How to Run a Percolation Test

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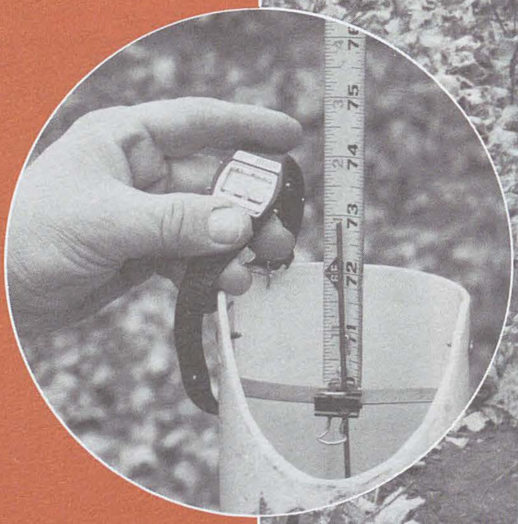

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Successful design of an on-site sewage treatment system depends on an adequate site evaluation. The percolation test is only one small part of a complete site evaluation. Refer to *Locating On-Site Home Sewage Treatment Systems*, CD-FO-0797, for the complete site evaluation procedure.

Suitable soil is the key to providing adequate on-site sewage treatment. Soil which is too coarse will not do a good job of removing nutrients and bacteria. Loam or clay loam soil will do an excellent job of nutrient and bacteria removal but will require a relatively large soil treatment area. Seasonal saturation of a soil will cause sewage to back up if the trenches are constructed too deep.

1. Use soil borings to locate a suitable area.

Soil borings should be at least 3 inches in diameter and at least 3 feet deeper than the bottom of the proposed soil treatment system. A boring may stop as soon as evidence of seasonal soil saturation or bedrock is encountered. Number the soil boring holes and locate them on a scale map of the site.

Evaluate the soil texture (sand, loamy sand, sandy loam, loam, silt loam, clay loam, etc.) for every foot of depth or at least where a change in soil texture occurs (see figure 2). Record this data on a log sheet of the boring hole. If you encounter seasonally saturated soil or an impervious layer (rock or clay) at a depth of 3 feet or closer to the ground surface, the area is not suitable for a subsurface soil treatment unit. A sewage treatment mound, however, could be installed at such a location if other factors such as slope were suitable. If saturated soil or a restricting layer is encountered between 3 and 4.5 feet, you can add fill over the entire site to bring the final ground surface elevation to at least 4.5 feet above the restricting layer.

Figure 2. A hand-operated bucket auger collects a relatively undisturbed sample, allowing proper evaluation of soil texture and observance of possible mottling.

Seasonal saturation of soil is indicated by a gray background color together with red streaks or splotches and is called mottling. The bottom of the drainfield trench should be located no closer than 3 feet from the mottled soil. Even though the hole may be dry when you make the soil boring, the soil will be saturated during wet conditions and during the operation of the sewage treatment system. The system will fail in clay soil or inadequately treat sewage in coarse soil.

The lawn area required for the soil treatment unit depends on the percolation rate of the soil and the amount of sewage discharged by the proposed or exisiting residence. Table 1 estimates the required lawn area according to soil texture for a three-bedroom home discharging 450 gallons of sewage per day and using 3-foot wide trenches spaced 10 feet on centers. Refer to your local sanitary code for required setbacks from buildings, property lines, water supply wells, etc. Take at least four soil borings in each soil texture in order to locate lawn area of adequate size. It is an excellent idea to locate an area twice as large as those specified in table 1 so that room for future expansion of the soil treatment unit will be available.

Table 1. Lawn area in square feet required for a drainfield trench system

Soil texture	Estimated percolation rate, minutes per inch	Area required for a three-bedroom home (square feet*)	Add for each additional bedroom (square feet)
Fine to medium sand	0.1 to 5	1,245	415
Fine sand and silt	6 to 15	1,905	635
Silty sand, little clay	16 to 30	2,505	835
Silty sand, some clay	31 to 45	3,000	1,000
Considerable clay	46 to 60	3,300	1,100

*Based on 150 gallons of sewage per day per bedroom and 3-foot-wide trenches spaced 10 feet center to center.

