APPENDIX H

ESTIMATING NATURALLY OCCURING NITRATE ATTENUATION OF WASTEWATER (rev 6/2024)

INTRODUCTION

After wastewater is treated in a wastewater treatment system and discharged via an absorption system, naturally occurring nitrate attenuation occurs under the proper conditions. This attenuation is most commonly due to denitrification. Estimating the amount of attenuation can be conducted using the Method for Estimating Attenuation of Nutrients from Septic Systems (MEANSS). The estimated attenuation can be accounted for in the loading values used in the groundwater nitrate sensitivity analysis (mixing zone calculations) and surface water impacts calculations (e.g., DEQ-7 trigger value calculations).

CALCULATING NITRATE REDUCTION

MEANSS uses matrices to determine the amount of denitrification for groundwater mixing zone analyses (Table 1), and for surface water impacts analyses (Table 2). MEANSS is based on three primary factors controlling denitrification: soil drainage type beneath the absorption system; soil drainage type in the riparian area; and travel distance. Travel distance is either to the end of the groundwater mixing zone (Table 1) or distance to the nearest receiving high-quality state surface water (Table 2). Soil drainage type is based on the Natural Resources and Conservation Service (NRCS) hydrologic soil group (HSG) classification system in the Soil Survey Geographic Database (SSURGO). The HSG classification used in MEANSS shall be based only on the SSURGO database. Accessing HSG soil classifications in SSURGO is described later in this appendix.

In Tables 1 and 2 each absorption system is assigned a total percent nitrate load reduction by adding the percent load reduction for each independent criterion in the table. The load reduction shall be determined by applying the nitrogen reduction to the wastewater discharge concentration only. MEANSS assumes steady-state conditions, it does not account for the time needed for the nitrate load to migrate in the unsaturated or saturated zone.

Table 1. MEANSS Wastewater Treatment System Nitrate Loading Matrix for Groundwater Mixing Zones

PERCENT NITRATE LOAD REDUCTION (1)	Hydrologic soil group (HSG) at absorption system	Groundwater mixing zone length (ft)
	(independent criterion 1)	(independent criterion 2)
0	A	<100
10	B	100 - 500
20	C	>500
30	D	

Notes:

1. The total nitrate reduction is the sum of the individual reductions for both criteria in the table. For example (**see Figure 1**), the nitrate load reduction associated with an absorption system in a HSG C soil (20% reduction) that has a 100-foot mixing zone (10% reduction) would be 30 percent reduction (20% + 10% = 30%). Therefore, the wastewater nitrogen concentration impacting ground water would be reduced by 30% in the nitrate sensitivity analysis (**Appendix A**).

Table 2. MEANSS Wastewater Treatment System Nitrate Loading Matrix for Surface Water Analysis

PERCENT NITRATE LOAD REDUCTION (1)	Hydrologic soil group (HSG) at absorption system	Hydrologic soil group (HSG) adjacent to receiving surface water	Distance to receiving surface water (ft)
	(independent criterion 1)	(independent criterion 2)	(independent criterion 3)
0	A	A	<100
10	B		100 - 500
20	C	B	>500
30	D	C	
50		D	

Notes:

1. The total nitrate reduction is the sum of the individual reductions for each of the three criteria in the table. For example (see **Figure 1**), the nitrate load reduction associated with an absorption system in a HSG C soil (20% reduction) that drains to a surface water with HSG A soil adjacent to the surface water (0% reduction) and is 600 feet from the nearest surface water (20% reduction) would be 40 percent reduction (20% + 0% + 20% = 40%). Therefore, the wastewater nitrogen concentration impacting surface water would be reduced by 40% in the trigger value calculations (**Appendix O**). Any system with a reduction of 100% is assumed to contribute no nitrate to the surface water.

The MEANSS results only apply individually to each absorption system evaluated including primary and replacement absorption systems.

