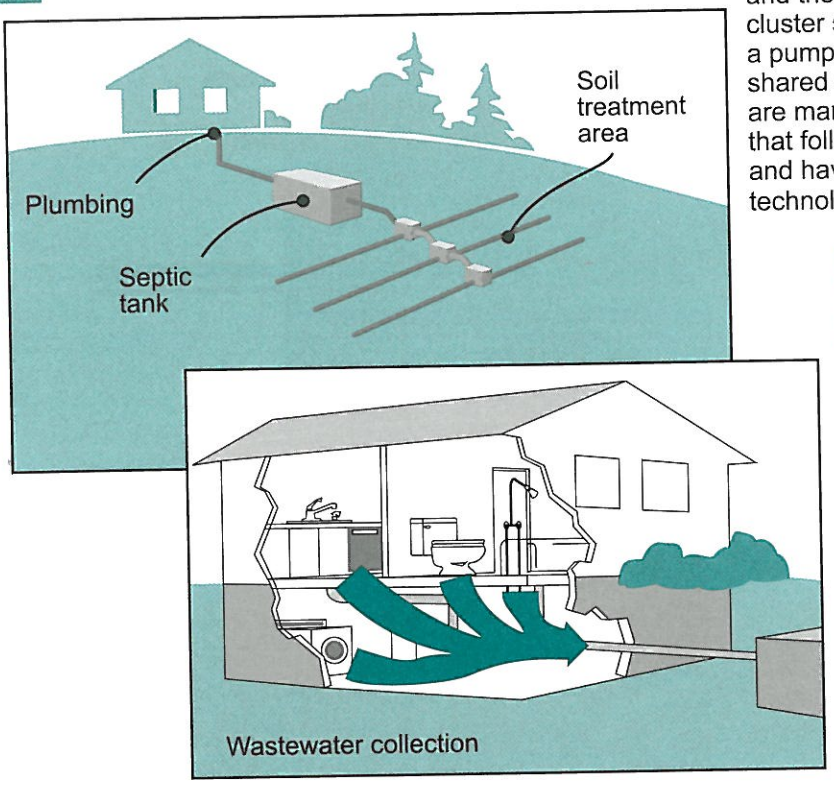
Septic System Features

The design and installation of a septic system is controlled by local and state rules through a permit process. The design takes into consideration all specific site characteristics including the type of soil, size of house, and sewage-generating fixtures and appliances. All systems must be designed and installed by licensed professionals and inspected by qualified officials to ensure proper installation. ***Operation and maintenance of the system is nearly always the owner's responsibility.*** Contact the appropriate local agency (planning and zoning, environmental services, etc.) with questions about local requirements.

The complete septic system is made up of three primary components:

- Plumbing: sewage collection
- Septic tank: primary treatment
- Soil treatment area: final treatment and dispersal

Figure 2 – Major components of an onsite treatment system



Note: Some homes are equipped with composting or incinerating toilets, which handle toilet wastes through a separate process. Other septic systems may also have an additional "pretreatment" step between the septic tank and the soil treatment area. If you are connected to a cluster system with other houses, you may have pipes, a pump tank, or a septic tank on your property with a shared soil treatment area in another location. There are many variations in the features and descriptions that follow because systems are individually designed and have been installed using different practices and technologies over many years.

Plumbing: Sewage Collection

All sewage containing human wastes, nutrients, dirt, and other contaminants must be collected and delivered to the septic tank and soil treatment area for treatment and dispersal. ***All water used in bathing, toilets, laundry, and dish washing must be treated by the system.*** A sewage pump in the basement may be necessary to move sewage from basement fixtures up to the septic tank. Sink and laundry drains allowing wastewater to enter the system should be equipped with strainers and other filtration devices to reduce the quantity of food particles, hair, and lint entering the system.

Older homes or "repaired" systems may have been plumbed to allow gray water (laundry) to bypass the septic tank, but this can cause damage by putting too many solids into the soil treatment area or disposing of wastewater directly to the environment. Minnesota, like most states, requires all sewage to be treated, including gray water. However, water from roof drains, basement drainage sump pumps, hot tubs, swimming pools, and other sources of clear or chemically treated water should not be put into the septic system. These large volumes of water will overload the system.