2. Make an adequate number of percolation test holes.

If the soil texture is uniform over the selected site, use at least two and preferably three percolation test holes. If the soil texture changes within the site, make at least two percolation test holes in each soil texture. Space the percolation test holes uniformly over the area proposed for the soil treatment unit.

3. Dig test holes.

The test holes should be round and at least 6 inches, but no larger than 8 inches, in diameter. Dig each test hole as deep as you intend to excavate the soil treatment trench. The bottom of the percolation test hole must be at least 3 feet above the level of seasonally saturated soil or an impervious layer. A clam shell-type post hole digger can be used (see figure 3). If you use a 6-inch auger, it is a good idea to drill a pilot hole with the 3-inch auger. Observe and record the soil texture as the percolation test hole is being dug.

4. Prepare the percolation test holes.

The auger or post hole digger is likely to smear the soil along the sidewalls of the test hole. Therefore, the bottom 12 inches of

Cover: An adequate site evaluation is essential to the successful design of an on-site sewage treatment system. The percometer shown is a convenient device for measuring the percolation rate. Inset: A stop watch measures the drop in water level.

the sidewalls and the bottom of the hole should be scratched or scarified with a sharp, pointed instrument such as a knife. Nails driven into a 1 × 2-inch board as shown in figure 4 will do a good job of scarifying the hole to provide an open, natural soil into which water may percolate. Remove all loose soil material from the bottom of the test hole. Add 2 inches of one-fourth to three-fourths inch gravel to protect the bottom from scouring when water is added. The gravel can be contained in a nylon mesh bag as shown in figure 5 in order to be removed after the test is performed and used for additional percolation tests.

5. Distinguish between soil saturation and soil swelling.

Saturation means that the voids between soil particles are full of water. This can happen in a short time.

Swelling is caused by intrusion of water into individual soil particles. This is a slow process, especially in clay soils, and is why a prolonged soaking period is necessary for some soils.

Carefully fill the percolation test hole with clear water to a depth of at least 12 inches above the soil bottom of the test hole. Use a hose to prevent the water from washing down the sides of the hole or add the water directly into the percometer as shown in figure 7. A 6-inch diameter hole requires about 1.5 gallons per foot of depth.

Sandy soils containing no clay do not swell. The percolation test may proceed immediately if the 12 inches of water seeps away in 10 minutes or less. The percolation test procedure for sandy soils is described under step 6C.

For prolonged soaking of the soil, keep the 12-inch depth of water in the hole for at least four hours, and preferably overnight. Add water as necessary. You may use an automatic

Figure 3. Either a post-hole auger or a clam shell digger can be used to dig the percolation test holes.

