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AGRONOMY TECHNICAL NOTE

MONTANA NITROGEN RISK ASSESSMENT

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Nitrogen Concerns in the Environment

Nitrogen (N) is an essential nutrient for plant and animal growth and is one of the most important nutrients necessary for crop production. However, nitrogen is easily moved by water and is often associated with the impairment of quality of groundwater and surface water. Nitrogen in the ammonium (NH_4^+) form is attached to clays and finer soil particles or to soil organic matter and can be transported via surface runoff to streams, lakes and reservoirs. Nitrogen in the Nitrate ($N0_3$) form is highly soluble, easily moved by water and is transported via surface runoff or leaching and can reach surface and groundwater. Nitrogen contamination of surface water occurs primarily from transport of water soluble nitrogen ($N0_3$) in surface runoff. Nitrate leaching out of the soil profile is the most common source of groundwater contamination in Montana. The EPA Drinking Water Maximum contaminant Level (MCL) for Nitrates is 10 mg/l and if enough water with high levels of $N0_3$ is ingested, potential adverse health effects can be the result. Generally, nitrate concentrations in groundwater in Montana have not been found to be excessive; however there are localized regions of high groundwater NO_3-N in Montana. Some areas are more prone to nitrogen leaching due to climate, soil, geological material overlying the aquifer, depth to groundwater, vegetation, cropping systems and other factors. Soils differ in their NO_3 leaching potential with sandy soils having a high leaching potential and fine textured soils have lower leaching potential. Crop selection and management, nutrient management, residue and water management can have a significant effect on NO_3 leaching.

Nitrogen Risk Assessment Tools

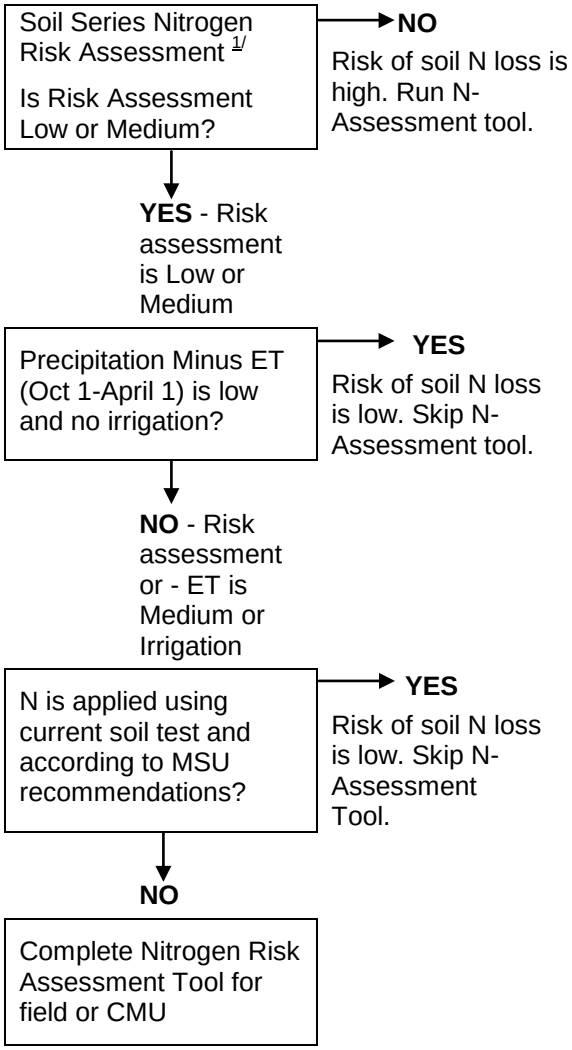
Nonpoint source N pollution of surface waters is a complex set of processes that involves N application, runoff or leaching of nitrate, and transport to ground or surface waters. High N application in the form of N fertilizer or manure can increase the risk of N transport to groundwater. Extremely high soil test N also increases the risk of N leaching, but there must be transport of N before there is an environmental concern.