Original and remodeled plumbing systems must be correctly designed and installed to allow trouble-free operation. ***Consider the impact on your septic system before remodeling your home.*** Adding a bedroom may mean adding capacity to your septic system. Building a garage or deck may trigger an inspection of your septic system. Different localities have different inspection triggers, but shoreland areas across the state require a compliant septic system before remodeling.

Septic Tank: Primary Treatment

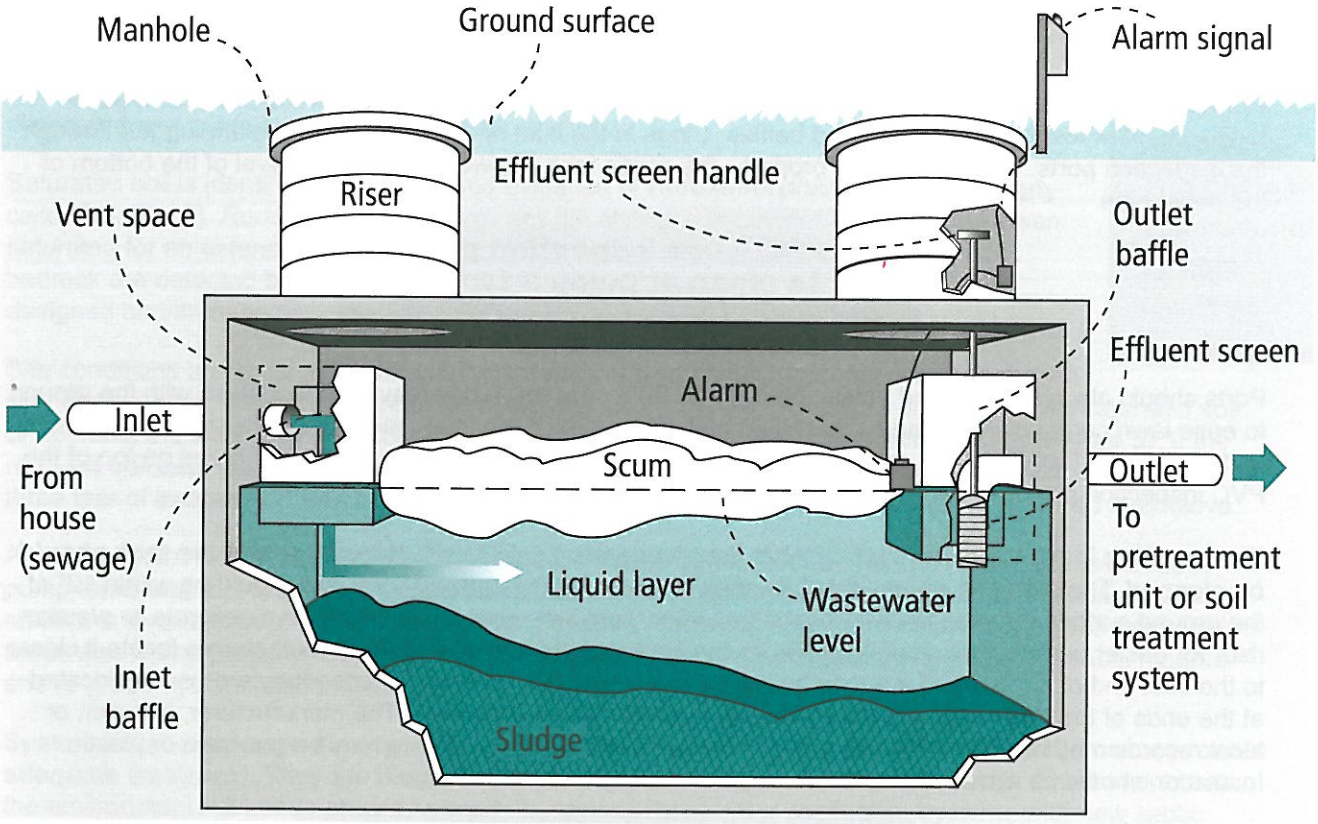
How the Tank Works

With time, the contents of the septic tank separate by density into three layers:

- ***Floating scum layer*** – soaps, greases, toilet paper, etc., form the top layer
- ***Liquid layer*** – liquid and suspended solids are in the center of the tank
- ***Sludge*** – heavy organic and inorganic materials sink to the bottom of the tank

Solids separate in the tank by gravity – lightweight materials float to the top and heavy materials sink to the bottom. Naturally occurring bacteria in the sewage begin to break down the organic materials. This is often referred to as ***primary treatment.*** Pathogens in the sewage are ***NOT*** destroyed in the septic tank. Anaerobic bacteria that live with very limited oxygen in the septic tank prepare the sewage for final treatment in the soil treatment area. Liquid leaving the septic tank is referred to as septic tank ***effluent.***

Figure 3 – Septic tank



Components of the Tank

The ***septic tank*** is the first step of the sewage treatment process. The septic tank is a solid, watertight tank. Septic tanks are most commonly constructed of concrete. Occasionally other materials (polyethylene, fiberglass, or coated metal) designed specifically to accept sewage are used. Installations may have two tanks in a row or one large tank with two compartments. Increased tank capacity is necessary if a garbage disposal is installed or if there is a pump in the basement. A few homes on small lots or with poor soil may have a large holding tank to store sewage until the entire contents are pumped and hauled away for treatment at another location. For shallow installations in cold climates, insulating material designed

to be buried in the soil should be placed over and around tanks to prevent freezing. Several tank designs are available, but all tanks must have inlet and outlet baffles, inspection pipes, and a manhole for cleaning **(Figure 4).**

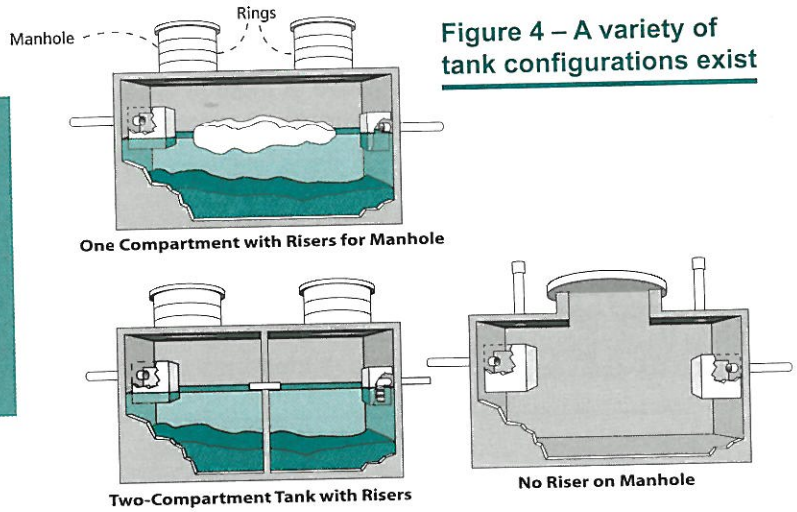


Figure 4 – A variety of tank configurations exist

The ***inlet baffle*** forces sewage entering the tank to mix with the liquid contents and begin bacterial breakdown of organic materials and separation of solids. The inlet baffle also prevents the floating scum layer from clogging the inlet pipe.

The ***outlet baffle*** prevents scum from leaving the tank. If the scum layer reaches the outlet pipe, the pipe will become plugged. Scum in the soil treatment area will clog soil pores and destroy its ability to treat sewage. Screening devices, known as "effluent screens," can be installed at the outlet of new or existing tanks to prevent solids from reaching the soil treatment area. Regular maintenance is required to keep the screens from clogging and causing backups. Screens are a very good idea but are not a substitute for proper operating or maintenance practices.

Inspection ports of four to six inch PVC (plastic) material should be located above the inlet and outlet baffles to allow inspection of pipes and baffles. Clogs in the inlet or outlet pipes can be unplugged through the inspection ports. When operating properly, the septic tank is always "full" to the level of the bottom of the outlet pipe.

! Do NOT use inspection ports to clean or pump a tank! !