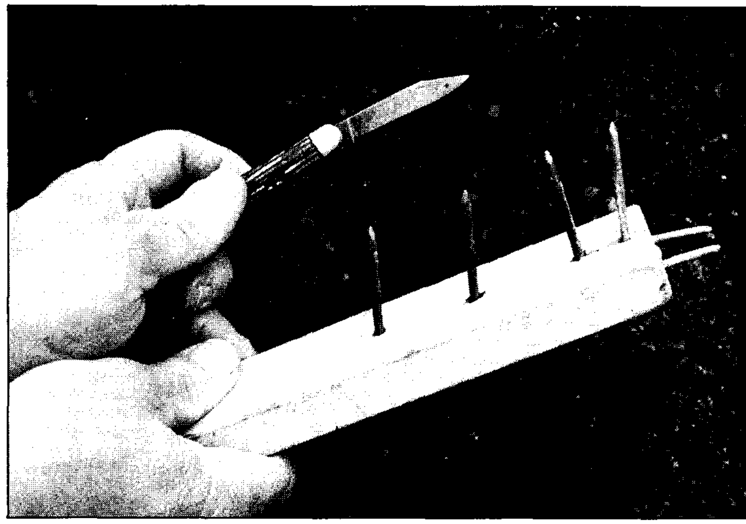
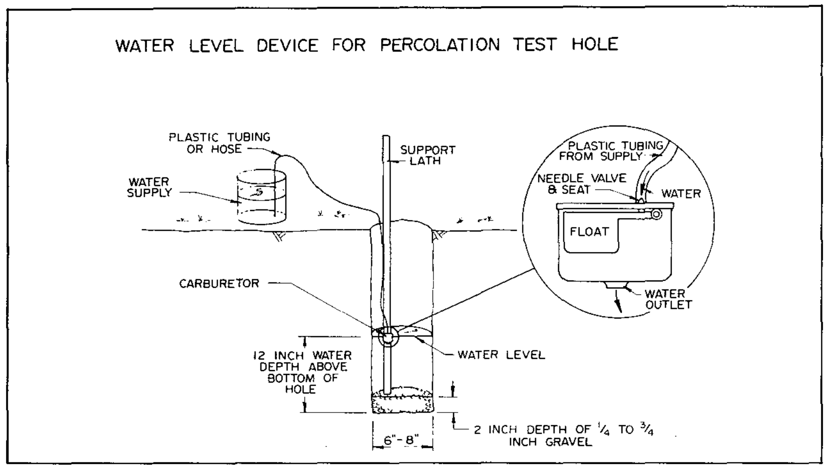


Figure 4. The percolation test hole can be scarified with a knife or nails driven into a 1" × 2" board.

Figure 5. If the gravel which protects the hole bottom from scouring is contained in a nylon mesh bag, it can be removed and reused.

Figure 6. Water level device for percolation test hole.



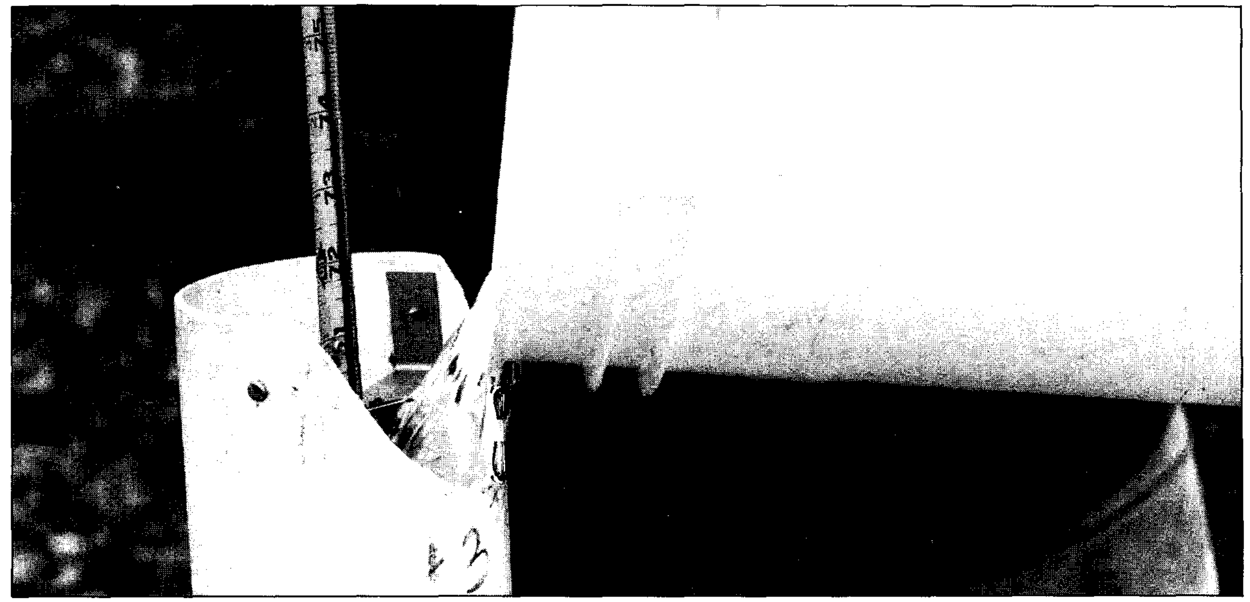


Figure 7. Cutting the top of the percometer tube at an angle allows for the convenient addition of water.

