

Residential Onsite Wastewater Treatment: Gravelless Drainfields for Effluent Treatment

Jan R. Hygnstrom, Extension Project Manager

Sharon O. Skipton, Extension Educator

Wayne E. Woldt, Extension Specialist

This NebGuide discusses recommended practices for the design and installation of a residential onsite gravelless drainfield.

In areas of Nebraska without public wastewater treatment services, a septic tank and effluent treatment system is an approved method of wastewater treatment (*Figure 1*). Effluent — wastewater that has received initial treatment in a septic tank — contains bacteria, viruses, organic particles, chemicals, and nutrients. A properly designed, installed, and maintained effluent treatment component treats effluent to reduce risk to people and the environment. A gravelless drainfield, also known as a gravelless lateral, leachfield, or soil absorption field, is one approved type of effluent treatment component. In Nebraska, only a registered environmental health specialist, professional engineer, Nebraska certified installer, or someone under that person's direct supervision may design and install a drainfield.

This publication explains how gravelless drainfields work and gives drainfield sizing and installation information for a home. It is not intended to provide all information needed to design a gravelless drainfield for a particular site or situation or to guarantee compliance with Nebraska regulations. Different specifications may apply to businesses or non-household situations, including home-based businesses such as beauty salons, taxidermy shops, or auto repair shops. For more information on gravelless drainfield design and to ensure that a design is in compliance with Nebraska

regulations administered by the Nebraska Department of Environmental Quality (NDEQ), see Nebraska Administrative Code *Title 124 - Rules and Regulations for the Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems*. Local regulations for homes or businesses may be stricter than those issued by the state. For example, some counties require the use of filter material or gravel in drainfield trenches, no matter what type of distribution piping or chamber is used. Contact your city or county health, environmental, zoning, or planning department for local requirements and restrictions.

How Does Treatment Occur?

Wastewater flows from the house through the building sewer line to the septic tank. After preliminary treatment in a septic tank, effluent flows through a tank outlet to a distribution pipe or chamber in a drainfield, through a trench that has been backfilled with native soil, into the undisturbed soil, where final treatment and recycling occurs. The soil and air in a properly designed, installed, and maintained gravelless drainfield destroy pathogens and filter out solids. Nutrients such as phosphate attach to soil particles, but nitrate may be carried through the soil by water.

Drainfield Location

The site — including slope, distance to surface water, depth to groundwater, and type of soil, as well as location of property lines, wells, and buildings — determines where to build a gravelless drainfield. By law, Diggers' Hotline (dial 811 or www.ne-diggers.com) must be contacted at least two business days prior to excavation. After notification, local utilities' employees will mark registered electrical, gas, phone, fiber optics, cable, and public water supply lines on the property.

Distance to Groundwater or Barrier Layer

An important factor in effluent treatment is the distance wastewater travels through soil before reaching seasonal high water tables, perched water tables, bedrock, or any restrictive layer that prevents water from passing through the soil. In a

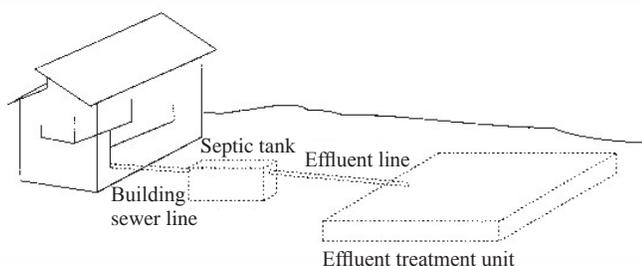


Figure 1. Typical components of an onsite wastewater treatment system.

Table I. Minimum Setback Distances (local codes may be more stringent).

Item	Distance to Gravelless Drainfield
Surface water	50 ft
Private drinking water wells	100 ft
Public drinking water wells:	
Non-community system	100 ft
Community system	500 ft**
All other water wells	100 ft
Water lines:	
Pressure-main	25 ft
Pressure service connection	25 ft
Suction lines	100 ft
Property lines	5 ft
Foundations (except neighbors')	
Class 1 foundations	30 ft
Class 2 foundations	20 ft
Class 3 foundations	10 ft
Neighbors' foundations	
Class 1 foundations	40 ft
Class 2 foundations	30 ft
Class 3 foundations	20 ft

**Effluent treatment systems handling more than 1,000 gallons per day (gpd) must be evaluated by a professional engineer and submitted to NDEQ for approval if less than 1,000 feet from a community system.

Class 1 foundations: Full basements or non-basement footing foundations and slab on grade for living quarters that are lower in elevation than the onsite wastewater treatment system.

Class 2 foundations: Non-basement footing foundations, trailer houses, and slab on grade living quarters that are higher in elevation than the onsite wastewater treatment system.

