Guidance for Managing Nitrate in Drinking Water

The purpose of this document is to guide water planning activities, as it relates to nitrate in drinking water. This guidance establishes classification thresholds related to nitrate concentrations in drinking water, identifies where best management practices (BMPs) will be most effective, and provides recommendations for reporting outcomes of implementation activities.

Using nitrate as an indicator of drinking water quality

Nitrate is one of the most common water pollutants in Minnesota groundwater, affecting a large number of private wells and public water supplies. Elevated nitrate in drinking water can be harmful to human health, specifically to the health of infants. Because of its pervasive nature, the focus of the protection framework is based on the understanding of its occurrence and distribution in Minnesota groundwater resources. Factors linked to nitrate as an indicator of drinking water quality include:

- Concentrations above 3 milligrams per liter (mg/L) is considered from anthropogenic sources or human impact on the environment.
- Fertilizers, manure, and septic systems are major sources of nitrate pollution in Minnesota.
- Nitrate can be easily measured.
- There is a potential for other contaminants, such as pesticides, when nitrate is present. The presence of nitrate indicates there is a pathway for contaminants from the lands surface to the drinking water aquifer.

Nitrate Protection Framework

The Minnesota Groundwater Protection Act established a prevention goal that groundwater be maintained in its natural condition, free from any degradation caused by human activity. Many state agencies are working to maintain and improve groundwater quality because of this act. The Minnesota Department of Health (MDH) is the lead agency protecting drinking water quality for public water systems. This authority applies to the Wellhead Protection Program (MN Statute, chapter 103I, section 103I.101, subdivision 5[7]) and the federal Safe Drinking Water Act, both ensuring drinking water safety. Additionally, MDH manages the Minnesota Well Code governing the construction, maintenance, and sealing of wells (MN Rules, chapter 4725). The Well Code is the primary authority protecting private wells at the time of installation, once installed private well owners are responsible for ongoing operation and maintenance.

The drinking water standard for nitrate in drinking water is 10 mg/L. The nitrate protection framework ranges from protection to restoration. Groundwater classified as protection is at risk to degradation, whereas groundwater classified as restoration exceeds the drinking water standard for nitrate. To better target activities and establish management priorities in the 'Protection' classification, the category is split into two subcategories: maintain and threatened. As nitrate concentrations increase, a greater level of management is required. The protection framework table below describes each nitrate classification and the associated implementation actions.

Nitrate Protection Framework	Nitrate Concentration	Implementation Emphasis
Protection – Maintain	0 – 4.9 mg/L	Proactive and preventive; ▪ Maintain existing land cover by discouraging or preventing land conversion ▪ Contaminant source management on existing land uses (Agricultural BMPs, SSTS management, easements, forest management plans)
Protection – Threatened	5.0 – 9.9 mg/L	Contaminant source reduction or elimination; ▪ Shifting land uses away from those that may leach excess nitrogen (Alternative Management Tools[1], upgrade failing SSTS, easements)
Restoration – Treatment	10.0 mg/L and above	Active intervention required by public water supplies to avoid drinking water consumption (new sources; treatment) while still aiming for long term contaminant source mitigation through reduction and elimination

Table 1: Nitrate protection framework and associated land use management goals

Implementation activities should build as you move from one classification to the next. For example, when nitrate concentrations increase from maintain to threatened, actions should still be proactive and preventive while engaging in contaminant source reduction or elimination. Changing nitrate concentrations may also dictate priorities within a certain class of the framework. For example, if multiple public water systems in a watershed have wells with nitrate concentration in the 'protection-threatened' classification, implementation should target systems with increasing trends, especially those at risk of exceeding 10 mg/L.

It can take years to decades for nitrate to manifest at high levels in the water we drink. The nitrate concentrations we see today are often a result of past land uses. Problems build slowly over time, are difficult to manage and take a long time to resolve. Therefore, protection activities take on added significance in groundwater management.

