Guide to Septic System Operation

"Onsite Wastewater Recyling System"

If properly designed, constructed and maintained, your septic system can provide long-term, effective treatment of household wastewater. If your septic system isn't maintained, you might need to replace it, costing you thousands of dollars. A malfunctioning system can contaminate groundwater which might be a source of drinking water. And if you sell your home, your septic system must be in good working order.

The information provided here will help you care for your septic system. This guide will help you understand how your system works and what steps you can take as a homeowner to ensure your system will continue to work properly. To help you learn more, consult the resources listed at the back of this section. A helpful checklist is also included at the end of this section to help you keep track of your septic system maintenance.

Four Things You Can Do to Protect your Septic System

1. Inspect your system every year and pump your tank as necessary.
2. Use water efficiently.
3. Don't dispose of household hazardous wastes in sinks or toilets.
4. Protect your drainfield. Don't drive or compact the soil.

How the Septic System Works

Components

A typical septic system has four main components: a pipe from the home, a septic tank, a drainfield, and the soil. Microbes in the soil digest or remove most contaminants from wastewater before it eventually reaches groundwater.

Pipe From the Home

All of your household wastewater exits your home through a pipe to the septic tank.

Septic Tank

The septic tank is a buried, watertight container typically made of concrete, fiberglass, or polyethylene. It holds the wastewater long enough to allow solids to settle out (forming sludge) and oil and grease to float to the surface (as scum). It also allows partial decomposition of the solid materials. Compartments and a T-shaped outlet in the septic tank prevent the sludge and scum from leaving the tank and traveling into the drainfield area. Screen filters are also recommended to keep solids from entering the drainfield.

Newer tanks generally have risers with lids at the ground surface to allow easy location, inspection, and pumping of the tank.

Locating Your System

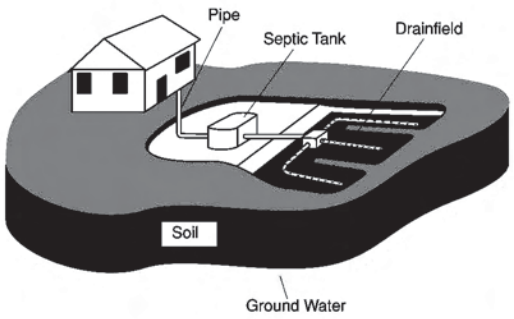
Your septic tank and drainfield should be clearly designated on the "as-built" drawing for your home. (An "as-built" drawing is a line drawing that accurately portrays the buildings on your property and is usually filed in your local land records.) You might also see lids or manhole covers for your septic tank. Older tanks are often hard to find because there are no visible parts. An inspector/pumper can help you locate your septic system if your septic tank has no risers.

Drainfield

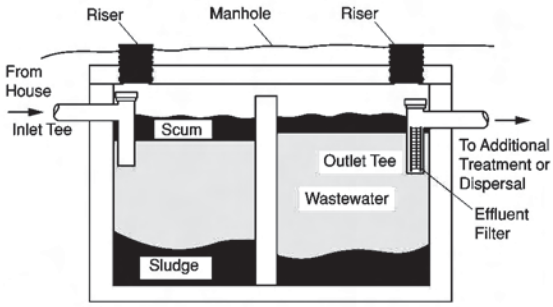
The wastewater exits the septic tank and is discharged into the drainfield for further treatment. The partially treated wastewater flows along into the drainfield. This is the final treatment stage where effluent is purified as it percolates down through the soil.

Soil

For proper effluent purification, adequate distance to groundwater must be maintained. The distance between the trench bottom and the water table should be equal to or greater than the minimum distance allowed by your local health department. The soil acts as a biological filter, removing harmful bacteria, viruses and nutrients before the effluent reaches the groundwater. Suitable soil is necessary for successful wastewater treatment.



Typical onsite wastewater treatment system



Typical two-compartment septic tank with ground-level inspection risers and sealant

Tip

To prevent buildup, sludge and floating scum need to be removed through periodic pumping of the septic tank. Regular inspections and pumping as necessary are the best and cheapest way to keep your septic system in good working order.

Alternative Systems

Because many areas don't have soils suitable for typical septic systems, you might have or need an alternative system. You might also have or need an alternative system if there are too many typical septic systems in one area or the systems are too close to groundwater or surface waters. Alternative septic systems use new technology to improve treatment processes and might need special care and maintenance. Some alternative systems use sand, peat, or plastic media instead of soil to promote wastewater treatment. Other systems might use wetlands, lagoons, aerators, or disinfection devices. Float switches, pumps, and other electrical or mechanical components are often used in alternative systems. Alternative systems should be inspected semi-annually. Check with your local health department or installer for more information on operation and maintenance needs if you have or need an alternative system.

Why should I maintain my septic system?

When septic systems are properly designed, constructed, and maintained, they effectively reduce or eliminate most human health or environmental threats posed by pollutants in household wastewater. However, they require regular maintenance or they can fail. Septic systems need to be monitored to ensure that they work properly throughout their service lives.

Saving Money

A key reason to maintain your septic system is to save money! Failing septic systems are expensive to repair or replace, and poor maintenance is often the culprit. Annual inspections are a bargain when you consider the cost of replacing the entire system. Your system will need pumping (generally every 3 to 5 years), depending on how many people live in the house and the size of the system. An unusable septic system or one in disrepair will lower your property value and could pose a legal liability.

Protecting Health and the Environment

Other good reasons for safe treatment of sewage include preventing the spread of infection and disease and protecting water resources. Typical pollutants in household wastewater are nitrogen, phosphorus, and disease causing bacteria and viruses. If a septic system is working properly, it will effectively remove most of these pollutants.

Inspection and Pumping

Four major factors influence the frequency of pumping: the number of people in your household, the amount of wastewater generated (based on the number of people in the household and the amount of water used), the volume of solids in the wastewater (for example, using a garbage disposal increases the amount of solids), and septic tank size.

Watch your Drains

What goes down the drain can have a major impact on how well your septic system works.

Waste Disposal

What shouldn't you flush down your toilet? Dental floss, feminine hygiene products, condoms, diapers, cotton swabs, cigarette butts, coffee grounds, cat litter, paper towels, and other kitchen and bathroom items that can clog and potentially damage septic system components if they become trapped. Flushing household chemicals, gasoline, oil, pesticides, antifreeze, and paint can stress or destroy the biological treatment taking place in the system or might contaminate surface waters and groundwater. If your septic tank pumper is concerned about quickly accumulating scum layers, reduce the flow of floatable materials like fats, oils, and grease into your tank or be prepared to pay for more frequent inspections and pumping.

What Does an Inspection Include?

- Locating the system.
- Uncovering access holes.
- Checking for sign of backup.
- Measuring scum and sludge layers.
- Identifying any leaks.
- Inspecting mechanical components.
- Pumping the tank if necessary.

Use Water Efficiently!

- Install high-efficiency showerheads.
- Turn off faucets while shaving or brushing your teeth.
- Run the dishwasher and clothes dryer only when they are full.
- Use toilets to flush sanitary waste only (not kitty litter, diapers or other trash).
- Maintain your plumbing to eliminate leaks.
- Install aerators in the faucets in your kitchen and bathroom.
- Replace old dishwashers, toilets and clothes washers with new, high-efficiency models.

