

SECTION 7: Septic Tanks

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SEPTIC TANKS

Definition and Description

The purpose of the septic tank is to provide an environment for the first stage of treatment in onsite and decentralized wastewater systems by promoting physical settling, flotation, and the anaerobic digestion of sewage. Additionally, the tank allows storage of both digested and undigested solids until they are removed. From 7080.1100:

1. A septic tank means any watertight, covered receptacle that is designed and constructed to receive the discharge of sewage from a building sewer or preceding tank, stores liquids for a detention period that provides separation of solids from liquid and digestion of organic matter, and allows the effluent to discharge to a succeeding tank, treatment device, or soil dispersal system (Subp. 70).
2. A sewage tank is defined as a receptacle used in the containment or treatment of sewage and includes, but is not limited to, septic tanks, aerobic tanks, pump tanks, and holding tanks (Subp. 74).

FIGURE 7.1 Three Layers Form In a Properly Operating Septic Tank

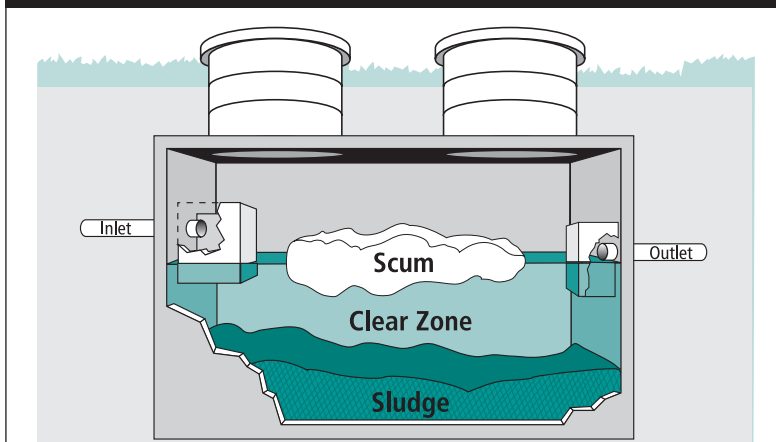
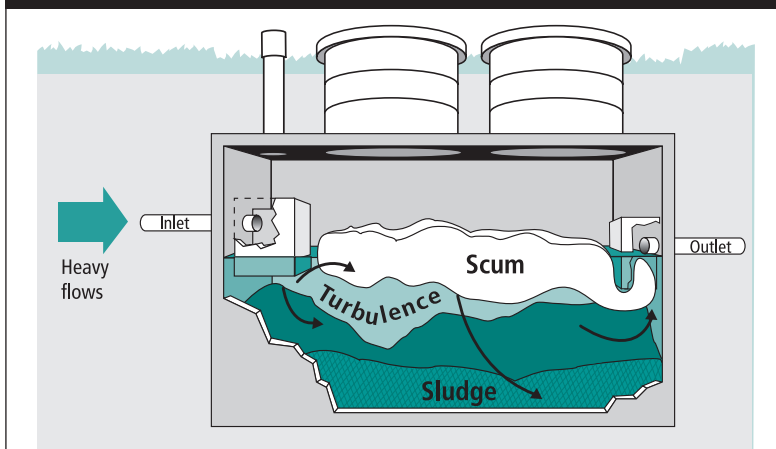


FIGURE 7.2 Large Doses and Excessive Flow Disrupts Tank Operation



Physical processes

Septic tanks allow the separation of solids from wastewater as heavier solids settle and fats, greases, and lighter solids float. The solids content of the wastewater is reduced by 60-80% within the tank. The settled solids are called *sludge*, the floated solids are called *scum*, and the liquid layer in between is called the *clear zone* as shown in Figure 7.1. Although the liquid in the clear zone is not highly treated, it is greatly clarified compared to the wastewater entering the tank, the larger particles having migrated to either the sludge or scum layers. Another important function of the tank is storage of these accumulated solids. The tank is sized large enough to hold solids until maintenance (i.e., tank pumping) is performed.

The effluent, or wastewater, that leaves the septic tank comes from the clear zone to minimize the solids loading on the downstream components of the system. The baffle, tee, or effluent screen at the outlet is designed to draw from the clear zone retaining floatable or settleable solids in the tank. The settling process requires time to occur, so the tank must be large enough to retain the wastewater in a turbulence-free environment for two to four days. Excessive flow and turbulence can disrupt the settling process as shown in Figure 7.2, so tank volume, size, shape, and inlet baffle configuration are designed to minimize turbulence.

Biological and chemical processes

Septic tank solids include both biodegradable and nonbiodegradable materials; although many of the solids will decompose, some solids will accumulate in the tank. Anaerobic and facultative biological processes in the oxygen-deficient environment of the tank provide partial digestion of some of the wastewater components. These processes are slow, incomplete, and odor producing. Gases (hydrogen sulfide, methane, carbon dioxide, and others) result from the anaerobic digestion in the tank and may create safety hazards for improperly equipped service personnel. The gases accumulate in bubbles in the sludge that, as they rise, may re-suspend settled solids. This will elevate the total suspended solids (TSS) concentration in the clear zone and ultimately send more suspended solids to downstream system components. This scenario often results when active digestion occurs during warm temperatures.

Attempts to reduce discharge of re-suspended solids led to the development of tank features such as gas deflectors. Effluent screens now help to perform this function.

Treatment achieved with domestic sewage

The septic tank provides primary anaerobic treatment (dissolved oxygen < .5 mg/L) in an onsite sewage treatment system of the raw wastewater. The effluent from the septic tank is typically treated so that it contains 140 to 220 milligrams per liter BOD, 45 to 70 milligrams per liter TSS, and 10-30 milligrams per liter FOG. **According to MN Rules Chapter 7081.0130, Subp. 2. If concentrations of biochemical oxygen demands, total suspended solids, and oil and grease from the sewage are expected to be higher than 175 mg/1, 65 mg/1, or 25 mg/1 respectively, an estimated or measured average concentration must be determined and be acceptable to the local unit of government. System design must account for concentrations of these constituents so as not to cause internal system malfunction, such as, but not limited to, clogging of pipes, orifices, treatment devices, or media.**

Factors affecting septic tank performance

The anaerobic digestion processes in tanks are affected by temperature in the tank and by substances that have an adverse impact on biological organisms. Higher temperatures will enhance the rate of biological processes and inhibiting substances will reduce it. Too high of temperatures may liquefy fats, oils and greases (FOGs). Ideal temperatures in the tank allow for FOGs to solidify and bacterial activity to take place. Some factors that affect the way a tank functions include:

- Strength (concentration) of the incoming wastewater;
- pH;
- Introduction of harsh chemicals, drain cleaners, paint, photo processing chemicals or other inappropriate substances into the waste stream which may affect pH and biological activity;
- Introduction of fats, oils and grease (FOG);

- Highly variable flow patterns that affect detention time;
- Introduction of pharmaceuticals (especially those for chemotherapy and dialysis; long term use of antibiotics, etc.);
- Introduction of process wastewaters, including backwash from a water softener, and; and
- Lack of maintenance resulting in excess accumulation of solids, reducing effective volume and reducing detention time.

User education and care are important factors in maximizing the effectiveness of septic tank processes.

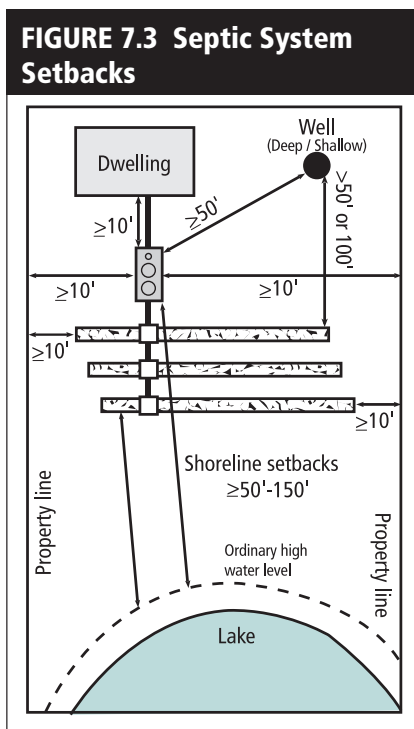
TABLE 7.1 Location of Septic Tank

Item	Minimum Setback
Property Lines	10 feet
Buried pipe distributing water under pressure	10 feet
Building	10 feet
Water supply wells	50 feet

Setbacks

To minimize potential problems of pipe blockage, freezing and to keep cost low it is advantageous to keep the septic tank(s) located near the main source of sewage. It is also critical that the selected tank location meet all the setback distances, as listed in Table 7.1.

Figure 7.3 highlights the setbacks from the septic tank and soil treatment area to critical site features. A detailed discussion of setbacks is in Section 2 of this manual.

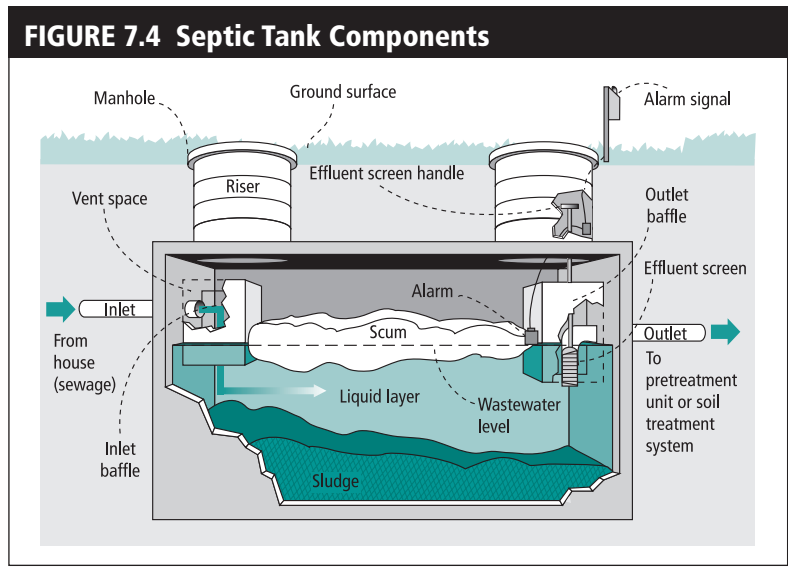


Design Impacts and Options

According to MN Rules 7080.1920, septic tanks must:

- A. Have a liquid depth of at least 30 inches. Any liquid depth that is greater than 84 inches must not be used when calculating the septic tank liquid capacity;
- B. Have a minimum of six feet between the inlet and outlet of the tank, rather than between compartments, or have a minimum of six feet from the inlet of the first tank to the outlet of the last tank in series;
- C. If site conditions warrant, the inlet and outlet may be located on walls that are not opposite each other along the axis of maximum dimension; however, the requirements of item B must be met;
- D. Have an inlet invert at least two inches above the outlet invert; and
- E. Have a reserve or storage space between the liquid surface and the top of the inlet and outlet baffles of not less than eight inches or 100 gallons, whichever is greater.

Figure 7.4 illustrates a septic tank with components labeled.



Tank Sizing for Dwellings

Required septic tank capacities are outlined in MN Rules 7080.1930. **Subpart 1 states that for dwellings, the liquid capacity of septic tanks must be at least as large as the liquid capacities given in Table 7.2.**

Number of bedrooms	Minimum Capacity of Septic Tank (gallons)	Minimum Septic Tank Minimum Capacity if Garbage Disposal or Sewage is being pumped into Tank (gallons)
3 or less	1,000	1,500
4 or 5	1,500	2,250
6 or 7	2,000	3,000
8 or 9	2,500	3,750

From MN Rules Chapter 7080.1100 the liquid capacity is defined as the liquid volume of a sewage tank below the invert of the outlet pipe.

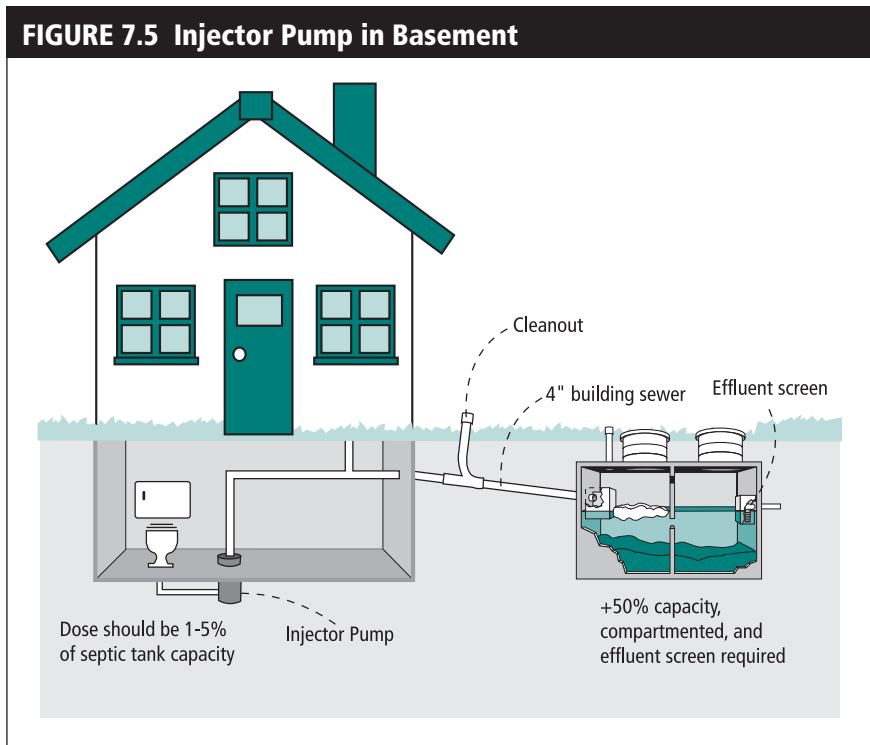
According to MN Rules Chapter 7080.1930, Subp. 6, the septic tank liquid capacity prior to other treatment devices must accord with manufacturer's requirements or accepted engineering principles. For example a trash tank is generally installed prior to aerobic treatment units (ATUs). These tanks can be as small as one-half of the daily design flow volume (300-500 gallons for a 600 gpd design flow). The size is generally specified by the manufacturer of the unit but may be code-driven. Trash tanks can serve as an anaerobic/facultative treatment device but are mainly intended to remove non-degradable items such as plastic from the wastewater stream. They may be an integral part of some proprietary ATUs.

Garbage Disposal and Pumps in Basements

If a garbage disposal unit is anticipated or installed in a dwelling, the septic tank capacity must be at least 50 percent greater than that required in the second column of Table 7.2 and must include either multiple compartments or multiple tanks. In addition, an effluent screen with an alarm must be employed (Subp. 2).

The use of garbage disposals adds unnecessary solids to the waste stream and encourages homeowners to introduce food scraps that result in increased BOD and FOGs. If garbage disposals are used, more frequent solids removal may be needed.

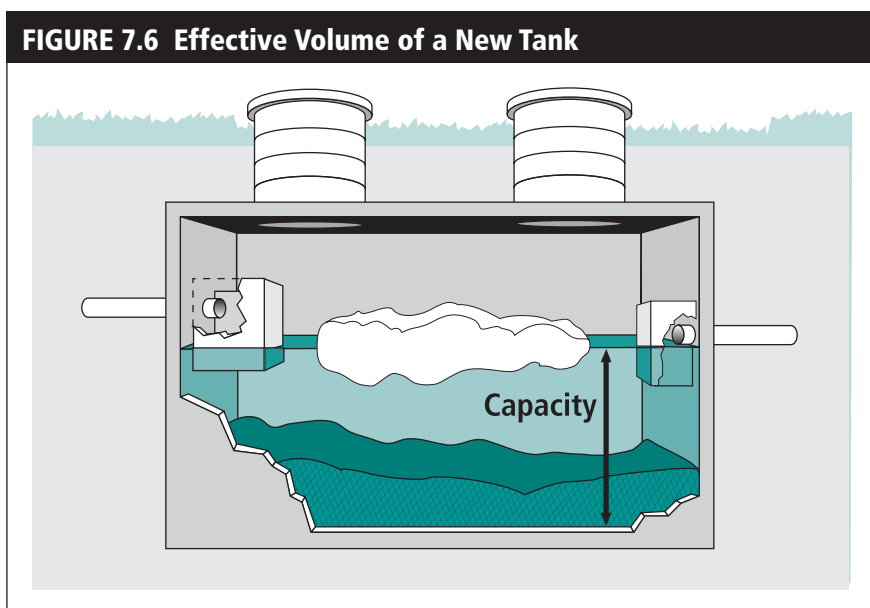
If sewage is pumped from a sewage ejector or grinder pump from a dwelling to a septic tank, the septic tank capacity must be at least 50 percent greater than that required in Subpart 1 and must include either multiple compartments or multiple tanks. In addition, an effluent screen with an alarm must be employed (Subp. 3).



This is required because the discharge line cannot be restricted by a valve and because the pumping rate is so rapid, a great deal of agitation will take place in the first tank. The second compartment/tank is necessary for a quiet zone to exist for proper solids separation. The pump dose volume from the injector pump is recommended to be limited to less than five percent of the volume of the first tank or compartment tank as shown in Figure 7.5.

Subpart 4 specifies that if either a garbage disposal or pump in the basement or both are present the system must include the additional 50% along with multiple compartments/tanks and effluent screen and alarm, but that the requirements are not additive (7080.1930).

For systems serving multiple dwellings with a common septic tank, the liquid capacity must be determined by adding the capacities for each dwelling as determined in Table 1.



Determining Tank Capacities

New tanks have a rated volume based upon the depth from the bottom of the tank to the invert of the outlet (Figure 7.6). Over time, the rated volume stays the same, but the effective volume is decreased as solids and scum accumulate. Septic tanks should be large enough to retain the wastewater in a calm, turbulence-free environment for sufficient settling. The average length of time that the wastewater spends in the tank is called detention time. Detention time is a function of the effective volume and the rate of flow into the tank.

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Liquid volume is calculated by using the surface area and the liquid depth as established by the bottom of the outlet pipe. The minimum recommended detention time to allow adequate settling of solids is two days. The tank should also have sufficient volume to accommodate storage of sludge and scum. Finally, if wastewater is recirculated from an advanced treatment device back to a treatment tank, the increased hydraulic load and reduced hydraulic detention time must be addressed in tank sizing. An additional 50% can help in these conditions.

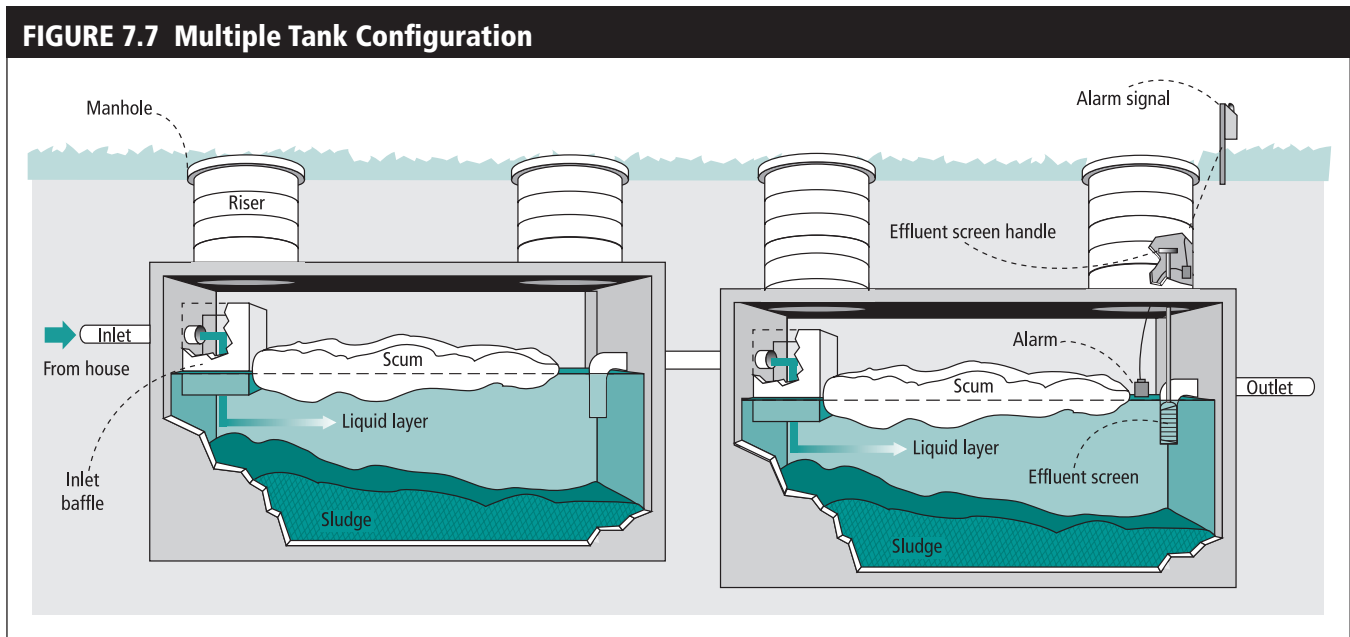
For example, if a tank has inside dimensions of 4 feet 6 inches by 9 feet 6 inches, the surface area is equal to $4.5 \times 9.5 = 42.75 \text{ ft}^2$ and the volume is 42.75 ft^3 per foot of depth. If a septic tank is to contain 1,500 gallons, this is equivalent to 200 cubic feet of liquid ($1,500 \text{ gal.} \div 7.5 \text{ gal/ft}^3$). If each foot of depth contains 42.75 ft^3 of liquid, then $200.0 \div 42.75 = 4.68$ feet of depth. This is equivalent to 56 inches of tank depth between the bottom of the tank and the bottom of the outlet pipe.

There will need to be additional volume in the tank to allow for floating scum storage. Sewage tanks should be placed so as to be accessible through the manhole for the removal of liquids and accumulated solids. They should be placed on firm and compacted soil capable of bearing the weight of the tank and its contents. Sewage tanks should not be placed in areas subject to flooding.

Multiple Tanks

One advantage of using multiple tanks is when very warm effluent is being discharged such as from a high temperature dishwasher. In these cases, multiple tanks will have more surface area in contact with the native soil to help cool the effluent. Another reason to consider using multiple tanks versus a large tank with compartments is based on local availability. Often large tanks may not be readily available. **From MN Rules 7080.1940, if more than one septic tank is used to obtain the required liquid septic tanks must be connected in series or employ multiple collection systems. If tanks are connected in series, each tank or compartment must contain at least 25 percent of the required total liquid capacity. For new construction, the first tank must be equal to or larger than any subsequent tank in the series.** The use of multiple tanks allow delivery and placement of smaller, lighter tanks and reduces the overall excavation width. The disadvantage of using multiple tanks is the installation and maintenance of the 2" drop in subsequent tanks. A multiple tank configuration is shown in Figure 7.7.

