Chapter IV

SITE AND SOIL EVALUATIONS

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INTRODUCTION

A comprehensive site and soil evaluation is the key component impacting design and long term performance of onsite wastewater systems. A thorough site and soil evaluation requires more than a walk on the site and a quick look at the soil. A complete evaluation includes an understanding of the owner's expectations and knowledge of all the factors that may impact the selection and design of a system. Such factors include soil conditions, slope, zoning restrictions, wetlands, separation distances from structures, wells, and property lines, easements, and rights-of-way. Sites characterized by slowly permeable (tight, low perc rate) soils, shallow soil over rock, high groundwater, poor drainage, or steep slopes are unsuitable for conventional soil absorption systems and may require more elaborate and expensive alternative methods for treatment of wastewater. If design considerations are not comprehensive, the system life is often substantially shortened and the total annual cost rises dramatically.

Poorly drained sites or sites with a high water table may require special surface and/or underground drainage to prevent periodic failures caused by rising groundwater levels or impounded surface drainage. The solution and control of such problems require consideration of the total drainage area and planning. Good designs for problem cases often increases the cost of onsite systems significantly. In some cases, wastewater treatment systems may be prohibited on such sites.

Site specific soil information is available from the Natural Resources Conservation Service (NRCS), K-State Research and Extension, or local Health or Environmental Departments. The site evaluator and designer should take into consideration all sources of site information and supplement that information with onsite investigations.

A thorough site evaluation will locate the area to be used for the onsite wastewater system. A soil evaluation is required to assess the suitability of an area and is used to determine the soil loading rate for effluent so that the required absorption field area can be calculated. The absorption field area and an alternate area for future use should be marked so they will not be disturbed during construction.

SANITARIAN TOOLS

A sanitarian needs a set of tools to do the job properly. Several practicing sanitarians who work with wastewater systems have collaborated to compile a list of useful tools. See Table IV-1 for a list of recommended tools. Sanitarians are encouraged to add items to this list that they find helpful to do their jobs.

The initial investigation of the soil and site conditions for an onsite wastewater system is crucial for identifying what is most suitable for the site. This investigation must thoroughly evaluate the site and soil constraints and determine from among the various onsite systems which are suitable and also meet provisions of the local code. A protocol for this investigation is contained in Protocol One at the end of this chapter.

TABLE IV-1. Suggested Tools for the Sanitarian

1) Heavy steel rod to probe tank and laterals	12) Shovel(s)
2) Soil probe, soil sampler, or soil auger	13) Soil color book (Munsell Color Chart)
3) NRCS county soil survey	14) Water soluble dye (two colors and two forms are recommended)
4) Clinometer or Abney hand level	15) Rope
5) Tape measures (100 and 10-20 foot)	16) Equipment for perc test
6) Hoe and clear acrylic tube with cork	17) Sturdy sealable plastic bags for samples
7) Engineer's level and rod, or laser level	18) Bags for trash collection
8) Rubber gloves	19) First aid kit and disinfectant, tincture of iodine is recommended
9) Work gloves	20) Tool box or other container to hold and carry equipment
10) Squirt bottle and paper towels	21) Camera and log book
11) Heavy sheath knife	

SITE EVALUATION

Selection of the wastewater disposal area must be an integral part of planning prior to home construction. The site evaluation of the property should be conducted before purchase and certainly before beginning construction. Low areas that are likely to be flooded should be avoided. Slopes greater than 20 percent will cause considerable difficulty during construction and are not recommended for onsite systems. Grading and landscaping should be utilized to help minimize soil erosion and allow the diversion of runoff.

Rock outcrops warn of shallow soil and may suggest the probable direction of groundwater flow. Examination of the soil profile on the site should assure that the required four feet of suitable soil is available below the bottom of the absorption area and above any restriction such as bedrock, unsuitable soil, high groundwater table, or perched water table. If four feet is not available beneath the absorption laterals, alternative designs are required. Table IV-2 shows recommendations for system selection based on percolation rate, slope, depth to high water table or bedrock, and depth to impermeable layers.

The area required for the soil absorption system depends on the wastewater flow and the design loading rate. Wastewater flow is a function of the wastewater source and how the source is used. Wastewater flow from homes is estimated by multiplying the number of bedrooms by 150 gallons per day (gpd). The calculation is based on 75 gallons per person, per day, for two people in each bedroom. Thus the design flow is determined for the number of people that can occupy the home for extended periods rather than how many actually live there when the system is installed. Houses frequently experience a change in ownership and occupancy over the life of the onsite wastewater system but if designed properly, the system can handle the maximum occupancy. When calculating wastewater flow, note that a water softener may increase water use by as much as 10 gallons per capita per day or possibly more where water is very hard. The design loading rate is a function of soil conditions and requires considerable information about the soil.

Table IV-2. Recommendations for System Selection

Limitation or Site Restriction	Traditional Lateral Field	Wastewater Pond (Lagoon)	Dosed In-ground System	Mound, Pump Dose to Shallow or At-grade	Drip Irrigation
Slope					
> 15%	x[1]	—	x	x[1]	x
5%-15%	x	—	x	x	x
< 5%	x	x	x	x	x
Depth Below Absorption Surface (feet)					
> 6	x	x	x	x	x
2-6	—	x[2]	x	x[3]	x
< 2	—	x[2]	—	x[3]	—
Soil Perc Rate (minutes/inch)					
< 5	—	—	—	x	x
5-30	x	—	x	x	x
30-60	x	—	x	x	x
30-60	x	—	x	x	x
60-120	—	x	x	x	x
> 120	—	x	—	—	x

x *means suitable*

— *means not suitable*

[1] - *limitations during construction may be a significant factor*

[2] - *depth to limitation may be overcome by importing suitable soil to the site and constructing the lagoon in that material*

[3] - *absorption fields receiving septic tank effluent require 4 feet soil depth to limitations. If enhanced treatment is used ahead of the absorption system this may be reduced to 1 foot.*

A thorough soil analysis should be done as part of the site evaluation. The soil evaluation will verify that the soil is suitable for an onsite wastewater system and provide information needed to determine the soil loading rate. If a complete soil analysis is not done as part of the site evaluation, a conservatively low loading rate should be assumed so a large enough area is reserved for the soil absorption field. Having more area than required is not a problem and will probably increase the life of the system

A topographic map of the site is helpful when designing a system. It enables the evaluation of surface water movement and slopes. When the map is to scale, it can be used to locate the area and assure that separation distances are adequate. USGS 7½ Minute Quadrangle maps are a readily available source of general topography information. When a topographic map is not available, more work must be done on the site to gather information about elevation and slopes.