Care for Your Drainfield

Your drainfield is an important part of your septic system. Here are a few things you should do to maintain it:

- Plant only grass over and near your septic system. Roots from nearby trees or shrubs might clog and damage the drainfield.
- Don't drive or park vehicles on any part of your septic system. Doing so can compact the soil in your drainfield or damage the pipes, tank, or other septic system components.
- Keep roof drains, basement sump pump drains, and other rainwater or surface water drainage systems away from the drainfield. Flooding the drainfield with excessive water slows down or stops treatment processes and can cause plumbing fixtures to back up.

What can make my system fail?

If the amount of wastewater entering the system is more than the system can handle, the wastewater backs up into the house or yard and creates a health hazard.

You can suspect a system failure not only when a foul odor is emitted but also when partially treated wastewater flows up to the ground surface. By the time you can smell or see a problem, however, the damage might already be done.

A system installed in unsuitable soils can also fail. Other failure risks include tanks that are inaccessible for maintenance, drainfields that are paved or parked on, and tree roots or defective components that interfere with the treatment process.

Failure Symptoms

The most obvious septic system failures are easy to spot. Check for pooling water or muddy soil around your septic system or in your basement. Notice whether your toilet or sink backs up when you flush or do laundry. You might also notice strips of bright green grass over the drainfield. Septic systems also fail when partially-treated wastewater comes into contact with groundwater. This type of failure is not easy to detect, but it can result in the pollution of wells, nearby streams, or other bodies of water. Check with a septic system professional and the local health department if you suspect such a failure.

– STOP –
LOOK
– SMELL–

Failure Causes

Household Toxics

Does someone in your house use the utility sink to clean out paint rollers or flush toxic cleaners? Oil-based paints, solvents, and large volumes of toxic cleaners should not enter your septic system. Even latex paint clean-up waste should be minimized. Squeeze all excess paint and stain from brushes and rollers on several layers of newspaper before rinsing. Leftover paints and wood stains should be taken to your local household hazardous waste collection center. Remember that your septic system contains a living collection of organisms that digest and treat waste.

Household Cleaners

For the most part, your septic system's bacteria should recover quickly after small amounts of household cleaning products have entered the system. Of course, some cleaning products are less toxic to your system than others. Labels can help key you into the potential toxicity of various products. The word "Danger" or "Poison" on a label indicates that the product is highly hazardous. "Warning" tells you the product is moderately hazardous. "Caution" means the product is slightly hazardous. "Nontoxic" and "Septic Safe" are terms created by advertisers to sell products. Regardless of the type of product, use it only in the amounts shown on the label instructions and minimize the amount discharged into your septic system.

Hot Tubs

Hot tubs are a great way to relax. Unfortunately, your septic system was not designed to handle large quantities of water from your hot tub. Emptying hot tub water into your septic system stirs the solids in the tank and pushes them out into the drainfield, causing it to clog and fail. Draining your hot tub into a septic system or over the drainfield can overload the system. Instead, drain cooled hot tub water onto turf or landscaped areas well away from the septic tank and drainfield, and in accordance with local regulations.

Water Purification Systems

Some freshwater purification systems, including water softeners, unnecessarily pump water into the septic system. This can contribute hundreds of gallons of water to the septic tank, causing agitation of solids and excess flow to the drainfield. Check with your licensed plumbing professional about alternative routing for such freshwater treatment systems.

Garbage Disposals

The conservative use of a garbage disposal can reduce the amount of grease and solids entering the septic tank and possibly clogging the drainfield. A garbage disposal grinds up kitchen scraps, suspends them in water, and sends the mixture to the septic tank. Once in the septic tank, some of the materials are broken down by bacterial action, but most of the grindings have to be pumped out of the tank. Using a garbage disposal frequently can significantly increase the accumulation of sludge and scum in your septic tank, resulting in the need for more frequent pumping.

Improper Design or Installation

Some soils provide excellent wastewater treatment; others don't. For this reason, the design of the drainfield of a septic system is based on the results of soil analysis. Homeowners and system designers sometimes underestimate the significance of good soils and believe soils can handle any volume of wastewater applied to them. Many failures can be attributed to having an undersized drainfield or high seasonal groundwater table. Undersized septic tanks (another design failure) allow solids to clog the drainfield and result in system failure.

If a septic tank isn't watertight, water can leak into and out of the system. Usually, water from the environment leaking into the system causes hydraulic overloading, taxing the system beyond its capabilities and causing inadequate treatment and allowing sewage to flow up to the ground surface. Water leaking out of the septic tank is a significant health hazard because the leaking wastewater has not yet been treated.

Even when systems are properly designed, failures due to poor installation practices can occur. If the drainfield is not properly leveled, wastewater can overload the system. Heavy equipment can damage the drainfield during installation which can lead to soil compaction and reduce the wastewater infiltration rate. And if surface drainage isn't diverted away from the field, it can flow into and saturate the drainfield.

Not in My Septic System!