FIGURE 7.7 Multiple Tank Configuration



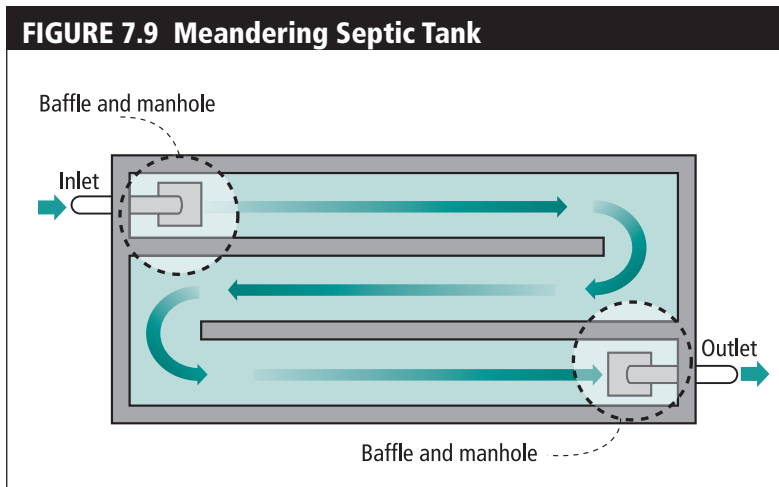
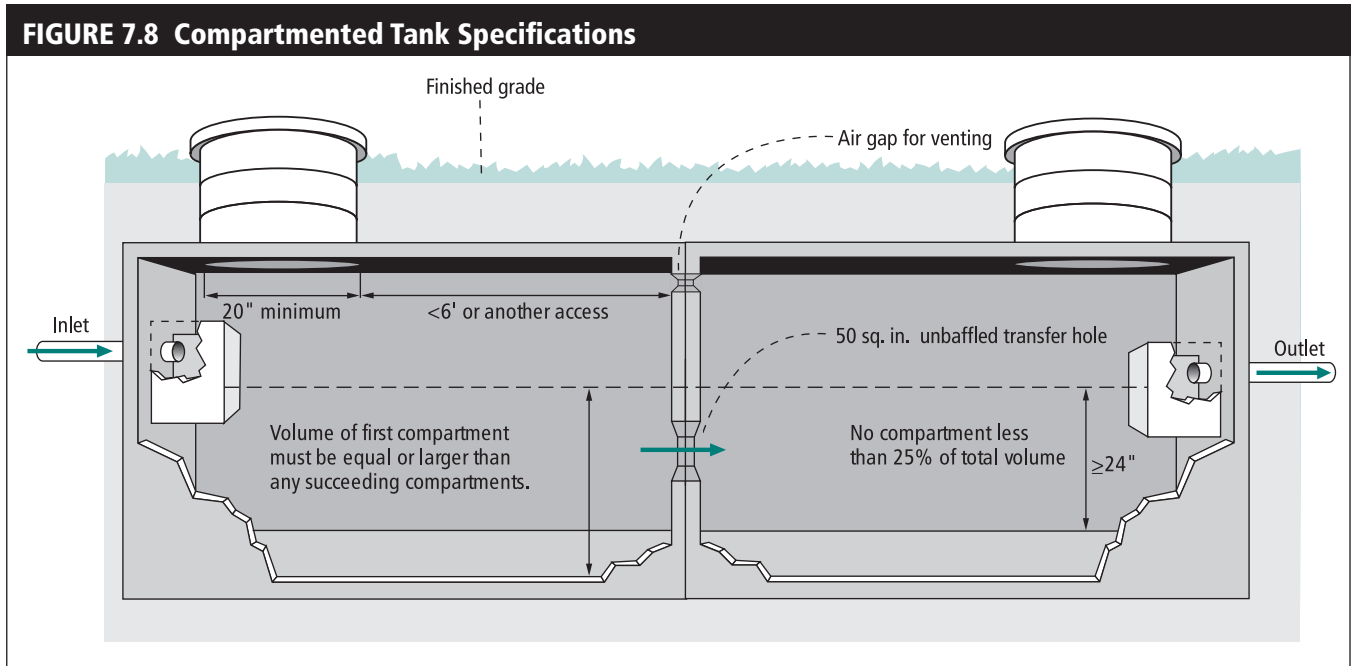
Compartmentalization of Single Tanks

Any time a garbage disposal is installed or a pump is delivering effluent into the septic tank compartments or multiple tanks are required. The additional barrier helps slow down the effluent and retain solids. **From MN Rules Chapter 7080.1950, if septic tanks are compartmentalized, items A to E apply:**

- A. When septic tanks are divided into compartments, the volume of the first compartment must be equal to or larger than any succeeding compartments. Each compartment must contain at least 25 percent of the total required liquid capacity and have an inside horizontal dimension of at least 24 inches.
- B. Flow between compartments can be achieved by an unbaffled transfer hole with a minimum size of 50 square inches located in the clarified liquid zone or a minimum 12-square-inch transfer hole located above the clarified liquid zone that is baffled according to part 7080.1960. The final compartment of a tank that employs a transfer hole in the clarified zone shall not be used as a pump tank.
- C. Septic tanks must have at least a two-inch drop between the invert of the inlet to the invert of the outlet. No liquid level drop is required between the compartments.
- D. Adequate venting must be provided between compartments by baffles or by an opening of at least 12 square inches near the top of the compartment wall.
- E. All compartmental walls must be designed to withstand the weight of the effluent against an empty compartment.

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Figure 7.8 below outlines the specifics for compartmented tanks.



A less common tank design is a meander tank with one or more baffle walls arranged longitudinally in the tank as shown. The flow enters one corner of the tank and travels the length of the tank where it moves across the tank to the next long chamber, changes direction, and travels toward the outlet. Here it may exit or be directed again into another longitudinal chamber and flow in the other direction once again. The objective of this circuitous flow path is to increase the length-to-width ratio, reduce short circuiting, reduce inlet and outlet turbulent zones, and improve overall tank effectiveness. One of the challenges of this design is to provide appropriate access ports for effective solids removal.

If a compartmented tank is used as a pump tank, the baffle wall should have an opening near the bottom to allow equalization of liquid level across the entire tank. The opening should be a product of the original manufacturing process. If an opening is retrofitted into the tank wall, care must be taken to preserve the wall's structural integrity. If no opening is included, the wall dividing the two compartments must have the structural strength to support the pressure of the water from one side. Otherwise when pump operation lowers the liquid level, the wall may collapse due to the force of the effluent in the other compartment. The compartment wall should be designed and manufactured to function as a load bearing wall.

Septic tank sizing for MSTs and other establishments

Requirements for septic tanks sizing for other establishments are given in MN Rules 7081.0230, Subp. 2, as specified below:

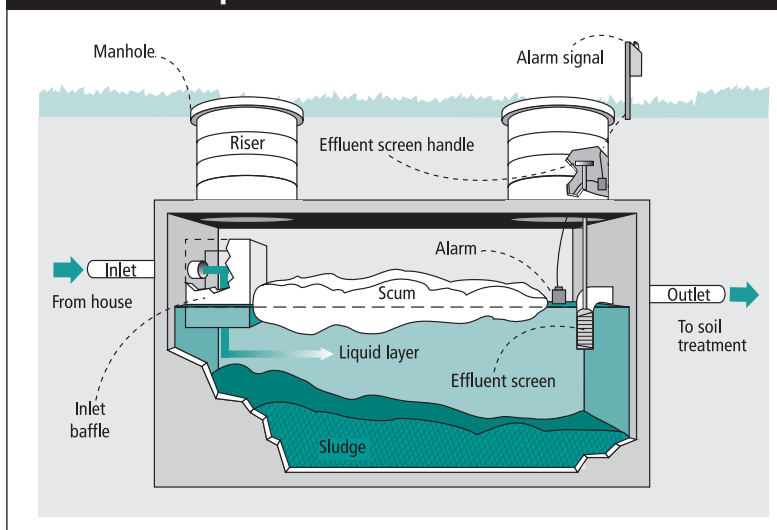
1. Total septic tank liquid capacity for other establishments with domestic strength waste is determined by multiplying the design flow by 3.0 if receiving sewage under gravity flow or multiplying the design flow by 4.0 if receiving sewage under pressure flow. Additional septic tank capacities or equalization tanks with pretreatment may be necessary for high strength waste sources connected to the other establishment.
2. Total septic tank liquid capacity prior to other treatment devices shall be according to manufacturer's requirements or accepted standards.

TABLE 7.3 Example Minimum Septic Tank Capacity for Other Establishments

Design Flow (gpd)	Minimum Capacity with Gravity Flow (gallons)	Minimum Capacity with Pressure Flow (gallons)
500	1,500	2,000
1,000	3,000	4,000
2,000	6,000	8,000
3,000	9,000	12,000
4,000	12,000	16,000
5,000	15,000	20,000

Lint filters, effluent screens, and pressure filters

FIGURE 7.10 Septic Tank with Effluent Screen



Effluent screens must be used as the outlet baffle on the sole or final septic tank or pressure filters must be used in the pump tank. Alarms must be employed on tanks equipped with effluent screens (7081.0240, Subp. 3). Figure 7.10 illustrates a tank with an effluent screen and a high water alarm that will notify the owner if the screen is plugged.

Tank geometry

A. For common septic tanks, the maximum liquid depth of septic tanks to determine liquid capacity must be no greater than 84 inches. The length-to-width ratio and the length-to-depth ratio must facilitate settling of solids.

B. For common septic tanks, the space in the tank between the liquid surface and the top of the inlet and outlet baffles must not be less than 20 percent of the total required liquid capacity (7081.0240, Subp. 4).

Septic tank design allows for a quiescent zone in order to slow the velocity of the waste-

water stream and optimize the settling of solids. In order to achieve this, the distance between the inlet and outlet should be maximized. A length to width ratio of at least 3:1 is preferable, with a recommended liquid depth of 3 feet. The practice of industry in some areas is to utilize tanks with length to width ratios in the range of 1.5:1 to 2.5:1, but 3:1 is preferable. For a given volume, shallower tanks result in increased surface area. This configuration will attenuate flow and promote settling of solids. The outlet pipe must be a minimum of 2 inches lower than the inlet pipe elevation, and a freeboard or air space must exist above the liquid level to allow venting of gases between compartments and out through the vent stack on the plumbing system of the house.

Special considerations in septic tank design

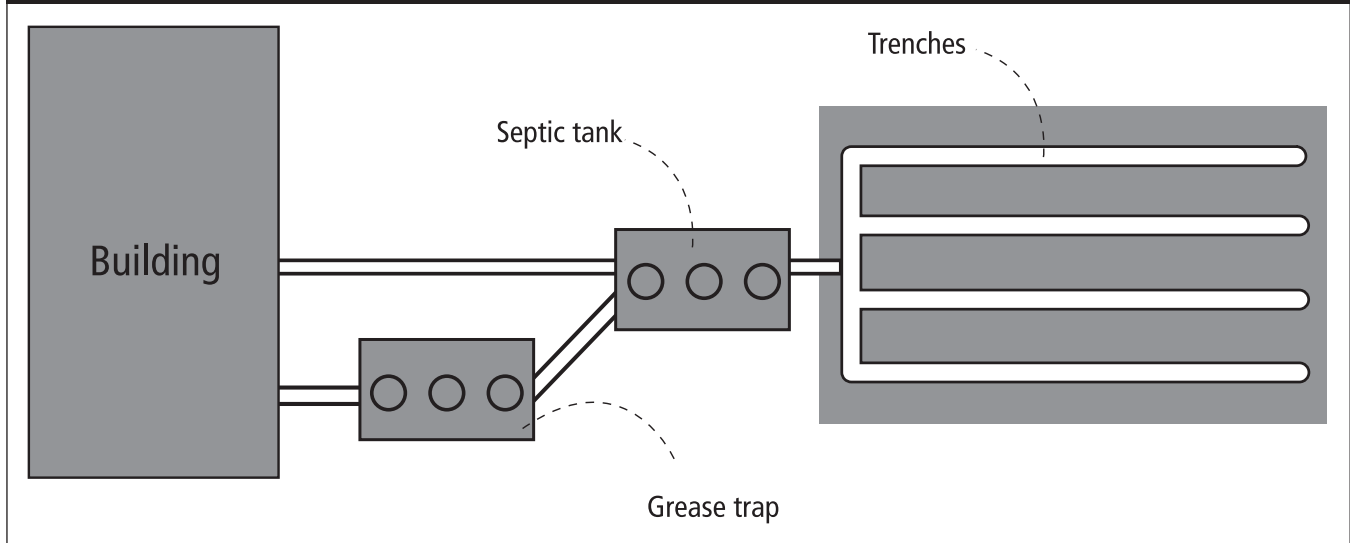
Special considerations should be made when designing a septic tank for any establishment that does not receive domestic strength sewage. Examples of those considerations can be found below.

External grease interceptors

A commercial or institutional food preparation facility such as, but not limited to, a restaurant, cafeteria, or institutional kitchen, served by a system regulated under 7081, shall install an external grease interceptor unless other grease control measures are taken and approved by the local unit of government. This grease interceptor will be considered part of the SSTS system (7081.0240, Subp. 7).

Grease traps may be included in residential or commercial treatment trains. Typically, the kitchen waste stream is plumbed to a grease trap while other waste streams are plumbed directly to a septic tank or other treatment tank as shown in Figure 7.11. The kitchen waste stream is typically high in organic material, including fats, oils, and grease (FOG). Grease traps are specifically designed to retain these constituents, provide minimal anaerobic treatment, and store undigested solids until they are removed from the tank. A grease interceptor is a smaller unit installed within the facility (instead of in an outside excavation like a grease trap) that serves the same purpose. Use of grease traps is particularly important on systems serving commercial food establishments because the kitchen waste stream is often the largest portion of the total wastewater generated. Removal of solids through use of a grease trap and periodic pumping protects downstream components that will malfunction if bypass occurs. Access for operation and maintenance (O&M) is critical for optimum performance because of the need for regularly-scheduled pumping of the component.

FIGURE 7.11 Separating Kitchen Wastes through a Grease Trap



Restaurants

Restaurant wastes typically contain large amounts of cooking fats, oils and greases (FOG). For the FOG to again coagulate and separate from the liquid as part of the scum layer, both dilution and cooling must take place. High temperature dishwashers, which have internal heaters, may discharge wastewater with temperatures as high as 1400F. Tanks that are in series, and thus with tank walls in contact with more soil, provide better cooling. Alcohol and dairy products have a high level of BOD that will not settle effectively.

Septic tank capacities along with additional pretreatment for restaurants should be large enough that the effluent from the tank(s) is of strength similar to that of domestic strength effluent. The BOD of the effluent should be less than 175 milligrams per liter; the TSS should be less than 65 milligrams per liter. It has been suggested that up to 7 days of detention time should be designed for establishments with high levels of organics and FOG.

Laundromats

Laundromats have the problem of excessive detergent use, along with the lint that is typically discharged with the wash water. Lint traps should be located in facility to limit the discharge into the septic tanks. **Lint filters are recommended if the sewage contains laundry waste (7081.0240, Subp. 3).** Effluent screens are also recommended along with outlet baffles submerged to 50 or 60 percent of the liquid depth to retain more floating solids. Generally, very little sludge accumulates in the septic tanks of laundromat systems.

Slaughterhouses

Blood has an extremely high soluble BOD, and is therefore very difficult to break down in a septic system. When slaughterhouses have their own onsite system, no blood should be allowed to enter the septic tank. There may be small amounts of blood entering with the cleanup water, but the great majority of the blood should be collected and disposed of separately from the sewage system. Pretreatment is the preferred design option for handling waste of this strength.

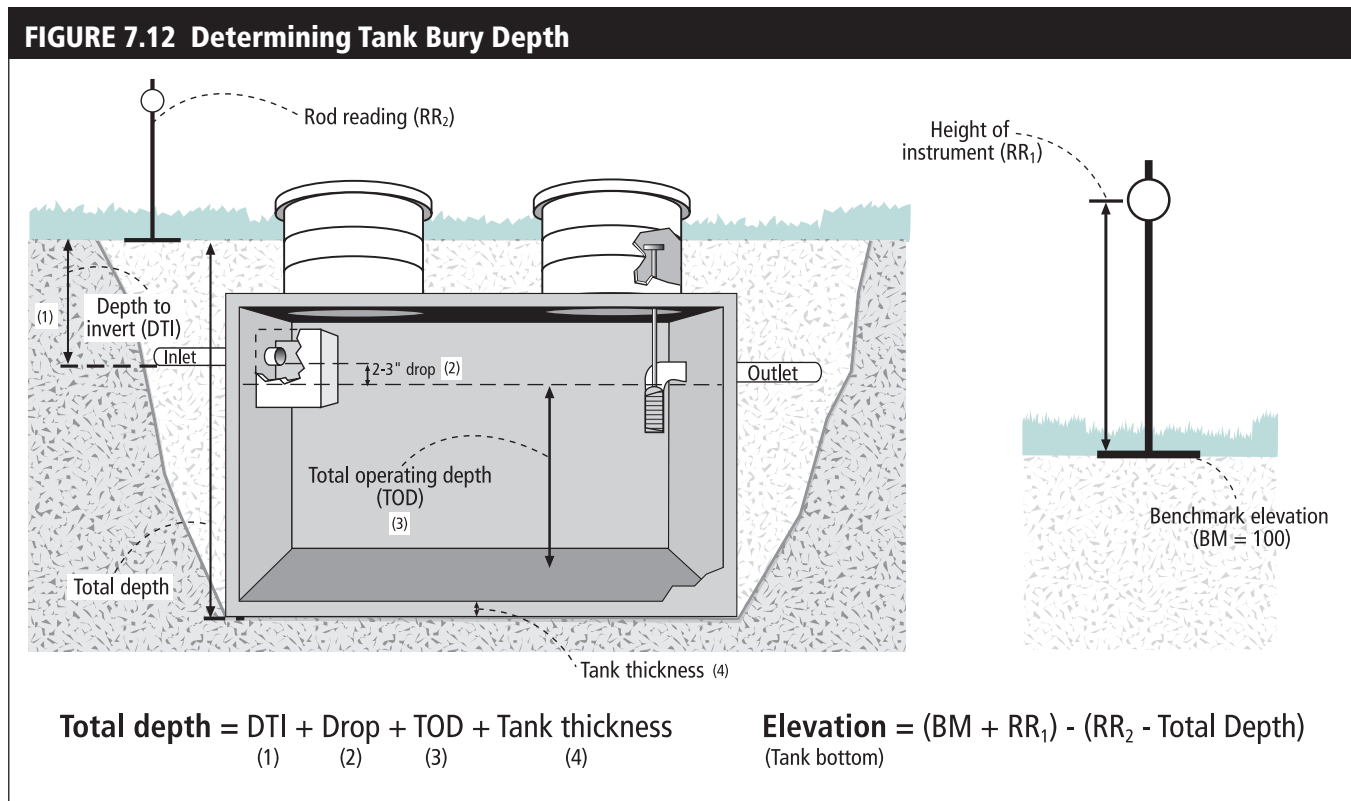
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Dairies, milkhouses

Milkhouse waste has a high level of soluble BOD and high levels of sanitizing chemicals. Consequently, a typical onsite drainfield should not be used with milk wastes. There are a number of ways to dispose of milk wastes if they are kept separate from other wastes. See http://www.manure.umn.edu/applied/milkhouse_waste.html for more information.

Tank Location and Bury Depth

The tank location should be determined considering both constructability and long term care. Chapter 7080 identifies setback distances for ease of construction and avoidance of management concerns. The code goes on to make sure the tank can be serviced long-term. These requirements include the avoidance of obstructions and the maximum bury depth of 48 inches. The access requirements also fit into these long-term management requirements. The schematic below illustrates how to identify the proper bury depth given certain benchmark elevations.



According to MN Rule Chapter 7080.2000, Location and Installation of Tanks:

- A. Sewage tanks must not be placed in areas that prohibit the removal of solids and liquids from the tank according to part 7080.2450.
- B. Sewage tanks must be set back as specified in Table VII in part 7080.2150, subpart 2, item F.
- C. The top of sewage tanks must not be buried deeper than four feet from final grade for new dwellings, unless a local ordinance allows for burial at a greater depth, not to exceed the tank manufacturer's maximum designed depth for the

- tank. The minimum depth of soil cover over the insulation on the top of the tank is six inches.
- D. Sewage tanks must not be placed in floodways, drainageways, or swales. Upslope drainage must be diverted away from the location of all tanks. A tank's final cover must be crowned or sloped to shed surface water.
 - E. Sewage tanks must not be placed in areas subject to vehicular traffic unless engineered for the anticipated load.
 - F. Sewage tanks must be placed on firm and evenly compacted soil and with the soil level in all directions. The bottom shall be excavated in a manner so the vertical load is borne by the tank walls and not the tank bottom. If the bottom of the tank excavation contains rocks, bedding material must be used according to manufacturer's instructions. The soil beneath the tank must be capable of bearing the weight of the tank and its contents.
 - G. Sewage tanks and risers must be installed according to manufacturer's requirements and in a structurally sound and watertight fashion.
 - H. If the top of a sewage tank is to be less than two feet from final grade, the lid of the tank must be insulated to an R-value of ten. Maintenance hole covers must be insulated to an R-value of ten. All insulating materials must be resistant to water absorption.
 - I. Sewage tanks placed below the level of the periodically saturated soil must employ a method to protect against flotation under periodic saturated soil conditions when the tank is empty.
 - J. Connections between the concrete tank and the building sewer or supply pipe must meet the requirements of American Society for Testing and Materials, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals, ASTM C923 (2002), or equivalent. The standard is incorporated by reference, is available through the Minitex interlibrary loan system, and is not subject to frequent change.
 - K. Joints of concrete tanks, concrete tank lids, and concrete risers must be sealed using a bonding compound that meets American Society for Testing and Materials, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants, ASTM C990 (2003). The standard is incorporated by reference, is available through the Minitex interlibrary loan system, and is not subject to frequent change.

Insulating Tanks

Insulation is necessary to maintain the internal tank temperatures necessary for active digestion when sufficient soil cover is not available. MN Rules Chapter 7080.2000 subp. H identifies that maintenance holes must be insulated if the top of the tank is less than two feet from final grade.

Vehicular Traffic

Standard concrete septic tanks are not intended to be installed under vehicular traffic loads. However, concrete tanks designed for traffic loading or special situations are available. Among the applicable industry standards that address designing load requirements for concrete tanks is ASTM C-857: Standard Practice for Minimum Structural Design

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Loading for Precast Concrete Utility Structures. Table 7.4 lists design criteria from Section 4 of the ASTM standard.

TABLE 7.4 Design Loads for Concrete Utility Structures (ASTM C-857)

Designations	Maximum Loads	Typical Uses
A-16	16,000 lbf/wheel	Heavy Traffic
A-12	12,000 lbf/wheel	Medium Traffic
A-8	8,000 lbf/wheel	Light Traffic
A-0.3	300 lbf/ft ²	Pedestrian Walkways

When designing an onsite system which may be subject to some form of live load factors due to potential vehicular traffic, a designer must follow established engineering analysis, including such items as: soil type, depth to groundwater, bedding materials, backfill materials, potential lateral earth pressures, and vertical loads. When designing onsite systems over which there may be vehicular traffic, designers would benefit from referring to AASHTO C98-HB-16 Standard Specification for Highway Bridges 16th Edition. The International Association of Plumbing and Mechanical Officials (IAPMO) Standard for Prefabricated Septic Tanks (IAPMO PS 1-2004) states that “septic tanks and covers shall be designed for an earth load of not less than five hundred (500) pounds per square foot when the maximum coverage does not exceed three feet”.

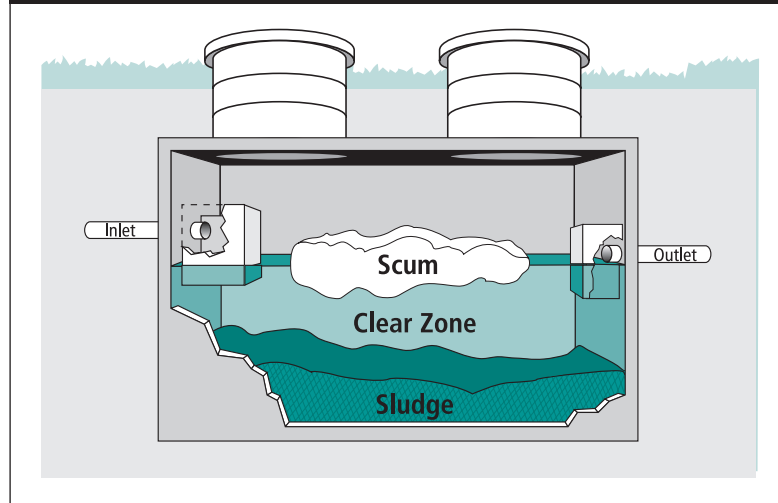
When considering use of tanks other than concrete in vehicular traffic areas, consult with the manufacturer or a structural engineer.

Septic tank alarms

Septic tanks with effluent screens are required to have a high water alarm. This alarm will indicate if the filter is slowing down the flow of effluent to a concerning level. The alarm can be as complex as an audible and visual alarm or can be as simple as a mechanical non-powered alarm (a float with a section of pipe that raises a visual indicator when the wastewater level is too high in the tank). Telemetry may be included as well. In this case, a high-water alarm triggers a phone or radio signal to alert someone (typically, the system O&M Maintainer/Service Provider that an alarm has been triggered. The height at which the alarm should be activated is dependent on how much storage is necessary after the alarm sounds. The elevation should be specified in the plans.

Tees and baffles

From MN Rules Chapter 7080.1100, Subp. 7, a baffle is defined as a device installed in a septic tank to retain solids and includes, but is not limited to, vented sanitary tees with submerged pipes and effluent screens. Baffles are structures made of various materials placed around the inlet or outlet pipe. These devices serve to direct incoming flow to or draw flow from the clear zone. Baffles extend only part of the way to the top or to the bottom of the tank.

FIGURE 7.13 Septic Tank Baffles

All septic tanks must be baffled according to items A to G (MN Rules 7080.1960). Effluent screens may be substituted for outlet baffles.

