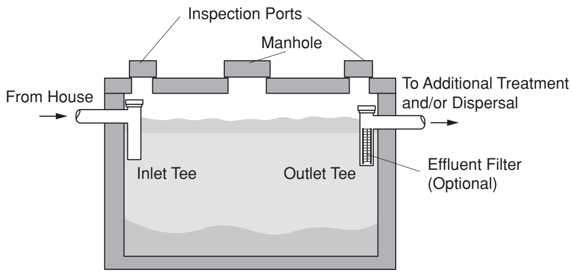
Common Onsite System Components

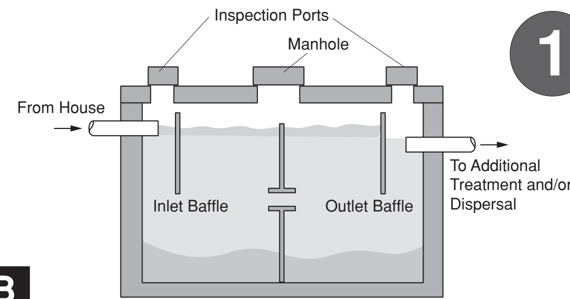
SEPTIC TANK

1



A

Single Compartment Septic Tank



B

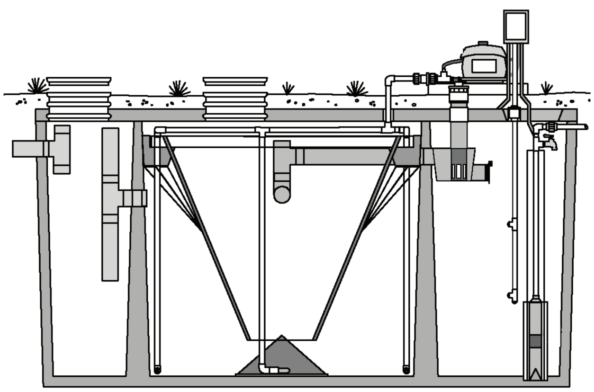
Multi Compartment Septic Tank

A septic tank is a receptacle designed to treat wastewater by settling out solid particles, then breaking down and storing solids. Typical retention time for the wastewater ranges from 24 to 48 hours. Wastewater enters the tank through an inlet: solids (sludge) settle to the bottom where some digestion occurs, and grease and fats (scum) float to the top of the water level. A clearer layer (effluent) is developed between the sludge and scum layers and eventually passes on to the next treatment step through an outlet device.

Inlet and outlet devices can be either baffles or tees (or a combination), with the outlet device approximately three to five inches lower than the inlet. A septic tank can be single or multi-compartment, as shown. Several states now require effluent filter devices in the outlet of new septic tanks or retrofitted to existing septic tanks for further solids removal. This helps ensure that solids do not reach the drainfield where they can cause clogging.

AEROBIC TREATMENT UNIT (ATU)

