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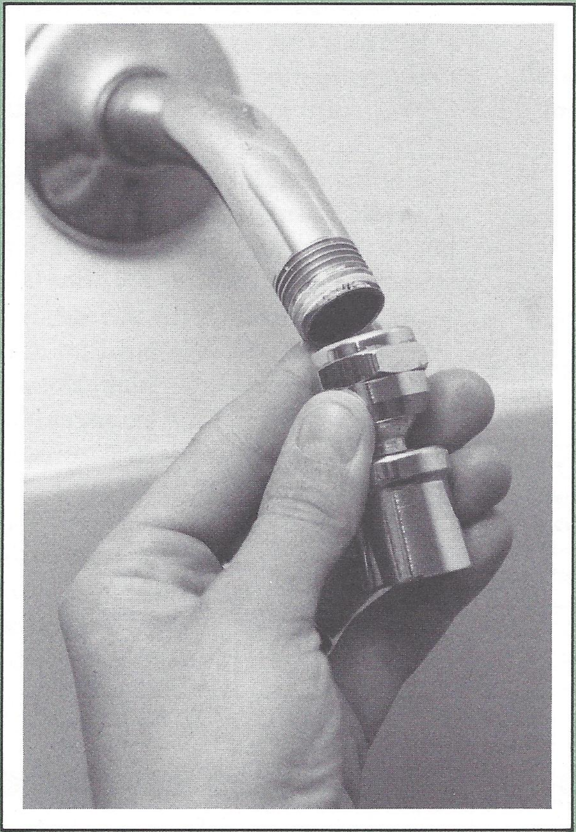
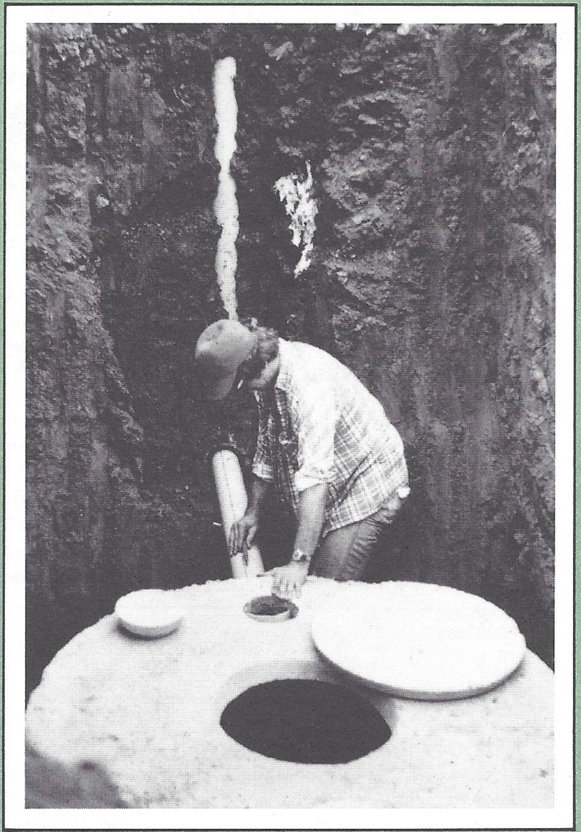
Two remedies for failing septic systems





Extension Circular 302

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If you own one of the millions of septic systems in this country, someday you may have problems with it. Effluent (wastewater from the septic tank) may back up into your plumbing or pond on your lawn. Besides being unsightly, a nuisance, and the cause of health problems, failing systems are often difficult and costly to fix.

This publication describes two recently tested methods that may be effective in restoring failing septic systems: (1) water conservation and (2) absorption-area resting. While the initial cost of either method may be slightly greater than the cost of reconstructing a system, both methods have benefits that will, in the long run, save money.

