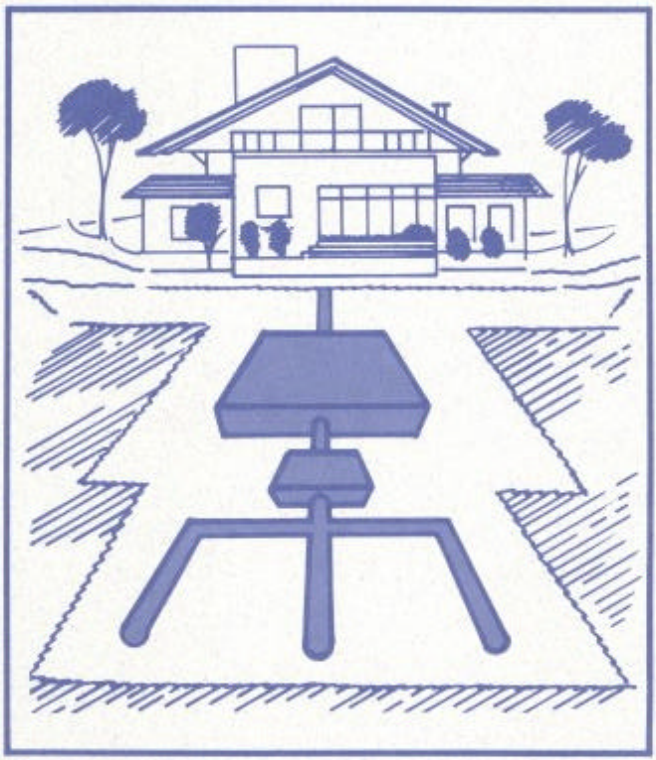
A Guide to
Septic Systems
and Alternatives



Virginia Water Resources Research Center

State regulations goveming septic tank construction and maintenance requirements may have changed since this report was published. The most current infommation can be obtained from the State Health Department office in your local~ty.

A Guide to Septic Systems and Alternatives

by
Kathryn P Sevebeck
and Carolyn J. Kroehler

Adapted from
A Homeowner's Guide to Septic Systems

by Torsten D. Sponenberg,
Jacob H. Kahn,
and Kathryn P. Sevebeck

Virginia Water Resources Research Center
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William R. Walker, director emeritus
Diana L. Weigmann, interim director

Illustrations by George V. Wills
Typesetting by T.W. Johnson

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INTRODUCTION

A third of the homes in ehe United States use septic tank/drainfield systems to dispose of human bodily wastes and gray water, the water used for bathing, dishwashing, and laundry. While central sewage treatment plants dispose of such wastes in many areas, population growth and distribution patterns make it impractical to build treatment plants everywhere. *About 566,000 households in Virginia are served by septic systems,* and more than 30,000 applications for constructing new systems are made each year in the state.

When properly designed, installed, and maintained, septic systems can provide cost-effective treatment of household sewage and certain wastes from small businesses. Unfortunately, septic systems that malfunction also can contaminate groundwater, surface water, and soils. According to the U.S. Environmental Protection Agency (EPA), *septic systems are the most frequently reported sources of groundwater contamination in the nation.* The potential for pollution is great: these individual wastewater disposal systems discharge about one trillion gallons of wastewater into the soil each year nationwide. Malfunctioning septic systems often affect the drinking water of users of the system first; many people who rely on a septic system also rely on groundwater, tapped by a well on the same property, to meet their drinking, household, business, and farm water needs.

Proper siting, installation, and maintenance are the keys to keeping a septic system functioning well. Although more than half the systems in the U.S. fail after 15 to 20 years, *the conventional septic system can last for as long as 50 years* if the homeowner maintains it properly. With a basic knowledge of these systems, homeowners can avoid septic system failures and expensive remedial work and help eliminate health and environmental hazards such as groundwater and soil contamination.

This booklet provides the information that current and prospective homeowners and business owners need to ensure that their septic systems function properly. How septic systems work, the basics of proper septic system use and maintenance, why septic systems fail, how to apply for a permit and have a site evaluation performed, and where to get more information about septic systems all are covered in the booklet. Brief descriptions of a number of alternative methods of household sewage disposal also are provided.

SEPTIC SYSTEM BASICS

A septic system consists of a sewer line from the house, a watertight underground receptacle called a septic tank, a distribution box, and a subsurface soil absorption area called a drainfield (Figure 1). Although prices can vary significantly, a basic septic system costs approximately $3,000 to install (in 1992 dollars).

The Septic Tank

Septic tanks usually are made of concrete, although other materials such as plastic or fiberglass may be used. The main function of the septic tank is to remove solids from household wastewater. Waterborne wastes from the bathroom, kitchen, and laundry leave the home through an underground pipe connected to the septic tank. Baffles or tees in the septic tank slow the flow of incoming wastewater and prevent sewage from flowing directly through the tank to the soil absorption field. Heavier solids settle to the bottom and accumulate as sludge; grease, foam, and some lighter solids float on the surface of the wastewater and form a mat of scum (Figure 2). Bacteria present in the tank digest some of the heavier solids and grease. During the decomposition process, some solids are liquefied, reducing the overall volume of solids retained. The digestive process produces bubbles and a foul-smelling gas that escapes through the sewer pipe and is discharged by a vent, usually through the roof of the house. The remaining solids and scum that accumulate in the tank must be pumped out periodically; every three to five years is the usual recommendation. A properly designed and maintained tank should last for 50 years.

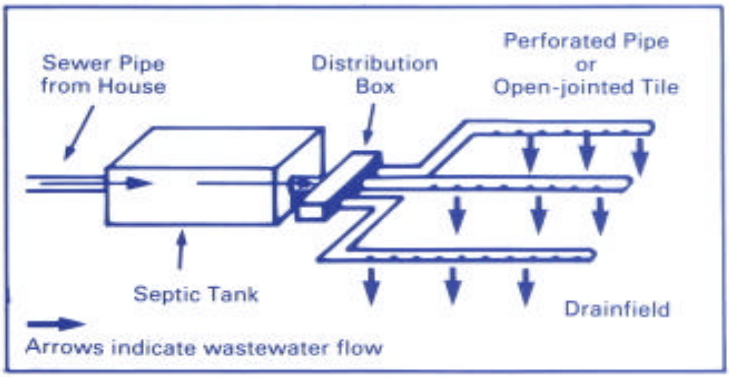


Figure 1.

The usual capacity of septic tanks is 750, *1,000,* 1,200, or 1,500 gallons. The required septic tank size is determined by the number of bedrooms in the home, with an estimated 150 gallons of wastewater generated each day for each bedroom. That number is doubled to allow for a two-day retention time in the tank so solids can settle or float properly. A three-bedroom home, for example, would require a 1,000-gallon septic tank (150 gallons per day times 3 bedrooms is 450 gallons; that figure doubled is 900 gallons, and the closest standard size is a 1,000-gallon tank).

The Distribution Box

The partially treated wastewater, or effluent, is displaced by incoming wastewater and flows by gravity from the tank into lines in the soil absorption area, or drainfield. A distribution box divides the flow among the lines to prevent any one line from becoming overloaded; the box has one inlet connected to the septic tank and several outlets connected to the lines in the drainfield (Figure 1). A level distribution box is essential for distribution of effluent to all drainfield lines. A septic system can include a pump if the effluent must be delivered uphill to the drainfield.