Ports should always be capped unless being used for inspection. They may be cut off flush with the ground to ease lawn care; however, the ports should be left "long" until the final grade on a new site is determined. Metal covers oxidize, corrode and generally deteriorate over time. However, a piece of metal on top of the PVC inspection pipe cap will help locate it with a metal detector.

The ***manhole*** in the top of the septic tank is the large entrance (20"-24") ***through which the tank should be cleaned.*** The manhole on an older tank may be buried below ground level, but should be within 12" of the ground surface for easy access. It may be raised from the cover of the tank with a concrete or plastic riser for easier access. It is usually located in the center of the tank but some manufacturers locate it closer to the inlet end of the tank. There may be more than one manhole, in which case they are usually located at the ends of the tank. At-grade manholes are required for new systems. The manufacturer, installer, or local records may be able to tell you where the manhole is located. Covers may be concrete or plastic. Insulation should be added to reduce the likelihood of freezing.

! Be careful when removing the manhole cover! It is heavy and creates a large, dangerous opening! !

The manhole allows for proper cleaning and inspection of the tank (see Tank Maintenance on page 18). The manhole cover must be kept securely in place. If the septic tank cover does not have a manhole or inspection openings, a new cover with these features can be installed on an existing tank. Be sure the tank is watertight before making this investment.

Soil Treatment Area: Final Treatment and Dispersal

How the Soil Treatment Area Works

All septic systems include the same basic plumbing and septic tank components. Final treatment of septic tank effluent occurs in the soil. Uncompacted, unsaturated (not full of water), undisturbed soil must exist above and below the soil treatment area. This area may be a series of trenches or a mound **(Figures 5 and 6)**. Soil treatment destroys disease-causing organisms in the effluent and removes many nutrients. In every tablespoon of soil, there are millions of naturally-occurring beneficial microscopic organisms that complete the sewage treatment process.

The beneficial microorganisms in the soil need air to live. Therefore, a zone of unsaturated soil must be present below the effluent's point of entry into the soil for complete treatment. At least three feet of unsaturated soil above bedrock is the recognized standard. Local units of government may have established different requirements based on local conditions.

The soil type, water percolation rate, sewage volume to be treated, and other factors determine how large an area is needed to properly treat the sewage at your site. The unique shape and slope of each site must also be taken into account during system design.

A ***biomat*** is a thin layer of fine solids, dead bacteria, and soil bacteria that forms where the effluent meets the soil. The biomat layer regulates how fast liquid passes out of the trench or bed into the soil so the soil beneath remains unsaturated. Once the effluent moves through the biomat layer and three feet of unsaturated soil, harmful pathogens have been eliminated and nutrient levels diminished.

Site conditions and local requirements determine the soil treatment system required.

Saturated soil is identified by its color and evidence of ***redoximorphic features*** (formerly called "mottling"). *Redoximorphic features* are the changes in color of a soil that has been saturated for an extended period of time. These indicators of saturation and depth to bedrock are detected by soil borings or pits dug by professionals when the system is designed and/or inspected.

Site conditions and local requirements determine the type of soil treatment required at each site. For instance, if there are three feet of unsaturated soil from the bottom of the trench to saturated soil or bedrock, the least expensive distribution and soil treatment area is a **trench system (Figure 5)**. If the required soil depth for a trench is not available, an above-ground ***mound system*** is required to achieve the three feet of treatment **(Figure 6)**. **At-grade systems** (see page 9) may also be the preferred alternative.

A mound system is an elevated drainfield built with clean sand. Mound systems require pumps and/or pump tanks and a pressurized effluent distribution system, which is a network of distribution pipes where effluent is forced through perforations under pressure. A growing number of below-ground soil treatment areas also utilize pressure distribution. There are many small variations in design, but all trench, mound, and at-grade systems accomplish the same final treatment function.

Systems that discharge directly from a septic tank to a ditch, stream, lake, or field tile never provide adequate treatment. They are **illegal** because they present an imminent public health threat and threaten the environment. All efforts should be made to replace these older, ineffective systems with new septic systems that provide acceptable treatment.