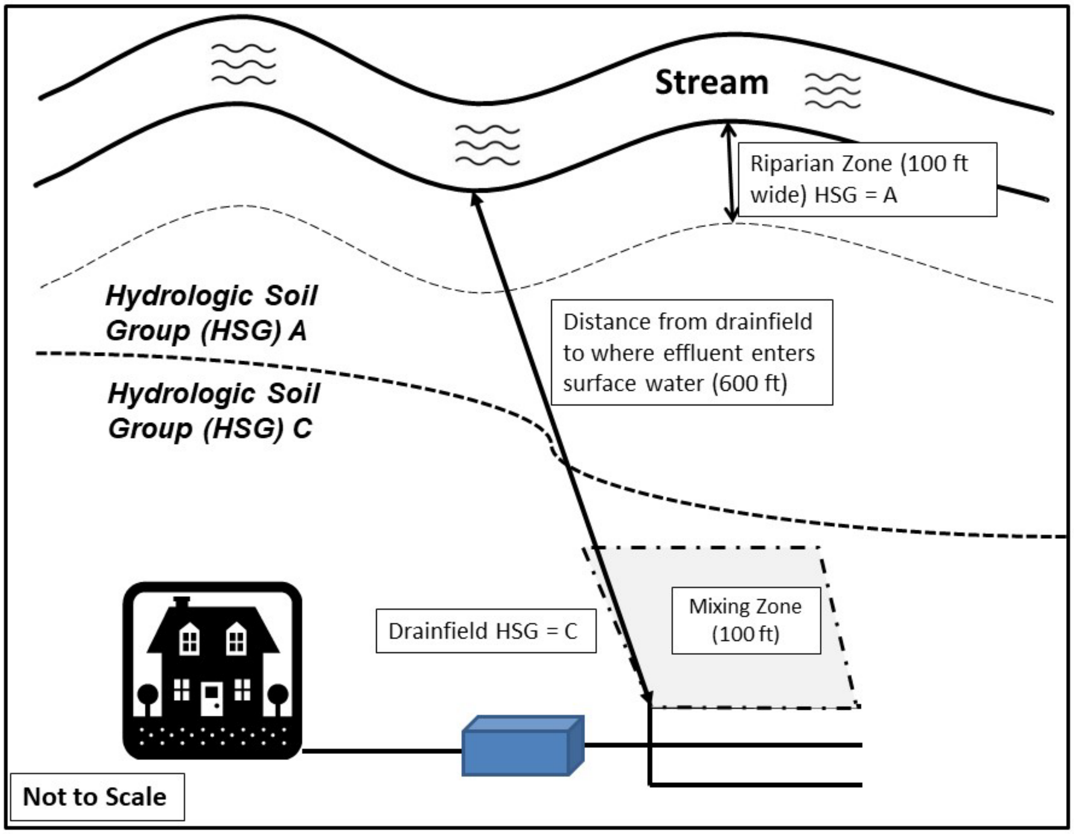

Figure 1. MEANSS example site

<u>DETERMINING DISTANCE TO SURFACE WATER</u>
The distance to the nearest receiving high-quality state surface water (Table 2) shall be based on the same distance to surface water described in ARM 17.30.715(4)(c).

<u>DETERMINING SOIL HSG</u>
The HSG at the absorption system location (Tables 1 and 2) shall be the HSG directly beneath the absorption system in the SSURGO database. If the absorption system overlies two or more soils with different HSG classifications, the percent nitrate load reduction will be the weighted average of the soils. For example, if 60 percent (0.6) of the absorption system overlies a B soil (10 percent reduction in Tables 1 and 2) and the remaining 40 percent (0.4) overlies a D soil (30 percent reduction in Tables 1 and 2), the percent nitrate load reduction for criterion 1 in Tables 1 and 2 is 18 percent. The calculation to derive the weighted average attenuation of 18 percent in this example is: (10*0.6) + (30*0.4) = 18 percent reduction.

The HSG adjacent to the surface water (Table 2) shall include the entire length of surface water where wastewater treatment system effluent may enter the surface water at the ordinary high-water mark. The area where effluent may enter surface water is defined by extension of the groundwater mixing zone to the surface water including the 5-degree expansion (ARM

17.30.517(1)(d)). The same weighted average method described above for HSG at the absorption system shall be used when the HSG at the receiving surface water consists of two or more HSG classifications.

For some soils the listed HSG in SSURGO will be “A/D”, “B/D” or “C/D”. The first letter describes the soil HSG if the area has had the water level artificially drained. The “D” describes the soil HSG if the area has not been drained and only applies when the depth to shallow groundwater is 2 feet or less. Because absorption system sites cannot be used when the groundwater is shallower than 4 feet, the first letter in HSG classification (A, B, or C) shall be used.

