Minnesota Department of Agriculture

Pesticide and Fertilizer Management Division

STATEMENT OF NEED AND REASONABLENESS

In the Matter of Proposed Permanent Rules relating to Groundwater Protection

April 30, 2018

The *State Register* notice, this Statement of Need and Reasonableness (SONAR) and the proposed Rule will be available during the public comment period on the MDA's website: **www.mda.state.mn.us/nfr**

Alternative Format:

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Acronyms or Abbreviations

Acronym or Abbreviation	Full Text
AMT	Alternative Management Tool
BMP	Best Management Practice
CFR	Code of Federal Regulations
Commissioner	Commissioner of the MDA (unless otherwise noted)
DAP	Diammonium Phosphate
DWSMA	Drinking Water Supply Management Area
USEPA	United States Environmental Protection Agency
HRL	Health Risk Limit
LAT	Local Advisory Team
MAP	Monoammonium Phosphate
MAWQCP	Minnesota Agricultural Water Quality Certification Program
mg/L	Milligrams per liter
MDA	Minnesota Department of Agriculture
MDH	Minnesota Department of Health
MDNR	Department of Natural Resources
MPCA	Minnesota Pollution Control Agency
N	Nitrogen
N2	Gaseous molecular nitrogen
N2O	Nitrous oxide
NFMP	Nitrogen Fertilizer Management Plan
NH3	Ammonia
NH4	Ammonium
NO	Nitric oxide
NO2	Nitrite
NO3	Nitrate
NRCS	Natural Resources Conservation Service
NRS	Nutrient Reduction Strategy
P	Phosphorus
SSURGO	Soil Survey Geographic Database
SONAR	Statement of Need and Reasonableness
SWCD	Soil and Water Conservation District
TTP	Township testing program
U of M	University of Minnesota
USDA	United States Department of Agriculture
USGS	United States Geologic Service
UAN	Urea and Ammonium Nitrate (solution)
WHPA	Wellhead Protection Area

I. Introduction

The Groundwater Protection Act states, *"it is the goal of the state that groundwater be maintained in its natural condition, free from any degradation caused by human activities. It is recognized that for some human activities this degradation prevention goal cannot be practicably achieved. However, where prevention is practicable, it is intended that it be achieved. Where it is not currently practicable, the development of methods and technology that will make prevention practicable is encouraged."* Minn. Stat. § Section 103H.001.

Nitrate is a compound that naturally occurs in our environment at very low levels, generally less than 3 mg/L, and has many human-made sources. Nitrate is in some lakes, rivers, and groundwater in Minnesota. The Minnesota Department of Health (MDH) Health Risk Limit (HRL) for nitrate (expressed as nitrate-nitrogen) is 10 mg/L; consuming too much nitrate can be harmful — specifically for infants under the age of six months. The majority of Minnesota households have access to safe drinking water supplies. However, in areas vulnerable to groundwater contamination, some public wells have nitrate-nitrogen concentrations that exceed the MDH HRL. While elevated concentrations of nitrate-nitrogen in groundwater can result from several factors, a major contributor in rural Minnesota is nitrogen fertilizer that leaches past the crop root zone (MDA. n.d. (d)). When groundwater resources become contaminated with nitrate, efforts to remove or mitigate the contamination are challenging and expensive. These results show that action is needed in order to ensure that Minnesotans have safe drinking water for years to come.

State agencies, under Minn. Stat. §103H.101, subd. 7, must identify and develop best management practices (BMPs) for programs under their authority that have activities that may cause or contribute to groundwater pollution. For those activities which may cause or contribute to pollution of groundwater, but are not directly regulated by the state, BMPs shall be promoted through education, support programs, incentives, and other mechanisms.

Specifically, Minn. Stat. § 103H.151, subd. 2, requires the Minnesota Department of Agriculture (MDA), in consultation with local water planning authorities, to develop BMPs for agricultural chemicals and practices. The MDA must give public notice and solicit comments from affected persons interested in developing BMPs. Once developed, Minn. Stat. § 103H.151, subd. 3 requires the MDA to promote the BMPs and provide education on how the use of BMPs will prevent, minimize, reduce, and eliminate the source of groundwater contamination. The MDA is also required to monitor the use and effectiveness of BMPs. BMPs are defined in Minn. Stat. § 103H.005, subd. 4 as, *"practicable voluntary practices that are capable of preventing and minimizing degradation of groundwater, considering economic factors, availability, technical feasibility, implementability, effectiveness, and environmental effects. BMPs apply to schedules of management plans; practices to prevent site releases, spillage, or leaks; application and use* *of chemicals; drainage from raw material storage; operating procedures; treatment requirements; and other activities causing groundwater degradation."*

Additionally, the MDA is also required under Minn. Stat. § 103H.251 to evaluate the detection of pollutants in groundwater of the state as it pertains to agricultural chemicals and practices. If conditions indicate a likelihood of the detection of the pollutant or pollutant breakdown to be a common detection, the MDA must begin developing BMPs and continue to monitor for the pollutant or pollutant breakdown products. Once detected, the MDA must develop and implement groundwater monitoring and hydrogeologic evaluations to evaluate pollution frequency and concentration trend.

Minn. Stat. § 103H.275 states that if groundwater pollution is detected, the MDA must also promote the implementation of BMPs to prevent or minimize the source of pollution to the extent practicable. Further, the MDA may also develop adopt water resource protection requirements by rule that are consistent with the goal of Minn. Stat. § 103H.001 and are commensurate with the groundwater pollution if the implementation of BMPs has proved to be ineffective. The water resource protection requirements are defined in Minn. State. § 103H.005, subd. 15 as, *"requirements adopted by rule for one or more pollutants intended to prevent and minimize pollution of groundwater. Water resource protection requirements include design criteria, standards, operation and maintenance procedures, practices to prevent releases, spills, leaks, and incidents, restrictions on use and practices, and treatment requirements."* They must be based on the use and effectiveness of BMPs, the product use and practices contributing to the pollution detected, economic factors, availability, technical feasibility, implementability, and effectiveness. The water resource protection requirements may be adopted for one or more pollutants or a similar class of pollutants. (Minn. Stat. § 103H.275, subd. 2).

The MDA has complied with all requirements under Minn. Stat. chap.103H to develop, educate and promote BMPs. The MDA has also conducted monitoring and testing as required under Minn. Stat. chap.103H, and, based on the extensive information gathered by the MDA, believes that the implementation of the nitrogen fertilizer BMPs have proven to be ineffective. Based on this determination, the MDA has proposed the Groundwater Protection Rule (the proposed Rule) under the authority of Minn. Stat. § 103H.275, subds.1 and 2.

This Statement of Need and Reasonableness (SONAR) is laid out in the following format:

- Background of the Nitrogen Pollution Issue
- Outline of the MDA's requirements under Minn. Stat. chap. 103H and how the MDA has complied with those requirements
- Justification of the MDA's authority to issue the proposed Rule (implementation of BMPs ineffective)
- Why the proposed Rule is needed and reasonable

II. Background regarding Nitrogen Fertilizer and its effects on Groundwater

A. What is Nitrogen Fertilizer?

Nitrogen fertilizers as addressed by the proposed rule are substances containing nitrogen that are designed for use or claimed to have value in promoting plant growth.

The behavior of nitrogen (N) in the environment is governed by a complex set of interrelated chemical and biological transformations. These reactions are summarized in the "nitrogen cycle" (Figure II-1). The nitrogen cycle describes the inputs, pools, pathways, transformations, and losses of nitrogen in the environment.

Current agricultural crop production systems require the input of nitrogen fertilizer to increase food and feed production for consumption by humans and livestock as well as fiber and fuel. However, nitrate that is not utilized by the crop may leach into the groundwater. Many of Minnesota's groundwater aquifers are susceptible to contamination due to diverse geology and soils, climate, and land use. Concentration of nitrates in the groundwater can be harmful, especially to infants under 6 months.

The complex interrelationships between nitrogen use, benefits, and long term environmental consequences are termed by Nobel Peace Prize recipient Dr. Otto Doering as a "*wicked problem"* (Frear, 2014; Charles, 2013). Some experts believe that 50% of the world's current population would not exist without the additional food supplies produced through the use of commercial nitrogen fertilizers. The problem of nitrogen fertilizer use is termed "wicked" because, despite the benefits of the additional food production, there is no clear consensus on how to solve the environmental issues due to the complexities and interrelationships between crop production and the environment. This has led to an enormous research effort to develop the nitrogen fertilizer Best Management Practices (nitrogen fertilizer BMPs). These nitrogen fertilizer BMPs are designed to improve use efficiencies, quantify movement into the atmosphere and water resources, as well as ensure economic benefits for increased food production.

One of the most in-depth examinations of nitrogen usage and subsequent losses to water and air was released by the USEPA Science Advisory Board (2011). This Board concluded that agriculture uses more nitrogen and accounts for more nitrogen losses to the environment than any other economic sector. The Board concluded that synthetic nitrogen fertilizers are the largest sources of nitrogen inputs to agricultural systems. The Board further characterized the nitrogen in the environment issue through the following statement:

> *"In the past 60 years N fertilizers have had a beneficial effect on agriculture both nationally and globally by increasing crop yields. However, the high loading of N from*

agricultural nutrient sources has led to deleterious effects on the environment, such as decreased visibility from increased aerosol production and elevated N concentrations in the atmosphere, ground, and surface waters." (USEPA Science Advisory Board, 2011)

The Nitrogen Cycle

The nitrogen cycle is the biogeochemical cycle by which nitrogen is converted to multiple chemical forms as it circles through the air, ground, and water. The nitrogen cycle reactions are influenced by the interaction of numerous chemical, biological, environmental, and management factors (Figure II-1; Lamb et al. 2008). The interaction of these factors complicates predictions of the behavior of nitrogen introduced into the environment. Understanding the nitrogen cycle is important to help understand how multiple factors will interact to influence nitrogen behavior at a given site. Sound nitrogen management decisions can then be made based upon knowledge of the nitrogen cycle.

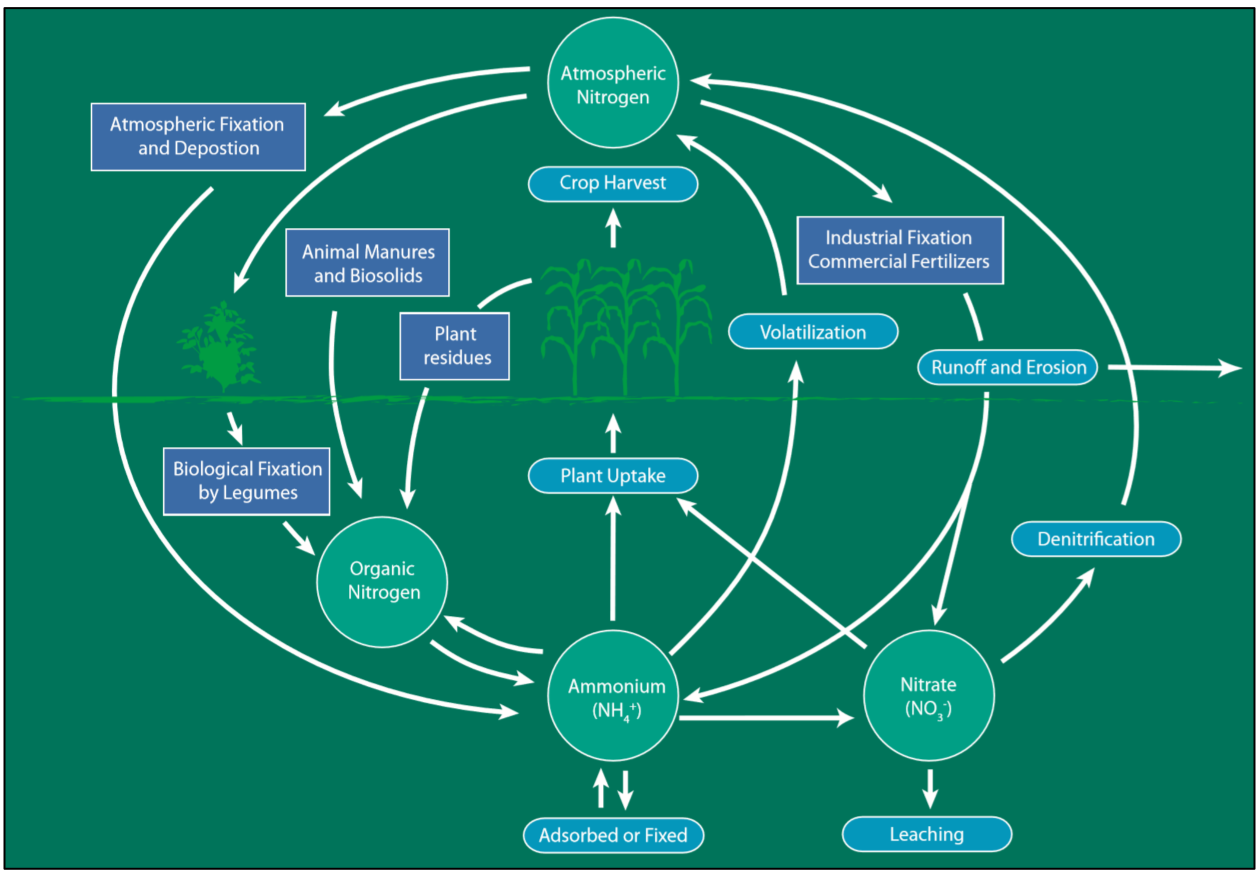


Figure II-1. The nitrogen cycle.

<u>There are multiple terms used in this rule when referring to nitrogen.</u> Nitrogen is used when referring to the nutrient for plant growth, fertilizer containing nitrogen or nitrogen fertilizer Best Management Practices (BMPs). Nitrate is a general term used in reference to leaching or

groundwater. Nitrate-nitrogen describes the concentration in groundwater and the health risk limit in milligrams per liter (mg/L).

Components of the nitrogen cycle

Although several nitrogen compounds are involved in the cycle, the primary compounds in the soil are nitrate-nitrogen (NO_3^-), ammonium nitrogen (NH_4^+), and organic nitrogen. Nitrogen in the nitrate form is highly water soluble and extremely mobile, which poses economic and environmental concerns. The characteristics of these compounds and related processes are summarized below:

- **Organic nitrogen:** Organic nitrogen is the predominant nitrogen compound in the soil profile. Organic nitrogen first must be transformed into inorganic forms by microbial action (mineralization) in order to dissolved into water. Organic nitrogen may be the primary source of nitrogen in surface runoff but rarely contributes to groundwater contamination.

- **Nitrate (NO_3^-):** Nitrate is extremely soluble in water. Due to its chemistry, nitrate does not tend to stay attached to the soil, but instead moves through soil. These characteristics mean it is highly susceptible to leaching and therefore groundwater contamination.

- **Nitrite (NO_2^-):** Nitrite is an intermediate product in the conversion of ammonium to nitrate in the soil and is the compound of toxicological concern in the human system. Although nitrite is highly soluble, it is also very unstable and is rarely detected in groundwater except at very low levels.

- **Ammonia (NH_3)/ammonium (NH_4^+):** Ammonia (gas) is the primary form of nitrogen feedstock applied in fertilizers. It reacts to form ammonium immediately upon contact with water. Ammonium will be temporally immobile until soil bacteria convert it to the much more soluble nitrate form.

The primary chemical and biological processes of the nitrogen cycle include:

- **Leaching:** Leaching is the process where nitrates move through soil via water. Nitrate is the principal nitrogen compound transported in subsurface water due to its solubility and exclusion from adsorption onto soil colloid surfaces. Nitrate leaching is one of the primary avenues of nitrogen loss, particularly during years with above-normal precipitation.

- **Mineralization:** The microbial degradation of organic nitrogen to produce the inorganic forms of nitrogen (nitrate, nitrite, and ammonia).

- **Immobilization:** The assimilation of inorganic forms of nitrogen by plants and microbes, producing various organic nitrogen compound.

- **Net Mineralization:** The cumulative balance at the end of the growing season between mineralization and immobilization.

- **Nitrification:** The transformation through microbes of ammonium to nitrite and then to nitrate. This is the primary nitrate-producing reaction in the cycle.

- **Denitrification:** The biochemical reduction of nitrate and nitrite to gaseous molecular nitrogen (N_2) or a nitrogen oxide form nitrous oxide (N_2O), nitric oxide (NO), or nitrogen dioxide (NO_2). This is a primary volatile loss pathway to the atmosphere. Over 78% of the atmosphere is comprised of N_2.

There are multiple potential sources of nitrogen in the soil system. In an agronomic context, all nitrogen sources applied to a field should be taken into account in determining the appropriate nitrogen fertilizer rate. All nitrogen sources perform the same function in the context of the nitrogen cycle, although they may enter the cycle at different points. This means that all nitrogen sources are potential nitrate sources and could contribute to groundwater contamination. It is important to recognize that nitrate occurs naturally in the soil system. Nitrate losses can occur under natural vegetative conditions, (such as grassland and forestland), although these losses are typically minor. Losses can be much higher after major events such as prairie fires, land clearing and/or disturbances, and the initiation of major tillage operations. Significant losses can also occur after extended drought conditions followed by prolonged wet cycles.

Nitrogen sources include agronomic inputs and external sources:

Agronomic Inputs:
- Soil organic matter and crop residue
- Commercial fertilizers
- Atmospheric deposition
- Atmospheric fixation (legumes fixing nitrogen in the soil)
- Land-applied manure and other organic residues

External Sources:
- Municipal Wastes and Landfills
- Septic systems
- Feedlots (concentrated animal wastes)
- Turf grass (golf course, parks, private and public lawns)
- Wildlife excretions.

B. Understanding Nitrogen Fertilizer Usage and Impacts to Water Resources

Nitrogen fertilizer is a major input to agricultural land, and fertilizer sales have increased along with nitrogen demanding crops. Unfortunately, nitrate can also leach into groundwater (MDA. n.d. (d)). Given the importance of this topic, there have been many studies on different soils and rates, and research to develop the nitrogen fertilizer BMPs. Studies in Minnesota and other Midwestern states have identified nitrogen fertilizer as a major source of nitrate in some aquifer systems.

1. Although there are multiple sources of nitrogen, the majority of nitrogen inputs are applied to agricultural land.

One significant challenge in dealing with nitrogen related environmental issues is the fact that there are multiple sources from either natural or human-induced sources (Figure II-2). Nitrogen inputs statewide have been evaluated by the Minnesota Department of Agriculture (MDA). The majority (over 82%) of the nitrogen inputs occur on agricultural lands. The sources include cropland mineralization (net); commercial nitrogen fertilizers; contributions from nitrogen fixing legume crops such as alfalfa, clover and soybeans; manure applications, and atmospheric deposition. There are also other minor sources such as septic tanks and feedlot contributions.

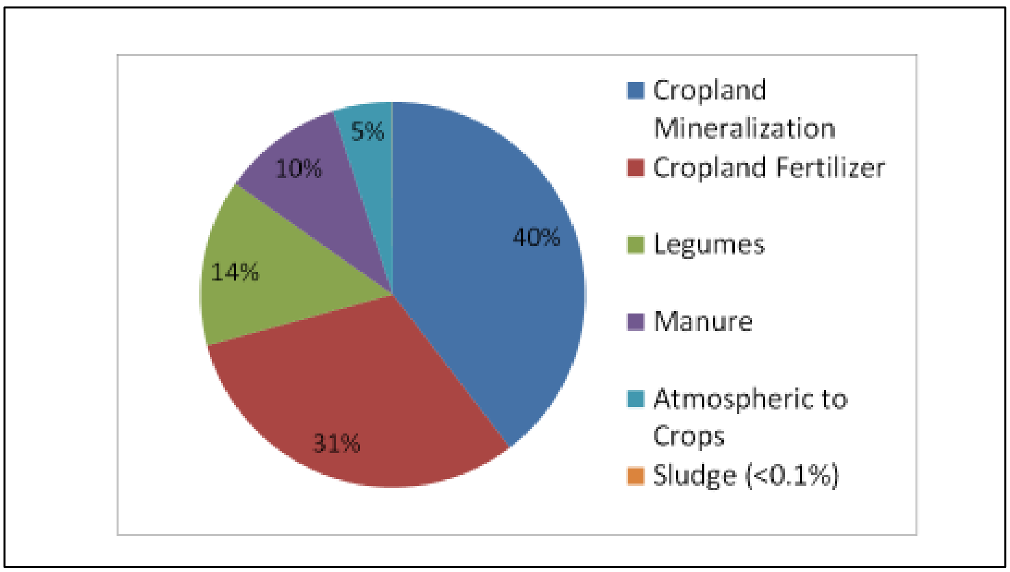


Figure II-2. Comparison of Minnesota's major agricultural nitrogen sources. (MDA, 2015)

Other inputs that are applied to non-agricultural landscapes include fertilizers applied to turf grass (lawns, parks and golf courses), non-cropland mineralization, septic system waste, and atmospheric deposition.

To put these inputs in perspective in terms of a representative acre of Minnesota farmland growing corn (in a corn-soybeans rotation which encompasses about 75% of the state's cropland), the nitrogen inputs would be in the following general ranges: 1) Commercial nitrogen fertilizer 120-150 lb/acre; 2) Legume credits of 30-40 lb/acre based on U of M soybean crediting; 3) Mineralization 50-100 lb/acre; and 4) Manure. Manure inputs are highly variable---about 15-20% of the intended corn acres in livestock regions get manure applied. Typically, manure inputs are under-represented, resulting in over-applications of commercial fertilizer.

It is generally accepted that anhydrous ammonia is one of the best commercial nitrogen sources available. Anhydrous ammonia is a gas and is applied by injecting it into the soil. For a number of reasons, this product generally produces the best yields and less likely to leach or be lost to various gaseous pathways. Despite being an excellent nitrogen source, anhydrous ammonia sales have dropped significantly over the past 25 years (Figure II-3; MDA, 2015). The primary reasons for the downward trends are likely safety and complex requirements regarding its storage, transportation, and use. Anhydrous ammonia must be stored and handled under high pressure and is highly dangerous. Misuse of this fertilizer can cause serious burns and death in severe cases (Shutske, 2013). Additionally, it is a difficult product to work with within precision type applications.

Urea has overtaken anhydrous ammonia as the most sold nitrogen fertilizer product. Urea is a solid. Urea sales have steadily increased and have taken up much of the marketplace sales reductions in anhydrous ammonia. This product (containing 46% nitrogen) is a solid and when properly used, can produce yields similar to anhydrous ammonia if leaching and gaseous losses can be managed. Because Urea is soluble, it should not be used in a fall application in areas with leaching concerns.

Nitrogen solutions (28%, 30%, and 32%) account for 10% of the statewide sales. These products are frequently applied as an application in the spring with a herbicide after the crop has already begun to grow. Many of the products listed as "Misc. Sources" in Figure II-3 are frequently custom dry blends for specialty crops.

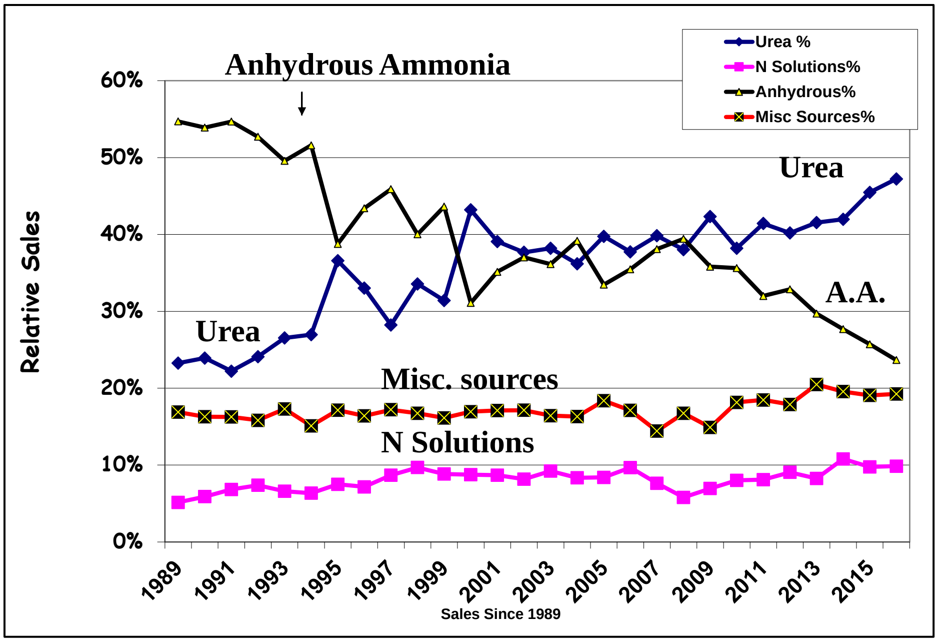


Figure II-3. Trends in three major nitrogen fertilizer sources used in Minnesota: 1989-2016. (MDA, 2015)

Nitrogen fertilizer is a valuable tool for producers. Unfortunately, it can also leach into groundwater and cause significant health concerns. The most prevalent use of nitrogen is application to agricultural land.

2. Studies show an increase in sales of nitrogen fertilizer and an increase in planting of nitrogen-demanding crops, resulting in an increase potential of leeching of nitrogen into groundwater.

Reliance on nitrogen fertilizers and subsequent consequences to water and air quality align with the post-war era. From a historical perceptive, the industrial process for creating ammonia was first developed in the early part of the 20th century. However, it was not until World War II ended that synthetic ammonia was readily available for agricultural use. Adoption of commercial fertilizer proceeded slowly but then catapulted in the United States during the 1960s and 1970s as a result of educational efforts, lower costs, and introduction of improved plant genetics that needed increased inputs.

Minnesota sales are very similar to the national trends (Figure II-4, data sourced from MDA, Tennessee Valley Authority, and the American Association of Plant Food Control Officials). Sales rapidly increased in the 1960-1970 era, stabilized during the 1980s, and then remained fairly consistent during the 1990s (averaging 653,000 tons/year) and the early 2000s (averaging 648,000 tons).

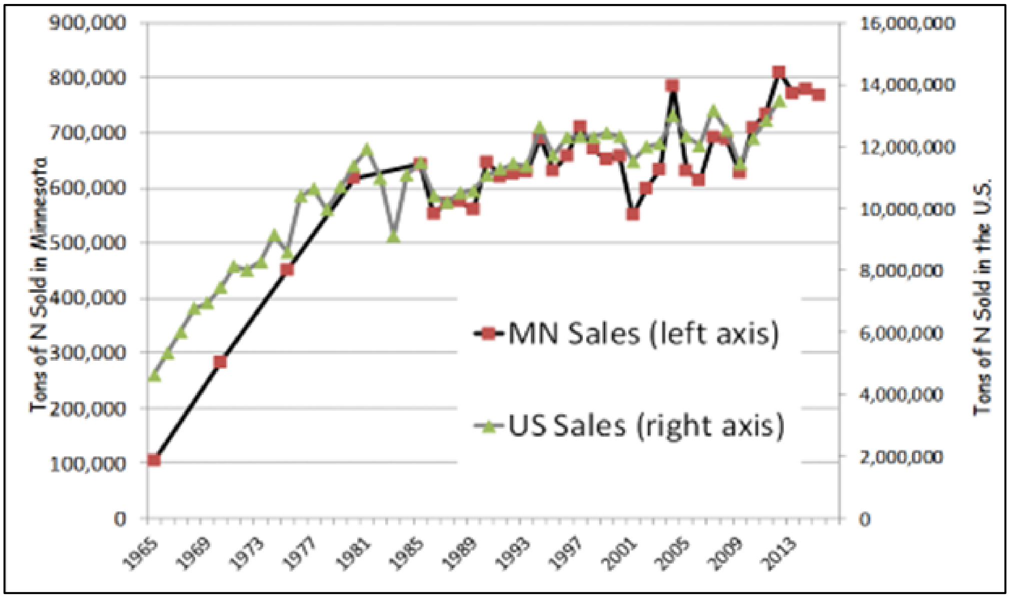


Figure II-4. Commercial nitrogen fertilizer sales trends, Minnesota and U.S.

More recently, nitrogen fertilizer sales have been trending upward with a notable jump when grain prices were high in 2010-2014. Nitrogen consumption over the past five years is averaging 760,000 tons/year, which is a 14-15% increase compared to the twenty-five-year average. Overall, Minnesota's nitrogen fertilizer sales have increased over six-fold since 1965 while at the same time corn production has increased four-fold and corn acres have substantially increased (MDA, 2015). This increase in corn production has had a significant impact on the use of nitrogen.

Crop selection, as reported by the National Agriculture Statistics Service (USDA NASS, n.d. (a)) over the past ninety years, has changed dramatically. Before the mid-1950s, Minnesota annually planted over 8 million acres of small grains, including wheat, oats, rye, barley and other minor crops (Figure II-5). Small grain acres dropped significantly in the late1950s and again during the 1980s and 1990s. Over the past decade, approximately 2 million acres of small grains have been grown. Small grains are generally considered to have a low-to-moderate impact on groundwater quality for the following reasons: solid seeding resulting in a uniform root distribution; they are typically grown in areas of low groundwater vulnerability; and they require moderate nitrogen inputs due to lodging concerns.

The following are some of the major crops currently grown in Minnesota:

- **Corn:** Corn acres have been steadily increasing for the last ninety years. Corn has high nitrogen requirements and has a narrow uptake period. Those implementing Minnesota's nitrogen fertilizer BMPs can select from options to ensure that corn crops have the nutrients needed during this critical uptake period.

- **Legumes:** Looking back at the trends in several legume crops since the 1920s, there has been a very steady decline of alfalfa and clover acres. These declines are linked to the significant changes in the dairy industry and due to lower production costs in neighboring states. These crops have strong, positive implications on groundwater quality and have been demonstrated to be extremely effective at removing nitrate from the soil profile resulting in high quality recharge into groundwater.

- **Soybeans:** Despite being one of the oldest crops known to human civilization, soybeans did not become an important crop in the U.S. until the turn of the 20th century. Soybean production started in Minnesota in the early 1940s and has steadily increased to about 7-8 million acres. Provided with the proper nitrogen-fixing bacteria (via inoculum), soybeans are highly capable of supplying their own nitrogen needs as well as utilizing residual soil nitrate from previous crops.

- **Other crops:** There are other nitrogen-demanding crops grown on a small scale in the state of Minnesota, but they can have significant impacts (both economic and environmental) on a local level.

Table II-1. Typical nitrogen requirements and potential impacts on nitrate leaching losses for crops/cover in Minnesota (MDA, 2015; p 117)

Commonly grown Agricultural Crops or Alternative Cover	**Typical Nitrogen Requirements (Pounds per Acre)**	**Characteristics**	**Relative Nitrogen Leaching Loss Rating System***
Corn (Grain or Silage)	70-180	Deep rooted; Inputs highly dependent on anticipated yields	M-H Spring Applied; H-VH Fall Applied; M-H Irrigated; M-VH Manured
Wheat, Barley, Oats	60-100	Solid seeded	L-M
Soybeans	Legume; No additional nitrogen needed	Poor scavenger of residual soil nitrate	M
Potatoes – Irrigated	200-250	High management, shallow root system	H-VH
Sugar Beets	100-120	Sugar quality decreases if too much nitrogen available	M
Alfalfa	Legume; No additional nitrogen needed	Very deep rooted, excellent scavenger; Crediting to subsequent crops critical upon termination	L; Potential losses after crop is terminated
Grass-Legume Mixtures	60; Lower nitrogen rates allow for legume growth	NA	VL-L
Pasture/Grazing	Plant nutrition provided by manure or supplemental fertilizer	NA	L (typically); Dependent upon grazing pressure
Conservation Reserve Program Mixtures	Application at establishment	Mixtures vary but diverse systems tend need less nitrogen	VL
Lawns and Golf Fairways	40-160	Fall nitrogen applications; Split applications	L; L
Golf Greens, High Input Areas	120-220	Split applications needed	M-H

* VH= Very High, H=High, M=Medium, L=Low, VL=Very Low, NA=Not Applicable

Between the 1920s and 1960s, amounts of nitrate-nitrogen leaching below the root zone were relatively minor compared to recent years. The major changes over the past ninety years are: 1) the additional influx of commercial fertilizers (Figure II-4); 2) substantially more acres of nitrogen demanding crops (Figure II-5); and 3) replacement of nitrogen conserving crops, such as alfalfa, clovers, pasture, and hay grasses with soybeans. These changes combined contribute to an increased risk of nitrate entering groundwater. The continuance of these trends will lead to an ongoing increased risk of nitrate loading to groundwater.

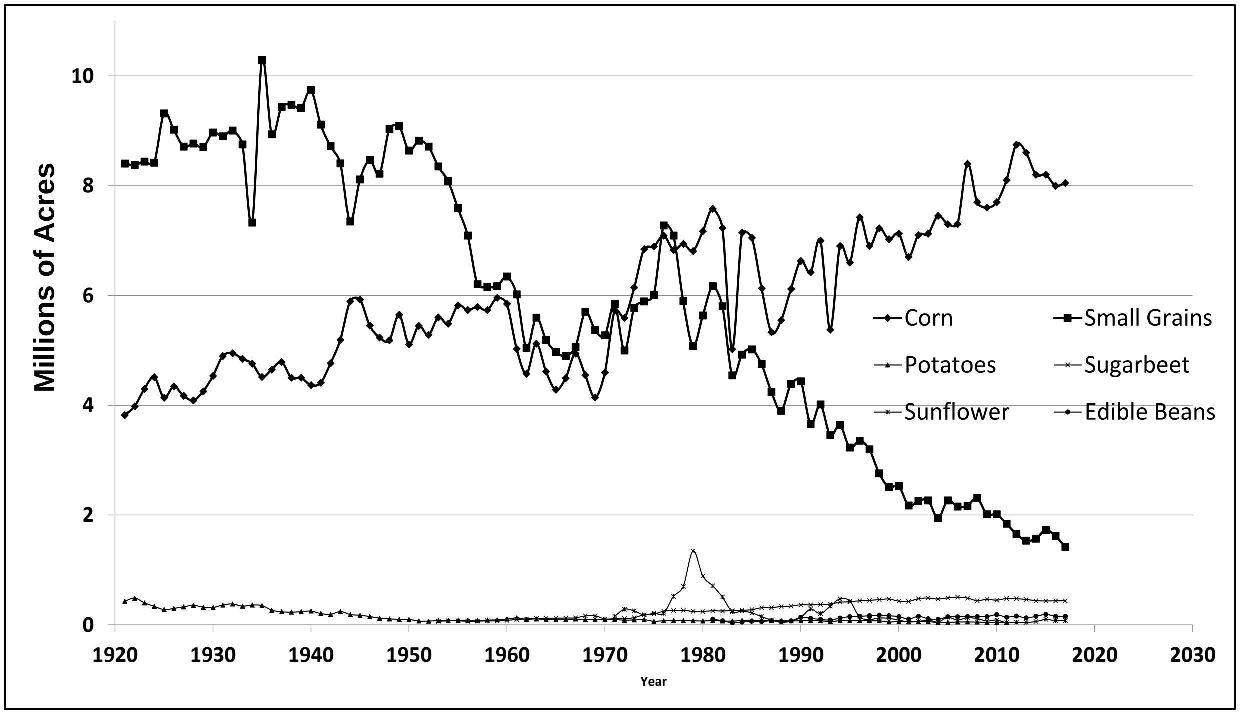


Figure II-5. Acreage trends for Minnesota's nitrogen demanding crops. (USDA NASS n.d. (a); MDA, 2015)

Therefore, studies showing an increase in nitrogen fertilizer sales, along with the change from planting nitrogen-friendly crops to more nitrogen-demanding crops, have created a greater probability of nitrogen leeching into groundwater.

3. Understanding Groundwater's susceptibility to nitrate pollution.

Groundwater is the most abundant source of freshwater in the world.

Groundwater is water found beneath the soil surface that resides in the soil pore spaces or within cracks of fractured rock. Most of groundwater is stored in underground layers known as aquifers. These saturated layers allow water to flow into and through them relatively easily. Even though water can move through these layers, the water typically moves slowly. In certain environments, where there are larger fractures or conduits in the rocks, groundwater can move more rapidly through these spaces. The susceptibility of groundwater to contamination is referred to as "vulnerability". Several environmental factors determine the vulnerability of an area, including 1) physical and chemical properties of the soil and geologic materials, 2) climatic effects, and 3) land use. These factors vary widely throughout Minnesota, making vulnerability very site-specific.

Nitrate can occur naturally in groundwater at levels typically in the range of 0 to 3 parts per million (ppm) (MDH, n.d.). Human activities such as sewage disposal, livestock production, and crop fertilization can elevate the level of nitrate in groundwater. The Minnesota Department of Health (MDH) has set a Health Risk Limit (HRL) of 10 milligrams per liter (10 mg/L, or 10 ppm) for nitrate-nitrogen (MDH, n.d.). Nitrate-nitrogen contamination above the MDH HRL is most commonly found in aquifers that are vulnerable to contamination from the land surface, such as sand and gravel aquifers and fractured bedrock aquifers. Areas with heavy row crop agriculture and vulnerable groundwater are especially at risk.

A simple search via Google Scholar using the key words “nitrogen fertilizer water quality Minnesota” will yield hundreds of studies conducted over the last three to four decades. There have been many small plot research efforts conducted that studied nitrogen movement below the crop root zone or via a tile drainage system. Much of the Minnesota research evolved from the finer textured, tile-drained soils found at the U of M Research and Outreach Centers (Waseca and Lamberton). Frequently variables include different rates, timings, sources, and other potential techniques to improve fertilizer use efficiency and reduce environmental impacts (Carlson et al., 2017; Davis et al., 2000; Feyereisen et al, 2006; Huggins et al, 2001; Jokela and Randall, 1989; Miao et al., 2007; Mulla and Strock, 2008; Nangia et al., 2008; Oquist et al., 2007; Randall, 1984; Randall and Mulla, 2001; Randall and Vetsch, 2005(a); Randall and Vetsch, 2005(b); Randall et al. 2003 (a); Randall et al., 2003(b); Randall and Goss, 2001; Schmidt et al. 2000; Schmitt et al., 1996; Vetsch and Randall, 2004; Yost et al., 2014). Studying nitrate leaching losses in the irrigated outwash soils is extremely difficult and consequently the knowledge base is smaller (Bierman et al., 2015; Hopkins et al, 2008; Venterea et al., 2011; Wilson et al., 2009; Zvomuya et at., 2003; Walters and Malzer, 1990, MDA. n.d. (d)).

These types of studies are extremely valuable for the development of nitrogen fertilizer BMPs and are frequently used to model nitrogen movement on a larger scale. These studies provide information on nitrogen fertilizer rate and management practices, and how these impact in crop yields and nitrate movement in the soil profile.

A small percentage of these Minnesota studies included the use of ^{15}N isotope technology. This approach allows researchers to effectively track the fate of nitrogen fertilizer as it is taken up by the crop, the atmosphere, the organic fraction or lost in the leachate (Zvomuya et at., 2003; Walters and Malzer, 1990). This is one of the most reliable methods for isolating fertilizer contributions from other inputs such as through mineralization of organic matter. Due to the high costs and complexities of analysis, these types of studies are very limited.

4. Studies demonstrate significant nitrogen contamination of groundwater in certain areas of the state where there is a demonstrated increase of nitrogen use.

Due to the post-World War II increase of nitrogen fertilizer use and the subsequent rise in nitrate-related water quality issues, there are few nitrate monitoring studies conducted prior to the 1960s and 1970s. It was uncommon to have the research opportunity to observe water quality conditions prior to the nitrogen fertilizer use era. Most monitoring reports for either groundwater or surface waters began in the 1980s or later.

For purposes of the statement of need and reasonableness (SONAR), groundwater conditions in Hastings, Minnesota and surface water conditions of the Minnesota River will serve as examples of monitoring studies illustrating the relationship between the increase in nitrogen fertilizer use and increased nitrate-related water quality concerns.

The Hastings public water supply, along with Perham and St. Peter, were some of the first to start showing rapidly increasing nitrate-nitrogen concentrations (Figure II-6).

In the case of Hastings, numerous studies were conducted with producers within the wellhead protection area (WHPA). Most of the soils there are vulnerable to leaching due to being coarse-textured, as well as areas of karst, and frequently under center pivot irrigation. Nitrogen from fertilizer, manure, and legumes were the dominant sources that could be managed or controlled by producers.

Over a number of years, nitrate-nitrogen concentrations continued to climb nearing the MDH HRL, forcing the city of Hastings to install a nitrate removal system in 2007 at a cost of $3.5 million. The city of Perham was experiencing similar trends and how they reversed these trends is discussed below. (Section II.b).

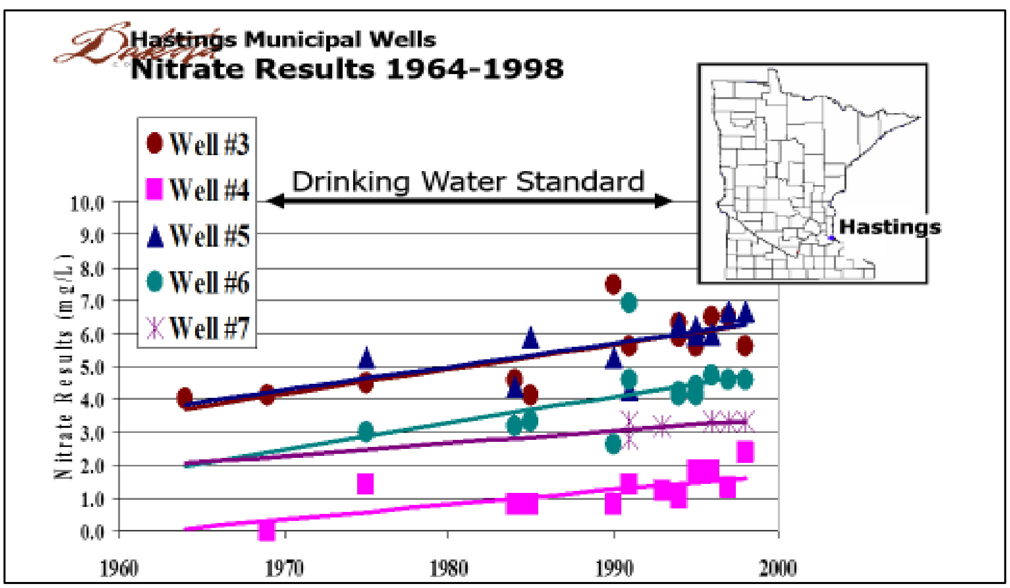


Figure II-6. Forty years of nitrate-nitrogen concentration trends in municipal wells, Hastings, Minnesota.

Another example is Mankato, which withdraws water from both the Minnesota and the Blue Earth Rivers for its public water supply. Nitrate-nitrogen concentrations and annual loads are slowly trending upward in the Minnesota River near Mankato (Figure II-7, S. Matteson, MDA. Personal Communication. 2017) and are highly influenced by rainfall and runoff amounts. Nitrate-nitrogen concentrations have doubled since the early 1970s. More importantly, the extremes are getting much larger.