SOIL EVALUATION

The preferred way to evaluate a site for an onsite wastewater system is a thorough investigation of the soil conditions. The soil evaluation includes examining the soil profile, determining soil texture, soil structure, soil consistence, measuring depth and looking for evidence of restrictive conditions. A soil profile usually identifies several soil layers. The properties of each layer are evaluated separately and recorded.

Describing the soil profile is important when evaluating the site for wastewater absorption and treatment capacity for designing an onsite wastewater system. A soil absorption field is normally constructed in naturally occurring soils. Satisfactory soil evaluation depends on how thorough the inspector is and how experienced he or she is with utilizing available resources to make a detailed site evaluation.

To perform a soil profile analysis, an excavator usually opens a pit to expose the soil profile. The soil evaluation should be performed by a trained and qualified person. The evaluator determines the soil horizons (layers), texture, structure, color, consistence, depth, and looks for evidence of a high or perched water table or other restrictions. The soil profile should be examined to a depth of at least 4 feet below the bottom of the absorption field laterals, or at least 6 feet below the natural ground surface.

Because OSHA regulations require shoring for trenches deeper than 5 feet for some soils, it is recommended that the pit be constructed so a person is not required to enter a trench deeper than 5 feet. Soil below 5 feet can be examined from cuttings, observation from a distance, or/and by digging a small hole in the bottom of the pit.

At least three pits should be opened in the area to establish the range of soil characteristics that are present on the site and to determine the best location for the absorption field. Sanitarians or environmental health specialists (usually found at county health or environmental departments) are available to assist in the site and soil evaluations. Some consultants such as engineers, soil scientists, or design/installation contractors, also provide this service.

Soil properties can limit the suitability of soil absorption system use. The USDA, Natural Resources Conservation Service has interpreted the suitability of each of the soil series for septic systems. As shown in Table IV-3, the range of values for each of several properties that cause the soil series to be classified as a slight, moderate, or severe limitation rating for septic systems. Note that site specific soil information is preferred to the County Soil Survey that presents general conditions for an area. After studying Table IV-3, one can better understand why some soil profiles are limited. Later chapters of this handbook describe other soil absorption systems that should aid in overcoming the limiting property

Table IV-3. Soil Limitation Ratings Used by USDA, NRCS for Onsite Suitability

Property	Slight	Moderate	Severe	Restriction or Feature
USDA Texture	------	------	Ice	Permafrost (not found in Kansas)
Flooding	None, Protected	Rare	Common	Flood water inundates site
Depth to Bedrock, (in.)	> 72[1]	40 - 72	< 40[2]	Bedrock, weathered bedrock restricts water movement or reduces treatment capacity
Depth to Cemented Pan, (in.)	> 72	40 - 72	< 40	Reduces water and air movement
Depth to High Water Table,	> 6 (ft below surface)	4 - 6	< 4	Saturated soil, poor aeration anaerobic soil, restrictive movement
Permeability, in./hr layers <24 in.	------	------	> 6.0	Poor filtration of effluent
24 - 60 in. layer	2.0 - 6.0	0.6 - 2.0	< 0.6	Slow Perc Rate, poor drainage
Slope, (percent)	0 - 8	8 - 15	> 15	Difficult to construct and hold in place
Large stones >3 in., (percent by wt)	< 25	5 - 50	> 50	Restricted water and air movement results in reduced treatment capacity

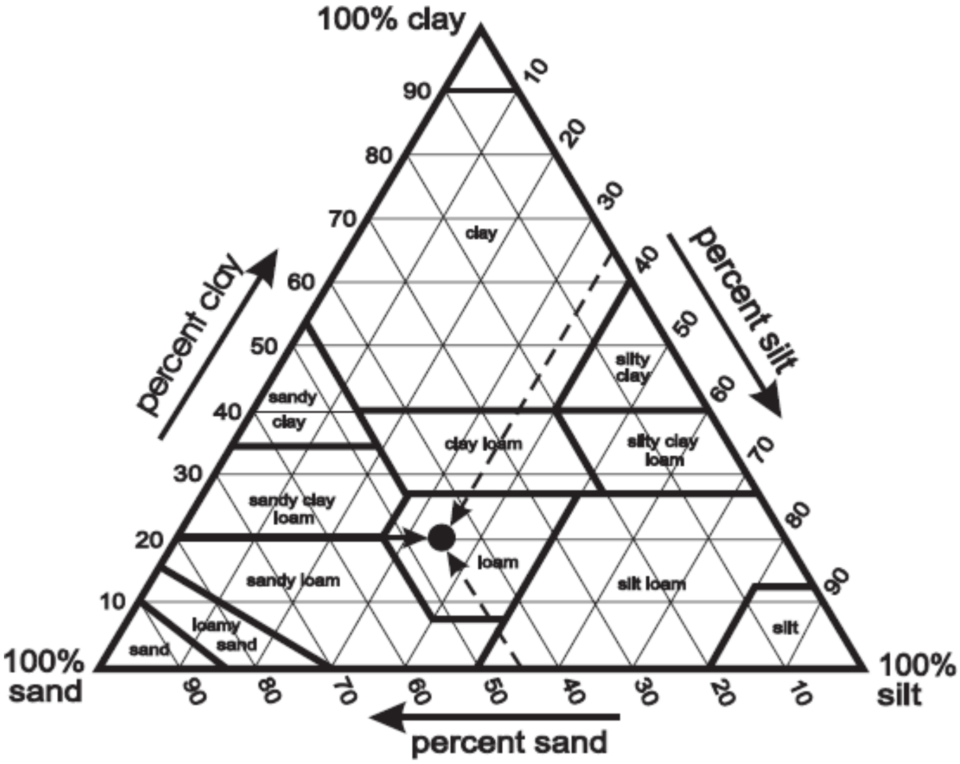
[1] *> means greater than*
[2] *< means less than*
Source: Design Manual - Onsite Wastewater Treatment and Disposal Systems, EPA Technology Transfer, Office of Water Program Operations, 1980.