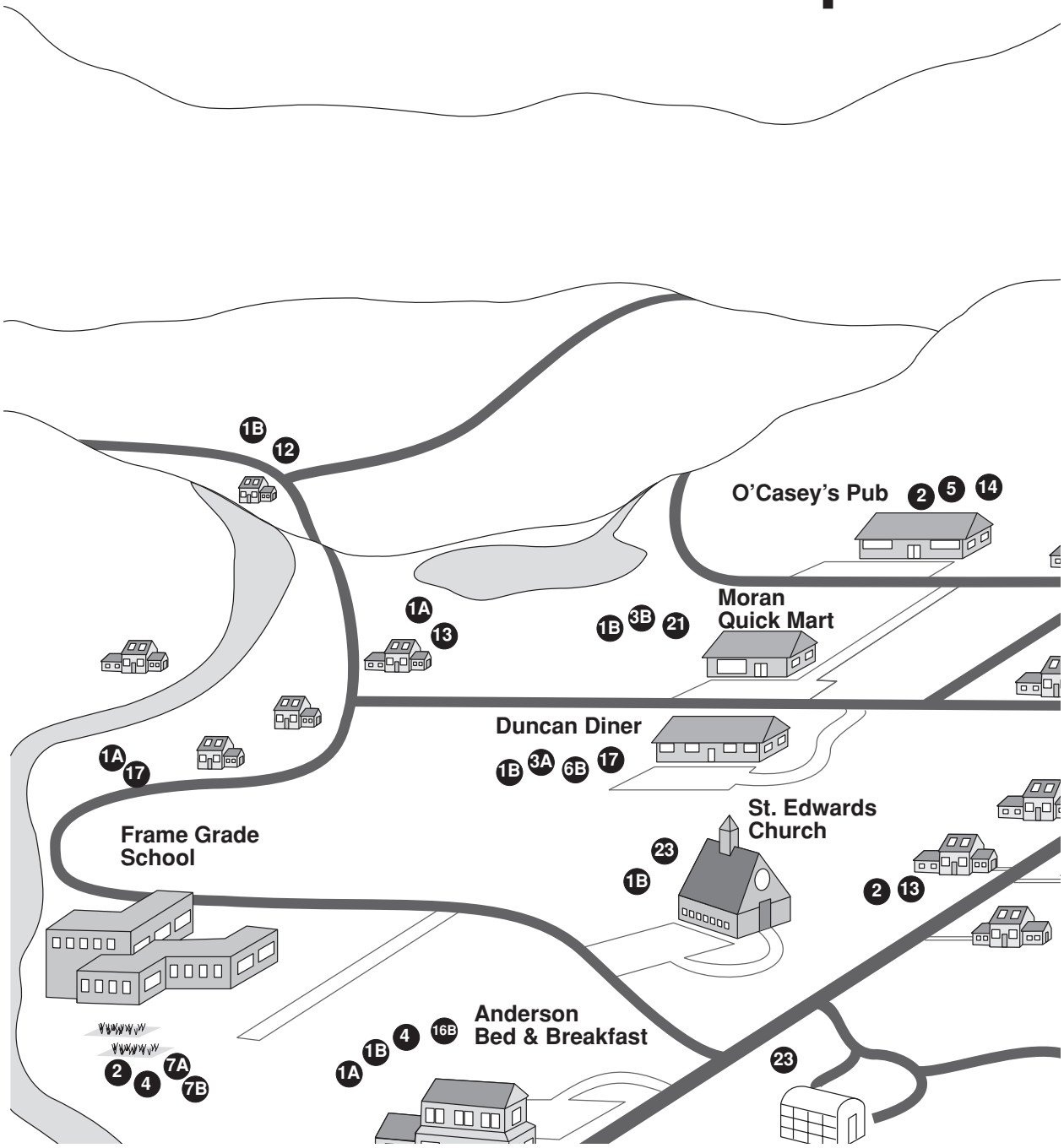
CLOGGERS

Diapers, Cat Litter, Cigarette Filters, Coffee Grounds, Grease, Feminine Hygiene Products, etc.

KILLERS

Household Chemicals, Gasoline, Oil, Pesticides, Antifreeze, Paint, Pharmaceuticals, etc.

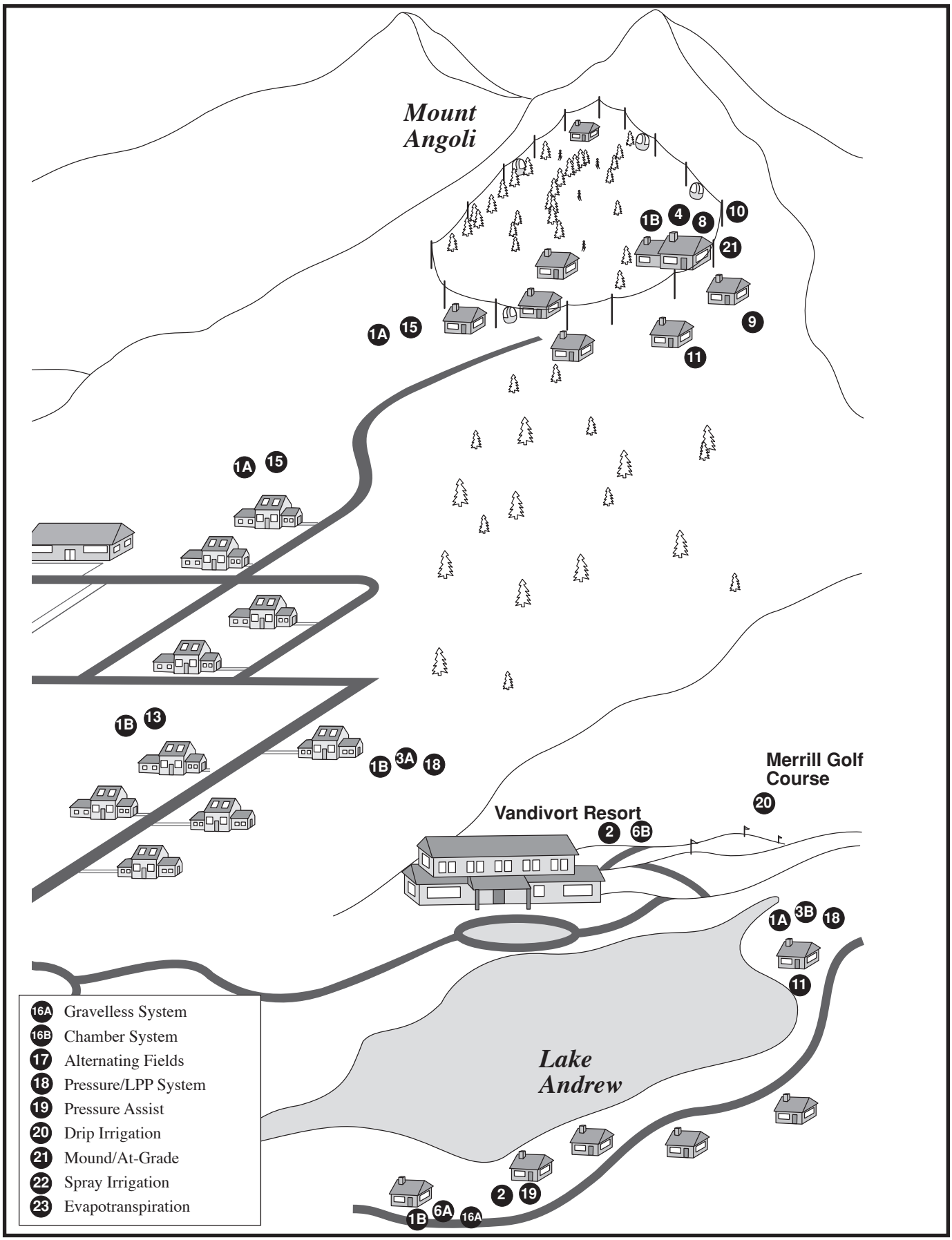
Onsite Wastewater Treatment Options



Onsite Wastewater Treatment for Small Communities and Rural Areas

NATIONAL SMALL FLOWS CLEARINGHOUSE

- 1A Single Compartment Septic Tank
- 1B Multi-Compartment Septic Tank
- 2 Aerobic Treatment Unit (ATU)
- 3A Separate Pump Chamber
- 3B Pump Chamber within Septic Tank
- 4 Sand Filter
- 5 Peat Filter
- 6A 6B Other Media Filters
- 7A Free Water Surface Constructed Wetland
- 7B Subsurface Flow Constructed Wetland
- 8 Disinfection
- 9 Alternative Toilets
- 10 Waste Segregation and Effluent Reuse
- 11 Holding Tank
- 12 Trench System
- 13 Bed System
- 14 Serial System
- 15 Contour System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Merrill Golf Course
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Vandivort Resort
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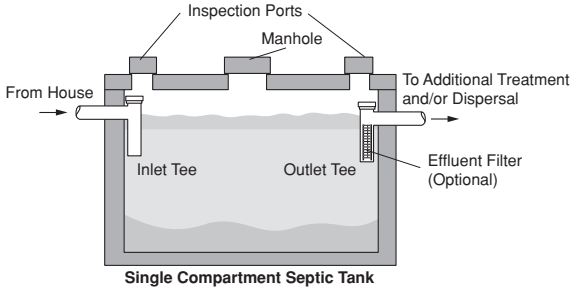
11
Lake Andrew
2 19
1B 6A 16A
16A Gravelless System
16B Chamber System
17 Alternating Fields
18 Pressure/LPP System
19 Pressure Assist
20 Drip Irrigation
21 Mound/At-Grade
22 Spray Irrigation
23 Evapotranspiration

Common Onsite System Components

SEPTIC TANK



A

Single 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.