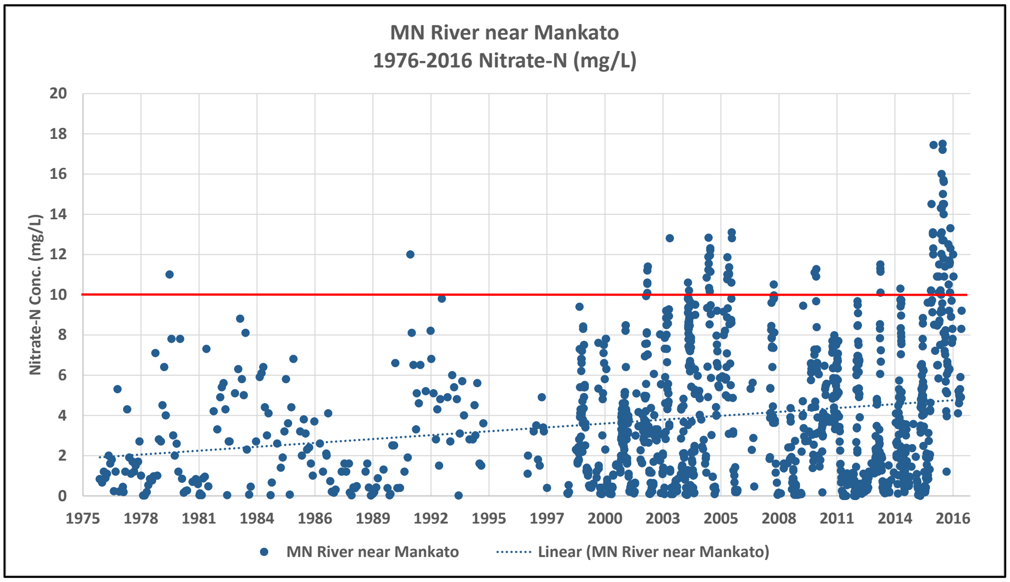


Figure II-7. Forty years of nitrate-nitrogen concentration trends in the Minnesota River.

a) Nitrogen fertilizer use and impacts to groundwater

In answering the question "what role does nitrogen fertilizer play in understanding elevated nitrates in groundwater systems," researchers from United States Geological Survey (USGS) conducted some significant studies in the Midwest, including Minnesota, which started in the 1970s (Figure II-7, S. Matteson, MDA. Personal Communication. 2017; Figure II-8, Puckett et. al, 2011; Puckett and Cowdery, 2002; Böhlke et al., 2002 and Puckett et al., 1999). These USGS reports are pertinent to the SONAR because they are highly focused on vulnerable groundwater systems typically found in Minnesota and the researchers have investigated potential sources. When nitrate-nitrogen concentrations were readjusted for denitrification losses, USGS concluded that nitrate-nitrogen concentrations in groundwater increased from about 2 mg/L in the early 1940s to about 15 mg/L in 2003 (Figure II-8 & Figure II-9, Puckett et al., 2011). Two of the eight sites were in Minnesota (Princeton and Perham) and represented vulnerable conditions found in the Midwest. This analysis also estimated that 14-18% of the nitrogen reaching the land surface as fertilizer, manure, and atmospheric deposition eventually would leach into groundwater.

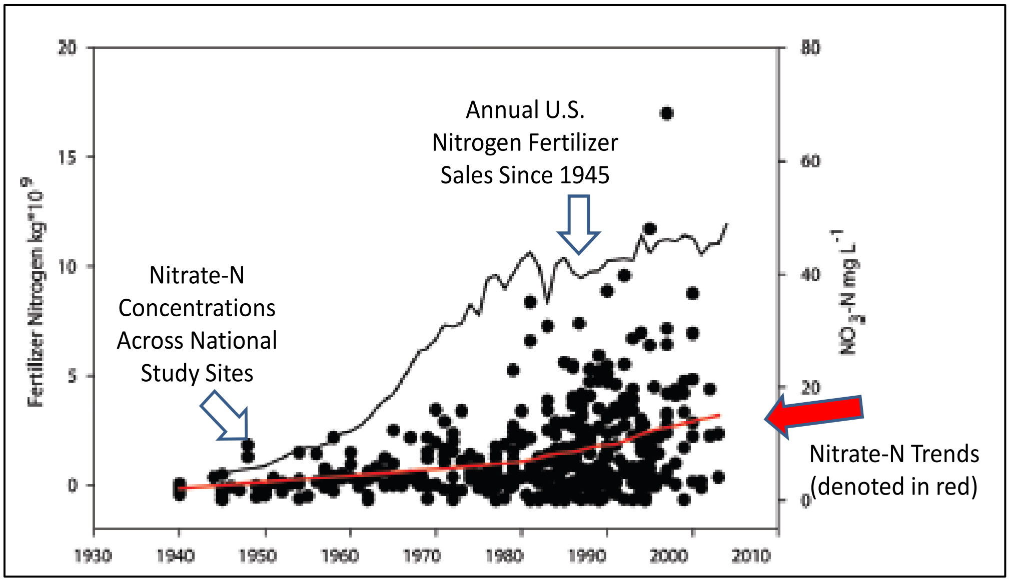


Figure II-8. U.S. nitrogen sales and nitrate-nitrogen concentration in groundwater from 20 long-term sites (including Perham and Princeton, Minnesota).

USGS scientists also reported that within these 20 vulnerable areas, the probability of finding nitrate-nitrogen concentrations above the MDH HRL of 10 mg/L increased from <1% in the 1940s to over 50% by 2000 (Figure II-9, Puckett et al., 2011). Nitrogen fertilizer was clearly identified as the major source of nitrate in selected Minnesota aquifer systems (Puckett and Cowdery, 2002; Puckett et. al, 1999).

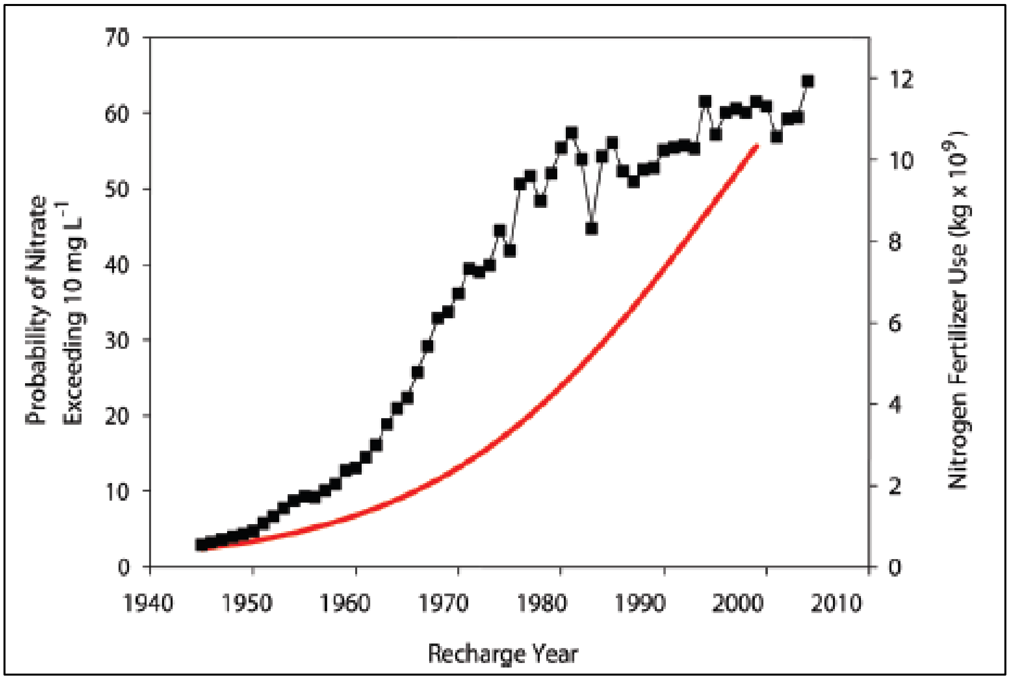


Figure II-9. Probability of nitrate-nitrogen concentrations in recharging groundwater exceeding 10 mg/L in areas of nitrogen fertilizer use (including Perham and Princeton, Minnesota).

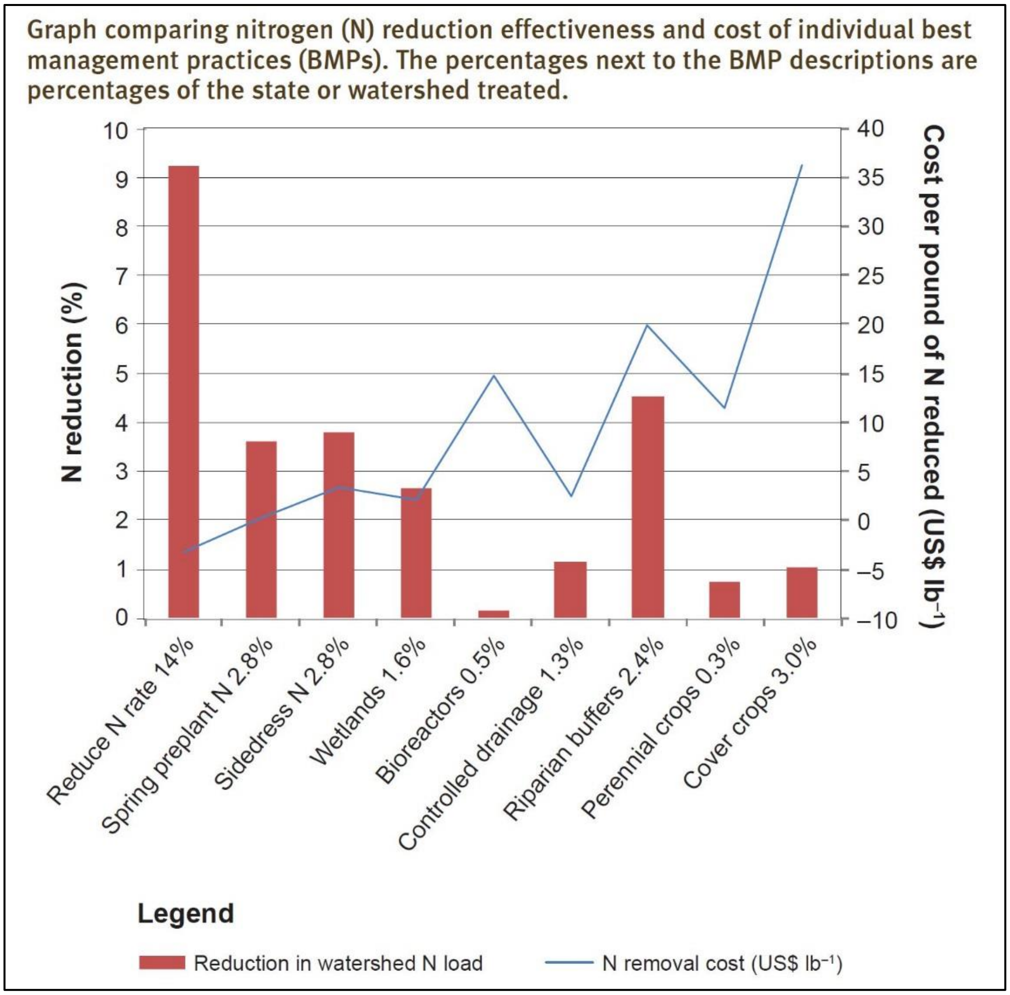


Figure II-10. BMP treatment opportunity (percent) in Minnesota's watersheds and corresponding nitrogen reduction effectiveness and cost estimated in the Nutrient Reduction Strategy. (Lazarus et al., 2014)

b) Perham drinking water protection

In the early 1990s, the city of Perham began to recognize that nitrate-nitrogen concentrations in their drinking water were rapidly increasing. By the late 90s, some of the city's wells sporadically exceeded the MDH HRL of 10 mg/L nitrate-nitrogen, requiring city staff to blend water from multiple wells to provide safe drinking water. Coarse textured soils, shallow groundwater, and an agricultural crop rotation demanding a high amount of nitrogen fertilizer created a challenging situation for groundwater protection in this area.

During this time, Perham leaders partnered with the MDA through state wellhead protection programs to engage local agricultural partners in reducing nitrate-nitrogen groundwater concentrations. Through combined efforts of the city and the agricultural community over 20 years, average annual nitrate-nitrogen concentrations in community wells have declined (Figure

II-11). Educational events, on-farm nitrogen trials, crop variety trials, fertilizer management changes, the use of new fertilizer technology, and perennial crops in select fields have led to higher nitrogen use efficiency across agricultural fields in the area. In addition, the city worked with area farmers in the early 2000s to purchase and trade land immediately up-gradient of public supply wells to further protect the city's drinking water. These elements are incorporated into the proposed Rule.

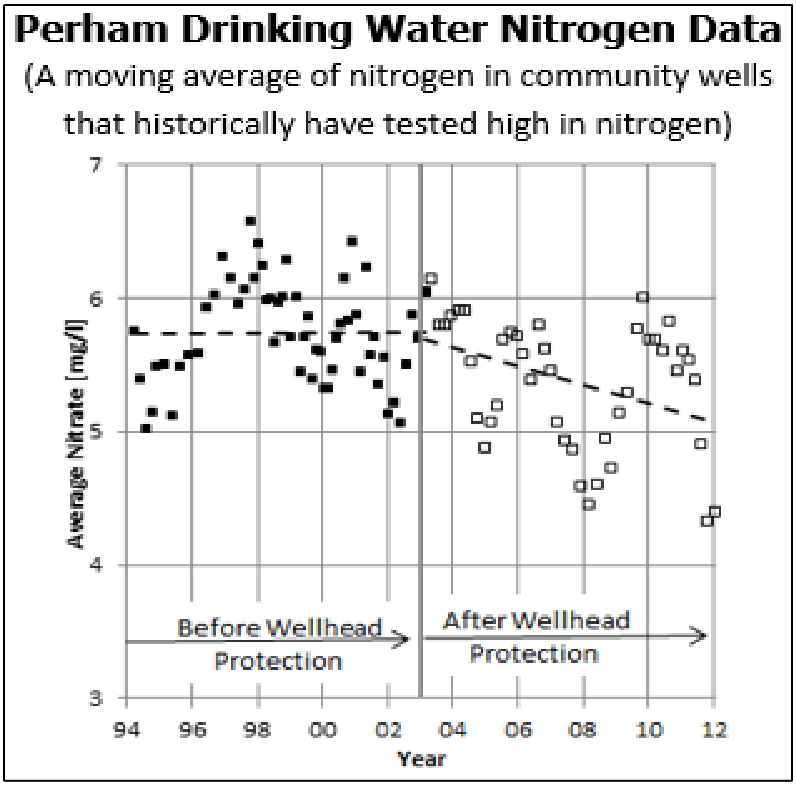


Figure II-11. Perham community well nitrate-nitrogen concentrations before and after wellhead protection efforts (Luke Stuewe, MDA Personal Communication)

c) Other Midwestern States have also linked nitrogen fertilizer use to water quality issues.

Commercial nitrogen fertilizer has been identified as the major source of groundwater nitrogen-contamination nationwide (Rupert, 2008; Burow et al., 2010, MDA. n.d. (d)) and has long been recognized as the major source of contamination in Nebraska's aquifers (Exner and Spalding, 1979; Gormly and Spalding, 1979).

Nebraska has extensive experience dealing with elevated nitrates in groundwater. Numerous Natural Resource Districts, in partnership with the University of Nebraska, have been pioneers in developing innovative methodologies for identifying nitrate sources, developing monitoring approaches, and implementation strategies, including the nation's first nitrogen fertilizer regulations. Scientists successfully developed a technique enabling them to distinguish nitrogen sources based on the inherent ratios of natural abundance ^{15}N (a naturally occurring nitrogen isotope) to ^{14}N (the normal atomic number). Scientists were also able to "age" groundwater to better understand the timeframe when most of the contamination occurred. A significant amount of loading occurred in the 1970s-1980s when the management of N and water inputs (via flood irrigation) was much less efficient compared to current practices. An excellent historical summary on various Nebraska nitrate research can be found in Exner et al., 2014.

Wisconsin is reporting a large increase in the number of municipal water supply systems exceeding the state's 10 mg/L level of concern (WI GCC, 2017). A 2012 survey found that 47 systems had raw water samples in excess of 10 mg/L compared to 14 systems in 1999. Collectively over $32.5 Million was spent in 2012 for mitigating nitrate contamination. Similar to Minnesota's private well results, about 10% of the private wells tested in Wisconsin exceed the MCL and 20-30% in highly cultivated regions.

Wisconsin researchers report that 20% of nitrogen fertilizer ends up in groundwater and estimated in 2007 that over 100,000 tons of nitrogen fertilizer was applied to agricultural lands in excess of UW recommendations (WIDATCP, 2015).

d) Drinking Water Supply Management Areas in Minnesota

Some Minnesota communities using groundwater supplies have exceeded the nitrate-nitrogen HRL 0f 10 mg/L in recent years, and others are approaching unsafe levels. Installing nitrate removal systems is one approach taken by public water suppliers within impacted communities. The number of community water systems with removal systems has increased from six systems serving 15,000 people in 2008 to eight systems serving 50,000 people in 2014.

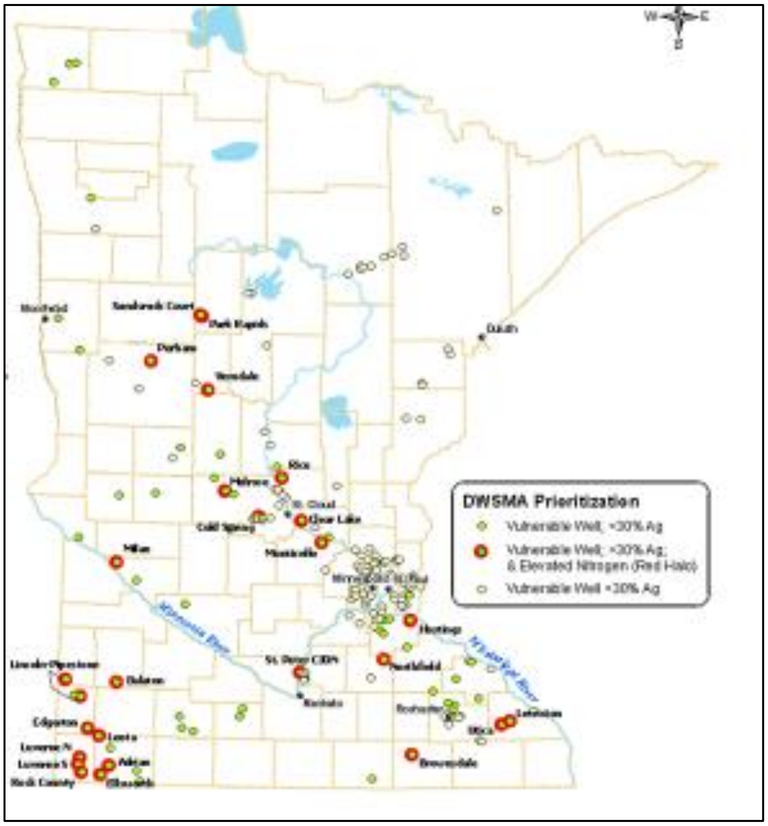


Figure II-12. Nitrate levels in public water supplies in agricultural areas.

There are roughly 30 to 40 public water suppliers in predominantly agricultural areas that are currently dealing with elevated nitrate-nitrogen concentrations. Associated costs for new wells, blending facilities, or installing nitrate removal systems can be significant, particularly to the smaller communities. Large systems serving many customers often can provide treatment at a lower cost per gallon than small communities. The cost of safe drinking water is not the same across the state and often the sources of contamination are outside water suppliers' control.

MDA has estimated that water costs to the consumer are several times higher in communities that are dealing with elevated nitrate levels compared to communities were nitrates are not an issue (UM, 2007).

III. Outline of the MDA's Requirements under Minn. Stat. chap. 103H

A. MDA must develop, educate and promote the use of BMPs for agricultural chemicals and practices.

Minn. Stat. § 103H.101, subd. 7 instructs state agencies to identify and develop best management practices (BMPs) for programs under their authority that have activities that may cause or contribute to groundwater pollution. For those activities which may cause or contribute to pollution of groundwater, but are not directly regulated by the state, BMPs shall be promoted through education, support programs, incentives, and other mechanisms.

Minn. Stat. § 103H.151, subd. 2-4 instructs the MDA specifically to develop and promote nitrogen fertilizer BMPs and provide education about how the use of BMPs will prevent, minimize, reduce and eliminate the source of groundwater degradation. The commissioner shall give public notice and contact and solicit comments from affected persons and businesses interested in developing the best management practices. The MDA also must monitor the use and effectiveness of the nitrogen fertilizer BMPs that the MDA has developed and promoted.

1. Nitrogen fertilizer BMP development

The nitrogen fertilizer BMPs are tools to manage nitrogen efficiently, profitably, and with minimized environmental loss. Nitrogen fertilizer BMPs were first developed for Minnesota in the late 1980s and early 1990s by the U of M and are based upon many decades of crop response research. The nitrogen fertilizer BMPs are tools to manage nitrogen efficiently, profitably, and with minimized environmental loss. Nitrogen fertilizer BMPs are a reflection of our understanding of the nitrogen cycle and are predicated on hundreds of site years of agronomics and environmental research. While acknowledging that no generalized recommendations are relevant all of the time, the nitrogen fertilizer BMPs represent a combination of practices that will reduce risk of excessive nitrogen loss in a normal year.

The nitrogen fertilizer BMPs are built on a four-part foundation that takes into account the nitrogen rate, application timing, source, and placement of the application, known as the "4Rs." If one of the "Rs" is not followed, the effectiveness of the system will be compromised, and there will be agronomic and or environmental consequences.

Minnesota has officially recognized statewide and regional nitrogen fertilizer BMPs. The MDA adopted the nitrogen fertilizer BMPs developed by the U of M according to the process laid out in Minn. Stat. § 103H.151, subd. 2. The MDA published public notice in the State Register, as well as contacted and solicited comment from affected persons and businesses that were interested in developing or who would be affected by the nitrogen fertilizer BMPs. The nitrogen fertilizer BMPs were published in the state register and adopted by the MDA in 1991, and irrigated potatoes were developed and adopted in 1996. The nitrogen fertilizer BMPs were updated in 2008 and the MDA again published in the State Register and solicited comment from affected persons and businesses as required by statute.

Due to major differences in geology, soils, and climate across the state, nitrogen fertilizer BMPs are not only needed statewide, but also on regional scale (Figure III-1; Table III-1). These regional recommendations give specific instructions on how to utilize the most appropriate nitrogen rate, source, timing, and placement. For example, practices that may work well in southwestern Minnesota may not be appropriate for southeastern Minnesota. Regional and specialized nitrogen fertilizer BMPs can be found on the MDA's website at http://www.mda.state.mn.us/protecting/bmps/nitrogenbmps.aspx.

- Best Management Practices for Nitrogen Use in Minnesota
- Best Management Practices for Nitrogen Use in Northwestern Minnesota
- Best Management Practices for Nitrogen Use in South-Central Minnesota
- Best Management Practices for Nitrogen Use in Southeastern Minnesota
- Best Management Practices for Nitrogen Use in Southwestern and West-Central Minnesota
- Best Management Practices for Nitrogen Use on Coarse-textured Soils
- Best Management Practices for Nitrogen Use: Irrigated Potatoes

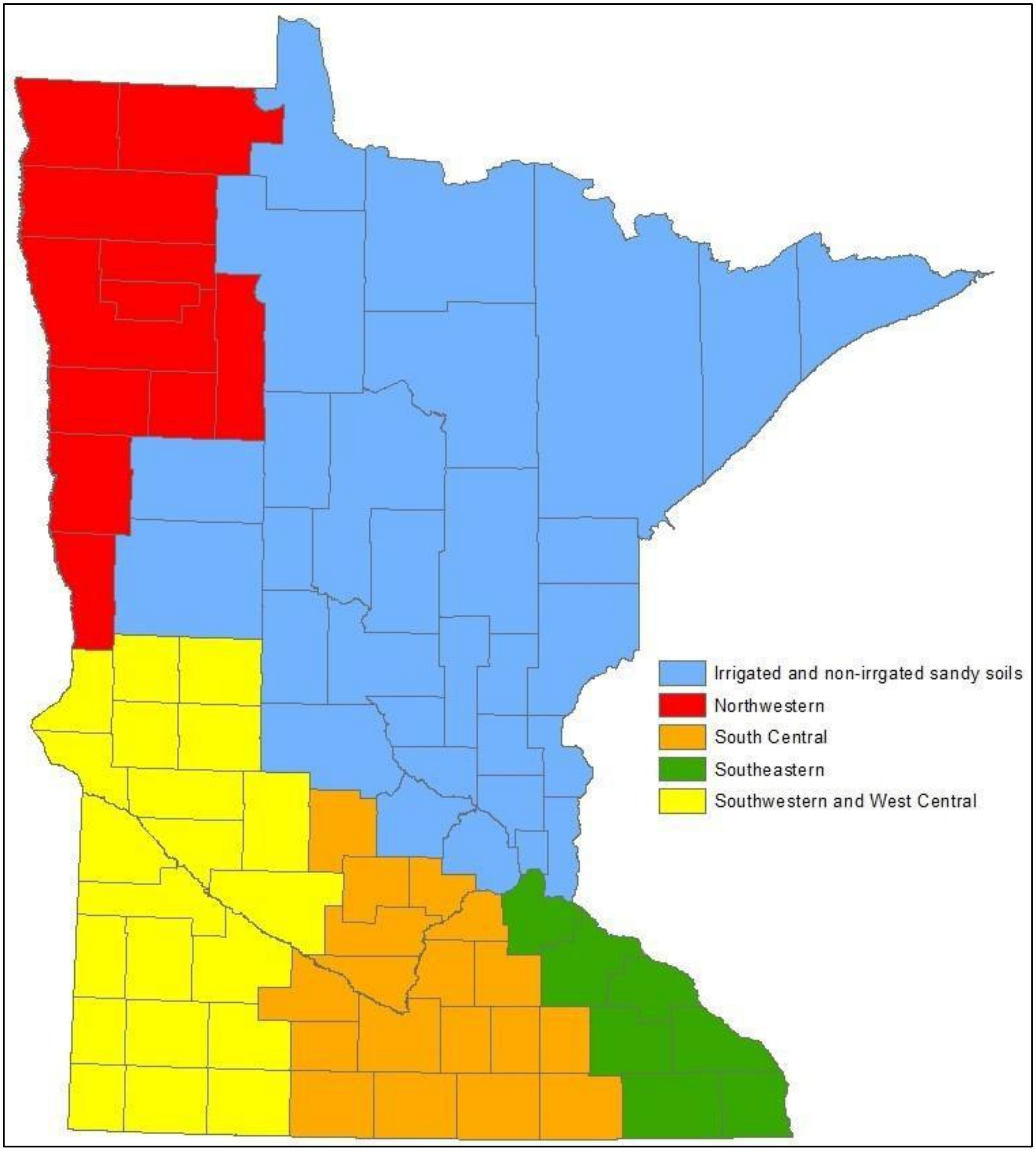


Figure III-1. Nitrogen fertilizer BMP regions. (Lamb et al., 2008).

Table III-1. Summary of the major nitrogen application timing and source BMP recommendations for corn by region (MDA, 2015).

	Minnesota Recommended Application Timing for Corn		
Nitrogen BMP Region	Fall*	Spring Preplant	Split or Sidedress
Southeast	Not Recommended	Highly Recommended: AA or Urea	Highly Recommended: AA, Urea, or UAN
		Acceptable with Risks: Preplant with UAN or ESN	
South-Central	Acceptable with Risks: AA or Urea with N-Serve	Highly Recommended: AA or Urea	Highly Recommended: Split Applications of AA, Urea, or UAN
	Not Recommended: Fall Application of Urea or UAN	Acceptable with Risks: Preplant with UAN or ESN	
Coarse-Textured Soils	Not Recommended	Acceptable with Risk: AA or Urea with N-Serve, Single Sidedress w/o N-Serve, or Single Preplant with ESN	Highly Recommended: Use Split Applications, N-Serve with Early Sidedress
Southwest/West-Central	Recommended: Fall Application of AA or Urea	Recommended: Urea, AA, or UAN	Recommended: Sidedress Prior to V7 Growth Stage
	Acceptable with Risk: Late Fall ESN or use of N-Serve or Agrotain		
	Not Recommended: Fall UAN or Any Fertilizer Containing Nitrate		
Northwest	Recommended: Fall Application of AA or Urea	Recommended: Urea, AA, or UAN	Recommended: Sidedress Prior to V7 Growth Stage
	Acceptable with Risk: Late Fall ESN or Use of N-Serve or Agrotain		
	Not Recommended: Fall UAN or Any Fertilizer Containing Nitrate		

*Only after six inch soil temperatures fall below 50 ºF

Note: AA=Anhydrous Ammonia, ESN=Environmentally Smart Nitrogen, UAN=Urea Ammonium Nitrate Solution

Recognizing that nitrogen fertilizer use efficiency is profoundly impacted by management (rate, timing, source, and placement) and significant nitrogen losses can occur under agricultural production, the U of M developed (and subsequently updated) a very complete set of nitrogen fertilizer BMPs in conjunction with the passage of the 1989 Groundwater Protection Act (Lamb et al., 2008; Randall et al., 2008 (a)(b); Rehm et al., 2008(a)(b); Rosen and Bierman, 2008; Sims et al., 2008). Minnesota has a great deal of variability in terms of soils, climate, geology, and crop selection. All these factors influence nitrogen management, so the state was divided into five BMP regions. Each region has specific recommendations in terms of nitrogen timing, placement and sources as well as the use of nitrification inhibitors and other helpful guidance for increasing fertilizer efficiencies. Nitrogen rate recommendations are imbedded within the BMP publications for corn, sugar beets, coarse textured soils, and selected other crops (Kaiser et al., 2016; Kaiser et al., 2011; Lamb et al., 2015). The U of M is continually studying the nitrogen requirements to account for changes in varieties, climate variability and similar, and are updating their rate recommendations annually. The updated rates are available at http://cnrc.agron.iastate.edu/

Figure III-2. Minnesota's nitrogen fertilizer BMPs. (Lamb et al., 2008; Randall et al., 2008 (a)(b); Rehm et al., 2008(a)(b); Rosen and Bierman, 2008; Sims et al., 2008).

The U of M also provides critical fertilizer rate guidance for the minor crops and special situations such as under irrigated conditions (Kaiser et al., 2011; Lamb et al., 2015).

The selection of the correct nitrogen rate is one of the most important decisions that farmers make in terms of potential impacts to water resources. A relationship exists between nitrogen rates, yields, and environmental outcomes. The cornerstone of the nitrogen fertilizer BMPs is identifying the optimum rate and then a series of other related practices (timing, split applications, inhibitors, etc.) to ensure that the nitrogen will be there when the crop needs it.

There are a number of key points worth noting:

1. First, nitrogen losses are never zero under row crop production. Even with corn/soybean production where no commercial nitrogen is applied, many Minnesota fields on fine-textured soils are losing approximately 10 lb/acre/year (Carlson et al., 2017). Background losses on coarse textured outwash (irrigated) ranged from 20-50 lb/acre (Struffert et al, 2016);

2. Losses under U of M recommendations tend to be linear up to the optimum rates. Nitrogen losses at optimum rates are frequently found to be between 15-40 lb/acre (weather dependent) on fine-textured soils. Losses on the soils using U of M recommended rates will range from 50% to 300% higher than non-fertilized conditions and are highly dependent on rainfall patterns (Carlson et al., 2017). Losses can be also significant on the irrigated outwash (Struffert et al, 2016);

3. Once rates exceed U of M recommendations, losses tend to increase in a quadratic response. When nitrogen rates were increased from 120 to 150 lb/acre in southern Minnesota, yields were increased by four bushels but the amount of residual nitrate left over in the soil profile increased by 40% (Carlson et al., 2017); and

4. Year to year climatic variability can strongly impact losses and general relationships.

A significant percentage of Minnesota's corn acres are receiving nitrogen rates above the MRTN (Maximum Return to Nitrogen) as recommended by the U of M.

2. Education and promotion of the nitrogen fertilizer BMPs

Field demonstration projects

As part of its statutory mandate to demonstrate and promote the effectiveness of the nitrogen fertilizer BMPs, the MDA has several on-going education and field demonstration programs. Educational outreach from these demonstrations are primarily with the participating farmers and their crop advisor(s), which in turn reaches other farmers and crop advisors they associate with. Educational outreach also occurs through presentations at field days and winter meetings, in media articles, and annual summary reports. Below are some examples of MDA's education and promotion work:

- *Rosholt Farm*
  In the coarse-textured irrigated sands of Minnesota, suction cup lysimeters have been utilized at the Rosholt Farm (MDA, n.d. (m)) in Pope County to quantify the loss of

nitrate from the root zone under nitrogen rate plots that are currently being managed by U of M Extension. These nitrogen rate plots are part of the ongoing effort to revise and refine nitrogen fertilizer BMP application rates for irrigated coarse-textured soils (Struffert et al., 2016). MDA staff have developed additional demonstration sites in the coarse-textured soils of Dakota, Lyon, Otter Tail, Stearns, and Wadena Counties.

- *Nutrient Management Initiative*
  The Minnesota Nutrient Management Initiative (NMI) assists farmers and crop advisers in evaluating nitrogen fertilizer BMPs (MDA, n.d. (h)). Farmers can compare nitrogen rates, timing, placement, or the use of a stabilizer product on their own fields. Many famers choose a rate trial, comparing their normal nitrogen rate to a 30 lb reduction. At the end of the season, farmers are provided with a yield comparison and a simple economic analysis based on their actual nitrogen costs and corn yields. The Nutrient Management Initiative is designed to help farmers and crop consultants evaluate management decisions using the farmer's actual field conditions. On-farm trials allow farmers to compare different practices and evaluate their outcome. Some of the data from this program is used to inform the U of M Corn Nitrogen Rate Calculator and help evaluate nitrogen fertilizer BMP effectiveness. From 2015 through 2017 there have been more than 380 NMI field trial sites. On average, 100 farmers and 30 crop advisers participate annually in approximately 100-125 field trials per year.

- *Minnesota Discovery Farms*
  Minnesota Discovery Farms (MDF, n.d.), a farmer-led program that is directed by the Minnesota Agricultural Water Resource Center (MAWRC) and supported by the MDA, is also contributing to the promotion of the nitrogen fertilizer BMPs and our understanding their field scale impact along with other conservation practices. Minnesota Discovery Farms encompass numerous farm enterprises across Minnesota and will inform our understanding the water quality impacts of common agricultural practices. Staff from MAWRC meets annually with the participating farmers to review the monitoring data. The monitoring data is available on the Discovery Farm program’s website. Monitoring data is additionally shared at field days and farmer meetings.

- *Root River Partnership*
  The Root River Partnership is designed to help southeastern Minnesota farmers and policy-makers better understand the relationship between agricultural practices and water quality (MDA, n.d. (j)). The purpose of this study is to conduct intensive surface and groundwater monitoring at multiple scales in order to provide an assessment of the amount and sources of nutrients and sediment delivered to the watershed outlet and also to determine the effectiveness of the nitrogen fertilizer BMPs and other conservation practices. This project includes an edge-of-field evaluation of the nitrogen fertilizer BMPs at one on-farm location. The study also includes a side-by-side field trial

comparing the U of M recommended rates and the farmer's normal nitrogen rates. Data is collected to compare crop yield as well as nitrate loss through tile drainage. This project has used monitoring data to provide information on the nitrogen fertilizer BMPs and other conservation practices needed to address water quality. This project is now transitioning from water monitoring to implementing conservation practices in the field. Project staff meet with the participating farmers annually to review the monitoring data, and the information is shared at field days, farmer meetings, professional meetings, as well as one-on-one meeting with area agronomists.

- *On-farm nitrogen fertilizer BMP studies with the U of M*
  MDA staff partner with U of M staff and staff of other partner organizations to conduct detailed nitrogen fertilizer BMP studies for the purposes of confirming or revising U of M guidelines on which the nitrogen fertilizer BMPs are based. Monitoring depends on the study being done and can include soil water nitrate-nitrogen concentration, as well as nitrogen concentrations in soil and tissue samples. Including in these studies is historic work done in Dakota County and current work at the Rosholt Farm in Pope County (MDA, n.d. (m)) and studies done as part of the Southeast Minnesota Nitrogen BMP Outreach Program. Education and outreach occurs through presentations at field days and winter meetings, media articles, and annual summary reports.

- *Soil temperature network*
  The MDA maintains a network of soil thermometers to assist farmers and applicators to follow the nitrogen fertilizer BMP of avoiding application in the fall until soil temperatures cool to 50^0 F (MDA, n.d. (l)). Every fall the MDA communicates through the media to remind farmers and applicators of this BMP and to remind them there are areas of the state where fall application of nitrogen fertilizer is not recommended, namely on coarse-textured soils and southeast Minnesota's region of karst geology.

a) Nitrogen fertilizer BMP education and outreach

There are many other outreach activities throughout the state that provide education about and promote the use of the nitrogen fertilizer BMPs. Some of these education and outreach programs are put on by other private or public groups outside of the MDA, with MDA either supporting or participating in the programs. All of these education and outreach opportunities "provide education about how the use of the best management practices will prevent, minimize, reduce, and eliminate the source of groundwater degradation."

- *Nitrogen Smart*
  Nitrogen Smart (UME, n.d.) is a training program for producers that presents fundamentals for maximizing economic return on nitrogen investments while minimizing nitrogen losses. The workshops deliver high-quality, research-based education so producers can learn:

    - Sources of nitrogen for crops
    - How nitrogen is lost from soil and how you can reduce losses
    - How to manage nitrogen in drainage systems
    - What the new NRS and NFMP mean for Minnesota producers
    - Practices to refine nitrogen management, including split applications, alternative nitrogen fertilizers, soil and tissue testing, and nitrogen models

  The Nitrogen Smart trainings are presented by U of M Extension, funded by Minnesota Corn Growers, and hosted by the Minnesota Agriculture Water Resource Center (MAWRC) at 8-10 locations throughout Minnesota during the winter months. There were 11 Nitrogen Smart trainings between February and March 2018.

- *Annual Nitrogen Conference*
  The U of M Minnesota Extension organizes an annual state-wide Nitrogen Conference that brings experts together to focus entirely on this valuable crop input (MAWRC, n.d.). The MDA is a lead sponsor of the conference. MDA staff regularly presents at the conference. Current topics in crop production and environmental stewardship are explored that are relevant and informative for farmers and their advisors. The conference attracts 125-175 attendees each year.

- *Annual Nutrient Management Conference*
  The MAWRC hosts an annual state-wide Nutrient Management Conference. The MDA is a lead sponsor of the conference. MDA staff members regularly presents at the conference. Although the conference covers all crop nutrient management issues, a substantial portion of its content is on nitrogen management. The conference is attended by farmers, their advisors, and water resource specialists and attracts up to 400 attendees each year.

- *U of M Extension winter meetings and summer field days*
  U of M Extension holds two winter meetings: the Research Updates held at the university's Research and Outreach Centers across the state and the Crop and Soil Days held at eight to ten state-wide locations. In addition to winter meetings, summer field days are held at the Waseca and Lamberton research and outreach centers, and the Institute for Agricultural Professionals Field School is held on the Saint Paul campus. Nitrogen fertilizer management is almost always on the agenda for meetings and field days because of its importance to agriculture agronomically and environmentally.

- *Minnesota Crop Production Retailers Association Short Course & Trade Show*
  Held jointly by the Minnesota Crop Production Retailers Association and the U of M Extension, this annual state-wide event for pesticide and fertilizer suppliers and

applicators is a reliable forum for sharing nitrogen management issues and technologies with licensed pesticide applicators, farmers, and crop advisors.

- *Source water protection plans*
  Public water suppliers are required to develop source water protection plans and update them on a ten-year schedule. When elevated nitrates in drinking water is an issue, these plans include educational activities to promote nitrogen fertilizer BMPs and AMTs in their WHPAs. Local soil and water conservation districts (SWCDs) are usually utilized to carry out the nitrogen fertilizer BMP and AMT education.

- *Ag supplier education and support*
  The primary source of nitrogen fertilizer management information for most farmers is their fertilizer dealer agronomist. It is with this advisor that most farmers decide on an annual NFMP. Fertilizer dealer agronomists provide education to their client farmers on crop nitrogen need, management, and water quality protection concerns. They also provide support services such as monitoring fall soil temperature to let farmers know soil temperatures have reached 50^{o} F so they can apply fall nitrogen.

- *Ag supplier winter meetings*
  A regular feature of Minnesota's agricultural industry is the agricultural suppler winter meeting. Suppliers of seed, fertilizer, and pesticides invite their farmer clients to meetings where they will provide a free meal and information on upcoming product and program developments. Nitrogen fertilizer management is almost always on the agenda for these meetings because of its importance to agriculture agronomically and environmentally.

b) MDA's external partnerships providing education and promotion of the nitrogen fertilizer BMPs

In addition to the Fertilizer Field Unit within the Pesticide and Fertilizer Management Division of the MDA, there are several staff throughout the state whose positions are dedicated to providing education about and promote the use of nitrogen fertilizer BMPs.

- *Agricultural Water Quality Protection Educators, U of M Extension*
  The U of M supports two extension educator positions in the area of crop nitrogen fertilizer management, one in Saint Cloud and one in Rochester. The focus of their positions is assisting crop producers in implementing nitrogen fertilizer BMPs and AMTs as outlined in the state's NFMP. The positions are funded by state Clean Water Fund dollars administered by the MDA.

- *Irrigation Management Specialist, U of M Extension*
  The U of M supports an irrigation management specialist extension educator position that focuses on crop irrigation management as it relates to nitrogen management and water

quality protection. The position's objective is to increase the capacity of farmers and their advisors to more effectively manage cropland irrigation state-wide, especially in areas vulnerable to groundwater contamination (MDA, n.d. (e)). The position is funded by state Clean Water Fund dollars administered by the MDA.

- *Nitrogen management specialist, U of M Extension*
  The U of M supports a nitrogen management specialist position within its Department of Soil, Water, and Climate. Funded by the Minnesota Corn Growers Association, the position concentrates through research and outreach education on environmental issues related to nitrogen management of corn cropping systems, seeking to identify and implement nitrogen management practices that are sustainable both in terms of water quality protection and improving crop yields. This position is critical to developing and updating the nitrogen fertilizer BMPs, conducts MDA-sponsored research projects, consults regularly with MDA staff, and serves on several MDA advisory boards including the nitrogen fertilizer BMP Education and Promotion.

- *Source Water Protection Specialists, Minnesota Rural Water Association*
  The Minnesota Rural Water Association has two staff positions, one in Park Rapids and one in Rochester, which focus on addressing elevated nitrate-nitrogen concentration of rural public water suppliers. Since the source of this nitrate is often agriculture, they are actively involved in promoting nitrogen fertilizer BMPs and AMTs in WHPAs. These staff are frequently partners on a variety of demonstration sites, including the promotion of Kernza and other perennials with the wellhead protection areas (WHPAs) and will be directly or indirectly active with future Local Advisory Team activities.