SOIL CHARACTERISTICS

Soil texture is composed of a mixture of soil particles, including sand, silt, and clay. The textural class is one basis for determining wastewater loading for soil absorption systems. All soil materials fit a specific spot in the soil texture triangle (Figure IV-1). An experienced soil evaluator can accurately estimate the soil texture in the field. A procedure for evaluating soil texture from the soil feel is shown in Protocol Two. Laboratory measurements are relatively inexpensive and can be used to accurately determine the amount of sand, silt, and clay and thus determine the soil texture with laboratory precision.

Soil structure refers to the aggregation of soil particles into clusters of particles, called peds, that are separated by surfaces of weakness. These surfaces of weakness provide planar pores between the peds that are seen as cracks in the soil. Structure often has a marked influence on water and air movement in soil especially in fine textured soils. Therefore, soil structure is the second critical aspect for selecting the design loading rate. A discussion of soil structure is also included in Protocol Two.

Figure IV-1. USDA Soil Textural Triangle



Source: USEPA Onsite Wastewater Treatment Systems Manual, 2002, page 5-19.

Soil consistency describes the cohesion between soil particles and the adhesion of soil to other surfaces and is the third aspect of soil that affects the loading rate. Consistency characteristics of individual soils vary widely according to moisture content of the soil.

Consistency characteristics are described for wet, moist and dry conditions. Moisture content can have a dramatic affect on the action of roots and animals in the soil. Soil consistency characteristics in addition to soil texture and structure may limit the installation of the onsite wastewater system until dry conditions prevail to avoid damage to the soil that would reduce water movement and cause early failure.

When the soil texture, structure, and consistence as well as the wastewater strength are known, the designer is prepared to select a suitable loading rate for soil absorption. Table IV-4 gives the recommended loading rates based on soil texture and structure information for two effluent qualities. These loading rates are based on research showing that soil characteristics and wastewater quality provide a strong basis for wastewater system design loading rate.

Table IV-4. Recommended Design Loading Rat for Various Soil Textures, Structures, and Two Effluent Qualities

Texture	Structure		Hydraulic loading (gal/ft²-day)	
	Shape	**Grade**	**BOD=150[1]**	**BOD=30[2]**
Coarse sand, sand, loamy coarse sand, loamy sand	Single grain	Structureless	0.8	1.6
Fine sand, very fine sand, loamy very fine sand	Single grain	Structureless	0.4	1.0
Coarse sandy loam, sandy loam	Massive	Structureless	0.2	0.6
	Platy	Weak	0.2	0.5
		Moderate, Strong		
	Prismatic, blocky, granular	Weak	0.5	0.7
		Moderate, Strong	0.6	1.0
Fine sandy loam, very fine sandy loam	Massive	Structureless	0.2	0.5
	Platy	All grades		
	Prismatic, blocky, granular	Weak	0.2	0.6
		Moderate, Strong	0.4	0.8
Loam	Massive	Structureless	0.2	0.5
	Platy	All grades		
	Prismatic, blocky, granular	Weak	0.4	0.6
		Moderate, Strong	0.6	0.8
Silt Loam	Massive	Structureless		0.2
	Platy	All grades		
	Prismatic, blocky, granular	Weak	0.4	0.6
		Moderate, Strong	0.6	0.8
Sandy clay loam, clay loam, silty clay loam	Massive	Structureless		
	Platy	All grades		
	Prismatic, blocky, granular	Weak	0.2	0.3
		Moderate, Strong	0.4	0.6
Sandy clay, silty clay, clay	Massive	Structureless		
	Platy	All grades		
	Prismatic, blocky, granular	Weak		
		Moderate, Strong	0.2	0.3

[1] *typical septic tank effluent BOD concentration*
[2] *typical enhanced (advanced) treatment component effluent*
Source: Adapted from EPA Onsite Wastewater Treatment Systems Manual, page 4-12

Color patterns in the soil are good indicators of the drainage characteristics of the soil. Light brownish, yellowish, or reddish colors are indicative of soils that are well drained and aerated. Bands or mottles of brighter color should be noted, particularly if they are interspersed or underlain by layers of grayish soil. This may indicate a seasonal or perched water table. Grayish colors indicate poorly drained soils. Evidence of seasonal or perched water tables is one of the most important aspects to be determined by the soil evaluation. If any evidence of restrictive conditions are detected in the first 4 feet of soil beneath the trench bottom, the site may not be well suited to a conventional soil absorption system. The designer should then consider other absorption system designs or wastewater stabilization pond that are better suited to restrictive soil conditions.

CRITERIA FOR LOADING RATES

System design shall be based on the most limiting soil texture found in the first 4 feet below the bottom of the proposed absorption system. Once the wastewater flow and the loading rate for the soil are known, the area needed for the absorption system can be calculated. The absorption field and an equal area reserved for future use should be marked and fenced so they will not be disturbed during construction. Required setback distances to property lines, wells, surface water, and buildings must be checked and included in the site plan.

Where evaporation substantially exceeds precipitation, as in central and western Kansas, a reduction in soil absorption area may be acceptable when the soil is well suited to wastewater absorption. A well suited soil has medium to coarse texture, perc rates less than 45 minutes per inch and wastewater loading rates of at least 0.5 gallons per square foot, per day. For marginal, high clay soil that has low loading rates, no reduction should be used, regardless of location in Kansas. Recommended allowable soil absorption system reductions and percent of total absorption area for central and western Kansas is shown on Table IV-5.

Table IV-5. Allowable Absorption Reductions for Dry Climate

	Western Kansas	Central Kansas	Eastern Kansas
Actual Absorption area (percent)	65	80	100
Allowed reduction (percent)	35	20	0

Source: KDHE, Bulletin 4-2 Minimum Standards for Design and Construction of Onsite Wastewater Systems

The soil profile evaluation provides a comprehensive assessment of soil characteristics and is the most accurate method for determining the suitability of the soil to accept and treat wastewater and to establish the design loading rate.