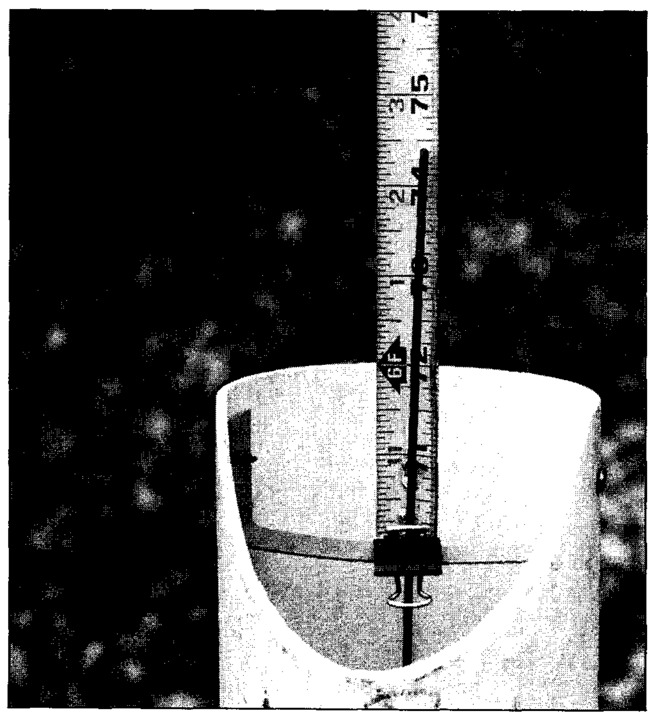
Figure 8. A small engine carburetor attached to a support controls the siphon and maintains a constant water level in the test hole.

siphon or valve to maintain the 12-inch water depth (figure 6). A valve made from the carburetor of a small engine is shown in figure 8.

6. Measure percolation rate.

Except for sandy soils, make the percolation rate measurements the day after completing step 5.

Figure 9. The liquid level in a percolation test hole can be observed directly at the top of the rod attached to the float. This is the most convenient way to observe the drop in water level.