Soil Treatment Area (Drainfield)

Common terms for the soil treatment area are drainfield, mound, seepage bed, leach bed, at-grade, dispersal area, and soil absorption field. The soil treatment area is where the final treatment and dispersal of septic tank effluent takes place. A properly designed and installed soil treatment area will destroy pathogens and filter out the fine solids contained in the effluent. Phosphorus is chemically attached to soil particles and remains in the soil treatment area. Nitrogen treatment under a soil treatment area can occur through various methods. Shallow systems enhance evaporation and interaction with plants. Nitrogen that remains in the downward percolating water may be diluted by ground water.

Nitrate from properly designed treatment areas rarely causes problems in drinking water. However, septic systems may contribute to elevated levels of nitrate in ground water in sensitive areas. This may be an issue in sandy soils, shallow bedrock, and karst areas where shallow wells are used for drinking water. In these cases the treatment solution may include pretreatment of effluent, pressurized distribution, or the use of different drinking water wells.

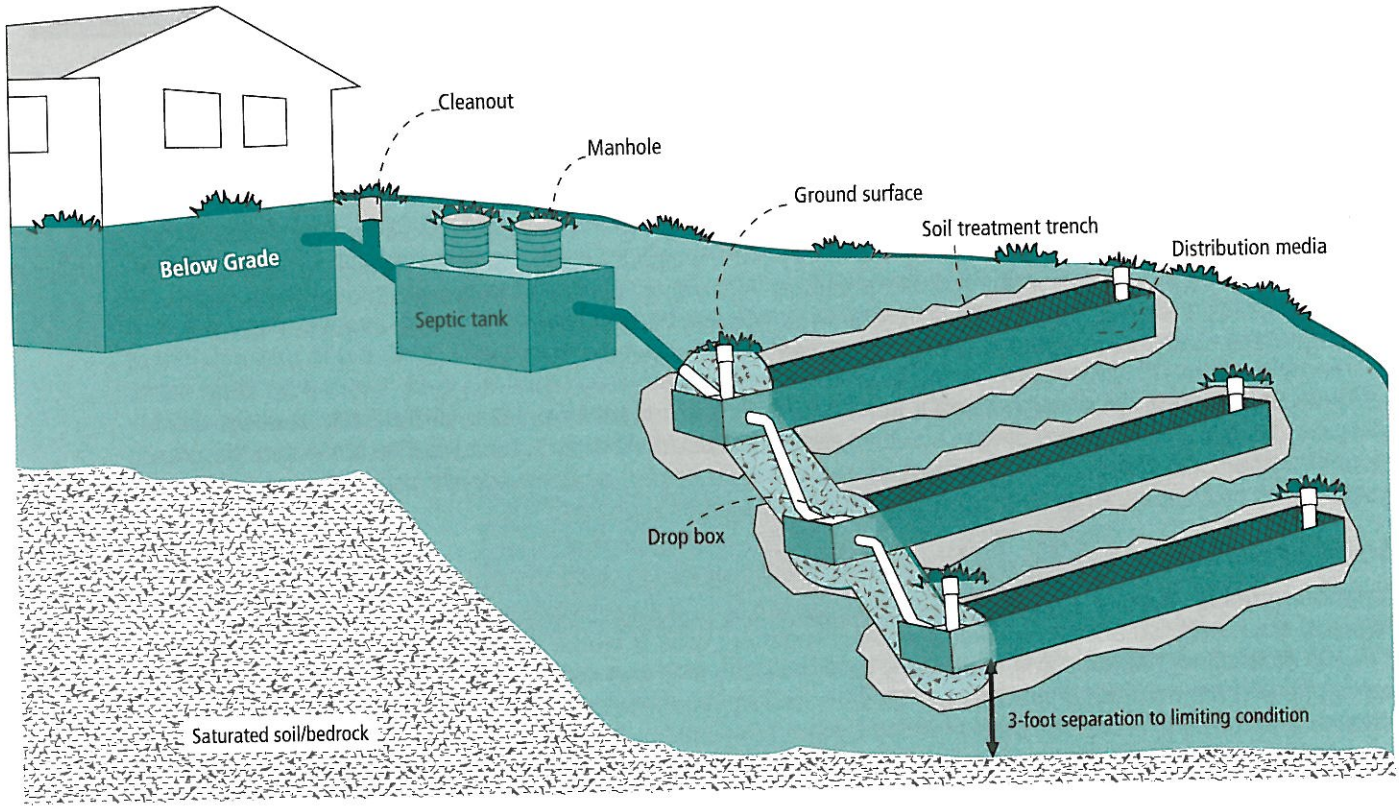
The two most commonly used types of soil treatment (drainfield) areas are trenches and mounds.