No onsite wastewater system shall be loaded at a rate greater than 1.23 gpd/ft^2, regardless of soil permeability. (Research indicates that the clogging mat which forms at the bottom of the trench has a maximum filtration rate of 5 cm/day or 1.23 gpd/ft^2.) A wastewater flow of 150 gpd/bedroom is assumed.

PERC TEST

The “Perc Test” (short for percolation) is another common method of determining the soil’s ability to accept wastewater. The word percolation means movement through a porous or permeable substance, in this case soil. The perc test really measures an infiltration rate for water into a wet, but unsaturated soil at the depth of expected absorption system placement. Since the driving force is gravity, the movement will be downward.

Permeability, or hydraulic conductivity, as used by soil scientists is a term applied to saturated or water table conditions. All pores are completely filled with water and water would freely flow out to the side. Permeability is measured at a unit gradient for each unit of thickness. Permeability will be greater than percolation because of the saturated conditions. Permeability, however, is usually measured in the laboratory because of the difficulty of creating a saturated condition in the field without a water table.

The perc test was first used for soil absorption system evaluation in New York in the 1920's. It has become widely used as a basis for designing the loading rate, and thus sizing the soil absorption field. This measurement is not a good representation of either the hydraulic conductivity or downward percolation which are measured under different conditions. The test is helpful for sizing soil absorption systems in many soils when combined with other tests.

The primary limitations of the perc test are in soils that shrink and swell with changes in soil moisture and soils that have perched or seasonal high water table. During dry periods, shrink/swell soils can develop wide cracks. A perc test that will reflect wet period conditions is most difficult, if not impossible, when beginning with dry, cracked soil. A seasonal perched water table is not detected by the perc test. However, it can easily be detected in an evaluation of the soil profile. **Because the perc test can lead to bad decisions about a suitable loading with soils that have shrink/swell or seasonal water tables, the preferred method is to establish soil loading rates based on soil evaluation.** When the perc test is used the best approach is to understand the limitations of the perc test and not rely on it alone. The procedure for conducting a perc test is given in Protocol Three.

Once the soil perc rate is known, the loading rate and soil absorption field area are obtained from Table IV-6. The loading rates in Table IV-4 and Table IV-6 may not always agree. The preferred loading rate as given in Table IV-4, is research-based and is more recently developed. Therefore, if a soil evaluation and a perc test should result in two loading rates that do not agree, always use the smaller rate. The use of a lower loading rate provides a larger absorption area and will result in a longer life system with less risk of failure.

Table IV-6. Loading Rate and Absorption Area Recommendations Based on Perc for Septic Tank Effluent

Perc Rate (minutes/inch)	Loading Rate (gpd/ft^2)	Required Absorption Area (ft^2/bedroom)
Less than 5 minutes	Not suitable for conventional soil absorption system[1]	
5 - 10 minutes	0.91	165
11 - 15 minutes	0.79	190
16 - 30 minutes	0.60	250
31 - 45 minutes	0.50	300
46 - 60 minutes	0.45	330
Greater than 60 minutes	Not suitable for conventional soil absorption system[2]	

[1] *Soil is too coarse for conventional soil absorption designs. Use pressure distribution dosing or other alternative system to prevent too rapid infiltration.*

[2] *Soils with these conditions may be acceptable for wastewater ponds or possibly other alternative systems (See Table IV-2). Enhanced treatment of wastewater (see Chapter VI) before delivery to the soil distribution systems may also be suitable.*

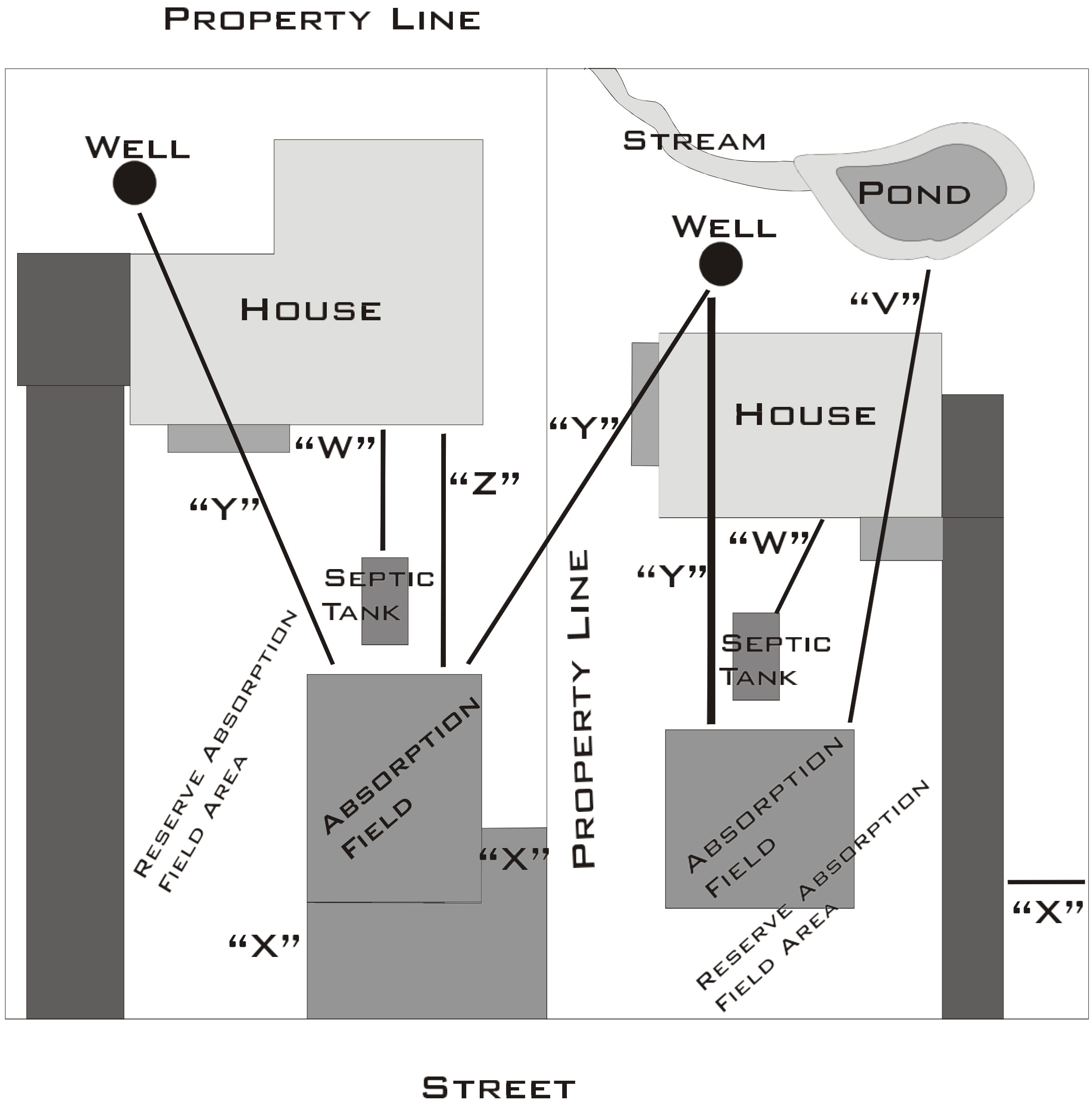
SEPARATION DISTANCES FOR WASTEWATER SYSTEMS