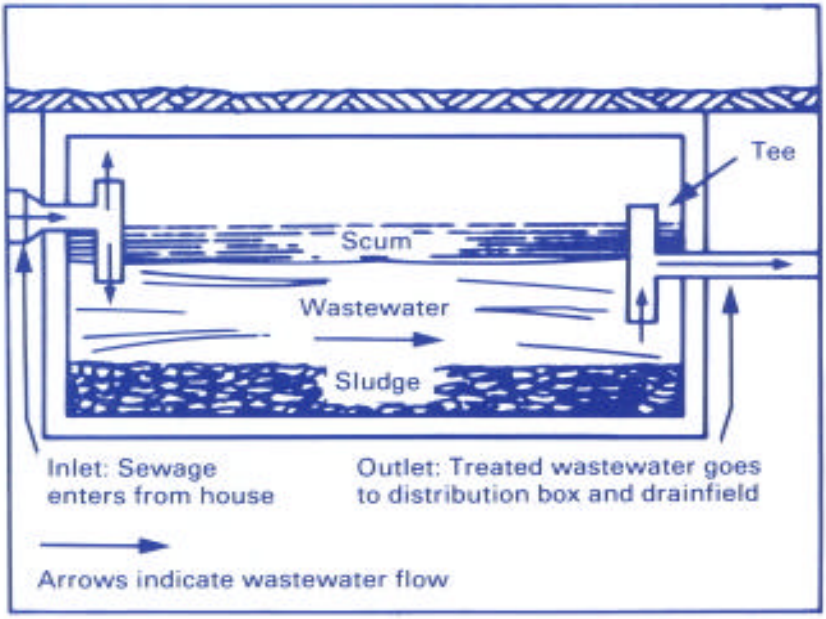
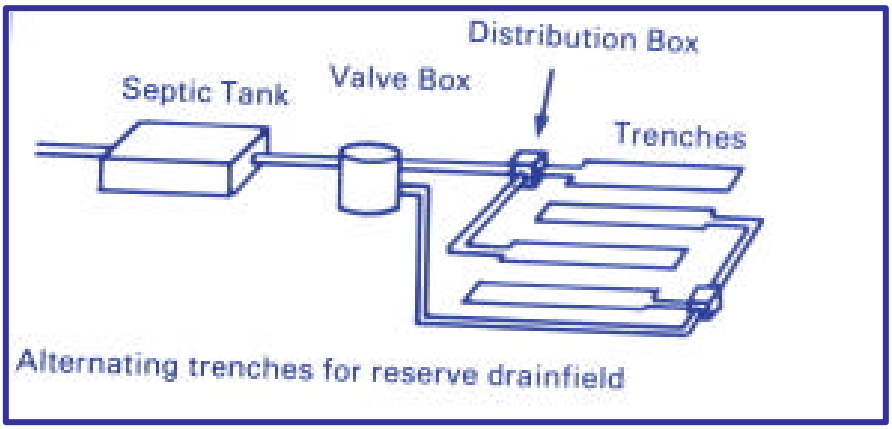


Figure 2.



The Drainfield

The drainfield consists of lines of perforated plastic pipe or open-jointed drain tile buried in a series of gravel-lined trenches. The length and number of drainfield lines are determined by the type of soil and the number of bedrooms in the home. Liquid seeps out of the holes in the pipe or the seams between the tile sections and filters through a layer of coarse gravel and into the soil. While moving through the soil, the wastewater is treated by soil organisms and by processes of soil filtration and adsorption. Eventually, this effluent reaches the groundwater below. Virginia's Sewage Handling and Disposal Regulations, administered by the Virginia Department of Health, require that a *reserve drainfield area* be set aside for soils with slower percolation rates. This reserve area must be at least half the size of the original drainfield. In 88 Virginia tidewater cities, counties, and towns, *the Chesapeake Bay Preservation Act requires that each building lot reserve an area equal to the size of the original drainfield.* This reserve drainfield need not be installed at the time the septic system is constructed, but many homeowners find it is more convenient and less expensive to do so. In some designs, the trenches for the reserve drainfield lie between the trenches for the original drainfield.

SEPTIC SYSTEM USE AND MAINTENANCE

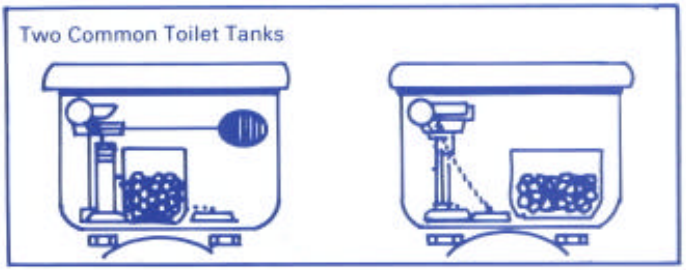
The effective treatment and disposal of domestic sewage requires maintenance of the entire septic system. With appropriate use and proper maintenance, a system that has been properly sited and installed can work effectively for many years. While a conventional septic system has no moving parts and normally does not require weekly or monthly maintenance, attention must be paid to some general principles of maintenance. Important maintenance practices include the following:

· **minimize water use**
· **pump septic tank regularly**
· **inspect system at each pumping**
· **provide adequate site drainage**
· **use proper landscaping**
· **use common sense waste: disposal practices**

Minimize Water Use

According to the Virginia Department of Health, reducing the amount of wastewater that goes to the septic system is one of the simplest and most important things homeowners can do to prolong the life of the system. Here are ideas for conserving water:

· Repair leaky faucets and toilets promptly.
· Keep showers short and reduce the amount of water used for baths.
· Reduce the amount of water used for flushing toilets. Rinse out an empty, one-gallon milk jug; cut off the top portion; place clean stones in the bottom to add weight; and submerge it in the toilet tank so it does not interfere with the flushing mechanisms.



- Run dishwashers and washing machines only with full loads.
- Distribute laundry washing throughout the week to avoid overloading the drainfield.
- Do not let water run while shaving, shampooing, washing hands, brushing teeth, or washing dishes.
- Install low-flow faucets and water-saving showerheads.
- When purchasing new appliances, choose models with water-saving features.
- Prevent backwash from home water softeners and other water treatment devices from entering the septic system.
- Teach family members, especially children, about water-saving practices.

For more information on water conservation, see page 35.

Pump Septic Tank Regularly

Failure to have the septic tank pumped out regularly is one of the most frequent causes of damage to the system. By periodically pumping out the tank, the major expense of installing a new drainfield can be avoided or delayed. Not pumping the tank regularly can cause the system to fail and contaminate well water.

Septic tanks should be pumped out every three to five years by a reputable septic tank service contractor, who is required to have a state permit to handle and dispose of the material removed from a septic tank (septage). Businesses that pump septic tanks are listed in the telephone directory; the local health department also can provide information about septic tank pumpers in the area. Pumping costs vary, so several estimates should be obtained.

Septic Tank Hazards

Never allow anyone to go down into a septic tank. Toxic gases build up in the septic tank and can kill in minutes. The major hazardous gases released during pumping are methane, an explosive gas, and hydrogen sulfide, a poisonous gas. Extreme caution should be exercised even in looking into the tank. Do not use torches or flames near the opening of a septic tank—they could ignite the gases and cause an explosion.