Trench: Soil treatment area trenches **(Figure 5)** effectively treat effluent flowing from the septic tank. They are preferred when soil conditions allow, because they are the most economical to install and maintain. A soil treatment area trench is a level excavation 18-36 inches wide. A trench wider than 36 inches is referred to as a "seepage bed." The trench contains a perforated pipe in a layer of ¾ inch to 2 ½ inch diameter rock covered by natural or synthetic permeable fibers. Some in-ground soil treatment areas use large 8 to 10 inch diameter plastic tubes wrapped with fabric or a plastic chamber in the trench without rock. A minimum of 12 inches of soil covers the trench. Effluent flows through the holes in the perforated pipe, to the rock, tube, or chamber, through the biomat, and into the soil. Bacteria and fine sewage solids are removed or destroyed in this process. Dissolved organic materials provide food for the soil bacteria.

The distribution of effluent into a gravity soil treatment area is accomplished using ***drop boxes*** or ***distribution boxes.*** The covers of either type of box can be removed for inspection and cleaning. All pipes from the house and septic tank to the soil treatment area are unperforated with sealed connections. In cold climates, such as Minnesota, insulated pipe should be used for shallow installations to prevent freezing, especially in high-traffic areas such as driveways and paths.

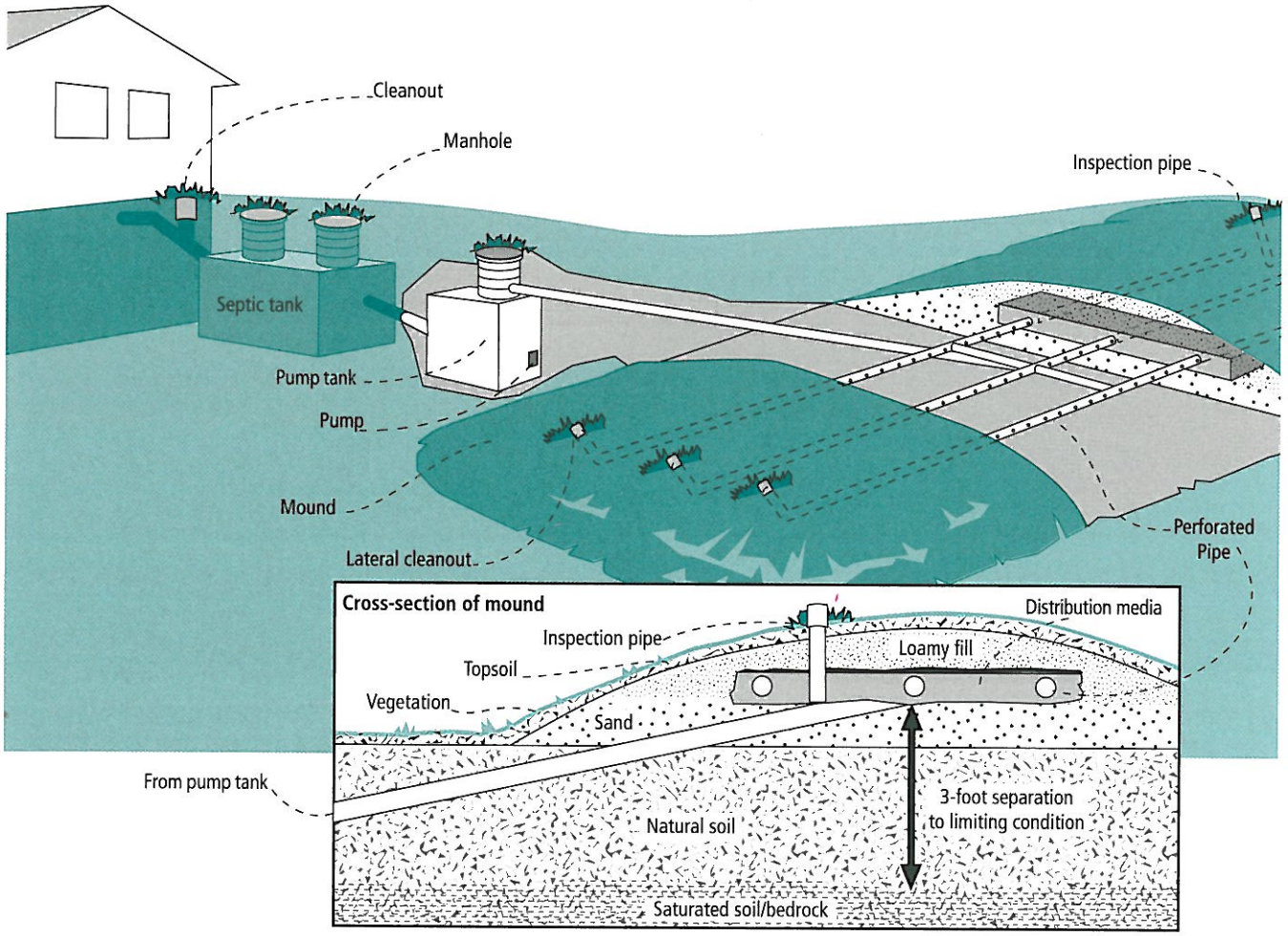
The trench system may be laid out in one of many configurations to fit the property and allow for the necessary square feet of treatment area. Often there are inspection pipes used to evaluate the system on one or both ends of the trench. The ground surface of the soil treatment area should always be slightly crowned above the surrounding ground to avoid excess rainfall ponding or flooding of the system.