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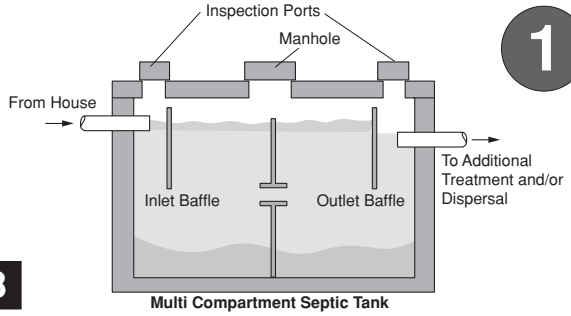


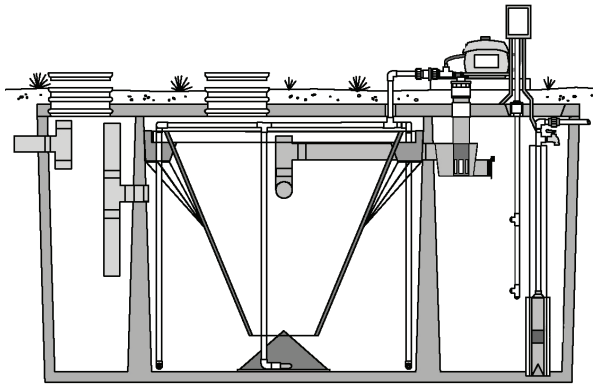
B

Multi Compartment Septic Tank

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)

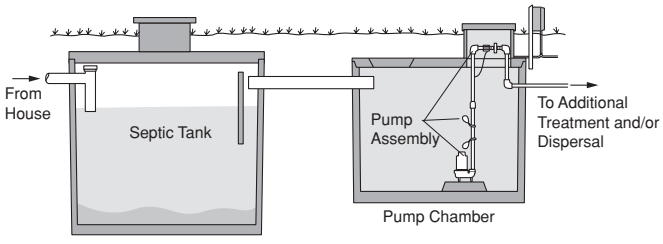
2



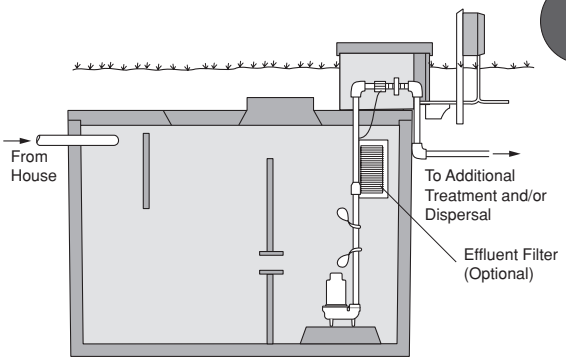
An ATU treats wastewater using natural processes that require oxygen. Most ATUs include a pretreatment step to reduce the amount of solids entering the aerobic unit. This pretreatment step could be a septic tank, primary settling compartment as part of the ATU, or a trash trap. Wastewater then enters 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

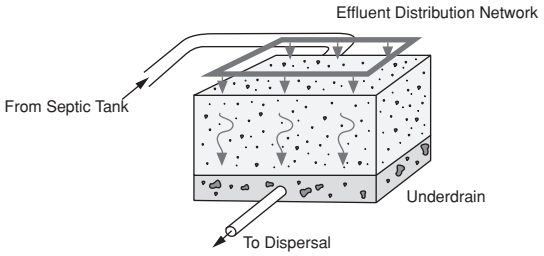


Multi Compartment Septic Tank

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

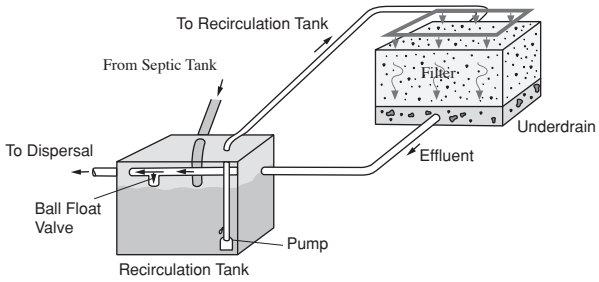
SINGLE-PASS FILTRATION



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

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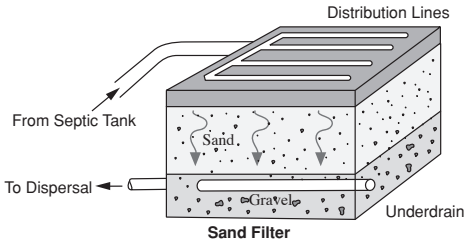

Sand Filter

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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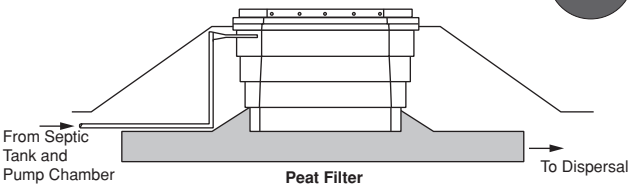

Peat Filter

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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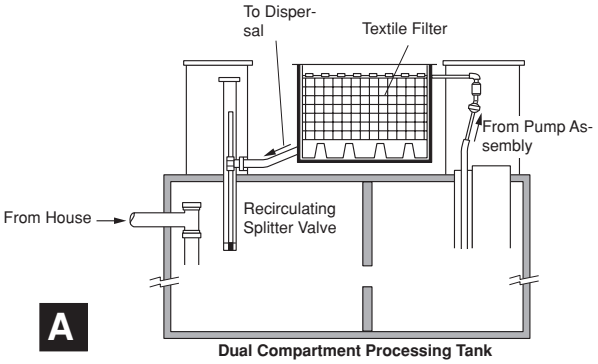
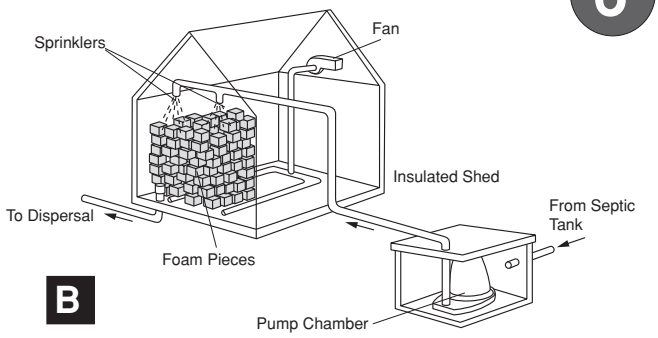