The two methods were successfully tested in a detailed study of failing septic systems at eleven homes in central Pennsylvania. The study was conducted in 1980 and 1981 for the U.S. Environmental Protection Agency (EPA) through the Institute for Reseach on Land and Water Resources at The Pennsylvania State University. A high level of water conservation was the only solution tested in three homes, and a low level was combined with the absorption-area-resting method in three others. The remaining five homes were fitted with water-conservation devices only: low-level devices in two homes and intermediate-level devices in three others. In these five homes the lower levels of water conservation weren't successful.

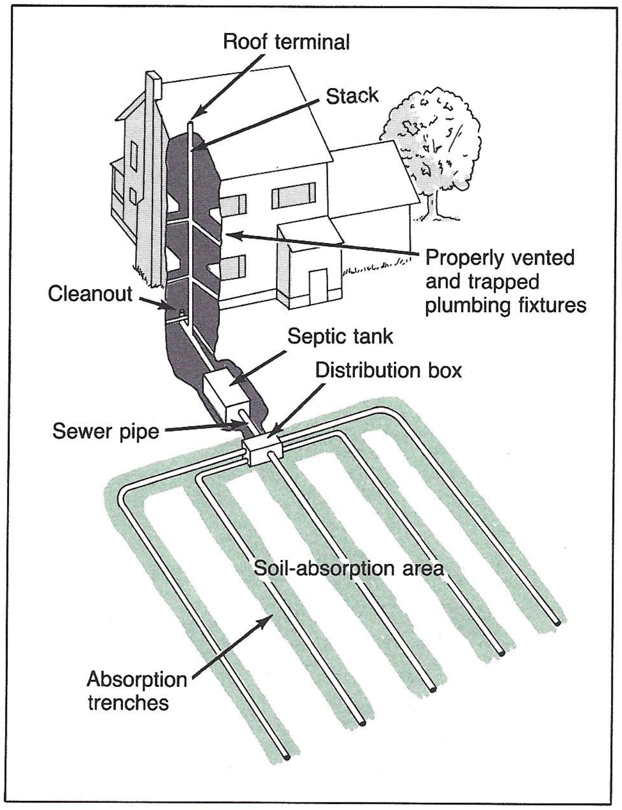


Figure 1. A typical septic system (with trenches). (Adapted from: *Septic System Care,* Environmental Resources Extension Bulletin 10, Cooperative Extension Service Cook College, Rutgers — The State University of New Jersey, New Brunswick.)

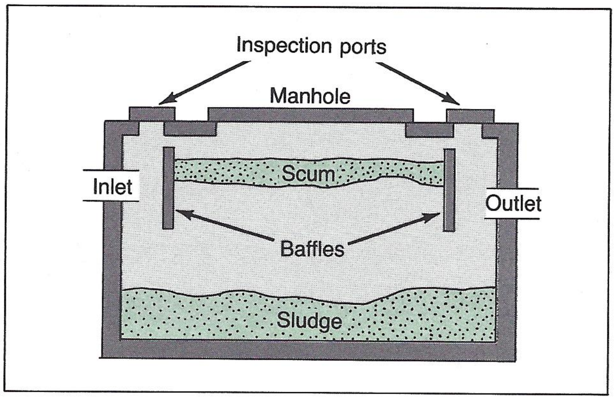


Figure 2. Cross section of a septic tank. (From: *Septic Tank Pumping,* Agricultural Engineering Fact Sheet SW-40, The Pennsylvania State University, College of Agriculture, Cooperative Extension Service, University Park, Pennsylvania.)

How a septic system works

Septic systems treat wastewater and dispose of it. A system is composed of two major sections, a septic tank and a soil-absorption area (see figure 1). Each provides some treatment. Wastewater from the house flows through a sewer pipe into a 900 to 1,600 gallon septic tank, usually made of concrete (see figure 2). There heavy solids settle to the bottom and form a layer of sludge. Lighter solids, such as fats and greases, rise to the top and form a scum layer. The relatively clear liquid between the layers is discharged into the absorption area by way of a distribution box or connection pipes. Even though some of the sludge and scum layer is broken down by bacteria, to prevent solids from entering the absorption area the homeowner must periodically — every two years or so — have the tank pumped.