Adequate separation distances must be maintained between onsite wastewater systems and other structures and facilities both on the site and on adjacent property. Separation is required to maintain system performance, to permit repairs, and to reduce undesirable effects of underground wastewater flow and dispersion.

The structures to consider include buildings, property lines, utilities, components of the wastewater treatment and absorption system, and especially wells and surface water. Minimum required and minimum recommended separation distances for onsite wastewater systems are given in Table IV-7.

The optimum time to establish the best location for the septic tank and soil absorption field with respect to structures, utilities, surface water, wells, and other features is when doing the site and soil evaluations. Figure IV-2 depicts an example of site plan showing two adjacent lots with septic tanks, absorption fields, and wells. Separation distances that must be met for the wastewater systems on each lot are shown.

Figure IV-2. Site Plans for Adjacent Lots Showing Onsite Wastewater System Separation Distances



"V" -50' minimum
"W" -10' minimum
"X" -50' minimum

"Y" -Public Well =100' minimum
-Private Well = 50' minimum

"Z" - 20' minimum

In order to meet these separation distances, a lot size of 2 acres is needed.

Table IV-7. Minimum Required and Minimum Recommended Separation Distances for Onsite Wastewater Systems

Separation Distances	Minimum Distance (ft.) Required	Minimum Distance (ft.) Recommended[1]
Septic Tank to foundation of house or other buildings	10	10
Soil Absorption System to dwelling foundation	20	50
Any part of a wastewater system		
to: public potable water line	25[2]	25
private potable water line	10	25
property line	10	50
public water supply well or suction line	100[3]	200
private water supply well or suction line	50[3]	100
surface water course	50	100
Wastewater Lagoons		
to: property line	50[4]	200
dwelling foundation	50[4]	200

[1] *These recommended separation distances reduce the risk of future problems, but they are not a guarantee that problems will not result.*
[2] *The minimum distance specified by KDHE guidelines for public water supplies.*
[3] *The minimum distance required by K.A.R. 28-30-8(a).*
[4] *When lot dimension, topography, or soil condition make maintaining the required 50 feet separation distance impossible, a written variance from the affected property owners shall be obtained from the owner and filed with deed for the property.*

DETERMINING THE ABSORPTION FIELD AREA

Only the bottom area of the trench is considered in determining the needed absorption area. The absorption trench width should be 18 to 36 inches, preferably 24 inches. The design flow and loading rate based on the soil evaluation (or perc) are used to calculate the required absorption area (see following example). The total lateral length is determined by dividing the required absorption area by the lateral width. A 1,500 square foot absorption area and three foot wide lateral, as in the example, require 500 feet of lateral. Using a lateral 100 foot long and 3 foot wide, 5 laterals are needed for the 1,500 ft^2 area required. If trenches are two feet wide, then the total lateral length is 750 feet. This is met by either 10 laterals each 75 feet long or 5 laterals each 150 feet long are needed. Other lateral length options could also be used.

An area equal in size to the absorption field used should be reserved for the future expansion and/or replacement of the field. If this area reserved for future use does not have soil properties equally as good as properties on the initial field site used, expansion options may be limited, and any needed absorption system replacement may require an alternative system.

EXAMPLE LOADING RATE CALCULATIONS

This example illustrates how to select a suitable loading rate and how to use the loading rate to size the system with the following wastewater and site characteristics:

- four-bedroom home
- septic tank effluent
- Harney silt loam soil series.
- Light silty clay loam with medium, subangular blocky structure at 17 to 40 inches
- greater than 6 feet to restrictions of rock or perched water table
- perc rate 40 minutes per inch
- trench width 3 feet
- undisturbed soil width between trenches is 6 feet

Wastewater Flow. Size of house (number of bedrooms) × flow rate (gpd) per bedroom = total daily wastewater production. For this example the numbers are

4 bedrooms × 150 gpd/bedroom = 600 gpd

Design Loading rate. From the soil evaluation, Table IV-4 recommends a loading rate of 0.4 gpd/ft^2 and from the perc test using Table IV-6 the loading rate is 0.5 gpd/ft^2.

Use the smaller of these, or 0.4 gpd/ft^2 for the design loading rate.

Note: No loading rate adjustment is used in this example but depending on location an adjustment based on Table IV-5 could be made.

Absorption Area. Wastewater flow divided by the design loading rate equals absorption area or

$$\frac{600 \text{ gpd}}{0.4 \text{ gpd/ft}^2} = \frac{600 \text{ ft}^2}{0.4} = 1{,}500 \text{ ft}^2$$

Trench Length. Absorption area (ft^2) ÷ trench width (ft) = length of lateral trench or

$$\frac{1{,}500 \text{ ft}^2}{3 \text{ feet}} = 500 \text{ feet of lateral trench length}$$

Total Absorption Field Area. To find the total area for the absorption field, include the undisturbed soil medians between trenches (recommended minimum six feet) plus half of the undisturbed median on each side of the absorption area. For this example the total width includes the 5 laterals, 4 medians between laterals, plus half of a median width on each side of the field or

Width = (5 × 3 ft) + (4 × 6 ft) + (2 × 3 ft) = 15 ft + 24 ft + 6 ft = 45 feet.