Class 3 foundations: Structures using slab on grade construction that are not used as living quarters.

properly working system, substantial treatment occurs in the first 3 feet of soil below the bottom of the drainfield. According to *Title 124*, the bottom of the gravelless drainfield must be at least 4 feet above the seasonal high water table, bedrock, or other restrictive layer. When there is less than 4 feet of vertical distance, bacteria, viruses, and other contaminants may be carried with wastewater directly to groundwater. An alternative to the traditional gravel or gravelless drainfield must be used when a minimum of 4 feet of vertical separation cannot be achieved.

Soil

Soil characteristics are important in the selection and design of a gravelless drainfield. The rate at which water moves through soil must be considered.

A soil percolation (perc) test measures how quickly water moves through saturated soil. Perc tests are required by Nebraska's *Title 124* for the design of soil absorption systems or drainfields. This determines the number of minutes it takes a specified depth of ponded water in a properly prepared soil test hole to drop 1 inch. It is a good indicator of whether a gravelless drainfield is feasible and, if so, the proper size required for a

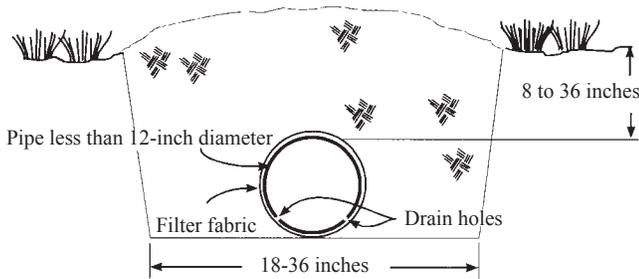


Figure 2. Gravelless trench with pipe and filter fabric.

given wastewater-loading rate. *Title 124* specifies that only a registered environmental health specialist, professional engineer, or Nebraska certified installer, inspector, or soil evaluator may conduct a soil percolation test for use in drainfield design. Also, some counties have a list of professionals approved for their county, in which case both the state and county requirements must be met. Contact your city or county health, environmental, zoning, or planning department for local requirements. The percolation test must be conducted on unfrozen ground in the area where the drainfield will be located. Ask for a copy of the percolation test data and results.

The soil percolation rate at the site of a gravelless drainfield must be no faster than 5 minutes per inch and no slower than 60 minutes per inch. If the soil perc rate is faster than 5 minutes per inch, the contractor may install a 12-inch loamy sand liner with a perc rate of 15 to 20 minutes per inch. If a loamy sand liner isn't installed, a permit from the NDEQ is needed. If perc rates in the proposed drainfield or reserve area are slower than 60 minutes per inch, an alternative effluent treatment method (NDEQ permit required) or a lagoon must be used. The lot must be at least 3 acres for a lagoon system.

Setback Distances

Title 124 specifies minimum setback distances for the location of the gravelless drainfield (*Table I*). Do not use areas subject to flooding, ponding, or surface drainage from surrounding areas. Do not build structures such as sidewalks, patios, driveways, garages, or storage buildings over a drainfield. This is illegal under Nebraska regulations and will prevent effective effluent treatment. *Title 124* requires that a reserve area be established for a replacement should the initial drainfield fail. This reserve area also must meet all setback requirements.

Designing and Sizing a Gravelless Drainfield

There are two main types of gravelless drainfields—those that use a pipe and those that use chambers. In the gravelless pipe drainfield (*Figure 2*), effluent travels through a corrugated pipe surrounded by a synthetic filter fabric. A permit must be obtained from NDEQ when using pipe that is 12 inches or larger in diameter. In the gravelless chamber drainfield (*Figure 3*), effluent passes through a series of chambers made of a nondegradable material. Gravelless chambers, typically made of plastic, are lightweight and can be carried to remote or difficult-to-reach sites. Both pipes and chambers must be made of materials not subject to decay (therefore not metal), and must have a load-bearing capacity of more than 1,000 pounds per linear foot.

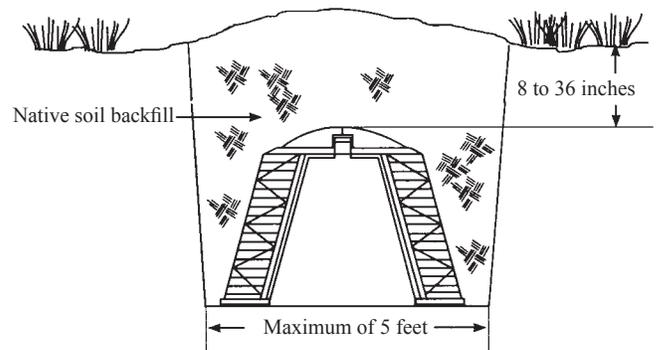


Figure 3. Gravelless trench with slotted sidewall chamber.