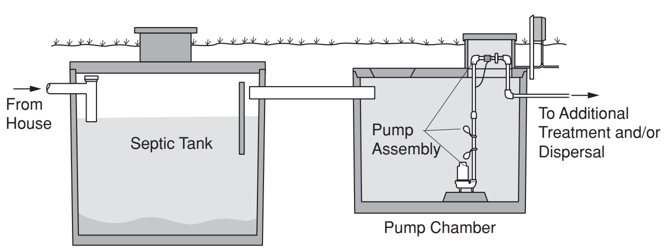
2



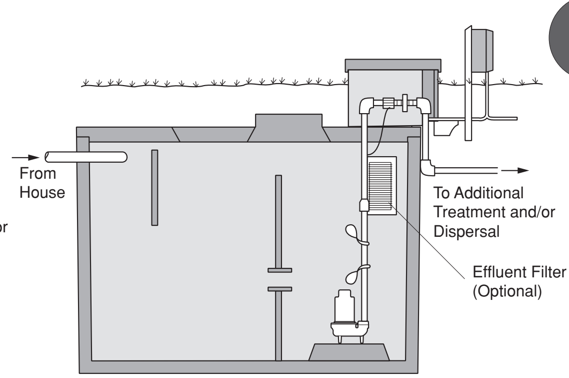
An ATU treats wastewater using natural processes that require oxygen. Most ATUs include a pretreatment step to reduce the amount of solids entering the aerobic unit. This pretreatment step could be a septic tank, primary settling compartment as part of the ATU, or a trash trap. Wastewater then enters the aeration compartment of the ATU where an air blower or compressor mixes air (oxygen) with the wastewater. Aerobic bacteria break down and remove some of the solids. Remaining solids are then allowed to settle out prior to the next treatment step. Depending on the design of the system, settling of solids may occur in a separate compartment or be allowed to accumulate in the bottom of the tank and may need to be pumped out periodically. Further treatment and/or disinfection is needed prior to final dispersal back into the environment.

PUMP CHAMBER

3



Pump Chamber from Septic Tank

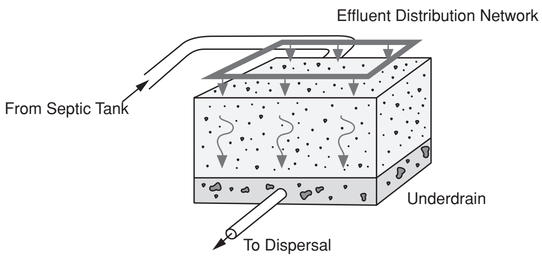


Multi Compartment Septic Tank

In non-gravity systems, effluent must be pumped to a desired elevation. The pump is housed in a pump chamber either as a separate unit or in the second (final) compartment of a multi-compartment septic tank, as shown. Effluent from a septic tank flows to the pump chamber, and when the effluent reaches a certain level, the pump is activated, sending the effluent toward additional treatment and/or final dispersal. The pump chamber should have an above-ground port for easy pump service and cleanout.

Optional Advanced Treatment

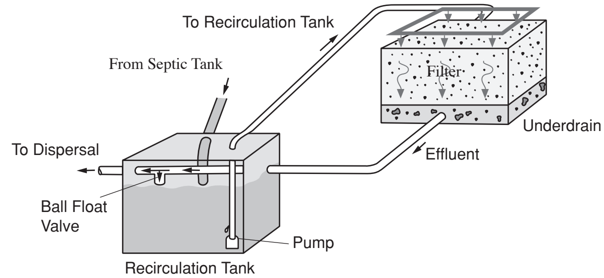
SINGLE-PASS FILTRATION



Filtration is a process whereby polluntants, primarily solids in suspension, are removed from water by physically trapping them in media containers called filters. Media can be sand, gravel, or alternative material that is permeable and allows water to pass through. Filtration consists of two common types: 1) single-pass filtration and 2) multi-pass filtration.

In single-pass filtration, the effluent flows through the filter only one time before being discharged for additional treatment or final dispersal.

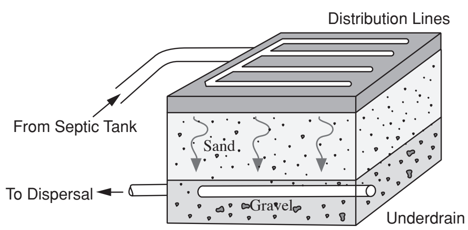
MULTI-PASS FILTRATION



In multi-pass (recirculating) filtration, the water passes through the filter as it does in sinagle-pass filtration except that when it reaches the filter underdrain, only a portion of the water is discharged for final dispersal. The remainder of the effluent is collected into a pump tank called a recirculation tank and goes through the filter again. The number of times the water passes through the filter is called the recirculation ratio and is determined by the desired quality of the effluent.

SAND FILTRATION

4



Sand Filter

Sand filters are designed as single-pass or multi-pass filters and use sand as the media for filtration. The sand is usually two or three feet deep and contained in a liner made of concrete, plastic, or other impermeable material. Depending on the design, the filter may be situated above ground, partially above ground, or below ground. The filter surface may be open or covered. Partially treated wastewater is applied to the filter surface in intermittent doses and receives treatment as it slowly trickles through the media. In most sand filters, the wastewater then collects in an underdrain and flows to further treatment and/or dispersal.

