Site and Soil Evaluation for Onsite Wastewater Systems

A comprehensive site and soil evaluation is the key component affecting selection, design, and long-term performance of an onsite wastewater system. A septic tank followed by a soil dispersal system is the most commonly used onsite wastewater system in Kansas and throughout the nation. Although effluent from a septic tank may be clear, it is still sewage. It is odorous and contains nutrients, disease organisms, and dissolved organic material. The soil must provide the additional treatment required.

An effectively operating soil dispersal, or absorption, field treats the septic tank effluent as it enters the soil and percolates downward. If not removed by evapotranspiration, the percolate from onsite wastewater dispersal will eventually reach the groundwater. The soil is the most important component of the wastewater dispersal field. Its properties determine appropriate treatment systems, the design loading rate, and the size of the dispersal field. The soil properties — including depth, profile limitations, description, and capacity to absorb and treat wastewater — must be evaluated.

Soil Surveys

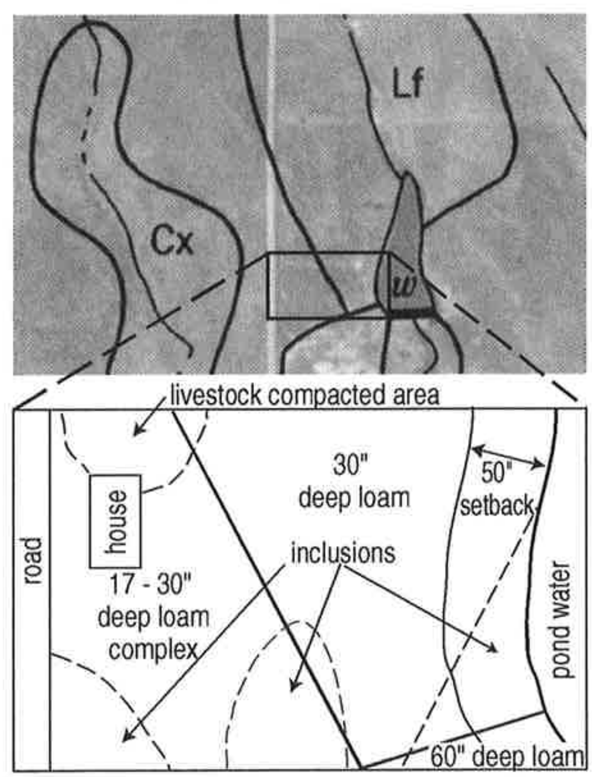
Soil surveys are a useful preliminary planning tool to help understand the general suitability of the area for an onsite wastewater system. The survey provides maps showing soils in the area and describes the soil's properties including texture, structure, depth, slope, permeability, internal drainage, and flooding potential. Suitability ratings and causes of soil limitations for septic systems and lagoons are interpreted and are shown on tables. A county soil survey report published by the USDA, Natural Resources Conservation Service (formerly Soil Conservation Service) is available for all Kansas counties from the County Conservation District or local K-State Research and Extension office.

Soil maps and surveys, however, do not have the detail needed to evaluate the suitability of a specific location on a homesite because soil properties can vary substantially within short distances, see Figure 1. Site-specific information of soil properties must be used to evaluate the soil's suitability in the proposed wastewater dispersal field area and to design the loading rate.

Soil Profile Evaluation

The soil profile evaluation to a depth of at least 6 feet provides a comprehensive assessment of soil properties on the proposed dispersal site. It is the recommended method to determine the suitability of the soil to treat wastewater and to design a suitable loading rate for a site. Opening a pit to expose the soil profile is ideal to allow the evaluator to do the examination. For safety, an excavator (backhoe) is usually used to dig the pit to 5-feet. A shovel, probe, or auger can be used in the bottom of the pit to examine the soil to 6 feet or deeper. The evaluation, performed by a trained and qualified person*, includes examining each soil layer (horizon) and determining soil texture, color, structure, consistence, thickness, and depth. The goal is to find and record evidence of restrictive conditions, specifically rock layers, poor drainage, high water table, or saturated conditions.