The total field area is the total width times the lateral length or

45 ft × 100 ft = 4,500 ft^2

REFERENCES AND READING MATERIALS

USEPA *Onsite Wastewater Treatment Systems Manual*, 2002

KDHE *Minimum Standards for Design and Construction of Onsite Wastewater Systems*, Bulletin 4-2, November 1997; K-State Research and Extension MF-2214.

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Kinds and Types of Levels, LR-17, Cooperative Extension Service, Kansas State University.

Operating Checking and Caring for Levels, LR-10, Cooperative Extension Service, Kansas State University.

On-Site Domestic Sewage Disposal Handbook, MWPS-24, Midwest Plan Service, Iowa State University, Ames, Iowa.

Using a Level, AF-19, Cooperative Extension Service, Kansas State University.

PROTOCOL
SITE EVALUATION FOR ONSITE WASTEWATER SYSTEMS

GOAL:
Ensure selection of the best onsite wastewater system suited to the site and designed and constructed to prevent contamination of the waters of the state.

POLICY:
Site evaluation of a new onsite wastewater system will be completed at the request of the landowner, contractor, lending agency or other interested party. The evaluation should address the points listed below. A letter summarizing the evaluation report should be provided to all individuals who have legal interest in the evaluation result. When the site has restrictions, the letter shall document reasons and offer reasonable alternatives, if possible. A file of all letters, data, supporting information, and documents shall be maintained.

EVALUATION:

1) The landowner shall complete an application requesting a site evaluation and a permit to construct a wastewater system. This should also include permission for the agency to enter the property as needed to conduct the evaluation .

2) A site visit shall be made by the inspector to examine the proposed location of the system. Available information about existing site conditions should be obtained from county soil survey and other sources before making this visit. The landowner should be present, if possible, as well as other interested parties.

3) The proposed site shall be evaluated for conditions which could limit the onsite wastewater system. Such conditions include, but are not restricted to, wells, property lines, easements, utilities, topography, soil conditions, depth to rock, and depth to ground water.

4) The proposed wastewater system location shall be marked with flags.

5) The systematic soil profile evaluation is highly recommended over perc tests and such evaluation should be conducted and recorded by a qualified person.

   a) The pits to examine the profile shall be within the flagged area. If the site slopes and has a difference in soils, two or more pits may be necessary.

   b) The soil profile examination will verify the soil series and the texture of each horizon.

   c) Soil texture shall be used to determine soil class.

   d) Loading rate (see Table IV-4) will be determined for the most restrictive horizon texture, structure and consistence.

   e) Loading rate and wastewater flow, based on number of bedrooms, will determine the size of soil absorption system.

6) When soil evaluation is not available and not possible, perc tests may be used to determine design loading rate and system area requirements. Refer to Protocol Three.

   a) Perc tests shall be conducted within the flagged area.

   b) Results of such tests shall be utilized to determine the design loading rate (see Table IV-6).

7) If the soils on the site are found to be favorable, the system shall be sized according to currently approved standards.

8) The owner and contractor shall be provided with all the necessary requirements, instructions, and diagrams for construction.

9) A permit to construct shall be provided to the landowner. The permit shall contain the following information:

   a) Time limit for construction. (The landowner must be instructed that delays which will prevent completion by the agreed upon time will require the owner to contact the inspector for an extension.)

   b) It is the owner's responsibility to contact the inspector for an inspection of the system **before** the tank or absorption field is covered or the lagoon is in use or fenced.

10) The inspector shall inspect the construction before the system is covered with soil, to assure compliance with construction requirements. If construction is acceptable, permission shall be given to cover the system. A permit to operate shall be issued at that time.

11) The permit to operate shall state that the regulating agency has the right to inspect the onsite wastewater system at any time deemed necessary to determine compliance with county code.

PROTOCOL
SOIL PROFILE EVALUATION: TEXTURE, STRUCTURE, AND CONSISTENCE

SOIL TEXTURE

Texture is the proportional amount of sand, silt, and clay in a soil. Each horizon may have a texture different from any other. Texture, in combination with soil structure, affects moisture-holding capacity, permeability, capacity to hold and furnish nutrients, tillage operations, bearing capacity, and erosion. The textures of both surface and subsoil layers should be determined. Texture of the underlying material is also important, especially for onsite wastewater systems, and building foundations.

The sand, silt, and clay particles of a soil are defined on the basis of their size. See the size relationship in Figure 1. Sand grains are large enough to be seen – 0.05 to 2.0 mm (0.002 to 0.08 inch) average diameter. They impart a gritty feeling to the soil. Silt particles are 0.002 to 0.05 mm (0.00008 to 0.002 inch) average diameter.

Silty soils feel powdery (like flour) and do not hold together well when wet, though they are more cohesive than sandy soils. Clay particles are the smallest, less than 0.002 (0.00008 inch) across and usually flat. Clay particles are small enough to make the soil sticky when wet or hard when dry. The size ratio of these particles is about 1000:25:1. Gravel is larger than 2.0 mm diameter (0.8 inch). Loam is a mixture of sand, silt, and clay with a minimum and maximum content of each size particle.