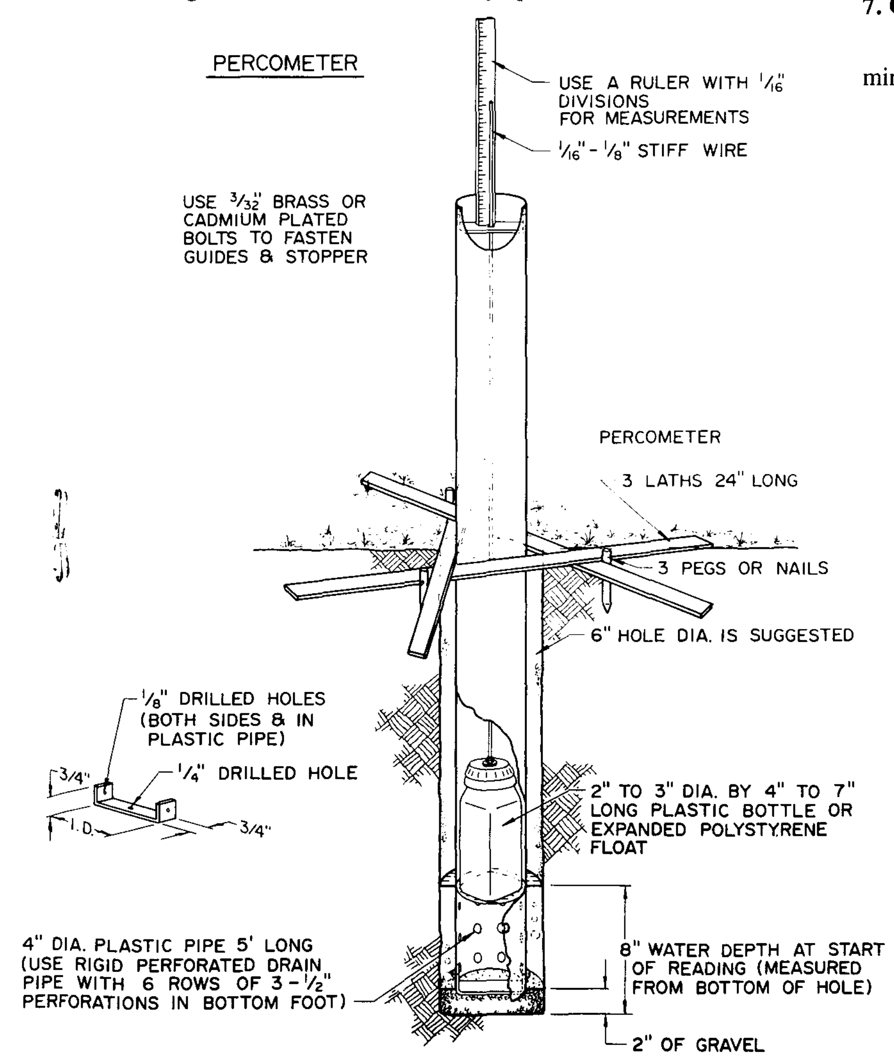


A. If there is more than 6 inches of water in the hole after the overnight swelling period, bail out enough water so that 6 inches of water remains above the gravel (8 inches if measured from the bottom of the hole). Measure the drop in the water level to the nearest ¹/₈ inch (preferably the nearest ¹/₁₆ inch) approximately every 30 minutes (figure 9). If possible, use a percometer to determine the change in water level (figure 10). A batter board can also be used as a reference point together with a hook gauge to accurately locate the water surface. The hook can be made from stiff wire or an 8d nail. After each measurement, refill the water in the hole so that the liquid depth is 6 inches above the gravel. Continue taking measurements until three consecutive percolation rates vary by a range of no more than 10 percent (see sample field notes, page 7).

B. If no water remains in the hole after the overnight swelling period, add 6 inches of clear water above the gravel. Measure the drop in the liquid level to the nearest ¹/₈ inch (preferably ¹/₁₆ inch) approximately every 30 minutes. After each measurement, refill the water to a depth of 6 inches above the gravel. Continue the water level drop measurements until three consecutive percolation rates vary by no more than 10 percent.

C. In sandy soils, or other soils in which the first 6 inches of water seep away in less than 30 minutes after the overnight swelling period, allow about 10 minutes between measurements. On some very sandy soils, use a stop watch and measure the time in seconds for the water level to drop from 6 to 5 inches (figure 11). Refill the percolation test hole after each measurement to bring the water to 6 inches above the gravel. Continue taking readings until three consecutive percolation rates vary by no more than 10 percent.

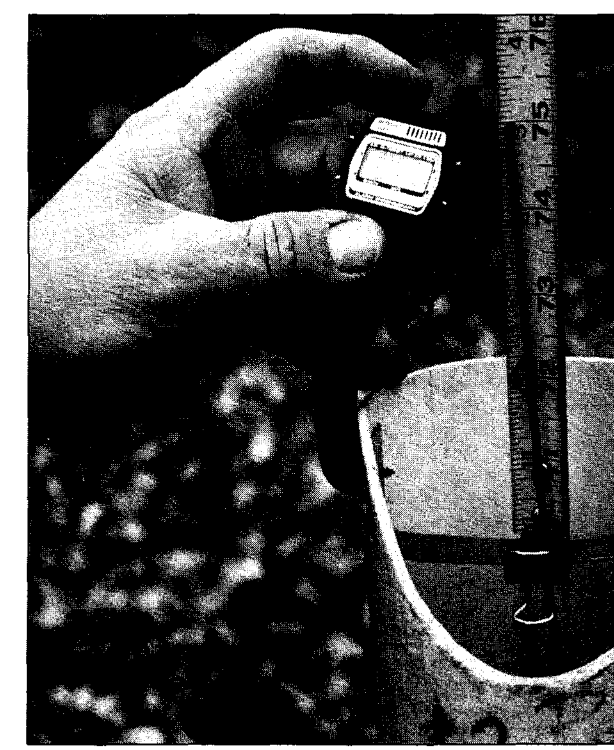
Figure 10. Construction and use of a percometer.