[1] MN Dept. of Agriculture developed Alternative Management Tools to protect groundwater quality from nitrate contamination. For more information, visit MDA Alternative Management Tools (http://www.mda.state.mn.us/chemicals/fertilizers/nutrient-mgmt/nitrogenplan/nitrogenmgmt/amts/amtools.aspx)

Targeting Conservation Activities

When it comes to protecting groundwater the same set of tools to protect surface water can be used. The main difference is where they are applied. For the effective management of nitrogen, activities should target:

- Public Water Supplies with an MDH approved Drinking Water Supply Management Area (DWSMA) with a high or very high vulnerability.
- Other Public Water Supply Systems located in geologically sensitive or vulnerable areas with agriculture or associated land uses where nitrates may be present.
- Areas identified as highly sensitive to pollution[2], based on the time it takes recharge and contaminants at the ground surface to reach the underlying aquifer.

Other factors for consideration to target implementation activities include:

- Aquifers used as a domestic source. Consider density of use as another layer for targeting.
- Are nitrate trends trending upward? For example, monitoring results demonstrate an aquifer has moved from 3 mg/L (maintain) to 5.2 mg/L (threatened). This aquifer is at a tipping point and with active management the nitrate concentration may be reduced to 4.9 mg/L or less.
- Are changes in land use occurring that will likely contribute to elevated nitrates in the underlying aquifer? For example, is perennial cover or forests being converted into a more intensive land use, such as row crop production?

Setting Measurable Goals

Defining measurable goals is an important part of water resource management. Goals allow us to evaluate the effectiveness of a given approach and to modify an activity if it is not achieving the expected results. However, when applied to groundwater it becomes more challenging because:

- Predictive tools are not currently available to measure the impact of conservation activities on groundwater.
- It can take a long time for land use changes to have an effect on groundwater quality.
- Lack of baseline data related to groundwater quality.

Therefore, other methods must be used to show implementation progress toward groundwater goals. Below are some examples that may prove useful in reporting the outcomes of implementation:

- Use Nitrate Monitoring Data – monitoring nitrate levels in a well can be an effective tool to measure success, however response in an aquifer can be slow. Consider incremental goals when planning for the desired future condition, such as a 10 percent reduction in nitrate concentration during the first five years of the planning cycle (10 mg/L of nitrate – 10% = 9 mg/L of nitrate) or a positive change in the nitrate concentration trend. Public water supply wells with greater than 5.4 mg/L nitrate are monitored on a quarterly basis, which provides a robust dataset for water planning purposes.
- Select a manageable and defined area – considering targeted areas, such as vulnerable drinking water supply management areas (DWSMAs), MDA's Township Testing areas, DNR's Groundwater Management Areas, or small sub-watershed boundaries (HUC 12 or smaller) will increase the chances for demonstrating success.

[2] The DNR developed a statewide map to assess the vulnerability of groundwater pollution (http://www.dnr.state.mn.us/whaf/about/scores/geomorphology/g_i_psnsm.html). Additionally maps contained in the GRAPS reports (http://www.health.state.mn.us/divs/eh/water/dwp_cwl/localimplem/index.html) identify areas of pollution sensitivity.

- Show multiple benefits - a conservation practice provides environmental benefit beyond the resource concern that is being managed for, the ancillary benefits are called ecosystem services often referred to as multiple benefits.
    - An example is managing field runoff from nutrients. Traditionally runoff is managed for the protection of surface waters, that same conservation practice also minimizes nutrient loss to groundwater in areas sensitive to pollution. In this example, report on the edge of field nutrient reductions as an outcome of implementation activities.
- Utilize scientific research findings – There are several research sites in Minnesota, and the surrounding states, that have studied nitrate leaching under various cropping systems and conservation practices. Assuming the research site has similar soils and cropping systems to your project area, one could conclude a comparable nitrate reduction will result from implementing a conservation practice.

One or a combination of the methods listed above will help in reporting the outcomes of work performed. Employing the use of a logic model[3] is a useful framework to think through and establish measurable goals relating to your desired future condition of reducing nitrate in drinking water.

Managing nitrate in groundwater can be challenging. When possible, keeping nitrate out of groundwater is the best approach, however when nitrate is present active management is required to reduce the concentration. The concepts identified in this document will help make the most of conservation efforts as it relates to nitrate in groundwater.

[3] As of August 2017, the Board of Water and Soil Resources (BWSR) is in the process of creating a short video about logic models that give examples of desired future conditions, measurable goals, outcomes, and outputs from watershed plans. For more information visit BWSRs webpage (http://www.bwsr.state.mn.us/planning/1W1P/index.html)