- A. Baffles must be installed at each inlet and outlet of septic tanks. Outlet baffles are required on compartment walls if the transfer hole is at the liquid level.
- B. Baffles must be resistant to corrosion or decay. Inlet baffles must not restrict the movement of solids.
- C. Baffles must be integrally cast with the tank or affixed at the top and bottom with connectors that are not subject to corrosion or decay. Baffles for fiberglass-reinforced polyester tanks are allowed to be either resin bonded or secured with suitable structural adhesive. Sanitary tees used as baffles must be affixed to the inlet or outlet pipes with a permanent waterproof adhesive.
- D. The inlet baffle must extend at least six inches, but not more than 20 percent of the total liquid depth, below the liquid surface and at least six inches above the liquid surface.
- E. The outlet baffle and any baffles between compartments must extend below the liquid surface a distance equal to 40 percent of the liquid depth, except that the penetration of the indicated baffles or sanitary tees for horizontal cylindrical tanks must be 35 percent of the total liquid depth. They must also extend above the liquid surface as required in item D. These baffles must extend at least six inches above the liquid surface.
- F. There must be at least one inch between the underside of the top of the tank and the highest point of the inlet and outlet baffles.
- G. The nearest point on the inlet baffles other than sanitary tees must be no less than six inches and no more than 12 inches from the end of the inlet pipe. The nearest point on the outlet baffle, other than sanitary tees, must not be closer than six inches and no more than 12 inches from the beginning of the outlet pipe to the baffle. Sanitary tees used as inlet or outlet baffles must be at least four inches in diameter.

7-16 ■ SECTION 7: Septic Tanks

Curtain baffles are partial walls (usually constructed of the same material as the tank itself) that extend across the short dimension and down into the clear zone of the tank near the inlet or outlet port. In the past, curtain baffles and pipe tees used as baffles were made of concrete or vitrified clay, which had a tendency to deteriorate over time in the septic tank environment. With the availability of composite materials, curtain baffles are not often used in modern tank construction and have been replaced by tees made of PVC. As the name implies, these are T-shaped pipes attached to inlet and/or outlet pipes.

TABLE 7.5 Baffle or Sanitary Tee Dimensions for Septic Tanks (inches)

Liquid Depth	Inlet Baffle					Outlet Baffle		
	Below Liquid		Above Liquid	Total Length		Below Liquid	Above Liquid	Total Length
	min	max		min	max			
30	6	6	8	14	14	12	8	20
33	6	7	8	14	15	13	8	21
36	6	7	8	14	15	14	8	22
39	6	8	8	14	16	16	8	24
42	6	8	8	14	16	17	8	25
45	6	9	8	14	17	18	8	26
48	6	10	8	14	18	19	8	27
51	6	10	8	14	18	20	8	28
54	6	11	8	14	19	22	8	30
57	6	11	8	14	19	23	8	31
60	6	12	8	14	20	24	8	32
63	6	13	8	14	21	25	8	33
66	6	13	8	14	21	26	8	34
69	6	14	8	14	22	28	8	36
72	6	14	8	14	22	29	8	37
75	6	15	8	14	23	30	8	38
78	6	16	8	14	24	31	8	39

The inlet pipe must be at least 2" higher than the outlet pipe.

There must be at least 1" of clearance between the outlet devices and the underside of the highest point of the inlet.

The use of a baffle or tee at the inlet is critical for proper tank operation. Baffles direct incoming wastewater flow downward to the level of the clear zone, dissipating the energy of the incoming flow to prevent turbulence and disruption of the segregated solids in the tank. They may also prevent short-circuiting of flow across the top of an accumulated scum layer to the outlet.

Outlet ports of septic tanks may be fitted with sanitary tees with drop pipes or with effluent screens. These are designed to retain floating solids in the tank. Outlet tees should extend far enough above the wastewater surface and deep enough into the clear zone to keep the scum layer from entering the outlet port. The scum layer can float several inches above the water level, so extending the outlet baffle above the top of the outlet pipe 4 to 6 inches is recommended. It should penetrate to about 40 percent of the liquid depth. Access openings or risers should be located so that the inlet and outlet devices can be inspected and serviced. In all cases, there must be a storage space between the top of the

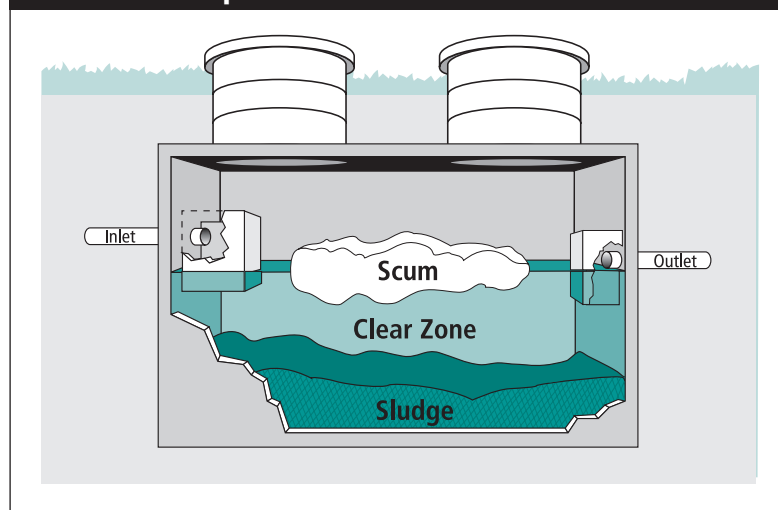
sewage and the top of the baffles of eight inches or 100 gallons, whichever is greater (MN Rules Chapter 7080.1920 subp. E). Table 7.5 above identifies allowable baffle dimensions based on tank size.

Access risers and inspection ports

Structurally sound and watertight risers are required over each tank access port in order to provide access for inspection and maintenance of tank appurtenances such as effluent screens and/or pumps. Risers and their lids may be made of concrete or composite materials such as polyethylene, PVC, ABS, or polypropylene. They are shown in Figure 7.14.

Access risers leading into septic tanks have traditionally been buried six to 12 inches beneath the ground in order to prevent unauthorized access to a tank. The practice of burying risers was viewed as a safety precaution to keep children from entering the potentially deadly environment. Chapter 7080 now requires that all access risers be brought to grade.

FIGURE 7.14 Septic Tank Risers



According to MN Rules 7080.1970:

- A. Septic tanks shall have a minimum of two maintenance holes with a minimum diameter of 20 inches (least dimension). One maintenance hole must be over the outlet device (baffle or screen). Another maintenance hole must be near the center of the tank, to facilitate pumping without interference. For a compartmented tank, this hole must be centered over the first compartment. The tank must also have an inspection pipe with a minimum diameter of six inches over the inlet baffle. Enough maintenance holes must be provided so access can be gained within six feet of all walls for solids removal of each compartment.
- B. All maintenance hole risers must extend through the tank cover above final grade.

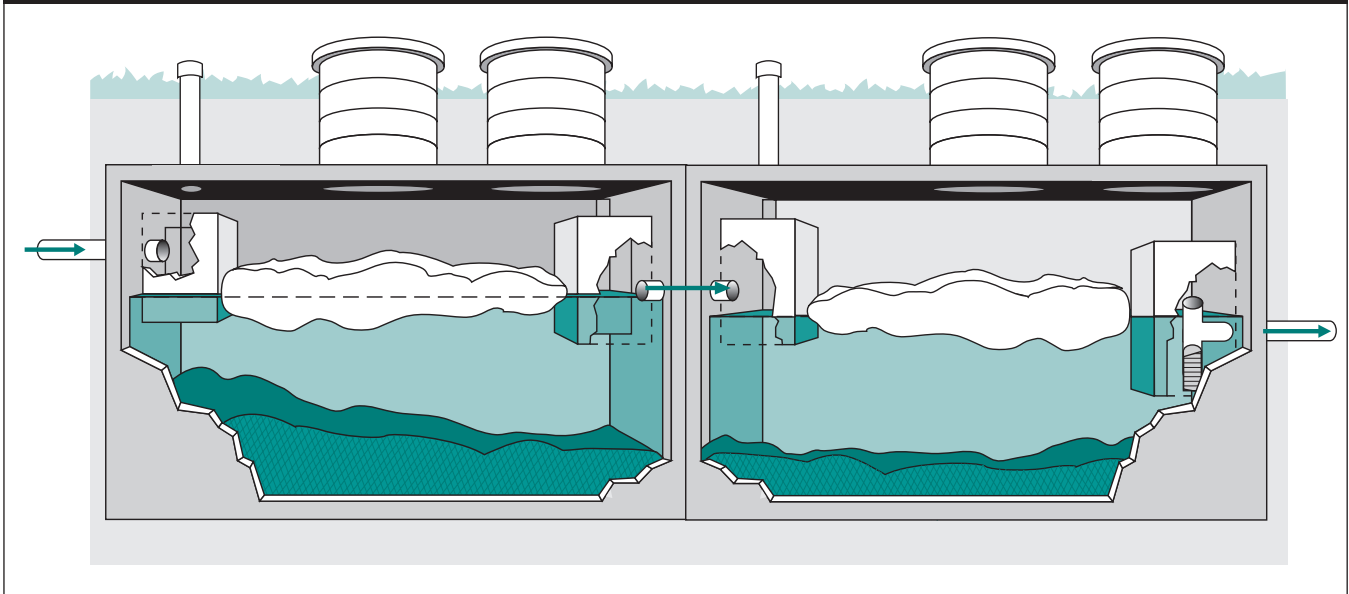
C. Covers for maintenance holes must:

1. be secured by being locked, being bolted or screwed, having a weight of at least 95 pounds, or other methods approved by the local unit of government. Covers shall also be leak resistant; and be designed so the cover cannot be slid or flipped, which could allow unauthorized access to the tank;
2. have a written and graphic label warning of the hazardous conditions inside the tank;
3. be capable of withstanding a load that the cover is anticipated to receive; and
4. be made of a material suitable for outdoor use and resistant to ultraviolet degradation.

The lid should be strong enough to support the weight of a man (about 200 pounds). If the lid is at the soil surface, strength is critical. Some concrete tank lids have two different thicknesses to hold them in place, which is a good idea, but if the top lid is too thin there can be problems.

The tank must also have an inspection pipe with a minimum diameter of six inches over the inlet baffle. The purpose of the inspection pipes is for cleaning the inlet baffle and for periodically evaluating the amount of sludge in the tank. Refer to Figure 7.15. A maintenance hole over the inlet meets this requirement.

FIGURE 7.15 Inspection Pipes over the Inlet Baffle

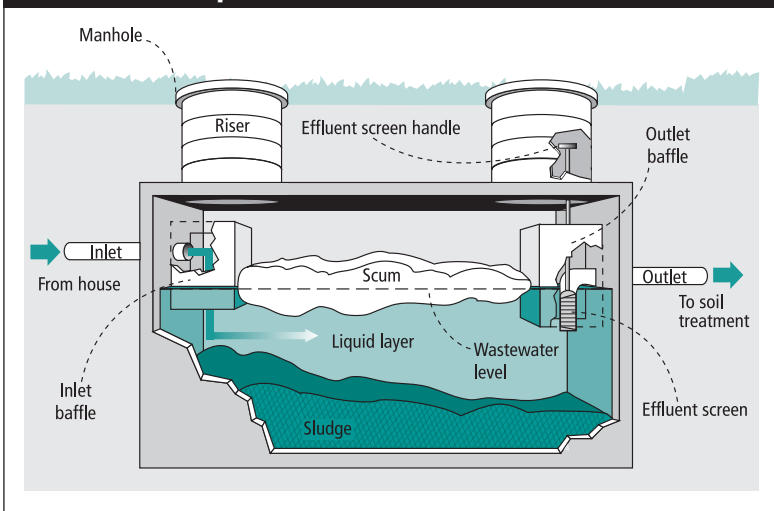


Septic Tank Effluent Screens

Septic tanks are designed to retain solids that accumulate over time. Some of these solids are byproducts of the waste treatment process, while others are materials that may not be

capable of being processed, such as human hair. It is important that the solids are retained in the septic tank and not released to the drain field. Excessive discharge of solids to the drain field can cause it to plug and lose efficiency in treatment and dispersal of the normal liquid flow. If the problem persists, the drain field may need to be replaced.

FIGURE 7.16 Septic Tank Effluent Screen



From MN Rules Chapter 7080.1100, Subp. 26 an effluent screen is a device installed on the outlet piping of a septic tank for the purpose of retaining solids of a specific size. Effluent screens are designed to help keep solids in the tank. These devices trap suspended solids, reduce the TSS concentration in septic tank effluent, and help protect the soil absorption field or other downstream treatment unit. They typically

replace the outlet baffle in the final compartment of the tank. All wastewater that exits the tank must first pass through the screen. Refer to Figure 7.16.

Several types of effluent screens are available, including multiple plates assembled with slots between, slotted cylinders, and multiple perforated tubes assembled together. Others may be fitted with an alarm or used in conjunction with a pump for pressurized applications. Although it is easier to install effluent screens in a new septic tank, several types can

be retrofitted to existing tanks. In addition to models that can be placed directly into concrete baffles, installation options include (1) replacement of PVC outlet tee or baffle with the effluent screen and housing; (2) placement in a sump outside the tank; and (3) placement within the pump vault of a pumped system. Solid accumulation in the screen will

cause poor performance of the septic tank, but creates a problem that is far easier and less expensive to clean and maintain than solids accumulation in the drain field. If the septic tank is maintained properly, including frequent inspection for solids accumulation and removal, then a screen may not be necessary.

Most screens are made of plastic with 1/16th inch to 1/8th-inch screen slots.

Choose and install effluent screens with ease of serviceability in mind since all will require service. Cleaning frequency depends on the overall size of the unit, screen opening size, and use. A screen in the second compartment of a two-compartment tank should require less service than a unit in a single compartment tank. Some effluent screens have shut-off mechanisms or secondary screens to keep solids from moving out of the tank when the screen is being cleaned. If such a device is not included, some solids may be discharged downstream when the screen is removed, thereby reducing its overall effectiveness.

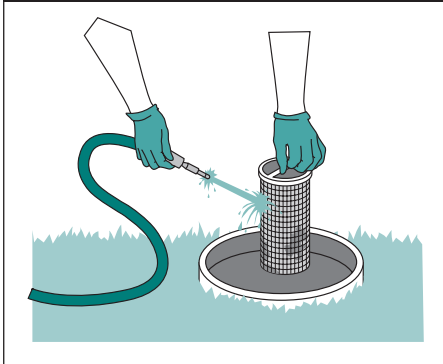
One method of preventing such solids discharge is to pump down the tank level before removing the screen for cleaning.

Effluent screens come in a variety of shapes and sizes, are produced by several different manufacturers, and have a range of applications from individual homes to commercial sites. The basic principle of the effluent screen is to provide additional surface area for suspended solids to collect and attach, before they can pass to the drainfield. Each screen is unique in its individual design, but all are similar in purpose; that is, to decrease the amount of solids carryover to the drainfield and by doing so reduces BOD and TSS.

Independent research performed at Tennessee Technological University (Treanor, 1995) suggests that effluent screens do indeed reduce suspended solids as well as BOD in onsite systems. The study was performed as research for a master's thesis, and was conducted at eight unrelated locations, under different loading rates and uses. Three different effluent screens were used. Statistical analysis showed that the screens significantly reduced the BOD and suspended solids in septic tank effluents. Although other research is being performed, there is still some debate on the overall effectiveness of septic tank effluent screens.

The effluent screen requires regular maintenance and must be periodically checked. As a concern for the homeowner's safety in dealing with the components of a septic system, most manufacturers and regulatory agencies recommend that a certified inspector or septic tank Maintainer or Service Provider provide this maintenance. The screen must periodically be removed from the tank, and the solids, which have been trapped and attached to the screen, must be washed back into the septic tank as shown in Figure 7.17. For this reason, it is more appropriate to have this maintenance done when the septic tank is being pumped. This perhaps is the one disadvantage of having an effluent screen. If the screen is not maintained, it will potentially clog and create problems for the onsite wastewater treatment system. Such an example could be plugging the septic tank, causing the sewage to back up into the home.

FIGURE 7.17 Cleaning an Effluent Screen



In choosing and installing an effluent screen, the following factors must be considered:

- Effluent screens are designed to reduce solids discharge, not necessarily BOD discharge.
- The screen case should act as an outlet baffle.
- Screens should allow solids of no greater than 1/16 to 1/8 inch to pass through the cartridge, depending on system design and regulatory specifications.
- The screen cartridge should be secured in place and should not allow bypass of unscreened solids if the screen openings become clogged.
- The effluent screen housing should be sized and placed so that it does not interfere with normal pumping of the tank.
- The estimated wastewater flow from the house should be matched with the surface area of the screen (i.e., as the design flow increases, more surface area must be provided).
- An access opening at grade over the screen should be provided for screen removal and cleaning as needed.
- The design should include a mechanism to prevent solids bypass during cleaning.

Tank Construction

Overview

From MN Rules 7080.1980

- A. All precast reinforced concrete sewage tanks must be constructed to meet the requirements of this chapter. Information on best practices for tank construction is found in the National Precast Concrete Association's best practices manual, *Precast Concrete On-site Wastewater Tanks (2005)*
- B. All fiberglass-reinforced polyester and polyethylene tanks must be constructed to meet the requirements of this chapter. Information on best practices for these tanks is found in the International Association of Plumbing and Mechanical Officials (IAPMO), *Material and Property Standard for Prefabricated Septic Tanks, Standard PS 1-2006 (2006)*.

Materials

Historically, many different materials have been used to construct septic tanks. Materials used in the past include redwood planks, bricks and mortar, and coated metal. Currently tanks are constructed using one of three materials: precast concrete, fiberglass-reinforced plastic (FRP), or rotationally-molded polyethylene/polypropylene resin (poly).

Reinforced concrete tanks have traditionally been used for onsite systems. This is reflected in the amount of information available regarding concrete tanks relative to tanks made of other materials. Concrete tanks are readily available, generally lower in cost than alternative materials and have, for the most part, proven to be reliable. Use of tanks fabricated from FRP and rotationally-molded polyethylene is becoming more common. Installing these tanks requires following manufacturer specifications and requirements.

Structural soundness

All septic tanks must be structurally sound in order to prevent collapse. They must be able to withstand handling and transport after manufacturing and not be susceptible to damage during installation. Additionally, tanks must be capable of supporting anticipated soil loads as well as a 2500-pound wheel load, and be able to withstand both internal and external hydraulic pressure. Regardless of the materials used in the production of septic tanks, structural integrity depends on good design, use of quality materials, proper manufacturing methods, and careful construction techniques.

- A. be capable of supporting long-term vertical loads for the conditions in which the tank will be placed. These loads include, but are not limited to, saturated soil load, based on 130 pounds per cubic foot;
- B. be capable of withstanding a lateral load for the conditions the tank will be placed;
- C. with proper maintenance and venting, not be subject to failure due to corrosion and degradation from sewage or sewage gases, including risers and maintenance hole covers; and
- D. be structurally capable of withstanding exposure and stresses from freezing conditions.

Subp. 2.

Poured-in-place concrete tanks.

Poured-in-place concrete tanks must be designed to meet each requirement of subpart 1 and be designed by a Minnesota licensed professional engineer.

Tank storage, transport, and use

According to MN Rule Chapter 7080.1990, the following rules apply to tank storage, transport, and use:

Subpart 1.

Precast reinforced concrete tanks.

Precast reinforced concrete tanks must:

- A. have a method to lift the tank for an ultimate load that is four times the working load;
- B. undergo proper curing to achieve a compressive strength of 4,000 pounds per square inch before transport, placement, or use; and
- C. have no pipe penetration points or openings in the exterior walls or tank bottom below the tank liquid level, unless designed for a specific operational purpose and approved by the local unit of government.

Subp. 2.

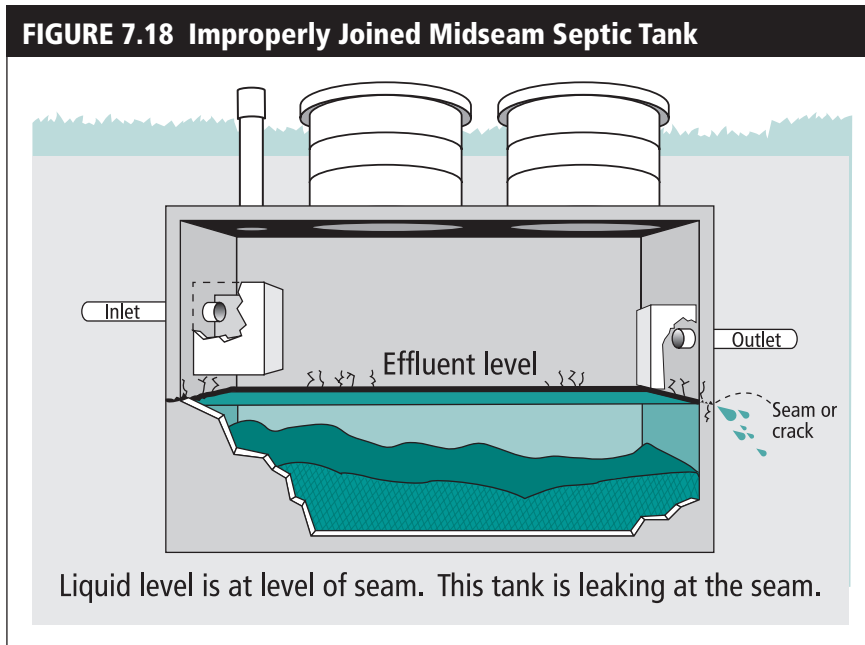
Other tanks.

Fiberglass-reinforced polyester or polyethylene tanks must be protected against deterioration during storage.

Precast concrete septic tanks and sealing materials

Precast tanks are widely accepted, readily available, and have proven long-term reliability. It is critical that they be manufactured properly to avoid leakage of water into the tanks or

untreated sewage into the environment, as shown in Figure 7.18.



Materials used to seal multiple-piece precast tanks typically consist of blended sealant compounds listed as butyl rubber-based or asphalt-based (bituminous). (Fuel/oil resistant sealants are also available for use on grease traps or in situations where petroleum products may be part of the waste stream.) Both types of sealant compounds should conform to ASTM Standard C-990 and AASHTO M198-75B standards that specify relative amounts of butyl rubber and fillers used in production. The federal standard SS-S-210(210A) provides information on the ratio of hydrocarbon to filler (typically cellulose or limestone) and temperature ranges for effective use.

Compressibility in cold temperatures (i.e., ambient temperature below 40°F) is a critical characteristic of a sealant compound. Bituminous (tar-based) mastic is widely used in warmer climates but is not appropriate in colder areas since it tends to crack under those conditions. In any climate, installation at low temperatures can render any seal ineffective. If tank sections are to be joined at temperatures below 40°F, measures should be taken to keep the sealant warm such as storing it in the cab of the delivery truck prior to use.

Quality mastic should not excessively compress when squeezed between the thumb and forefinger; when stretched, it should not shred or snap. Currently, there are no standards for mastic size, and the actual measurement of nominal one-inch mastic can vary in size to some extent. Because of this, a critical factor when evaluating the sealing potential of a sealant is its cross-sectional volume. Cross-sectional volume is defined as the geometrical shape of the sealant (i.e., 3/4 inches (H) x 1 inch (W)). Industry experience has shown that a sealant's cross-sectional height must be compressed a minimum of 30 percent to create a good seal, with 50 percent compression being desirable.

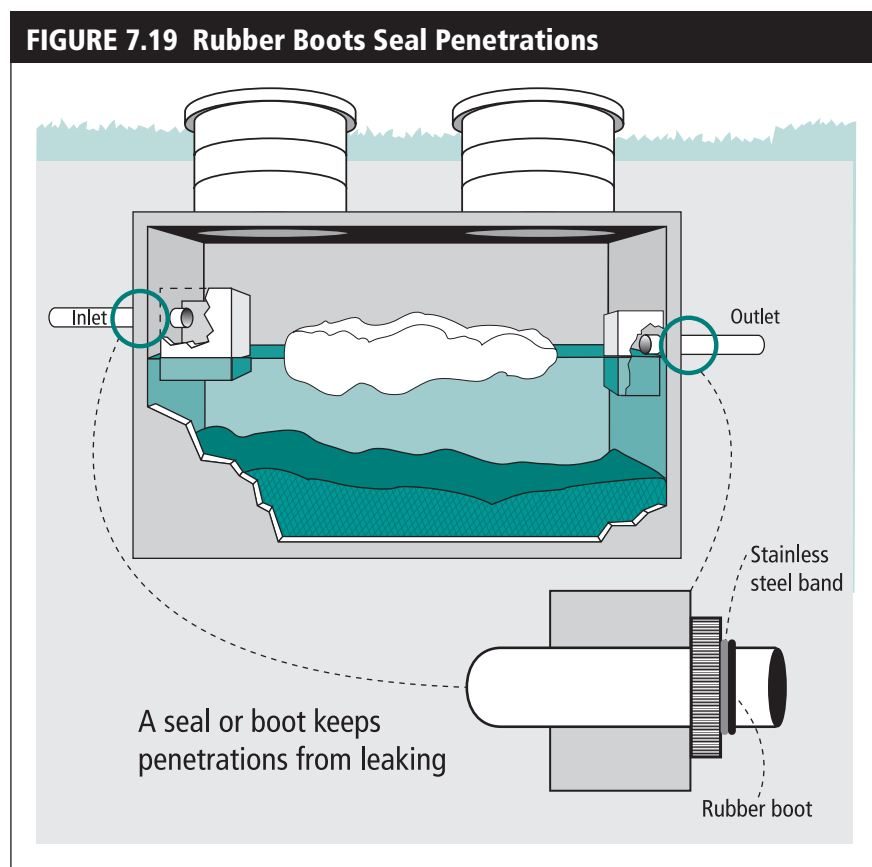
The seams to be joined should be clean and dry. If this is not the case, mastic manufacturers can provide information on primers to be used with their products. These are typically of three general types:

1. Liquid rubber;
2. A water based product that dries to a 'sticky' state; and
3. An all-season type that can be applied to wet or dry surfaces.