Figure 5 – Gravity flow to trench system



Mound (Elevated Treatment Bed): A sewage treatment mound is a pressurized seepage bed built with clean sand to provide adequate soil separation between the effluent released into the mound and the saturated soil or bedrock underneath. It is as effective in treating sewage as an in-ground system as long as it is properly designed, constructed, and operated and the septic tank is maintained correctly. In fact, mounds may remove more nitrogen than a trench. The mound system **(Figure 6)** has a pressurized distribution system of 1½ or 2 inch perforated pipe in a layer of ¾ to 2½ inch rock covered by a synthetic permeable fiber such as landscaping fabric. Distribution media other than rock may be used. The mound is covered with soil and planted with appropriate vegetation.

Figure 6 – Pressurized flow to mound system



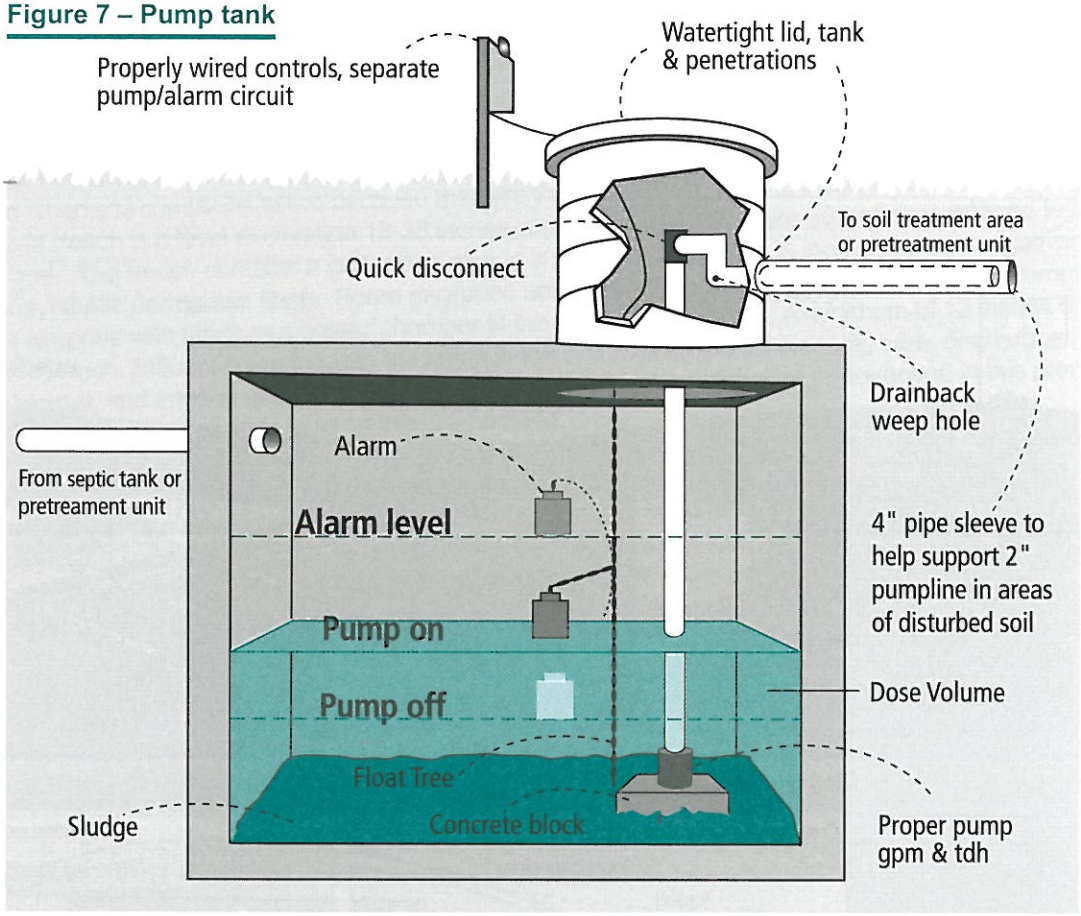
At-Grade: A system known as an "at-grade" can be used when a site's soil conditions indicate a limiting condition in between the depth acceptable for a trench and that which requires a mound. An at-grade is a bed of rocks or other distribution media containing pressurized pipe placed on the ground surface. Similar to a mound, the pressurized seepage bed is covered by a synthetic permeable fiber and soil cover.

Pumps and Pump Tanks

A ***pump tank*** is needed if the final soil treatment area uses pressurized distribution or the liquid flowing out of the septic tank cannot reach the trenches by gravity. A pump tank is a separate, smaller tank or second compartment of a septic tank containing a pump designed to move the effluent **(Figure 7)**. A pump may also be necessary to move effluent from the septic tank to a pretreatment unit. Pumps are rated by their gallons per minute (gpm) and their total dynamic head (tdh). The correct pump is critical