Mounding and Lateral Flow Analysis – Piedmont Region

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The North Carolina regulations governing the use of large septic systems (more than 3000 gallons/day) require a hydrologic evaluation to assure that all the applied wastewater to the drainfield can infiltrate the soil and move away from the drainfield area without causing the water table (or zone of saturation) to reach within two feet of the bottom of the trenches (or drip lines) of the system. Although the state of North Carolina requires such an evaluation, there is no universally accepted protocol to conduct the analysis. For more than 15 years we have offered a three-step hydrological analysis for designing large septic systems. In this analysis wastewater infiltration from the trenches into the soil, vertical movement of water/wastewater through the unsaturated zone below the trenches, and lateral transport of water away from the drainfield area are assessed. Although this evaluation methodology is applicable to any on-site wastewater disposal system, the characteristics of the soils and their underlying strata, as well as the topography and hydrology of the Piedmont region in North Carolina make such an assessment challenging. The required field data for the hydrologic analysis include depth and thickness of the most slowly permeable layer below the trenches, depth to water table or the impermeable layer below the drainfield, hydraulic conductivity of various horizons (or layers), topographic contour lines, distance to natural (or man-made) drainage outlet(s), and relative elevation of the water level in the drainage features. Also, this theoretical assessment of water flow assumes that wastewater infiltration from the trenches into the soil is uniform and symmetrical, the flow of water in the unsaturated zone below the trenches is vertical, and that the natural ground water or saturated zone formed above an impermeable layer below the drainfield moves away from the area in one or more directions depending on the water table gradient.

Comprehensive assessment of the soils in the drainfield area must be completed by a licensed soil scientist using hand auger borings and observation pits. Based on this soil/site assessment, the suitability of the site is confirmed, and a potential loading rate is determined according to the NC rules and regulations. The saturated hydraulic conductivity (K_{sat}) of the unsaturated soil at the depth where trenches will be located and in the middle of the least permeable layer can be measured by a number of field techniques. Using the Compact Constant Head Permeameter (also known as Amoozemeter), in situ K_{sat} of the unsaturated zone can be measured from the soil surface to 2 m (approximately 6.5 ft) depths. With an accessory, the depth of measurement can be easily extended to 4 m (13 ft). Hydraulic conductivity of the upper part of the saturated zone (i.e., below the water table) can be measured by slug test or auger-hole method.

The three-step hydrologic analysis is performed through the following stages:

1. Determining that all the wastewater applied to the trenches daily infiltrates the soil within a 24-hour time period. If the volume of wastewater applied to the trenches of the system cannot infiltrate the soil, the trenches will eventually fill up and wastewater will surface over the drainfield or sewage will back up into the dwelling.

2. Determining whether or not wastewater infiltrating the soil through the sides and bottom of the trenches can move vertically through the least permeable layer in the unsaturated zone near the bottom of the trenches. If the application rate of wastewater calculated based on the total area of the drainfield is greater than the rate of vertical water flow through the least permeable layer below the trenches, the

soil immediately under the trenches become saturated resulting in hydraulic and/or treatment failure of the system.

3. Wastewater percolating through the unsaturated zone below the trenches and reaching the impermeable/slowly permeable layer or ground water under the drainfield must move laterally away from the system. A localized rise in the water table immediately below the drainfield, referred to as ground water mounding, may occur when the amount of wastewater applied to the drainfield is relatively high compared to the lateral flow from the area without the septic system. The increase in mounding results in higher hydraulic gradient, which in turn will increase the volume of water that can move laterally. Treatment of wastewater by soil may cease if the saturated zone (i.e., the top of the mound) reaches within a certain distance (e.g., 60 cm) below the bottom of the trenches, or the system may fail hydraulically if the mounding reaches the bottom of the trenches.

A number of models are currently available for analyzing ground water mounding under the drainfield area of septic systems. These include a user-friendly program (based on Hantush model for mounding under rectangular and circular sources) available through the Civil Engineering Department at Colorado State University, DRAINMOD developed by Dr. Skaggs at North Carolina State University, and Modeflow (for information see http://water.usgs.gov/nrp/gwsoftware/modflow2000/modflow2000.html). Some of these models are complicated and require a relatively high level of expertise. Also, a number of them cannot be effectively used in the Piedmont region due to the topographic nature of the area. In lieu of sophisticated models, a simple analysis using Darcy's law can be used to estimate the amount of water that can leave the darinfield area of the proposed system. In this analysis, the volume of water that can leave the area based on the maximum allowable rise in water table under the drainfield is compared with the design flow volume. If the design flow exceeds the calculated volume of lateral flow, the site must be declared unsuitable or proper modifications must be made for another analysis. These modifications may include reduction in the design flow volume and changing the size and/or configuration of the drainfield.