The absorption area consists of a system of perforated pipes that discharge effluent into the soil. The distribution pipes are surrounded with gravel and buried in individual trenches (see figure 3) or a common bed (see figure 4). In a properly operating system, effluent exits through the perforations, then travels through the crushed rock, and infiltrates the soil. As effluent drains, the soil acts as a filter that removes many pollutants.

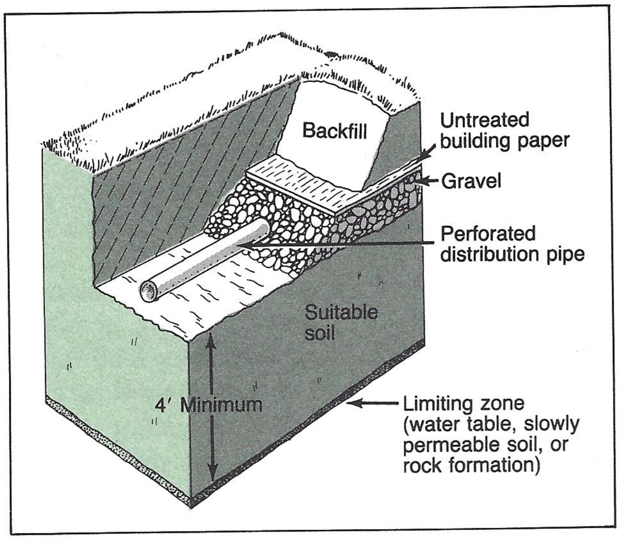


Figure 3. Cut-away view of an absorption trench. (Adapted from: *Design Manual, Onsite Wastewater Treatment and Disposal Systems,* U.S. Environmental Protection Agency, October 1980.)