7. Calculate percolation rate.

Divide the time interval by the drop in water level to determine the percolation rate in minutes per inch (MPI).

Figure 11. The percolation rate is determined by measuring the rate of water drop over time. For sandy soils a stop watch can be used to measure the drop in water level from six to five inches.



Examples:

A. If the drop in water level is 5/8 inch in 30 minutes, the percolation rate is

$\frac{30}{5/8} = 30 \times \frac{8}{5} = 48$ MPI or $\frac{30}{5/8} = \frac{30}{0.625} = 48$ MPI

B. If the drop is 2 1/2 inches in 10 minutes, then the percolation rate is

$\frac{10}{2\ 1/2} = \frac{10}{5/2} = 10 \times \frac{2}{5} = 4$ MPI or $\frac{10}{2\ 1/2} = \frac{10}{2.5} = 4$ MPI

Calculate the percolation rate for each reading (see sample field notes). When three consecutive percolation rates vary by no more than 10 percent, use the average value of these three readings to determine the percolation rate for that test hole. Percolation rates determined for each test hole should be averaged in order to determine the design percolation rate. For reporting the percolation rate, worksheets showing all measurements and calculations should be submitted with the site evaluation report. You can reproduce the blank form in this folder for use in recording percolation test data.

Note that a percolation test should not be run where frost exists in the soil below the depth of the proposed sewage treatment system.

8. Determine the trench bottom area.

Table 2 shows sewage flows and soil treatment areas. The amount of trench bottom area required depends on the porosity of the soil as measured by the percolation rate, the daily sewage flow, and the depth of rock placed below the distribution pipe.

The daily amount of sewage wastes must be estimated in order to size the soil treatment unit. For residences, the daily amount of sewage flow is based on the number of bedrooms and the type of residence. A luxury, three-bedroom house likely will generate more sewage than a more modest house. Sewage flows for different types of houses can be estimated from table 2. Using a large sewage flow provides a factor of safety in sizing the soil treatment unit. Also consider future house expansion.

To illustrate the use of table 2, determine the amount of trench bottom area required for a three-bedroom, type I dwelling. The soil percolation rate, as measured by the percolation data presented on page 7, is 27.3 MPI. From table 2, a three-bedroom, type I dwelling is estimated to generate 450 gallons of sewage per day. The trench bottom area required for a percolation rate in the range of 16 to 30 is 1.67 square feet per gallon of waste per day.

Thus, the total required bottom area is 1.67 × 450 = 750 square feet for trenches with 6 inches of rock below the distribution pipe. If 12 inches of rock is used as recommended, the trench bottom area can be reduced by 20 percent (see footnote c, table 2). The required trench bottom area is then 0.80 × 750 = 600 square feet.

The trench bottom area can be reduced by 34 percent for 18 inches of rock below the distribution pipe and by 40 percent for the maximum rock depth of 24 inches. As rock depth increases, the required trench bottom area decreases, because more soil is exposed along the trench sidewall and a greater liquid depth increases the flow through the trench bottom.

The minimum trench width is 18 inches; the maximum width is 36 inches. Using 36-inch wide trenches on the above example, total trench length with 12 inches of rock below the distribution pipe is 200 lineal feet (600 ÷ 3). No single trench can be longer than 100 feet. Thus, the 200 lineal feet should be divided into two or more trenches.

The sewage effluent should be distributed between the trenches by means of drop boxes. Proper trench construction and drop box operation are explained fully in *Town and Country Sewage Treatment,* AG-BU-1360.