PEAT FILTER

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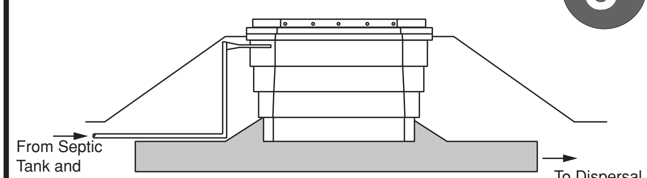

Peat Filter

Peat filters are commonly single-pass filters but also can be designed as multi-pass filters. The peat used in these filters is typically dried and millled sphagnum peat moss or a fibrous by-product of briquettes used in fuel production. Peat naturally filters, absorbs, and chemically interacts with effluent. Many different kinds of beneficial aerobic bacteria also adhere to the surface of the peat media to treat the effluent biologically. The peat is contained in modules placed above ground or at ground level. Effluent from the pretreatment unit is dosed onto the peat filter media. The effluent is then discharged to additional treatment and/or final dispersal. One advantage of peat as a filter medium is its effectiveness in situations where loadings are seasonal or intermittent.

OTHER MEDIA FILTERS

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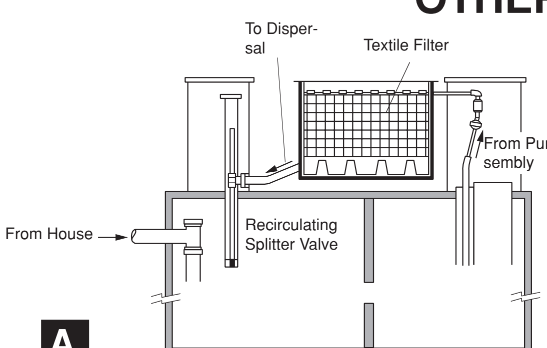
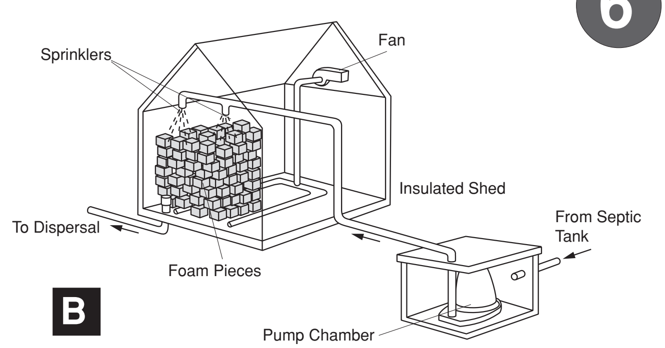


Dual Compartment Processing Tank



The media used in these filters are usually artificial or synthetic materials, such as plastic or foam particles. The media provide some physical filtration, but the main purpose is to act as a place for biological material (microorganisms) to accumulate. The media combine porosity and high surface area to provide a place for microorganisms. The biological material uses the nutrients in the wastewater as a food source, thereby reducing the amount of pollutants in the wastewater. Typically, these filters are single-pass aerobic filters. The units can be attached to a tank or stand alone and can either be gravity-fed or pressurized.

Optional Advanced Treatment

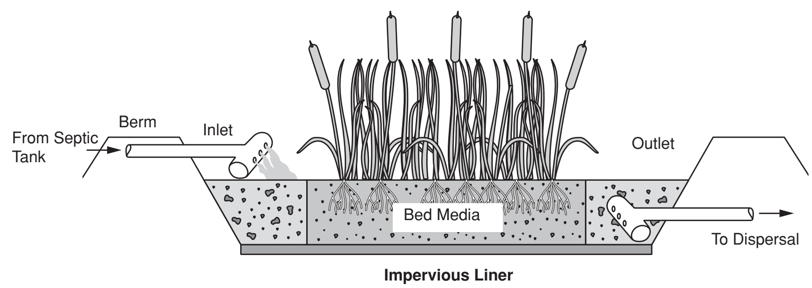
CONSTRUCTED WETLANDS

7

Constructed wetlands are artificially created, lined ponds with a coarse media, such as gravel, to support aquatic vegetation. The vegetation aids in the reduction of nutrient pollutants, such as nitrogen and phosphorus, and helps to remove solid particles by trapping them in the plant root structures or gravel. All wetlands require some harvesting of the plants (which should be performed just before the onset of summer) and periodic removal of solids from the gravel.

