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Residential Onsite Wastewater Treatment: Conducting a Soil Percolation Test

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This NebGuide discusses the importance of and recommended methods for conducting a soil percolation test.

Many Nebraskans rely on a private onsite wastewater treatment system, whether it is a traditional septic tank and drainfield, a lagoon, or another system specifically engineered for the site. Selecting the most appropriate system and properly sizing the selected system depends on site conditions and wastewater generation. Soil characteristics, especially the soil percolation rate, are important for evaluating the residential site's suitability for an onsite wastewater treatment system.

Soil Percolation Rates and Percolation Tests

The soil percolation rate indicates how quickly water moves through soil and helps evaluate the ability of the soil to absorb and treat effluent — wastewater that has received preliminary treatment in a septic tank. The percolation rate is measured in minutes per inch (mpi). Soils with slower percolation rates, through which it takes longer for water to travel, need larger drainfields to handle a given amount of wastewater than those with faster percolation rates. Soils with very slow percolation rates may be unsuitable for drainfields. In Nebraska, when soil percolation rates are slower than 60 mpi, consider installing a lagoon system if the lot is at least three acres. Otherwise, an engineer must design a specialized system.

The percolation rate is determined by conducting a percolation (perc) test. The percolation test measures the amount of time it takes for water in a test hole to drop 1 inch. The Nebraska Department of Environmental Quality (NDEQ) *Title 124, Rules and Regulations for the Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems* requires that a percolation test be conducted to help determine the type and size of an onsite wastewater treatment system. *Title 124* specifies that only a certified inspector, installer, soil evaluator, Nebraska registered environmental health specialist, or Nebraska licensed professional engineer may conduct a percolation test. Some counties have specific lists of those who may conduct percolation tests. Contact your local health or planning department for requirements in your area. It is a good idea to have a knowledgeable professional conduct the test.

Digger's Hotline (811 or *http://www.ne-diggers.com*) must be contacted at least two business days prior to excavation. It will contact local utilities to mark registered electrical, gas, phone, fiber optics, cable, and public water supply lines on the property.

How to Conduct a Soil Percolation Test

The following directions are based on NDEQ *Title 124*. Local requirements may be more stringent, so contact your local health or planning department for requirements in your area; specifics for conducting a percolation test may vary from those given below.

1. **Dig holes.** Using a 4- to 8-inch hand auger, posthole digger, or shovel, dig at least three (preferably four) holes spaced evenly where the drainfield is planned. If the soil type varies considerably, dig at least four (preferably six) holes, with two to three test holes per lateral or trench. Holes should be between 4 and 12 inches in diameter, and as deep as the proposed trench. A good average depth is 24 to 30 inches. Do not conduct percolation tests on disturbed soil or frozen ground.
2. **Roughen sidewalls and bottom.** Because tools may have smoothed, compacted, or sealed the sides and bottom of the hole during digging, roughen or scratch the sides and bottom of the hole with a knife, or nails driven into a board. Remove all loose material and place about 2 inches of 1/4- to 3/4-inch clean gravel in the hole to prevent bottom scouring *(Figure 1)*.

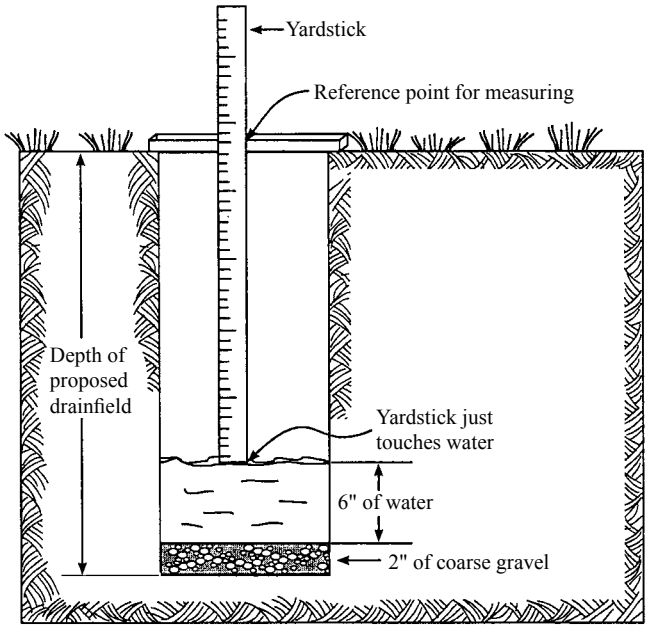

Figure 1. Percolation test hole.