When the septic tank service arrives to pump the tank, the contractor locates the tank and excavates enough sod cover and soil over the tank to get access to the top of the tank. The liquid level in the tank first is lowered below the outlet to keep sludge and scum from overflowing into the drainfield as the tank is being emptied; then some of the liquid is pumped back into the tank under pressure to agitate all the solids into suspension. If the scum layer is hard, agitation is done with air under pressure or with a long-handled shovel. When all the solids are suspended, the mixture is pumped out of the septic tank into the pumper truck tank.

The Virginia Department of Health recommends leaving a few inches of sludge in the tank after pumping to help reactivate bacterial action. According to the department, biological and chemical additives containing yeast, bacteria, enzymes, or degreasers are not needed to aid or

accelerate decomposition in the septic tank. There is no evidence that ehese additives prevent septic system failure or improve performance. While most bacterial and enzyme products will not interfere significantly with the decomposition already occurring in the septic tank, neither will they significantly improve it.

Never wash, scrub, or disinfect the septic tank. Washing can destroy the bacteria that decompose waste in the tank. Some products that manufacturers claim will clean the tank contain compounds that disrupt the bacterial action and damage the soil absorption system. Many of these products contain hazardous chemicals that can contaminate well water.

Inspect System at Each Pumping

The tees (leading from the house and to the distribution box) should be checked after the tank has been pumped and any missing or damaged ones replaced by the pumping service. The distribution box should be checked for shifting or other damage and cleaned after ehe tank is pumped.

Provide Adequate Site Drainage

Proper drainage of the drainfield is important so that the ground can absorb wastewater. Drainage can be improved by directing gutters and downspouts away from the septic tank and drainfield. The drainfield area should be graded so that it sheds, rather than accumulates, rainwater in low areas or depressions. Do not pile snow on the drainfield or clear snow off of it. Do not drive over the drainfield; compacted soil and loss of vegetation both reduce the soil's ability to accept wastewater. A line of cast-iron sewer pipe, instead of plastic sewer pipe, should be installed under all vehicle crossings.

Use Proper Landscaping

A healthy grass cover should be maintained over the drainfield to prevent soil erosion, and trees and shrubs should not be planted too close to the drainfield because roots may eventually damage or block the distribution lines. Even neighbors' decisions about planting trees may interfere with the drainfield. No structures or paved surfaces, such as patios or driveways, should be built over drainfields.

Use Common Sense Waste Disposal Practices

Septic systems are designed for the disposal of human bodily wastes and the water used for laundry, dishwashing, and bathing. Disposal through household plumbing of items that are not readily degradable fills

the septic tank more rapidly, increasing the chances that the drainfield will clog and fail. Appropriate precautions should be taken in everyday use of the system; remember that everything that goes down the drain or is flushed down the toilet goes to the septic system. The following substances **should NOT be disposed of in household plumbing:**

- **coffee grounds**
- **dental floss**
- **disposable diapers**
- **cat-box litter**
- **sanitary napkins**
- **tampons**
- **cigarette butts**
- **plastics**
- **facial tissues**
- **paper towels**
- **bulky wastes**
- **fat, grease, or oil**
- **household hazardous wastes**

Septic System Maintenance at a Glance

DO:

- conserve water
- pump tank regularly
- inspect system each time tank is pumped
- direct gutters and downspouts away from drainfield
- maintain a healthy grass cover over the drainfield

DON'T:

- allow backwash water from water softener or other water treatment devices to enter septic system
- use biological or chemical additives in septic tank
- scrub or disinfect tank
- drive, plant trees, pile snow, or build anything over the drainfield
- use a septic system for the disposal of anything besides toilet wastes and the water used for bathing, laundry, and dishwashing

Use of a garbage disposal unit in the kitchen sink also should be avoided if the septic system was-not originally designed to accommodate one. A disposal unit sends ground solids and extra water to the septic tank, adding to the system's load. Fat and grease solidify and may block parts of the system.

Septic systems have very little, if any, ability to effectively treat household hazardous wastes—substances such as petroleum products, cleaning solvents and degreasers, photographic solutions, paint thinners, pesticides, paints, caustic drain openers, and other chemicals. When such products are disposed of through a septic system, two problems can occur:

- the toxic products may kill the bacteria responsible for treating the human wastes in the system, resulting in septic system failure; and

- the toxic products may not be treated by the soil, leaving them free to seep into groundwater supplies.

These problems can be avoided by keeping hazardous chemicals out of the septic system. All hazardous substances should be disposed of with extreme caution. A local health department or county extension office can provide advice about the best way to dispose of potentially hazardous materials. Although moderate use of household cleaning agents, disinfectants, and bleaches will do little harm to the septic system, many safe and nontoxic alternatives are available. For more information about household hazardous wastes see page 35.

ALTERNATIVE CLEANING PRODUCTS

For ehis:	Try this:
Bleach	Borax
Brass polish	Worcestershire sauce
Chrome polish	Apple cider vinegar
Household cleaners	Baking soda
Coffee cup stain remover	Moist salt
Copper cleaner	Lemon juice and salt
Furniture polish	1 tbsp lemon oil in 1 pint mineral oil
Grease removal	Borax on damp cloth
Hand cleaner (paint/grease)	Baby oil
Linoleum floor cleaner	1 cup vinegar in 2 gallons water
Oven cleaner	2 tbsp liquid soap, 2 tsp borax, warm water
Porcelain stain removal	Baking soda
Rug/carpet cleaner	Club soda
Spot remover	Club soda, lemon juice, or salt
Stainless steel polish	Mineral oil
Toilet bowl cleaner	Paste of borax and lemon juice
Tub and tile cleaner	¼ cup baking soda, t/: cup vinegar, warm water
Window cleaner	2 tbsp vinegar in 1 qt warm water

(Adapted from Northern Virginia Soil and Water Conservation Dis trict newletter "Conservation Currents.")

A Septic System Map Facilitates Maintenance

To facilitate cleaning and maintenance, homeowners should know the location of their septic systems. Using graph paper to draw a map of the house, septic tank, distribution box, piping, and drainfield will make it easy to show scale. Distances from the house and property lines and the length of the drainfield should be noted. If a well is on the property, the well's location also should be indicated. This information should stay with the house, along with a permanent record of all septic system maintenance, regardless of a change in occupancy; serious injuries have resulted from the cave-in of abandoned septic tanks. A marker on the ground above the septic tank avoids the expense of hiring someone to locate it for maintenance.

Homeowners who do not know the location of their septic systems may seek assistance from local health department sanitarians, whose expertise allows them to discern the locations of the septic system components more easily.

SEPTIC SYSTEM FAILURE

A survey of health department sanitarians conducted in 1991 indicated that the most common causes of septic system failure include lack of maintenance, an old drainfield, shallow or seasonally high water tables, clay soils, and shallow depth to rock. Septic system failure, which often is signalled by sluggish drains, plumbing backups, or seepage on the ground surface, can be caused by system abuse or by poor siting, design, or construction. When a septic system fails, liquid wastes rising to the ground surface or backing up into the house's plumbing create offensive odors and can be a health hazard because sewage may contain viruses and bacteria that cause diseases. Ponded sewage in the yard also creates breeding places for mosquitoes and other insects. When a septic system fails, it can contaminate groundwater with bacteria, viruses, detergents, chlorides, and a variety of potentially toxic chemicals found in common household cleaning agents. Unfortunately, *some systems may contaminate groundwater with no outward signs of problems;* such failures usually are detected only when well water becomes noticeably contaminated.