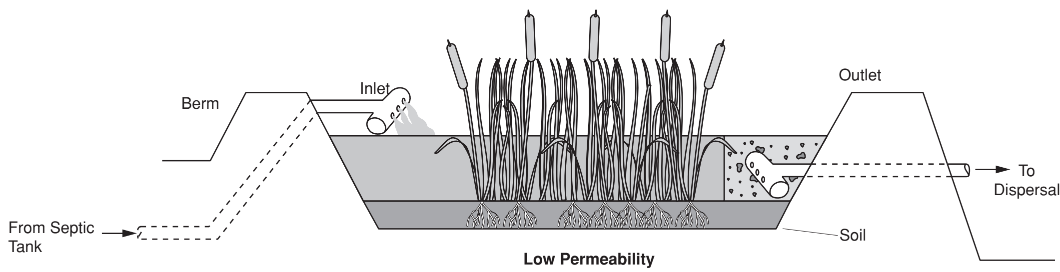
Constructed wetlands can be one of two types: 1) free water surface (FWS) or 2) subsurface flow. FWS wetlands are designed to be more attractive to aquatic life since they function very similarly to natural ponds. The water level in subsurface flow wetlands is kept below gravel base. This is advantageous because the possibility that people will come in contact with the effluent is reduced.

Subsurface Flow



A

Free Water Surface



B

DISINFECTION

Safe handling practices must be followed by anyone working with disinfection methods.

8

Chlorine

One of the most common forms of disinfection, chlorine is used to kill disease-causing bacteria and microorganisms in wastewater. Disinfection efficiency depends on factors such as contact time, dosage, temperature and pH. Tablet chlorinators are the most common means of chlorinating domestic wastewater on a small scale. Occasionally, when the effluent chlorine level is high enough to adversely affect the receiving waters, dechlorination is necessary. Dechlorination is accomplished by the addition of chemicals such as sulfur dioxide and activated carbon to the chlorinated effluent.

Ultraviolet (UV)

UV disinfection occurs when radiation penetrates the cell walls of microorganisms in the effluent stream and is absorbed by the cells. This prevents cell replication and often causes cell death. In order for UV light to be effective and reach the bacteria, the effluent must be relatively clear and free of solids. UV light is not a chemical agent and therefore produces no toxic residuals. Once only a common large-scale application, UV light is becoming more cost-effective and widely used for small-scale applications.

Ozone

Ozone disinfection is gaining wide acceptance for small-scale usage. Ozone is believed to disintegrate the cell wall, thus killing bacteria (pathogens) in wastewater. It is also very cost effective at removing viruses. Ozone, a chemically unstable gas formed through oxidation, decomposes very quickly; therefore, it must be generated onsite.

Options for Special Conditions/Situations

ALTERNATIVE TOILETS

9

Composting Toilet
A composting toilet is a waterless toilet designed to compost wastes deposited into the receptacle. The principle of operation is the digestion of human wastes and food scraps by microorganisms. Compost that is generated during the treatment process must be periodically removed. A bulking agent, such as sawdust, must be added to absorb liquids and help control odors. The advantages include the production of fertilizer, low maintenance, and water conservation. Disadvantages can include a high initial investment and considerable space allocation.

Low-flow Toilet
Low-flow toilets and ultra low-flow toilets use 1.6 gallons or less of water per flush. They generally cost more than conventional units, but pay for themselves over time by lowering the water bill. New construction requires the installation of low-flow toilets.