- *Southwest Minnesota Regional Water Resources Specialist*
  MDH and local funds supports a Regional Water Resources Specialist who works with six counties in southwest Minnesota with a focus on nitrogen management. The position promotes nitrogen fertilizer BMP and AMT use in WHPAs that are vulnerable to nitrate groundwater contamination. MDA staff partner with the person in this position on various demonstration and outreach activities. The person in this position also will be directly or indirectly active with future LAT activities.

c) Minnesota Agricultural Water Quality Certification Program

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) is a voluntary opportunity for farmers and agricultural landowners to take the lead in implementing conservation practices that protect our water (MDA, n.d. (f)). Those who implement and maintain approved farm management practices will be certified and in turn obtain regulatory certainty for a period of ten years. Part of the farm operation review process associated with certification is a discussion and evaluation of nitrogen management, including the nitrogen fertilizer BMPs and AMTs. As of March 2018, 544 farmers are certified, comprising 341,800 acres of agricultural land.

d) Historic nitrogen fertilizer BMP Promotion: 1990-2011

- *Source Water Protection Areas*
  Focused education and demonstration projects related to nitrogen management within key agricultural SWPAs (Perham, St. Peter, Verndale, Lincoln-Pipestone, and Cold Spring);

- *Nitrate Testing Clinics*
  Successfully created awareness of nitrates in private drinking wells through the testing of over 50,000 wells from 1996 to 2006. The clinic format provided many excellent opportunities to discuss nitrogen fertilizer BMPs with farmers and home owners;

- *Field Scale Demonstrations*
  Created water quality demonstration sites at Red Top Farm (Nicollet Co), Highway 90 (Blue Earth Co), Perham SWPA (Otter Tail Co), Verndale SWPA (Wadena Co), and others. Sites were instrumented to measure nitrate losses as a function of various nitrogen fertilizer BMPs and crop selection. Numerous field day events and winter educational events provided outlets for the results;

- *Soil and Manure Testing Certification Programs*
  In support of nitrogen fertilizer BMPs related to soil and manure testing, the MDA developed certification programs for laboratories providing these services to farmers. The programs require approved testing procedures and the presentation of results that are in an understandable and standardized format. The vast majority of soil and manure analysis now come from certified labs;

- *MDA Leadership in nitrogen fertilizer BMP Research Projects*
  The MDA partnered and managed numerous grants from the Legislative Commission on Minnesota Resources/Legislative-Citizen Commission on Minnesota Resources (LCMR/LCCMR) and USEPA 319 grants to assist the U of M in the development and validation of nitrogen fertilizer BMPs;

- *Nitrogen Fertilizer BMP Insurance Concept*
  This was a pilot project funded by USDA-Federal Crop Insurance Corporation, led by the MDA in partnership with Iowa Department of Natural Resource and Wisconsin Department of Natural Resources. The project provided insurance protection for growers experimenting with nitrogen rates recommended by the land grant universities. Although the program eventually was discontinued, several key features led to the development of the MDA's Nutrient Management Initiative.

B. Nitrogen Fertilizer Management Plan (NFMP)

Laws of Minnesota 1989, Chapter 326, Article 6, Section 33, subd 2 required MDA to establish the following:

(1) establish best management practices and water resources protection requirements involving fertilizer use, distribution, storage, handling, and disposal;

(2) cooperate with other state agencies and local governments to protect public health and the environment from harmful exposure to fertilizer; and

(3) appoint a task force to study the effects and impact on water resources from nitrogen fertilizer use so that best management practices, a fertilizer management plan, and nitrogen fertilizer use regulations can be developed.

The law further required that this Task Force be made up of a diverse group of representatives from agriculture, environmental groups, and local and state governments. The Task Force was responsible for reviewing current information regarding the impact of nitrogen fertilizer on water resources and for making recommendations on ways to minimize these effects. The nitrogen fertilizer management plan must include components promoting prevention and developing appropriate responses to the detection of inorganic nitrogen from fertilizer sources in ground or surface water.The MDA uses the state's NFMP as the blueprint for prevention and minimization of the impacts of nitrogen fertilizer on groundwater. The NFMP, revised in 2015, 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. Nitrogen fertilizer BMPs are the cornerstone of the NFMP and the proposed Rule. Authority for the proposed Rule comes from the Groundwater Protection Act, Minn. Stat. § 103H.275. The plan lays out education and promotion activities, how the MDA monitors groundwater and provides the framework for the proposed Rule.

In 2010, the MDA began the process of revising the 1990 NFMP to reflect current agricultural practices and activities, apply lessons learned from implementation activities and other work, and to better align it with current water resource conditions and program resources. The MDA assembled an Advisory Committee with 18 members, including three members from the original Task Force. The MDA hosted eighteen Advisory Committee meetings between 2011 and 2012 to review information related to the nitrogen cycle, nitrate contamination of ground and surface water, hydrogeologic conditions, crop production, nitrogen management, research, and implementation. Before the final version of the plan was released the MDA had a final public comment period. During this comment period, the MDA received 32comments from various stakeholders. These comments were addressed before releasing the final version of the NFMP (MDA, 2015). The NFMP is attached as appendix 9 and is available online at http://www.mda.state.mn.us/nfmp. The general approach used by the NFMP to address nitrate in groundwater consists of the following activities: prevention, monitoring and assessment, and mitigation.

The proposed Rule follows the process outlined in the NFMP and works with local farmers to make sure they are following the nitrogen fertilizer BMPs before moving to regulation.

Thus, MDA has satisfied its statutory obligation of education, promotion, and development of BMPs through their development in cooperation with the University of Minnesota, the numerous field demonstration projects, training programs and conferences, funding of positions dedicated to education of BMPs, and the Agricultural Water Quality Program. Through the NFMP, MDA has continued its development and education of BMPs, and is using the NFMP as a blueprint for the development of the rule.

C. MDA monitoring of nitrates in groundwater

MDA has been part of monitoring of groundwater for nitrates since 1987. Monitoring is done on both private and public wells.

A well is a hole drilled into the ground used to access water. A pipe and a pump move the water from an aquifer to a sink, shower, or other location for drinking, washing, etc. Wells can be either private or public. A private well is usually owned by a person and is intended to supply water to a home or for another nonpublic use. Public wells supply water to city residents, hotels, lodging facilities, schools, and other entities. If a public well is contaminated with nitrate, the water supplier bears the cost of treating the water or providing a safe source of water. Those costs are usually passed on to the ratepayers. Additional information on alternatives and costs is available in, the Regulatory Analysis section under, Alternative methods of achieving the proposed Rule that were considered and rejected, of the SONAR.

1. Private Wells – Township Testing

Water samples from large areas show that relatively small percentages of private wells exceed the health risk limit. The MDH estimates that around 1% of new Minnesota wells exceed 10 mg/L nitrate-nitrogen. A USGS report on nitrate concentrations in private wells in glacial aquifer systems of the United States estimates that less than 5% of wells had nitrate-nitrogen concentrations exceeding the health risk limit (Warner and Arnold, 2010).

However, wells in areas with vulnerable soils and geology are at much greater risk and exceed the health risk limit in larger numbers. The MDA is in the midst of offering nitrate testing to private well owners in areas vulnerable to groundwater contamination and with significant row crop production. The wells are sampled in townships and it is called the Township Testing Program (TTP).

From 2013 to 2017, 242 vulnerable townships from 24 counties participated in the TTP. Overall, 10.1% (2,583) of the 25,652 wells exceeded the health risk limit for nitrate in the townships that have been sampled. Some townships with initial results have yet to be analyzed for possible nitrogen sources, so the final percentage of wells over the health risk limit from a non-point source may change based on follow-up sampling (MDA, 2018 (b)). More than 70,000 private well owners will be offered nitrate testing in over 300 townships by 2019.

Table III-2. Township Testing Program nitrate-nitrogen summary: 2103-2017

Total Wells	Nitrate-Nitrogen mg/L (ppm)			
	<3	3<10	≥10	≥10
	Number of Wells			Percent
25,652	19,277	3,792	2,583	10.1

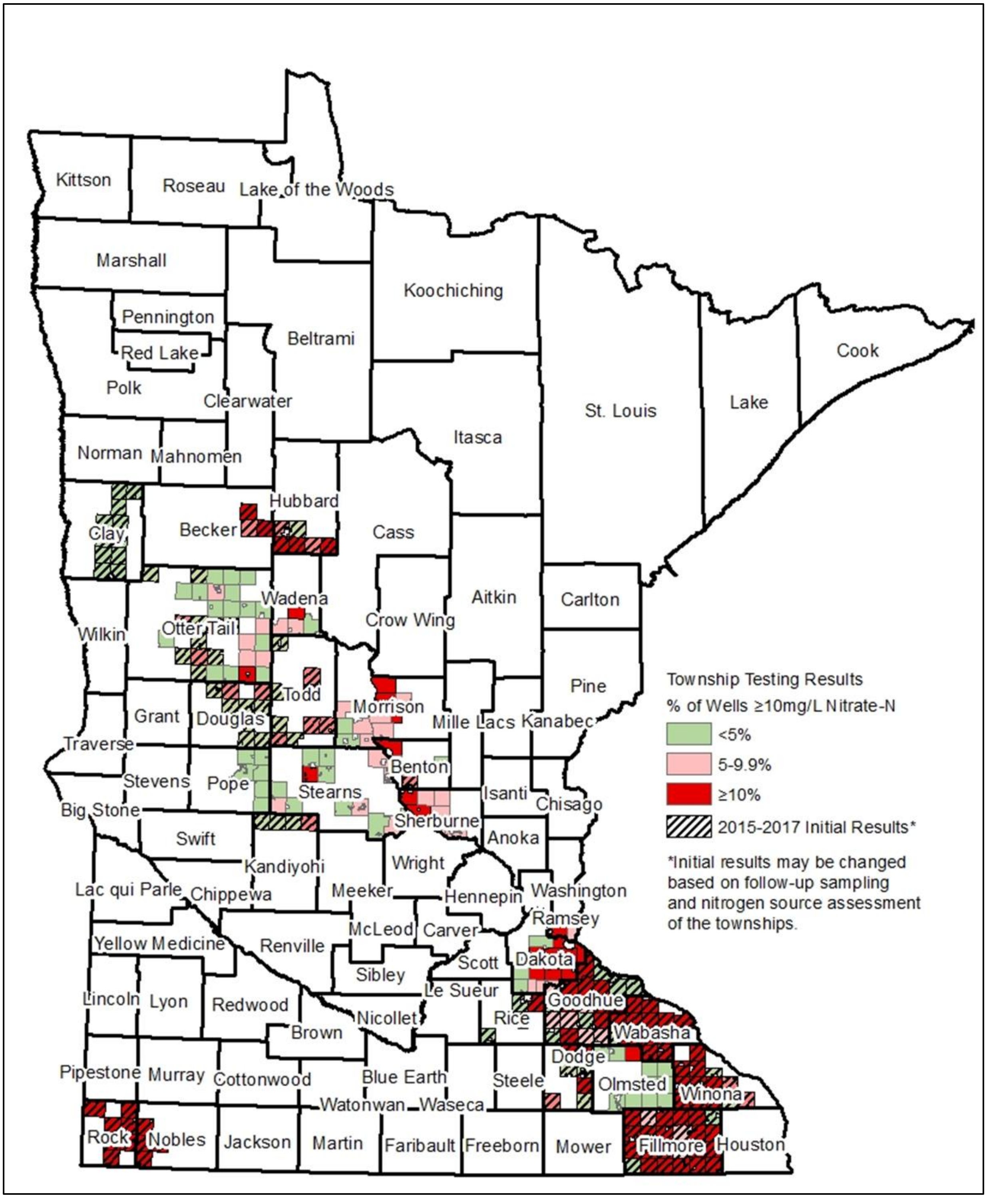


Figure III-3. Percentage wells in each Minnesota Township exceeding 10 mg/L nitrate-nitrogen MDH HRL at initial sampling.

2. Public wells

Various communities that use groundwater as their water source have exceeded the health risk limit for nitrate in recent years. According to the MDH, 15 community public water supplies had nitrate levels in groundwater above the health risk limit as of 2014. (MDH, 2015). The number of community water suppliers that treat for nitrate has increased from 6 systems serving 15,000 people in 2008 to 8 systems serving 50,000 people in 2014. Six non-community systems exceeded the 10 mg/L nitrate-nitrogen health risk limit in 2016, requiring corrective action (MDH, 2017). Non-community systems provide water to people in schools, lodging facilities, and businesses that are not connected to community water systems.

3. Monitoring wells

To monitor in areas with shallow groundwater, nested groundwater wells are installed by the MDA in or near areas with row crop agriculture. Monitoring these areas aids in early detection if chemicals are present, and is considered a preventive and proactive approach to protecting Minnesota's waters. Although the MDA's current groundwater monitoring program was originally designed for pesticides, the MDA collects and analyzes samples for nitrate to provide information about the potential environmental impact to groundwater associated with agricultural activities in the state. A description of the networks is available in the Nitrogen Fertilizer Management Plan (MDA, 2015)

In 2004, the MDA groundwater monitoring program, with assistance from the University of Minnesota, established a regional monitoring network that divided the state into ten regions. These regions were developed to facilitate water quality monitoring efforts, pesticide management, and BMP development, promotion, and evaluation. These regions were termed Pesticide Monitoring Regions (PMRs).

A 2012 report provided a summary of the MDA's nitrate groundwater monitoring activities (MDA, 2012). The nitrate data were compiled and analyzed on an annual basis for each region. The Central Sands area (PMR 4) and the Southeast karst area (PMR 9) were determined to be the most vulnerable to and the most impacted by nitrate contamination. Nitrate was detected in 94% to 100% of the samples from 2000 to 2010 in PMRs 4 and 9. According to the most recent data available, nitrate was detected in all samples from the two regions. Seventy-six percent of the samples collected in the Central Sands area (PMR 4) exceeded the HRL along with 26 percent in the southeast karst area (MDA, 2017).

The monitoring wells described here are properly constructed for monitoring and are not located near nitrogen point sources. They are located at the edges of fields. Therefore, it is reasonable to conclude nitrate is coming from agricultural practices.

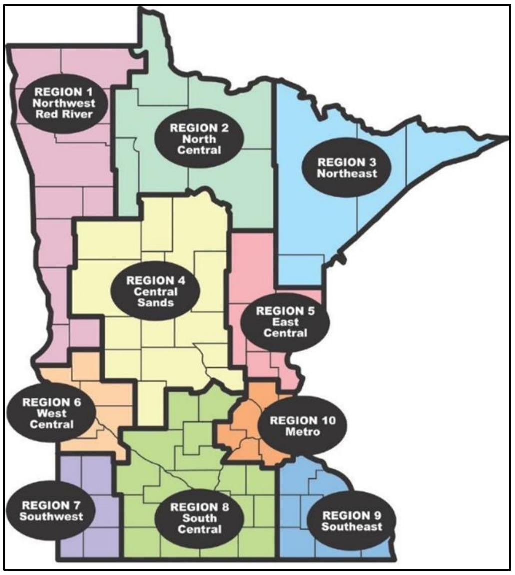


Figure III-4. Minnesota Pesticide Monitoring Regions (NFMP, 2015).

4. Southeast and Central Sands Private Well Volunteer Monitoring Networks

The MDA and partners have worked with private well owners to sample their wells for nitrate, and have found there can be variability in monitoring data in individual wells from year to year. The Southeast Volunteer Monitoring network has been in place since 2008 in 9 counties. Between 2008 and 2015, ten sampling events occurred representing approximately 4,300 samples. During this period, the percentage of wells exceeding the health risk limit for each sampling event ranged between 8 and 15 percent. Each year, between 373 and 519 wells were sampled. The MDA launched a similar project in the Central Sands area of Minnesota, which includes 14 counties. From 2011 to 2015, 3 to 4 percent of the wells exceeded the health risk limit. The number of wells sampled annually during this period ranged from 402 to 534.

The MDA in cooperation with other state agencies have done extensive monitoring of groundwater. Based on the above, MDA has complied with all its requirements under 103H, and has determined that the implementation of the BMPs has proven ineffective as it relates to Nitrogen fertilizer.

D. Nitrogen Fertilizer Management Plan (NFMP)

1. Development Process

The MDA uses the state's NFMP (MDA, 2015) as the blueprint for prevention and minimization of the impacts of nitrogen fertilizer on groundwater. The NFMP, revised in 2015, 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. Nitrogen fertilizer BMPs are the cornerstone of the NFMP and the proposed Rule. Authority for the proposed Rule comes from the Groundwater Protection Act, Minn. Stat. § 103H.275. The plan lays out education and promotion activities, how the MDA monitors groundwater and provides the framework for the proposed Rule.

The first NFMP was adopted in 1990. The original 1990 NFMP was created with the guidance of the Nitrogen Fertilizer Task Force. This Task Force was made up of a diverse group of representatives from agriculture, environmental groups, and local and state governments. The Task Force was responsible for reviewing current information regarding the impact of nitrogen fertilizer on water resources and for making recommendations on ways to minimize these effects (MDA, 2015). In 2010, the MDA began the process of revising the 1990 NFMP to reflect current agricultural practices and activities, apply lessons learned from implementation activities and other work, and to better align it with current water resource conditions and program resources. The MDA assembled an Advisory Committee with 18 members, including three members from the original Task Force. The MDA hosted eighteen Advisory Committee meetings between 2011 and 2012 to review information related to the nitrogen cycle, nitrate contamination of ground and surface water, hydrogeologic conditions, crop production, nitrogen management, research, and implementation. Before the final version of the plan was released the MDA had a final public comment period. During this comment period, the MDA received 32 comments from various stakeholders. These comments were addressed before releasing the final version of the NFMP (MDA, 2015). The NFMP is attached as appendix 9 and is available online at http://www.mda.state.mn.us/nfmp. The general approach used by the NFMP to address nitrate in groundwater consists of the following activities: prevention, monitoring and assessment, and mitigation.

With the updated NFMP in place the MDA has decided to adopt water resource protection requirements to support the state's plan to reduce nitrate in groundwater. The proposed Rule follows the process outlined in the NFMP and works with local farmers to make sure they are following the nitrogen fertilizer BMPs before moving to regulation.

IV. The MDA has determined that the Implementation of BMPs Related to Nitrogen Fertilizer is not Effective.

Minn. Stat. § 103H.275, subd. 1, states that the MDA may adopt water resource protection requirements by rule that are consistent with of Minn. Stat. § 103H.001 and are commensurate with the groundwater pollution if the implementation of BMPs has proved to be ineffective. This section will address the implementation of nitrogen fertilizer BMPs throughout the state.

The MDA is the designated lead state agency through Minn. Stat. chap.18C for the regulation of commercial fertilizers. Additional responsibilities, as stated in Minn. Stat. chap. 103H, require the MDA to protect groundwater from the use of nitrogen fertilizer. As part of these requirements, the MDA is required to assess the status of nitrogen fertilizer BMP implementation. Accurate nitrogen fertilizer BMP assessments are a critical component of the NFMP. Since 1993, the MDA has developed innovative assessment tools and techniques to determine the implementation of the nitrogen fertilizer BMPs at the statewide, regional, and local scales. Over the past 25 years, the MDA has interviewed thousands of Minnesota producers who represented different geologic settings, climatic regimes, crop rotations, and livestock operations. These various assessment tools help MDA and the agricultural community understand how farmers manage their nitrogen inputs including fertilizers, manures, and legume credits, as well as the rate, timing, placement, and sources of nitrogen fertilizers. The MDA also has developed several different groundwater monitoring systems to monitor the presence of pesticides and fertilizers in groundwater around the state. One of these systems uses edge of field monitoring wells, with no nearby point sources, indicating there is a high presence of nitrate in groundwater.

It has been established that Nitrogen fertilizer sales have increased over the years as the amount of nitrogen-demanding plants has replaced more nitrogen friendly plants. It has also been proven that Minnesota has seen an increase in nitrogen in the groundwater in some areas vulnerable to groundwater contamination, including DWSMAs. The surveys described in this section have been important for educating to farmers. The education process is an important tool, but by itself, is not effective in securing nitrogen fertilizer BMP adoption or stopping the increase in nitrates in groundwater, especially in areas where nitrate levels are the highest. The MDA concludes that excessive rates are used in some locations, credit for existing nitrogen is not always taken, and the excess of nitrate in groundwater in some agricultural areas needs to be decreased by requiring the adoption of water resource protection requirements. This data proves that the implementation of the BMPS is ineffective.

A. Data shows that producers are over-applying nitrogen fertilizer, including miscalculating how much nitrogen is applied when manure is used.

The MDA has authored and published numerous reports using the localized and highly detailed Farm Nutrient Management Assessment Program (FANMAP) (MDA, n.d. (b)) approach as well as a broader phone-based approach in partnership with the National Ag Statistics Service (NASS) (MDA, n.d. (i)). Through these assessment tools and routine monitoring of fertilizer tonnage sales, the MDA has developed extensive knowledge on nitrogen fertilizer trends and associated management practices in Minnesota. These various assessment tools help understand how farmers manage their nitrogen inputs including fertilizers, manures, and legume credits as well as the rate, timing, placement and sources of nitrogen fertilizers.

The MDA has authored and published numerous reports through the FANMAP which provides highly detailed information about agricultural inputs such as fertilizer, manure, and pesticides. This tool is extremely useful when working with farmers in different regions across Minnesota.

In order to conduct a FANMAP survey, it is critical to develop a representative sampling population. In all FANMAP activities, County Educators (Minnesota Extension Service) and SWCD staff from the appropriate counties are contacted and individually interviewed. The purpose of the interviews is to inform them of the specifics of the particular project and overall goals; obtain pertinent county information (i.e. locations and demographics); and identify potential candidates (farmers) and their agronomic management skills as perceived by the County Educator. Information about on-farm management and inputs is collected by a personal visit to each farm and typically requires one to two hours of contact. Since its inception, thousands of Minnesota farmers have shared valuable information about their farming practices. For more information, please visit the MDA's FANMAP website (MDA, n.d. (b)).

More recently, the MDA has partnered with the USDA National Agricultural Statistic Service (NASS) and U of M researchers to collect information about fertilizer use and farm management on a broader scale than FANMAP (MDA, n.d. (i)). Partners have pioneered a survey tool for characterizing fertilizer use and associated management on a regional and statewide scale. Surveys are conducted over the phone. Enumerators from NASS are highly skilled at obtaining critical information over the phone with minimal time and burden on the producer. Over the past 25 years, the MDA has interviewed thousands of Minnesota producers who represented different geologic settings, climatic regimes, crop rotations, and livestock operations. The first attempt using this technique was in 2010 and has been conducted on a yearly basis since then. NASS enumerators surveyed approximately 1,500 corn farmers from across the state to gather information about commercial fertilizer use. The statewide fertilizer use survey alternates every other year. Much of the focus is on corn production, where 70% of the commercial inputs are used. During alternate years, the survey focuses on regional issues in areas of the state where there is a high risk of groundwater contamination. Reports are compiled and available on the MDA's website. While the MDA has conducted numerous fertilizer use surveys, for purposes of this SONAR, much of the supporting documentation is derived from three extensive NASS surveys conducted in 2010, 2012 and 2014, which included thousands of Minnesota's corn producers.

In summary, the following general practices which directly threated groundwater quality are routinely observed on both a statewide level and on a localized (DWMSAs) scale. While there are many areas where Minnesota farmers have made great improvements in nitrogen management, a very significant number of cropland acres are using practices that threaten groundwater resources.

- *Lack of Nitrogen Crediting from Legumes:* The MDA found that 18 – 38 pounds in excess of U of M guidelines are commonly applied after growing soybeans. Soybeans are a legume and can put nitrogen back into the soil, so less nitrogen is needed for the next crop.

- *Lack of Nitrogen Crediting from Other Fertilizers:* The total amount of nitrogen fertilizer from all sources needs to be taken into account, or credited, when calculating the total amount of nitrogen applied to a crop. Phosphorus fertilizer sources that also contain nitrogen, such as monoammonium phosphate (MAP) or diammonium phosphate (DAP), and more recently ammonium sulfate, are seldom credited when they should be.

- *Lack of Manure Crediting:* Similar to not taking crediting for other fertilizers or legumes, manure sources are not being properly credited when producers are calculating the total amount of nitrogen applied to a crop. Over-application rates are frequently compounded when in tandem with legume crops.

- *Fall Applications:* Surveys indicate that 30-40% of all nitrogen is applied in the fall. Different areas of the state have different nitrogen fertilizer BMPs when it comes to fall application. The nitrogen fertilizer BMPs specify where and when fall application is appropriate. The surveys show concerns about improper nitrogen source selection, lack of using a nitrification inhibitor when recommended, applications made prior to proper soil temperatures, and application onto inappropriate soil types.

- ***Collectively, Excessive Nitrogen Fertilizer Use:*** Across the various rotations and different scenarios, it is conservatively estimated that Minnesota producers use 10-15% more nitrogen fertilizer then necessary to maintain optimum yields. Nitrogen sales should be reduced by approximately 100,000 tons/year to not only improve water quality but also reduce the financial burden on producers.

There is a very strong body of knowledge indicating that BMPs are not being adopted to an acceptable level and an equally strong body of knowledge on the related impacts to groundwater quality. Therefore is it needed and reasonable for MDA to move forward with Part One and Part Two of the proposed Nitrogen Rule.

The amount of nitrogen fertilizer that is used can have a great impact on the amount available to leach into groundwater (MDA. n.d. (d)). Rates are generally viewed as the most important single factor impacting both economic and environmental perspectives in comparison to the other remaining practices of right source, right placement and right timing. The choice of the appropriate rate is not easy to determine because of the transient nature of nitrogen in soil (Kaiser et al, 2016).The amount of nitrogen fertilizer that is used can have a great impact on the amount available to leach into groundwater.

The U of M has based their recommendations for nitrogen fertilizer rate on the maximum return to nitrogen (MRTN). This is determined using the ratio between the price per pound of nitrogen divided by the price per bushel of corn in order to determine the rate of nitrogen fertilizer that should be used in order for a farmer to get the greatest return from their crop (Kaiser et al., 2016). Numerous factors influence the price per pound of nitrogen and the price per bushel of corn which will vary over time and across individual farm operations. It is generally accepted that over the long haul, the prices of grain and fertilizers are closely linked within the marketplace and for most situations, the 0.10 ratio is highly appropriate for corn production when manure resources are not used.

By further examining the application rates for various crop rotations and comparing these rates with the U of M fertilizer recommendations, it is possible to make estimates on the amount of excess nitrogen that is applied during selected rotations. Appendix 1 shows the calculations used to determine over-application of nitrogen fertilizer in various rotations.

There are appreciable over-application rates found in the corn-soybean rotation. Over-application rates within this rotation range from 18 to 38 lb/A, depending up which top rate U of M recommendation is used. Statewide across all associated acres in this rotation, this translates into excessive nitrogen inputs between 32,000 and 67,000 tons of N per year. This was between 4 to 9% of the statewide N sales for 2014.

In rotations where manure is applied, an additional 3-4% of nitrogen fertilizer, conservatively, is over-applied. It is important to note that the acres of this over application are relatively small but the rate of over-application occurring on this land is high. In the continuous corn rotation, the excessive nitrogen inputs are minimal (1,765 to 3,437 tons per year) which is less than 0.4% of the statewide N sales for 2014.

When these two rotations are considered collectively, 55,000 to 100,000 tons of nitrogen fertilizer is used in excess of the U of M nitrogen fertilizer recommendations. This is 7 to 12% of the annual nitrogen fertilizer sales in the state of Minnesota. Based on the studies cited above, we know that this over-application threatens the quality of Minnesota’s groundwater.

Below are summaries from the 2010, 2012 and 2014 NASS survey’s documenting how the nitrogen fertilizer rate BMPs are ineffective based on crop rotation.

NASS Survey: Corn following Corn

Statewide, nitrogen fertilizer application rates for corn following corn averaged 158 lbs of nitrogen per acre (MDA and NASS, 2014, 2016, and 2017). The current U of M MRTN rate is 155 lbs with a range of 145-170 lbs of nitrogen per acre (Figure IV-1).

The average percentage of fields in a corn following corn rotation that exceed the guidelines in the past 3 surveys is 37%. Nitrogen rates in excess of the University of Minnesota guidelines frequently result in excessive residual soil nitrates at the end of the growing season. There is an increased probability that this extra nitrogen will be leached below the root zone by the following spring.

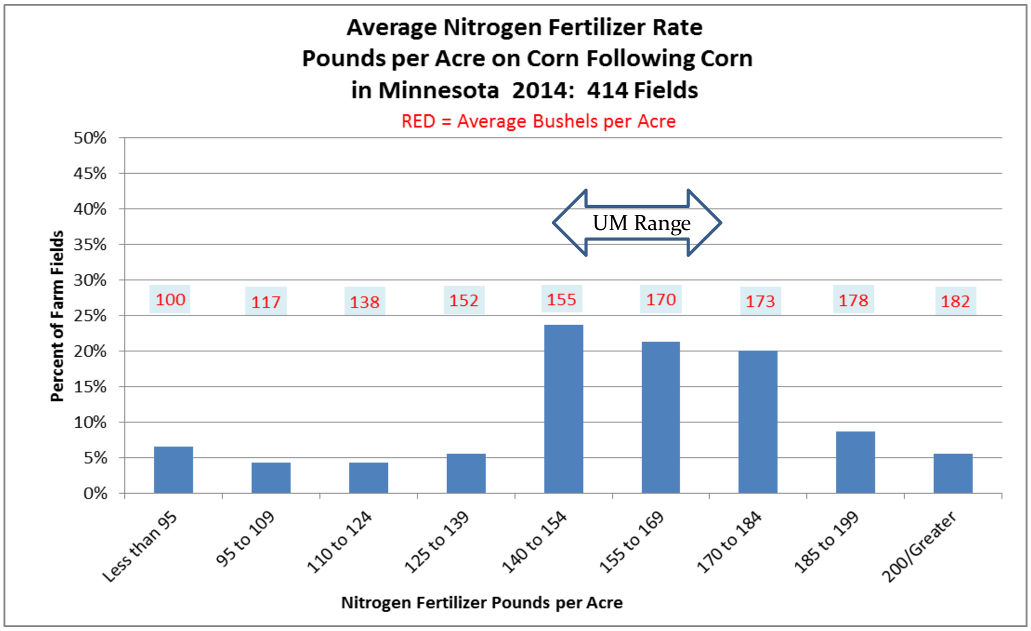


Figure IV-1. Percent fields within U of M recommended nitrogen rate ranges for corn following corn.

NASS Survey: Corn following Soybeans

Statewide, nitrogen fertilizer application rates for corn following soybeans averaged 145 lbs nitrogen per acre (MDA and NASS, 2014, 2016 and 2017). The current U of M MRTN rate is 120 lb with a range of 105 to 130 lb nitrogen per acre (Figure IV-2).

The percentage of fields in a corn following soybeans rotation exceeding the guidelines averages 65%. Surveys found that farmers were applying 20-40 lb in excess of the U of M guidelines in a corn following soybean rotation, which means there is extra nitrate present on the fields available that is leaching into groundwater.

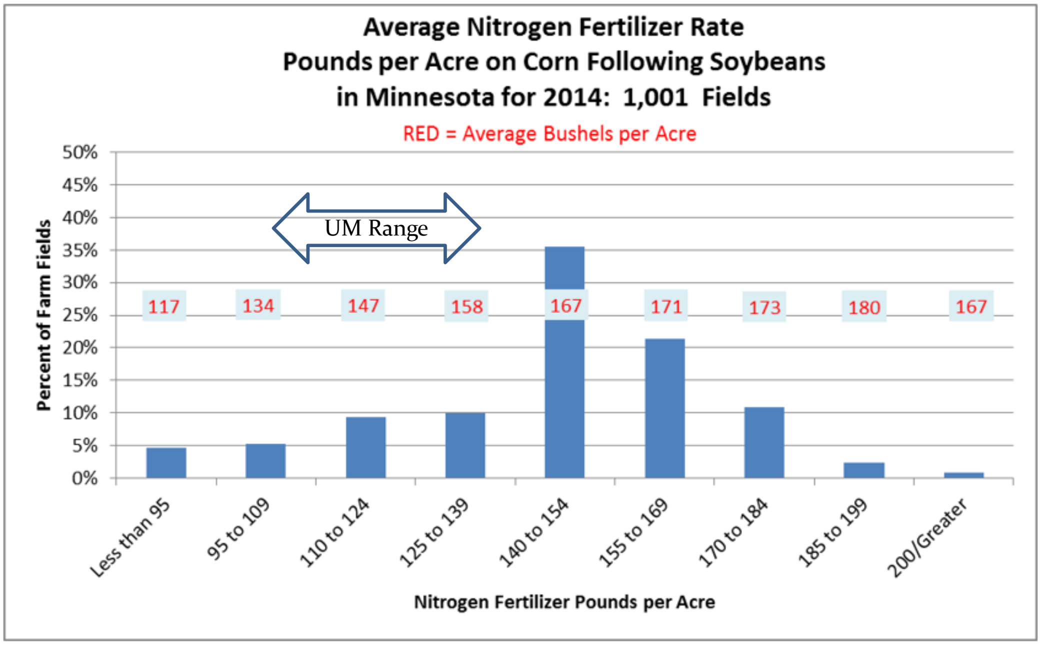


Figure IV-2. Percent fields within U of M recommended nitrogen rate ranges for corn following soybeans.

NASS Survey: Corn following Manure

Generally, 15-20% of the corn acres in the state will get a manure application either the fall before or just prior to spring planting. These percentages will vary significantly based on local livestock densities. Manure crediting is much more difficult to predict than other nitrogen sources. The nitrogen content of the manure is highly dependent on the type of manure, climatic conditions, how the manure was stored, and many other variables. Because of the high number of uncertainties associated with manure nitrogen credits, livestock producers and agricultural professionals tend to be conservative in their estimates of need and frequently over-apply manure in combination with nitrogen fertilizer.

Additionally, the manure applications are frequently made by either the producer or a commercial manure applicator. Proper nitrogen crediting requires that manure records are shared with the fertilizer dealer, so they can accurately reduce commercial inputs. However, even though the sharing of this information is required, the surveys show that it is not commonly communicated, and over-applications frequently occur.

A 2012 survey (MDA and NASS, 2016) documented the frequency and magnitude of nitrogen inputs on manured acres on corn (Figure IV-3). For purposes of the survey, manured acres are defined as those acres that had manure applied in the previous fall (after harvest) through applications made in the spring before planting. The survey documented average nitrogen inputs from manure at 120 lb/acre and from commercial nitrogen fertilizer at 76 lb/acre, totaling 196 lbs per acre. The current U of M MRTN rate is 155 lb per acre with a range of 145 to 170 lbs nitrogen per acre (Figure IV-3).

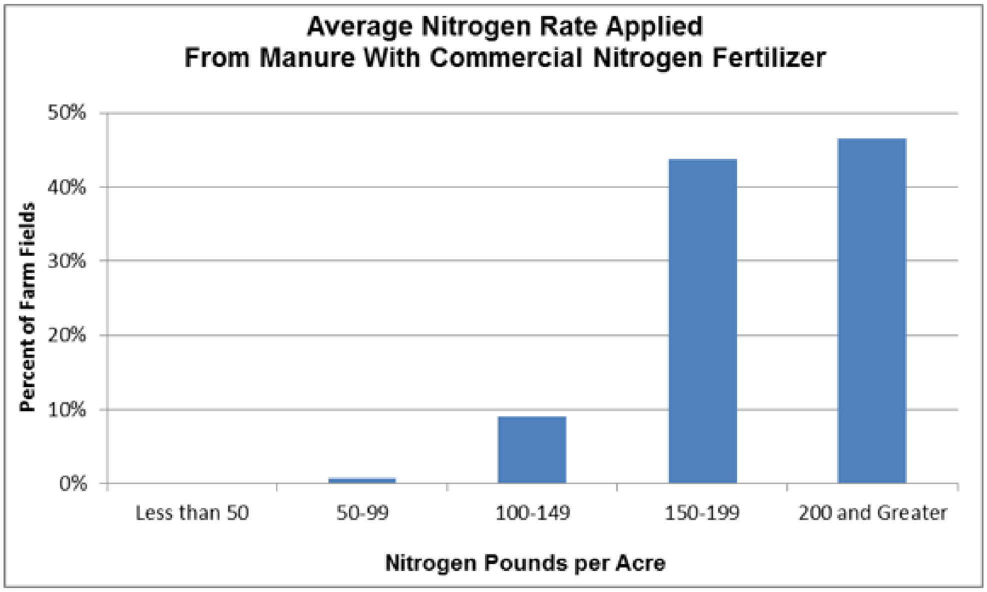


Figure IV-3. Average nitrogen inputs (fertilizer and all forms of manure) statewide.

Corn following Alfalfa, with Manure

Despite the large nitrogen credit typically provided by the killing of alfalfa (75-150 lb/acre), producers frequently apply manure before planting corn on fields with killed alfalfa. In a recent joint study, the U of M and USDA-ARS found fields where manure was applied to killed alfalfa prior to the first year of growing corn, the over-application rates were frequently found to be 100-200 lb nitrogen per acre over U of M guidelines (Figure IV-4, Yost et al., 2015).

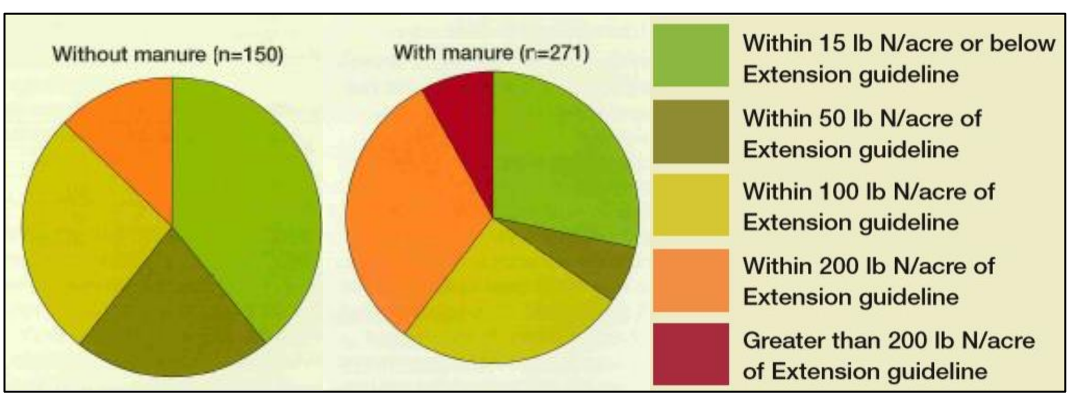


Figure IV-4. Applications of nitrogen fertilizer with or without manure on first-year corn following alfalfa.

Based on the NASS survey results presented above, there is ample evidence that nitrogen fertilizer is being over applied and that the BMP implementation is ineffective.

BMP Adoption Assessments within DWMSAs

Results from FANMAP surveys have been used to design focused water quality educational programs for localized areas such as DWMSAs. Data collected in the program's infancy were used as a baseline to assist in determining if voluntary BMPs are being adopted. Over the years, hundreds of farmers have volunteered two to four hours of their time to share information about their farming operations.

Since Part 2 of the proposed nitrogen Rule is very specific to DWMSAs, it is highly relevant to present DWMSA information on BMP adoption in a similar fashion to the statewide assessments previously provided. Most of MDA's experience and knowledge on BMP adoption evolved from working closely with farmers within DWMSAs. A listing of individual FANMAP reports can be found by going the following web link:
http://www.mda.state.mn.us/protecting/soilprotection/fanmap.aspx).

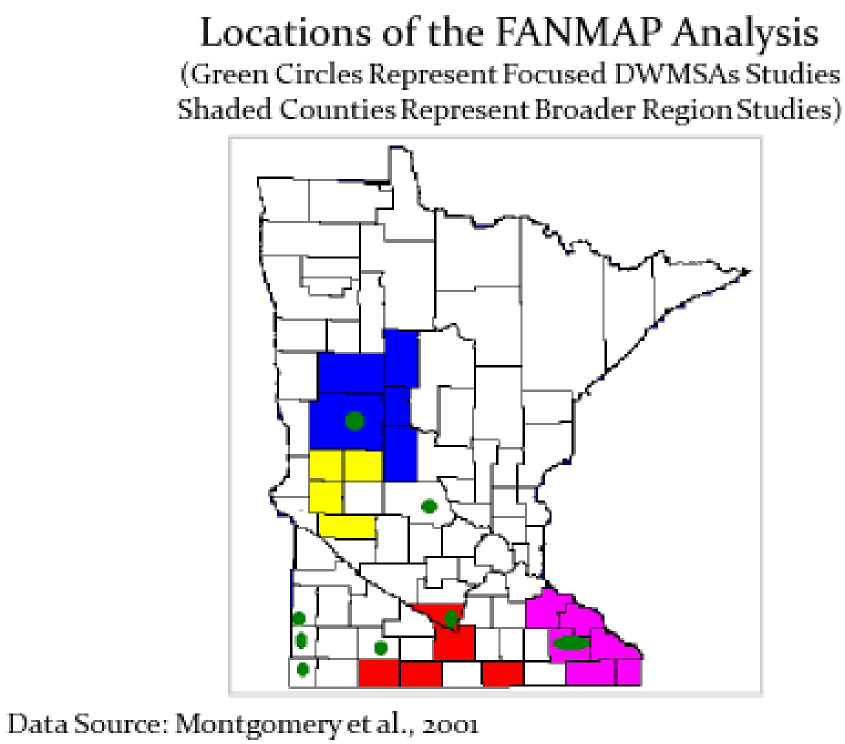


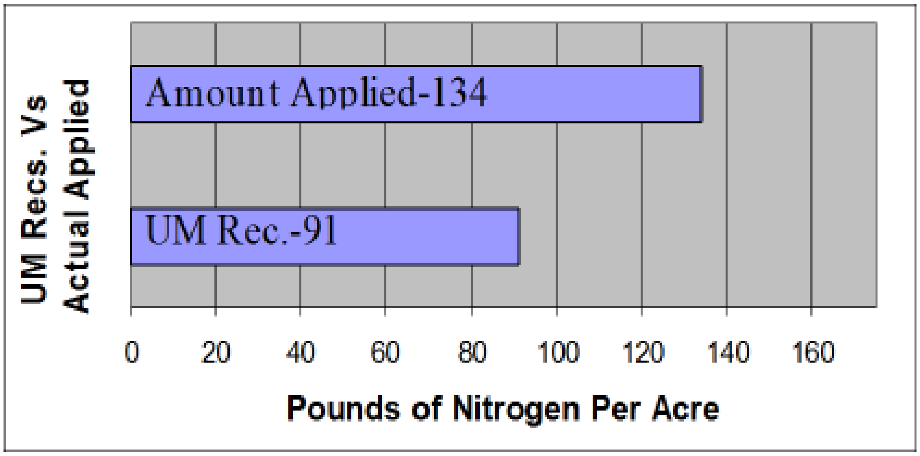
Figure IV-5. Locations of FANMAP Analysis

A general FANMAP overview is provided in Minnesota's Nonpoint Source Management Plan 2001 (Montgomery et al., 2001). While the results represent a composite of studies across the state, many of the farmers were located within DWMSAs. The communities of Perham, St.

