

Residential Onsite Wastewater Treatment: Septic Tank Design and Installation

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This NebGuide provides information on septic wastewater tank installation, such as selecting the correct tank size and placement, in order for owners to understand tank design and installation procedures used by installation professionals.

A properly designed, installed and maintained septic tank and effluent treatment system is an approved method of wastewater treatment in Nebraska for private residences in areas where public wastewater treatment systems are not available. The system includes the building sewer line (which starts 30 inches from the house and extends to the septic tank), the septic tank, the effluent treatment component, and all piping in between. A drainfield, also known as a lateral, leachfield or soil absorption field, is most commonly used for effluent treatment. Alternative effluent treatment components may be used. Examples include mounds and constructed wetlands. Where soil has a suitable percolation rate and other site conditions are appropriate, the septic tank/drainfield system is a good choice, and the most commonly used.

Only a Nebraska certified installer, registered environmental health specialist, professional engineer, or someone under their direct supervision may install a septic tank.

This publication gives design and installation information for a septic tank based on Nebraska Department of Environmental Quality (NDEQ) *Title 124: Rules and Regulations for the Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems*. Local regulations may be more strict than those issued by the state. Contact your city or county health, environmental, zoning or planning department for local requirements.

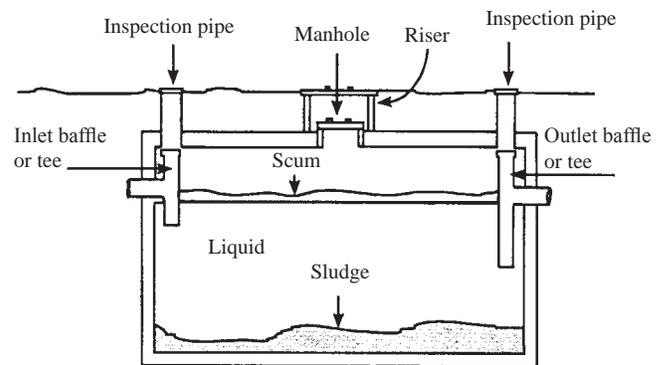


Figure 1. Septic tank.

How does treatment occur in a septic tank?

Wastewater flows from the building sewer line to the septic tank where both heavy and light solids separate from the wastewater. Solids that are heavier than water settle out forming a sludge layer on the bottom of the septic tank (*Figure 1*). Solids lighter than water float to the top of the wastewater forming a scum layer. A liquid layer of water with suspended solids, nutrients, microorganisms and other pollutants separates the sludge and scum. Anaerobic bacteria — those that can live without oxygen — begin to break down waste in the septic tank. As wastewater flows into the septic tank, an equal volume of the liquid layer, called effluent, flows out of the septic tank into the effluent treatment system. In a properly designed, functioning and maintained septic tank, scum and sludge will not flow out with the effluent.

While septic tank effluent may appear clear, microorganisms such as bacteria and viruses, nutrients such as nitrate and phosphorous, dissolved materials and very small particles of suspended solids are present. To protect the environment

and human health, effluent must receive additional treatment, typically in the drainfield, or in an alternative effluent treatment component.

Septic Tank Location

The location of plumbing within the home, lot configuration and slope of the land help determine placement of the septic tank. To protect the environment and human health, use no less than minimum setback distances (*Table 1*) for the tank and effluent treatment component that will be used. Avoid sites subject to flooding, ponding or surface drainage from surrounding areas. The location must be accessible so contents of the septic tank, known as septage, can be pumped. Typically, hoses on pumper trucks can reach 50 feet. Also, consider the possibility of future expansion and locations for sidewalks, patios, driveways, garages and storage buildings before selecting the tank site. It is not legal to construct a sidewalk or building over a septic tank, as maintenance and inspection would be very difficult, if not impossible.

Table 1 State minimum setback distances (local codes may be more stringent).

Item	Distance to:	
	Septic Tank	Effluent Treatment System
Surface water	50 ft	50 ft
Private drinking water well	50 ft	100 ft
Public drinking water wells:		
Non-community system	50 ft	100 ft
Community system	500 ft	500 ft*
All other water wells:	50 ft	100 ft
Water lines:		
Pressure-main	10 ft	25 ft
Pressure service connection	10 ft	25 ft
Suction lines	50 ft	100 ft
Property Lines	5 ft	5 ft*
Foundations (except neighbors')		
Class 1 foundations	15 ft	30 ft*
Class 2 foundations	10 ft	20 ft*
Class 3 foundations	7 ft	10 ft*
Neighbors' foundations		
Class 1 foundations	25 ft	40 ft*
Class 2 foundations	20 ft	30 ft*
Class 3 foundations	15 ft	20 ft*

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 and not used as living quarters.

*These distances are for subsurface type effluent treatment systems (traditional and gravelless, mound, etc.). Wetlands and lagoons require greater distances. See NDEQ *Title 124*, Table 5.2.