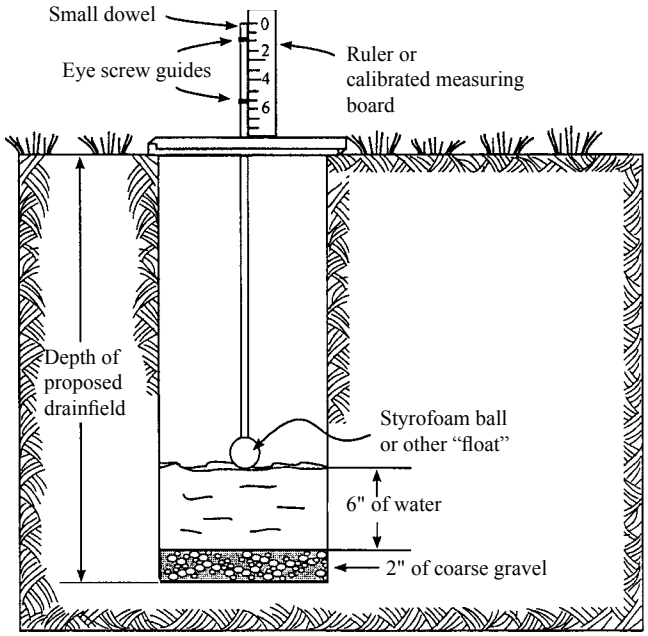

Figure 2. Alternative device.

3. **Presoak soil.** Carefully fill the hole with clear water to a point at least 12 inches above the gravel, being careful to avoid washing soil into the hole. Continue to add water until the soil becomes saturated. For most percolation tests, maintain a 12-inch water depth in the hole for at least four hours, and preferably overnight, before measuring the percolation rate. In clay soils, keep the hole filled at least 12 hours to allow the soil to swell. Soils with moderately slow permeability and/or containing more than 30 percent clay in the testing zone will require several days of saturation when the soil is dry in order to get an accurate reading. In sandy soils, soaking is unnecessary; if, after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, proceed with the test immediately (see Step 4c).

4. **Measure soil percolation rate.** Measure the percolation rate the day after the saturation process, except in sandy soils as previously discussed. Record the readings on paper and store with the onsite system records. As shown in *Figure 1*, the general measurement strategy is to place a board horizontally across the hole and anchor it firmly in position. Add or remove water as needed to maintain a depth of 6 inches over the gravel. One way to measure the depth is to slide a yardstick or pointed stick straight down until it just touches the water surface. Immediately record the time and depth (or draw a horizontal line on the measuring stick), using the horizontal board as a guide and reference point. Alternative measuring devices can be constructed as illustrated in *Figures 2* and *3*.

a. **If water remains in the test hole after overnight saturation,** add water to a depth to 6 inches over the gravel. Measure the drop in water level during an approximate 30-minute period.

b. **If no water remains in the hole after overnight saturation,** add clear water to a depth of 6 inches over the gravel. Measure the drop in water level at 30-minute intervals over a four-hour period, refilling the hole to a depth of 6 inches as necessary after each 30-minute period. Calculate the percolation rate based on the drop that occurs during the last 30-minute period.

c. **In sandy soils or other soils where the first 6 inches of water seep away in less than 30 minutes, even after the overnight swelling period,** use a 10-minute interval between measurements, refilling the hole to a depth of 6 inches as necessary after each interval. Make six test measurements at 10-minute intervals. Calculate the percolation rate based on the drop that occurs during the last 10-minute period.

5. **Calculate percolation rate.** The percolation rate is the average time in minutes required for water to fall 1 inch. Record the percolation test data from each hole. Divide the number of minutes elapsed by the drop in inches, using the last 30- or 10-minute reading taken for each hole.

   For example, the percolation rate for a hole where the water level drops 2 inches in 30 minutes is:

$$\frac{30 \text{ minutes}}{2 \text{ inches}} = 15 \text{ minutes per inch (mpi)}$$

6. **Calculate field percolation rate.** Determine the percolation rate for the entire field by averaging the last percolation rates of all test holes. However, if percolation test results for individual holes vary more than 20 mpi, there is considerable variation in the soil type. Under

