Simplified Method for Prescriptive Desktop Mounding Analysis

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Background

The Wastewater System and Potable Water Supply Rules (Rules) effective August 16, 2002 require that all subsurface wastewater disposal systems maintain an unsaturated zone of soil beneath and immediately downgradient of the disposal system. This unsaturated zone provides treatment of the wastewater effluent, and groundwater protection. The bottom of the disposal system must be at least 36" above the seasonal high water table when applying septic tank effluent or at least 24" above the seasonal high water table when applying filtrate effluent. In addition, the systems must maintain at least 36" separation between the bottom of the disposal system and the mounded water table when applying septic tank effluent or at least 18" when applying filtrate effluent.

Scope of this Document

This document incorporates a simplified method for a prescriptive desktop mounding analysis for use with mound systems with design flows of less than 1,000 gallons per day and in-ground and at-grade systems with design flows of less than 2,000 gallons per day. For larger systems, which include mounds over 1,000 gallons per day and in-ground and at-grade systems greater than 2,000 gallons per day, the Rules require a site/system specific hydrogeologic evaluation by a qualified hydrogeologist, as defined in Subchapter 2, §1-201, (a) (52) of the Rules, to insure that the design unsaturated zone is maintained. This document does not preclude a more in-depth site-specific hydrogeologic analysis by a qualified hydrogeologist for these smaller systems.

This document is for use by all licensed designers. It is based on a simple model incorporating Darcy's Law and using soil texture and ground-surface slope. It is intended that this model will generally produce conservative results, but care should be taken to insure that the site conditions used for the calculations are present beneath and within 25 feet downgradient of the entire disposal area.

Design standards set forth in the Rules must be adhered to. This approach may produce values, based on hydraulic loading, that do not meet the minimum design standards set forth in the Rules. If the design standard is more restrictive, the system must be designed to that standard.

If the Agency agrees with the assumptions made for this equation, this approach can be used to satisfy the desktop hydrogeologic study required by the rules when designing performance based systems.

Method and Assumptions

Incorporated in the Rules in the filtrate disposal and the enhanced prescriptive standards sections, the concept of system Linear Loading Rate (LLR) is conservatively used to insure the design unsaturated zone is maintained. This method identifies a design Linear Loading Rate (LLR) based on specific site characteristics, including soil texture, natural (not modified) ground slope, and the soil thickness available for groundwater mounding. The LLR is defined as the loading rate in gallons per day applied to each linear foot of the overall system **along the ground contour**. This is different than the LR, or Loading Rate, which is based on percolation rate and is used to determine the size of the system. The Loading Rate is the rate in gallons per square foot of trench or bed per day. Using this approach the minimum system length is calculated first based on the hydraulic capacity of the site. The system size is then determined based on the Loading Rate, site limitations, designer preference, and other restrictions in the Rules (i.e. length to width ratios for mound systems).

The soil texture is based on the NRCS soil triangle that classifies soil textures based on percentages of clay, silt and sand. ***Note: This Method may not be used on soils whose consistence is "firm" or denser.*** The soil descriptions must be representative of the soils beneath the disposal area and for 25 feet downgradient. Additionally, the ground slope must be representative of the disposal area and 25 feet downgradient. The available thickness for groundwater mounding (h) is the thickness of soil from above the highest limiting condition to within 6" of the surface of the naturally occurring soil. Limiting conditions include, but are not limited to: seasonal high water table predicted by soil indicators, seasonal high water table "critical levels" based on the monitoring method in Section 1-507(e) of the Rules, bedrock, soil with a consistence of "firm" or denser, or a maximum of 36 inches below the natural ground surface.

After the above site characteristics are identified, select the appropriate LLR Factor (f) from Table 1. Use the following formula to calculate the appropriate LLR for the disposal system:

$$LLR = (h)\ (f)$$

Where: LLR = linear loading rate, in gallons per day per linear foot of disposal system, measured parallel to the natural ground contours;
h = the soil thickness available for groundwater mounding, measured in feet;
f = the LLR Factor from Table 1, based on soil texture and ground slope.