The textural triangle shown in Figure 2 indicates the percent sand, silt, and clay for a soil. The terms sand, silt, clay, and loam are used in various combinations to name 12 soil textural classes shown in the figure. For example, one of the classes is loamy sand and another is silty clay. A simpler classification containing five textural groups will be presented here. These five groups are called *coarse, moderately coarse*, *medium moderately fine, and fine.*

Figure 1. Relative Sizes of Sand, Silt, and Clay Particles

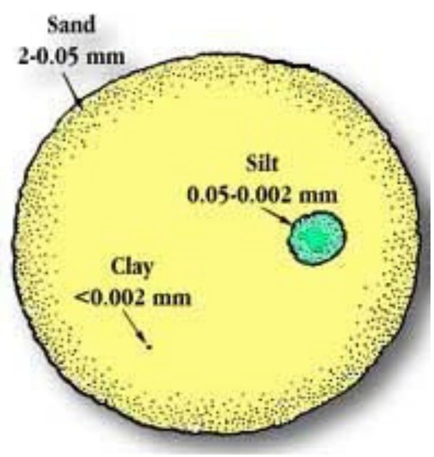
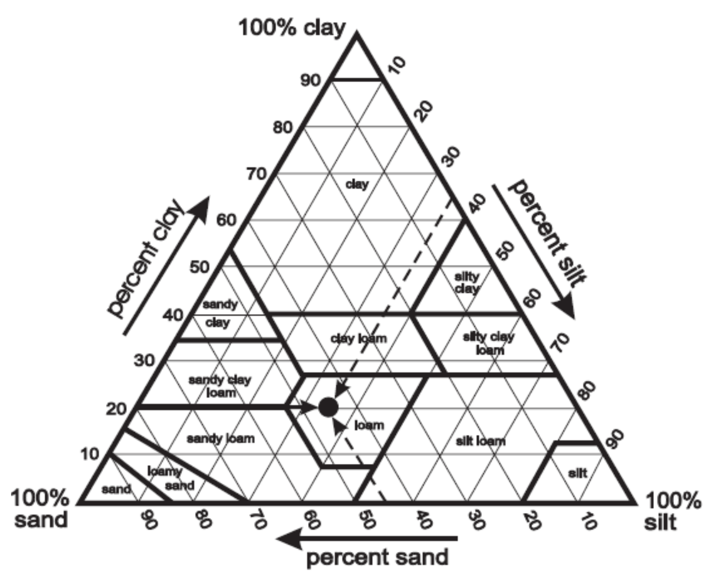


Figure 2. USDA Soil Textural Triangle



Soil texture can be determined by a laboratory procedure or in the field. The field method requires feeling the soil with the fingers. This skill can be developed and perfected with practice. Sanitarians should practice with samples of known texture. A brief description of each of the five textural groups follows:

Coarse-textured soils are loose, friable, and individual grains can be readily seen or felt. When squeezed between thumb and forefinger, the soil feels gritty. If squeezed when dry, it falls apart as pressure is released. If squeezed using moist soil, it is possible to form a mold but it is unstable and crumbles easily as the soil is handled.

Moderately coarse-textured soils are gritty but contain enough silt and clay to make moist soil hold together. The individual sand grains can readily be seen and felt. If squeezed when dry, it forms a mold that breaks readily upon handling. If squeezed when moist, it will form a mold that can be carefully handled without breaking.

Medium-textured soils have a slightly gritty, smooth, or velvety feel when moist. If squeezed when dry, the soil forms a mold that will bear careful handling. The mold formed by squeezing when moist can be handled freely, without breaking. When the moistened soil is squeezed out between thumb and forefinger it makes only a weak ribbon, less than an inch long.

Moderately fine-textured soils usually break into clods or lumps when dry. When the moist soil is squeezed out between thumb and forefinger; it forms a short ribbon, 1 to 2 inches long, that tends to break or bend downward. The soil also may have a slightly gritty or velvety feel when moist.

Fine-textured soils form hard lumps or clods when dry and are plastic and sticky when wet. When the moist soil is squeezed out between thumb and forefinger, it forms a long ribbon, greater than 2 inches, that will support itself. It may also have a slightly gritty or velvety feel when moist.

SOIL STRUCTURE

Soil structure is important in its effect on permeability and land use. Soil structure is individual grains of sand, silt, and clay bound together in larger units called peds. Plant roots, soil, organic matter, and clay particles provide physical and chemical binding agents.

Soil structure is important because it modifies some of the undesirable effects of texture on soil behavior. Structure creates relatively large pores which favor water passage in and through the soil. Moderate and strong soil structure that is small to medium in size means good aeration and favorable balance between pores that transmit air and pores that contain water. Soils with good structure are easy to work and provide an ideal environment for plant root growth.

The shape and arrangement of soil particles into clusters or aggregates determine the type of structure.

Granular structure is of spherical particles, 1 to 10 mm in diameter. The structure is most common in the surface soil, where plant roots, microorganisms, and sticky products of organic matter decomposition bind soil grains into granular aggregates.

Platy structure can occur as a tillage pan or at the bottom of the tillage layer. Platy structure is made of flat pads that lie horizontally in the soil. Most platy structures are less than 3/4 inch thick.

Blocky structures are roughly cube shaped, with more or less flat surfaces. There are two types of blocky structure, angular blocky and subangular blocky. Angular blocky structures have sharp edges and corners. In subangular blocky structure, the edges are rounded. Blocky structures range from ¼ inch to 2 inches across. Blocky structures are typical of the subsoil layer, or B horizon.

Prismatic structures are larger, vertically elongated blocks. Sizes are commonly $^{3}/_{8}$ inch to 4 inches across.

Massive structures are compact, coherent soil, not separated into pads. Massive structures can be found in very slowly permeable soils with high clay.

Single grain structure occurs in some sandy soils where every grain acts independently and there is no binding agent to hold the particles together. You can observe this structural type by carefully observing the soil and gently breaking it apart. It is best to observe soil structure in the undisturbed soil profile. The first step is to fill your hand with a large lump of soil and then gently apply pressure to break the soil apart. The shapes of the pads you broke out of the soil indicate the structural type.

SOIL CONSISTENCE

Consistence describes a soil particles cohesion and adhesion or resistance to deformation or rupture. It is used in soil evaluation for onsite wastewater treatment systems to describe the strength of the soil structural particles. Consistence is highly dependent on the soil-water state (moisture) and the description has little meaning unless the moisture state at the time is specified or is implied by the test. Unless specified otherwise the soil-water state is assumed to be that indicated for the horizon or layer when described.