In Nebraska, a drainfield's minimum size is determined using soil percolation test results along with the number of bedrooms in the home. The soil percolation test is a measure of the soil's ability to accept effluent. The number of bedrooms is used to estimate the amount of wastewater coming from the home. All of the home's wastewater must go to the onsite wastewater treatment system. The soil's ability to accept and treat effluent must be equal to or greater than the amount generated.

A drainfield can consist of chambers or pipes buried in a trench or bed. Since beds are rarely used, they will not be discussed in this publication. Refer to *Title 124* for more information. When the slope of the site is less than 10 percent (10 feet of drop per 100 feet of run), adjacent trenches must have at least 4 feet of undisturbed soil between them and must be at least 4 feet from the septic tank. When the slope is between 10 percent and 20 percent, that distance increases to 6 feet. If the slope exceeds 20 percent, adjacent trenches must have at least 10 feet of undisturbed soil between them and be at least 10 feet from the septic tank.

Drainfield trenches cannot be less than 18 inches nor more than 36 inches wide for pipe laterals and no more than 5 feet wide for chambers. Any trench wider than 36 inches for pipes or 5 feet for chambers is considered a bed and different calculations are used, which are listed in *Title 124*.

Table II illustrates the minimum required drainfield square footage for a single-family home using soil percolation rate information. For example, a single family dwelling with three bedrooms, where the soil has a percolation rate of 43 minutes per inch, requires at least 990 square feet of drainfield trench.

Table II. Minimum square feet of drainfield trench required for a single-family dwelling.

Perc rate min/inch	Number of bedrooms								
	1	2	3	4	5	6	7	8	9
Less than 5	Drainfield must have a 12-inch loamy sand liner with a perc rate of 15-20 min/inch, and must be designed for that rate.								
5-10	165	330	495	660	825	990	1155	1320	1485
11-20	210	420	630	840	1050	1260	1470	1680	1890
21-30	250	500	750	1000	1250	1500	1750	2000	2250
31-40	275	550	825	1100	1375	1650	1925	2200	2475
41-50	330	660	990	1320	1650	1980	2310	2640	2970
51-60	350	700	1050	1400	1750	2100	2450	2800	3150
Over 60	A professional engineer must design system. Construction permit is required.								

Sizing a Gravelless Drainfield With a Pipe

The depth of a gravelless trench must be the diameter of the pipe plus 8 to 36 inches. It can be up to 100 feet in length. It may extend up to 150 feet in length for a gravelless drainfield using gravity flow if a surveyor's level, laser level, transit, or other type of instrument is used during construction to ensure the trench is level. A carpenter's level is not sufficient.

A three-bedroom home on a lot with a soil percolation rate of 43 minutes per inch requires a minimum of 990 square feet of drainfield trench (use *Table II*). Credit for the pipe surface area, NOT the excavated width of the trench, is factored into the calculation for determining the total linear feet of gravelless trench necessary to obtain the required square footage. The credit given for the pipe surface area is 75 percent of the circumference, calculated using the formula $0.75 \times 3.14 \times$

pipe diameter in feet. To convert pipe diameter from inches to feet, divide by 12.

To convert the square footage of the total trench area to the length of trenches required when using a gravelless pipe, use the formula:

$$\frac{\text{Drainfield area in square feet}}{(.75 \times 3.14 \times \text{pipe diameter in feet})} = \text{Linear feet of trench}$$

A system for the previous situation but with a 10-inch diameter gravelless pipe would require 508 linear feet of trench. Convert the 10 inches to feet: 10 inches/12 inches per foot = 0.83 ft

$$\frac{990 \text{ sq. feet}}{.75 \times 0.83 \text{ ft} \times 3.14} = \frac{990 \text{ sq feet}}{1.95 \text{ feet}} = 508 \text{ linear feet of trench}$$

The gravelless drainfield with a 10-inch diameter pipe could be constructed with four trenches, each 127 feet long.

$$\frac{508 \text{ linear feet of trench}}{4 \text{ laterals}} = 127 \text{ feet per trench}$$

This gravelless drainfield would require special equipment to ensure that the bottom of the trench is level since each is more than 100 feet long.

Another option is to design the drainfield with six trenches, each 85 feet long. This would not require special equipment to ensure a level trench bottom, although care should be taken to make sure the trenches are level.

Sizing a gravelless drainfield with chambers

The depth of a trench with gravelless chambers must be equal to the height of the chamber plus 8 to 36 inches. The same length restrictions apply as for a gravelless pipe drainfield. Because of the sidewall slots in gravelless chambers, and since there is no gravel at the trench-soil interface, there is more area for the effluent to make contact with soil. This increases the treatment effectiveness, compared with traditional drainfields. Gravelless drainfields using chambers with at least six inches of slotted sidewall may be sized using 1.5 times the inside bottom width of the chamber as the effective trench width (effective width not to exceed 5 feet), rather than the actual excavated width of the trench. Effective width using a chamber with slotted sidewalls is calculated using the formula: Inside bottom chamber width X 1.5.