Dual Compartment Processing Tank



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

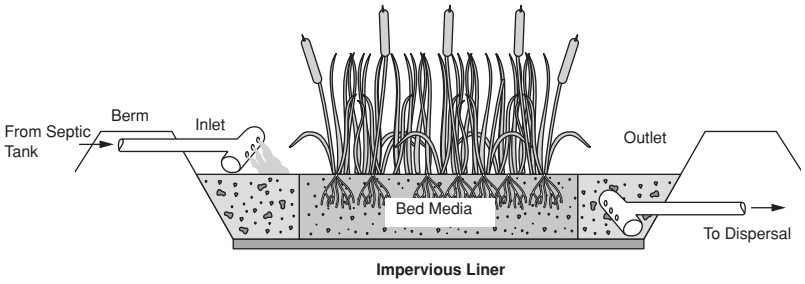
CONSTRUCTED WETLANDS

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



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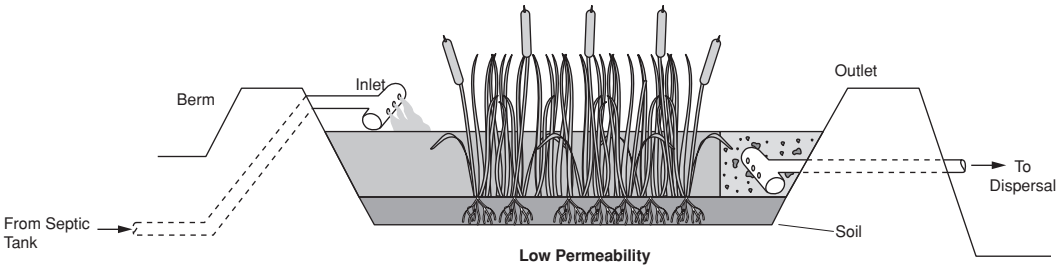
Free Water Surface



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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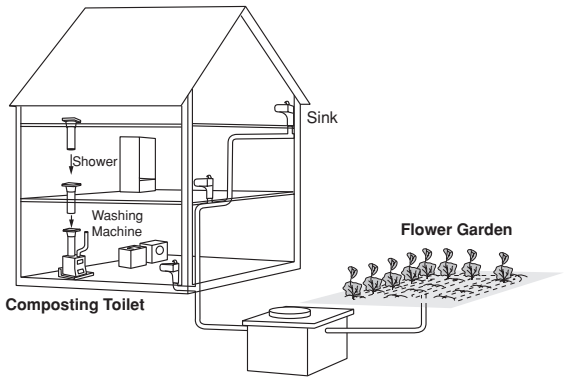


Wastewater coming from the house can be separated into two waste streams: blackwater and greywater. Wastewater from toilets is always considered blackwater and, depending on local guidelines, may also include wastewater from kitchen sinks. Greywater is the wastewater generated from other plumbing fixtures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

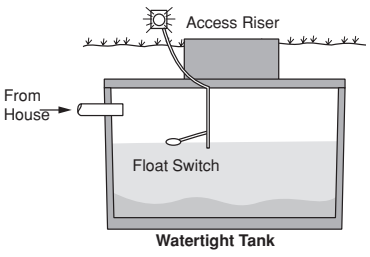
All onsite treatment systems require routing operation and maintenance to ensure that any mechanical devices are working and the system is functioning properly. Some drawings might be changed to reflect commonly used systems in Colorado.

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

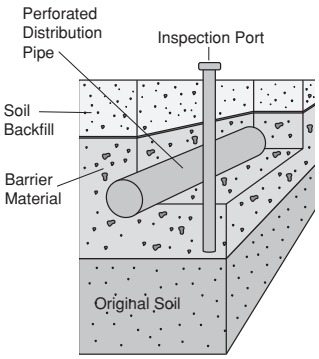


A holding tank is a large tank, similar to a single-compartment septic tank, that holds wastes discharged from a house, building, etc. The holding tank is designed to hold waste for a designated period of time. The tank requires pumping on a regular basis (weekly, bi-weekly, etc.), depending on the quantity 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

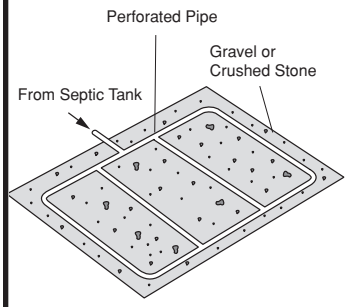
12



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

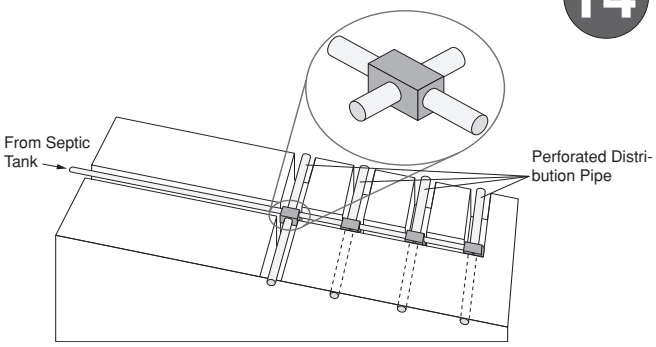
13



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

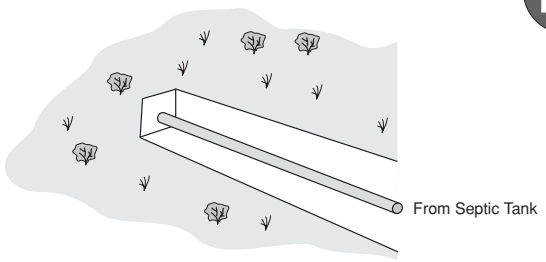
14



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

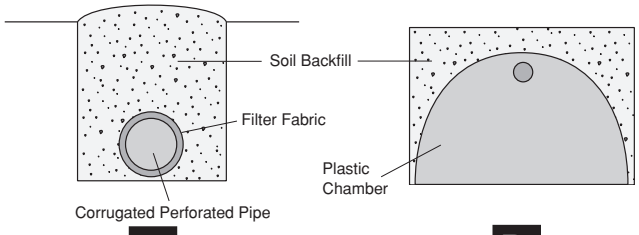
15



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

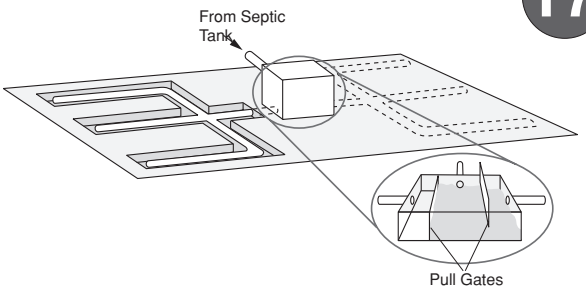
16



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

17

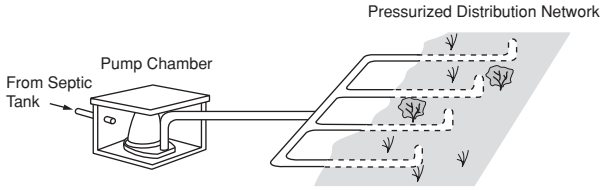


The division of a soil absorption system into more than one field allows alternate use of the individual fields over extended periods of time. This practice extends the life of the absorption system by allowing part of the system to "rest" periodically. This "resting" period allows the infiltrative surface 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