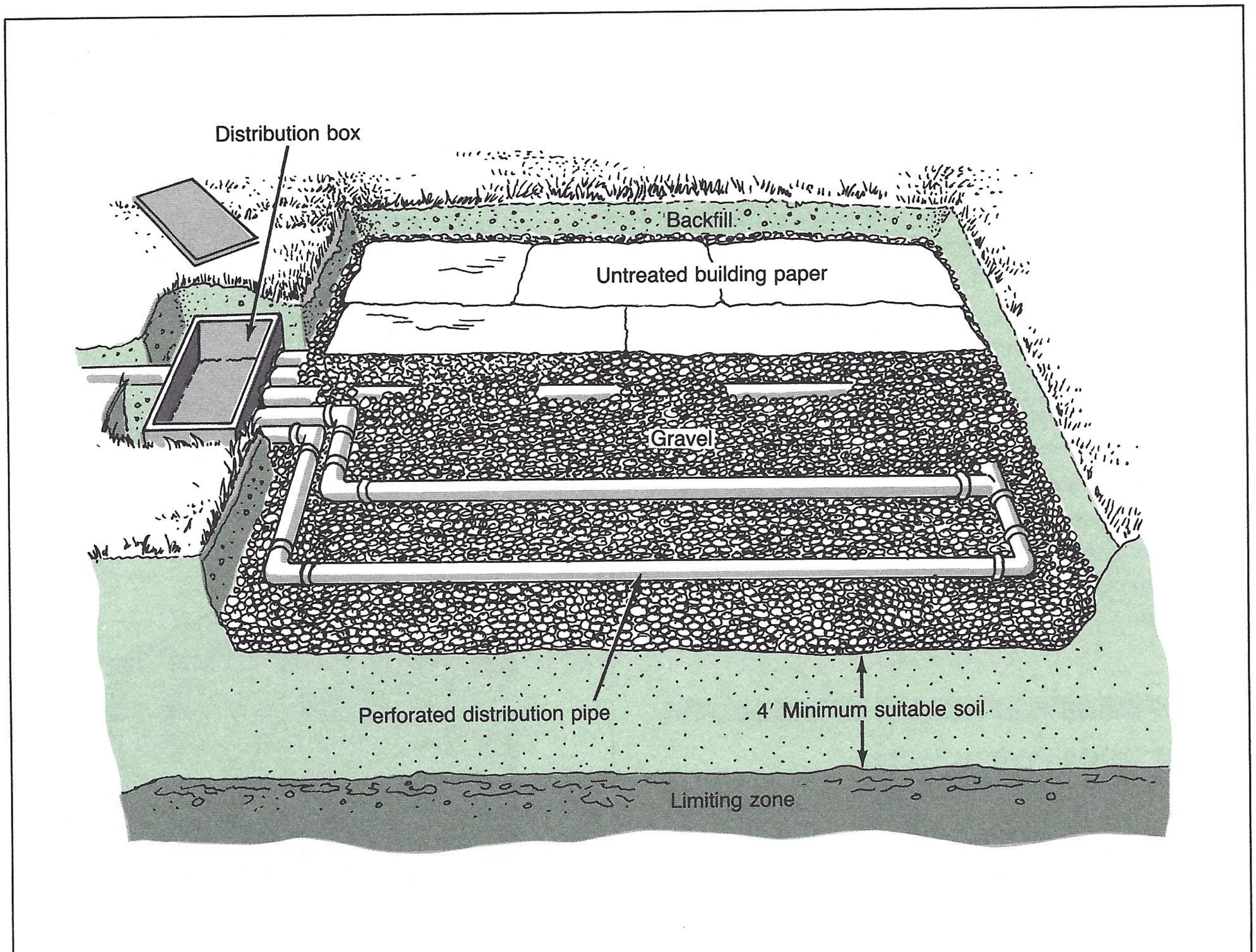


Figure 4. Cut-away view of an absorption bed. (Adapted from: *Home Sewage Disposal,* Special Circular 212, The Pennsylvania State University, College of Agriculture Extension Service, University Park, Pennsylvania.)

Septic-system failures

Two types of septic-system problems are efficiency failure and hydraulic failure.

An efficiency failure occurs when the absorption area doesn't adequately treat the effluent. For example, if the water table is too near the soil surface in the absorption area, effluent may reach the groundwater without passing through enough soil to purify it. The resulting contamination of the groundwater may pose a health hazard if wells draw from this groundwater.

The second type of failure, hydraulic, happens when the absorption area is unable to absorb all the effluent being discharged from the septic tank. The effect is effluent either backing up into the household plumbing or rising to the soil surface above the absorption area. Hydraulic failures also result in efficiency failures since the effluent isn't fully treated.

Several causes of hydraulic failure are

Cause	Example
Improper siting	Trenches or bed placed in an area with slowly permeable soils
Poor design	Too small an absorption area
Faulty construction	Distribution pipes not laid to proper grade
Physical damage	Crushed pipe or compaction of absorption-area soil by heavy equipment
Poor maintenance	Neglect of tank pumping
Soil clogging	Development of a clog layer in the absorption-area soil
Hydraulic overloading	Effluent volume exceeds absorption-area capacity

The cause of hydraulic failure can be diagnosed by the local sewage enforcement officer (sanitarian or county health officer in other states), the official responsible for issuing the permits required to construct or alter a system. The sewage enforcement officer can also recommend ways to correct failing systems.

Although water conservation and absorption-area resting may help correct many types of hydraulic failures, they're most effective on failures caused by *soil clogging* and *hydraulic overloading,* two common causes of failure. For advice on correcting other types of failures or problems with different kinds of systems (such as elevated sand mounds), talk with your sewage enforcement officer. And even if you can use the two technologies discussed here, you should work closely with this official.

Soil clogging

When effluent is continuously applied to the absorption area, a "clog layer" may build up between the gravel and the soil, eventually blocking the flow. The effluent now begins to pond in the trenches and may lead to hydraulic failure. Then part of a lovely lawn becomes a smelly swamp.

Hydraulic overloading

Hydraulic overloading simply means that the septic system is receiving more liquid (effluent or water) than it can handle. When the absorption area becomes "overloaded," it fails.