to proper operation. A ***pump*** typically operates on a float-controlled switch. When the volume in the tank is full it will pump the contents to the soil treatment area. Timers can also be used to operate the pump. They distribute effluent evenly throughout the day, which is beneficial for managing high flows. The pump has

! Something is wrong when your alarm is activated! Call your service professional !

Figure 7 – Pump tank



an emergency alarm to warn the homeowner when the water level is too high. If the alarm goes off, the problem needs **immediate attention!** Be sure to know where this alarm is, what it means, and what to do when it is activated. Remember, you may need to access the manhole cover on your pump tank at any time of the year, so it should be at ground level.

Alternative to Trenches, Beds, At-Grades, and Mounds

Drip Distribution

Drip distribution is used in places where standard trenches are hard to install such as on steep slopes, in forested areas, or with shallow soil over bedrock. Drip systems will usually require more space than trenches, beds, or mounds. They utilize a series of shallow small-diameter plastic tubes fitted with emitters. Emitters are regularly spaced holes that disperse very small amounts, or drips, of pretreated effluent into the soil, providing nutrients and water to plants.

Effluent is delivered to the drip tubing by a high-head pump. The effluent is filtered to prevent clogging of the small openings. Most systems are programmed to periodically "flush" the tubing. An air release valve is necessary to vent the tubing when the pump shuts off.

These components should be inspected at least annually. This should include checking pressure gauges and air relief valves, walking around the application area while the effluent is being applied, flushing the tubing, and cleaning the filters.