A gravelless chamber with a 36-inch outside bottom width and a 32-inch inside bottom chamber width may be sized using an effective width of (32 inches x 1.5), or 48 inches (4 feet). To convert the square footage of the total area required to the length of trenches required when using chambers with slotted sides, use the formula:

$$\frac{\text{Drainfield area in square feet}}{\text{Effective width of trench}} = \text{linear feet of trench}$$

For the same three-bedroom home on soils where the slowest perc rate is 43 minutes per inch, using a 3-foot trench with a 32-inch gravelless chamber (32-inch chamber x 1.5 = 4 feet), you would need at least 248 linear feet of trench.

$$\frac{990 \text{ square feet}}{4 \text{ feet}} = 248 \text{ linear feet of trench}$$

Although other options are available, the gravelless chamber drainfield could be constructed with four trenches, each 62 feet long.

248 linear feet of trench / 4 trenches = 62 feet per trench

Constructing this drainfield requires no special equipment to ensure that the bottom of the trench is level since each trench is less than 100 feet long. The length of the gravelless chamber should be considered when calculating the number of trenches to construct. Some chambers come in 75-inch lengths. A 62-foot lateral equals 744 inches (62 feet X 12 inches per foot). Each trench would use 10 chambers (744 inches/75 inches per chamber = 9.9 or 10 chambers). This system would require a total of 40 chambers (10 chambers per trench X 4 trenches). The contractor should follow manufacturer's instructions for proper installation.

Flow-Splitting Devices

A drainfield usually has more than one trench. A flow-splitting device, such as a header pipe, drop box, or distribution box distributes effluent to the various trenches in the drainfield. For more information on proper selection and installation of a flow splitter, see *Title 124*.

Constructing a Trench for a Gravelless Drainfield

A trench should not be constructed when the soil is wet. Excavating and driving heavy equipment over the site will alter the soil structure, causing compaction and reducing its effectiveness for treating effluent. The area for the soil absorption system or drainfield trenches should be identified and protected prior to the delivery of any building supplies or use of any construction equipment. *Title 124* requires that the trench be level. Trenches must have no dips or bumps. The sides and bottom should be raked to allow for better water penetration.

Pipe with filter fabric is placed in the bottom of the trench, keeping it level. The trench is backfilled with native soil to the top of the pipe, keeping it visible until inspected, if required. When using chambers, follow the manufacturer's installation directions regarding splash plates and end plates. The first chamber is placed directly on the bottom of the trench (*Figure 3*), with additional chambers latched together. Native soil is shoveled to fill space on the sides of the chamber and lightly compacted by walking on it. Chambers must remain level.

Have the septic tank/gravelless drainfield system inspected by a certified inspector, if required by local regulations, before backfilling over the top of the pipe or chambers. The trench should be backfilled with original soil, mounding it slightly above grade to allow for settling. If not graded properly, a depression may form in the soil over the drainfield. Rainfall or runoff could accumulate, which could cause premature failure of the soil absorption system. Driving equipment with rubber tires over the trench while backfilling will compact the soil, reducing the drainfield's effectiveness. Protect the drainfield

area from any vehicular traffic before and after installation, and establish a grass cover as soon as possible.

Permits

Nebraska law allows the owner of a home that generates less than 1,000 gallons per day of domestic wastewater to have an onsite wastewater treatment system constructed by a certified installer, registered environmental health specialist, or professional engineer, provided the system meets all design, setback distance, and reserve area provisions covered in NDEQ *Title 124*. In addition, Nebraska law allows an owner to operate such a system without a permit once the system has been registered with NDEQ. Both the construction and operation of the system are allowed under "Authorization by Rule" in *Title 124*. The owner must keep a copy of pertinent information on the premises, including the registration form, the results of the soil percolation test, and a scaled drawing of the system that includes its location on the property, setbacks, capacity, materials, and construction details. Although the *Title 124* regulations may not require a permit, the local (county and/or city) planning, zoning, or health department may have a permit requirement. Check local regulations.

Summary

Proper design and installation of a soil absorption system or drainfield using gravelless chambers by a Nebraska certified professional, registered environmental health specialist, professional engineer, or someone under the professional's direct supervision are essential for effective effluent treatment to minimize any negative impact on groundwater, surface water, and human health. Proper design includes sizing the gravelless drainfield correctly and considering soil characteristics and potential wastewater generation rates. A gravelless drainfield is a good alternative to a traditional drainfield using gravel, especially if the lot is remote, space is tight, and clean, properly sized gravel or other filter material is difficult to obtain.

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