The HSG of the soils are determined from the NRCS SSURGO database that is available via the NRCS website. The NRCS website uses SSURGO which is more detailed and up to date than the older STATSGO database. The STATSGO database is no longer maintained and shall not be used. Although there are other methods to electronically access and map SSURGO data, the simplest method is available at the USDA web soil survey: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm . A summary of the web soil survey is available here: https://www.nrcs.usda.gov/sites/default/files/2022-08/WSS-Four-Steps.pdf . Accessing the HSG soil classifications are described below:

- Create an area of interest (AOI) that is less than 10,000 acres in size;
- After the AOI is created the HSG data is available through the following tabs and categories: “Soil Data Explorer” -- “Soil Properties and Qualities” – “Soil Qualities and Features” – “Hydrologic Soil Group”. Criteria for mapping the HSG are described below:
    - For the aggregation method the “Dominant Condition” method shall be used because it provides a better representation of the average conditions than the “Dominant Component” method. A detailed description of the aggregation methods is provided in the NRCS “Soil Data Viewer 6.2 – User Guide”: https://www.nrcs.usda.gov/sites/default/files/2022-09/Soil-Data-Viewer-6-2-User-Guide.pdf ; and
    - The “component percent cutoff” shall be set to zero to include all soils in the results.

For sites that do not have a HSG designation in SSURGO, options to estimate the HSG include but are not limited to:

- Use the HSG of the nearest soil with a HSG classification;
- Use the HSG of a nearby soil with a HSG classification that has similar geomorphic and/or soil characteristics as the site in question; or
- Request NRCS to classify the soil

For sites where the site-specific test pit does not match the NRCS designated soil type (as determined by the reviewing authority and field verified by the county sanitarian upon request of the reviewing authority), the reviewing authority may assign the correct HSG to the location if a similar nearby soil type is available in the SSURGO database.

Nitrogen reduction can be applied to previously approved or existing wastewater treatment systems as part of a current nondegradation application.

<u>SUMMARY AND EXAMPLES</u>

Groundwater

To use the calculated nitrate reduction in a nondegradation review, the percent nitrate reduction estimated in Table 1 or 2 is subtracted from the nitrate concentration discharged from the wastewater treatment system (Table 3 lists the nitrate concentration for the different types of nitrate reducing wastewater treatment system). For example, if the combined nitrate reduction for a wastewater treatment system from Table 1 is calculated at 30 percent, the nitrate concentration for a level 2 system (24 mg/L in Table 3) would be reduced by 30% from 24 to 16.8 mg/L. The 16.8 mg/L value would then be used for that wastewater treatment system in the nitrate sensitivity analysis spreadsheet (**Appendix A**) for the Effluent Nitrate Concentration (Ne) value.

Table 3. Nitrate concentration from subsurface wastewater treatment systems and example reductions.

Type of Wastewater Treatment System	Approved Nitrate Effluent Concentration (mg/L)	Estimated Nitrate Reduction (%)	Nitrate Effluent Concentration Used in Nondegradation Analysis
Septic tank and absorption system	50	10	45.0
Level 2	24	50	12
Level 3	15	20	12.0
Level 4	7.5	30	5.25

Surface Water

For surface water analyses where impacts from multiple wastewater treatment system are calculated using **Appendix O**, the “CD” value in **Appendix O** would be based on a flow-weighted average of all the wastewater treatment systems included in the analysis.

Using an example of the cumulative effects of four wastewater treatment systems (see Table 4), the formula for the flow-weighted average wastewater nitrate concentration is provided below.

$$\text{Flow-Weighted Average Nitrate Concentration} = [(Q_1 \times C_1) + (Q_2 \times C_2) + (Q_3 \times C_3) + (Q_4 \times C_4)] \div (Q_1+Q_2+Q_3+Q_4)$$

Using the values in Table 4, the above formula provides a final flow-weighted wastewater nitrate concentration of 32.69 mg/L as shown below. The 32.69 mg/L concentration is then used for the nitrate concentration in **Appendix O**. **Appendix O** includes a worksheet for this calculation.

[(200 x 24) + (500 x 18.6) + (200 x 42) + (400 x 50)] ÷ (200+500+200+400) = 32.69 mg/L

Table 4. Flow and Concentration for Cumulative Effects Example

Wastewater treatment system ID	Wastewater treatment system Flow Rate (gpd)	Nitrate Concentration after Estimated Attenuation (mg/L)
	$Q_{\#}$	**$C_{\#}$**
1	200	24
2	500	18.6
3	200	42
4	400	50