To reduce this amount of liquid, fix all leaks in the plumbing system and make sure surface water drainage is diverted away from the absorption area. You should also use less water. But homeowners who try to change their water-use habits seldom are successful; changing habits is difficult. In addition, the reduction in water use may be insufficient to eliminate the hydraulic overload. Also, installing water-saving devices that provide only a *small* reduction in water use probably won't be effective either.

Water-saving devices as a remedy

Septic systems that fail because of overloading or because of soil clogging may be corrected by installing water-saving devices in the home. The success of this approach depends on how overloaded the system is. For example, suppose an absorption area is receiving 60 percent more effluent than it can handle. Installing the appropriate water-saving devices may reduce by 35 percent the amount of effluent produced. This won't correct the problem though, since the absorption area still has a 25 percent overload.

In the EPA study, three of the eleven homes with failing septic systems had these water-saving devices installed: low-flow shower heads, faucet-flow-control aerators, air-assisted toilets, and in two of the homes, front-loading clothes washers. Researchers found that water use in the homes declined by 27 percent, 40 percent, and 43 percent. This eased the strain on the failing septic systems, and dried the soggy yards considerably. Two systems no longer failed and problems with the other occurred much less frequently.

Will water conservation work on my system?

To determine if a failing septic system can be corrected with water-saving devices, you first must know the cause of the trouble. Call the local sewage enforcement officer to determine whether the system is failing because of hydraulic overloading, soil clogging, or some other cause. Installing water-saving devices may help if the system is less than 35 percent overloaded.

There is a procedure, not yet scientifically tested, that can be used to determine the amount of overload on a system. Your house must be equipped with a water meter ($50-$75, installed). Use the water meter to measure the number of gallons of water you use in a month, and divide this figure by the number of days in the month to determine your daily water use. During the measurement period you must not use outdoor faucets since that water doesn't enter the septic tank. The average daily water use will equal the amount of effluent the septic system must dispose of every day.

Now you must find out how much the system can actually handle without developing problems. There are two ways to do this; both must be carried out during the wettest time of the year. When the soil is very wet, the absorption area cannot accept much effluent before the system fails; so you'll be simulating the worst conditions.

If effluent bubbles up from a single point above your absorption area you can use this first method. Don't discharge any wastewater into the septic system for eight hours in order to allow the effluent in the absorption area to drain. After eight hours, check the reading on the water meter and turn on a faucet. Watch the spot where effluent usually surfaces. When you see the effluent, turn off the faucet and read the water meter again. The amount of water you add, multiplied by three (since 3 x 8 hours = 24 hours), gives the maximum amount of effluent the absorption area can handle in a day.

Use the following method if you can't pinpoint exactly where the effluent comes to the surface. To compensate for the lack of a single observation point, you need to construct one. You *must* locate the observation point above a trench (or the bed). If you don't have a diagram of the absorption area, look for areas where the grass is lush. A trench is probably located below. Then, in the wettest section, dig a hole (or use a soil auger to drill) down to the gravel. If you dig 2.5 feet without finding gravel, you're probably not above a trench. When you do reach gravel, you'll know immediately —

Water-Saving Devices Explained

The following is a list of some water-saving devices and fixtures with notes explaining how they work. Those marked with an asterisk* can be used in the water-conservation method of fixing septic systems.

Toilets	
*Air-assisted	Compressed air aids in flushing.
*Composting	Doesn't use water; wastes are decomposed.
*Ultra low volume	Gravity flush; designed to use 1 to 1.5 gallons per flush.
Shallow-trap	Redesigned fixture; uses 3.5 gallons per flush.
Tank inserts (dams, plastic bottles)	Displace water in the tank; reduce the volume used per flush.
Showers	
*Low-flow shower heads	Redesigned shower heads; reduce water use without affecting the quality of the shower.
Shower flow-control inserts	Usually neoprene washers placed inside shower arms; restrict the flow of water.
Faucets	
*Faucet-flow-control aerators	Attach to the end of faucets to restrict flows.
Spray taps	Replace faucets in lavatory sinks; produce a shower-type spray that uses less water. Washing up is quicker, too.
Clothes washers	
*Front-loading washers	Tumbling action requires less water.
Top-loading washers w/suds saver	Wash water can be reused.

the hole will rapidly flood with grey, foul-smelling effluent. It may even flow out of the hole; if that happens, wait until the flow stops and the effluent level is at the top of the hole before continuing. In other cases, effluent won't completely fill the hole; mark its level by pushing a spike into the side of the hole at the effluent surface.