Mastics should be applied in a continuous bead. Opinions vary on how to join two pieces of mastic: the ends can be overlapped and kneaded together or the two ropes can be carefully butted up to one another. Ultimately it is critical to ensure a good joint seal. When placing mastic in a seam, a higher rope is better than a wider one. For extra assurance for watertightness after assembling the tank halves, a butyl rubber wrap (approximately 1/8-inch thick and 4 to 12 inches wide) can be applied to the seam.

Pipe penetrations for precast concrete tanks

Inlet and outlet pipe penetrations are a common potential point of leakage, particularly if the tank or piping settles or shifts after installation. These connections should be mechanically sealed to the tank so that they are watertight and flexible. Although bituminous seal, mastic, or concrete grout have been used for many years, newer flexible gasket and boot fittings are available that can be cast in place at the time of tank manufacture and provide a much more reliable seal. Rubber boot seals are particularly desirable because they are flexible and retain a seal during backfilling and settling as shown in Figure 7.19. Be sure the pipe is supported by the tank wall since the rubber boots will not structurally support the pipe.

**Rotationally molded polyethylene/polypropylene septic tanks**

Polyethylene/polypropylene (“poly”) tanks are a relatively new innovation. Some early poly tanks were prone to deflection and splitting. Newer model tanks have a ribbed design to enhance structural stability. These tanks are lighter than concrete tanks. However, they are more prone than concrete tanks to float out of the ground in areas of high water tables, and precise installation practices must be followed when using them. (These practices are discussed in Section V: Installation.) Manufacturers of non-concrete tanks state that they are not subject to rust or corrosion and are resistant to the chemicals and gases present in sewage and soil. Although there are no uniform standards for manufacture of plastic septic tanks per se, their use in the onsite industry dictates that they meet the same requirements

for structural stability and watertightness as all other septic tanks. As time passes, industry standards for manufacturing will undoubtedly evolve.

Poly tanks are rotationally molded in one piece. Sufficient, high-quality raw material and careful attention to manufacturing practices are essential for structural soundness and watertightness. Walls of these tanks are typically $\frac{1}{4}$ inch thick, and defects in wall thickness will compromise the integrity of the tank. As with tanks made of other materials, access riser joints and pipe penetrations must be properly sealed to make sure they do not leak. Rubber and plastic pipe seals are routinely used in the production of poly tanks, and access risers are typically made of the same poly materials as the tank itself.

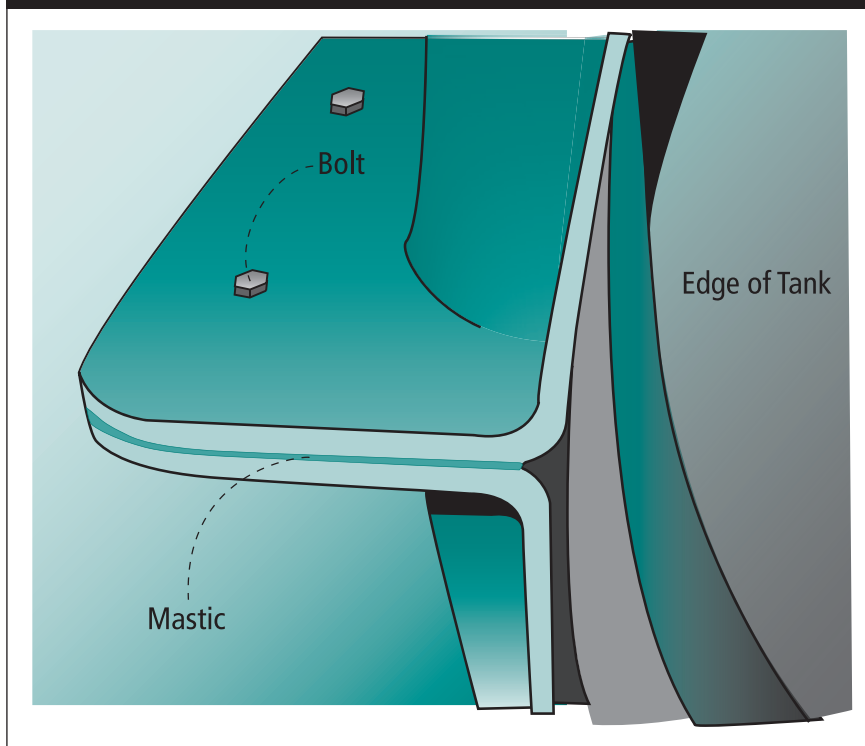
While their one-piece design implies that poly tanks should be watertight, it is imperative that they (and tanks of all other materials) be tested via appropriate methods. Most local codes specify where and how these tanks may be used; the reader is thus advised to review the strength requirements included in local and state codes when assessing the use of any tank in onsite systems.

Fiberglass reinforced plastic septic tanks

Fiberglass reinforced plastic (FRP) tanks are also relatively new compared to precast concrete tanks. Like the poly tanks discussed in the previous section, FRP tanks are light-

weight; so the same concerns regarding flotation and installation must be addressed. Manufacturers of FRP tanks advocate their use on the basis that they are not subject to rust or corrosion and are resistant to the chemicals and gases present in sewage and soil. There are established industry standards that address materials such as plastic laminates, rigid plastic, and cured reinforced resins. These may have a bearing on the production of FRP tanks. Specific standards for using FRP in the manufacturing of septic tanks are being considered by industry groups. Clearly, their use in the onsite industry dictates that they meet the same requirements for structural stability and watertightness as all other septic tanks. The reader is again advised to review the strength requirements included in local and state codes when assessing use of these tanks in onsite systems.

FIGURE 7.20 Two-Piece FRP Tank



Some FRP tanks are produced in one piece. Others are produced in two pieces using an injection molding process. As stated previously, sufficient, high-quality raw material and careful attention to manufacturing standards are essential for structural soundness and watertightness. It is possible (though not common) for FRP tanks to leak as a result of shipping damage, a substandard batch of adhesive, uneven application of adhesive, or stress placed on the midseam during installation.

Two-piece FRP tanks are often shipped unassembled and must be permanently fastened together before placement. The assembly process must be carefully done so that the joint will not leak or separate. Generally, this is achieved using appropriate adhesives and stainless steel bolts, as shown in Figure 7.20. The bolts are primarily used to hold the halves in place while the adhesive cures. As with tanks made of other materials, pipe penetrations and access riser joints must be properly sealed to make sure they do not leak. Rubber and plastic pipe seals are routinely used in the production of these tanks.

Constructing pour-in-place tanks

If the design specifies a pour-in-place tank, check with the system designer for specific design and installation requirements.

Overall Quality of Precast Concrete, FRP, and Poly Septic Tanks

Notwithstanding the wastewater source, the septic tank is the first component of any septic system. As such, it is important that high-quality, watertight tanks be used. If you are unsure about the quality of a tank, consult with a qualified structural engineer regarding potential problems with structural integrity. Ultimately, a hydrostatic or vacuum test of the tank after installation will indicate the status of watertightness.

A quality concrete tank should have the following characteristics:

- Reasonably smooth surface;
- No honeycombing or cracks;
- No efflorescence (the changing of crystalline compounds to a whitish powder through loss of water) that may indicate a very old tank or a bad pour;
- No exposed rebar or wire (inside or outside); and
- Smooth, well-made tongue-and-groove or lap joint with properly applied mastic.

A quality poly tank should have the following characteristics:

- Uniform wall thickness;
- No pin holes; and
- No deformation of tank or riser openings.

A quality FRP tank should have the following characteristics:

- Properly sealed mid-seam (if two-piece);
- No imperfections in lay-up;
- Uniform wall thickness;
- No de-lamination; and
- No cracks or dings from handling.

Additionally, tanks made from any of these materials should have:

- Flexible, watertight pipe seals at all pipe penetrations and
- Cast-in-place or mechanically-attached riser with tight fitting lid.

Keep in mind that a tank may have cosmetic deficiencies that do not affect performance in any way. Likewise, a tank may have an attractive appearance and still have structural

deficiencies. Ultimately, hydrostatic or vacuum testing should be employed to measure tank quality. These tests are discussed in the next section, Watertightness Testing.

Watertightness testing

All tanks used for MSTs must be tested for watertightness. The test shall be conducted to include the watertightness of all connections and risers (7081.0240, Subp. 5). Also all holding tanks must be tested (MN Rules Chapter 7080.2290 (B)).

There are many reasons to ensure that all septic tanks are watertight. Leakage from the tank releases minimally treated sewage into subsurface soils and/or groundwater. Sewage injected deeply in the soil profile is much less likely to be adequately treated as it moves down through the soil. In areas of relatively shallow water tables or where tanks are located in low areas, groundwater or surface water can leak into the tank. Inflow of groundwater can disrupt settling, treatment, and storage of solids (i.e., the important functions of the tank) as well as the function of downstream components of the wastewater treatment system. Possible locations on a septic tank where leakage can occur include:

1. Weep holes at the base of the tank. (Weep holes are used in some precast concrete tanks to release forms from tanks and to prevent collection of rainwater during storage prior to installation. If used, these should be sealed appropriately prior to installation.)
2. Mid-seam joint
3. Inlet/outlet pipe penetrations
4. Top-seam joint
5. Tank top/access riser joint
6. Access riser/lid joint
7. Any damaged, improperly-formed location or area where material is too thin.

The following rules are provided by MN Rules 7080.2010 regarding Tank Testing:

Subpart 1.

General.

- A. All sewage tanks must be watertight, including at all tank and riser joints, riser connections, and pipe connections.
- B. An assessment of all models of sewage tanks to be used must be conducted to determine:
 1. the structural integrity of the tank design; and
 2. the adequacy of the manufacturing process of watertightness.
- C. Sewage tanks, including riser joints, riser connections, and pipe connections must be designed, manufactured, and installed to be watertight under normal use.

Subp. 2.

Structural integrity of design test.

The structural integrity of each model of tank manufactured and all poured-in-place tanks must be verified by calculation, proof testing, or a licensed professional engineer to determine the horizontal and vertical loads that the tank can withstand when empty. Tanks must be reverified for structural integrity if the design, materials, or construction methods are modified. A licensed profession-

al engineer shall certify in writing if different manufactured models are similar enough so that the structural integrity information for one model is valid for other models. Verifications must be submitted to the commissioner. The commissioner shall maintain and make available the verifications upon request.

Subp. 3.

Watertightness test.

A. At least one tank per year, per model must be tested for watertightness. All poured-in-place tanks shall be tested for watertightness. Records of testing must be maintained by the manufacturer for three years and must be available to the commissioner and local unit of government if requested. Tanks must be tested and meet or exceed the applicable requirements of subitem (1), (2), or (3):

1. when empty, a tank must maintain a vacuum of at least two inches of mercury for five minutes, without loss of pressure;
2. concrete tanks must hold water for one hour, without loss, after the tank has been filled with water to the top of the tank, let stand for 24 hours, and then refilled to the same level; or
3. fiberglass-reinforced polyester or polyethylene sewage tanks must hold water without loss for one hour after being filled.

B. Sewage tanks that do not pass the tests listed in item A must not be used until repaired and retested. The repair and retest procedure must be repeated until the tank passes the test or the tank must not be used.

Hydrostatic testing

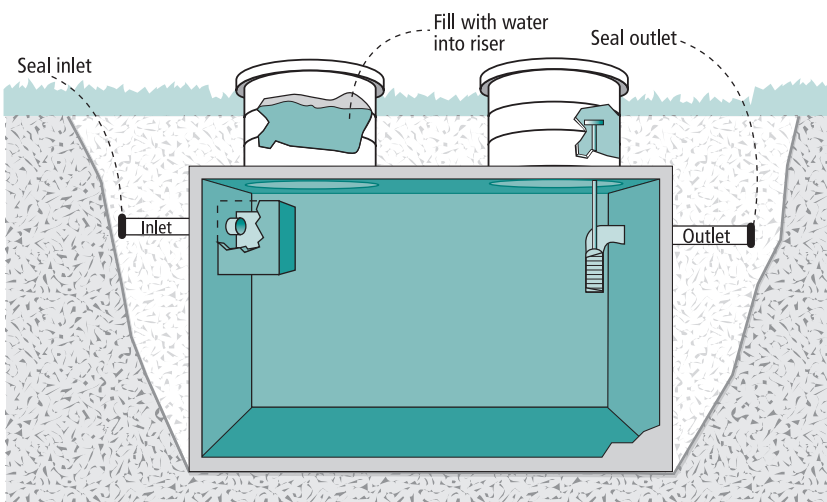
New tanks can be tested for watertightness by filling with water (hydrostatic testing) or by vacuum testing. In both cases, the tank should be tested in the ready-to-use state. Inlets

and outlets should be plumbed with the appropriate pipes, which can then be plugged for the test as shown in Figure 7.21.

Be careful when performing hydrostatic tests on plastic and fiberglass tanks as they gather much of their strength from soil support. For all mid-seam tanks, keep the backfill near the mid-seam, but leave the seam itself exposed to monitor the test.

The following is a suggested water testing procedure for tanks. Note that this test does not evaluate the tank's ability to withstand external pressures; that issue must be assured through adequate engineering design.

FIGURE 7.21 Hydrostatic Testing



1. Seal tank and fill with water into riser
2. Allow to stand for 24 hours
3. Check and refill if necessary (1-2" drop is acceptable)
4. Check 4 hours later and measure (There should no measurable drop)

Hydrostatic testing procedure for tanks:

1. Plug the inlet and outlet pipes with a watertight plug, pipe and cap or other seal. Seal the pipes away from the tank to test any pipe connections that may be of concern.
2. If testing a mid-seam tank, ensure that the seam is exposed for the water test.
3. Fill the tank to the top.
4. If the tank has a riser, add water into the riser to a maximum of 2-inches above the tank/riser seam. Care must be taken not to overfill as the top section of a two-piece tank may become buoyant.
5. Measure and record the level of the water.
6. Let the tank sit for 24 hours. Any obvious leakage during this time should be evaluated and remedied by the application of a suitable sealing compound.
7. If the test reveals leaks that cannot be repaired, the tank is considered unacceptable.
8. Refill concrete tanks to original level after 24 hours as they will absorb some water.
9. Check again after 24 hours. If less than 1 gallon is lost in a concrete tank, the leak test is considered acceptable.

Tables 7.5 and 7.6 provide information for calculating volumes in square and round risers.

TABLE 7.5 Depth Change Equivalent to One Gallon in Round Risers of Various Interior Diameters

Riser diameter (Inches)	Depth Equal to One Gallon (Inches)
18	0.91
24	0.51
30	0.33
36	0.23

TABLE 7.6 Depth Change Equivalent to One Gallon in Square Risers of Given Interior Dimensions

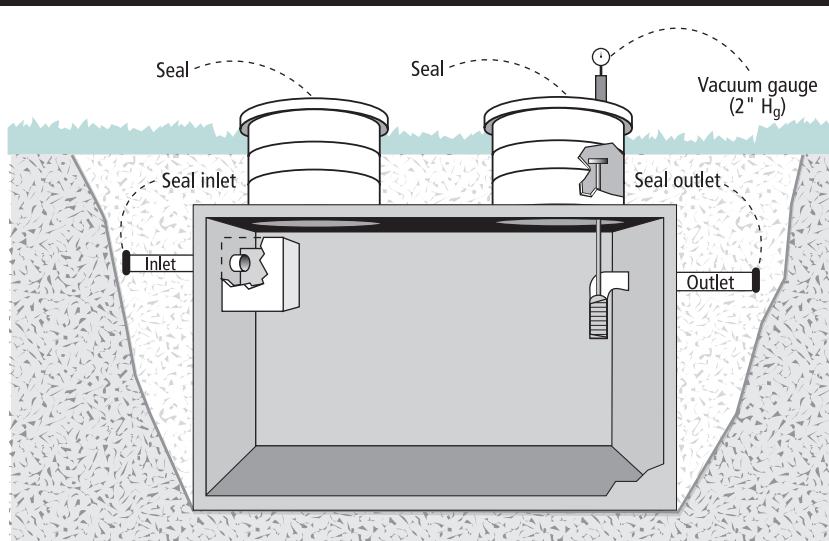
Riser Dimensions (Inches)	Depth Equal to One Gallon (Inches)
18 x 18	0.71
24 x 24	0.40
36 x 36	0.18

When performing hydrostatic testing in cold climates, there are a few important points to consider. First, water is its densest at about 4 degrees C (just above freezing), so water put into a tank at 10-20 degrees C (typical of groundwater) and left in the tank overnight at freezing temperatures will drop the level in the tank a substantial amount (about 2%, or 3 gallons in a 1500 gal tank). A “loss” of 3 gallons in the risers will look like a leak. Additionally, water used in the test will freeze and expand by approximately 9%. If the site is not occupied quickly, the tank may crack as a result of the test itself.

Vacuum testing

Vacuum testing of tanks requires less time than hydrostatic testing and can be performed without having water available on the site. Testing should be done on the tank in its ready-to-use state (i.e., pipes in the inlet and outlet, risers with lids, etc.) In this test, all pipe penetrations, manholes and risers are sealed airtight, and a special insert is sealed on one of the tank manholes. Using a pump, air is evacuated through this insert to a standard vacuum level, and the reading on a vacuum gage is recorded.

FIGURE 7.22 Vacuum Testing



1. Seal tank - Cap inlet and outlet pipe
2. Apply vacuum to 2" of H_g
3. No loss of pressure in five minutes

penetrations, manholes and risers are sealed airtight, and a special insert is sealed on one of the tank manholes. Using a pump, air is evacuated through this insert to a standard vacuum level, and the reading on a vacuum gage is recorded. Local codes, ASTM standard C-1227, or the National Precast Concrete Association (NPCA) standard can be used to determine the target vacuum for the size, shape, and tank material being used. Be careful not to exceed the recommended vacuum level. It is possible to damage or implode a tank.

As of August 2003, the NPCA standard states: "The recommended (vacuum test) procedure is to introduce a vacuum of 4 inches of mercury. Hold this pressure for 5 minutes. During this initial 5 minutes, there is an allowable pressure equalization loss of up to a half-inch of

mercury. If the pressure drops, it must be brought back to 4 inches and held for a further five minutes with no pressure drop."

If a tank will not hold the vacuum, leaks must be located and repaired. The test can then be repeated. If the tank cannot be repaired and rendered watertight, it should be replaced. Note that vacuum testing of concrete tanks draws seams together for a positive mastic seal, assuming there are no other problems. With any tank, collapse, deflection, deformation, or cracking indicate a poor quality tank. It is important to test the entire system: tank, pipe sleeves, risers, inspection ports and lids.

Visually examining existing tanks

It is more difficult to check watertightness in an existing septic tank. Adequate testing requires a period of several hours to a day or more without inflow to the tank and that inlet and outlet pipes be sealed off. Seal the line at the distribution box (or other appropriate place in the case of secondary treatment units) and at the clean-out between the building and the tank. Apply vacuum or water as desired. If there are no leaks, the entire system passes in one step. If there are leaks, successive tests will locate the source or sources.

Although actual testing of existing tanks may be impractical, much can be discerned by a thorough inspection of a tank both before and after it has been pumped out. Most tanks built using older methods of construction (such as built-in-place block or brick tanks) would typically not be watertight or structurally sound and probably cannot reasonably be repaired. In some cases, it may be possible to do more to check existing tanks. If the soil around the tank is saturated, the tank contents can be pumped down and observa-

tions made over the next few hours to detect leakage into the tank around pipe penetrations, seams, or through breaks in the tank. Caution should be exercised, however, as high groundwater may cause empty tanks to become buoyant and float out of the ground. Alternately, excessive soil pressure may collapse a tank. If there is any doubt about the integrity of the existing tank, it should be replaced. MN Rules Chapter 7080.2450 subp 2 A requires the tank to be visually inspected for leakage no less than every three years.

Tank labeling

According to MN Rules 7080.2020 sewage tanks must be properly labeled at the outlet with the following information:

- 1. the manufacturer's name;**
- 2. model number;**
- 3. liquid capacity;**
- 4. date of manufacture; and**
- 5. maximum depth of burial.**

In addition the tank inlet or outlet must be clearly marked and the installer shall submit items 1-5 above with the as-built drawing.

Tank installation

Safety

Maintaining a safe working environment during installation is essential. All excavations should comply with OSHA standards and must be done so that they are protected from sidewall collapse. Once a tank is in the hole, workers should never be in the hole between the tank and the excavation walls. If for some reason this is necessary, excavate back the sidewalls to prevent collapse, or use trench boxes for support. As a boom truck or other machine handles the tank, workers must stay clear of the unit and never be directly under the tank. Lifting slings must always be placed in grooves of concrete tanks or attached to lifting rings of FRP. Lifting slings must be placed at the appropriate location on poly tanks.

Planning and excavation

The first step in tank installation is to be sure the building stub-out elevation is consistent with that required to install the tank and soil treatment system at the correct elevations. Tanks should be kept as shallow as possible to minimize soil pressure and potential groundwater infiltration, and (where site conditions or regulations dictate) to keep the soil treatment system as shallow as possible. The tank inlet must be set to provide a slope of between 1 percent and 2 percent (i.e., 1/8 inch to 1/4 inch drop per foot of run) on the building collection pipe from the stub-out to the tank. The tank dimensions must be known so that the excavation can be made to the proper depth, assuring that the tank inlet will be set at the proper elevation. Proper compaction of the underlying soils and bedding materials is critical to minimize later settling. Excessive tank settling is measurable, predictable and preventable. Proper evaluation of the original soil, bedding materials, depth to groundwater, backfill materials, and potential stress loads reduces the extent of later settling.

Setting and securing a tank

Workers must be safely positioned while tanks are being set. Compliance with OSHA standards is critical. The tank must be set level to provide the proper drop from inlet to outlet. Level of the tank should be carefully checked as it is set in the excavation.

Installing two-piece concrete or FRP tanks requires that sealing materials be properly applied to a clean, smooth surface so that the joints will be watertight. Seams may be sealed at the point of manufacture or in the field.

Sewage tanks and risers must be installed according to manufacturer's requirements and in a structurally sound and watertight fashion. Sewage tanks placed below the level of the seasonally saturated soil must be anchored or have sufficient weight to protect against flotation under high-water table conditions when the tank is empty.

Installation in high water table conditions

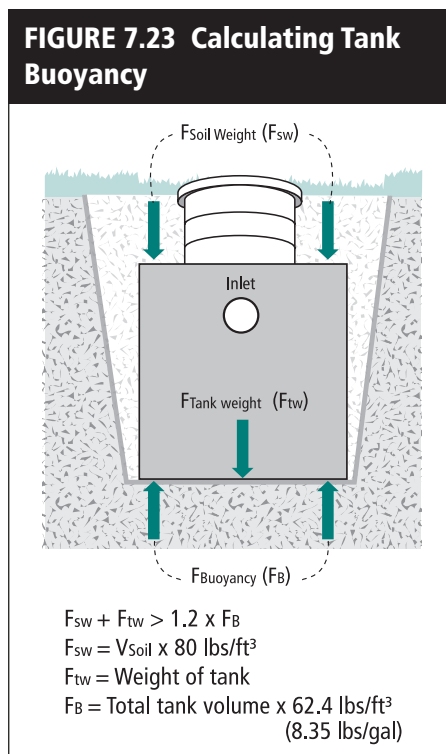
Under some soils and site conditions, granular backfill may create a void area where subsurface water can collect, creating hydrostatic pressure on the exterior of a tank where high groundwater conditions are not otherwise present. If groundwater to grade is possible, a concrete collar over the midseam or the installation of "deadmen" (steel cables attached to heavy concrete blocks) may be required for counteract buoyancy. Note that the use of a concrete collar with poly tanks may have an adverse affect on tank integrity because of chemical interaction between the materials.

Trenching leading to and from the tank excavation should include earthen dikes or diversions to prevent the free flow of groundwater into the tank excavation. Failure to include such water diversions may result in the creation of a "French Drain", which channels water directly to the tank excavation. When installing in areas with high water tables it may be necessary to incorporate a separate drain tile system to divert water away from the septic system.