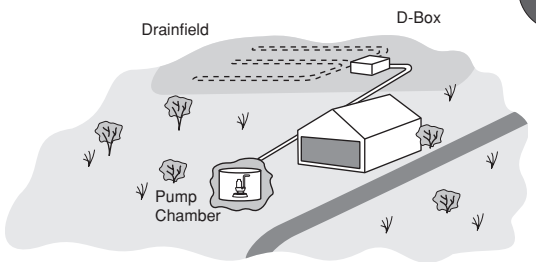
18



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

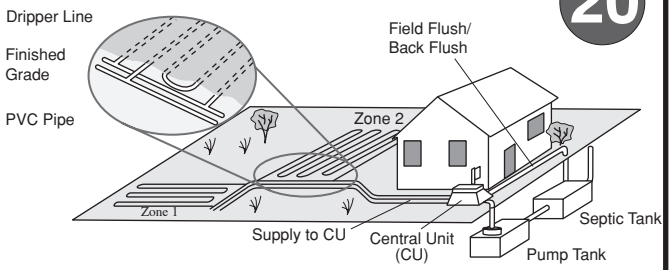
19



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

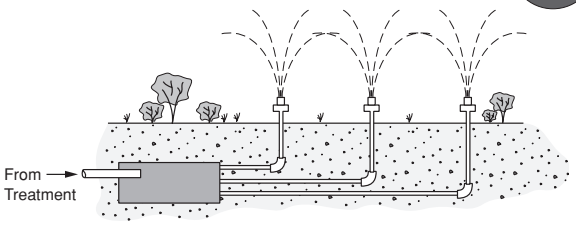
20



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

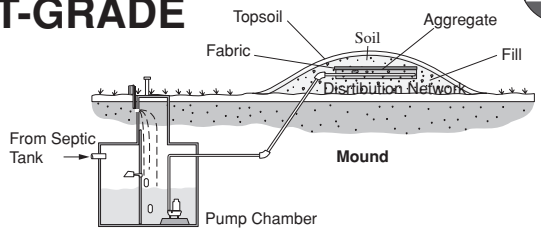
21



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

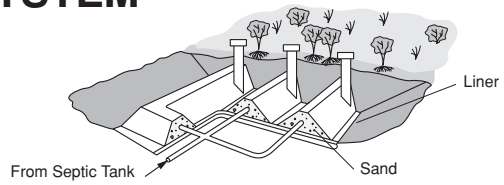
22



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.

Installing Precast Concrete Structures

Begin with a survey to verify that:

- The location of the concrete structure is clearly defined.
- All underground utilities, such as gas, water, sewer, electricity and telephone, have been located and marked.
- Any obstacles, such as overhead wires or trees, that would interfere with crane operation or create a safety hazard have been identified and necessary arrangements made to deal with them.
- The soil has been checked. and appropriate shoring, sloping or both have been planned.

Planning

- All necessary permits should be obtained before work begins, and the permits or a record of the permits should be available at the site.
- Utility companies and owners of any facilities in the area should be given advance notice of the excavation. If damage occurs, you should notify the owner of the damaged property immediately.
- Planning should include coordinating removal of broken pavement, rock, etc. Responsible parties should arrange for the delivery, distribution, and storage of required material either on or off-site.
- If there is a possibility that the excavation will interfere with traffic, consult with the engineer and notify the appropriate authorities.
- Make sure there is access to telephones and fire hydrants or other fire protection at the site.

General Safety

- Please follow all safety provisions called for in federal, state and local regulations.
- The concrete structure should be lifted only at the lifting points designated by Front Range Precast Concrete, Inc.

Excavating

- When your excavation is adjacent to facilities such as hospitals, fire stations or gas stations, you should coordinate excavation operations from beginning to end so that the work area is kept as small as possible.
- If you run into unexpected underground facilities or obstructions, stop excavating immediately. Expose the obstruction with wood-handled tools, and investigate with caution. If you have any doubt about what you've hit, get positive identification before you continue digging.
- Because installation of concrete products often requires the use of heavy equipment, be sure you have checked the soil condition to be sure it will support heavy loads. Take all preventive measures that may be needed to stabilize the area and protect trucks, products and installation workers.
- Inspect excavations after every rain or snow, and increase protection against slides and cave-ins if necessary.
- Be sure your excavation allows room for the assembled concrete product plus any risers and bedding materials required. A clearance of 12 inches around the sidewalls of the structure is recommended.

Shoring

- Install shoring, as required, immediately following the excavation, even if no work is to be done right away. The longer an excavation is left unsupported, the greater the chance of cave-in.
- Use only structurally sound timbers. If you use prefabricated box-type shoring, make sure it is clean and structurally sound after previous use.

Installation

- Consult your detailed plan to be sure you properly orient the concrete structure to insure alignment of pipes or conduits.
- Never place a damaged concrete structure, unless approved by the customer.
- Do not modify the product in the field unless you are positive the modification will not affect the strength of the structure.
- Do not install a concrete structure under conditions that will result in it having a load heavier than it was designed for.
- After the site has been excavated to the proper size, level the area where the base will be installed.
- Assemble multi-section structures by setting level and firmly positioning the base of each section before setting the next one.
- Where the possibility exists of a watertight structure floating in a flooded excavation, take steps necessary to avoid flotation of the structure.
- When joining sections of precast concrete structures, take particular care to insure that all foreign materials such as dirt, mud, and stones are removed from the joint surface, and be sure that sealing materials are placed properly.

Backfilling and Restoration

- Do the backfilling as soon as possible after the structure has been installed.
- When placing a precast concrete structure into an unpaved area, slope the area around the entrance frame and cover to send drainage away from the entrance. Slope the final grading upward to within 1 inch of the top surface of the cover.
- Perform follow-up inspections for settling. If settling occurs, the contractor is responsible for restoring the area to its original condition.