Peter, Cold Spring, and the Lincoln-Pipestone Rural Water System are strongly represented in the 2001 report. The shaded counties shown were broader regional studies with various commodity groups.

1. FANMAP Assessment within DWMSAs

Corn following Soybeans

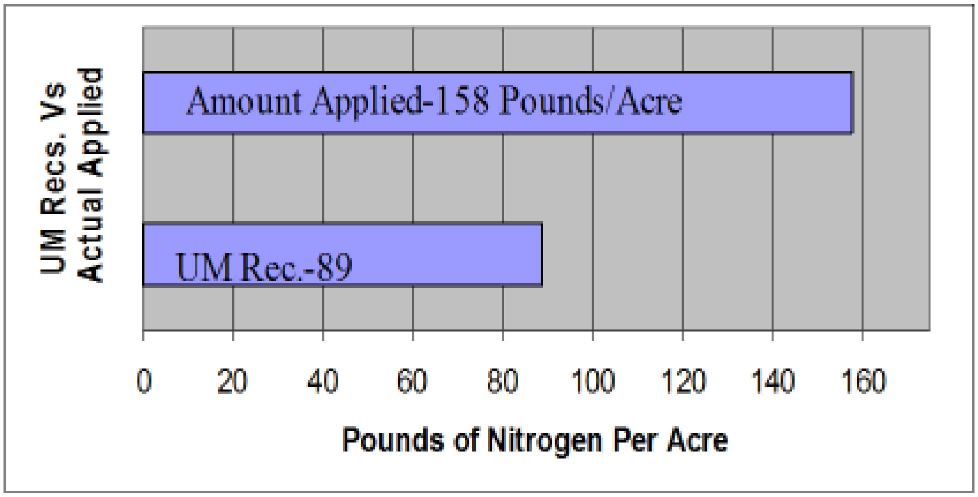


Data Source: Montgomery et al., 2001

Figure IV-6. FANMAP results across multiple DWSMAs. Actual applied nitrogen rates vs U of M recommended nitrogen rates for corn following legumes.

It is common to find corn in rotation with soybeans. In the 2001 report (Montgomery, 2001), 61% of the corn acres were in rotation with soybeans. Very similar to the previously reported statewide assessment (Figure VII-2) for this rotation, a significant amount of over-application was observed due to lack of proper crediting. In these early FANMAP assessments, over-application rates were commonly between 20-40 lb. N/A. This is very similar to the over-applications reported in the statewide MDA/NASS reports (MDA and NASS, 2014, 2016, and 2017).

Corn following Manured Legume Crops



Data Source: Montgomery et al., 2001

Figure IV-7. FANMAP results across multiple DWSMAs. Actual applied nitrogen rates vs U of M recommended nitrogen rates for corn following a manured legume crop.

Within the DWMSAs and other locations (Montgomery, 2001), over-application rates of nitrogen fertilizer averaged 70 lb. /A.

B. Studies have found that fall application of fertilizer in certain soil conditions can lead to groundwater leaching

The specific nitrogen fertilizer BMPs for the five nitrogen fertilizer BMP Regions contain detailed information on the timing recommendations which are highly linked to nitrogen source and soil type. Appropriate timing of nitrogen applications is variable due to soil texture, annual precipitation, and geologic considerations.

It is important to time the application of nitrogen fertilizer to when it can best be used by the plants. The more nitrogen that is used by the plants on the field, the less there will be available to leaching into groundwater. On some soil types, nitrogen fertilizer can be placed in the fall and still be available for plant uptake in the spring. With other soil types, such as coarse textured soils, nitrogen fertilizer must be applied in the spring. In some cases, it can be best to divide the nitrogen fertilizer application into several applications. Nitrogen fertilizer can even be applied between the rows of a growing crop. This type of application is called sidedressing.

The greater the time from application to actual crop uptake, the more opportunities for nitrogen loss. For this reason, farmers who rely on fall application frequently use higher nitrogen rates (additional 10-30 lb/A) compared to spring applications in the same region. Under Minnesota climatic conditions, nitrates left at the end of the growing season are frequently prone to leaching loss which result in potential groundwater contamination. Nitrates left in the soil have been shown to be 40% higher when a nitrogen fertilizer rate of 150 lbs of nitrogen per acre is used, compared to the U of M recommendation of 120 lb of nitrogen per acre (Carlson et al., 2013).

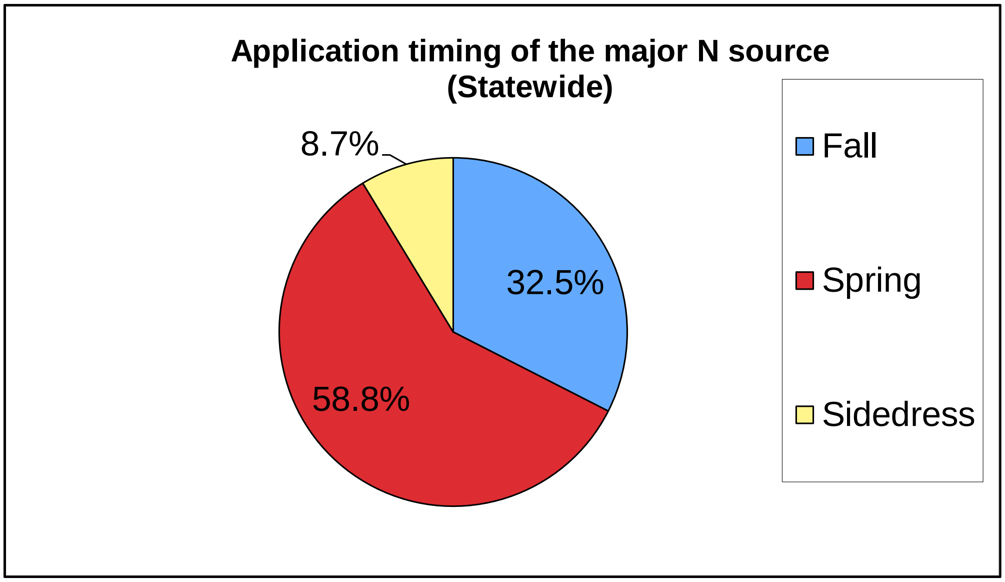


Figure IV-8. Nitrogen fertilizer application (non-manure) timing on corn statewide.

Secondary sources of nitrogen fertilizer: Timing and Crediting

The crediting and timing of secondary nitrogen sources are frequently overlooked in the nutrient planning process. Secondary nitrogen sources are fertilizers that primarily contain large amounts of other nutrients important for plant growth, such as phosphorus and potassium. In many cases these fertilizers also contain nitrogen, and this nitrogen should be subtracted from the total amount of nitrogen applied to the crop. Examples of secondary nitrogen sources include phosphorus fertilizers such as MAP (containing 11% nitrogen in addition to its phosphorus) and DAP (containing 18% nitrogen in addition to its phosphorus). In the past five years, there have been large increases in the use of sulfur products. Some of these products, such as ammonium sulfate (containing 21% nitrogen in addition to its sulfur) need to be managed appropriately for their nitrogen.

C. Conclusion

Based on the evidence provided above, the MDA has determined that the implementation of the BMPs has proven ineffective. Farmers are not taking proper credit for existing nitrogen in the ground and, in addition, are applying nitrogen fertilizer at rates over the recommended levels. This has resulted in leaching of nitrates into the groundwater. Strong evidence has shown that the groundwater in certain areas of the State are over the MDH recommendations. The evidence gathered demonstrates that the implementation of the BMPs as it relates to nitrogen has proven ineffective, and therefore, MDA can proceed with the proposed rule.

V. Statutory Requirements

A. Statutory Authority

Authority for the proposed Rule comes from Minn. Stat. § 103H.275, which was adopted in 1989. All sources of statutory authority for the proposed Rule were adopted and effective before January 1, 1996 and have not been revised by the Legislature, so Minn. Stat. § 14.124 does not apply per Minnesota Laws 1995, chap. 233, article 2, section 58.

Under these statutes, the MDA has the necessary statutory authority to adopt the proposed Rule.

Minn. Stat. § 103H.275, subd. 1(b).
"…the commissioner of agriculture may adopt water resource protection requirements under subdivision 2 that are consistent with the goal of section 103H.001 and are commensurate with the groundwater pollution if the implementation of best management practices has proven to be ineffective."

Minn. Stat. § 103H.275 lists requirements that the MDA must follow when adopting rules for water resource protection requirements.

Minn. Stat. § 103H.275, subd. 2.
"Adoption of water resource protection requirements. (a) …for agricultural chemicals and practices, the commissioner of agriculture shall adopt by rule water resource protection requirements that are consistent with the goal of section 103H.001 to prevent and minimize the pollution to the extent practicable…The water resource protection requirements must be based on the use and effectiveness of best management practices, the product use and practices contributing to the pollution detected, economic factors, availability, technical feasibility, implementability, and effectiveness. The water resource protection requirements may be adopted for one or more pollutants or a similar class of pollutants.

"(b) Before the water resource protection requirements are adopted…the commissioner of agriculture…must notify affected persons and businesses for comments and input in developing the water resource protection requirements.

"(c) Unless the water resource protection requirements are to cover the entire state, the water resource protection requirements are only effective in areas designated by the commissioner of the Pollution Control Agency by order or for agricultural chemicals and practices in areas designated by the commissioner of agriculture by order. The procedures for issuing the order and the effective date of the order must be included in the water resource protection requirements rule.

"(d) The water resource protection requirements rule must contain procedures for notice to be given to persons affected by the rule and order of the commissioner. The procedures may include notice by publication, personal service, and other appropriate methods to inform affected persons of the rule and commissioner's order.

"(e) A person who is subject to a water resource protection requirement may apply…for agricultural chemicals and practices [to] the commissioner of agriculture, and suggest an alternative protection requirement. Within 60 days after receipt, the agency or commissioner of agriculture must approve or deny the request. If the Pollution Control Agency or commissioner of agriculture approves the request, an order must be issued approving the alternative protection requirement.

"(f) A person who violates a water resource protection requirement relating to pollutants, other than agricultural chemicals, is subject to the penalties for violating a rule adopted under chapter 116. A person who violates a water resource protection requirement relating to agricultural chemicals and practices is subject to the penalties for violating a rule adopted under chapter 18D."

B. Regulatory Analysis

In some places, Statewide Water Resource Protection Requirements will be referred to as Part 1 of the proposed Rule; and Drinking Water Supply Management Area: Mitigation Level Designations will be referred to as Part 2 of the proposed Rule.

1. Persons affected

A description of the classes of persons who likely will be affected by the proposed Rule, including classes that will bear the costs of the proposed Rule and classes that will benefit from the proposed Rule.

Classes of persons affected by the proposed Rule
The regulatory portions of the proposed Rule apply to "Responsible Parties," defined as an owner, operator, or agent in charge of cropland.

Bear the costs of the proposed Rule
There are two parts to the proposed Rule: Part 1 restricts fall application in areas vulnerable to groundwater contamination; and Part 2 requires the adoption of nitrogen fertilizer BMPs if they are not adopted voluntarily, and can require AMTs if they are funded, as well as other practices within scope of Minn. Stat. § 103H.275, subd. 2 if the nitrogen fertilizer BMPs are not adopted or if nitrate concentrations in soil below the root zone or in groundwater continue to increase. For purposes of Part 2, the nitrogen fertilizer BMPs are designed specifically to be economically viable and their adoption in most cases will not result in any increased costs and should result in

increased profitability to farmers. The adoption of AMTs if they are funded also will not result in increased costs, as they would be funded. The requirements under Minn. Stat. § 103H.275, subd. 2 directs the MDA to consider economic factors and implementability, among other considerations before requiring a practice, and therefore are also unlikely to impose significant costs on Responsible Parties.

Under Part 1 of the proposed Rule, land owners, operators, and suppliers of nitrogen fertilizer could bear some cost. Restrictions on fall application in vulnerable groundwater areas have been a U of M recommended nitrogen fertilizer BMP for many years. The MDA believes that a large majority of farmers in southeast and central Minnesota, where most vulnerable groundwater areas occur, do not currently fall apply nitrogen fertilizer. In these areas there should be very little or no increased cost. It could even result in some savings by not losing nitrogen fertilizer to leaching.

Shifting from fall to spring application could possibly result in some additional costs for some farmers if fertilizer prices increase due to increased demand and a shorter time period for application. This is likely to be more of an issue in the western part of the state. Comments received during the listening sessions indicated that farmers fall apply in these areas, although there are far fewer vulnerable groundwater areas in these parts of the state, so this would not affect the majority of farmers (Bierman et al., 2011). It is possible that farmers or applicators could incur labor costs if they need to hire additional labor to apply in the spring; however, this was an issue primarily in the northwest part of the state, which is excluded from Part 2 of the proposed Rule. The MDA also heard comments about inadequate bulk dry fertilizer storage capacity and an extremely short spring planting season in some parts of the state. The climate exclusion should help alleviate the majority of these concerns.

The logistics of switching from fall to spring application in vulnerable groundwater areas might be more difficult and more expensive for some facilities in western Minnesota than in other parts of the state. The effective date of January1, 2020 is intended to provide additional time to adjust to these changes.

As for the Drinking Water Supply Management Area: Mitigation Level Designations, land owners, operators, and suppliers of nitrogen fertilizer could bear some cost if the DWSMA in which they raise crops are designated as regulatory mitigation levels and are required to follow the nitrogen fertilizer BMPs or water resource protection requirements. Since the nitrogen fertilizer BMPs are generally economically viable, those costs generally should not be substantial. If water resource protection requirements are imposed at mitigation level 4, then owners and operators could be affected, depending on what is contained in a mitigation level 4 commissioner’s order. The proposed Rule requires the commissioner to consult with local advisory teams, with the goal of creating water resource protection requirements that are specifically tailored to the region and minimize the burdens or costs to the responsible parties.

Benefit from the proposed Rule

High nitrate-nitrogen concentration in drinking water can pose a health risk for infants. When an infant consumes water with nitrate, it is converted into another compound called nitrite. Nitrite causes the hemoglobin in the blood to change into a substance called methemoglobin. This reduces the ability of the blood to carry oxygen, causing a condition known as methemoglobinemia, or "blue baby syndrome." In severe cases, nitrate poisoning can be fatal (MDH, n.d.). The MDH HRL of 10 mg/L nitrate-nitrogen in drinking water was developed based on epidemiological studies published in the 1950s and 1960s. Methemoglobinemia is not a reportable disease so is not tracked by the Center for Disease Control or the MDH. The proposed Rule will provide the greatest direct health benefit to infants under 6 months of age and to community water suppliers and private well owners who need, or are required by law, to provide water that is safe for infants or a general population which includes infants.

Various epidemiological and animal studies have reported a wide range of negative health effects attributable to consumption of water with elevated nitrate-nitrogen including birth defects, miscarriages, hypertension, stomach and gastro-intestinal cancer, and non-Hodgkin's lymphoma (MDH, 2014).

The proposed Rule will benefit citizens served by public water suppliers as well as private well owners in DWSMAs. This will occur by reducing nitrate in groundwater where nitrate levels are elevated and preventing it from occurring in areas where it is not. Preventing and reducing nitrate in groundwater decreases the costs public water suppliers spend to provide drinking water to the public.

There is a large social benefit to the general public from having groundwater with nitrate-nitrogen concentrations below the MDH HRL. This benefit is difficult to quantify but is important for Minnesota with the high value that citizens put on the quality of the waters in the state. One way the value is demonstrated resulted in an amendment to Minnesota's Constitution. In 2008, Minnesota's voters passed the Clean Water, Land and Legacy Amendment increasing the state sales tax. Two of the goals include the protection of drinking water sources and the restoration of groundwater, among others (LCC, n.d.).

Another way this value is demonstrated is through the passage of the Groundwater Protection Act in 1989. The Groundwater Protection Act states. "*It is the goal of the state that groundwater be maintained in its natural condition, free from any degradation caused by human activities. It is recognized that for some human activities the degradation prevention goal cannot be practicably achieved. However, where prevention is practicable, it is intended that it be achieved. Where it is not currently practicable, the development of methods and technology that will make prevention practicable is encouraged.*" The Groundwater Protection Act gives the MDA the authority to adopt the proposed rule.

2. Probable costs to state agencies

The probable costs to the MDA and to any other agencies of the implementation and enforcement of the proposed Rule and any anticipated effect on state revenues.

What is the cost to implement Statewide Water Resource Protection Requirements?
The primary cost for implementing Part 1 of the proposed Rule is the cost of education and enforcement. Education is needed to inform people about the locations of vulnerable groundwater areas and requirements of the proposed Rule. Enforcing the fall application and frozen soil restrictions will take place in 1) quarter-sections where 50% or more of the acres are designated as vulnerable groundwater areas; and 2) DWSMAs that exceed 5.4 mg/L nitrate-nitrogen. The MDA expects to enforce this part of the proposed Rule on a complaint-driven basis.

What is the cost to implement Drinking Water Supply Management Area: Mitigation Level Designation?
Total costs for the MDA to implement and enforce the Drinking Water Supply Management Area: Mitigation Level Designation section of the proposed Rule will vary depending on the number of DWSMAs that are found to have high nitrate. The MDA will bear the costs of evaluating the nitrogen fertilizer BMPs adopted in the DWSMA, establishing any groundwater monitoring networks, as well as providing education within the DWSMAs about the nitrogen fertilizer BMPs and providing financial and technical assistance to facilitate the local advisory team and associated activities. Enforcing the proposed Rule will also be a cost.

Additionally, if DWSMAs move to regulatory status, there will be costs for public notice and hearings.

There are minor or no increased costs to other agencies since where other agencies have roles related to the proposed Rule, the additional work should be limited in scope or should fit into current MDA responsibilities. Other Minnesota state agencies such as the MPCA and MDH will be invited to provide staff to advise regarding technical aspects of the projects. This will occur when topics involve their authority such as manure management or public water suppliers, respectively. The MDA will use nitrate-nitrogen concentration well data that is collected by MDH, but this information is already required to be collected by the federal Safe Water Drinking Act. No additional monitoring or sampling will be required by the MDH. SWCDs are also invited to participate in local advisory teams on a voluntary basis. Their participation is important but not mandatory, and the additional staff costs would be modest. The MDA has already convened several local advisory teams under the NFMP and has provided funding for SWCD participation.

There are no anticipated effects on state revenue associated with the proposed Rule.

3. Less costly or intrusive methods

Determination of whether there are less costly methods or less intrusive methods for achieving the purpose of the proposed Rule.

The MDA considered the cost and potential burden of the proposed Rule. The purpose of the proposed Rule is to reduce nitrate in groundwater and maintain the quality of groundwater to the extent practicable in its natural condition. There are many possible approaches that could be taken to meet this goal. When drafting the NFMP, the MDA convened an advisory committee to provide extensive review and input on the draft plan, which provided the conceptual framework for the proposed Rule.

Statutory requirements also influence the approach for the proposed Rule. Minn. Stat. § 103H.275 specifies that nitrogen fertilizer BMPs be promoted in areas where groundwater pollution is detected. Water resource protection requirements need to be consistent with the goal of Minn. Stat. § 103H.001 and be commensurate with the groundwater pollution if implementation of nitrogen fertilizer BMPs has proven to be ineffective before adopting the proposed Rule. Additionally, the water resource protection requirements must be designed to prevent and minimize pollution to the extent practicable and prevent pollution from exceeding the MDH HRL for nitrate-nitrogen, which is why these requirements are included in the proposed Rule and the reason for not taking a "less costly" approach or using "less intrusive methods."

Less Costly

Not adopting the proposed Rule would be less costly for the MDA. However, there would be costs for others as described in this SONAR (Section 2) and the goals of the Groundwater Protection Act would not be met. There might be less costly methods to accomplishing parts of the purpose of the proposed Rule, but these processes would not address either the presence and/or increase of nitrate in groundwater and would result in higher costs to society in the long run. For example, it might be less costly to install nitrate removal systems in all private and public drinking water systems to address the issue of public health. While this would provide safe drinking water for those individuals, the approach would not meet the goals of Minn. Stat. chap. 103H, which requires *"...groundwater be maintained in its natural condition, free from any degradation caused by human activities,"* and the water quality problems due to nitrates in groundwater would continue to increase.

The MDA has provided promotion and education on the nitrogen fertilizer BMPs since they were adopted in 1991. Nitrate in groundwater continues to be an issue and in some places has increased significantly over the past 25 years. During a comment period on the proposed Rule, a number of commenters stated that the Groundwater Protection Act's purpose could be achieved through continued and additional research and education. While the MDA strongly supports ongoing and increasing research and education efforts, the MDA also believes that such efforts, as noted above, are not enough to ensure that groundwater be maintained in its natural condition or to ensure that nitrate-nitrogen concentrations will not exceed the MDH HRL.

Less Intrusive

Water quality varies significantly throughout the state. Current adoption of the nitrogen fertilizer BMPs is mixed based on region; they are adopted at higher rates in some parts of the state than others. In some places, implementing the nitrogen fertilizer BMPs will be more effective than in other places.

The proposed Rule is targeted in vulnerable groundwater areas and DWSMAs where nitrate-nitrogen concentrations meet certain criteria. Areas that do not meet the vulnerability criteria or that do not meet the nitrate-nitrogen criteria do not fall under regulation. The proposed Rule is designed to be tailored to local conditions and practices. The MDA could have developed a statewide rule requiring the implementation of the nitrogen fertilizer BMPs. Although this approach may have been less work for the MDA, the MDA believes that not actively engaging local farmers and their agronomists in problem-solving to address the local water quality concerns would be far less effective while also being more intrusive for farmers and the agricultural industry throughout the state.

4. Alternative methods of achieving the proposed Rule that were considered and rejected

Description of any alternative methods for achieving the purpose of the proposed Rule that were seriously considered by the MDA and the reasons why they were rejected in favor of the proposed Rule.

Alternatives considered regarding Statewide Water Resource Protection Requirements

Alternative of exclusively relying on water resource protection requirements in proposed Rule – The MDA considered a rule solely based on nitrate-nitrogen concentrations in groundwater and not restricting the application of nitrogen fertilizer in fall and on frozen soils. The second part of the proposed Rule defines a process in which time is allowed for input from local advisory teams and the adoption of nitrogen fertilizer BMPs. It also requires adoption of the nitrogen fertilizer BMPs if 80% of the cropland is not implementing the nitrogen fertilizer BMPs or if certain nitrate-nitrogen water quality criteria are met. The MDA rejected this alternative because restricting the application of nitrogen fertilizer in the fall and to frozen soils in vulnerable groundwater areas serves as a preventive measure in some areas and a mitigation measure in others, allowing MDA to meet its obligation to achieve the goals of 103H.001.

Alternatives considered to Drinking Water Supply Management Area: Mitigation Level Designation

Alternative of regulating townships –The MDA considered a rule that included regulatory levels and water resource protection requirements for private wells in vulnerable townships with high nitrate-nitrogen concentrations that were similar to those in the proposed Rule for DWSMAs. The MDA rejected this alternative because the DWMSAs are the highest priority in the NFMP and the need to make DWSMAs a high priority was a recurring theme in many comments on a draft rule. DWMAs represent the greatest concentration of population at risk from high nitrate. Public water suppliers face substantial costs for addressing nitrate in groundwater as discussed in this SONAR (Section 2). Additionally, the large land area represented by the townships would have required an entirely new program requiring significant resources that the MDA currently does not have. The MDA's current proposed framework allows it to focus its resources on the highest priority areas affecting the greatest number of people, thus having the greatest impact on public health. The MDA will continue to implement the work set out in the NFMP for townships, including private well testing, development and promotion of nitrogen fertilizer BMPs, establishing monitoring networks where feasible, and helping to form local advisory teams to involve local farmers and their advisors in water quality issues in their area.

5. Probable costs of compliance

Probable costs of complying with the proposed Rule, including the portion of the total costs that will be borne by identifiable categories of affected parties, such as separate classes of governmental units, businesses, or applicants.

Statewide Water Resource Protection Requirements

Fall application prohibition – For most farmers, complying with Part 1 of the proposed Rule should not result in additional costs. The MDA believes that most farmers in southeast and central Minnesota, where most vulnerable groundwater areas are located, already follow the nitrogen fertilizer BMP restricting fall application on vulnerable soils or in karst that applies to these areas. It is possible that some farmers may have some additional costs if certain events occur – such as fertilizer prices going up in the spring due to higher demand at that time. Some farmers might incur additional costs if they need to pay for additional help to get their fertilizer applied in the spring. However, these costs are speculative and difficult to quantify.

Suppliers of nitrogen fertilizer, as well as agricultural chemical facilities, could face additional shipping and storage costs since applications will occur in spring and summer. We heard this comment primarily from those entities in the northwest part of the state, but that area is excluded from Part 1 under the current proposed Rule.

Drinking Water Supply Management Area: Mitigation Level Designation

Farmers could face additional costs if nitrogen fertilizer BMPs are required in mitigation level 3 and mitigation level 4 of the proposed Rule. Examples include additional education, soil and manure testing, using soil amendments, and splitting nitrogen fertilizer applications to apply smaller amounts at one time. However, most nitrogen fertilizer BMPs are developed to be economically viable and farmers may increase their profitability by following them.

Requiring the adoption of AMTs in DWSMAs for mitigation level 3 will increase overall costs, but the practices may only be required if funding is available, so it would not result in increased costs to Responsible Parties.

Water resource protection requirements in mitigation level 4 are based Minn. Stat. § 103H.275 and could increase costs. The criteria for evaluating water resource protection requirements cited in the statute include the use and effectiveness of best management practices, the product use and practices contributing to the pollution detected, economic factors, availability, technical feasibility, implementability, and effectiveness. Thus, economic factors and implementability are major considerations that are likely to prevent excessive increased costs to farmers. Further, the proposed Rule requires that these practices be selected in consultation with the Local Advisory Team (LAT), which should provide important input on which practices are practicable and implementable.

There will be no or limited additional costs to other units of government. The primary costs of implementing the proposed Rule will be borne by the MDA. The MDA will be using nitrate-nitrogen concentration data from public wells that the MDH is already required to collect through the Safe Drinking Water Act.

6. Probable costs of not adopting the proposed Rule

Probable costs or consequences of not adopting the proposed Rule, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of governmental units, businesses, or individuals.

If the proposed Rule is not adopted, public water suppliers dealing with high concentrations of nitrate-nitrogen will be required to continue to perform drinking water treatment while incurring increased costs, which can be very substantial. Public water suppliers who face high concentrations of nitrate-nitrogen in the future will need to take action. This could involve drilling a new well, blending from additional wells, or building a facility to treat water prior to consumption. Often current water pricing cannot cover the additional costs of new wells or treatment (MEQB, 2015), so public water suppliers have to raise water rates.

Public water suppliers are required to monitor quarterly if nitrate-nitrogen concentrations exceed 5.4 mg/L. If concentrations exceed 10 mg/L, public water suppliers must issue a drinking water advisory to the community and are required to take immediate steps to return to compliance, while monitoring, as directed by the MDH. Monitoring occurs until concentrations fall below the 10 mg/L nitrate-nitrogen limit. Residents, businesses and industries bear the economic cost of water use restrictions during the drinking water advisory (paying for bottled water, and possibly business-related costs).

The section provides cost estimates for alternatives that public water supplies may consider providing safe drinking water to the public. The estimates come from the MDH, from a report developed by the MDA based on interviews with seven water suppliers, and from a report titled Addressing Nitrate in California's Drinking Water.

Installing a new well - In some cases, a new public water supply well may need to be installed in a deeper or uncontaminated aquifer. Communities face considerable costs for locating and drilling wells and associated needs such as land purchase and constructing pump houses and transmission mains. Interviews from public water suppliers in 2007 estimated drilling, pump installation and well housing costs of $162,000 in Park Rapids and $246,300 in Clear Lake (UM, 2016). A California report estimates small community costs range from $40,000 to $290,000 to drill new wells and $80,000 to $100,000 to drill deeper wells (UC Davis, 2012). Although deep aquifers tend to be lower in nitrate, the water pumped from them may require treatment to remove iron, manganese, sulfate, arsenic, or radium. Installing a new well is not an option if a deeper aquifer is not available or if other aquifers contain nitrate.

Source water blending – Some public water suppliers blend water from a high nitrate source with water from a low- or no-nitrate source. Costs for blending include labor, pumping, monitoring, and reduced capacity. This alternative blend depends on having a connection to a source of water that is low in nitrate with adequate capacity. Annual costs ranged from $900 to $3,000, and capital costs may include the need to replace pumps and add transmission mains ($500,000 or more) (MDH, Personal Communication. 2018).

Purchase water from another entity – This can be an option if a nearby water supplier is able to provide low nitrate water. Costs can be substantial including costs for building the infrastructure to distribute the water and to ensure the chemistry or treatment is adequate for the distribution system.

Treatment – Nitrate removal (treatment) may be the only feasible option in situations where an adequate quantity or quality of water is not available. Nitrate removal systems used by public water suppliers include:

- *Reverse Osmosis Process* – Pressure forces water through a semi-permeable membrane leaving most contaminants behind along with a portion of the rejected solution. For one municipal reverse osmosis system, the initial construction cost was more than $7 million. Estimated annual operating and maintenance costs for these types of treatment plants can range from tens of thousands of dollars to more than $100,000. Disadvantages with this type of treatment is that the system uses up to 4 gallons of water for every gallon produced, has a large energy footprint, creates a salty waste product that is discharged to the environment, and it enhances corrosion potential for lead and copper exceedances in finished drinking water.

- *Anion Exchange Process* – Contaminated water is passed through a resin filled bead tank. The resin is saturated with chloride, which chemically trades places with the similarly charged nitrate ion. Eventually the resin needs to be recharged by back washing it with a sodium chloride solution. Construction costs range from $300,000 for a nonmunicipal system to more than $4 million for a municipal system, with annual maintenance costs at $7,000 to $22,000, or more. Disadvantages with this type of treatment is that it creates a salty waste product that is discharged to the environment, and it enhances corrosivity potential for lead and copper in finished drinking water.

According to the report based on interviews with public water suppliers, the installation and maintenance of municipal nitrate removal systems increased the cost of water delivered by fourfold or more. Additional costs range from $0.82 to $7.23 to produce 1,000 gallons. Communities with treatment also need to hire staff with higher class licenses and provide an adequate payscale to operate the treatment plant. These additional costs are passed on to rate payers.

The MDH estimates that the number of community water systems that treat for nitrate has increased from six systems serving 15,000 people in 2008 to eight systems serving 50,000 people in 2014. For communities with nitrate-nitrogen above 10 mg/L, annual costs over the five-year period of 2011 to 2016 ranged from $46 to $7,900 per household. Six noncommunity systems exceeded the 10 mg/L nitrate-nitrogen MDH HRL in 2016, requiring system owners to take corrective action (MDH, 2017). If community water systems that either sealed a well or removed a well from use are included, the number of affected communities increased to 56 between 1994 and 2016 (MDH, Personal Communication., 2018).

7. Assessment of differences between proposed Rule and federal regulations

The proposed Rule covers areas that are not addressed by federal law; therefore, this consideration is not applicable for those portions of the proposed Rule.

8. Assessment of cumulative effect of Rule with federal and state regulations

Minn. Stat. § 14.131 defines *“cumulative effect” as “the impact that results from incremental impact of the proposed rule in addition to other rules, regardless of what state or federal agency* *has adopted the other rules. Cumulative effects can result from individually minor but collectively significant rules adopted over time."*

There are no existing rules that regulate the use of nitrogen fertilizer. The proposed Rule is complementary to and works efficiently with existing regulations. Minn. R. chap. 7020 regulates animal feedlots and land application of manure. The proposed Rule does not regulate the application of manure, but manure application will need to be considered in order to determine the total amount of nitrogen fertilizer applied. The MDA has included a provision in the proposed Rule to allow the use of manure management plans and related approvals and inspections to document that appropriate nitrogen fertilizer BMPs are being followed as an efficiency option.

The MDH has the authority to administer the Safe Drinking Water Act in Minnesota. Public water suppliers monitor drinking water. Residents are informed, and corrective action is action if nitrate-nitrogen exceeds the 10 mg/L MDH HRL. The actions public water suppliers pursue involve providing alternative sources of safe water (MDH, 2015). The proposed Rule will complement these existing requirements by addressing nitrogen fertilizer, which is one of the main sources of nitrate in groundwater, prior to public water supplies reaching the 10 mg/L HRL.

E. Cost of Complying for Small Business or City

Minn. Stat. § 14.127, subd. 1. states, *"An agency must determine if the cost of complying with a proposed rule in the first year after the rule takes effect will exceed $25,000 for: (1) any one business that has less than 50 full-time employees; or (2) any one statutory or home rule charter city that has less than ten full-time employees. For purposes of this section, "business" means a business entity organized for profit or as a nonprofit, and includes an individual, partnership, corporation, joint venture, association, or cooperative."*

The rule does not apply to cities; therefore, there will be no cost to them.

The MDA does not believe that compliance with Part 1 of the rule will exceed $25,000 for any Responsible Party subject to the fall restriction. As noted above, most farmers in vulnerable groundwater areas already are not fall applying, or they should not be fall applying according to University of Minnesota BMPs. Potential scenarios where a Responsible Party would incur a cost of more than $25,000 would either be based on voluntary choices made by the Responsible Party, or are very speculative.

The MDA does not believe that compliance with Part 2 of the rule will exceed $25,000 for any responsible party subject to the rule within the first year after the rule takes effect. As noted in 1573.0060, Drinking Water Supply Management Areas will be initially designated level 1 or level 2 – both of which involve solely voluntary measures. Under part 2 of the rule, a Responsible Party cannot move to a level with mandatory regulations until after at least three growing seasons. DWSMAs can only move up one level at a time, so the first year of regulation that any Responsible Party would face would be level 3, which would entail a commissioner's order requiring implementation of nitrogen fertilizer BMPs. The nitrogen fertilizer BMPs are designed to be economically viable and their adoption in most cases will not result in any increased costs and should result in profitable to farmers. In level 3, the commissioner could order the implementation of AMTs but only if they are funded, so that will not result in increased costs.

F. Determination About Rules Requiring Local Implementation

The proposed Rule will not apply to local government (LGUs) because there is no requirement that a LGU must adopt any or all of this proposed Rule. The MDA has sole authority for the proposed Rule and the regulations therein. The MDA notes that there is no state pre-emption of local regulation of the use of nitrogen fertilizer (Minn. Stat. chap. 18C). A LGU may choose to regulate the use of nitrogen fertilizer with or without the MDA's proposed Rule.

G. Performance-Based Regulatory Systems

The SONAR must describe how the MDA, in developing the proposed Rule, considered and implemented the legislative policy supporting performance-based regulatory systems set forth in section 14.002 which states, *"whenever feasible, state agencies must develop rules and regulatory programs that emphasize superior achievement in meeting the agency's regulatory objectives and maximum flexibility for the regulated party and the agency in meeting those goals."*

Part 1 of the proposed Rule restricts the application of nitrogen in the fall and on frozen soils in vulnerable groundwater areas. This rule contains performance-based standards in that the proposed Rule focuses on areas that are most vulnerable to nitrates leaching into groundwater. The area covered in this proposed Rule includes quarter-sections that are equal to or greater than 50% vulnerable and does not include quarter-sections less than 50% vulnerable. Rather than regulate on invisible lines, the use of known boundaries is clearer for regulated parties. The proposed Rule is also performance-based in that, in Part 2, all of the regulations will be based on objective measures, such as documented increase in nitrates or the failure to implement BMPs, which are aimed at achieving the goal of the Groundwater Protection Act.

The proposed Rule also incorporates maximum flexibility for regulated parties and the MDA in achieving the MDA's regulatory goals. Some areas of the state are excluded based on climate or where counties are less than 3% agriculture. Exceptions are made in cases where fall fertilization is necessary and for fertilizers where phosphorus or micronutrients are included, among others.

In Part 2 of the proposed Rule, the primary purpose is to work with farmers to come up with local solutions to address nitrate levels in groundwater. The approach is designed to allow flexibility and for local input to influence the practices that are adopted or required in a DWSMA. Under the site specific water resource requirements, DWSMAs meeting the criteria will start in voluntary mitigation levels 1 or 2. This provides time for discussion and the formation of a local advisory team. The Local advisory teams will advise the MDA commissioner on the nitrogen fertilizer BMPs that should be adopted in that area, based on soils, crops grown, equipment available and other factors. Farmers will have at least 3 growing seasons to adopt the practices and to address nitrate levels. Farmers also have the option of implementing Alternative Management Tools, which are designed to go beyond the nitrogen fertilizer BMPs and to be local solutions. All of these factors make for a proposed Rule that meets the MDA's regulatory objectives and provides maximum flexibility for the regulated party.

H. Consultation with MMB

The MDA will consult with Minnesota Management and Budget (MMB) as required by Minn. Stat. § 14.131. The MDA will do this by sending MMB copies of the proposed Rule, SONAR and proposed Rule and SONAR form that will be sent to the Governor's office for review and approval prior to publication. The MDA will send these to MMB on, or near, the same day they are submitted to the Governor's office, well in advance of publishing the proposed Rule in the State Register. A copy of the correspondence and any response received from MMB will be included in the record the MDA submits to the Office of Administrative Hearings (OAH) for the required Administrative Law Judge's review.

I. List of Witnesses

If the proposed Rule goes to a public hearing, it is anticipated that the MDA will be represented by the following personnel involved at the administrative hearing on the need for and reasonableness of the proposed Rule.

1. Susan Stokes – Assistant Commissioner, Minnesota Department of Agriculture
2. Doug Spanier – Department Counsel, Minnesota Department of Agriculture
3. Dan Stoddard – Assistant Director, Pesticide and Fertilizer Management Division
4. Bruce Montgomery – Manager, Fertilizer Non-Point Section

J. Public Participation and Stakeholder Involvement

The proposed Rule has been in development for several years and the MDA has made extensive efforts to inform and engage specific stakeholders and the general public. The MDA used a number of mechanisms to encourage public participation and provide access to information.

Minn. Stat. §103H.275, subd. 2(b) requires the Commissioner of Agriculture to notify affected persons and businesses for comments and input in developing the water resource protection requirements. The MDA believes that it has met this requirement by conducting the activities outlined below. These activities are also part of the MDA's efforts to provide additional notification under Minn. Stat. § 14.14, subd. 1(a), to persons or classes of persons who may be affected by the proposed Rule.

1. Pre-proposal outreach and notice

The MDA began outreach activities with the updating of the NFMP in 2010 and these activities will continue beyond the adoption of the proposed Rule. The draft rules were part of the activities to address nitrate in groundwater included in the NFMP. This section describes the MDA's public outreach efforts.

Nitrogen Fertilizer Management Plan Advisory Committee

In revising the 1990 NFMP, the MDA used an advisory committee that consisted of representatives from the agricultural community, the environmental community, state and local government, and representatives from the U of M. The input from this advisory committee as well as the NFMP (which was revised and adopted in 2015) was used as guidance for the proposed Rule. (MDA, 2015).

Website – The Nitrogen Fertilizer Rule website (www.mda.state.mn.us/nfr) was created to provide information on the draft rule and the rulemaking process to interested parties. The availability of this website was included in correspondence with interested parties and linked to by other related websites. The website included information on the rulemaking process, details regarding components of the draft rule, and information about listening sessions held throughout the state and frequently asked questions (FAQs) about the rule. Also included was a comment page where persons were able to submit comments directly to the MDA. Drafts of the rule were also posted to the website. The website also provides MDA staff contact information if someone wished to contact the department directly.

A website was also created for the revision of the NFMP. This website contained factsheets, drafts of the revised NFMP, and links to other sites with information about projects related to the NFMP revision.

GovDelivery – GovDelivery is a self-subscription service that MDA uses to electronically notify interested or affected persons of various updates and public notices issued on a wide range of topics. Individuals can register their email address and choose the notifications they want to receive from the MDA at the following webpage: https://public.govdelivery.com/accounts/MNMDA/subscriber/new

The Nitrogen Fertilizer Rule was added to the list of topics for subscribers when the service became available to the MDA in 2015. Prior to GovDelivery being available, the MDA used a different service for notifying large groups via email. The listserv from the previous service was copied to GovDelivery when MDA transferred services. A notice was sent via GovDelivery when the Request for Comments became available for comment. Notice was also sent to this list when the draft Nitrogen Fertilizer Rule was made available for comment. Reminders were also sent regarding the listening sessions. The MDA will continue to use GovDelivery to inform stakeholders about the proposed Rule and the implementation of the NFMP.

Request for Comments – A Request for Comments on the Nitrogen Fertilizer Rule was published in the State Register on Monday, October 26, 2015. The MDA received 23 original written comments and over 100 copies of a form letter. These letters were made available on the MDA's website at http://www.mda.state.mn.us/chemicals/fertilizers/nutrient-mgmt/nitrogenplan/mitigation/wrpr/wrprcomments.aspx. These comments were considered by the MDA when drafting the language for the proposed Rule. The MDA asked for comments on specific areas proposed in the Rule, but also requested any additional information stakeholders thought might be relevant any comments interested parties wished to provide.

Public Presentations – Several public presentations were made to various groups throughout the state of Minnesota to gather input from various groups prior to, and during the writing the rules.

- Groundwater Conference, October 2016
- Nitrogen Conference, February 2017
- Nutrient Conference, February 2017

Draft Nitrogen Fertilizer Rule Comment Period – The MDA made a draft of the rule available for public comment. This draft was published on the MDA's website, distributed via the GovDelivery email list, and the MDA had a comment period open from June 7, 2017 until August 25, 2017. The comment period was originally scheduled to end on August 11, but after requests for an extension by many interested parties, especially agriculture associations and industry, the MDA extended it until August 25th. During this time the MDA received over 820 comments, held 11 listening sessions throughout the state and gave presentations at 6 invited meetings.

Listening Sessions on the Draft Rule – After the draft of the rule was published on June 7, 2017 the MDA held eleven public listening sessions at locations throughout the state in order inform stakeholders and interested parties about the Nitrogen Fertilizer Rule. Each of these listening sessions included a formal presentation by MDA regarding details of the draft rule, followed by participant questions and answers. Listening Sessions were held at the following locations:

Table V-1. Draft Nitrogen Fertilizer Rule listening session locations, dates and times: June 2017.