Three options are available when a septic system fails: salvage the failing system, build a new system, or provide an alternative means of waste disposal. The last chapter describes alternative wastewater disposal systems. This chapter describes some of the causes of septic system failures.

Distribution Box Problems

When a septic system's distribution box shifts from its level position, effluent moves toward one side of the box and travels to the drainfield through only one or two of the distribution lines (Figure 3).

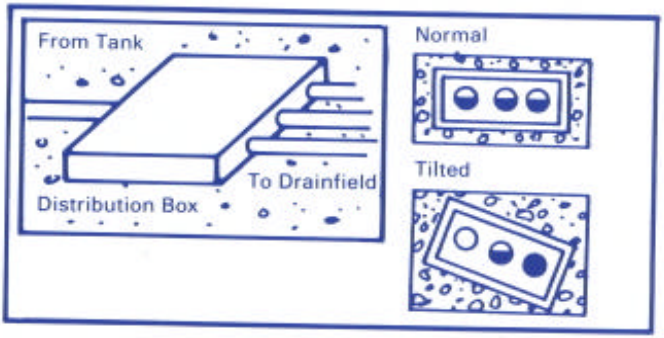


Figure 3.

Effluent concentrated in a small area of the drainfield saturates the area and prevents drainage through the soil. Wastewater then can pond on the land surface and eventually prevent drainage from the septic tank, causing wastes to back up into household plumbing. Improper installation and packing under and around the box can cause the box to shift as settling occurs. Allowing heavy equipment to drive over the box also can shift it. In some older systems, cast-iron pipe leading to the distribution box rusts, leaving the connections neither secure nor water tight.

Drainfield Failure

The drainfield has failed when its soil does not adequately absorb wastewater. Unusually lush, green grass or the appearance of a gray-black, odorous liquid indicates surface seepage. Sluggish drains or household plumbing backups also may indicate drainfield failure. Drainfield failure may be occasional or continuous. Occasional failures can coincide with

Failures Are a Health Hazard

Septic system failures are a serious health hazard; keep children and pets away from the area. Fence in or block off the area to keep people and pets out and notify the local health department of the problem.

periods of heavy rainfall or snowmelt, when poorly drained soils become saturated and unable to absorb wastewater. Steep land, thin soil over bedrock, slowly permeable soils, and seasonally high water tables also may be responsible for drainfield failure. In some locations, groundwater rises into the area in which the drainfield lies and creates saturated soil conditions underneath and around the distribution lines. The already wet soils are unable to adequately filter and treat large volumes of wastewater from the drainfield lines. Household water conservation may sufficiently reduce the wastewater load to the drainfield to prevent this problem. Installation of drains that intercept and collect excess soil water, which then is diverted away from the drainfield, also may be considered.

If failure oc0rs during the first year of use, it is probably due to poor design, construction, or siting of the system. A continuous failure that occurs after the system has operated effectively for many years is probably caused by poor maintenance or excessive wastewater flows. Plumbing leaks, foundation drain discharges, and excessive water use all can contribute to drainfield failure.

Drainfield failure also may result when homeowners neglect to pump the septic tank. Solids accumulate to the point that they are carried into the drainfield, where they can clog lines, perforations in the pipe, and soil pores. When clogged soil pores are the cause of system failure, diverting the flow to a new drainfield may allow the original system to regain its usefulness. Research has shown that biological breakdown of the substances that cause soil clogging may occur if the drainfield is not used for a period of time. A valve in the distribution box can divert the flow from the tank to a newly constructed drainfield while the old field is not used for 6 to 12 months. Because clogged drainfields often can be put back into service, the existing drainfield should not be dug up unless there is no room to install a new one.

Plumbing Blockages

Blockages between the house and septic tank also may result in sluggish drains or sewage backups. If the blockage is from tree roots, the roots must be removed and pipe joints resealed. If the blockage occurs at the inlet pipe to the tank, the tank must be pumped out and all baffles checked. Outlet pipes also should be checked. In some cases, a plugged sewer vent can slow the rate of flow. The assistance of a plumber or septic tank service contractor may be required to clear plumbing blockages.

Repairs Require a Permit

An application for a permit to repair a septic system must be submitted to the local health department before work is undertaken. There is no cost for a repair permit, but proposed work must be approved. Obtaining a repair permit helps ensure that the problem has been identified properly and that appropriate repairs will be made.

BEFORE BUYING PROPERTY

The first time many people encouneer septic systems is when they purchase a home or land for building a house or business and discover that the property is not served by a public sewage disposal system. This chapter provides information about evaluating septic system sites, obtaining construction and operating permits, and inspecting existing septic systems. Nonresidential septic systems such as those used by a small manufacturing industry, automotive repair or service station, or other small business require special permits.

Residential Septic Systems

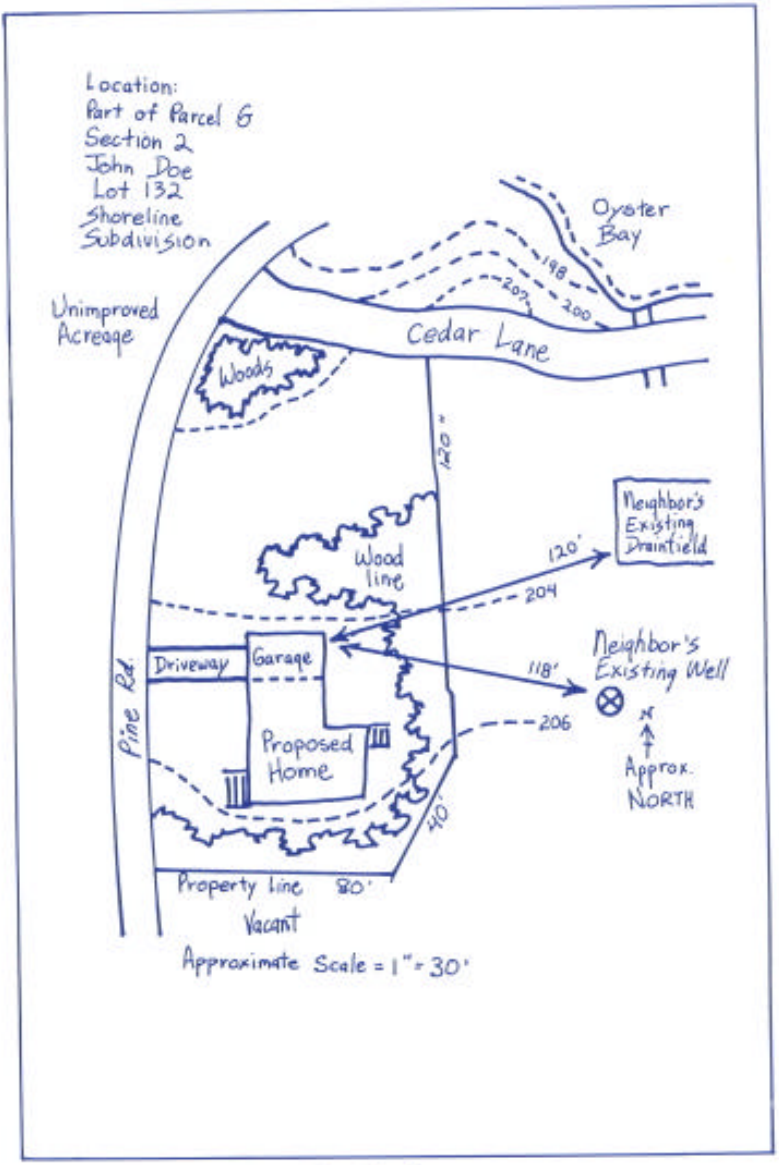
Permits The Virginia Department of Health is responsible for permitting septic systems in the Commonwealth. Homeowners must have a permit from the local health department to construct, modify, or expand a septic system. The site must meet the standards in Virginia's Sewage Handling and Disposal Regulations before a construction permit is issued. Virginia localities may adopt more stringent requirements than those specified in the state regulations, and many do so. Information about specific regulations can be obtained at local health departments.