The Nitrogen Preliminary Risk Assessment Tool (see Table 1) is used to determine if a more detailed assessment needs to be completed. The N Risk Assessment is a field-level assessment tool that ranks the relative potential for leaching of nitrogen into groundwater. The purpose of the nitrogen index is to provide field staffs, watershed planners, and land users with a tool to assess the potential risk of nitrogen movement into groundwater. The ranking of the Nitrogen Index identifies sites where the risk of nitrogen leaching may be relatively higher than from other sites. The N Risk Assessment can also be used to develop planning considerations and alternatives that can be provided to the land user to minimize the potential of leaching from fields. The N Risk Assessment uses seven specific field characteristics and management practices to obtain a rating for each field. Not all field features and management practices have the same influence on potential N leaching. Thus, site characteristics have been placed in categories and assigned a weight factor based on relative impact on N leaching from the site. Instructions and definitions are provided for each factor. Each category's weight factor is multiplied by its risk value to get a

weighted risk factor for each specific category. All categories are rated and the overall risk rating for the site is the sum of all values (refer to Table 3).

NRCS Nutrient Management 590 Standard requires a field-by-field nitrogen risk assessment of the potential for the movement off-site of nitrogen. The Montana Preliminary Nitrogen Risk Assessment Tool (Table 1) can be used to determine if a more detailed risk assessment is required.

Table 1. MONTANA NITROGEN PRELIMINARY RISK ASSESSMENT TOOL



This assessment is available on a county basis from the state soil scientist and is based on the **Critical Dominant Soil.** The Critical Dominant Soil is the soil map unit with the highest risk value that is of manageable size, 10 acres or 10 percent of the field.

1/ **Critical Dominant Soil.** Fields often have several soil map units with different soil properties, select the map unit that is of a manageable size (10 acres or 10% or the field) with the highest risk potential for each category. Soils survey information such as drainage class, soil texture, depth to groundwater and other important information is critical for nutrient management planning can be found at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

NOTE: The Montana Nitrogen Risk Assessment Tool must be completed for each field if this tool indicates that a more detailed nitrogen risk assessment is required.

Table 2. NITROGEN LOSS CATEGORIES AND WEIGHT FACTORS

FIELD FEATURE/MANAGEMENT PRACTICE	WEIGHTED FACTOR
Soil Erosion (Wind or Water)	1.0
Soil Series Risk Assessment	2.0
Precipitation Minus ET (October 1 – April 1)	2.0
Irrigation Method	2.0
Nitrogen Soil Test N	0.5
Nitrogen Application Method	0.5
Nitrogen Application Rate	0.5

The risk rating for each category is as follows:

- None = 0 (not applicable – N/A)
- Low = 1
- Medium = 2
- High = 4
- Very High = 8

Montana Nitrogen Risk Assessment Tool

Category Descriptions and Instructions

Individual sections from Table 3 are provided here to assist in determining the weighted risk factor for each category. After reviewing the descriptions and instructions for each category, assign a risk value and calculate the overall risk rating.

1. Soil Erosion

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Wind and Water Erosion	N/A	< 5 tons/ac/yr	5-10 tons/ac/yr	10-15 tons/ac/yr	>15 tons/ac/yr		X 1.0	

Soil erosion is the movement of soil from the site due to runoff. This category is quantified in tons/acre/year. Water erosion can be predicted using the Revised Universal Soil Loss Equation (RUSLE2) found in the Natural Resources Conservation Service (NRCS) Field Office Technical Guide (FOTG). Erosion predictions are calculated based on precipitation, rainfall intensity, soil characteristics, slope gradient and slope length, cropping system, and supporting practices including terraces, contour farming, etc.