Location		Date	Time
Marshall:	**Marshall Public Library 201 C Street Marshall, MN 56258**	Thurs. June 22	5:00 pm
Chatfield:	**Chatfield Center for the Arts 405 Main Street Chatfield, MN 55932**	Wed. June 28	6:00 pm
Farmington:	**University of MN Extension Office 4100 220th St W. Farmington, MN 55024**	Thurs. June 29	2:00 pm
St. Cloud:	**Great River Regional Library 1300 W. St. Germain Street St. Cloud, MN 56301**	Thurs. July 6	3:00 pm
Wadena:	**Robertson Theatre Wadena-Deer Creek High School 600 Colfax Ave. SW, Wadena, MN 56482**	Tues. July 11	6:00 pm
McIntosh:	**McIntosh Community Center 115 Broadway NW, McIntosh, MN 56556**	Wed. July 12	4:00pm
St. Paul:	**Orville Freeman Building 625 Robert Street North, St. Paul, MN 55155**	Mon. July 17	2:00pm
Fairmont:	**Holiday Inn 1201 Torgerson Dr. Fairmont, MN 56031**	Tues. July 25	2:00pm
Roseau:	**Roseau Civic Center 121 Center Street East Roseau, MN 56751**	Wed. July 26	6:30 pm
Warren:	**Warren Community Center 110 West Johnson Avenue Warren, MN 56762**	Thurs. July 27	8:30 am
Hawley:	**Hawley High School 714 Joseph Street Hawley, MN 56549**	Thurs. July 27	7:00 pm

After the publication of the draft rule the MDA also gave presentations and received feedback from groups requesting that the MDA provide more information on the proposed Rule. These additional meetings included:

Table V-2. Draft Nitrogen Fertilizer Rule presentation locations and dates: July 2017-December 2017.

Additional Meetings	Location	Date
Greater Blue Earth River Basin Alliance	Mankato, MN	Friday, July 14, 2017
Soybean Growers Meeting	Mankato, MN	Thursday, July 20, 2017
Corn Growers Meeting	Shakopee, MN	Thursday, July 27, 2017
MCPR Member Meeting	Morgan, MN	Monday, July 31, 2017
MPCA/MDA meeting on Nitrogen Fertilizer Rule	MPCA office, St. Paul, MN	Friday, August 11, 2017
MCPR Member Meeting	Cold Spring	Wednesday, August 16, 2017
Cooperative Network Farm Supply, Grain and Fuel Committee	Brainerd, MN	Wednesday, September 6, 2017
BWSR Board Presentation	St. Paul, MN	Wednesday, October 25, 2017
Minnesota Association of Townships Annual Meeting	Rochester, MN	Friday, November 17, 2017
Minnesota Association of Soil and Water Conservation Districts Annual Meeting	St. Paul, MN	Tuesday, December 5, 2017

In addition, the MDA held six stakeholder listening sessions in conjunction with Governor Dayton's 25 by 25 listening sessions. The rule was a primary topic addressed in those listening sessions. Those meetings were held at the following locations and dates:

Table V-3. MDA listening sessions held in conjunction with the 25 by 25 listening sessions.

Location	Date
Rochester	Monday, July 31, 2017
Mankato	Wednesday, August 16, 2017
Marshall	Thursday, August 17, 2017
Crookston	Tuesday, September 5, 2017
St. Cloud	Wednesday, September 6, 2017
Bemidji	Wednesday, September 13, 2017

2. Additional notice plan

Minn. Stat. §§ 14.131 and 14.22 require that the SONAR contain a description of MDA's efforts to provide additional notice to persons who may be affected by the proposed Rule.

Because of the degree of public interest in the proposed Rule, the MDA intends to conduct more outreach and public notice than the minimum required by the state Administrative Procedures Act. When the MDA publishes the Notice of Hearing, the MDA intends to conduct the following additional activities to ensure that all interested people and affected communities will be notified and have a chance to meaningfully engage in the comment process.

This additional notice plan was sent to the Office of Administrative Hearings for review and approval by Administrative Law Judge______________ on __________________.

The additional notice plan consists of the following steps:

1. Mail the Notice of Hearing, proposed Rule and SONAR to all registered parties on the MDA's rulemaking list, per Minn. Stat. §14.14, subd. 1(a).
2. Email the Notice of Intent, proposed Rule and SONAR to the Minnesota Legislature per Minn. Stat. § 14.116.
3. Email the Notice of Intent, proposed Rule and SONAR to the House and Senate committees with jurisdiction over the environment, natural resources and agriculture as required in Minn. Stat. § 103H.275, subds. 2(a) and 1(c)(3).
4. Publish the Notice of Intent to Adopt Rules, a copy of the proposed Rule, and the SONAR on the MDA's Nitrogen Fertilizer Rule website for public viewing and comment.
5. Issue a press release announcing the publication of the Notice of Intent to Adopt Rules and directions on how to comment.
6. Email the Notice of Intent, proposed Rule and SONAR to all parties that were sent the Request for Comments in October 2015.
7. Email all parties who have expressed interest in the proposed Nitrogen Fertilizer Rule by signing up for a GovDelivery email mailing list.
8. Email the Notice of Hearing, proposed Rule language and SONAR to other governmental agencies – MDNR, MPCA, MDH, BWSR, and SWCDs.

The Additional Notice Plan does not include notifying the state Council on Affairs of Chicano/Latino People because the proposed Rule does not have a primary effect on Chicano/Latino persons.

K. Effect on Local Government Ordinances

The proposed Rule will not apply to local government because there is no requirement that a local government must adopt any or all of this proposed Rule. The MDA has sole authority for the proposed Rule and the regulations therein. The MDA notes that there is no state pre-emption of local regulation of the use of nitrogen fertilizer. A local government may choose to regulate the use of nitrogen fertilizer with or without the MDA's proposed Rule.

VI. Rule by Rule Analysis of Need and Reasonableness

A. 1573.0010 Definitions

The proposed Rule 1573.0010 defines the terms used throughout the proposed Rule parts 1573.0010 – 1573.0090. The definitions are necessary to ensure that the proposed Rule is clearly understood. The inclusion of definitions is reasonable so that the MDA may consistently apply the proposed Rule, and so that regulated and other affected parties do not become confused as to how to interpret the language contained in the proposed Rule.

Twenty-two terms used in the proposed Rule were identified as needing definitions. Seven of these terms and their associated definitions were derived from existing terms and definitions in other state statutes or rules including: *commissioner, drinking water supply management area, groundwater, municipal public water supply well, public well, responsible party, section*.

Fifteen terms are unique to this proposed Rule and are further described below.

Subp. 2. Definitions. – Alternative management tools (AMTs)

This definition is needed and reasonable in order to clarify that these are practices and solutions that are different from the nitrogen fertilizer BMPs as defined in this SONAR. AMTs are designed to go beyond the nitrogen fertilizer BMPs and be local solutions for addressing groundwater nitrate problems that are implemented on a site-specific basis. Local advisory teams will be able to identify and promote these beneficial practices (AMTs) that go beyond the nitrogen fertilizer BMPs. Examples include alternative cropping systems, low nitrogen input crops, continuous cover such as CRP, or putting perennials in key charge areas, and land swapping to shift high nitrogen using crops to non-vulnerable land. Precision agriculture is included in the definition to provide clarity to stakeholders that various precision agricultural techniques such as variable rate planting and fertilization, soil and plant tissue sampling, nitrogen enhancement products, and others are recognized and encouraged. This term comes from the NFMP, which serves as the basis for the proposed Rule. Further discussion about how these tools will be defined and where they will be available is discussed in this SONAR, under 1573.0090 Alternative Management Tools; Alternative Protection Requirements (MDA, 2015).

Subp. 3. Definitions. – Coarse textured soils

This definition is needed because coarse texture is an important criterion within the vulnerable area definition and needs to be defined in order to provide clarity to the regulated party. While ‘coarse textured soils’ is a commonly used term, its definition varies depending on the context within which it is used. A definition of coarse textured soils is needed because coarse texture is a physical characteristic of soil that makes underlying groundwater at a higher risk for contamination by agricultural chemicals (IPNI, 2018). The U of M nitrogen fertilizer BMPs specify nitrogen fertilizer management practices for coarse textured soils, including not recommending fall nitrogen fertilizer application, regardless of form. However, a clear definition of ‘coarse texture’ is not provided in the nitrogen fertilizer BMPs (the term ‘sandy soil’ is used interchangeably with ‘coarse textured soil’), therefore it is reasonable that the proposed Rule provide a definition in order to clearly define the soils where this criterion applies. The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) is the national source for soils information (Soil Survey Staff, n.d.). The USDA-NRCS definition is used in federal practice standards and technical assistance programs, and this soils data has been used by farmers, agriculture and natural resource professions for many years, therefore it is reasonable that the definition comes from the USDA-NRCS.

This definition of coarse textured soils also aligns with the definition used by the Minnesota Pollution Control Agency (MPCA) for applying manure in areas sensitive to leaching of nutrients through the bottom of the root zone (MPCA, 2005) and the USDA-NRCS Minnesota conservation practice standard for nutrient management (USDA NRCS, 2007).

Subp. 5. Definitions. – Cropland

This definition is needed to clarify for the regulated party what is included as ‘cropland.’ This term is based on the USDA National Agricultural Statistics Service (NASS) definition of cropland and includes the major and minor row crops, hay and silage crops, a variety of pasturing scenarios, idle cropland such as Conservation Reserve Program and other set aside programs, and numerous miscellaneous crops. NASS conducts hundreds of national agriculture-related surveys on cropland and other features each year, therefore it is reasonable to use the NASS definition of cropland. It is broadly understood and anticipated that these lands would receive commercial nitrogen fertilizer applications somewhere in the rotation, and the vast majority of these acres would receive annual or biannual applications of nitrogen fertilizer.

Commercial sod production acres fall under this definition as sod is harvested from the land surface as an annual crop. Turfgrass is not included in this definition as it is not removed for use as a food, forage, fiber or energy crop and is not used as pasture. Forestland is not included in the definition of cropland as the land remains covered by trees for multiple growing seasons, is minimally fertilized not typically in an agricultural rotation and the risk of nitrate movement to the groundwater under forestland is normally small.

Subp. 7. Definitions. – Fall application

The definition is needed so the MDA and regulated parties have clarity and a mutual understanding of when fall fertilizer restrictions apply. This term defines the time of year where application of nitrogen fertilizer has the greatest potential for runoff or leaching through the soil. Fall applications on coarse texture soils and in karst regions are not recommended by the nitrogen fertilizer BMPs, therefore a definition of fall application is needed to define when nitrogen fertilizer application should not occur. This is a reasonable approach because a specific date provides the greatest clarity when this restriction goes into effect.

Subd. 8. Definitions. – Frozen soil

The term frozen soil is needed to define under what conditions nitrogen fertilizer should not be applied. When nitrogen fertilizer is applied to frozen soils, it is not able to be properly incorporated into the soil, resulting in a greater chance of fertilizer to runoff the soil surface or convert to a gaseous form. The MDA considered a definition of frozen soil using a temperature of 32 °F. However, this was ruled out, since there could be variability in soil temperature at different soil depths as well as variability by locations. In addition, it would take greater effort by the regulated parties to take temperature measurements and for the MDA to verify these. The MDA chose to use a more practical definition of frozen based on the physical ability to apply and incorporate fertilizer. Frozen soil is a commonly used term in the proposed Rule and defining it is reasonable to clarify the intent of the proposed Rule.

Subd. 10. Definitions. – Groundwater monitoring network

This definition is needed to define how the MDA may monitor shallow groundwater in a DWSMA. A groundwater monitoring network consists of multiple wells. The network will allow the MDA to determine the current nitrate levels in groundwater instead of waiting up to ten years to detect how nitrate levels in a public well respond to changes in agricultural practices in the DWSMA. It provides an approach to monitor nitrate in groundwater as required in Minn. Stat. § 103H.251, subd. 2.

Subd. 11. Definitions. – Growing season

This term is needed as it defines the timeframe and time of year in Minnesota where normal conditions for crop growth occur. The length of the growing season varies by crop and impacts the applicable nitrogen fertilizer BMPs. Growing season is a commonly used term in the proposed Rule and defining it is reasonable to clarify the intent of the proposed Rule.

Subd. 12. Definitions. – Lag time

The definition of this term is necessary to ensure the proposed Rule addresses, in a scientifically correct manner, how long it will take before changes in practices on the land surface will result in changes in water quality that can be observed in groundwater wells. Since regulatory requirements may be based on changes in water quality it is reasonable and necessary that the proposed Rule describe what lag time means. Since lag time is a method used by hydrogeologists in determining the potential impacts of surface land use on groundwater, it is reasonable that the MDA uses lag time criteria in the proposed Rule (Sousa et al., 2013).

Subd. 13. Definitions. – Leaching index

This term is needed to explain the risk of nitrate from nitrogen fertilizer moving through the root zone towards the groundwater in different parts of the state. The leaching index is calculated as the daily precipitation minus evapotranspiration (evaporation of water from the soil and from the vegetation) summed to annual values. The leaching index can be a positive or a negative number. A more negative leaching index indicates less water available for moving through the soil resulting in lower risk of nitrate leaching losses. The input data from the gridMET dataset is developed based on gridded climate data from the national PRISM dataset and reanalysis data from NASA's NLDAS-2 dataset (Abatzoglou, 2013). Evapotranspiration is estimated using the standardized, grass-based Penman-Monteith equation. (ASCE-EWRI, 2005)

Subd. 14. Definitions. – Local advisory team

The term local advisory team (LAT) comes from the NFMP. One of the goals of the proposed Rule is to involve the agricultural community in problem solving at the local level. This definition is needed in order to help meet that goal, and advise the MDA regarding appropriate response activities for the area and to support implementation of these activities. The team will help develop, communicate, and implement locally viable solutions to address elevated nitrate in the local project area. The intent is to develop a team which will consist of 15-20 people who are from the area, including farmers, crop advisors/consultants, representatives of local groups/organizations, representatives of public water supply systems (in Drinking Water Supply Management Areas, or DWSMAs), and government staff and/or professionals who can provide technical or financial support. The majority of the members will be local farmers and their crop advisors/consultants. It is reasonable that LATs be formed because they are best able to identify local conditions and nitrogen management practices to address nitrate in groundwater. In addition to LATs providing recommendations to the MDA on nitrogen fertilizer BMPs and other practices, successful LATs will provide credibility and support for the nitrogen management activities to be implemented.

Subp. 16. Definitions. – Nitrogen fertilizer best management practices

This term is needed to define the nitrogen fertilizer BMPs adopted under Minn. Stat. § 103H.151, subd. 2, the MDA developed best management practices (BMPs) for agricultural chemicals and practices specific to nitrogen fertilizer with the help of the U of M. The MDA gave public notice and solicited comments from affected persons and business interested in developing the nitrogen fertilizer BMPs and has updated these BMPs using the process outlined in Minn. Stat. § 103H.151, subd. 2, so as to reflect U of M updates to fertilizer recommendations. It is needed to provide farmers a set of practices to use to address nitrate in groundwater and is reasonable because the practices are based on U of M research.

Subp. 17. Definitions. – Nitrogen fertilizer

There are many different products that contain nitrogen and are used for agricultural purposes. This definition is needed to clarify what agricultural products are covered under the rule. This definition is reasonable because it is based on the definition of fertilizer in Minn. Stat. 18C.215 and modified based on public comment. Public comments were received stating that biosolids, industrial by-products, industrial wastewater, and irrigation water should not be included in this definition and they were removed.

Subp.19. Definitions. – Residual soil nitrate tests

For purposes of the proposed Rule, this term is needed to define the process of analyzing the results from soil samples between the root zone and the water table on an established time frame to evaluate changes in nitrate levels in soil. This definition is reasonable as this technique may be needed in areas where lag times are very long (typically in terms of decades) and where it may be cost prohibitive to install monitoring wells due to excess drilling depths.

Subp. 22. Definitions. – Spring frost-free date

The term was needed to specify the date where the probability of the last day of frost occurring in the spring is 10% or less. The spring frost-free date depends on the climate and varies across Minnesota. A later spring frost-free date indicates a shorter period in the spring to complete farm field operations and a greater risk of crops being damaged by frost. This is important for nitrogen fertilizer management because it is indication of when crops will be actively growing and using nutrients. The input data is from National Oceanic & Atmospheric Administration's (NOAA) National Climatic Data Center (NCDC) and is available through the Minnesota Department of Natural Resources (MDNR) State Climatology Office (MDNR, 2018).

Subp. 23. Definitions. – Vulnerable groundwater area

The term vulnerable groundwater area is needed to define the areas of the state where nitrate can move easily through the soil and/or bedrock to the groundwater. The criteria for this definition was developed using soil information from the USDA-NRCS (Soil Survey Staff, n.d.) and geology information from the MDNR to identify areas with the greatest risk of nitrate traveling into groundwater. In addition, the MDNR 'ultra-low' sensitivity layer (Adams, 2016) was used as a criterion to identify areas that are not vulnerable. A further discussion about the general need and reasonableness for this term can be found in this SONAR, 1573.0030 Statewide Water Resource Protection Requirements.

B. 1573.0020 Incorporation by Reference

Rather than repeating the content of these guidance documents in the proposed Rule, they are incorporated by reference. While not subject to frequent change, these guidance documents are updated more frequently than rules. These documents are all readily available on the MDA's website www.mda.state.mn.us/nfr/references.

C. 1573.0030 Statewide Water Resource Protection Requirements

Background on vulnerable groundwater areas

The proposed Rule restricts the application of nitrogen fertilizer in the fall and to frozen soils in vulnerable groundwater areas. Vulnerable groundwater areas are defined as:

- Coarse textured soils, as identified in the USDA-NRCS, Soil Survey Geographic Database (SSURGO) soil database (Soil Survey Staff, n.d.);
- Soils with shallow depth to bedrock as identified in the USDA-NRCS, SSURGO soil database, Web Soil Survey (Soil Survey Staff, n.d.); and
- Karst geology as identified in the Department of Natural Resources Pollution Sensitivity of Near-Surface Materials (Adams, 2016).

The MDA used the criteria above to define vulnerable groundwater areas, and it is needed, because of the increased risk of nitrogen fertilizer leaching into groundwater.

It is well established in research literature that nitrogen fertilizer is a source of nitrate, and nitrate, due to its high solubility in water can leach easily through soil to reach groundwater (IPNI, 2018). For this reason, U of M nitrogen fertilizer BMPs do not recommend fall nitrogen fertilization in vulnerable groundwater areas due to environmental and financial risk (Lamb, 2008). The financial risk is that a farmer applies nitrogen fertilizer in the fall and loses the investment if the nutrient has moved away from the root zone and is no longer available for next year's crop.

Factors influencing nitrate leaching

Nitrate is highly water soluble in water and due to its negative charge, it easily moves through the soil profile. The degree of leaching is affected by many factors, including soil characteristics (such as soil texture and moisture holding capacity), climate (such as timing and amounts of precipitation), and plant water use. These factors must be considered when designing appropriate nitrogen fertilizer BMPs and are discussed later in this document.

Minnesota has over 21 million acres of cropland. The MDA has recently estimated that 2.6 million acres are "vulnerable," meaning that nitrogen inputs must be very carefully managed to protect groundwater quality. This is a mixture of coarse-textured soils, karst landscapes, and situations where there is shallow depth to bedrock. The following section presents criteria used for identifying the vulnerable groundwater areas and other options considered in the process. Soils that are shallow to bedrock are those soils where the bedrock is within 5 feet of the surface.

Coarse textured soils and soils that are shallow to bedrock criteria

The MDA identified coarse textured soils and soils that are shallow to bedrock using the USDA-NRCS Soil Survey Geographic (SSURGO) soil database Web Soil Survey, an online tool USDA-NRCS developed to display the SSURGO data. The SSURGO database and Web Soil Survey are produced and distributed by USDA-NRCS.

Web Soil Survey, Nutrient Management for Sensitive Soils (MN) query. This data will be used as soil criteria to identify vulnerable groundwater areas. This definition of 'coarse textured soils' is also used in the USDA-NRCS Minnesota conservation practice standard for nutrient management (590) (USDA NRCS, 2007).

It is reasonable to use the SSURGO database for the following reasons:

- Soil maps have been used by farmers and their agriculture advisors for decades. This includes such things as soil testing for nutrients, variable rate fertilizer application, crop productivity index, as well as many other soil interpretations.

- Use of USDA-NRCS soils information is well established. Farmers, local government, and others have been using soils information for many years. Farmers participating in federal farm programs have been subject to soil evaluations on their fields and therefore will be familiar with an evaluation based on soil characteristics.

- It is readily available and contains the best available statewide data. Soils data provides continuous coverage across the state, including agricultural areas. (Note that portions of Pine, and 'Arrowhead' counties have not yet been soil mapped; it is anticipated these will be completed in 2022). There is a very low occurrence of agriculture in these areas of the state.

- Soil survey information is used, since it is the statewide (and nationally) recognized 'standard' for soils information. Rigorous investigation, mapping, evaluation, and scientific interpretation of soil information has been and continues to be done by USDA-NRCS Soil Scientists and others. Each soil mapping unit has been examined and soil interpretations are standardized throughout the state.

- This soils data used are based on published soil surveys which are of consistent scale and quality statewide. Soils data are reviewed and updated annually (if applicable) in Web Soil Survey. The scale of soils map range from 1:12,000 to 1:63,360, with most being 1:20,000 or less. The soils were mapped in each county, and data correction was done to ensure soil information matches across county lines.

- Criteria for "Sensitive Soils for Nutrient Management" data set is used in the USDA-NRCS Minnesota Nutrient Management specification. This is already being used (and has been for many years) by resource professionals for on farm nutrient management plans. This 'sensitive soils' data set includes nitrogen management and leaching into groundwater criteria, and specifically notes coarse textured and shallow to bedrock soils as soil features that must be considered.

- The SSURGO soil database is available in a user-friendly format online and can be searched by the public through Web Soil Survey portal (Soil Survey Staff, n.d.).

Using this 'coarse textured' soils definition is consistent with the U of M Extension nitrogen fertilizer BMPs (Table III-1). Consistency with the terminology between the proposed Rule and the nitrogen fertilizer BMPs will add clarity for the regulated party. U of M Extension has developed fertilizer application rate guidance and other nitrogen fertilizer BMPs specifically for coarse textured soils. It is beneficial to use the same soil criteria and consistent soils maps and criteria for fall restrictions in the first part of the Rule (see 1573.0030 Statewide Water Resource Protection Requirements,) and follow nitrogen fertilizer BMPs for coarse textured soils in the second part of the proposed Rule (see 1573.0040 Drinking Water Supply Management Areas; Mitigation Level Designations).

The USDA-NRCS definition of coarse textured and shallow to bedrock soils also aligns with the definition used by MPCA for applying manure in areas sensitive to leaching of nutrients through the bottom of the root zone (MPCA, 2015).

Other soil options considered

MDA staff evaluated alternative soil criteria that could be used to characterize the vulnerability of groundwater contamination from nitrogen fertilizer application. This included soils information from federal and state agencies as well as academic institutions, including the U of M. The MDA specifically worked with the USDA-NRCS Minnesota State Soil Scientist staff to discuss alternatives and they provided the statewide soil query results based on criteria identified by the MDA. The following are various options that the MDA considered. Note that some of these soils criteria were considered in combination but are generally discussed individually as follows:

- The texture of the uppermost soil layer, or soil horizon, was considered, because soil units within the USDA-NRCS Soil Survey system are named based on the surface texture. Users of soils information are normally familiar with the names. The MDA considered using soils with surface textures defined by the USDA-NRCS as sand, loamy sand, and sandy loam as a criterion. However, the surface horizon does not necessarily represent the texture of the soil layers below the surface and is not a good indicator of water movement through the soil profile. Based on this, the MDA decided against basing vulnerable groundwater areas on surface texture alone.

- A 0-5 foot soil profile depth was considered, since this is the standard depth of a typical soil profile. Soil profile data is available statewide (except in some or all of Pine, Cook, St. Louis and Lake Counties) at these depths. The USDA-NRCS is transitioning to a 0-2 meter profile depth and this depth was also considered in the evaluation process. This would provide additional depth information; however, the 2-meter depth was ruled out since it is not available yet statewide.

- Soil physical characteristics based on the USDA textural triangle were considered (Figure VI-1). The MDA, in the Request for Comments, specified that sand, loamy sand, and sandy loam would be considered. These textures represent the coarsest of the soil textures, and can be itemized by percentage of sand, silt, and clay thresholds. However, regulated parties may not be aware of these distinctions. Also, closer examination showed that sandy loams are diverse in characteristics that make them difficult to characterize as vulnerable based on texture alone. Some responses to the Request for Comments and subsequent comments during the summer 2017 comment period suggested that sandy loam should not be included as coarse texture criteria.

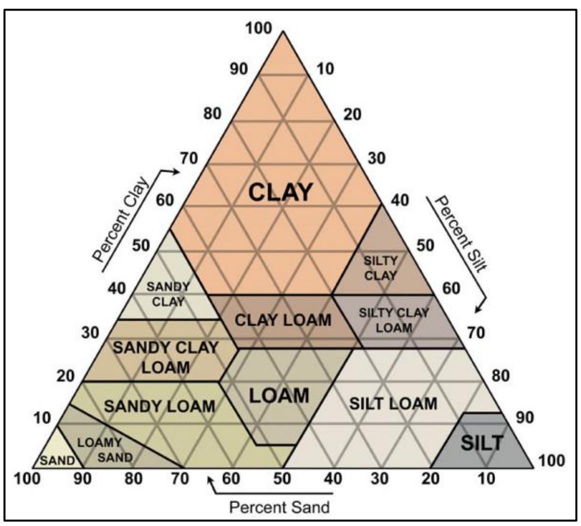


Figure VI-1. USDA soil textural triangle.

- Saturated Hydraulic Conductivity (Ksat), was considered as vulnerable soil criteria. Ksat is an objective measure of the ability of water to move through a saturated soil. Ksat values are available for each soil horizon of the soil mapping units; therefore a weighted average of the combined horizons was considered. The NRCS delineates values for high versus low Ksats that provide differentiation criteria for water movement through a saturated soil. Based on this, a Ksat >10 micrometers per second (µm/s; equivalent to approximately 1.4 inches per hour) criteria was considered ‘high’ for water movement through the soil profile; and therefore was considered by the MDA as the threshold for vulnerable soil. Combined criteria with other soil features was also considered to further refine vulnerable soil criteria. This included using Ksat in combination with coarse texture soils, using a Ksat<1 um/s value for any soil layer (horizon) within the soil profile as a disqualifying criterion to represent a confining layer for water movement within the soil profile, and slope >12% to represent slopes where water is more likely to runoff than infiltrate into the soil profile.

During the draft rule summer 2017 listening sessions, the MDA presented to stakeholders information on Ksat and vulnerable soil criteria. The MDA determined Ksat was not known or well understood by many stakeholders or policymakers, therefore it may be difficult for regulated parties to follow. In addition, stakeholders tended to know soils based on texture, including in many cases, the nitrogen fertilizer BMPs for coarse textured soils. Significantly, Ksat does not necessarily align with the nitrogen fertilizer BMPs for coarse textured soils. For these reasons, the MDA determined that Ksat should not be used.

- Bulk density, a measure of the weight of soil per volume, was considered because it could be a relative comparison of water movement through the soil profile by measuring ‘compactness’ a volume of soil occupied by soil and air (hence density). While this would provide a good indication of water movement through soil, there are other soil characteristics that better represent soil vulnerability. In addition, bulk density also does not necessarily align with soil texture. For these reasons, the MDA determined bulk density should not be used.

- The depth from the soil surface to the water table from NRCS was considered as vulnerable soil criteria. However, the NRCS definition provided in the soil survey data may not represent permanent water table conditions of an aquifer that is useable or extractable. A permanent water table is the level where saturated soil occurs. The water table definition for the NRCS data set may not represent the permanent groundwater level and may be present due to a soil confining layer, which keeps the water closer to the land surface and not connected to the aquifer. The water table level can change by season and the amount of precipitation in a given year, or could be altered due to drainage activities (ditching or tiling). For these reasons, the MDA determined depth from the soil surface to the water table should not be used.
- Hydrologic Group: The USDA-NRCS places soils into hydrologic group classes based on runoff potential. The classification in the four groups or three dual groups are based either on historic measurements or interpolation to similar soils based on factors including depth to restrictive layer or water table, texture, structure, and Ksat. Because: 1) the hydrologic

groups are designed for use with surface runoff, not water movement through the soil, 2) the groups are qualitative and there is substantial uncertainty associated with assigning quantitative flow rates to each category, and 3) many soils with a seasonally high water table are assigned a dual classification that may change based on drainage status (such as presence of artificial drainage), the MDA decided not to use hydrologic group as a criterion.

- Permeability: The term permeability has often been used synonymously with hydraulic conductivity. Confusion has arisen since the term permeability has been used to describe a soil's readiness to transmit water or other fluids, or as a parameter estimated based on hydraulic conductivity, fluid density and viscosity, and the gravitational pull. Because the meaning of permeability is not specifically discernable, the USDA-NRCS emphasizes Ksat rather than the term "permeability" and Ksat classes rather than Permeability Classes to prevent confusion and avoid scientific inaccuracies (Schoeneberger et al., 2012). (See previous discussion of Ksat.) For these reasons, the MDA determined permeability should not be used.

- Organic Matter: Percent organic matter was considered. Generally, soils with higher organic matter have greater water holding capacity, which would allow more water storage in the soil profile versus migration to groundwater. However, for the most part (i.e. for organic peat soils called histosols), organic matter is dominant in the surface profile and diminishes at soil depth. Due to this limitation, the MDA ruled out organic matter as criteria to determine vulnerable soils.

- Restricting fertilizer application based on soil temperature: The MDA considered using the U of M nitrogen fertilizer BMP language, "no fall N fertilization until soil temperatures have stabilized to less than 50 degrees [50ºF]." Soil temperature affects the activity of bacteria that converts nitrogen fertilizer to nitrate (Fernandez, 2017).

  It is difficult to ensure consistent depth at which soil temperature is measured (for example, it varies from 4 to 6 inches (MDA (n.d. (l)). Erosion, tillage, or animal disturbance may further change the depth of the soil temperature sensors over time. In addition, it may be difficult to determine when soil temperatures have 'stabilized' due to annual differences, temperature unpredictability and day versus nighttime temperatures. In addition, requiring soil temperature readings could be burdensome for the regulated party and regulator, since this could involve many and multiple readings per farmer and per field. It would be inefficient for MDA as well due to the volume of soil temperature readings that may need to be reviewed. There may be inconsistency in time and location between soil temperature supplied by the famer and those done by MDA is a compliance check. Therefore, soil temperature was not chosen to define fall application.

- The MDA considered using its soil temperature network to define fall nitrogen fertilizer application restrictions (MDA, n.d. (l)). This would rely on actual soil temperature readings at established sites. An advantage is that it uses known locations with accessible data to all. However, the issue of 'stabilized below 50 ^{o}F' would still be a concern, as described above. Additionally, it may be unclear to regulated parties which soil temperature station(s) to use for regulatory purposes, and the network only has a limited number of monitoring sites. Due to these difficulties, the MDA did not choose this option.

- There is climate variability throughout the state, so the MDA considered choosing various fall dates based on climate and location within the state. This would be difficult, however, since temperature patterns do not fall naturally on county or other cultural feature boundary. This would also create a substantial regulatory burden to the MDA, and to fertilizer suppliers and farmers that cover multiple counties. In addition, historic soil temperature data may be inadequate, and yearly variability would not be accounted for.

- August 31st was chosen because it represents the end of the quarter for meterological season as described by the State Climatology Office: The MDA consulted the MDNR State Climatologist when making and drafting this definition.

  The MDA provided this draft date during the request for comments and draft rule summer 2017 listening sessions. Though stakeholders provided some comments on this, most did not find an August 31st date unreasonable.

The MDA also considered some combinations of these criteria. These combinations were ruled out, primarily because the resulting criteria would be too complicated for regulated parties and difficult to administer by the MDA.

Geology criteria

The MDA used karst geology as identified by the DNR's Pollution Sensitivity of Near-Surface Materials Minnesota Hydrogeology Atlas (Adams, 2016) and Minnesota Regions Prone to Surface Karst Feature Development report (Adams et al, 2016) as one of the criteria for the proposed Rule's Part 1 restrictions.

Karst features are the most significant geologic feature that needs to be considered for determining groundwater vulnerability (Runkel et al, 2014, Steenberg et al, 2014, Gordon, 2016, Groten and Alexander, 2013, Katz, 2012). Karst geology is fractured bedrock, generally limestone, overlaid by shallow soils. This combination allows for nitrate dissolved in soil water to readily move downward into groundwater once below the plant rooting depth. Therefore, it is necessary and reasonable for the rule to include areas with karst geology when considering areas vulnerable to groundwater contamination.

The rule uses groundwater vulnerability data from the sources that provide the most accurate data with the highest level of resolution for the characteristic that is being evaluated and mapped. It is necessary to provide clear maps of areas subject to regulatory requirements in order for individuals to understand what is expected of them under the rule. It is reasonable to use the most accurate information available so that the purpose of the rule, to reduce nitrate contamination in groundwater, will be implemented in a practicable and effective manner as directed in the Groundwater Protection Act.

The rule uses DNR pollution sensitivity reports and maps (The Pollution Sensitivity of Near-Surface Materials Atlas) for defining areas with karst geology because it is the most accurate information available on areas with karst geology.

The rule also considers areas with ultra-low vulnerability to groundwater contamination. These are areas primarily in northwestern Minnesota where thick clay deposits provide an exceptionally high level of protection for groundwater. In these areas there may be shallow sandy soils near the ground surface but because of the thick clay layer the groundwater is not vulnerable to contamination. Considering this land characteristic is necessary to ensure that the vulnerability of groundwater is assessed accurately in all areas of the state. The rule uses DNR pollution sensitivity reports and maps (The Pollution Sensitivity of Near-Surface Materials Atlas) for mapping these areas. This is reasonable because they are the most detailed and accurate maps available on this characteristic and to use less accurate maps would be unreasonable.

Other geology options considered
The MDNR has completed geologic evaluations in some areas of the state through the County Geologic Atlas Program (MDNR, n.d.). However, these atlases are not available statewide; they are available only for some regions and counties. In addition, the criteria used for developing the atlases have changed over time, resulting in maps being inconsistent across the state. Hence, applying the Geologic Atlases would result in applying inconsistent vulnerable geology criteria depending on map availability and when the geologic investigation was done. For these reasons, the MDA determined the Geologic Atlases are inadequate to use for the purpose of developing geologic criteria.

The MDA considered using the ‘Bedrock at or Near the Surface’ criteria within the Pollution Sensitivity of Near-Surface Materials Report (Adams, 2016). This data source provides a statewide illustration where rock underlays the soil and unconsolidated surficial materials. This was ruled out because, as noted above under geologic criteria section, other sources of data provide a much higher level of resolution of this characteristic which is important for accurately defining those areas subject to regulatory requirements.

During the summer 2017 comment period, several comments recommended not including the shallow to bedrock geology criteria. This was because they were unclear on the criteria, and/or they felt it did not accurately represent actual ground features, and represent a sensitivity to groundwater contamination.

The MDA considered using other geology criteria as well, such as those shown on pages 13-20 of the NFMP (MDA, 2015). These were ruled out because they have the same scale limitations as other geology maps as previously described (all are approximately 1:500,000). Also, the Pollution Sensitivity of Near-Surface Materials Report was published more recently and contains the same or similar geology as those shown in the geology maps in the NFMP.

Based on the previous discussion, the agency determined that 'vulnerable area' must include both soils data for coarse texture and shallow to bedrock conditions, and geology data for karst, and an 'ultra-low' geologic sensitivity rating of the near surface as defined by vertical travel time to represents glacial lake geology (Breckenridge, 2015).

Subp. 1. Prohibitions. A. (1) – Fall application of nitrogen fertilizer in DWSMAs

The agency considers DWSMAs as high priority under the proposed Rule. Public wells supply drinking water to many people including homes, businesses, and public facilities. Communities rely on public wells to provide safe drinking water, therefore proper land and water management within the DWSMA must take place.

MDH delineates WHPAs based on a ten-year time of travel. DWSMAs are defined by MDH based on readily identifiable physical or political features as specified in Minn. R. 4720.5100, subp. 13.

On average there are 136 people served by a public well for every person served by a private well (MDH, 2017).

The proposed Rule restricts the application of nitrogen fertilizer in the fall and to frozen soils in DWSMAs with any municipal public water supply wells with concentrations greater than or equal to 5.4 mg/L nitrate-nitrogen. This is needed and reasonable because, public water supplies exceeding 5.4 mg/L nitrate-nitrogen value are required to monitor water as specified in Code of Federal Regulations (CFR) 141.23: National Primary Drinking Water Regulations (USEPA, 1998). *"(2) For community and non-transient, non-community water systems, the repeat monitoring frequency for groundwater systems shall be quarterly for at least one year following any one sample in which the concentration is ≥50 percent of the MCL. The State may allow a groundwater system to reduce the sampling frequency to annually after four consecutive quarterly samples are reliably and consistently less than the MCL."*

Accordingly, the MDH Drinking Water Protection Section Community Public Water Supply Unit uses a value of 5.4 mg/L as nitrogen-nitrogen when comparing analytical results with regulatory monitoring triggers (D. Rindal, MDH. Personal communication. March 5, 2018). Public wells that exceed this threshold need to monitor nitrate-nitrogen concentrations quarterly.

The public water supplier must be a municipal public water supplier. This is reasonable because the agency will use its resources to regulate larger DWSMAs and not those that are extremely small under this part of the proposed Rule.

There also must be a DWSMA established by the MDH so it is clear where the proposed Rule applies.

Currently, there are 30 DWSMAs that have nitrate-nitrogen in groundwater greater than or equal to 5.4 mg/l.

Subp. 1. Prohibitions. A. (2) – Fall application of nitrogen fertilizer where vulnerable groundwater makes up 50% of quarter-section

When more than 50 percent of a quarter-section has vulnerable groundwater areas (see SONAR, 1573.0010, Definitions), there is a progressively greater risk that nitrate from nitrogen fertilizer could make it into the groundwater. Therefore, the agency sees a need to restrict the application of nitrogen fertilizer to non-vulnerable groundwater areas in these quarter-sections, including on areas within the quarter section that are otherwise not considered vulnerable.

The agency considered many different options when deciding the scale on which vulnerable groundwater areas should apply. Vulnerable groundwater areas are based on soils and geology, and since these are natural features, their boundaries do not align with features such as county boundaries, roads, townships or sections. Defining an area is needed and reasonable in order to be clear to both the regulated party and regulator where fall nitrogen fertilization will be prohibited.

The approach of using a portion (percentage) of an area to designate an entire area is already used by USDA-NRCS under the federal farm bill. Use of percentage of an area criterion is used by the USDA-NRCS to determine highly erodible cropland (HEL). This criterion uses 33% or more of a field that contains highly erodible soils, then the entire field is considered highly erodible. The agency considered using 33% like the HEL criteria. However, this is used as criteria for soil erosion potential which is dissimilar to groundwater vulnerability which includes different soils characteristics as well as geology.

The agency considered using the section (1 square mile) scale. This scale was considered because a section of land is at an identifiable scale, nitrogen management is practicable at this scale, and in most cases in agricultural areas, and this involves few landowners. The agency presented this option to the public during the summer 2017 listening sessions. Many commenters believed that a section scale is too large of an area, and thus was an unnecessary and overly broad application.

Use of natural soil and geologic boundaries were considered, since this is their defined boundary and no vulnerable area extrapolation is needed because no additional conditions are included. However, even though this would identify vulnerable groundwater areas based on their mapped boundaries, soils and geology boundaries can be difficult to identify. This is not only because they are often irregular in shape and size, but they may not be visible at the surface. Therefore, it would be difficult for a regulated party to identify the exact boundaries on the ground. Though some comments noted soil boundaries should be used to define vulnerable groundwater area boundaries, and farmers are capable of doing this, it would be difficult to manage and regulate in a field where only some of the field is vulnerable. Individual vulnerable area mapping features are often variable and irregular in size and shape. This makes it more difficult to manage and understand for the agency and regulated parties. For example, in a field with various separate vulnerable soils and where fertilizer is custom applied, the farmer would need to provide vulnerable area information to the dealer. The dealer would need to ensure that applicator staff is aware of and able to avoid nitrogen fertilizer application in vulnerable groundwater areas of the field when fertilizing others. This is logistically more difficult both from a communication standpoint as well as actual application. For these reasons, the agency ruled out using the boundaries of soil and geology features in determining vulnerable groundwater areas.

As a subset of defining vulnerable groundwater areas based on soil and geology boundaries, the agency considered *de minimis* criteria. This would address 'small' vulnerable groundwater areas that were deemed to be too small to be a concern to impact groundwater contamination. *De minimis* criteria considered included area (acreage) and percentage. The agency considered an area too small based on whether it would likely cause practical difficulties for farming (i.e. too small to manage differently) or an administrative burden to the agency. The agency considered various *de minimis* acre ranges; from approximately 1-10 acres. The agency also considered *de minimis* based on a small percentage of an area. In the end, the agency concluded that any number or percentage used would create practical and administrative difficulties. There was no clear consensus on *de minimis* number or percentage that was reasonable, therefore *de minimis* criteria was ruled out.

The agency considered vulnerable area designation at a township scale. This would make sense because townships are a defined area, and the agency is actively monitoring townships for nitrate and is establishing Local Advisory Teams, as outlined in the NFMP. However, this is a large area (36 square miles) so a township with variable vulnerable area could have significant area (literally several square miles) that would be included or excluded from fall application, vulnerable or not. Therefore, due to this scale issue, this was ruled out.

The agency considered vulnerable designation based on BMP region. This was considered because U of M nitrogen management recommendations (as part of the nitrogen fertilizer BMPs) are variable by BMP region. However, this would include many counties, so is much too large of a scale to implement vulnerable area criteria. Therefore, this option was ruled out.

Using cropland boundaries to identify vulnerable area was considered. This could be ideal because farmers manage based on field boundaries; this is where the nitrogen fertilizer management activities take place. However, farmers and contractors who apply fertilizer on fields may not be able to apply nitrogen fertilizer based on variable vulnerable area in a field. In these cases, it is reasonable to determine whether the entire field is vulnerable. The 'scale' would be variable since fields vary significantly in size throughout the state (ranging for less than 1 acre through approximately 640 acres in size). Additionally, the boundaries of cropland are not public information, therefore is not available for the agency. USDA- Farm Service Agency (FSA) holds this information as non-public data, available only to FSA staff and the cropland owner and/or operator. Cropland information could be provided by the landowner or land occupier, however there may not be an incentive for them to provide this, and this could create an extra step and unreasonable burden to the landowner/land occupier and the agency. The agency considered determining crop field area through using USDA NASS (n.d. (b)) CropScape since this source provides statewide coverage on an annual basis. Claire et al. (2011) reported the mapping accuracies were 85%-95% correct for the major crop categories. Reitsma et al (2016) found crops were mapped correctly between 43% and 95%, with the largest errors occurring in landscapes with many different crop types present, making field boundaries indistinguishable. Reitema (2016) further stated that errors at this magnitude introduce uncertainty in land use calculations. Based on these findings, the MDA determined that the errors in the CropScape estimates are too high for this purpose.