Front Range Precast Concrete, Inc.
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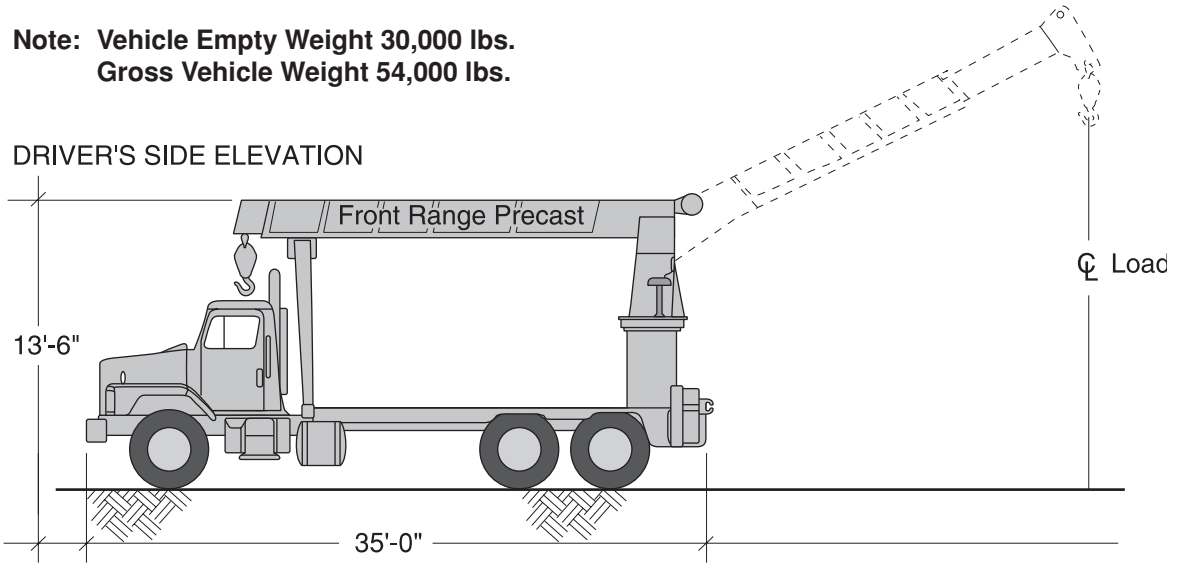
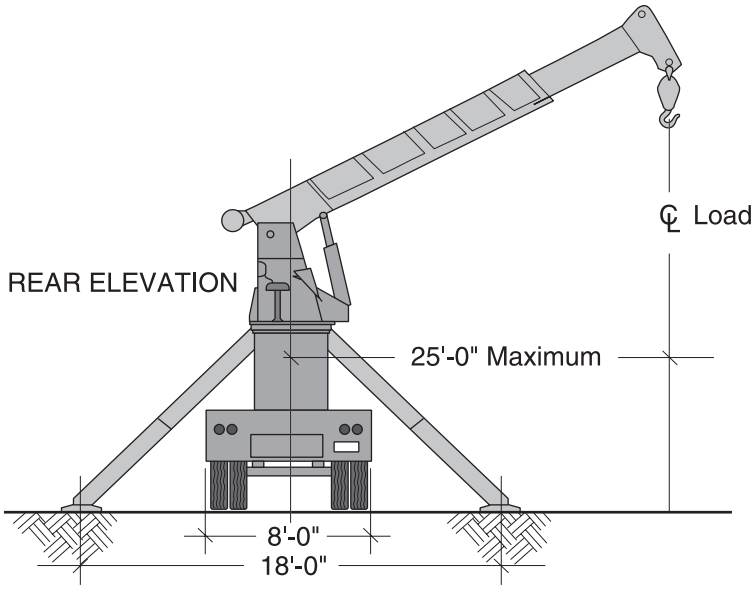
Delivery Vehicles

Note: Vehicle Empty Weight 30,000 lbs.
Gross Vehicle Weight 54,000 lbs.

DRIVER'S SIDE ELEVATION





Rated Lifting Capacity		
Radius	**Over Rear**	**Over Side**
10 ft.	15,000 lbs	10,000 lbs
15 ft.	14,000 lbs	8,000 lbs
20 ft.	10,000 lbs	5,000 lbs
25 ft.	6,500 lbs	3,000 lbs

Products may be unloaded into prepared excavations if safe and accessable to our trucks under their own power. A level, stable, solid parking area is required for crane operation.

General Product Warranty Terms and Conditions

These terms and conditions govern the sale of products ("Products") by Front Range Precast Concrete, Inc. ("Seller"). Unless otherwise agreed to in writing by Seller, acceptance by Customer is limited to these terms and conditions.

1. Warranty. (a) Seller hereby warrants any product manufactured by it to be free of defects in material and workmanship for a period of one year from the date of Product delivery. Notice of defect must be given in writing within ten (10) days of discovery of defect, or this warranty shall be null and void. In the event any defect is discovered within the one-year period specified above, Seller, at its option and within thirty (30) days after receiving written notice of defect, will (1) repair the Product or (2) replace Product free of charge or (3) refund the purchase price paid for the Product. NOT WITHSTANDING ANYTHING HEREIN TO THE CONTRARY, THE FOREGOING IS THE BUYER'S SOLE AND EXCLUSIVE REMEDY FOR BREACH OF WARRANTY BY SELLER WITH RESPECT TO THE PRODUCT.

(b) Replacement Products shall be warranted as set forth above. Any products repaired or serviced by Seller shall be warranted for the remainder of the warranty period. This warranty shall not apply to any product that shall have been subject to misuse, abuse, accident. disaster, or which has been operated contrary to current instructions relating to maintenance or operations.

(c) THE FOREGOING WARRANTIES ARE THE SOLE WARRANTIES, EXPRESS OR IMPLIED, GIVEN BY SELLER IN CONNECTION WITH THE PRODUCTS, AND SELLER DISCLAIMS ALL OTHER WARRANTIES, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THIS WRITING IS THE EXCLUSIVE EVIDENCE OF THE AGREEMENT BETWEEN THE PARTIES. TO THE EXTENT REQUIRED BY LAW, ANY IMPLIED WARRANTY SHALL BE LIMITED IN DURATION TO THE TERM OF ANY EXPRESS WARRANTY CONTAINED HEREIN.

(d) Seller assumes no liability for consequential damages, anticipated or lost profits, incidental damages, loss of time, or other losses incurred by Customer or third party in connection with the products.

2. Orders. All orders placed with Seller must be in a signed writing or upon verbal order confirmed in a signed writing. All orders must include price, delivery dates, quantities, and complete description of Products to be purchased.

3. Prices. Price quotations, unless otherwise stated, shall automatically expire thirty (30) calendar days from the date issued and may be canceled or amended within that period upon written notice to Customer. Unless otherwise agreed to in writing by Seller, all prices quoted are exclusive of transportation, insurance costs, and applicable use or sales taxes. Upon receipt of delivery instructions, Seller shall provide a separate quotation regarding the transport and delivery of goods.

4. Taxes. Customer agrees to pay all applicable sales or use taxes unless Customer has provided Seller with an appropriate exemption resale certificate. Customer agrees to indemnify and hold harmless Seller for any liability for tax (except Seller's net income tax) in connection with the sale.

5. Delivery. (a) Customer shall furnish instructions in writing to Seller with regard to the shipment and delivery of the Product and shall state the time and place of such delivery. Said instructions shall include specific directions to the product delivery site. Customer is responsible for providing a safe and accessible delivery site. Products may be unloaded into prepared excavations if safe and accessible to Seller's trucks under their own power. A level, stable, solid parking area is required for crane operation. Damage caused by Seller's vehicles when directed beyond a public roadway shall be the responsibility of Customer. Should delivery be delayed for field preparations, Customer shall incur a waiting period fee at the current hourly rate. Customer shall hold Seller harmless for any delays in product delivery or damages incurred as a result of Customer's failure to provide a safe and accessible delivery site as set forth in this provision.

(b) Risk of loss or damage to the product will pass to Customer upon delivery. Any product damage incurred after off-loading, except that specifically set forth in paragraph 1(a) above, is not warranted by Seller. CUSTOMER IS SOLELY RESPONSIBLE FOR THE INSTALLATION AND PLACEMENT OF PRODUCT. SELLER EXPRESSLY DISCLAIMS ANY RESPONSIBILITY FOR MISPLACEMENT OF PRODUCT OR INSTALLATION OF PRODUCT BY CUSTOMER NOT IN ACCORDANCE WITH LOCAL, STATE OR FEDERAL GUIDELINES.