2. Soil Series Risk Assessment

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Soil Series Risk Assessment	N/A	LOW	MEDIUM	HIGH	VERY HIGH		X 2.0	

This assessment was developed from the Agronomic Nitrate Leaching Potential Assessment Model (Non-irrigated-WA) from the Portland Major Land Resource Office and has been modified for use in Montana. Climate elements have been stripped. This interpretation is designed to evaluate the potential for nitrate-nitrogen to be transmitted through the soil profile below the root zone by percolating water under non-irrigated conditions. The ratings are based on inherent soil properties, and do not account for management practices, such as irrigation management, nitrogen fertilizer application rates and timing, or crop rotations. The risk assessment by soil map unit is available on a county basis from the NRCS state soil scientist.

Precipitation Minus ET (October 1 – April 1)

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Precipitation Minus ET (October 1 – April 1)	N/A	LOW	MEDIUM	HIGH	VERY HIGH		X 2.0	

The climate leaching classes for assessing nitrate leaching were derived by subtracting mean annual evapotranspiration from mean annual precipitation. The resulting numbers were then grouped into four classes (low, medium, high and very high) based on comparison with known areas with nitrate leaching. The method is based on monthly mean values for daily solar radiation and temperature and is based on the time period from October 1 – April 1. The shape file (leaching-Oct.1-May1.shp) is on NRCS field offices local server F:geodata\climate\leaching.

3. Irrigation Method

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Irrigation Method	N/A	SPRINKLER SYSTEM WITH SENSORS OR IWM	SPRINKLER SYSTEM WITHOUT SENSORS OR IWM	OTHER IRRIGATION SYSTEMS WITH SENSORS OR IWM	OTHER IRRIGATION SYSTEMS WITHOUT SENSORS OR IWM		X 2.0	

Select the irrigation method rating based on type of irrigation system and whether sensors are used to determine soil moisture and schedule application timing and rates.

4. Nitrogen Soil Test N

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Nitrogen Soil Test N	N/A	< 50 LBS /AC	50 -100 LBS /AC	101-150 LBS/AC	>150 LBS /AC		X 0.5	

Soil test should indicate total nitrogen in profile: Nitrate soil test minimum depth is 24"; preferable depth is 36"-48" or as deep as possible.

5. Nitrogen Application Method

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Nitrogen Application Method	None Applied	Applied according to current soil tests and MSU guidelines with split applications based on growth stage	Applied according to current soil tests and MSU guidelines < 2 weeks of planting or surface applied during the growing season	Applied < 2 weeks of planting with no soil testing	Applied > 2 weeks of planting with no soil testing		X 0.5	

The timing of N fertilizer as close to plant nutrient uptake will reduce potential loss of N through leaching.

6. Nitrogen Application Rate

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Nitrogen Application Rate	None Applied	TOTAL N APPLICATION RATE BELOW AGRONOMIC RATE	TOTAL N APPLICATION RATE EQUAL TO AGRONOMIC RATE	TOTAL N APPLICATION RATE 1-50 LBS ABOVE AGRONOMIC RATE	TOTAL N APPLICATION RATE >50 LBS ABOVE AGRONOMIC RATE		X 0.5	

Montana Nitrogen Risk Assessment Tool

Completing Risk Ratings

Each site category's weighting factor in Table 3 is multiplied by the site risk rating (value) to get a weighted risk value. All categories are rated (according to individual category instructions), and the overall rating is the sum of all values. After individual sites/fields are rated, refer to the appropriate vulnerability rating in Table 5.