Subp. 1. Prohibitions. A. (3) – Fall application of nitrogen fertilizer to frozen soils in vulnerable groundwater area or DWSMA

Applications of nitrogen fertilizer to frozen soils are not recommended by U of M nitrogen fertilizer BMPs. Nitrogen fertilizer products not properly incorporated on frozen soils are more likely to run off or be lost to the atmosphere thus lowering fertilizer use efficiency and possibly increasing groundwater contamination.

Rationale for vulnerable groundwater areas and DWSMAs is provided in this SONAR in 1573.0010 Definitions.

In vulnerable groundwater areas, nitrogen applications should be made much closer to the time period when the crop needs the nitrogen. This is why it is needed and reasonable for the agency to prohibit nitrogen fertilizer application in fall and on frozen soils in these vulnerable groundwater areas.

In many areas across the state, 75% of deep percolation and subsequent nitrate losses occurs between the spring thaw and early June (Struffert et al, 2016). Excessive nitrate leaching will occur most years with fall applications in these areas.

Subp. 1. Prohibitions. B. and C. – Vulnerable groundwater areas map

The map will be reviewed periodically to allow for adjustments to be made to account for new information in the rare instances where soils and karst geology information is updated. Additionally, the list of public water suppliers restricted from applying nitrogen fertilizer in the fall and to frozen soils will change as nitrate concentrations fluctuate above and below 5.4 mg/L nitrate-nitrogen. This indicates that the parties in charge of cropland in the areas shown on the map are responsible for meeting the requirements in this part of the proposed Rule.

Subp. 2. Exclusions. A. – Fall application restriction

During the comment period on the draft rule (summer of 2017), the agency heard many concerns from farmers in the western and northern parts of the state about the importance of fall nitrogen applications because of the short application window in the spring. Additionally, there were concerns that climate factors were not factored into the draft rule. The agency responded by evaluating statewide climate information to determine various factors that potentially impact fall nitrogen fertilizer management decisions. This statewide evaluation also reviewed climate factors that influenced leaching potential and nitrification rates. This evaluation confirmed that there is significant climatic variation across the state that must be considered when drafting the fall restriction rules. For example, in southeast Minnesota there is more precipitation, resulting in more water available to movie through the soil profile, and warmer spring soil temperatures resulting in a greater potential for fall-applied nitrogen to be converted to nitrate and potentially lost. In contrast, the cooler spring soil temperatures in tandem with less precipitation found in northern and northwest Minnesota create conditions of reduced risk of nitrogen loss to the groundwater.

After evaluating a variety of climate variables, the agency determined the following criteria when used in tandem provided meaningful metrics for guiding fall nitrogen fertilizer management restrictions:

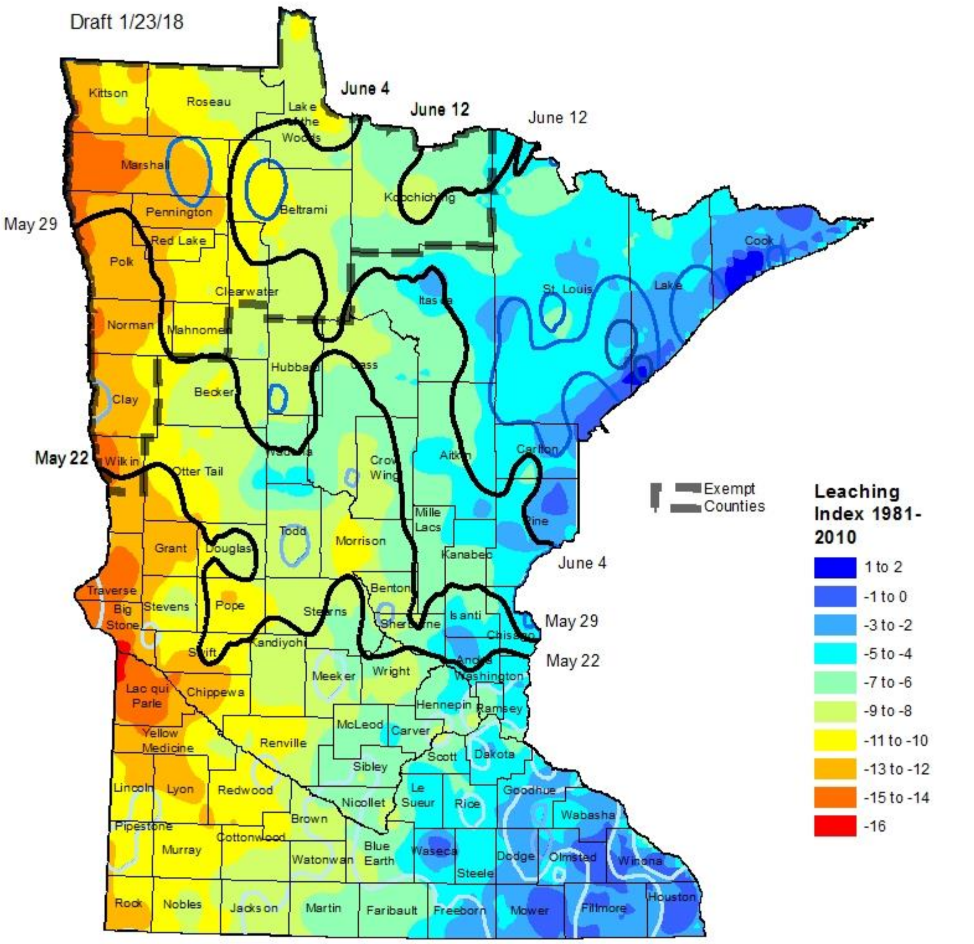
- leaching index
- spring frost-free date

Leaching Index: The leaching index is defined as the daily rainfall minus daily evapotranspiration summed to annual values. This index provides a very broad approximation of annual water movement through the soil profile. Nitrate will not move through the soil without water, so it is relevant to evaluate the nitrate leaching risk based on the amount of water available to move through the soil (Lamb et al., 2008). Therefore it is reasonable to exclude areas of the state from the fall application restriction where water movement is minimal under typical climatic conditions.

The leaching index was a core concept factored into the early recommendations for fall nitrogen applications. For years, the general U of M guidelines were that the use of the soil nitrate test worked west of Highway 71 (except for coarse-textured soils) because the leaching index was low. Corresponding, similar logic for fall nitrogen applications was used.

Spring Frost-free Date: Using the spring frost-free date provides some general guidance on spring soil temperatures. The later the date, it is more likely that spring soil temperatures will be cooler. This date also provides general guidance on the amount of time available for getting spring field work completed. The later the date, the narrower the timeframe for applying spring fertilizer, tillage and planting. There is a northwest to southeast gradient when the last frost-free date in the spring occurs (Figure VI-2). The spring frost free date intervals were derived by the MDNR State Climatology Office (MDNR, 2018).

Isolines indicating late to very late spring conditions with spring frost-free dates after May 22 are illustrated on the provided map. It is very difficult to grow long season crops like corn in these cooler regions and any unnecessary delays must be avoided. There are logistical problems such as with an insufficient numbers tender trucks and spreaders to complete all fertilizer applications in this compressed spring period.



Leaching Index (LI) and Spring Frost Free Date (SFFD) criteria:

- The delineation is based on county boundaries (unless otherwise stated) meeting ≥ 50% of the leaching index area, and spring frost free dates contiguous isolines (i.e. 'bullseyes' not included) based on the criteria below.
- If the SFFD is on or after May 22 and the LI is ≤ -12, and
- If the SFFD is on or after May 29 and the LI is ≤ -10, and
- If the SFFD is on or after June 5 and the LI is ≤ -6, and
- For Clearwater County, the area north of Highway 2 will be excluded from areas considered vulnerable.
- For Wilkin County, the area north of Highway 210 will be excluded from areas considered vulnerable.

Figure VI-2. Spring frost-free dates and leaching index.

Using Leaching Index and Spring Frost-free Date in Tandem: It is necessary and logical to create this dual criteria approach due to major climate variability across the state. Both leaching index and spring frost free date factors are significant contributors to affecting nitrogen fertilizer management. A graduated combined approach that corresponds the different risk frost free date and leaching index is needed to address this.

Taken together, the leaching index and the spring frost free dates show the risk of nitrate-nitrogen leaching loss and movement to the groundwater is greatly reduced in counties in the northern and western parts of the state. The criteria listed in the proposed Rule are based on the combined risk of nitrate-nitrogen leaching loss explained by the leaching index and the spring frost free dates.

The years 1981-2010 were used for the leaching index and spring frost free dates because this was the most recent decadal period of record that was available. A 30-year time period was used to be consistent with common practice within climatological contexts where 30-year periods are used to define ‘normal’ conditions (MDNR, 2018).

Since both of these are significant factors and in combination have greater influence on water movement, these were combined into one map (Figure VI-2) which was used to exclude the indicated counties from the fall application restrictions.

Subp. 2. Exclusions. B and C. – County lines or other geographical boundaries

While the criteria identified to exclude areas from the fall application restriction do not necessarily follow identifiable boundaries, boundaries are needed for the proposed Rule so that the regulated parties and the agency have clarity in understanding where the regulations apply. The criteria used as a basis for the exclusions to Part 1 of the proposed Rule are reflected on a map as isolines, meaning they are not based on a constant value. Isolines shown on the map of the exclusions are not easily identifiable or known on the ground or may be in the middle of a field. Therefore, the agency believes the leaching index and spring frost free date exclusion criteria largely should follow county boundaries. Using county boundaries and (Highway 2 in Wilkin County) will provide complete clarity for the regulated parties as to where the exclusions are in place. It is reasonable to use these geographic features versus the leaching index and spring frost free date isolines, which will in most cases be unidentifiable ‘on the ground.’

Subp. 2. Exclusions. D. – DWSMAs

The exclusion listed under Subp. 2, A does not apply to DWSMAs. As described under 1573.0030, Subpart 1. A. (1), communities of more than 25 people rely on the public wells in DWSMAs for safe drinking water. The agency will have water quality monitoring results showing that there are water quality problems in the DWSMAs public well and therefore it is needed and reasonable that fall application should be restricted in DWSMAs with nitrate-nitrogen concentrations greater than or equal to 5.4 mg/L.

Subp. 2. Exclusions. E. – Counties with less than 3% agriculture

USDA NASS (n.d. (a)) provides statistics for agricultural cropland in every county. The agency has used this data to exclude counties with very low agricultural intensity from the fall application restriction. This proposed exclusion is reasonable because in these identified counties, there is a low concentration of crops grown and therefore low nitrogen fertilizer use. Since nitrate in groundwater is associated with cropland acres, it is reasonable to exclude areas where minimal cropland acres exist. The agency used 3% because this value represents very few acres compared to the total county acres. It is reasonable that the agency allocates limited resources to counties with higher areas of land in cropland, where the public health and environmental risks are greater.

Subp. 2. Exclusions. F. – Point sources of pollution

In some cases, elevated nitrate levels within DWSMAs are due to point sources of nitrogen. Examples of point sources could include but are not limited to an improperly sealed well, animal feedlot or an agricultural chemical incident. This exclusion is needed and reasonable to exempt land owners within DWSMAs from the fall application restriction if the agency determines that elevated conditions where induced by a point source.

Subp. 2. Exclusions. G. – Partial DWSMA Exclusion Based on Low Risk

The commissioner may exclude part of a drinking water supply management area from the fall application restrictions if the commissioner determines that the area is not contributing significantly to the contamination of the public well in the drinking water supply management area. This provision in the rule is necessary to allow the commissioner to exempt parts of a DWSMA which are not contributing significantly to the groundwater contamination in the public well from fall application restrictions.

Fall application restrictions statewide are based on areas where 50% of more of a quarter section is vulnerable to groundwater contamination. This criteria was developed, in part, based on feedback from the public comment period that the previously proposed size, which was based on a full section, was unreasonable because sufficiently detailed information exists to better refine the areas subject to the restriction and not impose those restrictions on areas where it they will provide limited environmental benefit. This concern regarding an appropriate scale for the restrictions applies similarly to DWSMAs. MDA will be focusing more closely on DWSMAs and should be able to more precisely define areas that should be exempt from fall restrictions due to lower risk to groundwater based on a more precise analysis of the characteristics of the DWSMA.

DWSMAs vary in size from very small, less than a hundred acres, to relatively large, on the scale of tens of thousands of acres. For most DWSMA the soils types and vulnerability to groundwater contamination are likely to be fairly uniform across the DWSMA and this exclusion will not be needed. But for large DWSMAs it is reasonable to expect that there will be areas with significantly different soils types and groundwater vulnerability such that some parts of the

DWSMA may not be contributing significantly to high nitrate-nitrogen concentrations in the public well. For large DWSMAs there may be differences in soils types, land features or groundwater vulnerability such that the implementation of fall application restrictions may provide little environmental benefit to the public well with some cost for implementation to the farmer.

This provision is necessary to ensure that the commissioner does not impose requirements and related costs in areas where they will not significantly help reduce nitrate-nitrogen concentrations in the public well. It is reasonable because the Groundwater Protection Act directs that Water Resource Protection Requirements should be practicable and consider factors such as economics, implementability and effectiveness, and implementing fall application restrictions uniformly across a DWSMA including in areas where they may provide limited environmental benefits would not meet this requirement.

Supb. 3. Exceptions. A. - Fall application

In many cases, nitrogen applied in the fall increases the risk of groundwater contamination. The agency recognizes that in some cases, the practice of fall nitrogen application is a necessary agricultural practice despite being located in a vulnerable area. There are a few agricultural crops and practices that require an exception to the proposed Rule. The agency met with U of M staff as well as with internal experts to determine all possible exceptions. This list was then narrowed down based on applicability, feasibility, and relevance to applying nitrogen to crops in the fall. The list of possible exceptions was included when the agency released the request for comments in winter of 2015-2016. Many comments were received on this topic during the comments on the proposed Rule (summer 2017). The agency reviewed these comments and determined it was reasonable to include the following exceptions.

None of these exceptions apply to the application of nitrogen fertilizer to frozen soils. No benefit were identified from the application of nitrogen fertilizer to frozen soils.

Subp. 3. Exceptions. A. (1). Winter grains planted in the fall.

Phosphorus fertilization serves an important role in the winter hardiness of small grains. Since the common forms of phosphate fertilizers contain some ammonium, it is also considered a nitrogen fertilizer and it is needed and reasonable to have an exception to ensure that the proper phosphorus amounts are available. (Kaiser, 2011). Therefore it is reasonable to create this exception.

Subp. 3. Exceptions. A. (2). – Pasture fertilization

Under most production systems using cool season grasses (bromegrass, orchardgrass and reed canarygrass), an early spring nitrogen application is the recommended timing. However, in a high yield system, split applications are recommended with ¾ applied in early spring and the remaining ¼ in late summer/early fall. (Kaiser, 2011). Therefore it is reasonable to create this exception.

Subp. 3. Exceptions. A. (3). – Perennial crops

Research has shown that the most effective time to fertilize perennial crops is during the late summer and early fall (Kaiser, 2011 U of M Extension Service). Prior to freeze up, much of the fertilizer nitrogen will be absorbed by the root system and not subject to leaching. The net result is a healthier, more productive crop the following spring. Therefore it is reasonable to create this exception.

Subp. 3. Exceptions. A. (4). – Grass seed production.

Regarding grass seed production, the U of M Extension recommendations (Kaiser, 2011) provide criteria for rate selection but are silent on the timing. South Dakota State University (Gelderman et al., 1987) provides guidance for the cool season grasses. Adequate nutrition during the initiation of the tiller buds is important. For this reason, either a fall application or very early spring application is recommended and it is reasonable to create this exception.

Subp. 3. Exceptions. A. (5). – Cultivated wild rice.

Fall is also the most effective time to apply nitrogen to cultivated wild rice, but for very different reasons than perennial grasses or winter grains. Minnesota grows about 20-30,000 acres of cultivated wild rice with the majority grown in the north-central portion of the state. Cultivated wild rice is grown as an annual. Frequently the rice is seeded in the fall, nitrogen is then applied in the ammonium form, and then the field is flooded. The ammonium does not convert to the mobile nitrate form because it lacks oxygen needed for the bacteria to live. That bacteria is are necessary for the nitrification process. Because the nitrogen fertilizer does not convert to nitrates, there is no leaching risk when the rice fields are flooded in the fall. Additionally, the rice is protected in the flood conditions and will germinate the following spring. In the spring, water levels are lowered and the nitrification and germination process begins. (Kaiser, 2011). Therefore it is reasonable to create this exception.

Subp. 3. Exceptions. A. (6). – Cover crops to reduce the use of soil fumigants.

Cover crops are typically not fertilized, since the general concept of cover crops revolves around the concept of tying up any residual soil nitrates left after the growing season. However, one special situation was identified within a potato rotation. Soil fumigants are typically applied in the fall to fields scheduled for potatoes the following spring. The residual chemical compounds from cover crops such as brown mustard and other brassica plants have been found to reduce the need for the fumigants. However, to create enough biomass, it is recommended to fertilizer the cover crops with 25-50 lb N/acre. Therefore it is reasonable to create this exception.

Subp. 3. Exceptions. B. – Nitrogen fertilizer rates

When applying fall nitrogen to the exempted crops in a vulnerable groundwater area, nitrogen fertilizer application rates must follow the rates in the nitrogen fertilizer BMPs under Minn. Stat. § 103H.151, subd. 2. This information has taken in consideration both economic and environmental factors and the agency can be confident that nitrate leaching losses are minimized. Therefore it is reasonable to create this exception.

Subp. 3. Exceptions. C. (1). – Exception for ammoniated phosphates, micronutrient formulations

Growers frequently need to apply phosphorus fertilizer to maintain optimal yields with most traditional crops. In some areas of the state, phosphorus is commonly applied in the fall in tandem with the tillage operation. With Minnesota's short growing seasons, it is important to get as much soil fertility work completed in the fall as possible so that there are minimal delays with the spring planting operation.

In a corn-soybean rotation, growers typically will apply 100-120 pounds of phosphate (P205) to satisfy crop needs for the two-year rotation (i.e. it is applied in one year to meet the crop needs for 2 years). Phosphorus is very immobile in soil so applying it in the fall does not pose environmental issues as long as it is incorporated to reduce runoff risks and soil erosion is minimized. However, both MAP and DAP, the two dominate forms of phosphorus fertilizer, contain ammonium in the formulation. When applying 100 pounds of phosphate (a common application rate for a two-year corn-soybean rotation), 21 pounds of nitrogen will be applied with MAP and 39 pounds of nitrogen will be applied with DAP, per acre. Like all nitrogen fertilizer products, eventually the ammonium will be converted to the more soluble nitrate form and subject to leaching losses.

The purpose of the 40-pound nitrogen limitation is to guide producers to use practices that minimize unnecessary nitrogen losses without putting complete restrictions on fall applied phosphate in vulnerable groundwater areas. .

The forty-pound nitrogen limit was selected because:

- It satisfies phosphorus needs across all yield goal ranges when using the U of M Fertilizer Recommendations under medium soil testing levels (or higher) for either broadcast or banded (the two most common) application methods;

- It satisfies phosphorus needs across the majority of yield goal ranges when using either MAP or a private label product (e.g., 12-40-0-10, containing 12% nitrogen);

- For growers who can only purchase DAP in their region, they can still achieve the forty-pound ceiling limit by using the common standard of 100 pounds of phosphate within a corn-soybean rotation, recognizing that they may have to add supplemental phosphate prior to the soybean year if they have high crop removal values;

- Cropping scenarios have been analyzed to estimate yield goal of corn in a corn-soybean rotation while accounting for nitrogen input contributions from ammoniated phosphate and micronutrient formulation (Table IX-1). The example scenario illustrates an estimated yield goal of 200-219 bushels soils with a phosphorus (P) test in the medium range. Method One is the U of M recommendation for a broadcast application, Method Two is the U of M recommendation for a banded application, and Method Three uses phosphorus crop removal values across the rotation. Table IX-1 illustrates nitrogen inputs from MAP (11% nitrogen), DAP (18% nitrogen), AMS (ammonium sulfate ;) and Micro Essentials. The yellow cells represent combinations that result in summations that are below the 40-pound rate restriction. Conversely the red cells represent combinations exceeding the proposed restriction;

- The vast majority of Minnesota fields test “medium” or higher in (S. Murrell, IPNI. Personal Communication, 2015). Fields testing “Low” or “Very Low” need to address P deficiencies in order to use nitrogen and other inputs more efficiently. These fields are temporarily exempt from the nitrogen restriction. Once the soil P test moves into the medium range or higher, the restriction becomes active.

Table VI-1. Expected corn yield goal in a corn-soybean rotation on medium-P soils as affected by use of ammoniated phosphate and micronutrient formulations

Data from Table 9 in AG-FO-3790-D (Revised 2016) FERTILIZING CORN IN MINNESOTA : Important--Yield Goal in still used for non-Nitrogen nutrients. In this table, the Expected Yield Goal is 200-219 Bu/Acre AND a MEDIUM Soil P (Bray 11-15 PPM or Olsen 8-11 PPM)

Scenario #2: Average Yield Goals (200-219 Bushels) and Medium P Testing Soils

	Phosphorus and Sulfur Source	Phosphorus Approach	Method 1	Method 2	Method 3
	Yield Goal: 200-219		UM Recommendation for Broadcast Application	UM Recommendation for Banded Application	Based on P Crop Removal for Two Year Rotation (Slight Grow in Yield Goals)
Primary Phosphorus Sources	DAP (18-46-0)	N Input (lb/N/A) from DAP	21.5	11.7	47.7
		Total DAP Rate (lb/A)	120	65	265
		P205 Application Rate (lb/A)	55	30	121.8
	MAP (11-52-0)	N Input (lb/N/A) from MAP	11.4	6.2	25.3
		Total MAP Rate (Lb/A)	104	57	230
		P205 Application Rate	55	30	121.8
Phosphorus and Sulfur Sources	DAP (18-46-0) and AMS	N Input (lb/N/A) from DAP	21.5	11.7	47.7
		N Input (lb/N/A) form AMS	17.4	17.4	17.4
		Total N Input from DAP and AMS	38.9	29.1	65.1
	MAP (11-52-0) and AMS	N Input (lb/N/A) from MAP	11.4	6.2	25.3
		N Input (lb/N/A) form AMS	17.4	17.4	17.4
		Total N Input from DAP and AMS	28.8	23.6	42.7
	MicroEssentials SZ (12-40-0-10)	N Input (lb/N/A) from MESZ	16.5	9	36.5
		N Input (lb/N/A) form AMS	0	0	0
		Total MESZ Rate (Lb/A)	137.5	75	304.5
		P205 Application Rate	55	30	121.8
		Total N Input from MESZ	16.5	9	36.5

Subp. 3. Exceptions. C. (2). – Application of agricultural chemical contaminated soil and other media

Land application of contaminated soil and other media may be approved by the commissioner in accordance with Minn. Stat. § 18D.1052 if the commissioner determines that the land application will not cause unreasonable adverse effects on the environment. Land application of contaminated media is a critical component of the agency point source cleanup programs in the Incident and Emergency Response programs. Fertilizer-contaminated media is removed from agricultural chemical spill sites and samples of the contaminated media are analyzed and the number of pounds of nitrogen is determined. The contaminated media is typically applied at a rate less than or equal to 100 lb N/ acre and the most common crops utilized for land application are corn and soybeans. In order to prevent leaching to groundwater or runoff of contaminants, contaminated media cannot be applied within 200 feet of a well, abandoned well, or sinkhole; within 200 feet of intermittent or perennial surface water, on soil types prohibited by the label of a limiting pesticide, or on areas with slopes greater than 6%. The contaminated media is immediately tilled into the receiving soil. As part of the application approval process, the grower is asked to use the nitrogen in the contaminated media as an application credit for fertilizer applications for the following crop year.

Land application of contaminated media must occur in the spring before planting or in the fall after harvest. Most of the land application of contaminated media occurs in the fall because the longer timeframe between harvest and soil freeze up allows time to apply the media rather than in the very short window in the spring between soil thaw and planting. It is also difficult to store contaminated media over the winter for spring applications. The cost for land application of contaminated media is lower than disposal in landfills or other treatment or disposal methods and is a very effective way to use the agricultural chemicals that are present in the contaminated media for their intended purpose. Because disposal of contaminated media is a critical component of the agency's duties, it is needed and reasonable to include this exception.

Subp. 3. Exceptions. C. (3). – Research

In review of past U of M research projects involving phosphorus research, the vast majority use "small plot" research trials with a large number of replications. Since most Minnesota soils are medium or higher in phosphorous, researchers are generally seeking plots or entire fields that are in the medium or lower phosphorous range, then superimpose a range of phosphate levels with small, replicated plots. It is conceivable that future Discovery Farms or other field scale activities may want to monitor a portion of the field with higher than normal phosphate inputs. The 20-acre ceiling provides ample opportunity for this scale of demonstration/research.

D. 1573.0040 Drinking Water Supply Management Areas; Mitigation Level Designations

This part of the proposed Rule is intended to reduce or mitigate the nitrate concentration in groundwater in areas where nitrate has been identified as a concern in DWSMAs. The approach to mitigation in the proposed Rule is comprehensive, consistent with the goals and direction outlined in the Groundwater Protection Act (Minn. Stat. chap. 103H) and follows the conceptual approach to mitigation which is outlined in the NFMP (MDA, 2015).

The proposed Rule is the end product of an effort that began in 2010 to revise and implement the state's approach to address nitrate from fertilizer in groundwater. This development process included significant stakeholder engagement with an advisory committee and three comment periods before reaching the point of this draft proposed Rule. The process began with the revision of the NFMP using an advisory committee with stakeholder participation from a wide range of stakeholder groups. This included strong participation from the agricultural sector in addition to other groups referenced in the Groundwater Protection Act. This advisory committee met 18 times over approximately two years and brought in multiple experts including a representative from Nebraska, where a similar approach is in use. The goal of this process was to ensure that the committee understood the opportunities and limitations of agricultural practices and policies related to the management of nitrogen fertilizer to reduce nitrate leaching to groundwater, and that the approach used in Minnesota would be effective and practicable as directed in the Groundwater Protection Act. Every member of the advisory committee was welcome to suggest policies and criteria for consideration in developing the plan and conversations of options were extensive and thorough. As an outcome from the advisory committee process the MDA developed a draft NFMP, which was submitted for a public comment period, and held a series of public meetings around the state.

The MDA finalized the NFMP in March 2015 and immediately began implementation of the voluntary parts of the plan and developing the proposed Rule. The proposed rule is designed to implement the regulatory components of the plan. The development of this proposed Rule included two public comment periods to ensure that comments from stakeholders were fully considered before finalizing the proposed Rule. Although the NFMP outlined a conceptual approach to addressing nitrate in groundwater, significant changes have been made during the drafting of the proposed Rule based on careful consideration of stakeholder comments. While the proposed Rule is intended to provide the regulatory components for the plan, the proposed Rule has been developed using a significant public development process separate from any specific requirements in the plan. The plan outlines the regulatory components in a very general sense whereas the proposed Rule has gone through an extensive review process and, in consideration of that input, provides detailed requirements for decision making and regulation.

The draft proposed Rule released for the public comment during the summer of 2017 included draft regulatory approaches based on a township scale for private wells and by DWSMAs for public water supply wells. For reasons stated in more detail under Subp 1 below, the MDA decided to focus regulatory efforts and limited resources on the highest priority areas, which are DWSMAs.

Subp. 1. DWSMA mitigation levels. – Application

Approximately 75% of Minnesotans (4 million) rely on groundwater either from public or private wells for their drinking water supplies (MDA, 2015). Over half of the state's population is served by public water suppliers that use groundwater as the source of drinking water (Figure VI-3).

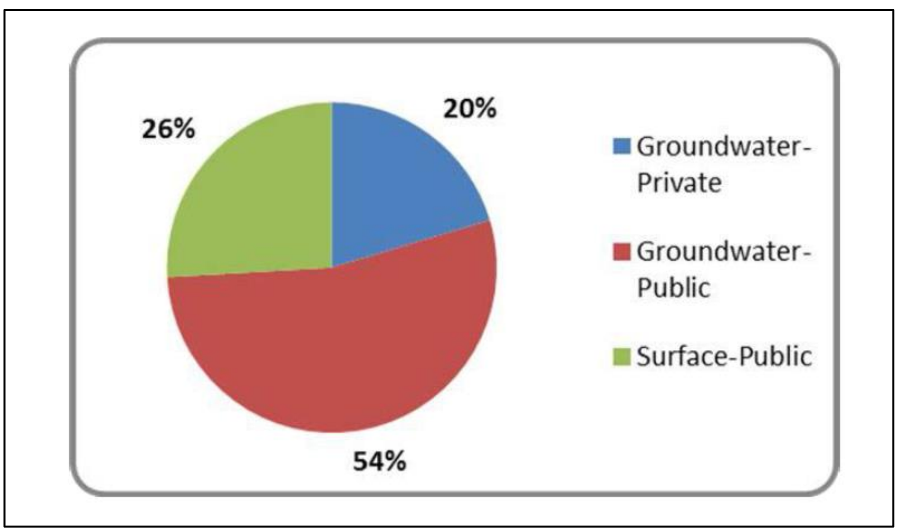


Figure VI-3. Drinking water sources in Minnesota.

Community and non-community public water supplies
Part 1573.0030, also referred to as Part 2 of the Proposed Rule, focuses on areas that provide groundwater to public water supplies or public wells. These areas surrounding public water supplies are called drinking water supply management areas (DWSMAs) The MDH is the lead agency dealing with public water suppliers (PWS). There are approximately 7,091 PWSs in Minnesota. These include those classified as "community" water suppliers, which include small to large communities. A community public water supplier by definition must serve at least 15 service connections used by year-round residents or regularly serve at least 25 year-round residents. There are currently 963 community water suppliers in Minnesota. The remaining systems are classified as non-community water suppliers. By definition, a non-community system must serve an average of at least 25 people at least 60 days a year at a place other than their home. Examples include restaurants, churches, schools, and businesses. Because of the large population in the state that public water supplies serve, it is needed and reasonable for the MDA to use the DWSMA scale for regulatory purposes in the proposed rule.

Wellhead Protection Areas and Drinking Water Supply Management Areas
The terms "Wellhead Protection Areas" (WHPAs) and "Drinking Water Supply Management Areas" (DWSMAs) are important to the proposed rule. WHPAs and DWSMAs are defined in Minn. R. 4720.5100, subp.43 and Minn. R. 4720.5100, subp.13, respectively, and the process for how WHPAs and DWSMAs are delineated is outlined in Minn. R. 4720.5205. The WHPA boundaries are established using a ten year time of travel (Minn. R. 4720.5510, subp. 2), which is based upon multiple scientific criteria, including hydrologic boundaries, which may or may not be identifiable on the land surface. Since WHPA boundaries may not be easily identifiable, DWSMAs are established. DWSMAs help define the WHPA by providing readily identifiable physical or political features as specified in Minn. R. 4720.5100, subp. 13.

The MDA determined that the rule should focus mitigation efforts on DWSMAs. Under the Groundwater Protection Act the MDA is directed to take action to prevent and minimize pollution to the extent practicable and to prevent the pollution from exceeding the health risk limit (see 103H.275 subd. 1 (c)). Therefore it is necessary for the rule to support actions that will reduce contamination in groundwater to meet these goals. Under the federal Safe Drinking Water Act a public well cannot exceed the drinking water standard and as the source water starts to approach 10 mg/L the municipality or party responsible for the well will have to take steps to ensure they don't exceed that concentration. These steps may include blending water from multiple sources, drilling a new well if a suitable alternative aquifer is available, or installing a water treatment system. These steps can be very expensive, difficult to implement and burdensome, especially for smaller communities. They create an urgent need to take action in areas where the nitrate-nitrate concentration is approaching the drinking water standard. In addition public water supply wells have the largest population that will be directly impacted by high nitrate levels in drinking water. Further, DWSMAs were identified in the NFMP as the highest priority areas for action. For these reasons it is reasonable for the rule to prioritize mitigation efforts in DWSMAs.

The DWSMAs also provide a useful regulatory boundary for protecting public water supply wells in the proposed Rule. It is necessary to define some geographic boundary for evaluation, implementation and regulatory purposes. It is reasonable to use the DWSMAs since they are already well-understood, and they are precisely defined by MDH hydrologists using computer modeling and other assessment tools to define the area where actions are needed to protect the source water for the well, and then applying it to a clear geographic boundary. If the MDA did not use the existing DWSMAs then the MDA would need to duplicate that effort in some manner in order to provide a technically defensible and easily explainable boundary for the area subject to this proposed Rule.

Alternatives considered: A significant effort was dedicated by the NFMP Advisory Committee to addressing private wells within the framework of the original 1990 NFMP. The 2015 NFMP focused on private well implementation on a township scale. In accordance to the revised NFMP (MDA, 2015), the MDA considered including regulation of private wells in townships in the MDA's Township Testing Program in the proposed Rule. That provision was included during the request for comment period during the summer 2017 listening sessions. After considering the comments from the request for comments and summer 2017 listening sessions, the MDA determined that the regulatory steps (mitigation levels 3 and 4) on a township scale would not be included. The MDA will continue to implement the NFMP with regard to townships designated as mitigation levels 1 and 2. Those activities are discussed briefly in a subsequent paragraph.

Some of the key factors influencing this decision were:

- The geographical area is involved if townships were included could be potentially extremely large. The MDA, through its preliminary results from the Township Testing Program, determined that at least twenty townships would more than likely be classified as a mitigation level 2 (NFMP, 2015) and a strong possibility that 10 to 20 additional townships would be added to the list. This would require a tremendous number of staff to focus on over 1 million cropland acres involving thousands of Minnesota producers;
- Installing the appropriate groundwater monitoring network across this number of townships that would be rigorous enough for regulatory purposes would be extremely expensive and the MDA currently does not have funding for establishing these networks;
- Comments from producers in the informal comment period during the summer of 2017 indicated that they are implementing a variety of practices beyond BMPs to address leaching, and they expressed strong support for a voluntary approach, rather than a regulatory approach, particularly in the townships.
- This will be the first rule promulgated by the MDA since the Groundwater Protection Act was passed in 1989. The proposed Rule creates a new regulatory structure, which will take

significant staff time and resources to implement. It is necessary and reasonable to focus the limited staff time and resources on the highest priority DWSMA areas. Through implementation of the proposed Rule in the DWSMAs, the MDA will build the Rule infrastructure and will learn important lessons, such as what land use practices worked, what elements contribute to a successful Local Advisory Team, and if there are parts of the Rule that are more or less difficult to enforce. These learnings can then be applied to a broader geographic area in the future, if circumstances warrant.

The MDA will implement the voluntary parts of the 2015 NFMP in townships up to level 2, including forming LATs and conducting groundwater monitoring. Based on the above, it is reasonable for the MDA to focus its regulatory efforts on DWSMAs and continue with the voluntary approach for townships that was outlined in the NFMP, based on available resources.

MDH's authority governing public water suppliers?
The state's Safe Drinking Water Act (SDWA) was adopted by the legislature in 1977 (Minn. Stat. §§ 144.381-144.387). It authorizes the MDH commissioner to promulgate rules which are no less stringent than federal regulations governing public water supplies (Minn. Stat. § 144.383(e)). This authority was granted by the legislature to allow the state, under the federal Safe Drinking Water Act of 1974 (Public Law 93-523 and amendments thereto), to assume primacy for enforcement of the USEPA safe drinking water regulations.

MDH collects data on public water supply wells which includes nitrate-nitrogen analysis. At a minimum, PWSs are required to submit annual samples. If the wells have exceeded 5.4 mg/L nitrate-nitrogen in the past, then quarterly testing is required in order to more closely monitor, evaluate and identify ways to reduce nitrate-nitrogen concentrations in their water supply.

For purposes of the proposed Rule, the MDA will use the nitrate-nitrogen data collected by the MDH in order to evaluate public water supply wells and their surrounding DWMSAs for mitigation levels. These monitoring results are an 'official record' of groundwater conditions that supply the public well. PWS monitoring has been conducted for many years and hence a relationship between communities and MDH is well established. Using this data for purposes of determining mitigation levels is reasonable because the public water supply monitoring program is firmly established and the additional testing requirement at 5.4 mg/L nitrate-nitrogen is an already established 'action level.' In addition, the value of 5.4 mg/L is used in Part 1 for DWSMAs, therefore it is reasonable to be consistent between both parts of the proposed Rule.

Subp. 2. DWSMA mitigation levels. – Evaluation of nitrate-nitrogen concentrations in groundwater

Nitrate-nitrogen concentration data from public wells
Minn. Stat. § 103H.251, subd. 1(a) directs the commissioner to evaluate the detection of pollutants from agricultural chemicals and practices in groundwater of the state. The statute does

not provide details on how this is done, therefore giving the MDA the discretion on how to conduct the evaluation of pollutants. For purposes of public water protection, it is needed for the proposed Rule to use public water supply wells to initially determine the nitrate-nitrogen concentrations in groundwater. This is reasonable because the MDH has conducted annual monitoring in these PWSs over the history of the wells; therefore, in many cases, there is reliable past data available on nitrate-nitrogen concentrations. Subsequent monitoring may continue to use the public well(s) monitoring data or a groundwater monitoring network may be established within the DWSMA for mitigation levels 2, 3 and 4. This approach will yield reliable, accurate results while allowing the MDA flexibility to monitor based on local conditions and allocate its resources appropriately.

Where did the mitigation level criteria come from?

The mitigation part of the NFMP and the proposed Rule is based broadly on a multi-level approach currently in use in the State of Nebraska (Central Platte NRD, 2016). The approach was modified in consideration of the requirements in the Groundwater Protection Act, conditions and data that are Minnesota-specific, and the existing MDH program. The NFMP advisory committee was presented with Nebraska's nitrate groundwater protection activities (including an in-person presentation from University of Nebraska staff) at advisory team meetings in 2011 and 2012. The advisory committee recommended that the MDA develop a phased approach which includes both groundwater monitoring and nitrogen fertilizer BMP adoption criteria, and voluntary and regulatory phases (now called levels). See also MDA, 2014.

There are four levels, two are voluntary and two are regulatory. Each mitigation level in the proposed Rule is designed to initiate actions commensurate with the level of contamination in the source water, or threatening the source water, in the public water supply well. DWSMAs that fall under Part 2 of the proposed Rule will be monitored and will move up or down according to changes in water quality or increases in residual soil nitrate below the root zone which can leach into the groundwater. Factors used for moving within levels include: past nitrate concentrations, the length of time of past public well monitoring, projecting future nitrate concentrations, residual soil nitrate below the root zone, and the adoption of nitrogen fertilizer BMPs. (These are discussed in greater detail below). A DWSMA will always start in a voluntary level and will only progress to a regulatory level if the voluntary approach is unsuccessful either because the nitrogen fertilizer BMPs are not being adopted or groundwater monitoring or soil sampling data indicates that nitrate levels are increasing. DWSMAs may only move up one mitigation level at a time. For example, a DWSMA will never go from mitigation level 1 to mitigation level 3 in a single cycle. (see also Subp. 10)

Initial designation of mitigation levels 1 and 2

The initial designation of mitigation levels 1 and 2 is necessary and reasonable for several reasons. The NFMP, published draft rule and proposed Rule follow the overall intent of and are necessary under the Groundwater Protection Act (Minn. Stat. chap. 103H). Prevention and implementation must be conducted within a voluntary framework until there is adequate information to provide feedback that the voluntary efforts are not effective in addressing nitrate concerns. The evaluation of monitoring results of the public water supply wells will be used by the MDA to initially designate an area as mitigation level 1 or 2. Mitigation levels 1 and 2 are voluntary levels with no immediate regulatory components. These voluntary levels are meant to encourage farmers to adopt nitrogen fertilizer BMPs and other nitrogen management practices and make changes on their own, without regulation. The MDA will always start the process at either a mitigation level 1 or 2 based on monitoring results. This approach was supported by the NFMP advisory committee, comments received during the NFMP public comment period, request for comments on the proposed rule and the summer 2017 comment period for the draft rule as well. Farmers are always given the chance to voluntarily comply with the nitrogen fertilizer BMPs and other practices (as recommended by the LAT). If they choose not to voluntarily adopt nitrogen fertilizer BMPs for level 2 sites, the MDA will proceed to a regulatory level. For these reasons, the initial designation is reasonable.

The approach is designed to prevent and minimize nitrate-nitrogen concentrations in groundwater to the extent practicable and to prevent pollution from exceeding the health risk limits as directed in Minn. Stat. § 103H.275, subd. 1(c) by working with local farmers and their agronomists to evaluate, promote, and adopt practices that are able to reduce nitrate-nitrogen concentrations in groundwater. The approach starts in a voluntary step because, based on the NFMP advisory committee discussions, the approach likely will be more effective if it is voluntary. This will be done through the formation of a local advisory team (LAT). It was noted that if local farmers and their agronomists are actively consulted and become committed partners in trying to address local nitrate concerns, they will have a much greater potential for solving the problem than any other group. Most farmers live in or near the communities that are experiencing nitrate problems and are concerned about protecting water quality. They control the land and have the ability to manage and change the use of the land in a manner that will be far more effective and efficient in reducing nitrate leaching than is the likely outcome of a purely regulatory approach. The goal of the plan and proposed Rule is, in part, to create a formal approach and structure to facilitate that engagement process. However, the proposed Rule and the specific actions outlined in the proposed Rule are necessary in the event that the voluntary approach is not successful and to outline a clear set of expectations regarding what performance-based outcomes are required before a regulatory action is justified and necessary.

The mitigation process in the proposed Rule has been designed to increase the level of response activity as the water quality gets worse in a manner commensurate with the nitrate pollution as directed in Minn. Stat. § 103H.275, subd. 1(b). It is also designed to be integrated in a practical manner with existing MDH source water protection strategies and regulations. The use of monitoring data, regulatory boundaries, and action level criteria all are based to a large extent on the existing MDH source water protection program. It is necessary for the MDA to determine regulatory boundaries and action levels in order to create an effective proposed Rule. It is reasonable for the MDA to align our regulatory process and guidance with the existing program requirements in order to prevent the inefficient duplication of efforts and in order to take advantage of the extensive amount of effort which has already been dedicated to protecting public water supplies.

Subp. 3. Criteria for initial mitigation level designation

The initial level designation will be based on the nitrate-nitrogen concentration from public water supply wells. The initial level designations are designed to prioritize DWSMAs based on the risk to human health from elevated nitrate. The MDA will continue to work on education and implementation activities in mitigation level 1 DWSMAs and will continue to evaluate nitrate-nitrogen concentrations from the public water supply wells but will not establish monitoring networks in mitigation level 1 DWSMAs. Mitigation level 2 DWSMAs are areas where nitrate-nitrogen concentrations are at or exceed 8.0 mg/L or have been at or exceeded that concentration at any point during the previous 10 years, or are projected to exceed the 10 mg/L MDH HRL within the next ten years. Farmers and their agricultural advisors are provided the opportunity to engage in local work groups to decide and implement local solutions before regulations are necessary. This is a reasonable approach, using objective data and making progressive decisions based on that data.