Incinerating Toilet
Wastes are deposited directly into a toilet receptacle with a combustion chamber for incineration. Incineration takes place on a grid within the combustion chamber fueled by electricity, gas, or oil. Heat-insulating materials surround the grid. An exhaust flue vents vapors. A small amount of ash is generated from the incinerated sanitary wastes and must be periodically removed. Liquids evaporate during the incineration process. Costs depend on the energy source used to operate the toilet.

Chemical/Portable Toilet
In chemical toilets, wastes drop directly into a receptacle containing a deodorizing chemical. Periodic pumping and recharging of the receptacle are required. Generally less than one pint of liquid waste is generated per use. Wastes are discharged into a holding tank contained within the unit and must be pumped out on a regular basis.

WASTE SEGREGATION AND EFFLUENT REUSE

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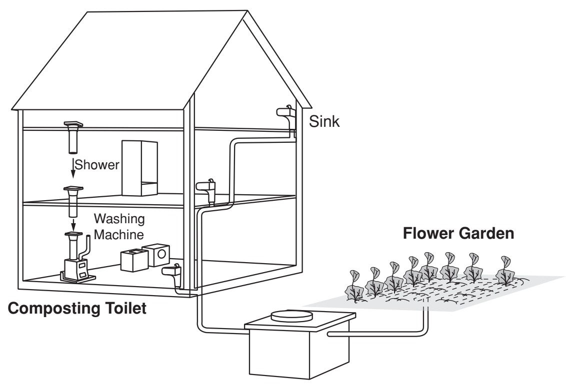


Wastewater coming from the house can be separated into two waste streams: blackwater and greywater. Wastewater from toilets is always considered blackwater and, depending on local guidelines, may also include wastewater from kitchen sinks. Greywater is the wastewater generated from other plumbing fixtures in the house, such as showers, bathtubs, dishwashers, washing machines and bathroom sinks.

Removing toilet wastewater from the waste stream can reduce the wastewater flows anywhere from 30% to 40%. Blackwater can be treated by a number of different methods, ranging from a composting toilet to a septic tank-soil absorption system. Greywater treatment systems (such as septic tank with a drainfield; a septic tank, sand filter, and soil absorption system; or an ATU with disinfection) treat the wastewater for final subsurface dispersal or reuse. Effluent can be reused to flush toilets or irrigate lawns/landscape. The level of treatment required depends on the final use of the effluent. Disinfection is required when the effluent may come into contact with people (usually through surface irrigation or in-house reuse).

NATIONAL SMALL FLOWS CLEARINGHOUSE

This publication is not meant to be a comprehensive guide to alternative onsite systems, but to acquaint the public with several representative systems used in the United States. The National Small Flows Clearinghouse (NSFC) does not endorse, approve, or disapprove any technology presented

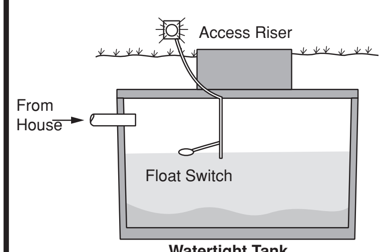
Not all systems shown are approved by all jurisdictions. Check with your local permitting authority to determine which systems are allowed in your area.

All onsite treatment systems require routing operation and maintenance to ensure that any mechanical devices are working and the system is functioning properly. Some drawings might be changed to reflect commonly used systems in Colorado.

The NSFC would like to thank the following companies and states for allowing modification of specific diagrams:
American Manufacturing Products Company, Inc., Manassas, VA
Bord Na Mona Environmental Products, US, Inc., Greensboro, NC
Connecticut Dept. of Public Health, Hartford, CT
Kansas Dept. of Health and Environment, Topeka, KS
Washington Dept. of Health, Olympia, WA
Waterloo Biofilter Systems, Inc., Guelph, ON, Canada

HOLDING TANK

11



A holding tank is a large tank, similar to a single-compartment septic tank, that holds wastes discharged from a house, building, etc. The holding tank is designed to hold waste for a designated period of time. The tank requires pumping on a regular basis (weekly, bi-weekly, etc.), depending on the quantity of wastewater generated. An alarm will sound when the wastes in the tank reach a specified level that requires pumping the tank.