Permit Applications: A Closer Look

An application for a sewage disposal system construction permit requests:

- **name, address, and telephone number**
- **directions the property**
- **subdivision, section, block, and lot numbers**
- **number of bedrooms in the house**
- **plans for basement, washing machine, dishwasher, or garbage disposal**
- **a sketch of the property and its surroundings showing:**
  - **existing septic systems, bodies of water, wells, and springs within 200 feet of the center of the proposed septic system**
  - **proposed and existing structures, driveways, and under ground utilities**

Homeowners can be prosecuted for installing a sewage disposal system without a construction permit or for using one without a health department operation permit. This can result in a misdemeanor or more serious charge, and the penalty may be a fine and/or a jail sentence.



Sample Sketch for Permit Application

Once a permit application has been accepted, a local health department sanitarian will evaluate the potential septic system site and its soils (see below). If the site location and soils are judged satisfactory, the sanitarian will draft a permit, which is reviewed for accuracy by a sanitarian supervisor. The construction permit, when granted, will include a schematic drawing of the sewage disposal system, indicating the sewer lines from the house, the septic tank, the conveyance system, the drainfield, and the reserve drainfield, if required. The drawing will include lot lines for the building site and natural and artificial topographic features. When the septic system has been constructed, a sanitarian must inspect and approve the system before it is covered with backfill and before an operation permit is issued and the system is placed in service. Any agreement with a contractor who installs a septic system should stipulate that no payment will be made until the system has received approval from the health department. Any plans for installing a well on the property must be considered when choosing a septic system site; approval of the water supply is an integral part of issuing an operation permit for a sewage disposal system.

Site Evaluations Virginia has specific regulations regarding the location of septic systems in relation to various landforms, buildings, water supplies, property lines, and the water table (Figure 4). The septic

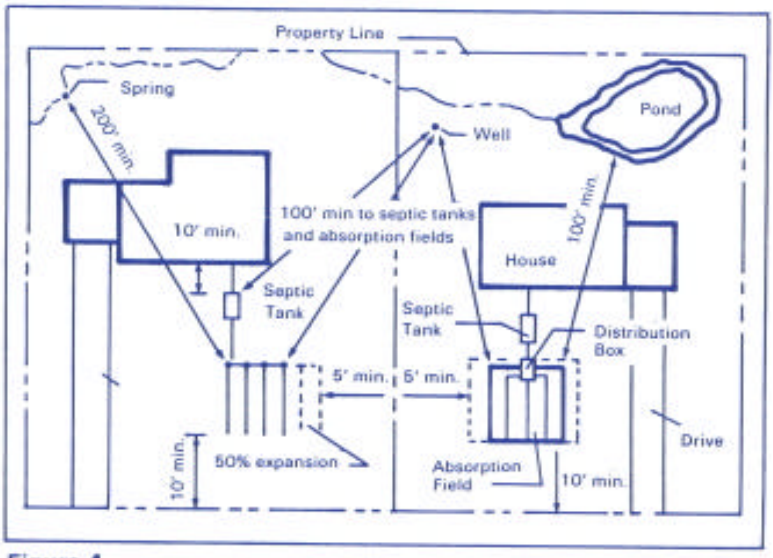


Figure 4.

tank and drainfield must not be located under a patio, garage, storage building, driveway, parking lot, sidewalk, or other paved area. The homeowner can assist a health department sanitarian in evaluating potential sites by having the property lines and property corners clearly marked and by clearing the property of dense underbrush to enable the sanitarian to see the topography. The site evaluation also is easier to complete if the homeowner is present, because the sanitarian needs to know the proposed locations of buildings, driveways, and other relevant structures. The site evaluation usually takes one to two hours by a sanitarian who will:

- determine the location of neighboring wells and septic systems and examine the landscape features of the property (ridges, slopes, rocky outcrops, and drainage patterns);
- evaluate the soil on the potential septic system site and take samples (soil color is indicative of the seasonal water table, and soil texture and structure can be used to determine how wastewater will flow through the soil);
- determine the soil percolation ("perk") rate, a measure of how quickly water moves through the soil.

If a sanitarian cannot find a suitable site for septic system, a private soil consultant can be hired. If a consultant identifies an acceptable site, the sanitarian prepares a draft permit, which is reviewed by the health department. The construction permit, if acceptable, is issued to the homeowner, usually one to three weeks after the site visit.

Existing Septic Systems In many areas of Virginia, real estate transactions that involve the purchase of properties using septic systems for wastewater disposal require a septic system inspection, which can be performed by a septic tank pumping service contractor. Even if such an inspection is not required, a responsible buyer will want to have the system checked before purchase agreements are signed. Copies of the original installation and operation permits for the septic system should be available from the seller. The local health department may be another source of permits, unless the system is extremely old. **The prospective buyer should:**

- Check that the system is located where it is not likely to endanger well water.
- Compare the original permit allowances with the current size of the house and the number and type of water-using appliances to be sure that the drainfield is capable of handling the wastewater load.
- Pay special attention to homes that have been remodeled or enlarged without expansion of the septic system.

- Examine the ground surface above the system's drainfield to determine whether wastewater has seeped to the surface, an indication of a failing system.

Nonresidential Septic Systems

In many rural areas of Virginia not served by a central sewage system, a wide variety of commercial establishments, institutional facilities, and recreational areas rely on septic systems for onsite wastewater disposal. These nonresidential septic systems require special permits and are evaluated more critically. The use of septic tanks and drainfields for wastewater disposal by nonresidential facilities requires a special permit from the health department, the Virginia Water Control Board, or both. For many establishments, the wastewater characteristics are similiar to those of residential wastewater. However, some nonresidential systems differ from residential systems in the constituents, volume, and nature of the wastewater treated. Suburban office parks and light industries (such as automobile repair shops, dry cleaners, photofinishers, furniture strippers, and service stations) may have wastewater containing chemicals that can endanger public health if they enter a water supply. Many of these contaminants from light industry undergo minimal change when passed through the septic tank and drainfield. Toxic waste products also may damage or destroy biological organisms necessary for wastewater treat ment, rendering the septic system unusable for wastewater treatment.

Some of these nonresidential septic systems qualify as underground injection wells under the Underground Injection Control (UIC) program established by the Safe Drinking Water Act. This program was created specifically to ensure that fluids placed in injection wells (certain septic systems are considered injection wells) do not threaten present and future drinking water sources. The Safe Drinking Water Act mandates that a federally approved UIC program be developed for every state; the EPA's Region III office administers the program for Virginia.