Table 1. Linear Loading Rate Factors Based on Soil Texture and Natural Ground Slope

	LINEAR LOADING RATE FACTORS (f)						
	Natural Ground Slope						
Soil Texture	**0 - 2%**	**2.1 - 4%**	**4.1 - 6%**	**6.1 - 8%**	**8.1 - 10%**	**10.1 - 15%**	**15.1 - 20%**
Coarse Sand, Sand, Loamy Coarse Sand, Loamy Sand	7.5	22.4	37.4	52.4	52.4	52.4	52.4
Coarse Sandy Loam, Sandy Loam, Fine Sand, Very Fine Sand, Loamy Fine Sand, Loamy Very Fine Sand	3.7	11.2	18.7	26.2	33.7	33.7	33.7
Fine Sandy Loam, Very Fine Sandy Loam	1.5	4.4	7.5	10.5	13.5	18.7	26.2
Loam	1.1	3.4	5.6	7.9	10.1	14.0	19.6
Silt Loam	0.7	2.2	3.7	5.2	6.7	9.4	13.1
Sandy Clay Loam, Silty Clay Loam, Clay Loam	0.4	1.1	1.9	2.6	3.4	4.7	6.5
Sandy Clay, Silty Clay, Clay	0.2	0.7	1.1	1.6	2.0	2.8	3.9

Limiting conditions include, but are not limited to:

- seasonal high water table predicted by soil indicators
- seasonal high water table "critical levels" based on the monitoring method in §1-507(e) of the Rules
- bedrock
- soil with a consistence of "firm" or denser
- 36 inches maximum below the natural ground surface.

Example #1

Three bedroom home with a design flow of 420 gpd with a fine sandy loam friable to 28 inches with the estimated seasonal high water table (SHWT) at 24 inches and a ground slope of 8%.

LLR = (h) (f)

h = 18 inches or **1.5 feet**. (24 inches to SHWT minus the 6 inches of unsaturated soil needed to be maintain between the induced mounding and the ground surface)
f = 10.5 (From Table 1)

LLR = (1.5) (10.5)
LLR = 15.75 gpd/lf

System length is design flow divided by LLR

System Length = **420 gpd / 15.75 gpd/lf**
= **27 lf.**

System size:

The maximum application rate for a mound system is 1.0 gallons/day/square foot. Therefore, 420 square feet of trench or bed bottom is needed.

The minimum system length is 27 feet.

The system width is: 420 square feet/ 27 feet = 16 feet.

A system 27 feet long and 16 feet wide does not meet the 2:1 ratio required by the Rules. The length of the system has to be increased to meet the design standards of the Rules.

System design could include a mound with 2.5 feet of sand beneath the disposal area for septic tank effluent or 1 foot of sand for filtrate effluent.

Example #2

Four bedroom home with a design flow of 490 gpd with a silt loam with the estimated seasonal high water table at 8 inches and a ground slope of 3%.

LLR = (h) (f)

h = 2 inches or 0.17
f = 2.2

LLR = (0.17) (2.2)
LLR = 0.37 gpd/lf

System length = 490 gpd / 0.37
= 1324 lf

System design could include a mound with 2.5 feet of sand beneath the disposal area for septic tank effluent or 1 foot of sand for filtrate effluent.

Example #3

Determine the LLR of an at-grade filtrate disposal system maintaining an 18 inch design unsaturated zone for a three bedroom home with a design flow of 420 gpd with a silt loam with the estimated seasonal high water table at 40 inches and a ground slope of 12%.

LLR = (h) (f)

h = 18 inches or 1.5 feet (36 inch limiting factor minus 18 inches of unsaturated soil needed)
f = 9.4

LLR = (1.5) (9.4)
LLR = 14.1 gpd/lf

System length = 420 gpd / 14.1
= 30 lf

System size:

The maximum application rate for an at-grade system is 1.0 gallons/day/square foot. Therefore, 420 square feet of effective infiltration bottom is needed.

The minimum system length is 30 feet.

The system width is: 420 square feet / 30 feet = 14 feet

Example #4

Determine the LLR of an at-grade filtrate disposal system maintaining an 18 inch design unsaturated zone for a four bedroom home with a design flow of 490 gpd with a loamy sand with water table at 31 inches and an average ground slope of 3%.

LLR = (h) (f)

h = 13 inches or 1.08 feet (31 inches minus 18 inches of unsaturated soil)
f = 22.4

LLR = (22.4) (1.08)
LLR = 24.2

System length = 490 gpd / 24.2
= 20 lf