Dispersal Options

TRENCH SYSTEM

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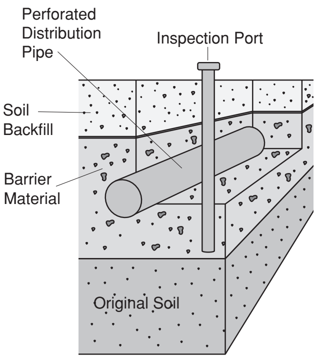

Trench systems consist of shallow, level excavations, usually one to five feet deep and one to three feet wide. The excavated area is usually filled with six inches or more of a porous medium, such as gravel. Next, a distribution network is laid out over the media. A single line of perforated distribution pipe is laid in each trench. Building paper, straw, or some other semipermeable barrier is then placed on top of the network before the system is covered with soil. The wastewater trickles through the distribution network, through the media, and into the soil. Treatment of the wastewater occurs in both the media and soil sections of the trench system.

BED SYSTEM

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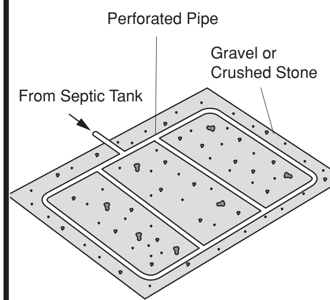

A bed system consists of an excavated area, normally wider than three feet and from one to five feet deep. The excavated bed is filled with gravel, and a distribution network is laid out over the gravel. Building paper, straw, or some other semipermeable barrier is then placed on top of the network before the system is covered with soil. The wastewater trickles through the distribution network, through perforated pipes, through the gravel, and into the soil. Treatment of the wastewater occurs in both the gravel and the soil sections of the bed system.

SERIAL DISTRIBUTION

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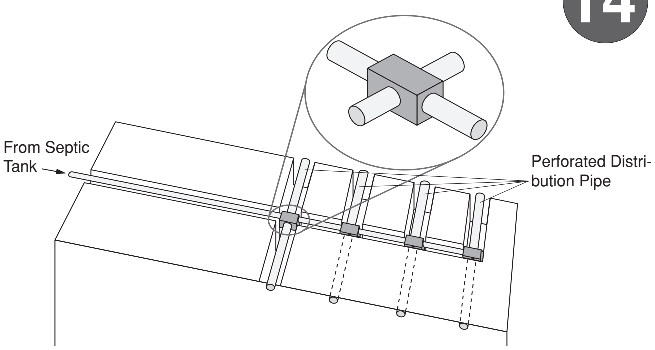

A serial distribution system utilizes a series of absorption trenches in succession. The pretreated effluent is usually gravity fed. However, some serial distribution systems may require a pump to move the effluent from trench to trench thus maximizing the infiltrative capacity of each trench before effluent flows from one trench to the next.

CONTOUR SYSTEM

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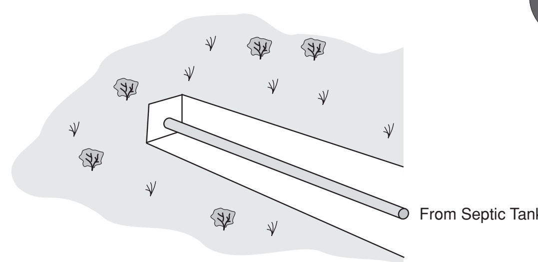
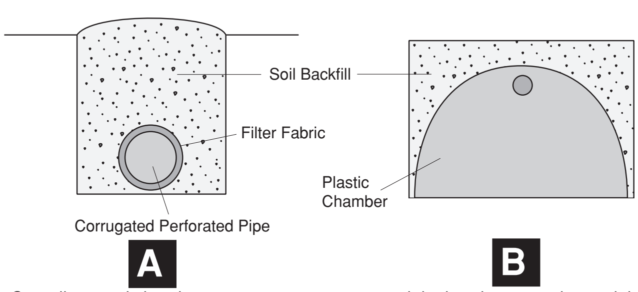


In this gravity-fed system, a connecting line leads to several feet of perforated distribution pipe set in one shallow trench that follows the contour of the land. Sand and gravel, together with a geotextile covering, are placed in the trench. This system provides a large area for effluent dispersal into the soil. As with any soil absorption system placed on slightly sloping land, an interceptor ditch may be placed up slope from the dispersal trench to help divert surface runoff away from the trench.