Figure 1. *Typical soil map of central Kansas and detail of homesite area showing soil inclusions and local variations.*



At least three pits should be dug near the proposed dispersal field. Pit locations should be positioned to examine all possible strata of sloping sites. The soil profile characteristics are used to determine the loading rate and size the dispersal field. These characteristics include texture, structure, and consistence of the contact surface, profile, and limiting soil layers. The wastewater loading rate is usually stated in gallons per day per square foot (gpd/ft^2). Recommended loading rates for different soil textures and structures are shown in Table 1 on the back page.

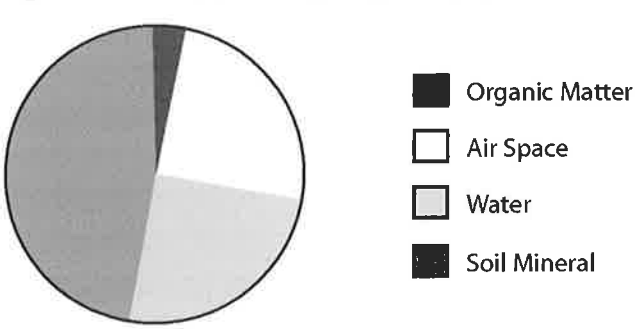
Soil Depth

Kansas' regulations require a minimum of 4 feet of suitable aerated soil beneath the bottom of soil absorption fields before reaching bedrock, groundwater, or a seasonal water table. This depth helps assure adequate treatment before percolate reaches a limiting condition that restricts further treatment. If a limiting soil profile condition exists within about 5 feet of the ground surface, traditional in-ground soil dispersal laterals are not suitable for the site.

An ideal profile for a soil dispersal field is at least 6 feet of aerated and well-drained soil with no restrictive layers that would cause saturation. Figure 2 depicts a typical relationship of soil, air, and water content of a good soil. The occurrence of ideal soil conditions may be quite limited in much of eastern and central Kansas. A soil profile evaluation that includes texture, color, structure, consistence, and layers is essential within the area of the proposed dispersal field. When soil limitations exist, then adjustments may be needed. Adjustments could involve using lower loading rates or selecting a different onsite wastewater system than a traditional septic tank and soil dispersal lateral field.

Onsite alternatives may be suitable for sites with profiles that do not have the desired depth and permeability conditions. Enhanced treatment systems provide a higher quality effluent than produced by septic tanks. This allows marginal soils to more easily absorb wastewater. However, these alternative systems require more attention to design requirements, material selection, and construction detail. Regular maintenance is critical to good performance and long life of these systems.

Figure 2. *Soil components in typical proportions*



Measuring the Soil's Ability to Absorb Water

A perc (short for percolation) test measures the rate at which clean water infiltrates wet soil. Previously, local health departments or designers used this test to obtain site-specific data for selecting a loading rate and sizing the soil dispersal field.

The perc test is conducted using six or more holes 6 to 8 inches in diameter and 24 inches deep, placed throughout the proposed soil absorption system area. The holes are presoaked for at least 24 hours by maintaining a 12-inch water level. The perc rate then is measured for each hole until the rate is consistent, then reported as the number of minutes that it takes for an inch of water to soak into the soil.

A perc test description is in Appendix A of Kansas Department of Health and Environment (KDHE) Bulletin 4-2, *Minimum Standards for Design and Construction of Onsite Wastewater Systems* (K-State Research and Extension publication MF-2214). A suitable long-term effluent-loading rate is a small fraction of the measured perc. This allows for development of the biomat (or surface seal) which will restrict the long-term acceptance of wastewater.