Virginia has over 3,000 Class V wells, a catchall category of 32 different types of disposal wells, including nonresidential septic systems. Three of the Class V well types include septic systems used for disposal of solely domestic wastewater in establishments serving more than 20 per sons per day. Three more Class V categories include industrial, commercial, and utility disposal wells, such as groundwater heat pumps and auto mobile service station disposal wells. For more information on non residential septic systems see page 35.

SEPTIC SYSTEM VARIATIONS AND ALTERNATIVES

Alternative waste disposal systems have been developed for sites that are unsuitable for septic systems. The successful operation of alternative disposal systems generally requires more careful attention to siting, design, installation, and maintenance than for conventional septic systems. The site and soil conditions where they are used are often less favorable for wastewater absorption. These systems are usually more mechanically complex and require regular maintenance. The result is more local restrictions on alternative systems. The Virginia Department of Health can provide information on permits for alternative systems.

Some of these alternative systems are similar to conventional septic systems in that they discharge effluent to the ground through a soil absorption area. These include mound systems, low-pressure distribution systems, and enhanced-flow systems. Other alternatives discharge treated wastewater into a stream or a ditch that leads to a stream instead of to a soil absorption area. They include sand filters, aerobic treatment units, and constructed wetlands.'

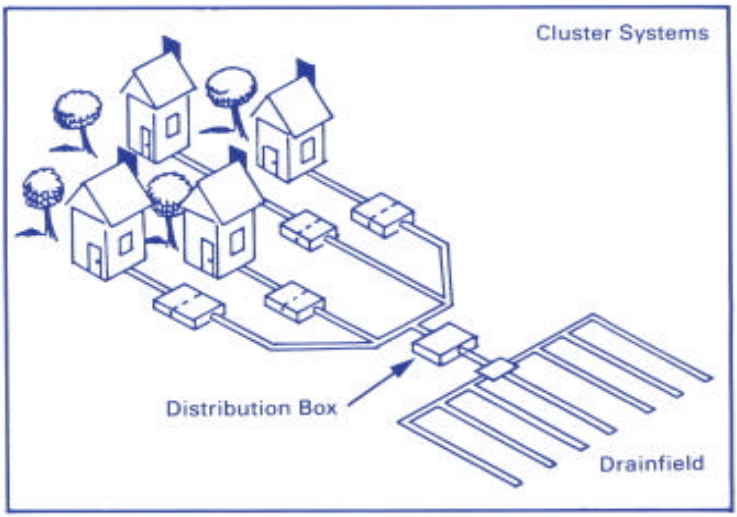
These alternative systems treat wastewater flow from a home—both black water (toilet wastes) and gray water (kitchen, laundry, and bathing wastes). Also described in this chapter are waterless toilets, which provide disposal for human wastes only and must be used in conjunction with a separate gray-water treatment system. These include recirculating oil-flush toilets and toilets that compost and incinerate wastes.

Cluster Systems

In the cluster septic system, one large drainfield is used for several septic tanks. Each home or unit has an onsite septic tank to settle solids. Wastewater flows from the individual tanks to the community drainfield. These systems have been used in planned residential developments and in neighborhoods where drainfields have failed. If soil and site conditions permit, one mass drainfield may be more effective for several residences.

1. The treated wastewater from these alternative systems typically is discharged to surface waters surface water discharges are regulated by the Virginia Water Control Board. For residential systems, however, the Virginia Department of Health handles permit applications for the Virginia Water Control Board.

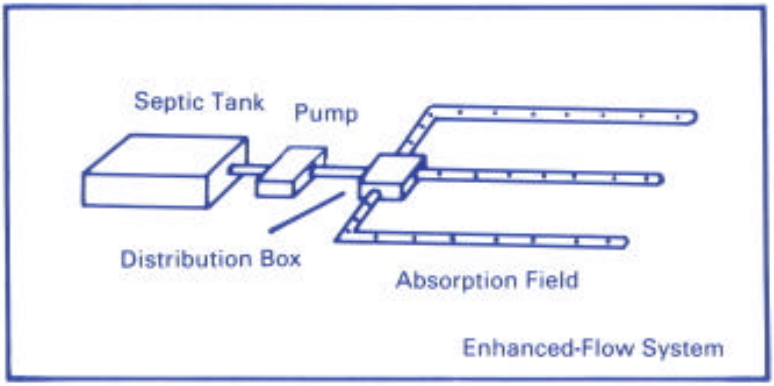
For clusrers of homes or commercial/institutional flows, a two compartment septic tank provides for more efficient removal of suspended solids. The second compartment receives the clarified liquid from the first compartment at a slower rate and with less turbulence, providing more settling area and more favorable conditions for settling the remaining solids. The additional compartment also reduces the effect of periodic high wastewater flows. Two single-compartment tanks in series can work in a similar fashion. A reduction of suspended solids and a longer retention period improves the quality of the effluent, which helps improve the performance and extend the life of soil absorption areas.



Enhanced-Flow Systems

Enhanced-flow systems are conventional septic systems with the addition of a pump to distribute effluent to a larger portion of the drain field. In a conventional septic system, less than 15 percent of the drain field is dosed with effluent at any time and parts of the system, usually areas close to the distribution box, never have a chance to dry out. An enhanced-flow system uses a pump to improve wastewater distribution

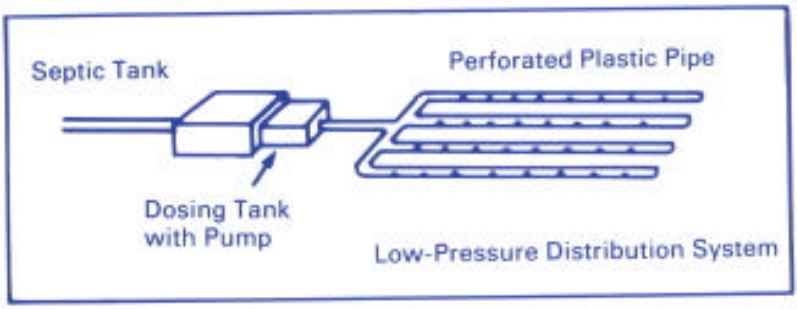
throughout the drainfield. Pumping the effluent periodically wets the entire drainfield. The drainfield dries out between dosings, which is beneficial to soil organisms and helps to reduce soil clogging. Maintenance of enhanced-flow systems is basically the same as for a conventional septic system, but pump maintenance and replacement must also be considered.