GRAVELLESS SYSTEM/CHAMBER

16



Gravelless and chamber systems use some material other than gravel or rock in the excavation to provide an infiltrative surface onto which septic tank effluent is distributed along the length of the trench. These systems provide some capacity to store effluent until it can be absorbed into the soil and also may inhibit sand and silt infiltration. Soil compaction can be reduced since the need to use heavy equipment to haul and place gravel is eliminated.

ALTERNATING FIELDS

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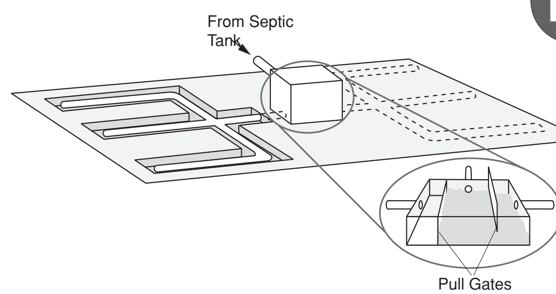

The division of a soil absorption system into more than one field allows alternate use of the individual fields over extended periods of time. This practice extends the life of the absorption system by allowing part of the system to "rest" periodically. This "resting" period allows the infiltrative surface to rejuvenate naturally through biodegradation of the clogging mat. Usually, alternating systems consist of two fields, each containing 50% to 100% of the total required area, and are manually switched once or twice a year.

Dispersal Options

PRESSURE/LOW PRESSURE SYSTEM

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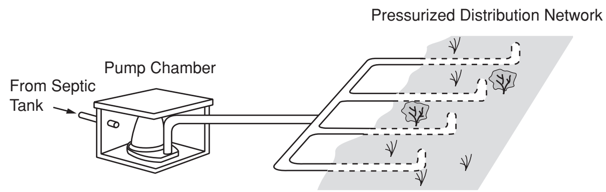

Pressure and low pressure pipe (LPP) systems are shallow dosed soil absorption systems. The effluent flows by gravity from the pretreatment system to the pump chamber. When a predetermined level within the pump chamber is reached (usually marked by a float control), the pump forces the effluent through the distribution lines under pressure. This allows effluent to be evenly dosed at intervals. Dosing frequencies may vary between sites and soil conditions. Differences between these systems include the amount of pressure and pipe size.

PRESSURE ASSIST

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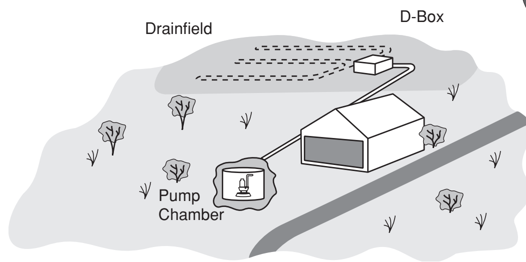

In a pressure assist drainfield, the wastewater is pumped to the field because it cannot flow by gravity. Wastewater flows from the septic tank to the pump chamber where it is pumped uphill and dispersed by gravity through the absorption field lines. Other than the addition of the pump chamber, this system operates identically to a septic tank-soil absorption system.