Table 3. MONTANA NITROGEN RISK ASSESSMENT TOOL

SITE CATEGORY	NONE (0)	LOW (1)	MEDIUM (2)	HIGH (4)	VERY HIGH (8)	RISK VALUE (0, 1, 2, 4, 8)	WEIGHT FACTOR	WEIGHTED RISK FACTOR
Water and Wind Erosion	N/A	<5 ton/ac/yr	5-10 tons/ac/yr	10-15 tons/ac/yr	>15 tons/ac/yr		x 1.0	
Soil Series Risk Assessment	N/A	LOW	MEDIUM	HIGH	VERY HIGH		X 2.0	
Precipitation Minus ET (October 1 – April 1)		LOW	MEDIUM	HIGH	VERY HIGH		x 2.0	
Irrigation Method	N/A	Sprinkler system with soil moisture sensors or IWM	Sprinkler system without sensors or IWM	Other irrigation systems with sensors or IWM	Other irrigation systems without sensors or IWM		x 2.0	
Nitrogen Soil Test N	------	< 50 lbs / ac	51-75 lbs / ac	76-100 lbs / ac	>100 lbs / ac		x 0.5	
Nitrogen Application Method	None Applied	Applied according to current soil tests and MSU guidelines with split applications based on growth stages	Applied according to current soil test and MSU guidelines < 2 weeks of planting or surface applied during the growing season	Applied < 2 weeks of planting with no soil testing	Applied > 2 weeks of planting with no soil testing		x 0.5	
Nitrogen Application Rate	None Applied	Total N application rate below agronomic rate	Total N application rate equal to agronomic rate	Total N application rate 1-50 lbs above agronomic rate	Total N application rate >50 lbs above agronomic rate		x 0.5	
						Overall Risk Factor		
						Overall Risk Rating		

Interpreting Results of Site Vulnerability Ratings

After multiplying the weighting factor by the risk value for each category and totaling all values in Table 3, assign the overall site/field vulnerability to nitrogen loss from Table 4.

Table 4. SITE/FIELD VULNERABILITY TO NITROGEN LOSS

Total of Weighted Risk Values	Site Vulnerability	Site/Field Number(s)
<11	LOW	
11-21	MEDIUM	
22-43	HIGH	
> 43	VERY HIGH	

Vulnerability Definitions

LOW – This site has a low potential for N leaching from the site. If farming practices are maintained at the current level there should be a low probability of an adverse impact to surface resources.

MEDIUM – This site has a medium potential for N leaching from the site. There is a greater probability of an adverse impact to groundwater resources than from a low rated site. Some remedial action such as using N management measures such as no-till, crop diversity to include perennial or deep-rooted crops, irrigation water management and other conservation practices may be needed.

HIGH – This site has a high potential for N leaching from the site. There is a higher probability of an adverse impact to ground water unless remedial action is taken. Soil and water conservation as well as N management measures (i.e., No-Till, nutrient management, P based manure application rates, re-crop rather than fallow) and a nitrogen management plan should be taken to reduce the risk of N movement and probable water quality degradation.

VERY HIGH – This site has a very high potential for N leaching from the site. There is a very high probability for an adverse impact to groundwater. Remedial action should be taken to reduce the risk of N movement. Soil and water conservation practices and a nitrogen management plan are needed to reduce the potential of water quality degradation.

Practices utilized to reduce N loss can vary from one site to the next. Site categories that have the highest weighted risk value are the most critical factors impacting N loss. Practices that reduce the risk value of these categories are the most effective.

Effective practices can include: N management measures such as diversifying the rotation to include perennial and / or deep-rooted crops, rotating manure application sites, reduced manure application rates, manure application set-backs from areas where runoff concentrates, timing (growing season, spring and split applications versus fall or applications), and soil and water conservation practices such as residue management (no-till or reduced till), nutrient management, irrigation water management and other conservation practices may be needed.

NOTE: Annual soil testing which includes at a minimum, NO_3 (Nitrate), Phosphorus (Olsen Method), Potassium, Organic Matter (OM), pH, and Electro-Conductivity (EC) for the 0" - 6" sample for annual crops and 0" - 12" for pasture and hayland. A sample to test for NO_3 (Nitrate) should be taken at the 6" - 24" depth for annual crops. Deeper samples (36" - 48", or as deep as possible) should be taken when there is a potential for nitrogen leaching. Deep testing for nitrate levels will help detect potential loss of nitrate from leaching and assist in planning conservation practices to mitigate impacts to groundwater quality.

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