All buried electrical, gas or other utility lines must be located before excavation. Nebraska state law requires that

Diggers Hotline of Nebraska (811) be notified at least two business days before excavation. They will contact local utilities to mark registered electrical, gas, phone, fiber optics, cable, public water supply and public sewer lines on the property.

Septic Tank Design

Configuration

The depth of a septic tank, from the bottom of the outlet to the floor, must be at least 42 inches. The maximum depth to consider when determining tank capacity is 78 inches. There must be at least 48 inches between the inlet and outlet baffles. A horizontal, cylindrical tank must be at least 60 inches in diameter and the length must be two to three times the width of the tank. Any tank or compartment must have an inside horizontal dimension of at least 24 inches.

Tanks holding over 3,000 gallons must be divided into two or more compartments (*Figure 2*). Smaller tanks may have two compartments, but this is not required. Typically, more solids are collected in the first compartment, and the second compartment offers a safety factor, reducing the chance for solids to enter the drainfield. With a two-compartment tank, the first compartment must hold at least one-half, but not more than two-thirds of the total volume. With three or more compartments, the first compartment must hold one-half of the total volume with the other half equally divided between the other compartments. Compartments must have baffles between them to improve settling. Another option is to connect multiple tanks in series; however, no more than four tanks may be connected in series. The volume of the first tank must be equal to or greater than any other tank in the series.

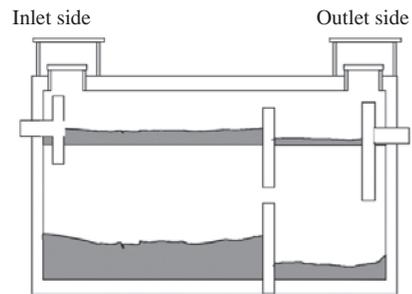


Figure 2. Two-compartment septic tank.

A septic tank must have devices such as baffles or sanitary tees to help ensure that settling occurs, solids are retained and venting is provided (*Figure 1*). An inlet device prevents the scum layer from building up and plugging the end of the sewer pipe. An outlet device prevents the scum layer from flowing out of the tank into the effluent treatment system. Inlet and outlet baffles may be made of plastic, acid-resistant concrete or acid-resistant fiberglass. Baffle lengths and depths must be within the ranges specified in NDEQ *Title 124*, Chapter 8.

The tank must have inspection pipes at least six inches in diameter above both the inlet and outlet devices, capped at or above the soil surface. They are used to check sludge and scum depth and to clean plugged baffles or tees. Inspection ports should not be used for pumping the tank because their

size and location make it impossible to remove all waste from the tank or to inspect the tank for cracks.

A septic tank must have a manhole at least 12 inches in diameter for pumping access. For a tank with multiple compartments, access to each compartment must be provided by one or more manholes. A cleaning manhole may replace one of the inspection pipes, or it can be a separate access point, usually in the center of the tank. The manhole must be between 6 and 12 inches below the soil surface. For easier access, a riser that extends from the manhole to the soil surface or within six inches of the soil surface may be installed. A riser that extends to the soil surface should have a secure cover to reduce the chance of a child or other unauthorized person accessing the tank. The tank must be permanently marked with the capacity in gallons, and the manufacturer's name and address on the inlet side near the manhole.

Capacity

The capacity of a septic tank is the volume of wastewater, including scum and sludge, held in the tank below the bottom of the outlet. Required minimum capacity is based on the number of bedrooms in the dwelling and the presence or absence of a whirlpool bath (*Table II*). Nebraska regulations require that a dwelling with three or fewer bedrooms must have at least a 1,000-gallon tank, with an additional 250 gallons for each additional bedroom. For example, a four-bedroom home would require at least a 1,250-gallon tank. Also, tank capacity is increased by 250 gallons when a whirlpool bath is installed in a 3-bedroom or larger home. For example, a four-bedroom home with a whirlpool bath requires a 1,500-gallon tank.

Table II. Septic tank sizing for a single dwelling.

<i>Number of bedrooms - Single dwelling</i>	<i>Tank size - gallons</i>	<i>Tank size for dwelling with whirlpool bath</i>
1	1,000	1,000
2	1,000	1,000
3	1,000	1,250
4	1,250	1,500
5	1,500	1,750
6	1,750	2,000
7	2,000	2,250
8	2,250	2,500
9	2,500	2,750
10 * Establishment	See NDEQ Title 124	See NDEQ Title 124

*An establishment is a building, structure, or house with 10 or more bedrooms, generates more than 1,000 gallons of wastewater a day, generates non-domestic wastewater, or is a restaurant or food preparation facility.

To determine the correct size septic tank when more than one dwelling is connected to a single septic tank, additional tables and calculations are needed. In addition, some onsite septic systems for establishments must handle wastewater that is highly concentrated or has characteristics that would slow down or prevent biological treatment, such as high temperatures or the presence of certain materials (inhibitors). Examples include systems for camper dump stations, public laundry facilities and butcher shops. Consult NDEQ *Title 124*

for more information on determining tank sizes for these and establishments in general.