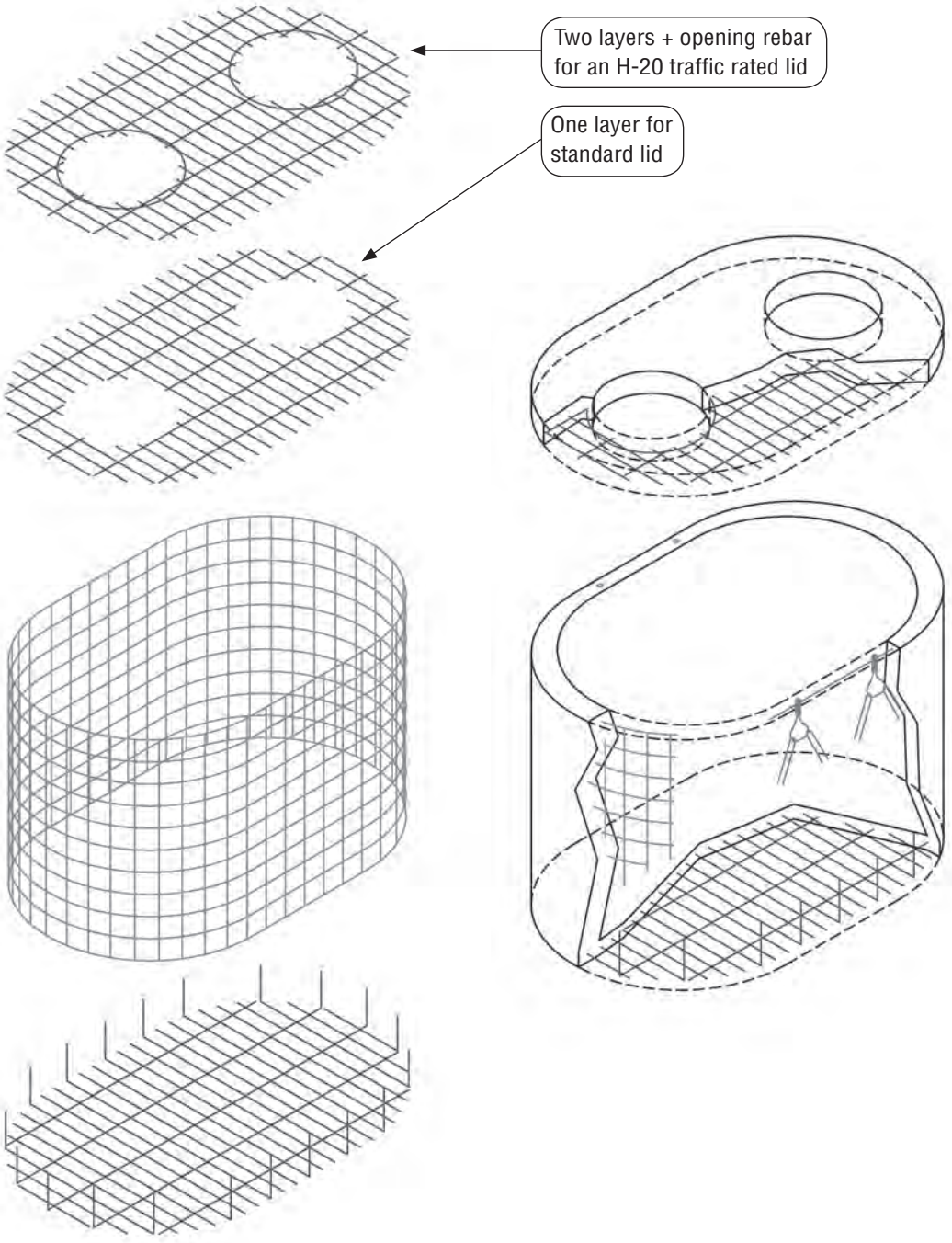
(c) The Seller shall not be liable for consequential or incidental damages resulting from any delay or failure to deliver.

6. Payment. Payment shall be due upon or prior to delivery unless otherwise agreed to in writing by Seller. All late payments shall be charged interest computed on a daily basis from the due date until paid in full at a rate of 18% per annum or the maximum rate permitted by law, whichever is less.

7. Limitations of Liability. Under no circumstances shall the liability of Seller exceed the sum of Customer's payments for the products that are the subject of dispute.

8. Entire Agreement. This agreement shall constitute the entire Agreement between the parties and shall not be modified or rescinded, except by a writing signed by the Seller and Customer. The provisions of this agreement supersede all prior oral or written quotations, communications, agreements, and understandings of the parties with regard to the subject matter herein. In accordance with this provision, Seller accepts no responsibility for any loss incurred by reason of any error or omission in Seller's product catalog or other communications.

Typical Tank Reinforcement



FLXX® Watertight
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Handy Reference Tables

Weight of reinforcment bar

	pounds per linear foot	diameter inches	cross section area square inches
#3	0.376	0.375	0.11
#4	0.668	0.500	0.20
#5	1.043	0.625	0.31
#6	1.502	0.750	0.44
#7	2.044	0.875	0.60
#8	2.670	1.00	0.79

1 cubic yard of concrete places:

depth	ft^2
2"	162
4"	81
6"	54
8"	40
10"	32.5
12"	27

Water

1 cu. ft. ..... 7.48 gals.
1 cu. ft. ..... 62.3 lbs.
1 gal ..... 8.33 lbs.
1 gal ..... 231 in^3
1 gal ..... 0.1337 ft^3

Its greatest density is at 39.1° F weighing 62.4 pounds / ft^3

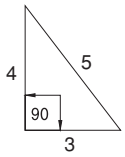
Materials Average Weight

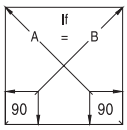
Concrete ..... 150 lbs./ft^3
Steel ..... 490 lbs./ft^3
Sand (dry) ..... 98 lbs./ft^3
Sand (wet) ..... 124 lbs./ft^3
Gravel ..... 120 lbs./ft^3
Cast Iron ..... 446 lbs./ft^3
Wood (fir) ..... 32 lbs./ft^3
Wood (oak) ..... 40 lbs./ft^3

Circle Measure

π = 3.1416
circumference = diameter x π
area = π x radius^2

Geometric Measure





Data for Pipe Volumes

Nominal Pipe Size Inches	Gallons per Ft. of Pipe Length	Feet of Pipe Holding One Gallon
1/2	0.016	63.35
3/4	0.028	36.03
1	0.045	22.79
1-1/4	0.078	12.85
1-1/2	0.106	9.45
2	0.174	5.74
2-1/2	0.249	4.02
3	0.384	2.61
4	0.661	1.51
6	1.501	0.67
8	2.599	0.39

Technical Data Disclaimer

Specifications, descriptions and illustrations contained in this catalog were as accurate as known at the time of printing. However, no responsibility is assumed for any loss incurred, including consequential, incidental and contingent damages, as a result of errors or omissions. There are no warranties, expressed or implied, of the merchantability, fitness or suitability of products contained in this catalog for a particular application. Front Range Precast Concrete reserves the right to discontinue models at any time, or change specifications or designs without notice or obligation.