All tanks have the potential of being lifted out of the ground due to forces acting on the tank in saturated soil. In many instances, the tank hole is excavated into a relatively solid material. Once the tank is placed in the excavation, the hole is backfilled with a less dense material that allows water to collect in the excavation. Even though the surrounding soil is not saturated, the excavated volume may still become saturated. The upward force (buoyant force) is equal to the weight of the water displaced by the tank. If the weight of the tank and the soil cover does not exceed the buoyant force, there is a risk of flotation, as shown in Figure 7.23.

If the buoyant force is a concern, the design should specify some sort of countermeasure to prevent the tank from floating. Methods include tying the tank down to a "dead man" or soil tie-downs as shown in Figure 7.24. Another option is to pour a collar of concrete around the tank.

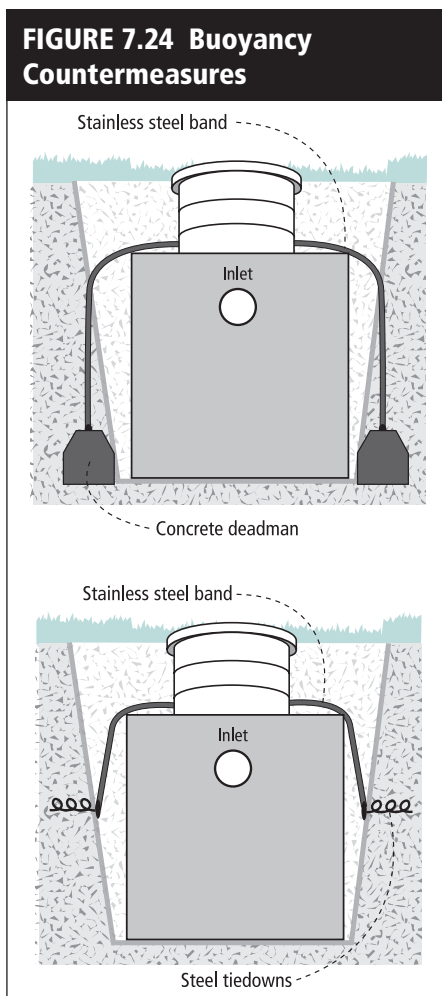
No matter what anti-floatation methods are used, be sure that the tank can handle any increased load and be sure that the buoyant force acting on the bottom of the tank will not cause the tank bottom to implode. Questions or concerns should be directed to the system Designer without delay because floatation is a significant safety concern.



Minimizing the forces allowing the tank to float or come to the surface due to the buoyant force acting on the tank is a critical concern. The force of the water surrounding the empty tank is equal to the water displaced by the tank plus a safety factor. The forces keeping the tank buried are the weight of the tank and the weight of the soil. In order for the tank to surface, the force of the water needs to be greater than weights keeping the tank buried. An example would be a 4 feet x 7 feet x 6 feet deep (total depth) tank. This tank is buried 3 feet deep and weighs 11,000 lbs., the weight given by the manufacturer of the tank. The forces pushing up are $\{4' \times 7' \times 6' = 168\text{ft}^3 \times 62.4 \text{ #/ft}^3 \times \text{safety factor } [1.2-1.5] = 12,579$. The total buoyant force is 12,579 lbs. upward. The downward forces are $11,000 \text{ #} + 4' \times 7' \times 3' \text{ [bury depth]} = 84\text{ft}^3 \times 80 \text{ lbs/ft}^3 = 11,000 + 6,720 = 17,720 \text{ #}$

This tank is designed to stay buried even when empty.

FIGURE 7.24 Buoyancy Countermeasures



In these situations dewatering during installation may be needed. The methods for dewatering including:

- **Hole at one end of the excavation:** This is appropriate on sites with finer-textured soils where the flow through the soil is slow enough that a pump can keep pace. The pump must be removed once backfilling begins.
- **Hole with sump:** A slotted pipe backfilled with washed rock serves as a sump at the end of the excavation. A pump installed inside the slotted pipe removes collected water. This method allows the back filling process to proceed while continuing to pump. If this is a long-term scenario, appropriate management strategies should be required.
- **Well points:** These are used to control a regional water table in sandy soils and must be designed and installed well in advance of the excavation. This option is chosen when the water enters the excavation faster than a sump can dewater. This application may or may not be permanent and is often tightly regulated.

Dimension/capacity check and the use of existing tanks

It is the responsibility of the Installer to verify that new tank(s) delivered to the site meet the minimum requirements of the design. If the design indicates that an existing tank be used as part of replacement system, either the Designer or Installer must verify that the existing tank is watertight.

A design will either indicate the required tank capacity or specify a particular tank from a designated manufacturer. It may also state that an equivalent tank may be used. Adequate tank capacity is critical to effective performance and must always be the starting point for determining tank equivalency. Configuration should be considered next. The length of a septic tank determines the

length of the flow path and thus the time available for settling and floatation of solids. A shorter septic tank has less operating depth which means less storage for solids. When evaluating equivalency of tanks, the installer must consider this relationship between tank dimensions, operating depth, and operating volume.

The overall tank dimensions (both inside and outside) should be documented. The outside tank dimensions (length, width, and total depth) must be known so that the excavation can be made to the proper length, width, and depth. The depth below the pipe

inverts is typically the measurement used to determine the depth of the excavation. **There must be a drop of 2 inches between the inlet pipe and the outlet pipe (MN Rules Chapter 7080.1920).**

Placing and bedding tanks

Sewage tanks must be placed on firm and evenly compacted soil and with the soil level in all directions. The bottom of the tank excavation should be excavated so that the vertical load is borne by the tank walls and not the tank bottom. If the bottom of the tank excavation contains rocks, bedding material must be used according to manufacturer's instructions. The soil beneath the tank must be capable of bearing the weight of the tank and its contents.

The depth of the excavation should take into consideration a layer of granular material (washed stone or coarse sand) with which tanks should be bedded. This bedding is helpful to fully support the bottom of the tank and distribute the weight evenly. Avoid over-excavating the hole to maintain relatively undisturbed soil under the granular material. In the event of over-excavation, clean, granular material should be used to re-establish the correct elevation. Ensure that there are no native rocks under the tank that could rupture the structure. This is important for all types of tanks. Note that in some cases, naturally occurring soil may serve as suitable bedding material.

Insulating tanks

According to MN Rules Chapter 7080.2000 H, If the top of a sewage tank is to be less than two feet from final grade, the lid of the tank must be insulated to an R-value of ten. Maintenance hole covers must be insulated to an R-value of ten. Maintenance hole risers should be insulated to an R-value of ten. All insulating materials must be resistant to water absorption. Tank walls, lids, and risers may all be insulated, and a number of options are available for this purpose:

- Insulation board can be placed along the side and on top of the tank prior to back-filling.
- A flexible insulation board can be wrapped around the riser.
- If a riser is installed over a smaller tank opening a piece of insulation can be placed inside the riser above the smaller tank opening.
- Two feet of soil (although some contractors use 48 inches as the measure below the frost line) should provide enough insulation for operation in cold climates. Tanks buried at shallow depths (less than 2 feet of soil cover) may require additional insulation.
- In most situations, just the tank lid will be insulated with foam board.
- Spray-on insulation is now available and provides an additional sealant for seams coated in the insulation. In order for this option to be effective, there must be no loose-fitting manholes, broken inspection pipes, or unsealed conduit that may allow cold air to be drawn into the tank.

Be sure that the insulation used for the tank is designed for burial. Keep in mind that insulation is not necessary for all tanks buried deeper than two feet. For example, if the system is not used during colder times of the year, the tank contents may freeze because warmer water is not being added. In this case, insulation can actually delay the thawing process in the spring.

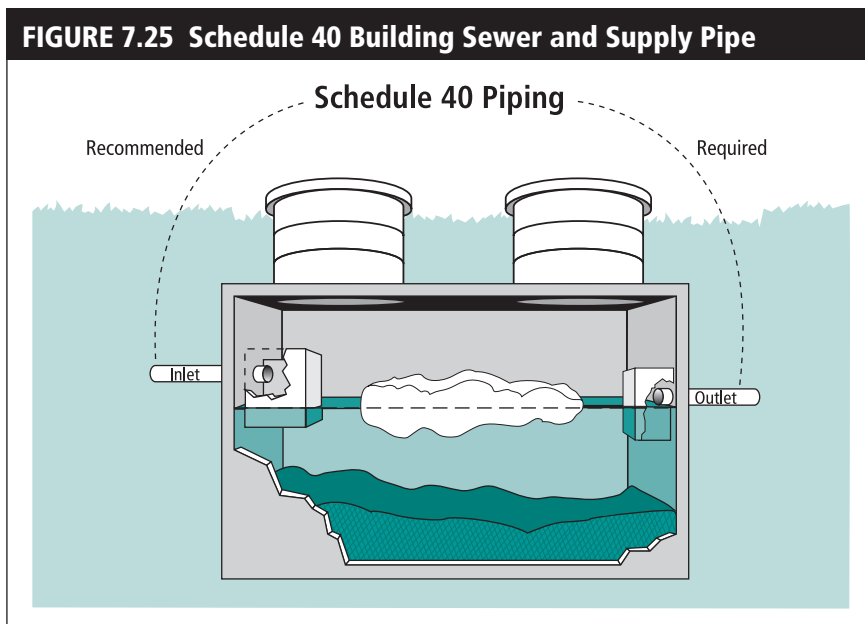
Pipe penetrations

Connections between the concrete tank and the building sewer or supply pipe must meet the requirements of American Society for Testing and Materials, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals, ASTM C923 (2002), or equivalent.

Check for settling of soil around the tank. Depressions in the soil at the edges of the tank can lead to ponding of rainwater, followed by infiltration. The pipe going out of the tank should also be constructed and installed to minimize soil settling. For existing systems, note the presence of cast iron pipe, clay pipe, or orangeburg, which can react with soap products, causing corrosion and eventual flow problems. Cast iron pipe should be avoided or replaced if at all possible.

For all types of tanks, pipe penetrations must remain watertight after backfill; therefore, it is critical to assure that there is no movement of the inlet and outlet pipe during the backfill process. Movement of this pipe during or after backfilling can alter the working liquid elevation in the tank and can damage or displace the effluent screen and case. Tamp the backfilled soil under the pipe to give it a firm foundation. The section of pipe across the excavation from tank to undisturbed soil should be rigid (Schedule 40 PVC or stronger) to reduce deflection. Pipe seals formed with mortar, mastic, and some rigid plastic seals are likely to be sufficiently stressed during the backfill operation that they may leak and allow root penetration. Attempting to bond wet mortar to dry concrete or PVC is not an effective pipe seal. As illustrated in Figure X, flexible boot seals can overcome this problem and are highly recommended.

Even though the MR 7080-83 code only specifically addresses the supply or outlet piping, the principles apply to both sides. The pipe should be supported and stiff enough to avoid settling across the excavation. This includes compacting and using at a minimum schedule 40 pipe as shown in Figure 7.25.



Baffling

Some tanks have baffles that must be installed by the installer. A tank may have an inlet, outlet, and/or a compartment baffle.

An inlet baffle is intended to direct the incoming flow downward into the clear zone and protect the inlet piping from being clogged by the scum layer. There are typically two different kinds of inlet baffles used in tanks. One type is a plate or partial wall baffle which is separate from the piping. These devices must be attached to the walls using appropriate fasteners (i.e., stainless steel connectors). Plate baffles may be installed by the manufacturer prior to delivery of the tank or by the installer after the de-

livery. Be sure that as the building sewer pipes comes into the tank that a sufficient space exist (4" - 6") to allow solid chunks to drop and not block the pipe.

Another type of inlet baffle is a sanitary tee. A sanitary tee is different from a standard tee in that it has a flow line that will not catch solids. Like plate baffles, these can be installed at the site by direct attachment to the inlet piping (building sewer) on the inside of the tank. This standard PVC connection must be made using the proper materials and procedures as described in the piping section. Some tanks are delivered with a sanitary tee already installed. If the inlet baffle is installed by the manufacturer, be sure that the stub of piping is long enough to extend past the excavation so that the joint to the next pipe section is located over unexcavated soil. Care must be taken to support this connection because any settling increases the potential for leaks or shifting of the tee out of plumb.

Like the inlet baffle, an outlet baffle may be either a partial wall baffle or a pipe configuration. The outlet baffle typically extends to the middle of the operating depth of the tank so that effluent is drawn from the clear zone of the outlet.

An effluent screen is typically placed in the tank outlet to remove additional suspended solids that could potentially clog downstream components. Proprietary screens often include a housing that essentially serves as a tee. Alternately, the screen is designed to be inserted into a standard tee. The screen must be installed under the tank access so that it can be inspected and maintained.

Sealing between joints, inlet and outlet pipes

Joints of concrete tanks and concrete tank lids must be sealed using a bonding compound that meets American Society for Testing and Materials, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants, ASTM C990 (2003).

Access risers and inspection pipes

Risers must extend to the final finished grade (or 1 to 3 inches above) and the ground should be sloped away to prevent surface water collection or inflow around the riser. Access risers for use with concrete tanks are available in a variety of materials. Typically, rises for precast concrete tanks are manufactured from precast concrete, polyethylene, polypropylene or ribbed PVC. No matter what material is used, the riser must be structurally sound and watertight.

Concrete risers may be cast into concrete tanks with a "cold joint". The riser itself is produced separately and allowed to cure. It is then placed into the tank or tank lid form, and the structure is poured. This cold joint will require further sealing (mastic or other appropriate sealants) to ensure watertightness. Concrete riser section joints should also be wrapped to better seal them. Polyethylene, polypropylene and PVC risers can also be cast directly into concrete tanks. Because of concerns regarding an effective bond between concrete and some of these materials, supplemental seals should be used to ensure watertightness. If additional riser sections are added, joints should again be wrapped. Note that cast-in-place risers are the best choice in high groundwater conditions and in cold climates where frost heave might otherwise cause separation of a riser that was added after the tank is produced.

When concrete risers are attached to a tank after it is made, an integrated (tongue and groove) connection in combination with mastic or other appropriate sealant is more likely to remain undisturbed and watertight compared to a mortared seam. If additional concrete riser sections are added, these should also be made with tongue and groove joints and sealed with mastic. Wrapping seams provides additional protection especially in high water table- and freezing/thawing soil conditions.

Polyethylene and polypropylene risers are typically connected to a precast tank using an adapter ring cast into the tank. Another option is to attach mechanically a flange to the tank top using butyl rubber and stainless bolts. The riser is then sealed in place using appropriate adhesives.

It is essential to note that no matter what materials are used, access riser joints on tanks installed in areas where freezing and thawing soil conditions occur will require supplemental sealing to remain watertight.

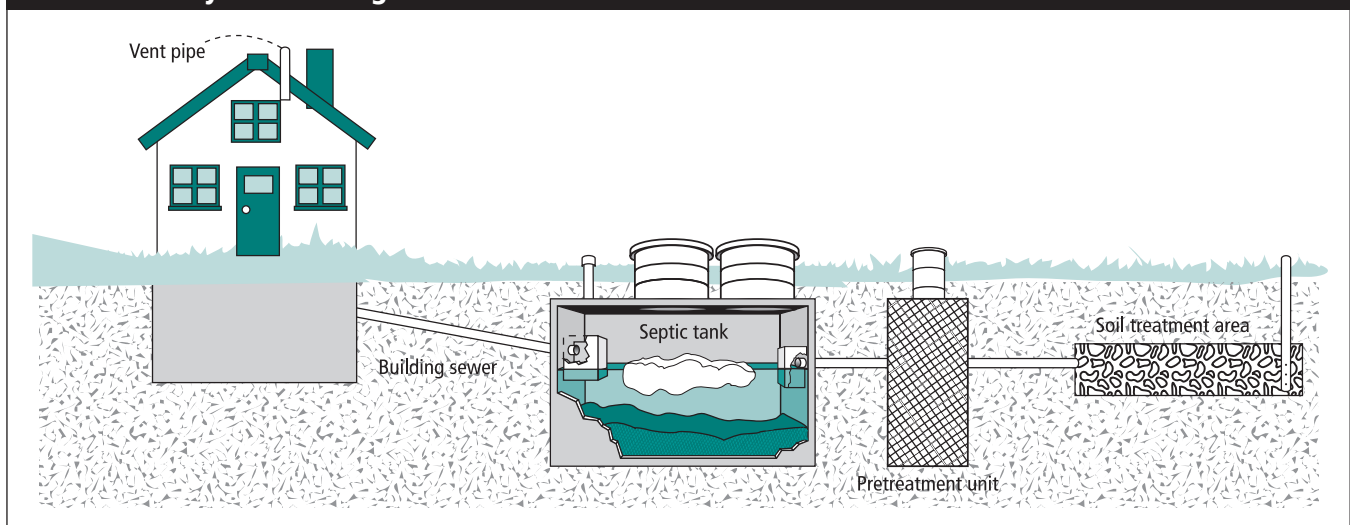
Cleaning accesses

A manhole at least 20 inches in diameter must be located within six feet of any wall of the septic tank to allow adequate cleaning. The cleaning access cover should be secured or have proper soil cover to prevent the untrained from attempting to get into the tank. Since the cleaning access is not covered with soil in newly constructed systems, the cover must be secured to prevent unauthorized access. This is for purposes of safety, since the gases in a septic tank may be toxic or cause asphyxiation. There have been people who have drowned in septic tanks with improperly protected cleaning accesses.

Tank Venting

Tanks must be vented to prevent accumulation of odorous gases. Venting also minimizes accumulation of hydrogen sulfide gas which may be converted to sulfuric acid in the head space of tanks. Concrete tanks are prone to corrosion under such conditions. All residential systems are designed to vent through the tanks and out the plumbing stack as shown in Figure 7.26, but additional vents may be included at the tank and these may include a filter.

FIGURE 7.26 System Venting



Air must flow from one compartment to another for proper ventilation of sewer gases through the plumbing stack in the facility. Verify that air can pass from one compartment to another via a gap in the top of the baffle wall. A smoke test may be used for verification. For concrete tanks with a slot or center hole positioned over the wall, a thin film of concrete left over from the pouring process must be removed for venting to occur. The thin film of concrete can be removed with a light tap of a hammer.

Backfilling tanks

All tanks should be backfilled with successive tamped “lifts” or depth increments of uniform gradation with no deleterious material or stones larger than 2 ½ inches in diameter. Crushed rock or pea gravel of ½-inch diameter is preferred if native materials are not appropriate. Each layer should be uniform, no greater than 24 inches thick and nearly equal height around the perimeter of the tank. Compaction under the haunch (bottom curvature of some tanks) is best done in 6 to 12-inch layers. When installing non-concrete tanks, it is critical to simultaneously fill the tank with water to just above the backfill level to avoid uneven or excessive pressures on the tank walls during the installation process and to minimize the risk of the tank shifting position. A tamping tool may be necessary to provide good contact against and between tank sides. Be careful not to damage the tank when carefully backfilling a tank installation.

Backfill with granular material to at least the midseam of the tank. Flowable fill or native soil free of deleterious material may be used above midseam. Note: never try to backfill an empty fiberglass or poly tank as it may collapse.

Supply pipe

The supply pipe extending from the septic tank to the undisturbed soil beyond the tank excavation must meet the strength requirements of American Society for Testing and Materials (ASTM), Schedule 40 Pipe, contained in Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120, ASTM D1785 (2006) (MN Rules 7080.2050, Subp. 2).

This pipe must not subject to corrosion and decay. Experience has shown that outlet sewers from septic tanks that are cast iron will corrode shut or structurally fail in five to 15 years. Schedule 40 plastic must be used over the excavation, and it must be properly supported between the edge of the septic tank and the edge of the natural soil base in the excavation so that it will not sag or be broken during backfilling. The soil around the pipe extending from the septic tank must be compacted to original density for a length of three feet beyond the edge of the tank excavation. The location of the outlet pipes in the tank must be watertight.

Final grading

A final cover must be applied, mounded to allow for settling, and graded away from the tank and components as appropriate. The ground should be sloped away to prevent surface water collection or inflow around the riser. The Installer should indicate the type of soil material used for the final cover and document the proper mounding and grading so that surface water sheds away from the tank and components.

Operation and Maintenance

In most cases, system owners are the operators of septic tanks and the entire onsite system. They should be provided with basic information by a certified professional about how to assure that their systems are properly operated and maintained. **From MN Rules Chapter 7080.2450, Subp. 2, the owner of an ISTS or the owner's agent shall regularly, but in no case less frequently than every three years**

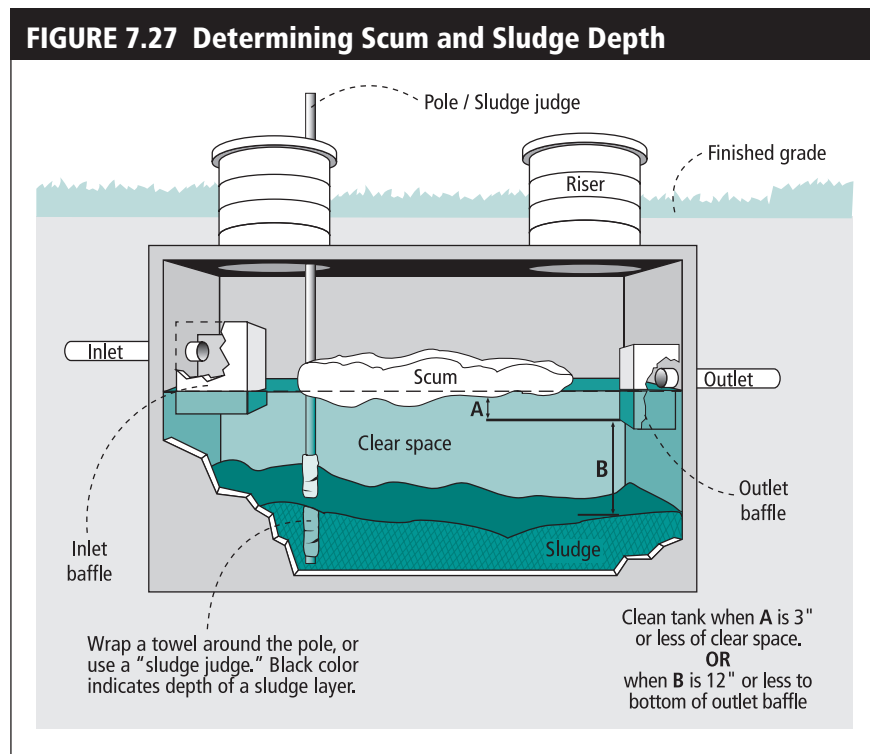
- 1. assess whether sewage tanks leak below the designed operating depth and whether sewage tank tops, riser joints, and riser connections leak through visual evidence of major defects; and**
- 2. measure or remove the accumulations of scum, grease, and other floating materials at the top of each septic tank and compartment, along with the sludge, which consists of the solids denser than water**

Tank cleaning

If a tank is operating properly, solids are retained and take up increasingly more volume. At some time they must be removed. (If there is little accumulation of solids, either the household is extremely conservative with water use and waste generation or there is a problem causing solids to pass through the tank.) When there is little clear zone left, proper solids separation will no longer occur, detention time for settling is further reduced, and solids will wash out of the tank, eventually clog the soil treatment area, and cause system failure.

Research on solids accumulation shows the interval between pumpings depends on tank size, number of people in the house, and the nature of the sewage (which in turn depends on household habits and lifestyles). Many publications and maintenance programs recommend a three to five year pumpout interval. This interval is probably reasonable but checking sludge levels at the time of service can provide a better estimate of the necessary pumpout interval.

The most reliable method for determining the need to pump is regular inspection of the tank, including measurement of sludge and scum thickness. If we use regular inspection as a method for determining pumpout needs, a good rule of thumb is to pump before the top of the sludge layer reaches a level 9 to 12 inches below the bottom of the outlet baffle, or when the bottom of the scum layer reaches a level 3 inches above the bottom of the outlet baffle, as shown in Figure 7.27. Some local regulations, guidelines, and practices regarding when a tank should be pumped may be based on total scum thickness, total sludge thickness, or proportion of tank volume occupied by solids. A typical guideline is pumping when sludge levels reach 25 to 33 percent of tank liquid capacity. MN Rules Chapter 7080.2450 subp 3 A states that a tank must be cleaned when the total volume of scum and sludge exceeds 25%, as shown in Table 7.7



When inspecting two-compartment tanks or systems with two tanks in series, it is important to open and evaluate both of the compartments and tanks. Although solids may accumulate at a much slower rate in the second compartment, it will still need to be pumped at some time and is usually pumped at the same time as the first compartment. Solids are removed from septic tanks using vacuum tanker trucks operated by a licensed Maintainer.

There are many devices that can be used to either determine sludge and scum accumulations periodically or to monitor levels on a continuous basis. The Sludge Judge™ and the Bigger Dipper™ are proprietary devices made using clear PVC pipe, and are tools for measuring the sludge and thin scum. Devices can be constructed of a small paddle on a stick or an L-shaped rod for measuring thicker scum levels.

