeled the nitrogen loss reductions possible below the following AMTs (Table 5). If AMTs were adopted across the land area listed the model estimates that nitrogen leaching below the cropland rootzone within this DWSMA could be reduced by 10% annually. These are voluntary practices. Working with local farmers this list will be promoted widely and funding will be identified to support adoption of these practices.

[2] Environmental Policy Integrated Climate (EPIC) model. https://epicapex.tamu.edu/epic/

Table 5. Verndale DWSMA nitrate-nitrogen loss below alternative practices considered by the Verndale LAT. Modeled nitrogen loss below cropland with alternative management tools adopted.

Alternative Practice	Additional Acres Needed within DWSMA	Nitrogen Loss Reduction	Notes
Cover Crop (following soybeans)	41	10%	41 acres in addition to 20 already in place (61 total acres) in a C-SB rotation. This would be 30.5 acres of cover crop following soybeans annually within the DWSMA.
A-A-A-C-C	15	10%	15 acres in addition to 64 already in place (79 total acres) in place of C-C or C-SB acres within the DWSMA.
Grass Hay	14	10%	14 acres in addition to 60 already in place (74 total acres) in place of C-C or C-SB acres within the DWSMA.
Pasture	14	10%	14 acres in addition to 77 already in place (91 total acres) in place of C-C or C-SB acres within the DWSMA.
CRP	14	10%	14 acres in place of cropland in a C-C or C-SB rotation. Currently, the is no CRP in the DWSMA.

MDA Recommended Nitrogen Fertilizer Best Management Practices for the Verndale DWSMA

In consultation with the local advisory team that includes farmers and agronomists managing cropland within the DWSMA and City of Verndale leadership, the MDA has developed the following list of BMPs to protect groundwater. A more detailed list of these BMPs is available at www.mda.state.mn.us/verndale-dwsma.

- Maintain the existing perennial cover.
- Apply nitrogen to corn in a corn-corn rotation at or below the 0.15 Maximum Return to Nitrogen (MRTN) in the University of Minnesota's nitrogen fertilizer application guidelines.
- Apply nitrogen to corn in a corn-soybean rotation at or below the 0.15 Maximum Return to Nitrogen (MRTN) in the University of Minnesota's nitrogen fertilizer application guidelines
- Account for all nitrogen sources when calculating nitrogen rate.
- Take appropriate credits for previous legume crops and manure used in the crop rotation.
- Split applications of nitrogen fertilizer.
- For all other crops grown within the DWSMA, nitrogen rates must follow the current University of Minnesota guidance applicable to that crop.

The MDA will conduct an evaluation in this Level 2 DWSMA to determine whether these nitrogen fertilizer BMPs have been implemented on 80% of the cropland, excluding soybeans. The evaluation will occur no sooner than three growing seasons after the BMPs are published.

Conclusion

In the Verndale DWSMA the MDA has reviewed the cropping history, surveyed nitrogen management practices, modeled nitrogen loading estimates below existing nitrogen fertilizer management practice and alternative practices.

The cropland in perennial cover including grass hay, alfalfa, and pasture accounts for a substantial amount of cropland within this DWSMA. Over the past ten years, the percentage of cropland in perennial cover ranged from 60-83% when soybeans are not counted in the calculation.

The current University of Minnesota nitrogen fertilizer BMPs are already being followed within the DWSMA. Nitrogen rates applied to corn are below the 0.15 MRTN for both corn following corn and corn following soybeans, all nitrogen sources are considered, nitrogen from legumes and manure are counted and split nitrogen applications are

used. There are no additional University of Minnesota BMPs appropriate for the cropping rotations and soils within this DWSMA that the MDA can recommend to further protect groundwater. Farmers in this DWSMA are managing nitrogen well and following appropriate nitrogen fertilizer BMPs.

Modeling of nitrogen loss below alternative management tools within this DWSMA illustrate options for cropland within this DWSMA that can further reduce nitrogen loss below the crop root zone. These options were developed in consultation with the LAT. Specific cropland acres have not been identified for the establishment of these alternative management tools, but the LAT acknowledges the additional groundwater protection that this could provide if adopted. The next steps within this DWSMA are to review these practices with individual landowners and explore possible funding opportunities to establish these alternative management tools.

If the percentage of perennial cover within the DWSMA were to be reduced from its current level, additional review of the appropriate nitrogen fertilizer BMPs for this DWSMA may be needed and a new list of nitrogen fertilizer BMPs approved. Examples that could cause such a change include, but are not limited to, changes in the cropping rotation, changes to the MDH groundwater vulnerability designations, and changes to the MDH approved DWSMA boundary.

Based on the understanding and information provided above, the MDA believes that the recommended nitrogen management practices within the Verndale DWSMA are appropriate and that the continued use of these practices over the long-term will prevent nitrate-nitrogen loss below cropland from increasing. Additionally, modeling of nitrogen loss below cropland indicates that further reductions are possible with the establishment of alternative management tools. Promotion and funding to support the establishment of alternative management tools within the Verndale DWSMA will be a priority.

Addendum: Updated Corn Nitrogen Fertilizer Rate Guidance
Added 5/15/25

This addendum explains changes to University of Minnesota nitrogen fertilizer rates for corn. Other text in the document has not been edited and reflects the University of Minnesota guidance available at the time this summary was published in May 2023.

In April 2025 the University of Minnesota (UMN) nitrogen rate recommendations for dryland corn were updated. The updated UMN corn nitrogen rate guidance is based on the latest research available in Minnesota. To align with the current guidance, the corn nitrogen rates included in the BMP list published for this DWSMA were updated. The tables below are adapted from the UMN rate guidance released in April 2025 and reflect the new rate guidance to which the BMPs published in this DWSMA will refer.

Guidelines for use of nitrogen fertilizer for corn grown following soybeans when supplemental irrigation is not used.

N Price/Crop Value Ratio	Maximum Return to Nitrogen	Acceptable Range
0.075	155	145-170
0.100	150	135-160
0.125	140	130-155
0.150	135	125-145

Guidelines for use of nitrogen fertilizer for corn grown following corn when supplemental irrigation is not used.

N Price/Crop Value Ratio	Maximum Return to Nitrogen	Acceptable Range
0.075	200	180-220
0.100	185	170-200
0.125	175	160-190
0.150	165	150-175

Adoption of the BMPs can be evaluated no sooner than three growing seasons after the DWSMA BMP list is published. For the Verndale DWSMA, the evaluation could occur as soon as 2026. Following that evaluation, the BMP list for the Verndale DWSMA may be adjusted considering water quality information, input from the LAT and any new Nitrogen Fertilizer BMP updates from the University of Minnesota.