Low-Pressure Distribution Systems

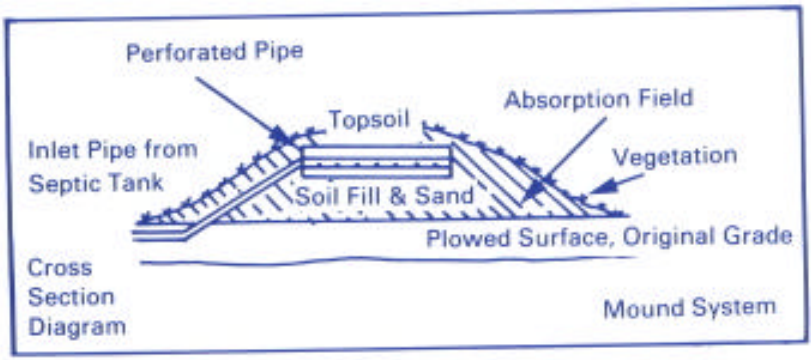
Approximately 1,000 of these alternatives to conventional septic systems have been permitted by the Virginia Department of Health. These systems, like the enhanced-flow systems, use a pump to distribute the effluent through pipes in controlled doses to the drainfield. Unlike the enhanced-flow systems, there is no distribution box. The pump is housed in a dosing tank adjacent to the septic tank, and the effluent is pumped directly from the dosing tank to a set of perforated small-diameter plastic pipes that are buried in trenches. Site conditions and soils determine the pipe layout and the number and size of holes in the pipe. These systems may include a second septic tank in series with the first or a two-compartment tank to provide more opportunity for solids to settle before effluent is pumped out. The drainfield area may be the same size as a conventional system, but can be reduced by up to 50 percent with proper soil conditions.

Low-pressure distribution systems can cost twice as much as a conventional septic system. The system also requires more maintenance and energy, so the operating costs are higher.



Mound Systems

Mound systems, also known as "Wisconsin mounds," can provide adequate wastewater treatment when soil and site conditions limit the use of conventional, enhanced-flow, or low-pressure distribution systems. The components of the system are a septic tank, pumping chamber, submersible pump, high-water alarm, supply line, perforated distribution lines, and a mound constructed on top of the existing ground surface to concentrate additional soil for treatment of the wastewater. To construct the mound, the soil surface is lightly disked and covered with graded sand. A small, low-pressure distribution system is placed in gravel-filled trenches over the sand layer, and the entire system is covered by topsoil and seeded with grass. Use of a two-compartment tank or two tanks in series is recommended to reduce solids that might clog distribution pipes. Wastewater is pumped from the tanks to the mound, where it passes through a sand fill and into the soil beneath the mound.



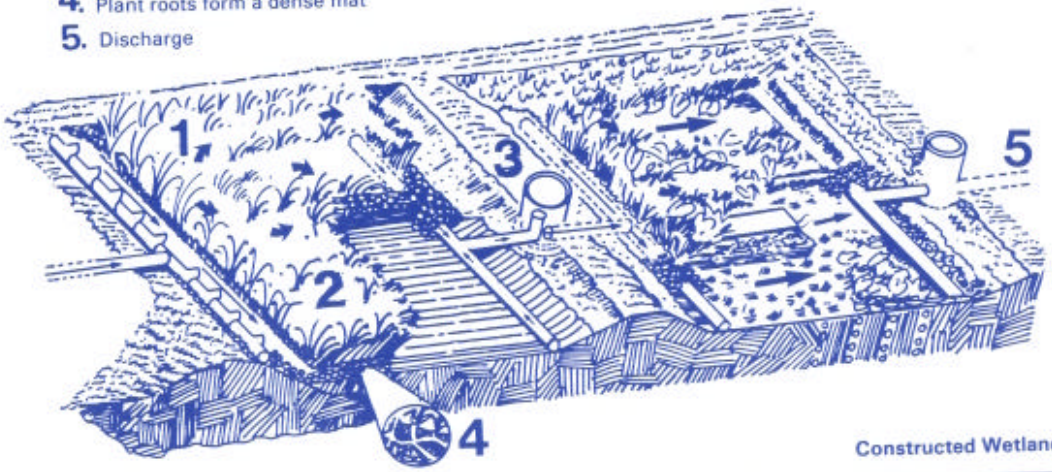
Special maintenance requirements include maintaining adequate vegetation on the mound surface to prevent erosion. Deep-rooted plants should be avoided so that roots will not clog distribution pipes. Heavy traffic should be kept away from the mound site to prevent soil compaction. Mound systems can cost from two to five times as much as conventional septic systems; their annual operating costs also are higher.

Constructed Wetlands

Constructed wetlands are simple, effective wastewater treatment systems specifically designed and built to treat domestic, agricultural, industrial, and mining wastewater. Constructed wetlands generally are used by small communities as an alternative to the more expensive conventional wastewater treatment plant, but they also provide an option for homeowners with failing septic systems. The Virginia Department of Health and the Virginia Water Control Board currently consider these systems experimental, however, and only a few have been permitted in the state.

A constructed wetland for onsite domestic wastewater treatment is designed and built to resemble a natural wetland. The sides and bottom of an 18-inch-deep excavated area are covered with a synthetic or clay waterproof liner to prevent leaks. The size of the excavation varies depending on wastewater treatment needs and other factors. The area then is filled with rock, gravel, sand, and soil. Aquatic vegetation, such as cattails, bulrushes, and reed grasses, is planted to provide a habitat for the microorganisms that treat the wastewater. Wastewater from the septic tank or other type of primary wastewater treatment system flows through a pipe and is distributed through the wetland. In most residential systems, the effluent is controlled to keep it about one inch below the top of the gravel surface. These systems, like sand filters, typically discharge treated wastewater to a stream or ditch leading to a stream and are regulated by the Virginia Water Control Board. Permit applications for residential systems can be handled by a local health department. In cases where final discharge to groundwater is desired, constructed wetlands have a second excavated area that is unlined, allowing treated water to seep into the ground. Limited experience with the use of constructed wetlands for individual homeowners makes it difficult to estimate installation costs; some sources suggest that they are slightly less expensive than conventional septic systems and that operating costs are similar to those for conventional systems. Little information is available on maintenance requirements.

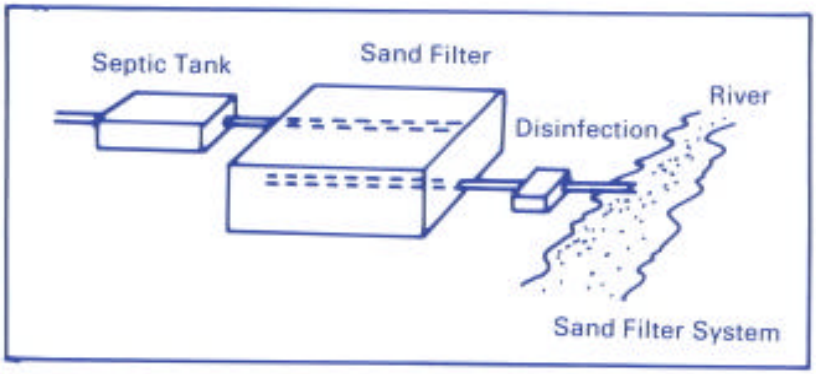
1. Arrows indicate wastewater flow direction
2. Aquatic vegetation planted in gravel
3. Swivel standpipes regulate water level
4. Plant roots form a dense mat
5. Discharge



Constructed Wetland

Sand Filters

Sand filters discharge treated wastewater to a stream or ditch leading to a stream instead of to a soil absorption area; such systems are regulated by the Virginia Water Control Board, but permitting for residential systems can be handled through a local health department. Sand filters are used for small flows from residences and small commercial establishments where a soil absorption field is not possible, and are the most commonly used alternative system in Virginia.