Pumping too frequently may prohibit development of a normal population of beneficial microbes. From the perspective of system longevity, it may be best to err on the side of pumping too often rather than not enough; however, excessive pumping increases the burden on septic disposal facilities unnecessarily and adds unnecessary cost for the owner. In addition, there is some evidence that when tanks are pumped every year or even more fre-

quently, they sometimes do not develop normal scum and sludge layers. Decision-making based on actual tank conditions observed during inspection is recommended.

TABLE 7.7 When to Pump a Tank

Add depths of scum and sludge. If the combined depth is 25%-33% of the tank depth, it is time to pump the tank.

Tank Depth (inches)	Depth of Scum plus Depth of Sludge
30	7.5 - 10
33	8.25 - 11
36	9 - 12
39	9.75 - 13
42	10.5 - 14
45	11.25 - 15
48	12 - 16
51	12.75 - 17
54	13.5 - 18
57	14.25 - 19
60	15.0 - 20
63	15.75 - 21
66	16.5 - 22
69	17.25 - 23
72	18 - 24
75	18.75 - 25
78	19.5 - 26

Tanks that are not designed, installed, and used correctly may float out of the ground when they are pumped during seasons of high groundwater. If a tank must be pumped under high groundwater conditions, consider placing a uniformly distributed static load over the tank until it can be refilled with water immediately after pumping. The static load should be sufficient to ballast the tank without causing structural damage. In addition, tanks may collapse from external soil pressure. This can be costly since the tank must be re-excavated and replaced. To prevent flotation or collapse, it is best to pump at a time during the year when the seasonal water table is below the tank.

When servicing septic systems, damaged tees and baffles are sometimes observed in older tanks. Concrete baffles and clay and concrete tees used as baffles may deteriorate in the moist, corrosive atmosphere of a tank. Deteriorated or missing baffles must be replaced as soon as the condition is discovered. This is usually done by replacing the original unit with a PVC or other plastic baffle tee. It is recommended that an effluent screen be added as part of any outlet baffle replacement operation. A failed outlet baffle can usually be replaced by inserting a section of 4-inch PVC into the outlet pipe and adding necessary fittings inside the tank to either use a 3-inch baffle tee or fit to a selected outlet screen.

At the time of pumping or service, access risers and lids must be checked for leakage or any structural damage. Any leaks should be repaired or patched, but structural damage indicates the need for replacement.

Effluent screens

Effluent screens should be removed and cleaned upon service. Proper instructions for the cleaning and troubleshooting of an effluent screen are provided in Section 8.

Myths and additives

There are many myths about substances that can help start biological activity or “improve performance” of septic tanks. Dead chickens and dead cats used to be favorite recommendations. They do nothing to enhance the function of the tank. Another myth is that a few inches of solids should be left in the tank when it is pumped to “start the tank up again”. There will be sufficient bacteria left in the tank even after a thorough pump-out, as well as bacteria carried in the incoming wastewater, to begin digestion again. However, the tank should not be washed or excessively cleaned during pump-out.

One of the most frequently asked questions about septic tanks is “what about septic tank additives?” Some chemical additives are corrosive and can actually harm the tank or its normal biological processes. Repeated use of drain cleaners, antiseptic products, medicines and laundry bleach by homeowners can upset the bacteriologic balance in the septic tank. Biological additives (bacteria and enzymes) are not likely to harm the tank, but evidence as to their usefulness in residential septic tanks has not yet been conclusively shown in carefully controlled studies. Studies show no significant positive effect associated with additives. In these studies, there was some minor reduction of the scum layer. This may

mean that the floatable solids moved into the soil treatment area. Thus, the additives may actually defeat the purpose of the tank i.e., to retain solids and protect the soil treatment system. Some people promote the addition of yeast to a new or recently pumped tank. While this is harmless, it is not needed.

Some additives advertise, “Never pump your septic tank again”. With these products the homeowner may be fooled into ignoring proper inspection and maintenance of their septic tank. Pumping is not just for solids removal; it provides an opportunity to observe potential problems and identify needed repairs. There is no substitute for proper operation, inspection, and maintenance of a tank to keep the system working as intended.

MN Rules Chapter 7080.2450, Subp. 5, specifies that ISTS additives, which are products added to the sewage or to the system with the intent to lower the accumulated solids in sewage, must not be used as a means to reduce the frequency of proper maintenance and removal of sewage solids from the sewage tanks as specified in this part. The use of additives does not fulfill the solids removal requirement of this part or a management plan. ISTS additives that contain hazardous materials must not be used in an ISTS.

Inspections and troubleshooting

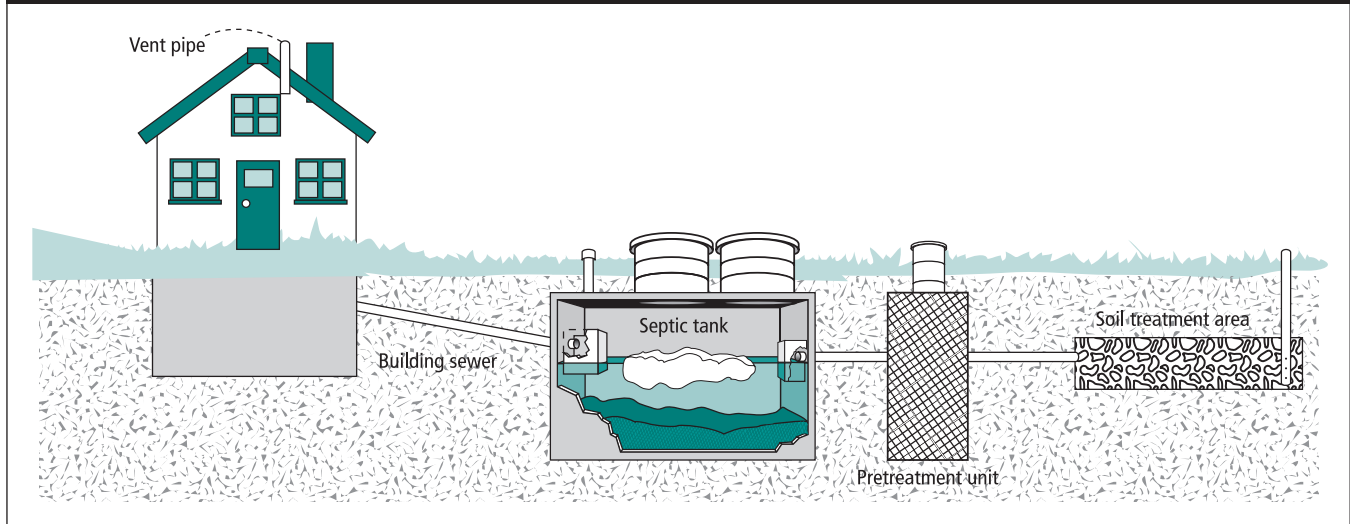
A trained and experienced Maintainer/Service Provider (SP) can perform troubleshooting relatively easily through an inspection of the septic tank. The process requires removal of the lids over the inlet and outlet portions of the tank. The SP will first note the liquid level in the tank by either looking directly at the water level in or behind the outlet baffle or tee. The water should be at the level of the invert (bottom inside lip) of the outlet pipe if no water has recently flowed into the tank. If the water level is not elevated above the invert, the sludge and scum levels can be measured. For more information about this, refer to Operation and Maintenance (Section VI). If the water level is below the invert, there is a leak in the tank that should be located and repaired.

If the level is above the outlet invert, there is a blockage in the outlet pipe or effluent screen or a back up from the soil treatment system. Pipe blockages can be a result of many different things: root intrusion, crushed pipes, deteriorated clay or concrete pipes, or a pipe with a “dip” that prohibits gravity flow. If the soil treatment system seems normal, investigate for a line blockage. It may be possible to run a plumber’s snake through the line from the tank (after pumping the tank), or it may be necessary to expose and cut into the pipe outside the tank to get a snake into the line. This can be an unpleasant job if there is effluent backed up in the line. It is a good practice to have a vacuum truck at the site to remove effluent as needed. Additionally, gloves and eye protection should always be worn.

Odor

Is there any odor in the vicinity of the tank? Odors typically indicate a venting problem, but may indicate system failure. Odors should be vented out through the system, not back through the house. Make sure that the system is not venting through the electrical system or through the lids.

FIGURE 7.29 Investigate Venting If Odors Persist



Odor from and around septic tanks may be noticed in some systems. Odor around older systems may be caused by deterioration of tank components, broken tank tops, or submergence of the inlet that prevents proper venting of the tank through the plumbing roof stack. Odor may also be detectable from a new tank that has not developed normal biological processes yet or a tank that has been recently pumped. Normal odor may come from the roof stack. This may be especially prevalent during times of still air and particularly during temperature inversions that may occur early morning or late evening. Possible remedies for stack odor include extending roof vents higher to an elevation above the roof ridge or installing activated carbon filters on the top of vent pipes to filter odor.

Evaluating sewage tank performance

The tank holds a wealth of information about the operation and performance of the whole onsite system. Some regulatory programs use the tank as the single point of information about an entire system. Although your inspection will include examinations of other system components, start by opening the tank and looking into it. This means opening the 20-inch manhole. For other tanks, it means taking off a section of the lid. You have to be able to see the inside of the tank, so opening the four-inch inspection pipe will not be sufficient.

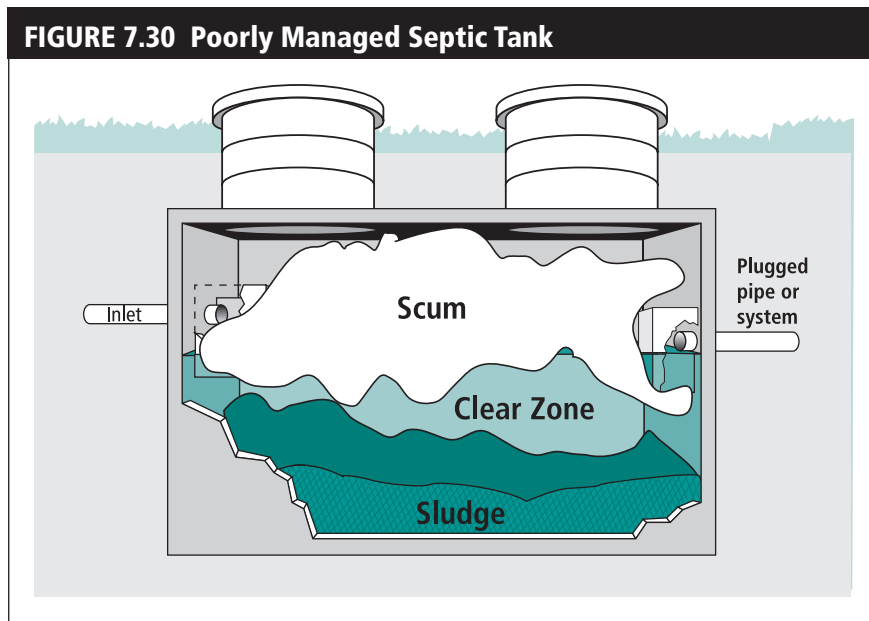
Finding the tank can be difficult. Water flows downhill, so usually the tank is downhill from the house. The sewer service coming out of the house will give you a general direction, and then look for clues: an inspection pipe, a low spot, dead grass, early snow melt, or other landscaping.

Flow, settling and bacterial action

First, get a general overview of the tank and its contents. Refer to Figure X. If there's a lot of floating material that doesn't belong in the tank, such as plastic products or undigested food, you know that the users of the system may be causing some problems.

7-44 ■ SECTION 7: Septic Tanks

The tank should be developing three layers, a scum layer on top, clear water in the middle, and a sludge layer on the bottom. If these three separate layers are not present, then the system is not operating the way it should, and you need to find out why. When wastewater does not form these three layers, it is often because some chemical has been added that has killed the bacteria, or because one of the baffles in the tank is missing. Sometimes the layers will form but then become mixed due to turbulence in the water, particularly if there is a pump in the basement introducing too much water into the system.



Evaluate the scum layer. It should not be excessively thick, and should always be less than three inches from the bottom of the outlet baffle to ensure that excessive scum is not leaving the tank. The scum layer should also not be higher than the outlet baffle or overflowing the baffle and flowing into the outlet as shown in Figure 7.30.

Excessive scum in the tank may mean that the tank needs to be cleaned out, or it may mean that the wastewater has high levels of soap or grease. Users of the system may be able to reduce the amount of soap or grease in the water, or they may have to have the tank cleaned on a more frequent basis. For systems serving commercial establish-

ments, such as restaurants, it may be a good idea to extend the outlet baffles, so that the first of two or three tanks becomes a grease trap.

If a particularly thick scum layer contains a large proportion of undigested food, there is usually a problem in the house, either with excessive garbage disposal use or a medical problem such as bulimia. Only the users of the system can deal with these issues.

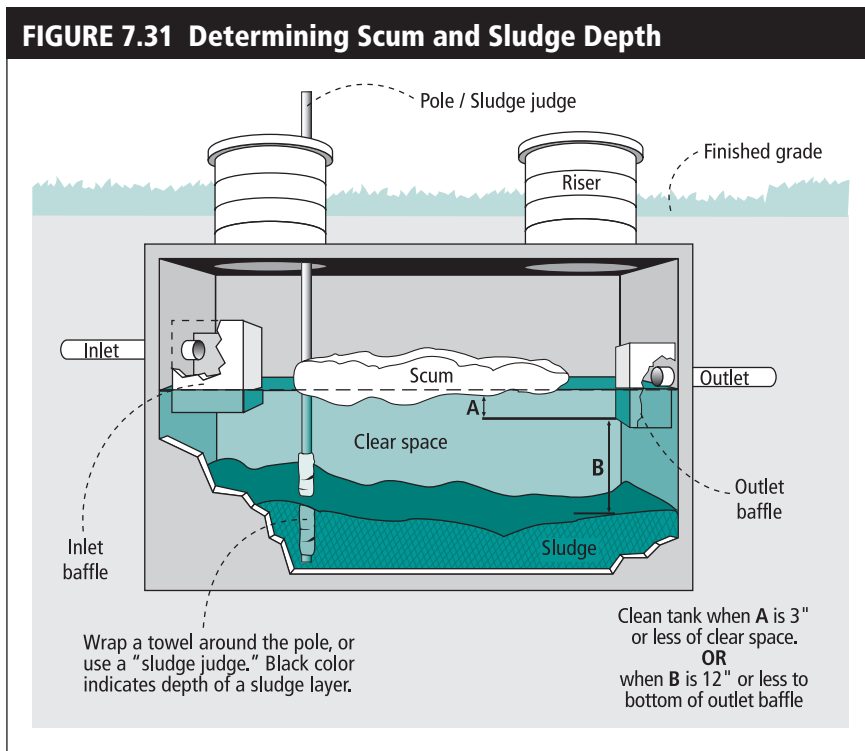
Other problem materials to check for include feminine hygiene products, such as tampons and pads, and barrier-method birth control products, such as condoms. These products should not be in the tank! They will neither sink nor float; instead, they will tend to flow through the tank and into the soil system, where they can plug both the outlet line and the soil system. Users of the system should understand that these products must not become part of the sewage flow. For systems serving restaurants or other commercial establishments, an effluent screen to prevent these materials from leaving the tank may be necessary.

Evaluate the sludge layer. It should not be within 12 inches of the bottom of the outlet as

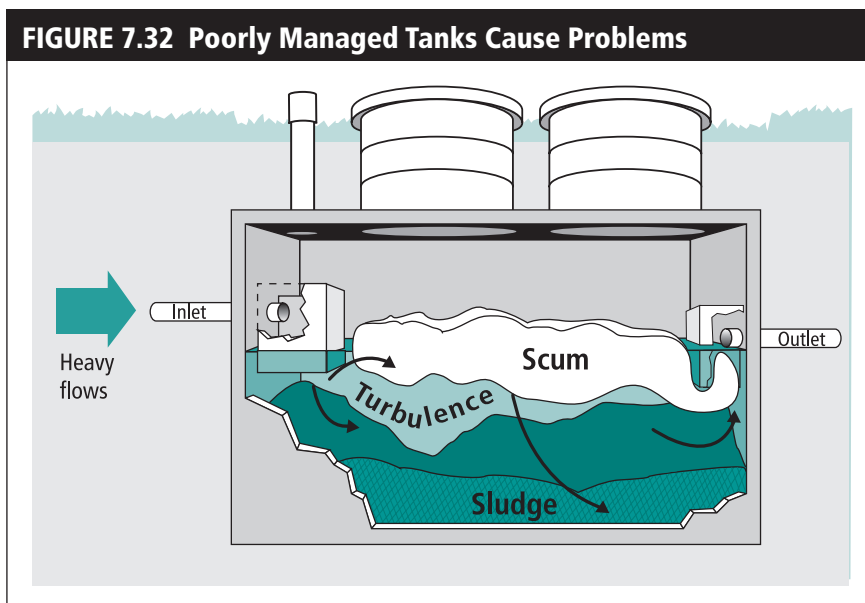
shown in Figure 7.31. Allow time for the sludge to settle before measuring this distance. Verify that the sludge is settling well and that there is not excessive movement of sludge out of the tank. Sludge will not settle properly if the water in the tank is turbulent. Turbulent conditions could be from a pump in the basement adding high volumes of water, “stirring up” the wastewater, or there may simply be too much water entering the tank.

If sewage flow from the house to the tank has increased since the tank was designed and constructed, the tank may not be large enough to handle the amount of wastewater entering it. Users of the system may be able to reduce their water use to improve the performance of the system.

If there is an excess of material that cannot be broken down by the bacteria in the tank, such as coffee grounds, soil, or soap, both the scum and the sludge layers can quickly become too thick. The only way to get these materials out of the tank is by pumping.



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If the tank is over-full (if the water level is higher than the outlet invert), the system is not operating as it should. An over-full tank is not conducive to settling, so sludge and other solids may reach the soil treatment area. There may be plugging in the line, or the soil treatment system at the other end of the line may be plugged (Figure 7.32).

If a pump tank is part of the system, the pumps may have had problems, causing the tank to overflow. If, after pumping out the tank, there is excessive runback (water entering the tank from the outlet side) into the tank, there is certainly plugging of the soil treatment area.

Effluent quality

The performance of a septic system can be determined by laboratory testing of the effluent. Septic tanks should produce effluent with a BOD of less than 175 milligrams per liter, TSS less than 65 milligrams per liter and FOGs less than 25 milligrams per liter. When effluent has higher values than these, soil treatment systems typically develop clogging problems.

Watertightness

An inspector must determine if an existing tank is watertight. Without inspecting the tank for soundness, the inspector cannot issue a certificate of compliance. Any tank that is not watertight is, in essence, a cesspool. If the tank is watertight, then it meets the minimum requirement.

Watertight means that water is not allowed to flow in or out of the tank other than through the design penetrations (inlet and outlet pipes). Watertightness is critical to tank performance. Excess water entering the tank from surface runoff can result in inadequately-treated effluent entering the soil treatment system, causing premature failure of the soil system. Untreated wastewater entering the soil from a leaky tank presents health risks to humans and can have serious environmental consequences. A licensed Maintainer can help determine if the tank is watertight, and may be a useful resource about the system. General experience has been that most tanks without a maintenance access are not watertight.

To assess a tank's watertightness, verify that the concrete walls are watertight. Pay particular attention to seams in the walls. Tanks with mid-wall seams have a higher probability of breaking through and not being watertight. These walls should include some type of tongue and groove; check this joint.

Inspection of the walls includes checking the corners where the cover and the walls meet. These joints also should have a tongue-and-groove connection and some type of a mastic sealer in and on them. The other watertight surface is the tank bottom. This may seem straightforward, but tank floors were not properly constructed or installed in years past and may no longer be watertight.

Next, check all the penetrations, including inlet, outlet, manhole riser, lid of the manhole, and inspection pipes. All of these should be watertight. A very good hint that they are not is the intrusion of roots. The presence of roots indicates a problem that has been in existence for a long time.

Another indication of a problem is a trickle of water entering the tank. Surface water must not be allowed to enter the system. One place water might enter is through the manhole, which can be buried to minimize access. If it is not buried, it should be elevated at least one inch above the finished grade to guarantee that there is not extra flow into the tank. Sealing this lid with a mastic may seem like a good option, but sometimes a sealed manhole lid becomes permanently sealed and cannot be opened for maintenance. A number of local units of government required that the maintenance access be brought to the surface and MN Rules 7080.1970 B currently requires this of all new systems. . This is a good idea, but if access is not brought to the surface, the system can still be in compliance.

Inspection pipes must be watertight at the surface of the tank. More importantly, they must have a cover on them. A coffee can is not a cover. The cover should be a tight-fitting plastic pipe. The best cover would be a threaded cap, to allow repeated opening without affecting the fit of the cover.

There should be self-sealing gaskets wherever penetrations meet the tank walls or lid. A number of the newer septic tanks have gaskets that require some type of a masonry support to work.

The riser itself needs to be watertight at all joints; plastic and concrete materials are available to achieve this. The typical length of the riser is ten to 12 inches, so using concrete means more pieces are necessary to bring it to the surface, and every connection must be watertight.

With large-diameter smooth-wall plastic pipe, it is critical that a seal be made where the pipe is connected to the tank. Simply setting the pipe on top of the tank does not make a watertight connection. Staining in the risers will identify leaks going into the system.

Another consideration is the location of the tank in the landscape. It should be located where a minimum amount of water will run off over it. Be particularly aware of hard surfaces from which the most water will run off; ideally, the tank would be upslope from these.

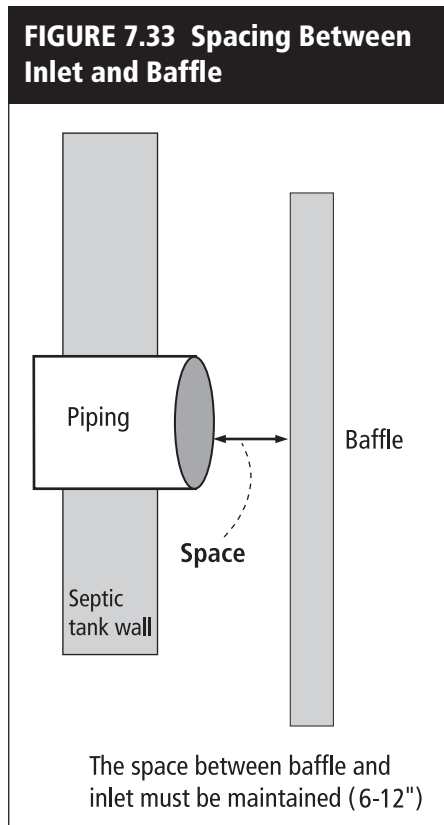
Baffles

Check the baffles in the tank. The baffles begin the settling process by forcing the flow down, keep the scum inside the tank, and ensure that effluent leaving the tank comes from the clear liquid layer. If there are problems with the baffles, the system cannot work properly. One way to correct the problem of too many solids leaving the tank is to install effluent screens.

There are two general types of baffles: plastic pipe (sanitary tees) and wall baffles. The advantage of wall baffles is that they are built in. They have a larger space to allow larger solids to enter the tank. The downside of the wall baffles is that if the tank is not properly constructed the baffles will be significantly impaired. It's also difficult to add effluent screens to a tank with wall baffles. But either type of baffle will work adequately as long as it is in place.

Baffles must be properly connected. A wall baffle or a large pipe baffle should be connected in such a way that it will not corrode. All baffles must be securely attached so they

remain in place over the life of the tank, and they must be inspectable. Baffles made of PVC sanitary tees must be properly glued and affixed onto the system.



During the inspection you it should be verified that nothing is plugging the baffles. It's also a good idea to verify that there is enough free space between the inlet pipe and the baffle to allow the free flow of both water and the solids in the water. There should be six to 12 inches between pipe and baffle, as shown in Figure 7.33. Note the depths of the baffles: the inlet baffle should be at least six inches deep. The outlet baffle should be drawing from the clear portion of the tank, typically about 40 percent of the depth. If the tank's function is to handle excessive suds or grease, the depth of the outlet baffle may be lowered so that the tank functions as a grease trap.