DRIP IRRIGATION

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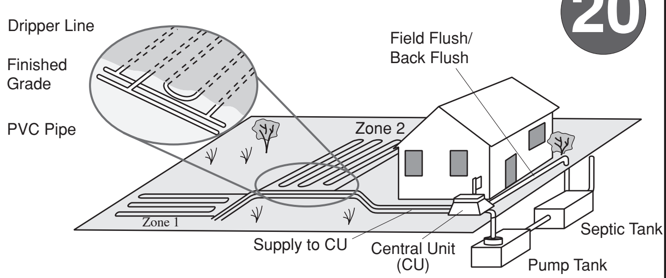

Drip irrigation systems apply treated wastewater to soil slowly and uniformly from a network of narrow plastic, polyethylene, or polyvinylchloride (pvc) tubing placed at shallow depths of usually six to twelve inches in the plant root zone. The wastewater is pumped through the drip lines under pressure but drips slowly from a series of evenly spaced openings called “emitters”. One advantage to these systems is minimal site disturbance due to the flexible tubing that can be placed around trees and shrubs. Wastewater must be pretreated and filtered prior to subsurface dispersal.

SPRAY IRRIGATION

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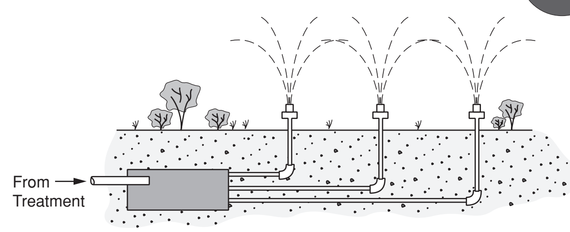

Spray irrigation systems apply treated effluent above ground to reclaim wastewater. The area to be irrigated must be vegetated and landscaped to minimize runoff and erosion. The wastewater must be treated to a high enough level to protect public health and reduce odors. For this reason, the wastewater must be disinfected (ozone, UV or chlorine). After treatment, filtration, and disinfection, a pump equipped with timers sends the wastewater under pressure through the mains and lines of the spray distribution system at preset times and rates.

MOUND SYSTEM/ AT-GRADE

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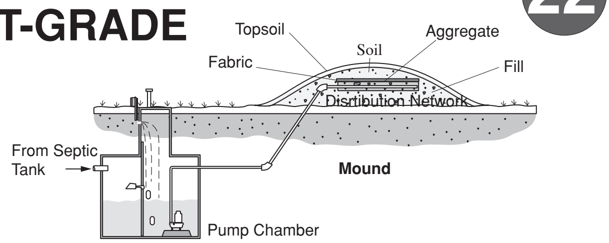
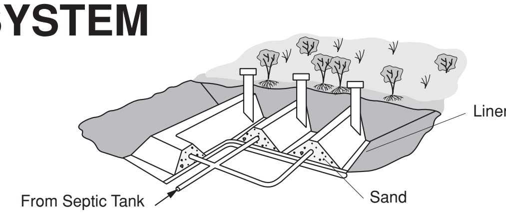


A mound system is a soil absorption system that is elevated above the natural soil surface using a suitable fill material, such as quality sand media. Wastewater is first pretreated then fed by gravity to a pump chamber where the effluent is dosed to the mound system. The purpose of the design is to overcome site restrictions, such as slowly permeable soils, shallow permeable soils over creviced or porous bedrock, and permeable soils with high water tables. In an at-grade system, the ground surface is the bottom of the trench. Construction consists of scarifying the ground surface to expose the existing soil and eliminating vegetation prior to adding gravel to the ground surface.

EVAPOTRANSPIRATION SYSTEM

23



Evapotranspiration (ET) systems are ideal in locations where the annual evaporation rate exceeds the annual precipitation rate. The effluent flows from the pretreatment unit to the sand bed underlaid with an impermeable liner. Capillary action in the fine sand causes the effluent to rise to the surface to escape through evaporation while at the same time, vegetation transports the wastewater from the root zone to the leaves where it is transpired as a relatively clean condensate. The design allows for complete wastewater evaporation with no discharge. Evapotranspiration-absorption (ETA) systems are similar to ET systems. However, these systems are unlined and designed for use where soils are fairly impenetrable, but not entirely so. The ETA system disposes of wastewater in the same evaporation/transpiration manner but also allows effluent to trickle slowly into the underlying ground.