After you have a point from which to observe the effluent, turn off the water to your house so that you add no water to the septic system for eight hours. During this time the effluent level will fall. After eight hours, note the reading on your water meter; then while you watch the septic-system observation point, have someone in the house turn on a faucet until effluent rises to the surface (or the spike). Check the water meter. The amount used, multiplied by three, will equal the effluent that can be absorbed in a day.

Now you have enough information to estimate the system overload. The overload percentage is

$$\frac{\left(\begin{array}{c}\text{average daily}\\ \text{water use}\end{array}\right) - \left(\begin{array}{c}\text{amount of water}\\ \text{absorbed in 1 day}\end{array}\right)}{(\text{average daily water use})} \times 100$$

By choosing the proper water-saving devices you can reduce the flow of effluent by about 35 percent. So if the "percentage overload" is less than 35 percent, installing the water-saving devices should correct the failure. However, in some cases, occasional malfunctions may still occur.

An example of water conservation calculations

Henry and Helen Homeowner have a failing septic system. Their yard is a mess. They call their sewage enforcement officer who tells them, after an inspection, that the cause is hydraulic overload. The Homeowners want to find out if installing water conservation devices will correct the problem.

First they must determine their average daily water use. Their home has no water meter, so they have one installed and find they use 8100 gallons in a month. Their average daily water use is

$$\frac{8100 \text{ gallons}}{30 \text{ days}} = 270 \text{ gallons per day}$$

Next they determine the capacity of their absorption area. Harry digs a hole in the wettest spot above a trench. Effluent completely fills the hole. That night the Homeowners plan not to use any water for the eight hours between 11 p.m. and 7 a.m. Shortly before eleven Harry notes the effluent level — the top of the hole — and turns off the water supply. During the night the effluent level in the hole drops. The next morning at seven o'clock the Homeowners record the reading on their water meter and turn on an indoor faucet to add water to their septic system. When the effluent level reaches the top of the hole they read their water meter again to find out how many gallons were used: 72. This means that 72 gallons of effluent drained from the absorption area in eight hours. They triple that figure and find that their absorption area can handle a maximum of about 216 gallons of effluent per day.

With this information they can determine if water-saving devices will correct their failing septic system. If their daily use is 270 gallons and their absorption rate is 216 gallons, their percent overload is estimated to be

$$\frac{(270 \text{ gallons}) - (216 \text{ gallons})}{(270 \text{ gallons})} \times 100 = 20 \text{ percent}$$

If the Homeowners install the proper water-saving devices, they can reduce their overload by about 35 percent. This method should correct the septic-system problem. They need the full 35 percent reduction since the estimated overload is an *average;* on some days the overload will be more than 20 percent.

Water-saving devices

To reduce water use, you can install various water-saving devices — they can be additions to existing fixtures or totally new, redesigned fixtures. Table 1 compares typical water use by conventional fixtures with water use by water-saving devices. The toilet and shower account for nearly 70 percent of the water used in most homes. Devices that substantially reduce these flows have the greatest impact on the septic system.

Cost

The initial cost of equipping a home with water-saving devices may be quite high. Costs vary ac-

Table 1. Water use by conventional fixtures and water-saving fixtures/devices.

Conventional fixture	Gal. used[1]	Water-saving[2] fixture/device	Gal. used[1]
Toilet	4-6	air-assisted toilet	0.5
Shower head	4-6	low-flow shower head	2.1
Faucets		faucet-flow-control aerators	
bathroom	4-6	bathroom	0.5
kitchen	4-6	kitchen	1.5
Top-loading clothes washer	40-55	front-loading clothes washer	22-33

[1]Toilets — gallons per flush.
Shower heads and faucets — gallons per minute.
Clothes washer — gallons per use.