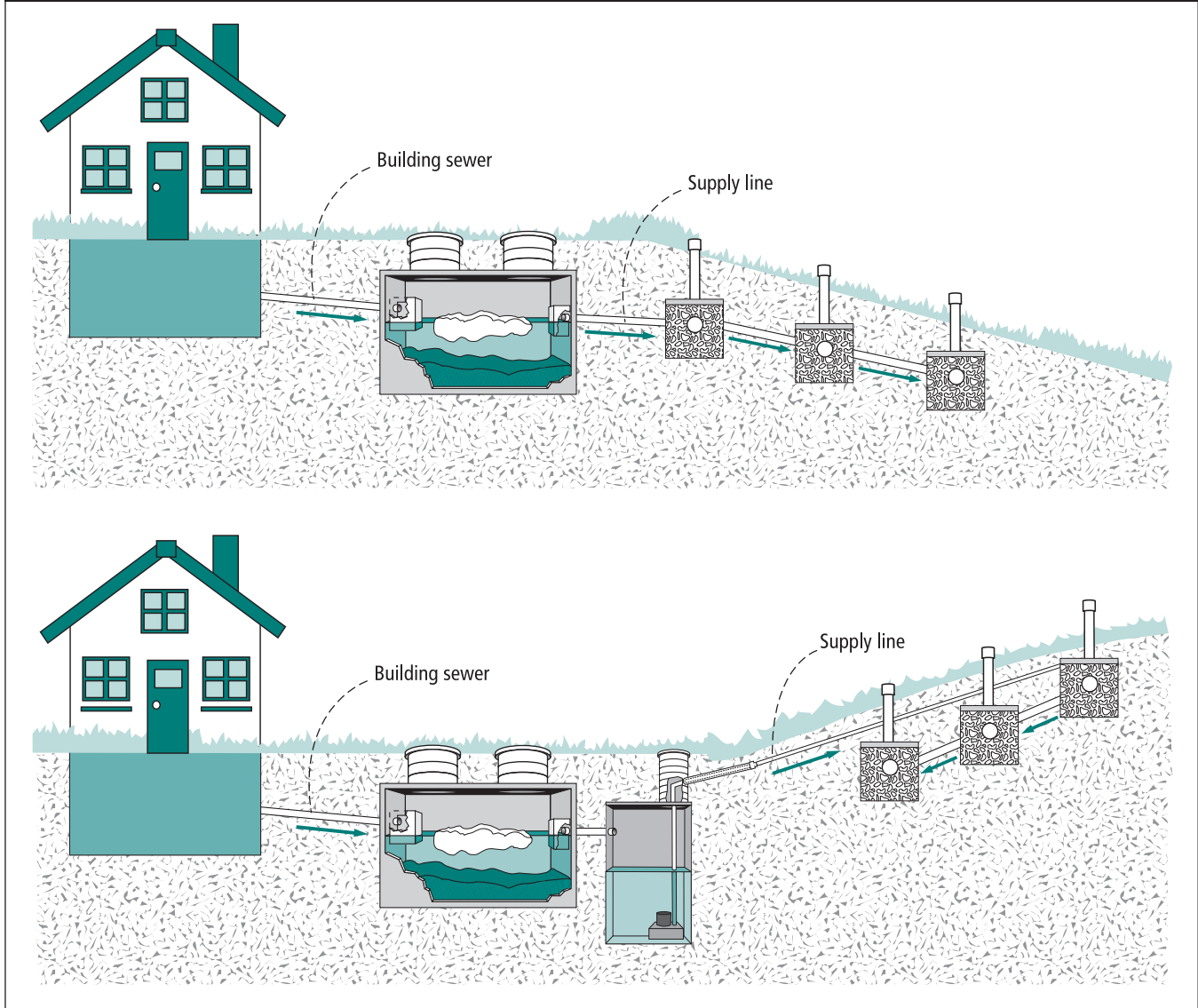
Supply lines

Outlet sewer

The outlet sewer carries the septic tank effluent to a nother septic tank, a pumping station or to the soil treatment area. This pipe should have a minimum slope of 1 inch per rise of 8 feet to ensure that water will flow properly. You do not have to be concerned about a maximum slope because the solids have been removed in the septic tank. For gravity systems, the outlet sewer delivers the effluent to a drop box or distribution box. From there it is delivered into the distribution network of trenches or beds. Here, a lighter plastic pipe with 1/2- inch holes every 6 inches can be used in rock-filled trenches or beds. In most cases, if pressure distribution is being used, Schedule 40 pipe should be chosen for the supply pipe from the pump station to the pressure distribution system in the soil treatment area. This is important in cold climates as it allows the water to drain out of the supply pipe to avoid freezing. Due to its higher lateral strength, Schedule 40 is less likely to develop small dips in the pipe as it is laid. This prevents water from standing in the pipe and freezing. Placing smaller-diameter pipe 1 to 2 inches in a larger (4-inch) pipe can also minimize settling across excavated areas. Typically, pressure distribution manifolds and laterals are also Schedule 40 pipe, as this helps contractors avoid dealing with multiple grades of pipe on the job.

The line that delivers the effluent from the septic tank and solid pipe throughout the system is identified as the supply line. A supply line can use either gravity or pressure for its operation, both shown in Figure 7.34. As in any piping, the supply pipe should drain properly. If gravity is being used the pipes must have proper slope to allow drainage to the next treatment unit. If the supply pipe relies on a pump, the drainback when the pump shuts off should drain back to the pump tank. The minimum pipe slope of 1 inch per 8 feet applies to both of these locations.

FIGURE 7.34 Gravity (Top) and Pumping (Bottom) Situations



For gravity systems, 4-inch pipe should be used. For pressure systems, the size of the pipe is going to impact the pressure loss in the system. Typically 2 to 3-inch pipe is used for the supply lines. The size of the pipe also impacts the pipe's strength. Smaller-diameter pipe will have a thinner wall and therefore will be more flexible. This is an advantage during installation in that the pipe can be bent to allow for placement with fittings in the layout of the supply line. The problem with smaller-diameter pipe is that if there is settling, smaller pipes have a tendency to create sagging. To avoid this, a number of solutions can be employed. One is to go to larger-diameter pipe, which will be less likely to settle. Settling creates problems in terms of additional drain back, resulting in pump inefficiency. The other option is to support the pipe. Placing the smaller supply-line in a larger diameter pipe is an excellent way to accomplish this support. For example, run a 2-inch supply line inside a 4-inch schedule 40 pipe for support. This will adequately support the pipe and settling issues will be avoided. This also will insulate the 2-inch pipe and protect it from other

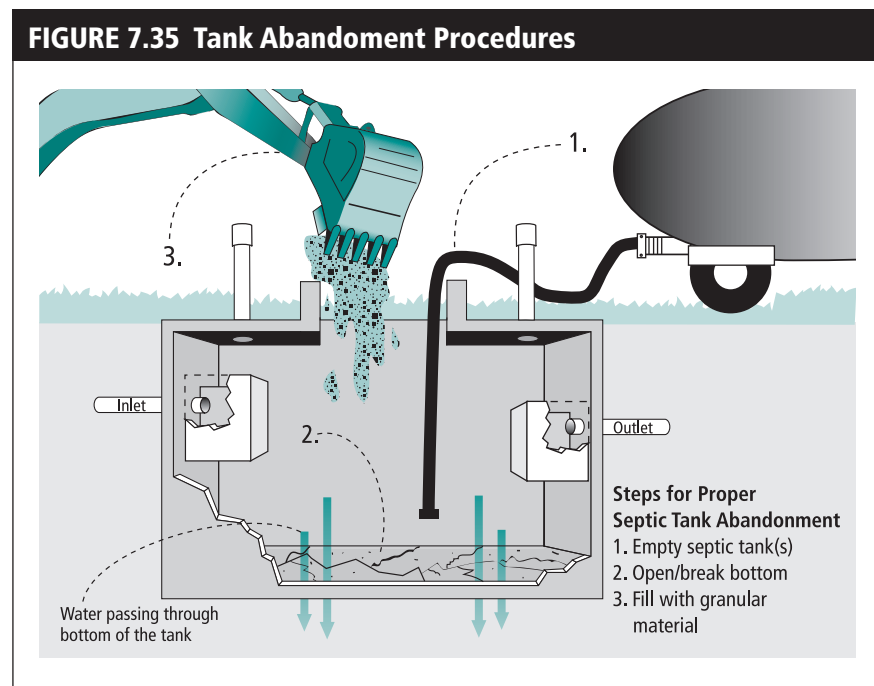
damage. When applying larger pipe around smaller pipe, be sure that the larger-diameter pipe is sealed at the ends. This can be done with a fitting or with expandable foam.

Management of supply lines

Management of supply lines is necessary to make sure that the wastewater will move through the system. It is important to use proper construction techniques that will allow the pipeline flow to be maintained. The potential for plugging in these lines is minimal, but downstream or at pressure orifices plugging is greater. The use of an in-line filter is a method to minimize potential for plugging. These filters are installed at the outlet of the pump using a metal screen to capture solids leaving the pump tank. Maintenance of these components is as directed by the manufacturer.

Tank abandonment

Tank abandonment should be performed by a licensed professional as shown in Figure 7.35. When a tank is no longer going to be used, specific procedures (from MN Rules 7080.2500, must be followed:



Subpart 1: Tank abandonment

All systems with no future intent for use must be abandoned according to this part. Tank abandonment procedures for sewage tanks, cesspools, leaching pits, drywells, seepage pits, vault privies, pit privies, and distribution devices must meet the requirements in items A to C.

- All solids and liquids must be removed and disposed of according to part 7080.2450, Subp. 6, by a licensed maintenance business.
- All electrical devices and devices containing mercury must be removed and disposed of according to applicable regulations.

- C. Abandoned tanks or any other underground cavities must be removed or remain in place and crushed with the remaining cavity filled with soil or rock material.

Subp. 2: Future discharge

Access for future discharge to the system must be permanently denied.

Subp. 3: Removal of system

If soil treatment and dispersal systems are removed, contaminated materials should be properly handled to prevent human contact. Contaminated materials include distribution media, soil or sand within three feet of the system bottom, distribution pipes, tanks, and contaminated soil around leaky tanks. Contaminated material also includes any soil that received sewage from a surface failure. Contaminated materials must be disposed of according to items A to D.

- A. Contaminated materials disposed of off-site must be disposed of according to part 7080.2450, Subp. 6.
- B. If contaminated material is to be spread or used on-site within one year of contact with sewage, the material must be placed in an area meeting the soil requirements described in part 7080.2150, Subp. 3 (D), item D, and the material must be covered with a minimum of six inches of uncontaminated soil and protected from erosion. After one year following contact with sewage, the material may be spread in any location, covered with a minimum of six inches of uncontaminated soil, and protected from erosion. After one year following contact with sewage, the material may be used to fill in the abandoned in-place sewage tanks.
- C. Contaminated pipe, geotextile fabric, or other material must be dried and disposed of in a mixed municipal solid waste landfill.
- D. The person or business abandoning the system must complete and sign a record of abandonment that states the system was abandoned according to this part. The record must be sent to the local unit of government within 90 days of abandon.

In the event that a septic tank is no longer used (because of an alternate connection to city sewer, tank replacement during system upgrade or repair, etc.), the tank must be properly abandoned. Local codes may list specific requirements for this activity and must be followed. In the absence of specific code requirements, the following procedures are recommended. The goal is to render the area of the old tank safe and free of environmental or public health impacts.

The tank must first be completely emptied of its contents using vacuum tanker trucks operated by a licensed Maintainer. Three common processes for dealing with the empty tank are listed below:

- Remove and dispose of the tank at an approved site (normally a landfill);
- Crush the tank completely and backfill; and
- Fill the tank with granular material or some other inert, flowable material such as concrete

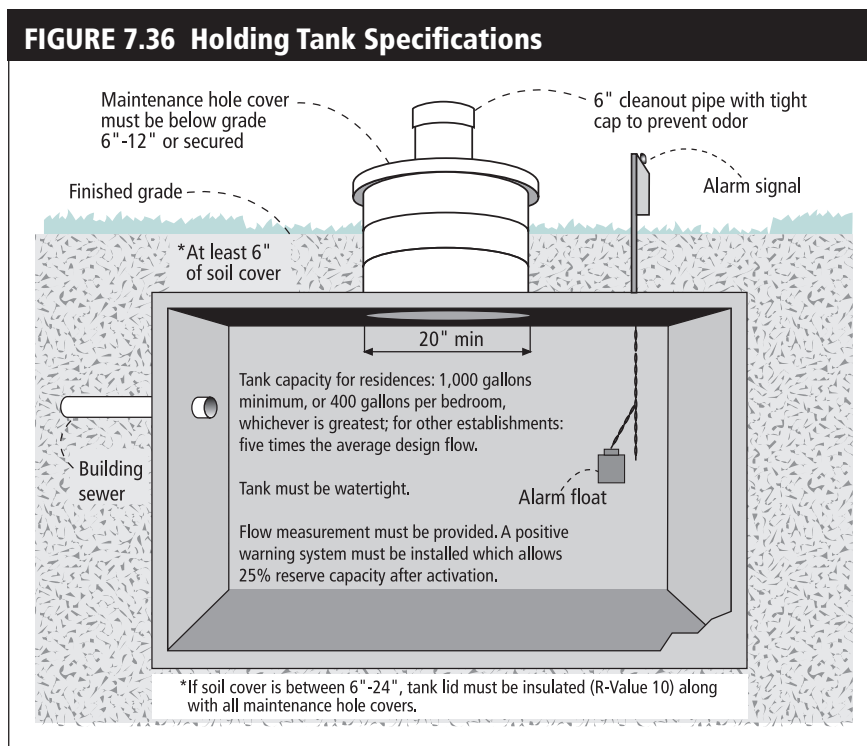
The abandoned tank must present no collapse or confined-space hazard.

Holding Tanks, Privies and Graywater Systems

Holding Tanks

A holding tank system is a watertight tank into which sewage from a facility flows to be properly removed and disposed of. While holding tanks are not recommended for installation on newly developed lots, there are some developed lots which do not have adequate area for a sewage treatment system. In some cases, a holding tank may be the only alternative.

FIGURE 7.36 Holding Tank Specifications



A holding tank is a watertight device capable of storing several days of wastewater generated by a facility and is not intended for treatment. Holding tanks are typically prohibited except under extenuating circumstances and used either as a last resort or on a temporary basis while alternatives for permanent use are explored. Use of a holding tank in an onsite wastewater treatment system incorporates the services of a sewage maintainer and off-site treatment for the sewage generated.

Definition

From MN Rules Chapter 7080.1100, Subp. 40, a holding tank is a tank for storage of sewage until it can be transported to a point of treatment and dispersal. Holding tanks are considered a septic system tank under Minnesota Statutes, section 115.55.

Holding tanks are considered Type II systems under MN Rules Chapter 7080.2290. Holding tanks may be allowed by the local unit of government only as replacement for existing failing systems which pose an imminent threat to public health and safety, or on existing lots. Holding tanks may only be installed where it can be conclusively shown that no other options are available. Figure 7.36 identifies specifications for holding tanks.

Under MN Rules Chapter 7082.0100, Subp.3 (G) LGUs must address the allowance of holding tanks in their ordinance. The ordinance must specify holding tank operation and maintenance requirements. At a minimum, a monitoring and disposal contract signed by the owner and a licensed maintenance business is required unless the owner is a farmer exempt from licensing under Minnesota Statutes 115.56, Subd. 2, (b), (3). The homeowner is responsible for ensuring that the contract guarantees the removal of the tank contents before overflow or any discharge.

A sample monitoring and disposal contract can be found in the forms section of this manual.

Rule Requirements

According to Minnesota Rules Chapter 7080.2290, to qualify as a holding tank, the tank must meet or exceed applicable requirements of parts septic tank strength, design, construction, storage, transport and use, location, installation, assessment and identification covered in 7080.1900 to 7080.2030. Holding tanks must also meet or exceed the applicable requirements of part 7080.2150, subpart 2 which are the general technical requirements for all systems including setbacks. These systems must all employ structural components and joint sealants that meet or exceed the system's expected design life (MN Rules Chapter 7080.2150, Subp 3 (B)).

Setbacks and location

Holding tanks can only be installed:

- In an area readily accessible to the pump truck under all weather conditions;
- Where accidental spillage during pumping will not create a nuisance.
- At least ten feet from property lines, buried pipe distributing water under pressure, and occupied buildings and at least 50 feet from any source of domestic water supply or buried water suction line; and meet all lake, river and stream setbacks set in MN Rules 6105 and 6120.

In addition, all tanks used as holding tanks must be tested for watertightness as specified in part 7080.2010, Subp. 3. The MPCA has stated that this testing can occur either at the site or at the manufacturing facility and that only the tank needs to be tested, not the supply line. The University of Minnesota recommends that the tank be tested after being installed to minimize concerns relating to cracks developing during transport and installation and potential leaks in the inlet and risers.

A cleanout pipe of at least six inches in diameter must extend to the ground surface and be provided with seals to prevent odor emissions and exclude insects and vermin. A maintenance hole of at least 20 inches in dimension must extend through the cover to a point within 12 inches, but no closer than six inches, below finished grade. If the maintenance hole is covered with less than six inches of soil, the cover must be secured according to part 7080.1970, C:

1. be secured by being locked, being bolted or screwed, having a weight of at least 95 pounds, or other methods approved by the local unit of government. Covers shall also be leak resistant; and be designed so the cover cannot be slid or flipped, which could allow unauthorized access to the tank;
2. have a written and graphic label warning of the hazardous conditions inside the tank;
3. be capable of withstanding a load that the cover is anticipated to receive; and
4. be made of a material suitable for outdoor use and resistant to ultraviolet degradation.

Holding tanks must have an alarm device to minimize the chance of accidental sewage overflows unless regularly scheduled pumping is used. An alarm device shall identify when the holding tank is at 75 percent capacity (7080.2290, F).

Application and Design

There are several issues to consider when choosing whether to use a holding tank. First, the cost of hauling the sewage can be excessive. Based on an informal survey of SSTS Maintainers, costs of pumping septic tanks are about \$200 for approximately 1,000 gallons. Costs may differ somewhat for holding tanks since they are usually readily accessible and the material is not as difficult to remove due to the reduced amount of sludge. A family of four is likely to generate approximately 200 gallons of sewage per day. At a cost of \$200 per 1,000 gallons, the annual cost to remove the sewage would be \$14,600. Cost will vary with amount of sewage and hauling fees. Water conservation will reduce sewage flow, hauling costs and disposal fees. It should also be taken into consideration that weather conditions or road restrictions may prevent pumping and hauling when necessary and require that the plumbing systems not be used until the holding tank has been pumped.

Also, the liquid level in the holding tank will need to be continuously monitored in order to prevent an overflow. A water meter is recommended and can be used to determine the amount of sewage pumped and hauled and make sure that the tank is not allowing surface or groundwater into the tank or leaking untreated sewage out.

A continuous contract must be maintained to be sure that pumping service is available and that the sewage can be treated and disposed of.

Capacity

For a single family dwelling, not located in a flood plain, holding tank capacity should be 1,000 gallons or 400 gallons times the number of bedrooms, whichever yields the greatest volume.

For other establishments, the capacity should be based on measured flow rates or estimated flow rates. **Holding tanks serving other establishments must provide storage of at least five times the design flow (7081.0240, Subp.2 (E)).**

Floodplain areas

In floodplain areas, the capacity is 100 times the number of bedrooms, times the number of days the site is flooded during a ten-year flood, or 1,000 gallons, whichever is greater. Information regarding the number of days of flooding is available from the 100-year hydrograph or by contacting the local planning and zoning agency. **The system must be designed to permit rapid diversion of sewage into the holding tank when the system is inundated. The holding tank must be accessible for removal of tank contents under flooded conditions (7080.2270 Subp. 9 &10).**

Reduced-size systems

Many of the design criteria used for designing sewage systems are quite conservative, particularly with respect to estimated water use. Some local government units will not allow anything other than a full-size sewage system to be installed, and base their sizing criteria upon 150 gallons per day per bedroom, although actual use may be much less. The system proposed in Figure 7.37 should be seriously considered for lots that do not have area for Type I system.

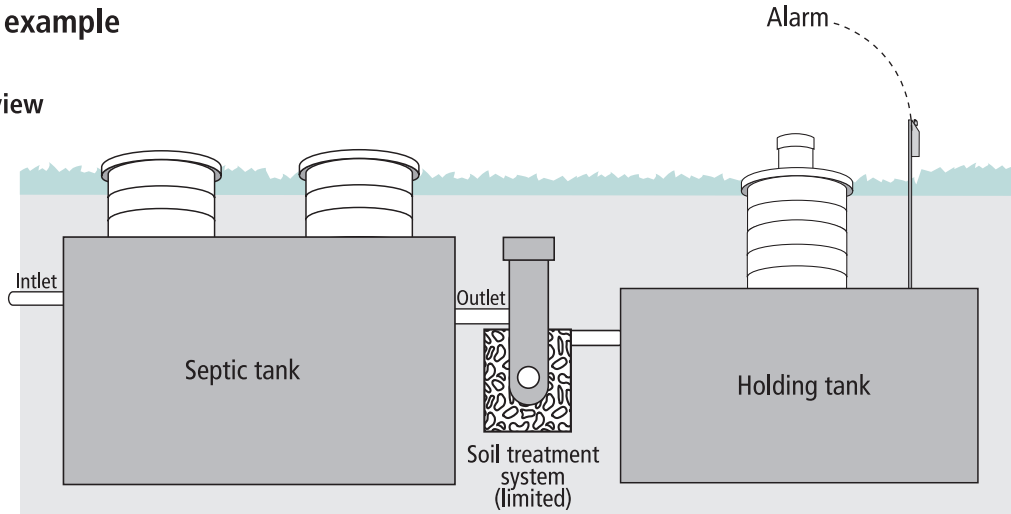
Holding Tank with Drainfield: An Alternative

This installation has successfully been used in a number of areas in Minnesota where allowed by local ordinance and teaches homeowners to conserve water. If the volume of liquid wastes generated is less than the treatment capacity of the soil absorption system, then no wastes will flow into the holding tank. The use of a timer in these systems assures that the system is not overloaded and can be a long term solution for the property.

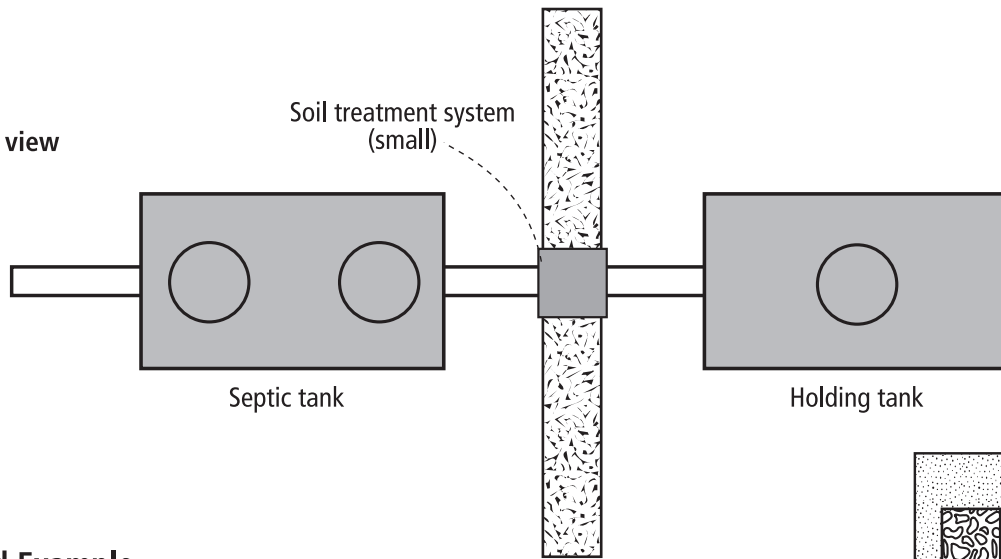
FIGURE 7.37 Small Lot Solutions

Inground example

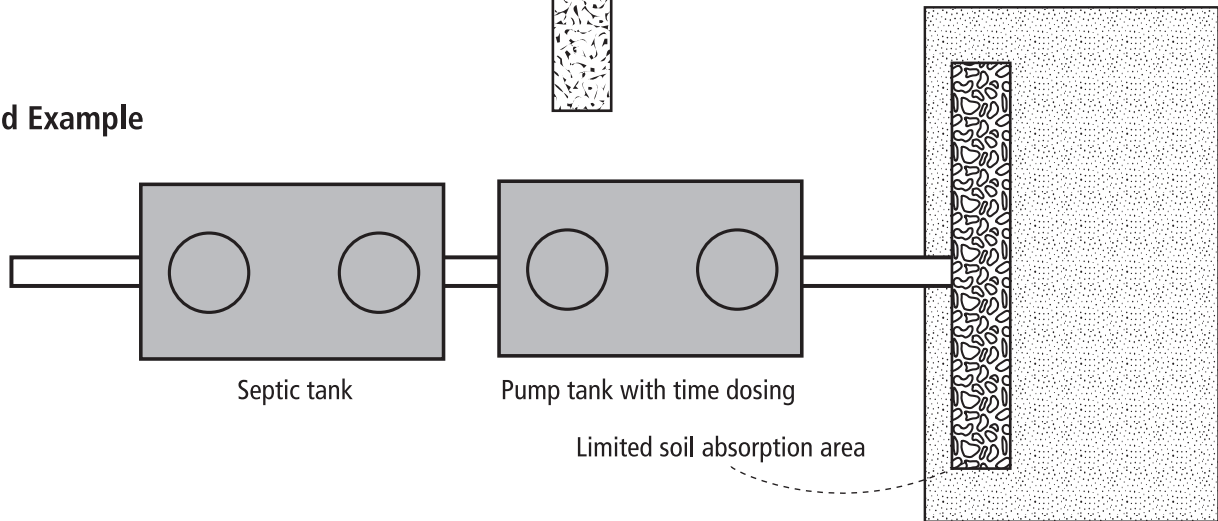
Profile view



Plan view

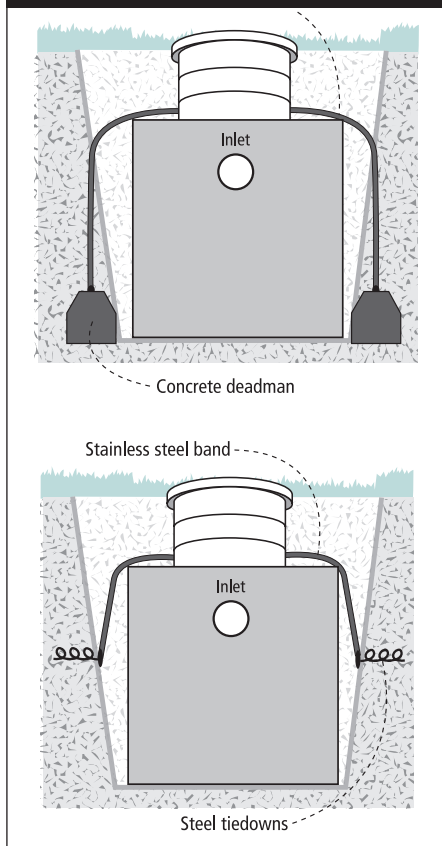


Mound Example



Installation

FIGURE 7.38 Protecting Against Flotation



Holding tanks are constructed of the same materials and by the same procedures as septic tanks. Because these systems can be empty during wet times of the year, they must be designed to stay buried. This can be accomplished by the weight of the soil over the holding tank or by anchoring the tank in the soil as shown in Figure 7.38. Weight can also be added to the bottom of the tank to effectually keep the tank buried.