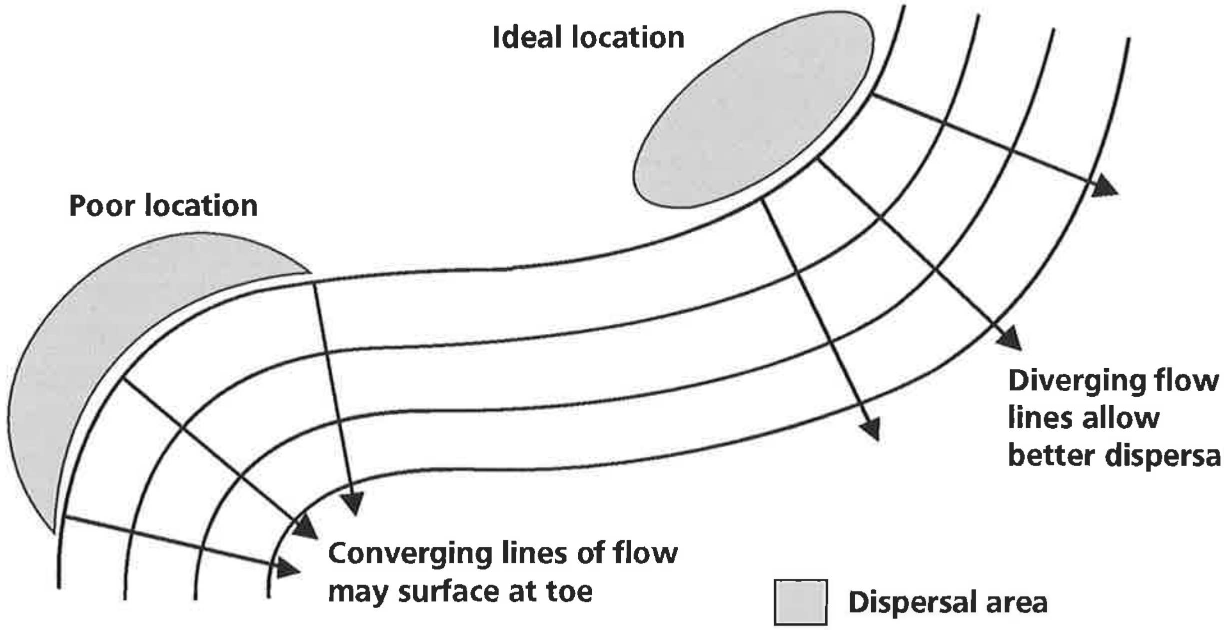
The perc test has two serious limitations: It does not reveal limiting conditions in the soil profile, and special equipment is necessary to fully wet clay soils. During dry periods, shrink-swell soils develop cracks that can be more than an inch wide. In this condition it is almost impossible to adequately presoak the soil in 24 hours so an accurate perc measurement can be obtained for a wet soil condition. Thus, perc rates are often falsely measured as higher during dry conditions, leading to an inappropriately high loading rate. The designer must understand the limitations of perc tests and use them only in combination with soil information from other sources. When doing perc tests, compare results with other soil property information, and apply the most restrictive.

Options for Soils with Limitations

Coarse soils that accept and transmit water quickly (high perc rates – less than 5 minutes per inch) require special designs to assure adequate treatment of the wastewater. A timed, pressure-dosed system or loamy-soil lined lateral helps control the loading rate to assure that adequate treatment will occur.

Soils that accept water very slowly, loading rate less than 0.4 gpd/ft^2 in Table 1, are easily overloaded and may have difficulty handling full wastewater flows from a home. Therefore, traditional soil dispersal laterals are not well suited to soils with high clay content and limited structure. Lagoons, enhanced treatment prior to dispersal, or alternative dispersal options are more suitable for sites with slowly permeable soils.

Figure 3. *Site with complex slope depicts good and poor locations for onsite wastewater systems.*



Slope and Surface Shape

Soil properties can vary dramatically in short distances up or down slope. This is because of differences in the material from which the soil is formed or in soil development. Sloping sites therefore require more extensive site evaluation. Slopes may require substantial site preparation and typically result in a long, narrow system. Because dispersal laterals must be level, they are installed on the contour. This may result in more area used than a similar design for a level site. Avoid lateral locations that wrap inside a drainage or low area. (Figure 3.) In this case surface runoff converges from three sides.

Local Government Enforces Requirements

In Kansas, county government regulates septic systems. In counties with a sanitary code, regulation is usually through the local health department, planning and zoning, or code enforcement office. Typically, sanitarians evaluate site conditions and soil suitability and issue permits for onsite wastewater systems receiving up to 2,500 gallons per day. The guidelines in KDHE Bulletin 4-2, *Minimum Standards for Design and Construction of Onsite Wastewater Systems* apply statewide for all counties with or without a sanitary code. It is the responsibility of county government to assure that minimum standards are met.