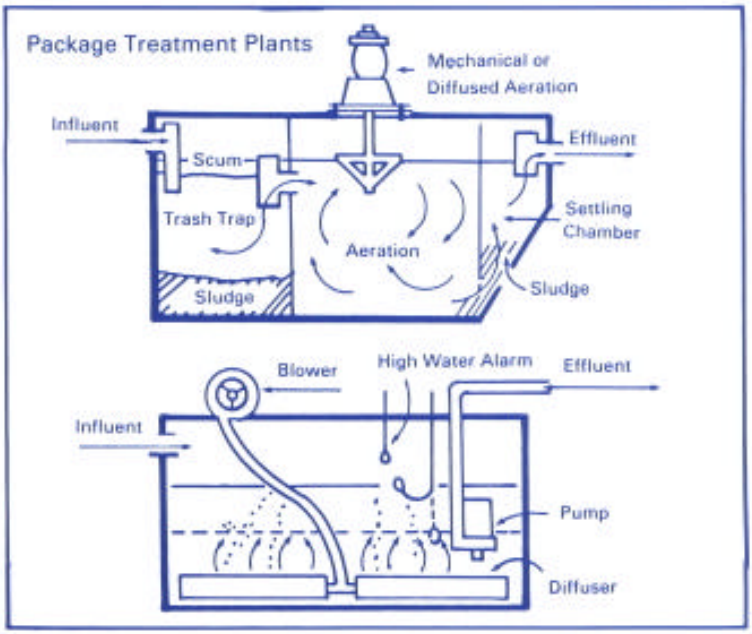
Wastewater passes through a pretreatment unit (a septic tank or an aerobic treatment unit) before being applied intermittently to a bed of granular material (sand, activated carbon, mineral tailings, anthracite, and other materials have been used) that is underlain by graded gravel and collecting tile. Bacteria living in the filter materials are responsible for much of the treatment of the wastewater. Dosing rates can vary from once every 30 minutes to once a day. In one variation of this system, the effluent is repeatedly recirculated through the pump chamber and the sand filter to achieve alternating wetting and drying cycles. The effluent must be disinfected (usually chlorinated) before discharge; dechlorination also may be required. Site conditions determine the design and type of sand filter, which can be either ground level or a buried sand pit.

Maintenance requirements include servicing the pump used to apply the wastewater to the bed, raking the bed periodically, and replacing the top layer of sand. The health department also requires that sand filters be equipped with a high-water alarm over the sand bed to alert the owner when the sand has become clogged. Sand filters cost at least twice as much as conventional septic systems, with higher operating costs adding to the expense.

Aerobic Treatment Units

Aerobic treatment units operate much like a municipal sewage treatment plant. The effluent may be discharged to a stream or ditch leading to a stream or to a subsurface drainfield. Surface discharges are regulated by the Virginia Water Control Board, with permit applications for residential systems handled by local health departments.

Several types of aerobic treatment units may be used for household wastewater; the most commonly used unit in Virginia is the extended aeration package treatment plant. These systems typically have three compartments. In the pretreatment compartment, solids settle to the bottom, a scum layer forms on top, and a trash trap catches other materials. In the second compartment, an electrically driven air compressor injects air beneath the water surface to promote digestion by aerobic bacteria. The third compartment is the settling chamber, where undigested solids settle to the bottom and are returned to the aeration compartment for further treatment. Effluent is chlorinated and, in some cases, dechlorinated before being discharged.



Aerobic units are susceptible to upsets (failures) and require more supervision and maintenance than other wastewater treatment systems. Maintenance is so important that a two-year maintenance contract must be purchased before an operating permit is issued. Sludge should be pumped from the system every 8 to 12 months. Monthly maintenance activities include checking air filters, seals, oil level, back pressure, the electrical control box, and the functions of all controls and alarms. Excess grease, cleaning substances, and various waste materials can cause both equipment and process failures. Routine maintenance requires skilled personnel. Package treatment plants are only slightly more expensive than conventional septic systems to install, but annual operating costs can be 30 times higher than for a conventional system.

Waterless Toilets

Waterless toilets can help solve domestic sewage disposal problems by taking care of toilet wastes; these units must be used in conjunction with a wastewater treatment system that handles the water used for bathing, washing dishes, and doing laundry. All waterless toilets require the approval of the health department.

Composting Toilets

In a composting toilet, human wastes, toilet tissue, and often kitchen scraps are decomposed by aerobic microorganisms to yield a soil-like material, approximately 5 to 10 percent of the volume deposited. There are a number of different designs for composting toilets, but perhaps the best known is the bi-level version of the Clivus Multrum. In this system, a sloping fiberglass box with three compartments is lined with a starter layer of soil and peat moss. Toilet wastes fall into the first compartment; organic kitchen wastes fall into the middle compartment. The decomposed wastes slide into the final storage chamber where aerobic decomposition continues because of ventilating air inlets. It may take two to four years before the soil-like material appears in the final storage chamber. The residue from these units must be buried and cannot be placed in a vegetable garden or on the ground surface.

Incinerating Toilets

Incinerators use oil, gas, or electricity to evaporate liquids and burn human wastes to a sterile ash. Ventilation usually occurs through a forced-air exhaust blower. The ash box must be emptied periodically; cleaning and adjustment of the burner should be done semiannually. These toilets are often used at construction sites and areas without access to water.

Biological Toilets

A biological toilet uses aerobic and anaerobic bacteria to break down human wastes. A charcoal filter bed recycles and filters the 15 gallons of water within the unit. An updraft vent stack to the outside is required, as is the weekly addition of a package of freeze-dried enzymes and bacteria.

Oil-Flush Toilets

The recirculating oil-flush toilet uses mineral oil as a flushing medium to carry wastes from the toilet bowl to a settling tank. The wastes sink to the bottom and the lighter oil is drawn off the surface, filtered, and recirculated to the toilet. The concentrated wastes must be removed periodically. The system itself is expensive, costly to maintain, and is used most frequently at highway rest stops.

FOR MORE INFORMATION

The municipal or county health department is the first place to check for more information. They have several brochures on *septic systems and alternative sewage disposal systems* (see titles below). A health department videotape on septic systems, "Clean Groundwater: Virginia's Endangered Inheritance," is available at most public libraries. Local health departments also can explain regulations governing construction of septic systems and can provide *applications for septic system construction permits.* Area telephone directories list local health departments under city or county government offices. Cooperative Extension agents, who can provide advice and information, usually are listed under Cooperative Extension Service in the state government section of the phone book.

The National Small Flows Clearinghouse serves as the national information center on small flows technology and low-cost *wastewater systems for small communities.* The clearinghouse offers two free newsletters, a computer bulletin board, databases, informational booklets and videotapes, instructional materials, and workshops, seminars, and consultation and referral services. For information, contact National Small Flows Clearinghouse, West Virginia University, P.O. Box 6064, Morgantown, WV 26506-6064.

For more information on *water conservation,* request the free brochure *Be Water-Wise* from Publications Services, Virginia Water Resources Research Center, 617 North Main Street, Blacksburg, Virginia 240603397; telephone (703)231-8036. More information on *nonresidential septic systems* that qualify as injection wells also is available from the Center; request the publication *Underground Injection Control in Virginia.*

The Virginia Department of Waste Management has a variety of brochures and booklets available with more information about *ho2`selold hazardous wastes* and how to dispose of them safely; contact the department at 101 North 14th Street, 11th Floor James Monroe Building, Richmond, VA 23219.

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