Subp. 3. Criteria for initial mitigation level designation. A. (1) – Mitigation Level 1

For a mitigation level 1 designation, a threshold concentration of 5.4 mg/L nitrate-nitrogen was selected because it is the concentration under which the MDH, as the lead state agency implementing the federal Safe Water Drinking Act, (Minn. Stat. § 144.381-144.387) requires more frequent monitoring of a well because of the potential for increased health risk due to elevated nitrate-nitrogen concentrations.

Mitigation level 1 is voluntary. However, a mitigation level 1 designation provides notice to the local agricultural community and others within a DWSMA that the source water to the well and groundwater within the DWSMA have significantly elevated concentrations of nitrate-nitrogen and require immediate increased attention and care to nitrogen management practices. This is reasonable because it uses an existing and established guideline for action. For mitigation level 1 DWSMAs the MDA will seek to work with the local agricultural community to increase protective actions, including nitrogen fertilizer BMP adoption, and promotion and funding for implementation of AMTs, within the DWSMA.

Mitigation level 1 DWSMAs will continue to be monitored through the MDH’s programs. If nitrate-nitrogen concentrations increase and meet the requirements for a mitigation level 2, the MDA will reevaluate and re-designate the mitigation level of the DWSMA.

Subp. 3. Criteria for initial mitigation level designation. A. (2). – Mitigation Level 2

A DWSMA will initially be placed in mitigation level 2 if the source water has met or exceeded a concentration of 8.0 mg/L nitrate-nitrogen at any time during the previous 10 years or if the projected trend of the source water nitrate-nitrogen concentrations will exceed 10 mg/L within 10 years. These criteria are necessary because some clear benchmarks are needed to determine when the nitrate concentrations are increasing such that increased actions are required commensurate with the nitrate contamination and to prevent the water quality from exceeding the MDH HRL as directed in the Groundwater Protection Act. They are reasonable because they are appropriate indicators that there is an increasing risk that the source water for the public water supply well may exceed the MDH HRL. They were selected specifically to provide for increased response actions before the source water for a well exceeds the MDH HRL.

The concentration of nitrate in groundwater can vary significantly in a well based on a number of factors. For shallow wells or wells constructed in areas with karst geology, the nitrate concentrations in groundwater can vary rapidly over short periods of time due to rapid travel times through the aquifer (Runkel et al, 2014, Steenberg et al, 2014). For deeper wells or wells in slightly less vulnerable aquifers concentrations tend to change at slower rates. Nitrate concentrations in groundwater can also change in response to changes in land use, for example, a significant increase or decrease in the number of acres planted to a high nitrogen using crop like corn, or because of adverse weather which can affect the rate of nitrate leaching. Because of the range of possible situations considering well construction, hydrogeology, land use and weather, the MDA selected indicators for a level 2 determination which are applied over a long period of time. A single detection of nitrate-nitrogen over 8 mg/L at any time over the last 10 years or a projected increase in nitrate-nitrogen concentration to over 10 mg/L over the next 10 years should provide sufficient notice that the source water is at risk and additional actions are needed to prevent the source water from exceeding the MDH HRL of 10 mg/L.

The criteria in the proposed Rule changed from the previous draft and the NFMP by reducing the benchmark from 9 mg/L nitrate-nitrogen over the previous 10 years to 8 mg/L nitrate-nitrogen over the previous 10 years. MDA concluded that this change was needed and reasonable to provide an increased margin-of-safety to take action before source water might exceed the MDH HRL. This change represents moving from an action level that was 10% below the MDH HRL to one that is 20% below the MDH HRL, for a single sampling event.

The proposed Rule requires that the projected increase in nitrate-nitrogen concentrations to greater than 10 mg/L over 10 years be based on a statistical analysis. The statistical trend analysis is reasonable because this is a standard practice already used to evaluate trends in data (generally and specifically water quality trends). Statistical analysis is a rigorous evaluation, using scientific methodology to arrive at results that are highly reliable. The analysis of monitoring data is described in this SONAR, 1573.0040, Supb. 5. Monitoring.

Moving to mitigation level 2 will initiate several actions to address the nitrate-nitrogen concentration concern. These include, most importantly, the formation of a LAT including local farmers and their agronomists to advise on appropriate nitrogen fertilizer BMPs and AMTs to reduce nitrate levels in groundwater. These actions are described in other places in this SONAR.

Subp. 3. Criteria for initial mitigation level designation. B. – Exceptions

The proposed Rule allows the Commissioner to make exceptions for increasing the mitigation level designations for non-municipal public water supply wells. These exceptions might be for one or more of the following reasons:

1. whether there has been a significant change in the amount of land used for agricultural production within a drinking water supply management area;
2. the severity of the nitrate-nitrogen concentration found in other wells in a drinking water supply management area;
3. the population affected by the groundwater contamination of nitrate-nitrogen; and
4. other factors expected to influence nitrate-nitrogen concentration.

Non-municipal community wells serve at least 25 year-round residents or 15 service connections used by year-round residents and are privately owned. They might include nursing homes, mobile home parks, or housing developments. There are about 260 such wells in Minnesota. They typically have much lower capacity (lower pumping rate) wells compared to municipal systems. Because of the low capacity wells, the DWSMA might be very small – on the order of a few hundred acres or less. Many of these systems do not currently have DWSMAs delineated by the MDH, but MDH staff have indicated they plan to develop DWSMAs for the systems that are located in areas with vulnerable groundwater (Steve Robertson, MDH Supervisor, personal communication).

Although these systems are small in scale, they may involve a significant amount of MDA staff work to implement the proposed Rule within them. These exceptions were included in the proposed Rule to allow the MDA to prioritize work with the larger systems which are the most contaminated and serve the largest population being addressed as a higher priority than smaller systems with a smaller served population and less nitrate-nitrogen contamination. In addition, the exceptions allow the commissioner to consider changes in land use that can be especially significant for small DWSMAs. An example would be a nursing home on the edge of a town where the land in the DWSMA is being developed and converted from cropland to residential housing. The exceptions also allow the MDA to consider other factors because of the potential for unusual situations that can occur but are difficult to fully predict.

This provision in the proposed Rule is necessary because it allows the MDA to prioritize work in a practical manner if there are insufficient staff resources to address all of the community water systems with elevated concentrations of nitrate-nitrogen at one time, or if actions in the DWSMA are unlikely to improve water quality because of changes in land use or for other reasons. It is reasonable because it is anticipating situations that might realistically occur, it will ensure that staff resources are used efficiently by working on those areas that pose the greatest risk first, and because the MDA has professional staff able to exercise good judgement when allowing exceptions to the mitigation level criteria for smaller non-municipal water systems.

Subp. 3. Criteria for initial mitigation level designation. C. – Point Sources of Pollution

As stated in the SONAR for 1573.0030, Subp. 2. F., in some cases, elevated nitrate levels within DWSMAs are due to point sources of nitrogen. Examples of point sources may include but are not limited to an improperly sealed well, animal feedlot or an agricultural chemical incident. This exclusion is needed and reasonable since it is clearly inappropriate to consider any mitigation actions, especially regulations, for nitrogen fertilizer if the source of the contamination in the public well is not related to the use of nitrogen fertilizer.

Subp. 3. Criteria for initial mitigation level designations. D. - Partial Exclusions Due to Low Risk

The commissioner may exclude part of a drinking water supply management area from a level designation if the commissioner determines that the area is not contributing significantly to the contamination of the public well in the drinking water supply management area. This provision in the rule is necessary to allow the commissioner to exempt parts of a DWSMA which are not contributing significantly to the groundwater contamination in the public well from the level determination and subsequent requirements in the rule.

DWSMAs vary in size from very small, less than a hundred acres, to relatively large, on the scale of tens of thousands of acres. For most DWSMAs the soils types and vulnerability to groundwater contamination are likely to be fairly uniform across the DWSMA and this exclusion will not be needed. But for large DWSMAs it is reasonable to expect that there will be areas with significantly different soils types, land features, and groundwater vulnerability such that some parts of the DWSMA may not be contributing significantly to high nitrate-nitrogen concentrations in the public well.

This provision is necessary to ensure that the commissioner does not implement surveys, install monitoring wells, promote practices, and potentially impose regulatory requirements and related costs in areas where these activities will not significantly help reduce nitrate-nitrogen concentrations in the public well. It is reasonable because the Groundwater Protection Act directs that Water Resource Protection Requirements should be practicable and consider factors such as economics, implementability and effectiveness, and implementing certain practices uniformly across a DWSMA including in areas where they may provide limited environmental benefits would not meet this requirement.

Subp. 4. Determination of nitrogen fertilizer best management practices and mitigation levels. A. – Determination of BMPs and LATs.

Determination of nitrogen fertilizer BMPs for each DWSMA?

The U of M nitrogen fertilizer BMPs are developed and promoted as general guidance for the majority of the soils, climate conditions and crops found in the each of the five BMP Regions. Frequently localized conditions can be considerably different requiring site specific recommendations. In many DWMSAs, the unique conditions are frequently much more conducive for nitrogen leaching. Many of the DWMSAs already identified having elevated nitrates are frequently those with significant acres comprised of coarse texture soils or thin mantles of loamy soils underlain by sands and gravels. For these reasons, the local advisory teams (LATs), in partnership with experts from the U of M and the MDA will be helpful in recommending the most appropriate practices.

A primary goal of the NFMP and the proposed rule is to create a process which encourages local farmers and their agronomists to learn about and adopt the most current and effective practices and technologies that will help reduce nitrate contamination in highly vulnerable groundwater areas. The use of LATs is intended specifically to accomplish that goal.

Local advisory team

When a DWSMA is designated as a mitigation level 2, it indicates that additional monitoring and education/promotion activities need to begin. After a DWMSA is designated in mitigation level 2 status, a very important step is the establishment of a local advisory team (LAT). The purpose of LATs will be to make recommendations to the commissioner about the appropriate nitrogen fertilizer BMPs and AMTs that should be used in the DWSMA While the formation of the LAT in a mitigation level 2 is not mandatory, it is desirable because the LAT can help develop and implement locally viable solutions to address elevated nitrate-nitrogen concentrations. The LAT will be critical to advising the MDA on designing educational aspects including field demonstrations, the Nitrogen Smart training program (U of M Extension/Minnesota Corn Growers) and other outreach approaches.

The LAT will consist of people who are from the area, including farmers, representatives of local groups/organizations, public water supply systems, and government staff and/or professionals who can provide technical or financial support. The majority of members will be local farmers and their crop advisors/consultants. The size and composition of the team will vary depending upon the size of the area, the nature of the problem and availability of local stakeholders; however, it will likely be no more than 15 -20 people. The MDA will develop guidance that outlines the roles and responsibilities of the LAT.

Local farmers and their crop advisors/consultants are critical in helping develop and implement appropriate activities to address elevated nitrate in their groundwater because they control the land use. The mitigation strategy is constructed specifically to involve the local agricultural community in problem solving with the opportunity to avoid regulations if voluntary actions are taken.

LAT decisions will not be determined by majority vote, but rather the team will seek consensus and common ground. The team will advise the MDA in an open process. All members' comments and recommendations will be considered. The MDA will be responsible for final determinations of potential regulatory actions and will seek to provide consistency in decision making for similar situations/areas.

In addition, the MDA believes LAT members know their local area the best, and therefore are best able to determine what will work locally. The MDA acknowledges that a 'one size fits all' approach is not ideal. Instead, the LAT is a reasonable and better alternative to find local solutions to address nitrate in groundwater. During the summer 2017 comment period, there were significant comments supporting the formation and use of LAT to address local nitrate in groundwater issues.

Subp. 4. Determination of nitrogen fertilizer best management practices and mitigation levels. B. – Notice.

Legal notice of proposed and established commissioner's orders is required in Minn. Stat. § 103H.275, subd. 2. Providing legal notice is a balance between providing adequate and appropriate notice to affected parties, but not creating an undue burden (time and expense) to the regulator in providing this notice. Use of a local legal newspaper is a reasonable alternative for the larger DWMSAs. Due to the limited number of producers in many of the smaller DWMSAs, the MDA will contact the landowners, operators, and dealerships directly if they are known. If not, the MDA will publish the water resource protection requirements in two consecutive issues of the legal newspaper.

In addition, it is reasonable to provide other options to provide notices of proposed Rule actions. The agency website is a reasonable option because this is a likely location where individuals impacted by the proposed Rule will go to find more information.

Supb. 5. Monitoring. A and B – Public wells and groundwater monitoring networks

The primary monitoring point for water quality in a water supply well is the raw (untreated) water pumped from the well. This is the source of nitrate-nitrogen concentration data that will be used to evaluate if the source water has exceeded the water quality thresholds used for mitigation level determinations and for assessing if nitrate concentrations are projected to exceed 10 mg /L within a 10-year period. It is reasonable to use this data for decision making since it is the actual water being provided for use by the public water supply system and it is the point where monitoring is conducted under the direction of the MDH.

Public wells

Historical nitrate data provided by the MDH from the water supply well(s) will be evaluated to estimate future nitrate concentration in the well(s). This analysis will use the most recent 10 years of nitrate-nitrogen concentration data provided by the MDH to project future nitrate-nitrogen concentrations. Using regression techniques, the future nitrate-nitrogen concentration in the well(s) will be projected to determine if the concentration is likely to exceed the MDH HRL within ten years.

When a groundwater monitoring network is established within a DWSMA, the groundwater nitrate-nitrogen concentration data will be evaluated after a minimum of three growing seasons or the estimated lag time, whichever is longer. A statistical analysis will be performed to assess change in the nitrate-nitrogen concentration by comparing pre-and post-implementation periods for nitrogen fertilizer BMPs. Changes will be assessed using the 90^{th} percentile concentration from nitrate samples collected from the groundwater monitoring network. It is anticipated that the 90^{th} percentile concentration will generally indicate changes in the nitrate-nitrogen concentration distribution sooner. The statistical significance of change in the 90^{th} percentile concentration will be determined utilizing a 90% confidence level ($p <0.10$).

It is necessary and reasonable to use statistical methods to evaluate changes in water quality data which sometimes includes considerable variability in the data. Statistical analysis will provide robust analysis of the groundwater nitrate-nitrogen concentration data (from public wells and the groundwater monitoring network – if applicable) to ensure confidence in the results. It is reasonable to consider and use statistical methods that have been developed for this purpose.

The MDA hired a national expert in statistical analysis of groundwater monitoring data to provide guidance on the groundwater monitoring network design and the interpretation of groundwater monitoring data. (Comments on statistics of the conceptual design, the five assumptions of network design, and the seven statistical questions in the Township Nitrate Monitoring Scope of Work, July 2017). Statistical analyses such as those suggested by Dr. Helsel provide a basis for evaluating change in nitrate-nitrogen concentration within the DWSMAs. Dr. Helsel outlines a variety of statistical analyses that can be used to evaluate changes in concentrations over time. These methods will be evaluated to determine which would be the most appropriate for the data being assessed.

Groundwater monitoring network

The MDA may also conduct monitoring to evaluate the effectiveness of nitrate reduction practices in two other ways, through the installation of a groundwater monitoring network within the DWSMA or through monitoring of residual soil nitrate below the root zone. Both of these approaches to monitoring can be used to determine if nitrate levels are increasing or decreasing in the DWSMA.

The MDA may install a groundwater monitoring network to evaluate if the nitrate-nitrogen concentrations are increasing or decreasing across the DWSMA. This is reasonable because a DWSMA is defined as the area that contributes water to a pumping well over a period of 10 years. That means it will take 10 years for groundwater to travel from the boundary of the DWSMA to the pumping well. As such, it would take a minimum of 10 years for changes in practices across the entire DWSMA to be reflected in the water quality in the pumping well. A groundwater monitoring network can be designed and installed to evaluate changes in water quality in the upper portion of the aquifer, at multiple locations within the DWSMA. This will reduce the amount of time required to measure changes in water quality associated with practices that have been implemented at the land surface. This approach is reasonable since the network will be specifically designed to provide an accurate assessment of changes in water quality across the agricultural areas of the DWSMA and will reduce the time required to evaluate those changes. The groundwater monitoring network data will not be used to determine if source water in the DWSMA meets water quality thresholds in the public water supply well, because it is not directly representative of the water supply well. The pumping well may be screened at different depths in an aquifer or in different aquifers and nitrate-nitrogen concentrations can change with increasing depth in an aquifer. Therefore the monitoring data in the public well is not directly comparable to the water quality measured in the shallowest portion of the aquifer.

The wells in the groundwater monitoring network will be constructed to evaluate the water quality in the upper portion of the shallowest aquifer. The groundwater monitoring network will specifically target row crop agricultural areas to assess changes in water quality as a result of changes in agricultural and land management practices within the DWSMA. The groundwater monitoring network will meet the minimum requirements for statistical analysis and may include a variety of well types (monitoring wells, temporary monitoring wells, domestic wells), provided each of the wells meet the specifications and requirements for the monitoring network. The requirements could include but are not limited to: well depth, construction, age, screen length, and well access.

If a groundwater monitoring network cannot be installed, changes in water quality can still be evaluated for regulatory decision making using water samples collected at the pumping well following a period of time equal to the lag time plus the groundwater travel time within the DWSMA.

Subp. 5 Monitoring C. – Residual soil nitrate tests

Residual Soil Nitrate Tests

Researchers routinely examine residual soil nitrate levels while developing and evaluating new nitrogen fertilizer management practices. If application rates exceed crop consumption or if other management changes (such as timing or source) result in reduced fertilizer recovery, the efficiency of the imposed practices can be evaluated through examining the nitrate levels remaining in the soil profile upon crop termination. Quantifying residual soil nitrate levels is an important metric because it is this fraction of the overall nitrogen inputs that has a high probability of escaping through the soil and eventually reaching groundwater supplies. Generally, soil scientists monitor the root zone or directly below the root zone using this technique.

Besides using standard groundwater monitoring approaches, the MDA also considered employing two soil sampling procedures used in Nebraska to evaluate changes in shallow “residual” soil nitrates levels: shallow residual soil nitrate monitoring and deep residual soil nitrate monitoring. In both Nebraska techniques, the idea is to determine if the potential for nitrogen loading is changing without having to wait for the groundwater to respond. Inorganic nitrogen is analyzed by depth increments providing valuable quantitative values on the nitrogen amounts in transport to the water table. Subsequent resampling provides critical information on the rate which the nitrogen is moving and if improvements over time are being achieved. The two different Nebraska approaches are described below.

Shallow Residual Soil Nitrate Monitoring

In a number of nitrate-impacted areas of Nebraska, farmers are required to provide three-foot soil samples annually from each field which grew either corn, potatoes or sorghum. Ferguson (2015) examined forty years of soil testing (0 to 3’) results from the Central Platte Natural Resource District and determined that a strong correlation existed between the residual soil nitrate levels and nitrate-nitrogen concentrations of the underlying shallow groundwater in areas of coarse-textured soils. This is important because it provides strong evidence that Nebraska’s approach for addressing elevated nitrate-nitrogen concentrations in groundwater is working and the timeframe for seeing measurable improvements is better understood.

Canadian researchers have also used nationwide residual soil nitrate information from shallow sampling over time to make policy decisions related to fertilizer use efficiencies and groundwater implications (Yang et al., 2007; Drury et al., 2007).

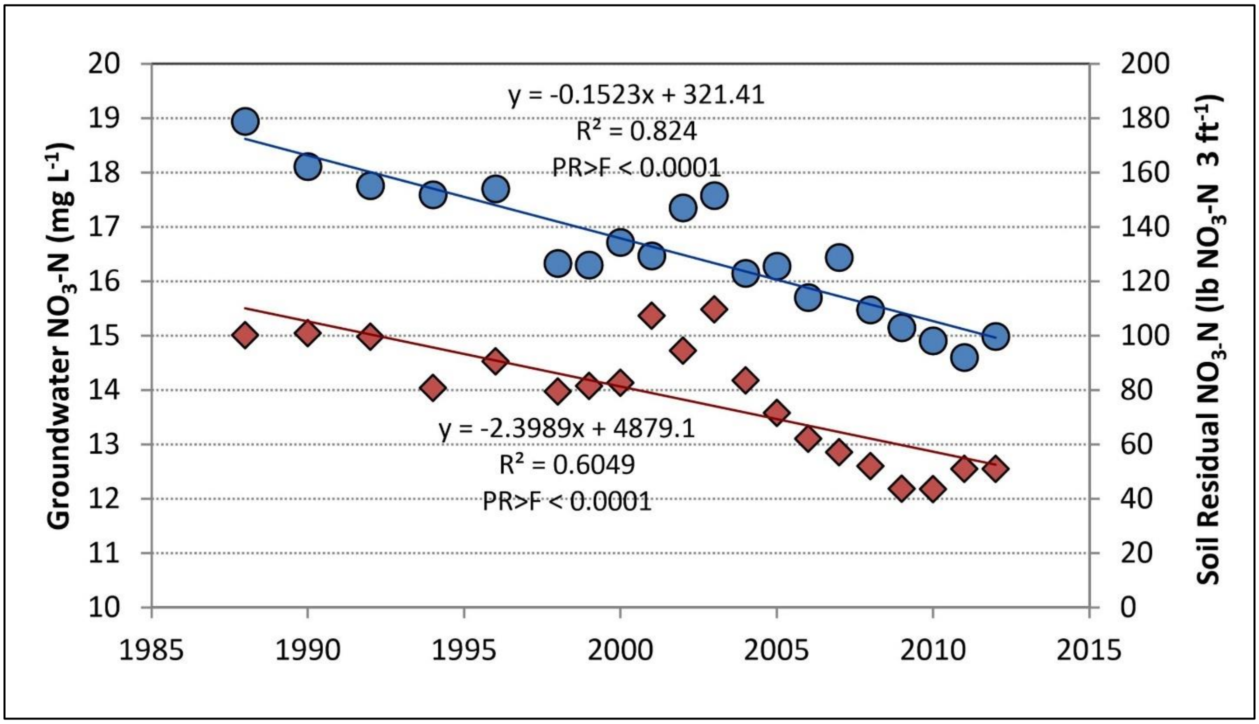


Figure VI-4. Relationship between nitrate-nitrogen in soil and shallow groundwater.

<u>Deep Residual Soil Nitrate Monitoring</u>

Some regions of Nebraska have very deep soils ranging from loams to clay loams. The estimated lag time (the travel time for nitrogen applied to the soil surface to the time it enters the groundwater) is frequently measured in decades. University of Nebraska scientists have experimented with the concept of using deep soil coring information (60 to 100 feet) in order to better understand the nitrogen inventory and the travel speed to groundwater. Routine groundwater monitoring in these types of environments can be greatly enhanced with the associated time lags.

Shields et al. (2017) summarized a number of previous related research projects which established a small number of study sites in the 1990s. The original researchers found that there were very high amounts of inorganic nitrogen (frequently over 1,000 lb. /acre) between the crop zone and the water table. Much of this excess nitrogen is believed to be from poor fertilizer and water management practices used in the 1970s. In the recent re-sampling, Shields determined that nitrogen was traveling at a rate of approximately 29 inches/year. **Error! Reference source**

not found. (Shields and Snow, 2017). Figure IX-5 illustrates a soil coring down to 80 feet at two different time intervals. After twenty years of nitrogen and water management outreach and regulations, this data suggests some drastic reductions in nitrate leaching losses.

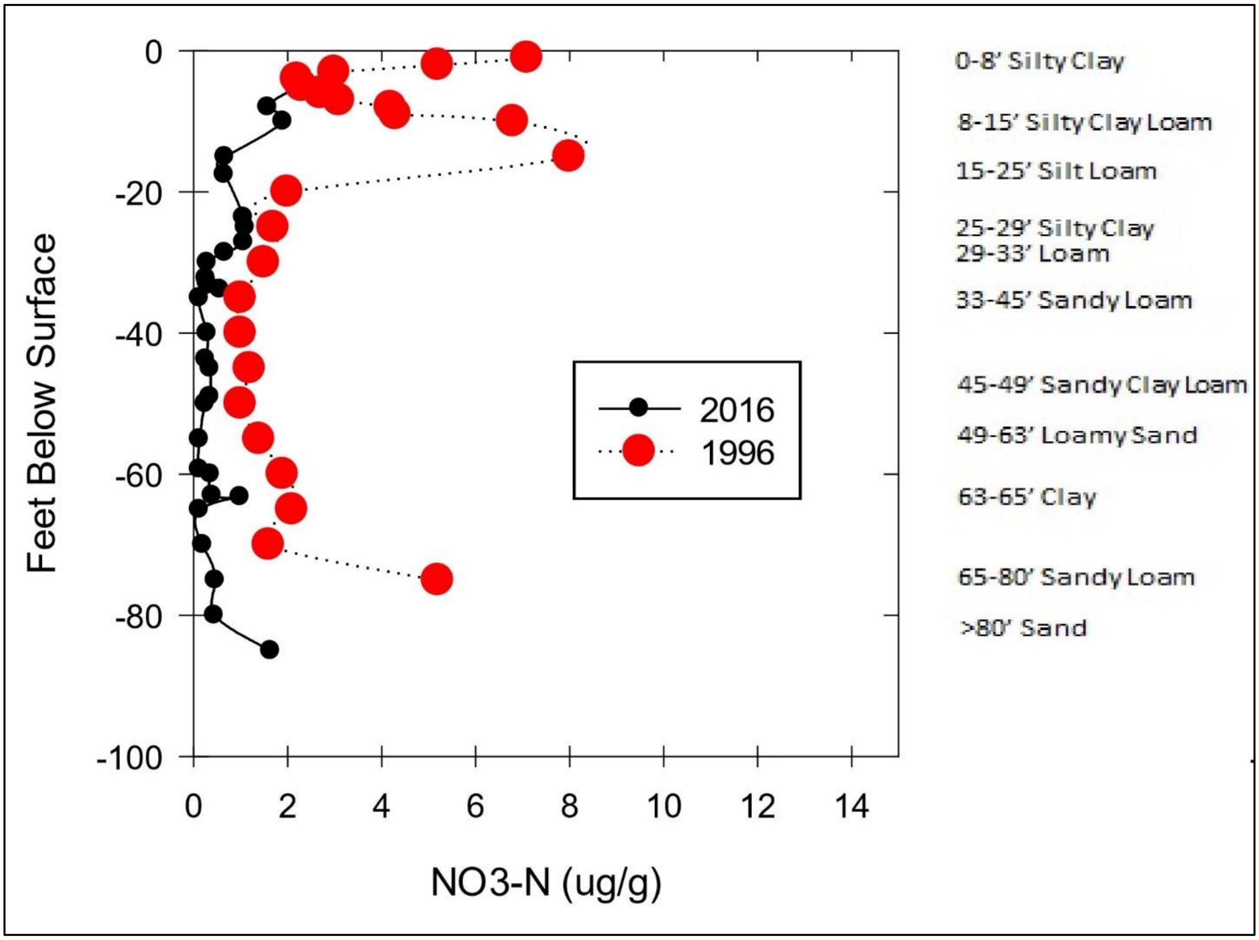


Figure VI-5. Deep soil nitrate coring and lag time to assess nitrogen and water management outreach and regulations.

Implications of the Residual Soil Nitrate Test for the proposed Rule

Use of the shallow residual soil nitrate test provided very good feedback for the Nebraska regulatory process. As previously mentioned, it worked in areas where the soils were coarse textured and the lag times where short because of shallow depth to groundwater. However, this method imposes some burdens: all Nebraska farmers in certain areas with elevated nitrates are required to provide shallow soil test results annually on fields receiving nitrogen fertilizer, and they are required to bear that additional cost. In addition, this testing requires access to a large number of acres. For this reason, the agency chose not to include this method in the rule, but it may be useful in some voluntary responses under the NFMP such as for townships with elevated nitrate.

The deep soil sampling method, the second approach used by the University of Nebraska, provides an accurate and useful approach and is included in the proposed Rule. In regions of the state where groundwater is located at much greater depths, it may be cost prohibitive to install monitoring wells. Similar to the Nebraska approach, deep soil samples would be obtained to establish a baseline inventory of the amount of inorganic nitrogen which has accumulated between the root zone and close proximity to the water table. Borings would be collected early in the Mitigation Level 2 process and then resampled on a predetermined sampling cycle. The number of sampling sites could be limited within the DWMSAs where this approach is used depending on available resources. MDA and the LATs would need to designate a small number of representative fields where the technique would be used.

This technique will provide useful metrics in terms of the initial levels of nitrogen currently in transport to the water table. The nitrogen levels should be reduced over time with improvements in nitrogen management practices. Once the resampling is conducted, the travel time of the nitrogen to groundwater can be quantified. The advantage of this approach is it is possible to determine if the implementation of BMPs and AMTs are effective by reducing the amount of nitrogen in the unsaturated profile without having to wait for extended lag times to actual reach (and ultimately impact) groundwater resources.

Subp. 6. Nitrogen fertilizer best management practices evaluation A.

BMP evaluation in mitigation level 2

According to Minn. Stat. § 103H.275, the MDA shall evaluate the nitrogen fertilizer BMPs based upon two components: 1) the evaluation of BMP implementation; and 2) the evaluation of BMP effectiveness. Each component must be evaluated individually, and their combined effect must be evaluated as well. Evaluation of either component will be a complex process. This section will discuss the tools used for assessing the implementation of nitrogen fertilizer BMPs.

The results of BMP implementation may not be discernible for a long period of time, as measured by the change in nitrate-nitrogen concentration of groundwater. Furthermore, changes in nitrate-nitrogen concentration observed over the course of a single year may or may not be related to BMP adoption. In view of these challenges, it is recognized that BMP adoption must be evaluated as well as BMP effectiveness in preventing or reversing the degradation of water quality.

On-Farm Nutrient Assessments: The ability of the MDA to document farmer adoption rates of voluntary nitrogen fertilizer BMPs is a critical component of the 1989 Minnesota Groundwater Protection Act (Minn. State. chap. 103H). The MDA has developed a diagnostic tool called FArm Nutrient Management Assessment Process (FANMAP) to get a clear understanding of existing farm practices regarding agricultural inputs such as fertilizers, manures and pesticides.

Although it is labor intensive, it provides a useful and accurate method of compiling data on BMP adoption. This approach was developed for DSWMAs and other small-scale water quality projects.

Results have been used to design focused water quality educational programs. Data collected in the program's infancy can be used as a baseline to assist in determining if the nitrogen fertilizer BMPs are being adopted. Over the past twenty years, hundreds of farmers have volunteered two to four hours of their time to share information about their farming operations. The complete compendium of FANMAP surveys is available on the MDA’s FANMAP website (n.d. (b)).

Phone Surveys: The MDA has partnered with the NASS and U of M researchers to collect information about fertilizer use and farm management on regional or statewide scales. Partners have pioneered a survey tool for characterizing fertilizer use and associated management. Surveys are conducted over the phone.

Enumerators from NASS are highly skilled at obtaining critical information over the phone with minimal time and burden on the farmer. The first attempt using this technique was in 2010. NASS enumerators surveyed approximately 1,500 corn farmers from across the state to gather information about commercial fertilizer use on corn (Bierman et al. 2011). Statewide nitrogen use surveys for grain corn production are now conducted every other year in partnership with NASS. During the alternate year, surveys on other crops and practices are conducted.

Evaluation for purposes of the proposed Rule will be conducted after a minimum of three growing seasons after the publication of the nitrogen fertilizer BMPs. Since the proposed Rule is focused on DWSMAs, the FANMAP approach previously described will be the likely tool. To determine if proper nitrogen rates are used, it will be necessary to look back at past years practices for the purposes of crediting all sources of nitrogen that are applied. The survey will take into consideration all cropland except soybean (i.e. corn, alfalfa, wheat, etc.)

Time period for BMP adoption

The MDA will inform farmers of the selected nitrogen fertilizer BMPs (and AMTs if funded in mitigation level 3, or for mitigation level 4) prior to the beginning of a growing season and give them adequate time before implementation is required and evaluated by the MDA. The MDA determined that three growing seasons should be used because this is the length of the most common corn-soybean crop rotation. The corn-soybean rotation for the past several years has covered approximately 16 million acres which represents over ¾ of Minnesota’s cropland acres.

It is reasonable that the MDA gives farmers time for implementing the nitrogen fertilizer BMPs (and AMTs if required) because after the selection and promotion of the nitrogen fertilizer BMPs, it may take some time for adoption. The MDA routinely finds that growers tend to use rates higher than the U of M recommendations in some parts of the rotations. Farmers will need time to experiment with these more conservative rates. In addition to farm management changes, there may be supplies (e.g., nitrogen fertilizer product availability), equipment (e.g., 'specialized' fertilizer application equipment), or other issues beyond the control of the farmer that may take time to resolve.

Exclude soybean acres

The MDA will not include soybean acres when evaluating compliance whether 80% of the cropland is following nitrogen fertilizer BMPs. Being a legume, soybeans fix their own nitrogen and therefore do not have a nitrogen recommendation except under unique circumstances. The proposed Rule is intended to apply to crops that apply nitrogen fertilizer; therefore it is reasonable that soybeans not be included. If soybeans were included, those acres would artificially increase the number of acres that followed the (non-existent for soybeans) nitrogen fertilizer BMPs. In addition (as noted above), soybeans are most often in rotation with corn, therefore those acres could be evaluated for compliance with required nitrogen fertilizer BMPs during the year corn is grown.

U of M research has shown that soybean loses appreciable amounts of nitrogen in comparison to other legume crops such as alfalfa. Beans frequently lose about 75% of the rate losses typically found under corn even though nitrogen fertilizer is seldom directly applied. Losses, in part, are due to the contributions from mineralized nitrogen along with lower crop water use (resulting in greater nitrogen flux). Alfalfa and other perennials are extremely effective in reducing nitrate losses through the root zone and when these crops are managed correctly, they can have extremely positive water quality benefits. For this reason, the introduction of these crops is considered an AMT and highly encouraged.

The MDA received some comments that suggested that it should not include soybeans in the 80% cropland calculation. Considering all of these factors, it is reasonable that the MDA does not include soybeans in the '80% cropland compliance'.

Justification for using 80% of cropland

Within any geographical region, it is reasonable to expect that some percentage of the agricultural landscape will experience climatic conditions or other conditions which will impede the producer's ability to manage nitrogen inputs in accordance to the nitrogen fertilizer BMPs and corresponding Fertilizer Guidelines (MDA, n.d. (g) Kaiser et al., 2011, 2016, Lamb 2015). For example, one of the consequences of climate change is more localized thunderstorms resulting in wide variations of rainfall within small distances. Large differences are frequently observed within the boundaries of an individual farm. Localized saturated conditions, as well as drought conditions, can have a profound impact on time management and the producer's ability to implement nitrogen management on these minor acres.

Additionally, making alterations to fertilizer management practices can also impact time management, labor costs, labor availability, and many associated equipment issues. For a variety of reasons, it is not realistic to assume that nitrogen fertilizer BMPs can be implemented across all acres for any particular growing season.

There was considerable discussion and eventual consensus across the NFMP Advisory Committee that this threshold level should not be 100%. A range of percentages were discussed and eventually the committee agreed that 80% would represent a balance between challenging producers to continue adopting the best available science yet reflecting that the forces of nature must always be considered.

Why is it needed and reasonable to allow periodic evaluations to monitor progress?
Periodic evaluations of nitrogen fertilizer BMP adoption will allow the agency to check on progress and compliance, and to make adjustments as needed. Over time, cropping systems and nitrogen fertilizer BMPs may change and the MDA will need to track these changes. In addition, evaluations indicate whether the practices needed to improve groundwater quality are in place. These periodic evaluations will allow the MDA to make sure that the desired nitrogen fertilizer BMPs/AMTs in mitigation levels 3 and 4 are being implemented. This type of feedback will also be informative for the LATs and other partners to evaluate the effectiveness of mitigation level 2 promotional activities. For these reasons, it is reasonable that the MDA conduct evaluations of nitrogen fertilizer BMP adoption.

The timeframes of these evaluations may be variable due to the mitigation level and DWSMA area as further discussed below.

Subp. 6. Nitrogen fertilizer best management practices evaluation. B – Evaluation criteria.
The proposed Rule has established several additional considerations when determining whether the nitrogen fertilizer BMPs (and AMTs) are being adopted. The MDA has determined that it is necessary for the rule to include additional circumstances that are relevant in determining compliance with the BMPs. These include:

> *Approved Alternative Management Tools (AMTs):* The AMTs are a replacement or improvement to the nitrogen fertilizer BMPs; therefore, it is reasonable that they be deemed in compliance with the nitrogen fertilizer BMPs. In the NFMP and in subsequent proposed Rule outreach activities, the MDA has repeatedly stated the goal of going beyond the nitrogen fertilizer BMPs and implementing AMTs. Therefore, in an effort to facilitate their use within the proposed Rule, the MDA will maintain a list of agency-approved AMTs so they are readily accessible for the MDA to promote and for farmers to implement. Therefore, it is needed to understand if farmers adopted approved AMTs in order to assess whether they are in compliance with the BMPs.
>
> *Minnesota Agricultural Water Quality Certification Program (MAWQCP):* A compliance determination for MAWQCP is needed because Minn. Stat. § 17.9891 states that enrollment in MAWQCP is deemed in compliance with any state regulation. This

includes the proposed Rule. In addition, in order to get certified under the MAWQCP, the nitrogen fertilizer BMPs as well as other fertilizer management practices will have been adopted on the certified acres.

Lack of Information: If a regulated party does not provide the MDA any information, or provides inadequate information, that party will be determined to not be in compliance with the proposed Rule. The MDA expects regulated parties to be forthcoming during compliance checks, and noncooperation by providing inadequate information will result in an assumption that nitrogen fertilizer BMPs have not been adopted. This is reasonable because the proposed Rule begins in a voluntary level, providing farmers adequate opportunity to comply before regulation. In the regulatory levels, it is reasonable to expect continued cooperation in compliance with regulatory requirements. In addition, determination of noncompliance is reasonable because it is equitable to all regulated parties in an area to require all to comply with the same regulatory requirements.

Waiver from non-compliance due to an agricultural emergency – In some cases, events will occur that are beyond the control of a farmer (e.g., weather events). The proposed Rule needs to account for agricultural emergency events, so that farmers are not deemed noncompliant due to an event that is unpreventable. It would not be uncommon for agricultural emergencies to impact more than one farmer in an area as well. Therefore, an exception for agricultural emergencies is needed and reasonable.

MPCA-approved and implemented manure management plan that include the required BMPs: Manure management plans are in place for feedlots of a defined size throughout Minnesota. These plans require proper management of manure based on the nutrient content including nitrogen. The plans provide a formal process for reviewing and approving the proper management of nutrients. In the comment process, the MDA received several recommendations that MDA use this existing process for approval of any required BMPs and practices so that farmers do not need two reviews of their practices. This provision has been included in the rule in response to those recommendations. A manure management plan that includes any required practices for the land in the DWSMA and has been approved by the MPCA or their designee will be considered to be implementing the required practices under the rule. This is reasonable, because a manure management plan requires that land application of manure be done in a manner that protects surface and groundwater. Therefore, including MPCA approve management plans is reasonable because feedlot rules (Minn. R. chap. 7020) require that nutrient applications be based on crop needs. This includes nitrogen from all sources including manure, fertilizer, crop credits and other sources; however, in addition the proposed Rule requires that the manure management plan is determined to be implemented (by MPCA staff or designee) as well. This is needed and reasonable because the plan must be implemented to reflect that actual manure (and associated nitrogen) management activities protective of water quality are being done.

Subps. 7-9. DWSMA mitigation levels. – Mitigation level 2, 3 and 4 designation review

The proposed Rule provides for a systematic process to determine the appropriate mitigation level. This process considers a review of water quality monitoring data and residual soil nitrate data below the root zone (if available) for all mitigation levels. In addition, for a mitigation level 2 site, it considers a survey on the adoption of designated nitrogen fertilizer BMPs.

The criteria for determining a site to be at a specific mitigation level are clearly defined. A site will move up a mitigation level if the criteria for a specific mitigation level are met. If the criteria for a mitigation level are no longer met because water quality is improving, then the site will be moved down.

The criteria for initial mitigation level 1 and mitigation level 2 determinations were previously discussed in Subp. 3. The criteria for moving a mitigation level 2 site to mitigation level 3 are if the recommended set of nitrogen fertilizer BMPs are not being adopted on 80% of the crop land acres (excluding soybean) or if water monitoring data or residual soil nitrate testing data indicates that nitrate-nitrogen concentrations are increasing.

The development of mitigation level criteria is needed to provide for a consistent approach and for ensuring that the goals of the regulation (reductions of nitrate-nitrogen concentrations in groundwater) are met. These mitigation level criteria are reasonable for two reasons. First, one of the primary goals of the Groundwater Protection Act is to ensure the adoption of nitrogen fertilizer BMPs. The criteria of 80% adoption of the recommended nitrogen fertilizer BMPs was selected because it means that most of the agricultural land with high nitrogen using crops in the DWSMA will be adopting the most important nitrogen fertilizer BMPs to ensure that nitrogen fertilizer is used appropriately and in a manner that will minimize nitrate leaching to groundwater. As is discussed elsewhere in the SONAR, the required percent of BMP adoption is not 100% because there are frequently practical limitations to 100% adoption of some practices and the Groundwater Protection Act clearly directs that any regulatory requirements must be practicable.

The 80% of cropland acres surveyed does not apply to soybean acres. This is reasonable because they do not generally receive significant applications of nitrogen fertilizer. In the case of soybean, it is generally grown in rotation with corn and proper crediting for nitrogen for soybean will be considered during other parts of the crop rotation. Other crops such as alfalfa and perennial crops are included in the assessment of cropland. This is reasonable because growing certain other crops such as perennials can have a significant beneficial effect on reducing nitrate losses. If these crops were not included in the assessment of cropland it might cause an unintended consequence of discouraging their adoption.

The other criteria for moving to mitigation level 3, and also for moving to mitigation level 4 for sites in mitigation level 3, is if nitrate-nitrogen concentrations in groundwater or in residual soil nitrate below the root zone are increasing. These criteria are intended to ensure that, at a minimum, the agricultural practices within the DWSMA are sufficiently protective to prevent water quality from getting worse and from eventually exceeding the HRL for nitrate-nitrogen of 10 mg/L. If nitrate-nitrogen concentrations are continuing to increase that indicates additional implementation actions beyond the widespread voluntary adoption of nitrogen fertilizer BMPs are necessary. In mitigation level 3 the commissioner – in consultation with a local advisory team – would require landowners to implement best management practices and may require other practices such as testing, educational programs and AMTs if they are funded. These actions would represent a significant increase in implementation activities to address the issue.