Construction Materials and Installation

Septic tanks, manhole risers and connections to inlets and outlets must be watertight to prevent untreated wastewater from entering the environment, as well as to prevent surface or other water that doesn't need treatment from entering the tank. Tanks may be made of concrete, concrete block, fiber-reinforced plastic (FRP), high-density plastic or fiberglass. All interior concrete surfaces 3 inches below the water line and higher must be coated with bitumastic (coal tar and filler) material to minimize corrosion. Metal tanks are not allowed because of their potential to corrode. If concrete blocks are used, they must be laid on a solid foundation. Joints must be filled with mortar, and the interior of the tank must be coated with either two, one-fourth-inch coats of Portland cement and sand plaster, or coated with a bitumastic material.

The tank must be designed to withstand soil pressures when empty. If a tank collapses or the sides flex, the tank may crack, baffles may move out of alignment, watertight seals on connections and access risers may be broken or tank capacity may be reduced. Any of these conditions would result in a violation of the regulations and prevent proper operation of the system.

Wastewater Pipe from Dwelling to Tank

A four-inch diameter or larger sewer pipe (also known as the influent line) is used to carry wastewater from the house to the septic tank. All pipe and joints must be watertight. The pipe must have a minimum loading capacity of 1,000 pounds per linear foot. Schedule 40 thermoplastic sewer pipe with solvent welded joints is durable and easy to install. It should be smooth on the inside to prevent solids from being caught.

The line between the house and septic tank should have a slope of 1/8" to 1/4" drop in 1 foot of run. Solids may settle in the pipe if liquid moves either too rapidly or too slowly due to a slope that is too steep or too gradual. Local plumbing codes may specify slope requirements.

Installing The Tank

Tank Placement

Although not necessary, it is desirable to have gravity flow throughout the wastewater treatment system to avoid the need for mechanical assists such as pumps and valves. For homes with a basement sewer drain or toilet, it may be possible to install the septic tank at a depth that will allow for gravity flow from the basement plumbing to the tank. However, tanks are typically designed to withstand the weight of 2 to 3 feet of soil cover. Refer to technical information for the maximum recommended placement depth of your specific tank, since deeper placement may void any warranties. It often is better to construct the home at a high enough elevation to allow for gravity flow, rather than risk placing the tank too deep, or

relying on pumps to move wastewater through the system.

If it is not possible to construct the house high enough for gravity flow from the basement plumbing to the tank, a grinder pump or sewage ejector pump will be needed to lift wastewater out of the basement to an elevation suitable for drainage to a septic tank. In this situation, both solids and liquids must be pumped. In some cases, there may be gravity flow to the tank, but the system may need a pump to lift septic tank effluent from a pumping chamber, connected to the septic tank, up to higher drainfield lines. In this scenario, only the septic tank effluent, liquid from which larger solids have settled out, must be pumped.

The installer will excavate a hole large enough to place and level the tank. Appropriate safety precautions must be taken when working around the hole to prevent a cave-in, especially if sidewall soil is unstable or sandy. If there is rock at the bottom of the hole, a layer of sand or fine gravel at least six inches deep should be placed in the bottom of the excavated hole. Then the tank can be placed in the hole and leveled. Tanks installed in areas of high groundwater must be anchored or ballasted to prevent floatation when empty. Finally, the excavated site is backfilled in 4-6 inch layers, compacting each layer to prevent future settling. Backfill material must be free of large stones or other debris. The contractor may install a covered riser to allow for easier access to the manhole. A riser that extends to soil surface should have a secured cover. Inspection pipes must be placed over the inlet and outlet of the tank.

Pipe from tank to effluent treatment system

Effluent travels from the septic tank through an outlet pipe to the effluent treatment system. The outlet pipe must be round, watertight, durable and not subject to corrosion. Schedule 40 thermoplastic is commonly used. The pipe must be properly supported between the end of the tank and edge of the excavation to prevent sagging or breakage during backfilling. Soil around the pipe must be compacted to its original density, extending from the septic tank to at least three feet beyond the edge of the tank excavation.

Permits

Nebraska law allows the owner of a home with less than ten bedrooms that generates less than 1,000 gallons per day of domestic wastewater to have an onsite wastewater treatment system designed and 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 once the system has been registered with NDEQ. Both construction and operation 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.

Contact the local health, environmental, zoning or planning department to determine if a local permit is required. When waste from other than domestic sources will enter a residential onsite wastewater treatment system, NDEQ must be contacted. A state permit may be required.

Summary

A septic tank will provide preliminary wastewater treatment. The tank must be sized to handle the wastewater load and installed properly. It requires periodic inspection and maintenance in order to treat wastewater and protect the environment and human health. The tank must be used in combination with an effluent treatment system. Additional UNL Extension publications are available on various effluent treatment options including traditional and gravelless drainfields, mound systems and constructed wetlands. For more information on septic tank design, and to ensure that your septic tank design is in compliance with Nebraska regulations, see Nebraska Department of Environmental Quality *Title 124: Rules and Regulations for the Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems*.

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UNL Extension publications are available online at <http://extension.unl.edu/publications>.

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