Table 2. Sewage flows and soil treatment areas

Estimated sewage flows in gallons per day					Soil treatment areas in square feet	
Number of bedrooms	Type of residence[a]				Percolation rate, minutes per inch	Soil treatment area in square feet per gallon of waste per day[c]
	I	II	III	IV		
					Faster than 0.1[b]	Soil too coarse for sewage treatment[b]
2	300	225	180	60% of	0.1 to 5	0.83
3	450	300	218	values	6 to 15	1.27
4	600	375	256	in	16 to 30	1.67
5	750	450	294	Type I,	31 to 45	2.00
6	900	525	332	II, or	46 to 60	2.20
7	1050	600	370	III	Slower than	Refer to information
8	1200	675	408	columns	60[b]	on mounds and alternative systems

[a]Type I: The total floor area of the residence divided by the number of bedrooms is more than 800 sq. ft. per bedroom, or more than two of the following water-use appliances are installed—automatic washer, dishwasher, water softener, garbage disposal, or self-cleaning humidifier in furnace.
Type II: The total floor area of the residence divided by the number of bedrooms is more than 500 sq. ft. per bedroom and no more than two of the water-use appliances are installed.
Type III: The total floor area of the residence divided by the number of bedrooms is less than 500 sq. ft. per bedroom, and no more than two of the water-use appliances are installed.
Type IV: No toilet wastes flow into sewage treatment system.
[b]Soil is unsuitable for standard soil treatment units. Refer to information on mounds and alternative systems.
[c]For trenches only, the bottom areas may be reduced if more than 6 inches of rock is placed below the distribution pipe; for 12 inches of rock below the distribution pipe the bottom areas can be reduced by 20 percent; a 34 percent reduction for 18 inches; and a 40 percent reduction for 24 inches.

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PERCOLATION TEST DATA SHEET

Percolation test readings made by R. Machmeier on 9/14/84 (date) starting at 1:30 ~~a.m.~~ p.m.

Test hole location T & C Estates Lot 14, Hole number 3, Date hole was prepared 9/13/84

Depth of hole bottom 30 inches, Diameter of hole 7 inches

Soil data from test hole:

Depth, inches	Soil texture
0-6	Silt loam
6-18	Loam
18-30	Sandy loam

Method of scratching sidewall 1 X 2 with 8d nails

Depth of gravel in bottom of hole 2 inches

Date and hour of initial water filling 9/13, 10am, Depth of initial water filling 12 inches above hole bottom

Method used to maintain at least 12 inches of water depth in hole for at least 4 hours Automatic siphon

__________, Maximum water depth above hole bottom during test 8 inches

Time	Time interval, minutes	Measurement, inches	Drop in water level, inches	Percolation rate, minutes per inch	Remarks
1:30		5 7/8			Fill
2:00	30	4 1/2	1 3/8	21.8	
2:02		6			Refill
2:34	32	4 5/8	1 3/8	23.3	
2:35		5 15/16			Refill
3:03	28	4 7/8	1 1/16	26.4	
3:05		6			Refill
3:39	34	4 3/4	1 1/4	27.2	
3:40		5 7/8			Refill
4:10	30	4 13/16	1 1/16	28.2	
	Ave =	$\frac{26.4 + 27.2 + 28.2}{3} = 27.3$			

Percolation rate = 27.3 minutes per inch.

PERCOLATION TEST DATA SHEET

Percolation test readings made by____________________on__________ (date) starting at__________ a.m. p.m.

Test hole location____________________, Hole number________, Date hole was prepared________

Depth of hole bottom________inches, Diameter of hole________inches

Soil data from test hole:

Depth, inches	Soil texture

Method of scratching sidewall____________________

Depth of gravel in bottom of hole________inches

Date and hour of initial water filling________, Depth of initial water filling________inches above hole bottom

Method used to maintain at least 12 inches of water depth in hole for at least 4 hours____________________

____________________, Maximum water depth above hole bottom during test________inches

Time	Time interval, minutes	Measurement, inches	Drop in water level, inches	Percolation rate, minutes per inch	Remarks

Percolation rate = ________minutes per inch.