The timeline for review and possible redetermination of a mitigation level may vary depending upon the lag time for each DWSMA. The approach is to reevaluate the appropriate mitigation level after not less than three growing seasons or the estimated lag time, whichever is longer, following when the recommended practices are first published for mitigation level 2 or when the order is finalized and published for mitigation levels 3 and 4. The monitoring data and mitigation level will then be reviewed not less than every three years thereafter. The exception to this approach is if residual soil nitrate testing below the root zone is conducted in which case the timeline for evaluating these tests will be highly dependent upon the characteristics of the site and the procedures employed in the testing. Soil residual nitrate tests would be conducted in cases where the lag time is measured in decades. In such instances it is not feasible to wait until after the lag time and soil residual nitrate tests offer an alternative method to tracking the amount of nitrate moving to groundwater. However, these procedures will require an initial and one or more follow-up series of soil tests. In most cases the timeframe for evaluating these tests will be several years between tests at a minimum. For purposes of the rule it states that the time interval for review of residual soil nitrate tests will be not less than three years. Use of this test to assess changes in nitrate-nitrogen concentration is reasonable because it provides a more rapid alternative to groundwater monitoring in areas where there are very long lag times (which can be decades) or where it is very expensive to install monitoring wells. However, residual soil nitrate testing is highly resource intensive and still relatively new therefore it is anticipated that its application will be very limited. (see SONAR Supb. 5. Monitoring, Residual Soil Nitrate Monitoring).

Lag Time

Lag time is the period of time for nitrate to travel from the point of application on or near the land surface, through the unsaturated zone and reach the aquifer being monitored. This lag time can vary significantly in different locations across Minnesota from periods of less than a year in extremely vulnerable aquifers to decades or longer in some deeper aquifers. It is necessary to account for the lag time when evaluating if changes in land management practices are having an effect on water quality in an aquifer. The lag time can be estimated in several ways, including through models or calculations that estimate these travel times and/or through the use of a variety of tracers. Tracers are chemicals which are used in the environment at a known point in time so that when they are first detected in an aquifer they provide an estimate of the travel time to that aquifer. There are a number of commonly used tracers including the first use of a specific pesticide, pharmaceutical or compound linked to atmospheric deposition. The Minnesota Geologic Survey (MGS), the United States Geologic Survey (USGS) and the MN DNR have all provided technical advice, research publications, and conduct or support ongoing research to estimate travel times to different aquifers in Minnesota (Runkel et al, 2014, Steenberg et al, 2014, Puckett and Cowdery, 2002). The following references provide information on tracers. https://water.usgs.gov/lab/references/group/

These timelines provide clear guidance on expectations to the public regarding the MDA's process for review of water quality data, and expectations on when changes in water quality can reasonably be anticipated based on changes in practices. It is necessary to have some guidance in the proposed Rule on the evaluation process including timelines for moving to regulation or, if water quality improves, when regulatory requirements may be dropped. The timelines proposed in the proposed Rule are reasonable for several reasons. Three growing seasons is based on the three-year timeline that is frequently used for a crop rotation. This will provide a reasonable timeframe for all of the farmers in the DWSMA to learn about, evaluate and adopt any changes in practices that are necessary. During this time the MDA and partners in the agricultural community and local government will actively promote the nitrogen fertilizer BMPs, and at the same time discuss and encourage the adoption of AMTs. It is important to note that one of the primary goals of the NFMP is to educate on and promote the most effective and current agricultural practices that can minimize nitrate losses. The AMTs, which are described elsewhere in the SONAR, are intended to provide a highly flexible approach to engaging and sharing information across the entire agricultural community in Minnesota on new or proven strategies and technologies the can help reduce nitrate losses in vulnerable groundwater areas. Anyone can suggest AMTs and if they are suitable, they will be listed on the MDA website and may be considered for use in DWSMAs. The MDA is currently funding agricultural educator positions with U of M Extension specifically to promote nitrogen fertilizer BMPs and AMTs in targeted high-risk areas including DWSMAs. The three-year adoption period, especially in mitigation level 2, will be an important time for working with the local advisory committee, local farmers and agronomists to promote both the nitrogen fertilizer BMPs and AMTs in the DWSMA. This is reasonable and supports the goal of promoting practices that can improve water quality in the DWSMA.

As previously discussed, consideration of the lag time from when a change in practices will have an effect on groundwater quality is necessary and reasonable because we cannot know if changes in practices are having the desired effect until after the lag time (see 1573.0040, Supb. 5. Monitoring).

The timeline for mitigation review states that it will be “not fewer than” three cropping seasons or the lag time for water sampling, whichever is longer, or “not fewer than” three years for residual soil nitrate tests. The phrase “not fewer than” has been used because it is necessary and reasonable to use a longer timeline in some situations. For example, it is necessary to align the survey of BMP adoption in the DWSMA with the monitoring data, so they are assessed together. If the BMP adoption survey takes longer than anticipated, then it will be necessary to delay the review of the mitigation level until it is completed. In addition, there might be other factors which require a delay in the survey of BMP adoption. There could be extreme weather events such as a drought or extremely late planting due to heavy rainfall or late spring planting under which the Commissioner may allow wide spread exceptions to BMP adoption. In those years the MDA would postpone surveys until following a normal cropping year. The timelines for use of residual soil nitrate tests will vary by the test and may also be modified during periods of extreme weather. When working with agricultural systems, it is necessary to have some flexibility to adjust to weather conditions. An approach that provides this flexibility is reasonable and necessary to efficiently align different testing and survey methods into a single review cycle and to adjust or correct for extreme weather events.

The proposed Rule allows the commissioner to grant a one-time delay moving a mitigation level 2 or mitigation level 3 site up a mitigation level for a period equal to three growing seasons or the lag time, whichever is longer, or for a time period equal to the time used for the reviewing the level determination for residual soil nitrate tests, if the responsible parties have demonstrated progress in addressing nitrate in groundwater within the DWSMA. This provision has been included in the proposed Rule to recognize situations in which actions in the DWSMA have already been implemented that are comparable to, or go beyond, the actions that would likely be required in a mitigation level 3 or mitigation level 4 order. In this case the order would be unnecessary and even counter-productive. This provision might be applied in a situation where it took several years to implement practices that are much more extensive than mitigation level 2 nitrogen fertilizer BMPs or mitigation level 3 water resource protection requirements, such as a change in the cropping system to a perennial crop. This delay in implementation might be because it took a long time to obtain funding to implement the new practice, which is quite common when implementation funds are limited as they generally are. But since the new practices will have been implemented, it is appropriate to provide additional time to evaluate how effective they are. This provision in the proposed Rule is necessary because if the increased actions taken are effective the order would be unnecessary. Further, it might actually be counter-productive to issue the order because any regulatory action tends to provoke a defensive response from some members of a regulated community and an order that might reasonably be viewed as clearly unnecessary might offend and discourage further voluntary cooperative efforts. It is important to note that a goal of the Groundwater Protection Act and the NFMP is to address nitrate concerns through a voluntary approach and only move to a regulatory approach if the voluntary approach is not successful. This provision allows the commissioner to encourage and reward a strong voluntary response to elevated nitrate in the DWSMA.

The proposed Rule also allows the commissioner to make exceptions to increasing a mitigation level due to changes in land use. Some DWSMAs are very small and changes in land use might have a dramatic effect on water quality. In some cases there may be limited cropland left in a DWSMA. An example might be a DWSMA on the edge of an area where land is being converted from agriculture to suburban development.

The commissioner could not use the exceptions to increase the mitigation level faster than the other parts of the proposed Rule allow. However, the commissioner may make exceptions to the criteria and not increase a mitigation level based on a reduced risk of nitrate contamination to groundwater.

This provision in the proposed Rule is necessary because it allows the MDA to use resources efficiently and to be able to respond to situations where the source for elevated nitrate in a public well has been removed or greatly diminished even though, because of lag times and travel times within the DWSMA, it may take many years for high nitrate-nitrogen concentrations in the well to fall. It is reasonable for MDA to include provisions in the proposed Rule which allow flexibility for quickly adjusting to changes in nitrogen sources so that limited resources are not wasted.

A mitigation level 3 site will be moved to mitigation level 4 if nitrate water monitoring data or residual soil nitrate testing data shows nitrate-nitrogen concentrations are increasing as described above, or if the nitrate-nitrogen concentration in the sampling data from the public well exceeds 9 mg/L three times over the previous 10 years. The criteria indicate that the source water to the public well is at great risk of exceeding the nitrate-nitrogen MDH HRL of 10 mg/L and additional implementation activities than are required for mitigation level 3 are needed to prevent this from occurring. For mitigation level 4, the proposed Rule allows the commissioner, in consultation with the LAT, to order the implementation of any actions that are allowed under the Groundwater Protection Act. For a mitigation level 4 order the commissioner, in consultation with the LAT, would conduct a detailed site-specific assessment of the site, and then select practices that are likely to reduce nitrate-nitrogen concentrations in the source water to below the MDH HRL in consideration of the requirements in the Groundwater Protection Act. It is important to note the commissioner must consider economic and other practical factors for any requirements in the order. The specific statutory language (Minn. Stat. § 103H.275, subd. 2) regarding what the commissioner could require in the order is the following:

> *"The water resource protection requirements must be based on the use and effectiveness of best management practices, the product use and practices contributing to the pollution*

detected, economic factors, availability, technical feasibility, implementability, and effectiveness."

It is necessary to have clear criteria of when the concern for high nitrate-nitrogen concentration in groundwater or threatening groundwater justify moving to the highest regulatory requirements allowed by the Groundwater Protection Act and the proposed Rule. It is reasonable for the proposed Rule to adopt these specific criteria for moving to a mitigation level 4 because the criteria are reasonable indicators that there is a significant risk that the source water will exceed the MDH HRL if additional actions are not implemented than are currently being conducted under mitigation level 3.

If the criteria for a given mitigation level are no longer met, then a site will be moved to a lower mitigation level. The criteria for a specific mitigation level do not change. For a mitigation level 4 site it would be moved down one mitigation level to a mitigation level 3 site, and a mitigation level 3 order would be prepared in accordance with the mitigation level 3 requirements in the proposed Rule. For a mitigation level 3 site it would be moved down to mitigation level 1. This is because the water quality goal of not exceeding 8 mg/L nitrate-nitrogen over 10 years is the same for mitigation level 2 and 3. In addition, the site cannot have increasing nitrate-nitrogen concentrations as previously discussed.

It is necessary to have clear guidance in the proposed Rule for when a site will be removed from regulatory requirements. It is reasonable to use the same set of criteria for moving a site up or down since the criteria are based an increasing concern that nitrate-nitrogen concentrations are threatening to exceed the MDH HRL for source water in a public well, and if this concern no longer true, then regulatory requirements should be reduced. It is important to recognize that the water quality criteria are based on the nitrate-nitrogen concentrations observed over period of 10 years. It is felt that this is a sufficiently long period to provide confidence that the changes are likely to continue to be sustained over the long term

Subp. 10. DWSMA mitigation levels. - Limitation on change in designation

It is needed and reasonable for a DWSMA to only increase one mitigation level at a time in order to give regulated parties certainty about regulation. No less than every three growing seasons or the lag time, whichever is longer, DWSMAs with a mitigation level of 2 or higher will be reevaluated. If nitrate-nitrogen concentrations are increasing, the regulated party knows that they will only move up one mitigation level until the next re-evaluation cycle. This proposed Rule provides certainty for the responsible party and allows some certainty for the regulated party regarding the process of increasing mitigation levels.

E. 1573.0050 Water Resource Protection Requirements Order

Subp. 1. Commissioner's water resource protection requirements order

The MDA is required to lay out the procedures for notice to be given to persons affected by the water resource protection requirements order under Minn. Stat. § 103H.275, subd. 2(d). This provision of the proposed Rule is reasonable to identify who is subject to the water resource protection requirements order when it is issued for a DWSMA. Minnesota farms can be operated by an owner, a tenant, or other arrangements. Where neighboring DWSMAs are the same mitigation level and the cropping systems are similar, meaning that the implemented nitrogen fertilizer BMPs would be the same or similar, it is necessary and reasonable to use the MDA's limited resources to address these areas with one LAT and one mitigation level. This can reduce complications for those farmers that operate on land in more than one DWSMA and will not provide any additional regulations for those farmers that only operate in one DWSMA.

Subp. 1. Commissioner's water resource protection requirements order. A. – Mitigation level 3 and 4 DWSMAs

To address the most serious groundwater concerns, it is necessary and reasonable for the commissioner to issue a water resource protection requirements order, as described in Minn. Stat. § 103H.275, subd. 2(c), for DWSMAs that meet the requirements of mitigation levels 3 and 4 as described in this SONAR 1573.0040 Drinking Water Supply Management Areas; Mitigation Level Designations.

The water resource protection requirements in the proposed Rule are necessary to achieve the purpose of the Groundwater Protection Act, which is to ensure that groundwater is "maintained in its natural condition." Minn. Stat. § 103H.001.

Under the Groundwater Protection Act, the commissioner of agriculture is charged with, among other things, promoting the implementation of BMPs to prevent or minimize pollution from agricultural chemicals "to the extent practicable." Minn. Stat. § 103H.275, subd. 1. The commissioner of agriculture may issue water resource protection requirements if "the implementation of best management practices has proven to be ineffective." Minn. Stat. § 103H.275, subd. 1(b). Thus, if BMPs have not been implemented or if they have been implemented and found to be ineffective, the commissioner may issue water resource protection requirements. The proposed Rule addresses both the "implementation" factor and the "ineffectiveness" factor.

Implementation: Under the proposed Rule, the commissioner will issue water resource protection requirements if nitrogen fertilizer BMPs have been implemented on less than 80% of the cropland in the affected DWSMA. If nitrogen fertilizer BMPs are implemented on less than 80% of the cropland in the affected DWSMA, it is expected that nitrate-nitrogen concentrations in groundwater will continue to rise, making it necessary for the commissioner to issue a water resource protection requirements order. The use of 80% is a reasonable measurement to determine if nitrogen fertilizer BMPs have been implemented.

Ineffective: Under the proposed Rule, the commissioner also will issue a water resource protection requirements order if the nitrogen fertilizer BMPs have been proven ineffective. This will be assessed by measuring whether nitrate-nitrogen concentrations are increasing.

This is reasonable because, before moving to any water resource protection requirement, the MDA intends to use voluntary mitigation levels 1 and 2 to alert farmers to groundwater conditions, encourage farmers to voluntarily adopt the nitrogen fertilizer BMPs, and employ farmer-led strategies to protect groundwater. Farmers will have adequate time to implement the measures voluntarily, and adequate time will be allowed to take into account the travel time of the affected groundwater. It is also reasonable because the commissioner will assess whether the criteria have been met through scientifically accepted methods for testing for nitrate in groundwater (see 1573.0040 Drinking Water Supply Management Areas; Mitigation Level Designations). If the nitrate-nitrogen concentrations meet those objective criteria, it will be necessary for the commissioner to adopt water resource protection requirements in order to prevent the nitrate-nitrogen concentrations from becoming a broader public health issue by exceeding the MDH HRLs. It is also reasonable and satisfies the provisions of Minn. Stat. § 103H.275, subd. 2(c) because the water resource protection requirements order will be site-specific for each affected DWSMA.

Subp. 1. Commissioner's water resource protection requirements order. B. – Presence of groundwater monitoring networks or residual soil nitrate testing

It is necessary for the rule, as part of the mitigation level decision, to account for the time it takes for changes in agricultural or land management practices on the land surface to have an effect on water quality in the aquifer or in the public well. As noted in 1573.0060, subp. 5, the Commissioner may construction a groundwater monitoring network or conduct residual soil nitrate testing to evaluate if the water quality within a DWSMA is getting worse for purposes of designating a mitigation level. The groundwater monitoring network will be designed to evaluate water quality for groundwater considering the unique hydrogeology in each DWSMA. The installation of a monitoring network and use for mitigation level decisions is reasonable because it will provide a rapid and technically defensible assessment of changes in groundwater quality. The monitoring data from the monitoring network will be a direct reflection of the effectiveness of changes in agricultural or land management practices in reducing nitrate-nitrogen contamination in the aquifer. Residual soil nitrate testing below the root zone provides similar information on the increase or decrease of nitrate levels in soils below the root zone. Nitrate in soil below the root zone will not be taken up by the crop and is available for migration to the groundwater, and provides a useful indicator of future nitrate leaching into the aquifer.

For all aquifers there is a lag time before changes in agricultural or land management practices have a beneficial or harmful effect on water quality in the underlying aquifer. This is because it takes time for nitrate to migrate below the root zone of the crop where nitrate may be taken up by the plant, and through an unsaturated zone below the ground surface before it reaches an aquifer. An aquifer is a geologic formation that yields usable quantities of groundwater. This lag time can vary substantially from less than a year to decades or longer depending upon the depth to groundwater and ability of the soil or bedrock to rapidly conduct water (the hydraulic conductivity) (Adams, 2016, Struffert et al, 2016).

The DWSMA is a two-dimensional estimate of the area within an aquifer that would provide groundwater to a pumping well within a period of 10 years. The DWSMA is based on horizontal travel times within an aquifer (i.e. movement of nitrate once it has reached groundwater) and does not generally consider the lag time for nitrate or another contaminant to travel downward to reach the aquifer. The installation of a groundwater monitoring network or conducting residual soil nitrate testing will assess the changes in water quality across the entire DWSMA at once, without waiting 10 years for groundwater from the most distant part of the DWSMA to reach the public water supply well. Therefore it is reasonable, in areas where a groundwater monitoring network is installed or residual soil nitrate testing is conducted, for the order to apply to the entire DWSMA.

Subp. 1. Commissioner’s water resource protection requirements order. C. – for areas where a groundwater monitoring network is not installed or residual soil testing is not conducted

It is necessary for the rule, as part of the mitigation level decision, to account for the time it takes for changes in agricultural or land management practices to have an effect on water quality in the public well. As described in subpart 1 (B), a DWSMA is calculated based on the two dimensional area in an aquifer that will provide water to a pumping well over a period of 10 years without consideration of lag time. In contrast to the situation described in subpart 1 (B), if a groundwater monitoring network is not installed, or residual soil nitrate testing is not conducted, then the monitoring information will not be available to assess the entire DWSMA at one time until a period equal to the lag time plus 10 years to account for the horizontal travel time across the entire DWSMA. However, the effectiveness of practices on water quality can be evaluated for those parts of the DWSMA that are having an impact on water quality in the public well based on estimated lag and horizontal travel times.

This provision in the rule provides that an order in a DWSMA may only apply to that part of the DWSMA for which practices on the land surface would impact water quality in the public well, considering both the lag time for nitrate to reach the aquifer and the horizontal travel time for water in the aquifer to reach the well. This is reasonable, because it ensures that the order will only apply to those fields where practices are impacting water quality in the public well based on a detailed assessment of the estimated travel time for nitrate-nitrogen to travel from the place of application to the well.

Subp. 1. Commissioner's water resource protection requirements order. D. – Prioritizing issuance

Minnesota's agricultural economy and its geology are very diverse and using a water resource protection requirements order is necessary as they allow the MDA to tailor groundwater improvement solutions to fit an affected area. The MDA has limited staff and resources, and the criteria described in part 1573.0040, Subp. 3 (A) of the proposed Rule allows the commissioner to prioritize the areas of greatest concern in order to use these resources most efficiently. Using the criteria described in the proposed Rule to prioritize water resource protection requirements orders are reasonable as it allows for areas with high groundwater nitrate concentrations that affect the largest populations to be prioritized over areas where nitrate-nitrogen concentrations are low and/or where there are higher levels of nitrogen fertilizer BMPs are adopted.

Subp. 1. Commissioner's water resource protection requirements order. E. – Contents and application

Due process requires notice of a government action that may affect a private interest and provides a meaningful opportunity to be heard. The content of the water resource protection requirements order are needed and reasonable in order to inform the responsible parties in the DWSMA of the basis for its designation of a mitigation level 3 or 4. Including the information described in the proposed Rule is reasonable to sufficiently inform a responsible party why the DWSMA had been designated a mitigation level 3 or 4. This information includes letting responsible parties know of their mitigation level; providing responsible parties with the evidence as to why the mitigation level has been designated for their area;, informing regulated parties about the boundaries of the DWSMA that the order applies to, when the water resource protection requirements order will be effective, and their rights to contest the case. It is needed for the MDA to provide the responsible parties with the data that lead to the mitigation level designation. This data can help farmers understand that there is a groundwater problem in their DWSMA. It is reasonable and will help the regulated parties in that DWSMA understand the steps the MDA will take to work with the local area to reduce the concentration of nitrate-nitrogen in groundwater.

Subp. 1. Commissioner's water resource protection requirements order. F. – DWSMA partial exclusions

This provision in the rule is necessary to allow the commissioner to exempt parts of a DWSMA which are not contributing significantly to the groundwater contamination in the public well from certain requirements in the rule, and to allow MDA to consider other factors that may make implementation of a specific practice impracticable because of the unsuitability of the location for the specific practice.

An important consideration when working with agricultural systems is that one size or set of practices does not fit all landscapes and cropping systems. DWSMAs vary in size from very small, less than a hundred acres, to relatively large, on the scale of tens of thousands of acres. For most DWSMAs, the soils types and vulnerability to groundwater contamination are likely to be fairly uniform across the DWSMA and this exclusion will not be needed. But for large DWSMAs, it is reasonable to expect that there will be areas with significantly different soils types and groundwater vulnerability such that some parts of the DWSMA may not be contributing significantly to high nitrate-nitrogen concentrations in the public well.

In addition for large DWSMAs there may be differences in soils types, land features, or groundwater vulnerability such that the practices that are highly desirable for one area may not be as beneficial or even practicable to implement across the entire DWSMA. This is especially important for level three orders that may require more complex AMTs (if fully funded) and for level four orders that can require any practices allowed under the Groundwater Protection Act. These practices could be much more difficult to implement then standard fertilizer BMPs and may not be suitable for all of the land area in a large DWSMA or their implementation in some parts of the DWSMA may provide little or no improvement in nitrate-nitrogen concentrations in the public well.

This provision is necessary to ensure that the commissioner does not impose requirements and related costs on individuals in areas where they will not significantly help reduce nitrate-nitrogen concentrations in the public well. It is reasonable because the Groundwater Protection Act directs that Water Resource Protection Requirements should be practicable and consider factors such as economics, implementability, and effectiveness; implementing certain practices uniformly across a DWSMA including in areas where they may provide limited environmental benefits would not meet this requirement. It is necessary to be able to exclude parts of a DWSMA from a water resource protection requirements order so that they are not overly broad and do not include persons whose practices are not contributing significantly to the contamination. It is also reasonable to include only those responsible persons whose actions can affect the groundwater in the DWSMA.

Subp. 1. Commissioner’s water resource protection requirements order. G. – Exclusion.

This requirement is addressed under in the SONAR under 1573.0040, **Error! Reference source not found.**

Subps. 2-4 and 6. Commissioner's water resource protection requirements order – Notice, contested case hearings, final order effective date and judicial review

These provisions are necessary and reasonable because they provide due process and follow the requirements set forth at Minn. Stat. § 103H.275, subd. 2

Minn. Stat. § 103H.275, subd. 2(d) requires the MDA to provide procedural due process to persons affected by a commissioner's order. Procedural due process requires notice of a government action that may affect a private interest, and a meaningful opportunity to be heard. The MDA considered the question of how much process is due in issuing a water resource protection requirements order. *"[T]he requirements of due process must be measured according to the nature of the government function involved and whether or not interests are directly affected by the government action." Barton Contracting Company, Inc., v. City of Afton*, 268 N.W.2d 712, 715 (Minn. 1978). The MDA believes it is reasonable and necessary to provide sufficient notice of its proposed action and ample, meaningful opportunity for affected farmers to be heard. The process for issuing a water resource protection requirements order was drafted to follow the process outlined in the Public Waters Inventory because it involved similar due process challenges that are shared by the MDA (Minn. Stat. § 105.391). The procedural due process described in the public waters inventory has been upheld by the Supreme Court of Minnesota in *Application of Christenson*, 417 N.W.2d 607 (Minn. 1987).

Minn. Stat. 103H.275, subd. 2(d) authorizes the MDA to provide notice by personal service, publication, or other appropriate methods. While personal service will be the first priority, in large DWSMAs, the MDA may encounter significant difficulty and administrative burden in identifying potentially affected operators. In many cases, the landowner and the operator are different entities. Landowners may be living out of state and, while it might be possible to identify all landowners through tax records, not all landowners and operators are the same entity. It is possible that the task of comparing maps with land records to determine owners and addresses would only provide the MDA with partial information. The MDA would still not be aware of the operator on the land. Under these circumstances, providing published notice is the most efficient and effective way to provide notice to the actual operator of affected farmland. As the rule on the public waters inventory states, *"To provide personal notice to all interested persons in the public water inventory process throughout the state would be a nearly impossible administrative task."* For large DWSMAs, notifying each individual landowner and operator of that land could similarly be a nearly impossible administrative task.

The USDA Farm Service Agency (USDA-FSA) collects data about operators on agricultural land for federal grants and funding purposes. However, this information is federal and not available to the MDA.

The proposed Rule incorporates many procedural safeguards to prevent erroneous designation or mandatory practices that may a farmer may object to: there are required informational meetings, multiple publications in legal newspapers, public hearings, and notice to other governmental agencies, cities, counties and the township board. Judicial review pursuant to Minn. Stat. §§ 14.63-14.69, is also available to any person or entity subject to a final order. All of these measures are reasonable and necessary to provide meaningful opportunities to be heard about proposed action to interested parties.

Subp. 5. Commissioner's water resource protection requirements order. – Amended orders

A water resource protection requirements order may need to be amended for a variety of reasons. Research and agricultural practices are always changing and the LAT may recommend that new or additional nitrogen fertilizer BMPs or other practices are needed. An amendment process for the water resource protection requirements order is needed to order to update water resource protection requirements orders. The proposed Rule is reasonable as it outlines the amendment process, which requires due notice similar to the original issuance of a water resource protection requirements order, and will allow affected parties to seek beneficial changes.

Subp. 7. Commissioner's water resource protection requirements order. – Recording

This provision is needed and reasonable so that all affected persons will have notice of specific water resource protection requirement orders and amendments.

F. 1573.0060 Requirements for Water Resource Protection Requirements Orders

All water resource protection requirements orders will be site-specific for each DWSMA, and will be designed with input from a LAT and technical support from the MDA. This is needed so that the water resource protection requirements require a set of activities that are appropriate for the specific cropping systems, soils, hydrogeology, and the climate of the area. The one exception is a record keeping requirement applied to all orders for fertilizer-related records, which is reasonable and necessary in order determine if the required practices in the order have been adopted. This is also necessary to determine proper crediting for the nitrogen contribution or estimated losses due to agricultural practices that may include nitrogen or result in increased or decreased leaching losses of nitrate to groundwater. Many agricultural practices can have an influence on nitrate leaching and losses through runoff or atmospheric loss.

All responsible parties must comply with the requirements described in the proposed Rule and the final water resource protection requirements order. Minn. Stat. § 103H.275, subd. 2(f) states that a person who violates a water resource protection requirements order is subject to the orders under Minn. Stat. chap. 18D, which gives the MDA authority to enforce rules. This section of the proposed Rule is needed and reasonable because it gives the regulated party and the public knowledge and notice of the MDA's statutory authority.

G. 1573.0070 Water Resource Protection Requirements Order Contents

Subp. 1. Mitigation level 3.

This subpart outlines the categories of what might be included in the water resource protection requirements order. The order under mitigation level 3 may include nitrogen fertilizer BMPs formally approved by the MDA under Minn. Stat. § 103H.151 and any of the specific related practices that are listed under 1573.0070. Setting forth the practices that can be included in a mitigation level 3 order is necessary and reasonable to provide a transparent, consistent, and structured process for selecting technically defensible practices for a mitigation level 3 order. The general list of practices listed under 1573.0070 is reasonable and necessary because it is the result of a lengthy development process starting with the development of the NFMP and continuing into the development of the proposed Rule. It includes suggestions from a stakeholder advisory committee and input from three public comment periods - one on the NFMP and two discretionary comments periods on the draft rule. It includes activities that are widely accepted as being important to properly manage nitrogen fertilizer under different cropping systems and in different settings. It also includes an option for an education requirement which was an option strongly recommended by the advisory committee and has been generally supported as an important option by many commenters.

The nitrogen fertilizer BMPs that can be considered by the MDA for the order have been approved by the MDA under Minn. Stat. § 103H.151. This requirement is reasonable because it is based on the process for developing and approving nitrogen fertilizer BMPs, which is science-based and formal, with a public comment period. Nitrogen fertilizer BMPs are developed based on guidance in Minn. Stat. § 103H.005, subd. 4. They are developed with direct input from U of M scientists and consider economics and other practical considerations. In most cases, adopting the nitrogen fertilizer BMPs will increase a farmer's profitability. They are also flexible and can be amended through the above-stated process to address new studies, new practices, and other considerations such as climate change. Many of the practices are specific to the different regions across Minnesota. Because of the differences in nitrogen fertilizer BMPs for different soils and different regions, not all nitrogen fertilizer BMPs may be suitable for all locations. Therefore, some judgement in the selection of appropriate nitrogen fertilizer BMPs is needed and is an important part of the order development process. The nitrogen fertilizer BMPs are the foundation of good nitrogen management, which in turn is the most important step in minimizing nitrate losses. There is extensive research and many publications on their environmental and economic benefits. For all these reasons considering a requirement for appropriate nitrogen fertilizer BMPs in a mitigation level 3 order is both necessary and reasonable.

The MDA considered other options when drafting the list of water resource protection requirements for mitigation level 3. One of these options includes a fixed list of all possible options that could be considered a nitrogen fertilizer BMP now or in the future. The MDA concluded that this would not be a feasible requirement, as there is continuing research and advancement that may lead to updates of the nitrogen fertilizer BMPs. Practices that may be included on the list now may be outdated in a few years. In addition, new developments should be expected in the future that will likely be included on the recommended nitrogen fertilizer BMP list. Including these in the proposed Rule would make them static and would not allow the proposed Rule to follow future nitrogen fertilizer BMPs. It is necessary and reasonable for the list to be broad enough to cover practices that may be developed in the future, but specific enough so that LATs and responsible parties know what regulations could potentially become eligible nitrogen fertilizer BMPs included in the water resource protection requirements order. The water resource protection requirements order will be developed based on the recommendations of the LATs using the options included under 1573.0100 as the basis for the recommendations. All interested parties will have the opportunity to review the water resource protection requirements order before it goes into effect under the process described in 1573.0080.

Alternative management practices may be required for mitigation level 3 DWSMAs if there is a source of funding available to help offset the costs of implementing the practice. In mitigation level 4, alternative management practices that meet the requirements listed under Minn. Stat. § 103H. 275, subd. 2(a) shall be considered for inclusion in a water resource protection requirements order regardless of whether or not funding is available. As described in this SONAR Section I, 1573.0090 Alternative Management Tools; Alternative Protection Requirements, these practices will go above and beyond the nitrogen fertilizer BMPs and are locally optimized practices that will have been shown to reduce nitrate-nitrogen concentrations in groundwater. In the proposed Rule, AMTs are defined as "specific practices and solutions approved by the commissioner to address groundwater nitrate problems." In areas with highly vulnerable groundwater, the use of nitrogen fertilizer at the recommended rate, timing, source and placement of the nitrogen fertilizer BMPs may not be enough to decrease the amount of nitrate leaching into groundwater to meet water quality goals. In these areas, the MDA will work with the LAT on locally developed solutions for addressing groundwater nitrate problems that are implemented on a site-specific basis. AMTs are needed because they are practices and activities designed to reduce nitrate leaching. AMTs represents an advanced level of groundwater protection that go beyond traditional nitrogen fertilizer BMPs.

Mitigation level 3 DWSMAs are areas where nitrates have exceeded or are projected to exceed the MDH HRLs within the next 10 years. These areas will affect large populations around the state and regulatory action is being taken to ensure the nitrogen fertilizer BMPs are being adopted. It is necessary for the MDA to be able to require the stronger practices of AMTs to reduce nitrate at this level. However, the MDA acknowledges that there may be additional costs associated with implementing AMTs and given that economic factors are one of the considerations the MDA must consider under Minn. Stat. § 103H.275, subd. 2(a), it is reasonable that these factors will only be required if there is additional funding available.

Mitigation level 3 DWSMA may include requirements for AMTs if funded. This is reasonable because farmers may need incentives to implement AMTs. AMTs may not be profitable, and funding could bridge this gap. Use of funding is reasonable, to ensure that farmers can implement these practices even during periods of very low crop prices. Sources of funding exist from Federal, state, and often also local sources (Lenhart et al., 2017). Funding would currently be available for some of the AMTs being considered, subject to funding levels and priorities within the local area.

Rules that include funding requirements to implement conservation practices to improve water quality are being applied in Wisconsin (Wisc. Stat. § 281.16; Wisc. R. NR 151.09(4)).

Subp. 2. Mitigation level 4.

A commissioner's order for a mitigation level 4 may contain any of the requirements for mitigation level 3, requirements for rate for nitrogen fertilizer, and any practices that meet the definition of water resource protection requirements in Minn. Stat. § 103H.005, subd. 15 (with two exceptions, see below, Subp. 3. Exceptions.) that meet the criteria set forth in Minn. Stat. § 103H.275, subd. 2(a). This is the highest mitigation level and it is reasonable that it would contain the most stringent requirements. It is necessary and reasonable to include these more stringent water resource protections requirements because DWSMAs will have had a minimum of six growing seasons to implement nitrogen fertilizer BMPs and will have had a minimum of three growing seasons under a mitigation level 3 water resource protection requirements order, yet specific indicators show that nitrate levels are not improving.

It is necessary and reasonable for the commissioner to implement more stringent water resource protection requirements in mitigation level 4, because the criteria set forth in the proposed Rule for moving to mitigation level 4 will be the indicators that nitrogen fertilizer BMPs have proven to be ineffective, which is the trigger for implementing more stringent water resource protection requirements under Minn. Stat. § 103H.275, subd. 1(b).

It is necessary and reasonable to include in a mitigation level 4 order any practice that meets Minn. Stat. § 103H.275, subd. 2(a) factors, rather than limiting the commissioner's authority (except as described below in Subp. 3. Exceptions.) to specific, enumerated practices at this time, because agricultural methods, scientific knowledge, treatment methods, and technology will have advanced significantly by the time a DWSMA gets to mitigation level 4, and it would be unreasonable to limit the commissioner's authority to what technology exists at the time a proposed Rule is passed. The commissioner will need to meet the statutory requirements set forth in Minn. Stat. § 103H.275, subd. 2(a) that require that any water resource protection requirements must be *"based on the use and effectiveness of best management practices, the product use and practices contributing to the pollution detected, economic factors, availability, technical feasibility, implementability, and effectiveness."* The MDA must consider these conditions in order to require a practice under mitigation level 4. In considering economic factors in mitigation level 4, it is reasonable and necessary to consider economic impacts both to affected farmers as well as to area residents who must bear the costs of treatment of public water supplies that have been contaminated with nitrate.

The proposed Rule states that the commissioner shall not restrict the selection of the primary crop in mitigation level 4. This part of the proposed Rule is needed and reasonable to clarify for farmers that the water resource protection requirements order will not dictate the main crop they should grow. Requiring farmers to grow the primary crop could put a huge burden on a farmer and have a significant effect on their livelihood. It is probable other crops that could be grown would not be as profitable as the primary crop. Also, other crop options may need other management than the primary crop; therefore farmers would need to alter their management. It would be unreasonable for the commissioner to prevent farmers from selecting which crop to raise in order to earn their livelihoods. The proposed Rule also states that the commissioner cannot require a nitrogen fertilizer application rate lower than the bottom of the rate range in U of M recommended nitrogen fertilizer BMPs. This is reasonable and necessary because requiring a rate that is lower than the bottom of the range would have the effect of restricting the primary crop raised by a farmer.

Subp. 3. Exceptions.

It is needed and reasonable for exceptions to the water resource protection requirements order to be allowed on a site-specific basis as there can be factors that can affect whether nitrogen fertilizer BMPs can be implemented. Weather plays an important role in agriculture, more so than many other industries. In the case of a severe weather event, where there has been damage to large amounts of a crop or a damaging storm that requires crops to be put in late, or other situations where the BMPs can't be followed, it is needed and reasonable for the MDA to grant an exception from a requirement of the water resource protection requirements order to a targeted area or even individual farmer.

H. 1573.0080 Minnesota Agricultural Water Quality Certification Program Exemption

Minn. Stat. § 17.9897 (a)(1) states that once a producer is certified, the producer *"retains certification for up to ten years from the date of certification if the producer complies with the certification agreement, even if the producer does not comply with new state water protection* *laws or rules that take effect during the certification period."* Proposed Rule language was added in order to provide certainty for those producers that are certified that they are deemed to be in compliance with the proposed Rule, for the length of their certification.

Agricultural producers certified in the Minnesota Agricultural Water Certification Program (MAWCP) shall be deemed to be in compliance with the proposed Rule so long as they are consistent with the Certification Agreement signed by the commissioner. As stated in Minn. Stat. § 17.9891 *"whereby a producer who demonstrates practices and management sufficient to protect water quality is certified for up to ten years and presumed to be contributing the producer's share of any targeted reduction of water pollutants during the certification period."* In order to be certified and meet the intent of the statute, producers need to be addressing the groundwater resource concern in areas subject to the proposed Rule. This means that they will be not only implementing the nitrogen fertilizer BMPs but exceeding them with conservation practices and management appropriate to their operation that reduces the risk of nitrate loss to both groundwater and surface water. It is necessary to include this exemption because it is required by Minn. Stat. § 17.9897.

I. 1573.0090 Alternative Management Tools; Alternative Protection Requirements

Alternative management tools (AMTs) are practices and activities designed to reduce nitrate leaching. AMTs represent an advanced level of groundwater protection that go beyond traditional nitrogen fertilizer BMPs. The MDA recognizes that implementation of nitrogen fertilizer BMPs may not be adequate to decrease the amount of nitrate leaching into groundwater to meet water quality goals in some areas or situations. In areas where groundwater is vulnerable, the MDA encourages farmers to consider AMTs to meet water quality goals.

In many cases AMT practices are developed and used by farmers and implemented in ways that are optimized for local conditions and opportunities. The tools are designed to be flexible and can be adjusted or tailored to local conditions to a greater extent than BMPs. The MDA will continue to work toward providing technical and financial resources regarding the effectiveness of these alternatives. The MDA will work with the local agricultural community to encourage and incentivize their use. The general benefits of AMTs have been documented in scientific studies.

At the present time, the AMTs fall into the following categories:

- Alternative cropping systems, including low nitrogen input crops or continuous cover,
- Advanced nitrogen fertilizer management, including variable rate application and use of advanced nitrogen requirement prescription tools,
- New technologies that can increase nitrogen use efficiency, including the use of advanced crop sensor technology,

- Enrollment in the Minnesota Agricultural Water Quality Certification Program (MAWQCP).

The AMTs are needed for the following reasons:

- Because the nitrogen fertilizer BMPs are relatively static and require a long process to change, the MDA needs AMTs to recognize new practices and technology that are developed to reduce nitrogen leaching as they evolve.
- The nitrogen fertilizer BMPs may not have sufficient flexibility to work under all conditions or situations. The AMTs provide this additional flexibility.
- Nitrogen fertilizer BMPs may not be sufficient to meet water quality goals in all areas or in all situations. The AMTs represent an advanced level of groundwater protection and are designed to go above and beyond the BMPs and improve water quality faster.
- AMTs allow the MDA to support and recognize a regulated party who wishes to implement practices that exceeds the nitrogen fertilizer BMPs.
- Including AMTs as an option in the proposed Rule will allow farmers to be recognized for practices and activities they have adopted that go beyond the nitrogen fertilizer BMPs.
- Including AMTs as an option in the proposed Rule will engage the agricultural community in problem solving and will provide an effective approach for the agricultural community to propose workable solutions and new technologies that can improve water quality on both the local and state level.
- Maintaining a list of approved AMTs will provide a rapid and effective means for sharing information on new and effective methods to address nitrate concerns.

Thus, it is needed and reasonable for the MDA to include AMTs in the proposed Rule.

Subp. 1. Alternative Management Tools. A and B.

The MDA will maintain a list of approved AMTs and make this list available on the website. This list will be updated on a regular basis as AMTs are evaluated and approved. The list of alternative management practices is needed to inform responsible parties of the recognized AMTs available to them. Publishing this list on the MDA's website and updating it annually is reasonable as it informs regulated parties of options available to them to reduce the risk of nitrate leaching into groundwater. If the regulated party is subject to a water resource protection requirements order this list will inform them of other practices that could be implemented and allow them to still meet the requirements of the water resource protection requirements order.

Subp. 1. Alternative Management Tools. C.

The list of AMTs on the MDA's website will state whether these practices can be used in addition to nitrogen fertilizer BMPs or if they can be substituted for a nitrogen fertilizer BMP. Substitutions are necessary as in some cases, an AMT might go above and beyond a particular

BMP and implementation of that BMP is no longer necessary, or the tool may be incompatible with the BMP. In some cases the AMT might be most effective when used in combination with a nitrogen fertilizer BMP. Keeping records of the practices used where an AMT was substituted for another required practice will allow for the AMTs to be counted during the evaluation of nitrogen fertilizer BMPs.

Subp. 1. Alternative Management Tools. D.

This proposed Rule is needed and reasonable because if a producer wants to go above and beyond the nitrogen fertilizer BMPs, the MDA supports this. In many cases, AMTs can be tailored to the local conditions to a greater extent than the nitrogen fertilizer BMPs.

Subp. 2. Alternative protection requirements.

Minn. Stat. § 103H.275, subd. 2(e) requires the MDA to allow persons subject to water resource protection requirements to be able to suggest alternative protection requirements. Therefore, it is needed and reasonable for the proposed Rule to lay out the process by which a responsible party could apply to the MDA for an alternative protection requirement.

J. Effective Date.

The effective date is necessary to give affected parties time to implement the necessary changes in their organizations before the restrictions go into place. January 1, 2020 is a reasonable start date as the MDA heard from several comments during the summer 2017 comment period that some of the larger affected parties can purchase fertilizer as much as a year ahead of time,. With the proposed Rule expected to be adopted in early 2019, giving that additional year to use the existing stock seemed reasonable. The proposed effective date is also reasonable because the MDA plans to use the fall of 2019 to conduct education and outreach to affected parties.

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VIII. Appendixes

1. Fertilizing Corn Grown on Irrigated Sandy Soils
2. Best Management Practices for Nitrogen Use in Minnesota
3. Best Management Practices for Nitrogen on Coarse Textured Soils
4. Best Management Practices for Nitrogen Use: Irrigated Potatoes
5. Best Management Practices for Nitrogen in Southeastern Minnesota
6. Best Management Practices for Nitrogen Use in South-Central Minnesota
7. Best Management Practices for Nitrogen Use in Southwestern and West-Central Minnesota
8. Best Management Practices for Nitrogen Use in Northwestern Minnesota
9. Nitrogen Fertilizer Management Plan
10. Potential Nitrogen Sale Reduction