The tanks should be protected against flotation under high water table conditions by the weight of tank, earth anchors or shallow bury depth.

Operation, Maintenance and Troubleshooting

According to MN Rules Chapter 7080.2450, Subp.3 (B) when holding tanks are maintained the liquid and solids removal can occur through clean out pipes event though removal of accumulated sludge, scum, and liquids from septic tanks and pump tanks must be through the maintenance hole. The University of Minnesota recommends that the maintenance hole be used to empty the tank so the overall tank characteristics can be evaluated and any heavier material that may have settled out be properly removed.

The largest challenge with holding tanks is tank leakage. Having a flow meter in the dwelling is critical for troubleshooting as this value can be compared to the volume and time between emptying the holding tank.

Inspection and Abandonment

Holding tanks are inspected and abandoned following the same procedure as septic tanks covered previously in this section of the manual

Privies

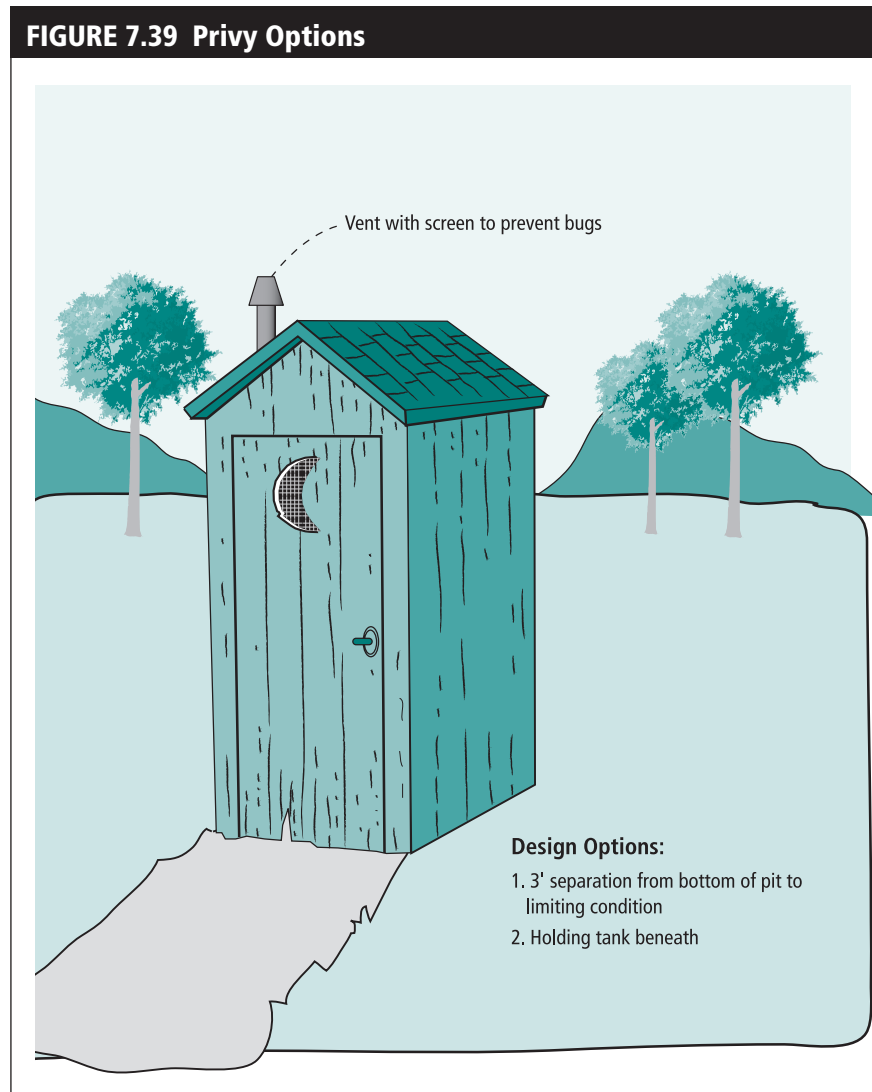
Definition

From MN Rules Chapter 7080.1100, Subp. 62, a privy is an aboveground structure with an underground cavity meeting the requirements of part 7080.2280 that is used for the storage or treatment and dispersal of toilet wastes, excluding water for flushing and graywater. A privy also means a non-dwelling structure containing a toilet waste treatment device.

Outhouses are sometimes also referred to as a pit toilet defined by the Consortium of Institutes for Decentralized Wastewater Treatment (CIDWT) as a self-contained waterless toilet used for disposal of non-water carried human waste consisting of a shelter built above a pit in the ground into which human waste falls.

Rule Requirements

The use of privies is allowed by the provisions of Chapter 7080.2280, Subp. 2). If the pit has an earth bottom, this point should be at least three feet above saturated soil conditions. If this separation distance cannot be achieved in the location of the privy, then the pit should be liquid-tight, with the wastes periodically removed by someone who services septic tanks, as shown in Figure 7.39. The privy should be securely attached to the ground or to the tank used for the pit.



According to MN Rules Chapter 7080.2280, to qualify as a privy, a system must meet the general technical requirements for all systems covered in 7080.2150, Subp. 2

Design and Setbacks

There are two options for the design of a privy:

1. A pit can be dug that meets the 3 foot separation requirement. This means that the soil beneath the bottom of the pit that meets or exceeds the requirements of part 7080.2150, Subp 3, (C). Pits or vaults must have sufficient capacity for the dwelling they serve, but must have at least 25 cubic feet of capacity. The sides of the pit must be curbed to prevent cave in (MN Rules Chapter 7080.2280, (B and C)). The pit must meet all the same setbacks as any soil treatment system.
2. A watertight holding tank meeting applicable requirements of parts 7080.1900 to 7080.2030 can be used instead of a pit. This tank must meet the same setbacks as septic tanks.

Ventilation

From MN Rules Chapter 7080.2280 (E), privies must be adequately vented. To minimize odors in the upper part of the privy a vent should extend from the underside of the seat board through the roof or up to a horizontal vent open to the sides of the toilet. The vent must be flush with the underside of the seat board and must not extend down into the pit. Gases which cause odors are lighter than air, and if the vent extends down below the seat board, these gasses will collect under the seat board to be released upward into the privy when the seat cover is opened. At the top of the privy there should be a screened opening on each side or, preferably, all the way around the top to allow air to pass through and carry away any odors which may seep into the upper part of the structure.

From MN Rules Chapter 7080.2280, (D), the privy must be easily maintained and insect proof. The door and seat must be self-closing. All exterior openings, including vent openings, shall be screened. All vent openings to the outside should be properly screened to keep out insects. Insect-proof openings should be placed in the walls below the seat.

The opening in the seat board must have a tight-fitting cover. The type of seat and cover used on a flush toilet is not satisfactory unless weather stripping is added. The cover should be kept in place when the privy is not in use, and can be hinged to close automatically.

A tight-fitting door, preferably with a self-closing feature, such as a spring, should be used to minimize the number of insects that get into the privy. (A crescent-shaped window, also screened, may be cut into the door so that the utility of the structure will be recognized.)

Operation and Maintenance

According to MN Rules Chapter 7080.2450, Subp. 4 (B), when the privy is filled to one half of its capacity, the solids must be removed. Abandoned pits must have the sewage solids and contaminated soil removed and must be filled with clean earth and slightly mounded to allow for settling. Removed solids shall be disposed of properly.

Odor Control

A number of products on the market claim to minimize odors in a sanitary privy. One that is reasonably effective is hydrated lime. Associated compounds containing the same chemical are slaked lime, quicklime, hot lime, chloride of lime, and pebbled lime.

Approximately one cup of hydrated lime sprinkled over the solids in the pit will minimize odors and aid in decomposition. As the odors again become objectionable, another cup of lime should be added. Excess amounts of hydrated lime will retard decomposition, however, rather than promote it, although the generation of odors will be inhibited. Caution should be used to keep the hydrated lime dust out of eyes and nostrils.

Commercial compounds are available and may be tried by the individual owner in order to determine their effectiveness. Some of them are odor suppressants while others change the bacterial environment within the pit.

Keeping wood odor-free

Any odors which in the past have risen into the structure of an old privy have probably become entrapped in the pores of the wood. To remove these odors, make a solution of disinfectant and tri-sodium phosphate, and scrub the inside walls and all other inside sur-

faces of the privy. This solution will remove odors from the pores of the wood. After the wood has dried, paint the inside of the privy with a polyurethane compound to prevent any additional odors from penetrating the wood.

These techniques should minimize the odor that collects in the structure of a sanitary privy. Proper air circulation can be very helpful in carrying away any odors, so proper venting of the structure is absolutely essential.

Even though bacteria are decomposing the organic waste, there will be some residue remaining. This residue will gradually build up until it must either be removed or the structure moved to a new location. Usually the solids can be removed by a septic tank Maintainer or someone with equipment to perform the task in a sanitary manner. The frequency of solids removal will depend upon the size of the pit and the amount of use.

Troubleshooting

Odors

An outdoor toilet can be kept relatively odor-free and can be constructed for year-round use. But while an outdoor toilet is the least costly alternative to a flush toilet, it may be the least desirable alternative for a residence in a northern climate.

An improperly constructed and maintained privy can be an abomination to both eyes and nose. Several methods can be used to minimize the sanitary privy odor problem caused by decomposition of the organic matter in the pit:

- Using chemical additives to change the bacterial action so that less odor is generated.
- Venting both the pit and the upper part of the structure.
- Placing tight-fitting covers on the seat openings.
- Finally, the inside of the structure should be painted with a polyurethane-type paint to minimize the penetration of odors into the wood.

Inspection

When an existing privy is being inspected it is either evaluated as a soil treatment system needed to meet the two to three foot separation or as a holding tank which needs to be watertight. See the tank inspection portion of this section or the inspection criteria identified in Section 12 for ensuring appropriate vertical separation.

Abandonment

The abandonment of a privy is a relatively simple procedure. If a soil pit was used all liquid should be removed and the pit filled with granular material. If a holding tank is being abandoned it should follow the septic tank abandonment procedures discussed previously in this section of the manual.

Graywater Systems

Definition and Applications

Graywater is defined as sewage that does not contain toilet wastes (MN Rules Chapter 7080.1100 subp 37). This includes water captured from non-food preparation sinks, showers, baths, spa baths, clothes washing machines, and laundry tubs. Graywater systems are systems that remove the toilet waste from the system.

The primary reason why a homeowner may want to separate this waste is to conserve space on their lot, as graywater systems allow a 40% reduction in the required size of the soil treatment area. Other reasons include using graywater systems to reduce nitrogen loading in sensitive areas and reusing non-toilet water for other applications. Other separation of flows may also benefit other establishments with high fat, oil, or grease content.

Rule Requirements

MN Rules Chapter 7080.1100, Subp. 37 & 38 defines graywater as sewage that does not contain toilet wastes and a graywater system that receives, treats, and disperses only graywater or other similar system as designated by the commissioner.

Graywater systems designed according to parts 7080.2260 to 7080.2290 are considered Type I systems (7080.2250). According to MN Rules Chapter 7080, Chapter 2240, Subp. 1, to qualify as a graywater system, the system must meet or exceed the following requirements:

- employ 60 percent of the flow values in part 7080.1850

TABLE 7.8 Estimated Sewage Flows in Gallons per Day

Number of Bedrooms	Class I	Class II	Class III	Class IV
2 or less	300	225	180	*
3	450	300	218	*
4	600	375	256	*
5	750	450	294	*
6	900	525	332	*

* Flows for Classification IV dwellings are 60 percent of the values as determined for Classification I, II, or III systems. For more than six bedrooms, the design flow is determined by the following formulas:

Classification I: Classification I dwellings are those with more than 800 square feet per bedroom, when the dwelling's total finished floor area is divided by the number of bedrooms, or where more than two of the following water-use appliances are installed or anticipated: clothes washing machine, dishwasher, water conditioning unit, bathtub greater than 40 gallons, garbage disposal, or self-cleaning humidifier in furnace. The design flow for Classification I dwellings is determined by multiplying 150 gallons by the number of bedrooms.

Classification II: Classification II dwellings are those with 500 to 800 square feet per bedroom, when the dwelling's total finished floor area is divided by the number of bedrooms, and where no more than two of the water-use appliances listed in Classification I are installed or anticipated. The design flow for Classification II dwellings is determined by adding one to the number of bedrooms and multiplying this result by 75 gallons.

Classification III: Classification III dwellings are those with less than 500 square feet per bedroom, when the dwelling's total finished floor area is divided by the number of bedrooms, and where no more than two of the water-use appliances listed in Classification I are installed or anticipated. The design flow for Classification III dwellings is determined by adding one to the number of bedrooms, multiplying this result by 38 gallons, then adding 66 gallons.

Classification IV: Classification IV dwellings are dwellings designed under part 7080.2240.

In addition, no toilet waste may enter a graywater system (7080.2240, Subp. 2). Graywater septic tanks must meet the requirements of part 7080.1900, except that the liquid capacity of a graywater septic tank serving a dwelling must be based on the

number of bedrooms existing and anticipated in the dwelling served and should be at least as large as the capacities given in Table 7.9 (7080.2240, Subp. 3).

TABLE 7.9 Septic Tank Capacity is Based on Bedroom Count

Number of bedrooms	Minimum Septic Tank Liquid Capacity (gallons)
3 or less	750
4 or 5	1,000
6 or 7	1,250
8 or 9	1,500

For ten or more bedrooms, the graywater septic tank shall be sized as: $(1,500 + ((\# \text{ of bedrooms} - 9) \times 150))$.

The following text are courtesy of the Model Decentralized Wastewater Practitioner Curriculum Technology Overview

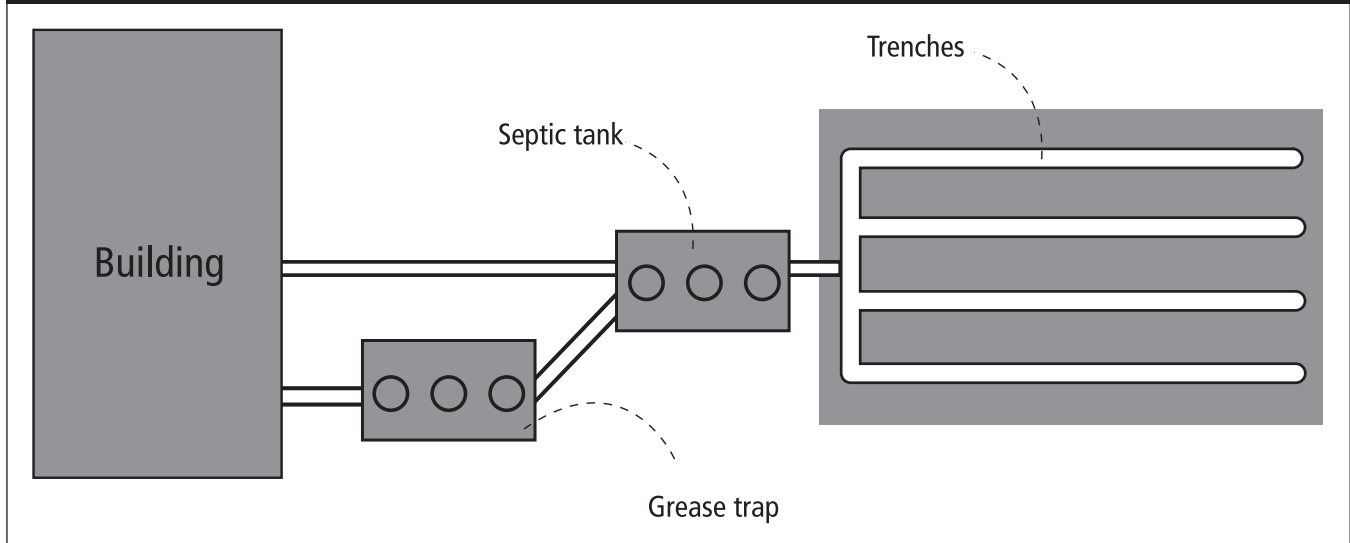
Segregation of wastewater flows

Wastewater that is treated by SSTS is generated by a number of activities in a residence or other facility. Wastewater uses have been identified as consisting of blackwater (in most locations this is just wastewater from toilets) and graywater (wastewater from all other plumbing fixtures). Most of the time, systems treat the combined wastewater from all sources in a structure. Occasionally, the decision is made to split the system so one or more components treat one source of wastewater while another one or more components treat other sources. This will require separate plumbing networks in the residence or other structure.

The primary reasons for splitting flows include:

1. Wanting to have separate systems treat blackwater and graywater:
 - a. To minimize nitrogen being discharged to ground or surface water in nitrogen sensitive areas by using non-discharging blackwater toilets, such as composting or incinerating toilets. These toilets retain most of the nitrogen in residential wastewater flows, since most of the nitrogen is in the blackwater.
 - b. To reuse wastewater where wastewater reuse is a priority, by treating and reusing graywater for landscape irrigation, toilet flush water or other uses.
2. Keeping wastes containing high concentrations of fats, oils and greases (commercial kitchens) from fouling components handling wastewater from other sources until the fat, oil and grease concentrations have been significantly reduced.

FIGURE 7.40 Typical Split Flow System Combined for Dispersal



Sometimes, even though the flows are initially split, they are combined somewhere downstream. For example, when a grease trap or interceptor is used to handle wastewater from the kitchen only, the resulting effluent may be combined with the rest of the wastewater in a downstream septic tank. See Figure 7.40.

Other times this separation continues throughout the entire system, so there are two complete wastewater systems. See Figure 7.40. Examples of this are when non-discharging toilets (composting toilets & holding tanks) are used to handle the blackwater and another pretreatment and dispersal system is designed and constructed to handle the graywater.

Graywater may go through one or more treatment processes so that the graywater can be used for one or more non-potable uses: irrigation, toilet flushing, and greenhouses. This allows the graywater to be reused as a resource. Graywater may be collected in a holding tank, where permitted, and periodically pumped and hauled away to a site that can treat and dispose of it properly.

Data indicate that graywater contains significant concentrations of organic and inorganic material (whatever is poured down a sink or drain). Graywater also can contain fecal coliform concentrations as high as those found in blackwater. Thus, graywater must be treated. If a typical SSTS is used, it may be reduced in size since just the graywater is being treated. Alternatively, some jurisdictions may require a typical full size system. When reductions in size have been permitted for an SSTS to handle graywater, there have been historical concerns that a non-discharging blackwater toilet will be replaced with a flush toilet.

When graywater is being treated for a later non-potable use (toilet flush water, landscape irrigation), there must be assurances that the treatment is being reliably provided. Ongoing monitoring and maintenance is critical. Effects of not meeting treatment standards include: 1) clogging of pipes, valves, and orifices by nutrients, algae, and solids, and 2) exposure of humans to pathogens in inadequately treated reuse water.

Non-flush toilets

From MN Rules Chapter 7080.1100, Subp. 86, a toilet waste treatment devices is a toilet waste apparatuses including incinerating, composting, biological, chemical, recirculating, or holding toilets or portable restrooms.

For primitive dwellings using toilet waste treatment devices in low dwelling density areas, septage disposal from these devices by the owner must be in accordance with local ordinances. If no ordinance exists, the septage must not be discharged to surface waters, drainageways, steeply sloping areas, or wet areas in a manner or volume that is harmful to the environment or public health or that creates a nuisance. The material must be buried or covered with soil. For site conditions not met in this subpart, the solids disposal from toilet waste treatment devices shall be done by a licensed maintenance business (7080.2450 Subp. 4).

Following is information on three different classes of non-discharging toilets to handle blackwater. In some jurisdictions, plumbing codes may prohibit non-discharging toilets for some uses. The MN Plumbing code requires that all plumbing fixtures be connected to the building sewer (MN Rules Chapter 4715.1200). Non-discharging toilets, though, may not be considered a plumbing fixture and therefore may be used where local ordinance allows.

Incinerating toilet

An incinerating toilet reduces human excreta and urine to ash and vapor by incineration. This toilet only handles blackwater and is not designed for any water-carried sewage. This process is fueled by natural gas or electricity.

Careful consideration must be given to select the appropriate model and size for a specific application. As this process only handles blackwater, a system providing treatment and dispersal for the graywater is necessary. This blackwater handling process is located inside a residence, requiring extra considerations for the SSTS professional, especially those responsible for monitoring and maintenance. This option requires the use of a bowl liner and/or other methods specified by the manufacturer to keep the toilet bowl clean. There are gases that must be properly ventilated. Residual ash must be taken from the toilet and disposed of properly. Operation of the toilet (i.e. use of a liner and activating the burning cycle) is unfamiliar to the general public and, therefore, may not be appropriate for public access restrooms.

Composting toilet

A composting toilet that receives human excreta and urine, and some carbonaceous kitchen wastes and transmits it to a composting chamber. Depending on the size of the composting chamber, the material undergoes drying and varying degrees of decomposition.

Toilets may be large or small capacity units. Careful consideration must be given to select the appropriate model and size for a specific application. If larger units are to be used, they are usually installed as part of a building's construction. Retrofitting an existing structure with a larger unit can be difficult. As this process only handles blackwater, a system providing treatment and dispersal for the graywater is necessary. This blackwater handling process is located inside a residence, requiring extra considerations for the SSTS professional, especially those responsible for monitoring and maintenance. Some of the units are relatively small and are self-contained. Others have big chambers under the toilet, requir-

ing space in a basement or crawl space. These units have been used extensively in many public and commercial recreational facilities. They have also been used in communities to minimize wasteful use of valuable potable water. The toilets contain mechanical agitators, thermostats, humidistats, heaters and fans to assure the proper moisture content and temperature are maintained. The toilets must be properly vented. Direct homeowner involvement in the operation, monitoring and maintenance of the toilet is required, even if a management structure exists to provide on-going system monitoring and maintenance. This involvement includes monitoring moisture content, control of flies, periodic mixing of the composting material, and periodic removal and proper disposal of the composted material. The fact that most of the composting toilet's sub-components may be inside a residence or structure complicates the ability for a third-party management entity to care for the toilet.

Chemical toilet

In most chemical toilets, a charge of chemical is added to a small amount of water. After use, the liquid is recirculated by an electric or hand-operated pump to flush the wastes into a holding chamber. The initial charge of chemical is adequate for 40-160 uses, depending on the model used. When the holding chamber is full, a valve can be opened to discharge wastes into a holding tank. On some chemical toilets, the holding chamber can be removed for waste disposal. Wastes are reduced to about two percent of those from a conventional flush toilet.

For more information on various brands of non-flush toilets visit the links section of the University of Minnesota's website at <http://septic.umn.edu/Links/>

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