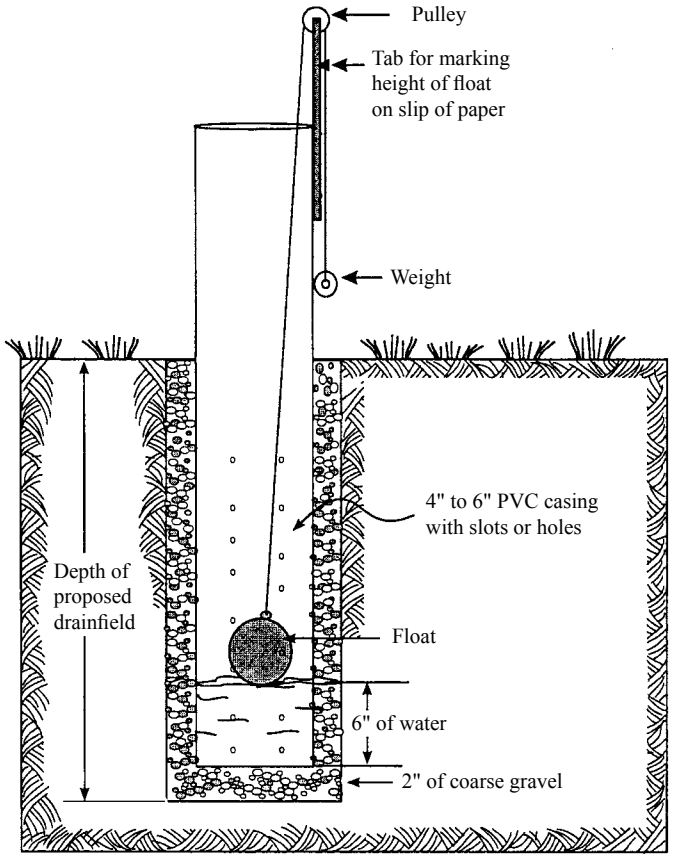

Figure 3. Alternative device.

these circumstances, **do not** calculate an average for the entire field. Instead, design the system based on the slowest rate, or consider using a different location with less soil variation.

Example: The following percolation rates were calculated from data collected at a site:

Hole #	Last Test
1	14.9 mpi
2	20.4 mpi
3	20.9 mpi
4	18.7 mpi

To determine the percolation rate for the site, add the individual percolation rates for the last test and divide by the number of test holes. Although only three test holes are required, the person conducting the test chose to use four holes to get a better idea of soil permeability at the site.

$$\frac{14.9 \text{ mpi} + 20.4 \text{ mpi} + 20.9 \text{ mpi} + 18.7 \text{ mpi}}{4 \text{ holes}}$$

$$= \frac{74.9 \text{ mpi}}{4 \text{ holes}}$$

$$= 18.7 \text{ mpi}$$

7. **Determine site suitability.** If the percolation rate for the site is faster than five mpi, the soil is unsuitable for a drainfield system. Wastewater would travel too quickly through the soil to be treated properly. This could result in groundwater contamination, especially if the water table is shallow. When the percolation rate is faster than five mpi, dig the trench 1 foot deeper than the proposed trench depth. Using loamy sand soil with a percolation rate of 15 to 20 mpi, install a 1-foot thick soil liner in the bottom of the trench to improve soil characteristics. Base the trench size on the soil liner's percolation rate.

   Likewise, if the percolation rate for the site is slower than 60 mpi, it is unsuitable for a traditional soil absorption system. This soil has a high clay content, resulting in slow permeability. Clay generally swells when wet, reducing permeability even more. Wastewater would travel too slowly through the soil and could pond on or near the ground surface, or back up into the house. These situations could result in system failure, causing odor and the spread of disease.

In some cases, a soil-based effluent treatment system can be installed if the percolation rate is outside the range defined above. However, it must be designed by a professional engineer and meet NDEQ approval. Likewise, NDEQ must review plans for any alternative onsite wastewater system, such as a mound system or constructed wetland, that is proposed to accommodate unsuitable soil conditions. A professional engineer must design alternative systems and an NDEQ construction permit must be obtained.

Title 124 also requires each site to be evaluated for soil properties and conditions, and to determine if there are any barrier layers such as bedrock or seasonal groundwater within 4 feet of the bottom of the proposed trenches. This requires using information from the U.S. Department of Agriculture and the Natural Resources Conservation Services (NRCS) soil maps and soil interpretation records; a soil boring or test pit dug to a depth of at least 4 feet below the proposed trench bottom; or measured water levels from nearby test holes, observation wells, or water wells.

8. **Keep soil percolation test data on the premises.** If a construction permit is required, the percolation test results must be submitted to NDEQ along with the permit application, alternative system plans, specifications, soil evaluation, and soil boring information. When the system is registered, keep a copy of the registration form with soil percolation data.

Summary

Soil varies from one location to another, even within short distances. Therefore, before selecting a site for an on-site wastewater treatment system, measure soil permeability using a soil percolation test performed by a certified onsite professional, registered environmental health specialist, or professional engineer. The percolation rate is used to select the most appropriate system, and to determine the proper size for the system.

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This publication has been peer reviewed.

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