In the laboratory, procedures and devices have been developed to apply pressures in increments to standardized blocks of soil. Using laboratory procedures results are reasonably reproducible within the range of normal soil variability. Obtaining reproducible measurements of resistance of a soil in the field is difficult and requires considerable practice. A common method has involved using standardized block-like specimens of about 25-30 mm (1 inch) on a side. When blocks of this size cannot readily be obtained smaller sizes can be tested, however, the force withstood may be assumed to decrease as the size of the block is decreased. A block of 10 mm should take a force of only a third of that for a 30 mm block to produce rupture. The block is placed between the thumb and forefinger and pressure is slowly applied gently at first and then greater pressure until the block ruptures.

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PROTOCOL
CONDUCTING A PERC TEST

PURPOSE:
To obtain information regarding the rate that water moves into fully wet soil.

1) To assess suitability of soil on a specific site to adequately accept septic tank effluent.

2) To select from among alternative onsite wastewater systems and determine a design loading rate.

Note: A soil profile evaluation is required to reveal subsurface restrictive soil and/or rock layers.

BRIEF DESCRIPTION:
Four to six holes are placed throughout the proposed site of the absorption field and soaked with water until the clay is swelled (usually for at least 24 hours). The perc rate is then measured in each hole and reported as the number of minutes it takes for an inch of water to be absorbed by the soil surrounding the hole. To ensure maximum benefits, all available information should be utilized, including history of high water tables and description of soil profiles from county soil surveys. The optimum time to conduct a perc test is in the spring when soil is usually wet.

PROCEDURE:

1) **Select Proposed Site of Lateral Field** - Site preferably should be located downslope from the septic tank. If effluent will not flow by gravity, an effluent pump may be used to move effluent from the septic tank to the absorption field. For new home sites, the area reserved for future use should also be checked for suitability.

2) **Number and Location of Tests** - Four to six holes are placed uniformly over the proposed absorption field site. If the site is sloping, it is especially important to have test holes at all elevations to be used so that the different soils are evaluated.

3) **Type of Test Hole** - Dig or bore the hole to the depth of the proposed trench (usually 18 to 30 inches) and with a diameter of about eight inches. All test holes must be the same dimension to provide consistency in results. Scratch the sides of the hole to eliminate sealed soil surfaces and remove loose material from the hole. Place two inches of washed gravel in the bottom of the hole. The gravel can be contained in a mesh bag for easy removal and reuse at other sites. This gravel protects the bottom of the hole from scouring and sediment when water is introduced.

4) **Allow Time for Soil Saturation and Swelling** - Saturation means that the voids between the soil particles are filled with water. This can happen in a short time for soil in contact with water. Swelling is caused by intrusion of water into the clay particles and can take many hours, or even days, when the soil is quite dry.

    a) Carefully add 12 to 14 inches of water. Using a hose will prevent soil washing down from the sides of the hole.

b) Maintain the water level for at least 24 hours to allow for swelling to occur. In most cases it will be necessary to add water periodically from a reservoir. A float supplied by a hose from a reservoir simplifies the procedure.

c) If the soil appears to be sandy or lacking soil moisture, plan to check the condition of the perc test after 12 hours or overnight. If there is no water left in the hole and the reservoir is dry, refill the reservoir and holes. After the full 24 hours have passed since soaking was initiated, begin measuring as described in below in the Perc Test Measurement Section.

MATERIALS NEEDED TO CONDUCT THE PERC TEST

1) Metal measuring device (yard stick)

2) Four to six batter boards - 1" x 2" boards of 18" length.

3) Number each board so that each test hole will be distinguishable.

4) Mark a center line on each batter board. This will provide a consistent reference point to place the measuring device.

5) Plan of the site, proposed absorption area and location of test area. Dimensions will ensure the test holes are properly located.

6) Supply of water; may have to be transported to the site. 200-300 gallons is usually adequate.

PERC TEST MEASUREMENT

1) Remove the apparatus used to add water to the hole.

2) Place the batter board across the top of each hole and secure with weights, spikes, or attach to stakes. Be sure that the centerline mark is centered over the hole.

3) Align the measuring device with the marks and lower until it just touches the water surface. Record the measurement.

4) Measure at 30-minute intervals until two consistent measurements are recorded. If the water level in the hole drops too rapidly, it will be necessary to reduce the time interval for measurement. The time interval should be short enough that the water level should not fluctuate more than 25 % of the wetted hole depth. For rapid perc rates, the hole must be refilled between each set of measurements. If the holes have been properly soaked for the full 24 hours, consistent measurements are usually found after the first few readings.

Note: If the water drops more than two or three inches in 30 minutes, it will be necessary to add water to the hole after each reading until it is the same depth as recorded initially.

COMPARE PERC WITH PERMEABILITY IN THE NRCS SOIL SURVEY.
The perc should be no greater than about 3 times the permeability rate shown in the table of physical and chemical properties of soils in the soil survey report. If it is higher than this, suspect a problem with the perc test. A well aggregated, undisturbed soil may have a good perc rate.

CALCULATION OF RESULTS

1) Convert fractions to decimals (1 $^{3}/_{16}$" = 1.19")
2) Perc rate is obtained by dividing the number of minutes between readings by the number of inches the water dropped.
3) *EXAMPLE: 30 minutes ÷ 1.19 inches = 25minutes/inch*
4) This test is concluded when three consecutive measurements vary by no more than 10 percent between the high and low value. Average these three numbers.
5) Determine the average perc rate for the site by adding the results of the average from each hole and dividing by the number of holes.

Note: If one reading is much faster or slower than the others, determine if soil is consistent. When there is no apparent explanation such as compaction, cracks in the soil, etc. disregard the different reading and average only the remaining readings.

CHECK LOADING RATE
The design loading rate from the perc test should be checked with the loading rate based on soil texture in Table IV-4.

Note: The size of the absorption field must be designed for the number of bedrooms, not the number of people currently living in the residence. Thus it is important to use the table of absorption area requirements for private residences because different size families may live in the same residence at different times. Refer to Table IV-6 for the minimum square footage of absorption area required based on perc results. In all cases, sufficient area should be provided for at least three bedrooms. The absorption area is figured as trench bottom area only. This table allows for the use of typical water appliances including garbage grinder, automatic washer and dishwasher. If other appliances, such as whirlpool, water softener, filter backwash, and A/C condensate are used and discharge to the septic system, a larger absorption area may be necessary.