Soil Evaluation Assistance

The soil survey gives general soil information and is a basic guide. A comprehensive evaluation is essential because of local variation in soil conditions. Soil scientists with the USDA, Natural Resources Conservation Service, are trained and may assist with soil evaluations for specific sites. They can assist planning agencies and local health departments with understanding site suitability for soil dispersal systems. Training for soil profile evaluation for onsite wastewater treatment has been conducted in Kansas since 1991. Information about when and where this training is available can be obtained from the local sanitarian, KDHE district office, or Kansas State University, Extension Biological and Agricultural Engineering.

For more information on septic tank and soil dispersal systems, lagoons, or other treatment systems, contact your local health department or K-State Research and Extension office.

**Note: A trained and qualified person would include a soil scientist (such as those with NRCS), environmental health specialist, sanitarian, or other person who has received appropriate soil training, is competent through experience, and who keeps up to date through continuing education.*

Table 1. *Recommended design loading rate for various soil textures, structure, and effluent quality*

Texture	Structure		Hydraulic loading (gpd/ft^2)		Organic Loading (lbs BOD / 1,000 ft^2-day)	
	Shape	Grade	BOD=150	BOD=30	BOD=150	BOD=30
Gravel, very coarse sand	Single grain	Structureless	Unsuitable for conventional soil dispersal laterals [a]			
Coarse sand, sand, loamy coarse sand, loamy sand	Single grain	Structureless	0.8	1.6	1.00	0.40
Fine sand, very fine sand, loamy very fine sand	Single grain	Structureless	0.4	1.0	0.50	0.25
Coarse sandy loam, sandy loam	Massive	Structureless	0.2	0.6	0.25	0.15
	Platy	Weak	0.2	0.5	0.25	0.13
		Moderate, strong	Unsuitable for conventional soil dispersal laterals [b]			
	Prismatic, blocky, granular	Weak	0.5	0.7	0.50	0.18
		Moderate, strong	0.6	1.0	0.75	0.25
Fine sandy loam, very fine sandy loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, moderate, strong	Unsuitable for conventional soil dispersal laterals [b]			
	Prismatic, blocky, granular	Weak	0.2	0.6	0.25	0.15
		Moderate, strong	0.4	0.8	0.50	0.20
Loam	Massive	Structureless	0.2	0.5	0.25	0.13
	Platy	Weak, moderate, strong	Unsuitable for conventional soil dispersal laterals [b]			
	Prismatic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Silt Loam	Massive	Structureless	0.0	0.2	0.00	0.05
	Platy	Weak, moderate, strong	Unsuitable for conventional soil dispersal laterals [b]			
	Prismatic, blocky, granular	Weak	0.4	0.6	0.50	0.15
		Moderate, strong	0.6	0.8	0.75	0.20
Sandy clay loam, clay loam, silty clay loam	Massive	Structureless	Unsuitable for conventional soil dispersal laterals [b]			
	Platy	Weak, moderate, strong	Unsuitable for conventional soil dispersal laterals [b]			
	Prismatic, blocky, granular	Weak	0.2	0.3	0.25	0.08
		Moderate, strong	0.4	0.6	0.50	0.15
Sandy clay, clay, silty clay	Massive	Structureless	Unsuitable for conventional soil dispersal laterals [b]			
	Platy	Weak, moderate, strong	Unsuitable for conventional soil dispersal laterals [b]			
	Prismatic, blocky, granular	Weak	Unsuitable for conventional soil dispersal laterals [b]			
		Moderate, strong	0.2	0.3	0.25	0.08

Source: Adapted from EPA Onsite Wastewater Treatment Systems Manual, page 4-12, 2002

a Soil is too coarse for conventional soil absorption designs. Use pressure distribution dosing or other alternative system to prevent too rapid infiltration.
b Soils with these conditions may be acceptable for wastewater stabilization ponds or alternative systems.

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