[2]Installation of *all* these devices should reduce water use by about 35 percent.

cording to the number of devices required and the models selected. In the EPA study, costs (including installation and adjusted to 1988 dollars) for equipping the three homes with high-level water-saving devices were $1,643, $1,906, and $2,436 (see table 2).

To keep these figures in perspective, remember that the cost of installing a new absorption area is about $2,000, *if* the area is suitable. Often the house lot is too small to accommodate another absorption area. And even on those lots that have adequate space, construction of another conventional absorption field may not be wise. If the first absorption area failed because of soil clogging, it's likely the second one will fail also.

Although the initial cost is high, water-saving devices eventually pay for themselves because they reduce water and energy bills. Heating water is the second largest energy use in the home, and water-saving devices, with the exception of toilets, reduce the amount of hot water used.

Table 2. Water saving devices used in the EPA study (costs adjusted to 1988 dollars).

Device	Water[1] use	Manufacturer/ distributor	Device cost($)
Faucet-flow-control aerators			
kitchen	2.5 gpm	Moen[2]	4.65
kitchen	1.5 gpm	Omni Products[2]	5.30
bathroom	0.5 gpm	Chicago Faucet	8.30
Low-flow shower heads	2.3 gpm	Vanderburgh Enterprises	8.00 to 15.00
	2.1 gpm	Resources Conservation[2]	
Front-load clothes washer	30.0 gal.	White-Westinghouse	620.00
Air-assisted toilet	0.5 gal.	Microphor	950.00[3]
Toilet dams	3.0 gal.	NY-DEL Corp.[2]	6.00

[1]Manufacturer's ratings.
[2]Not used in study.
[3]Includes labor ($100), air compressor, and parts.
gpm: gallons per minute.

Choosing the devices

To maximize water savings, select devices that significantly reduce water consumption — to approximately the levels shown in table 1. Such units are available from various manufacturers in a broad price range. Further, different types of devices may achieve similar levels of reduction. For example, the Microphor toilet, an air-assisted unit, reduces flows to about 0.5 gallons per flush. It requires an air compressor. An ultra low-volume toilet, eg. Eljer's Ultra-One/G, uses about 1.5 gallons per flush; it is less expensive than the Microphor and uses a standard gravity flushing system. Both toilets have performed satisfactorily.

If you're considering installing water-saving devices, see the materials listed at the end of this publication. Also read the manufacturers' literature and talk to your sewage enforcement officer and friends and neighbors who have water-saving devices.

Other factors to consider are

- Expected amount of water reduction
- Initial cost
- Installation cost
- Maintenance
- User acceptability
- Design life
- Service availabilty

Absorption-area resting as a remedy

A second method of correcting failing septic systems examined by the EPA study was absorption-area resting. The results indicated that septic systems failing as a result of soil clogging could function again after resting the absorption area. During the rest period, the clog layer breaks down and allows the effluent to drain. An absorption area is rested by removing it from active use for six months to a year. During this time an alternate trench system can be used (see figure 5).

Water-saving devices also should be installed. But since they are not being solely depended on to correct the problem, they don't have to reduce water consumption drastically. Instead of buying an expensive water-saving toilet, you can use inexpensive toilet dams in your present toilet. (An even less expensive alternative is to use clean plastic bottles weighted with stones. Placing these bottles in the toilet tank displaces water so that less is used per flush.) And it isn't necessary to buy a front-loading clothes washer, although you may want to consider one when your present machine needs to be replaced.

In the EPA study, the absorption areas of three failing septic systems were rested for ten months.

Each home also had these devices installed:

- Toilet dams
- Low-flow shower heads (2.1 gal./min.)
- Faucet-flow-control aerators
  (0.5 gal./min. in the bathroom)
  (2.5 gal./min. in the kitchen)

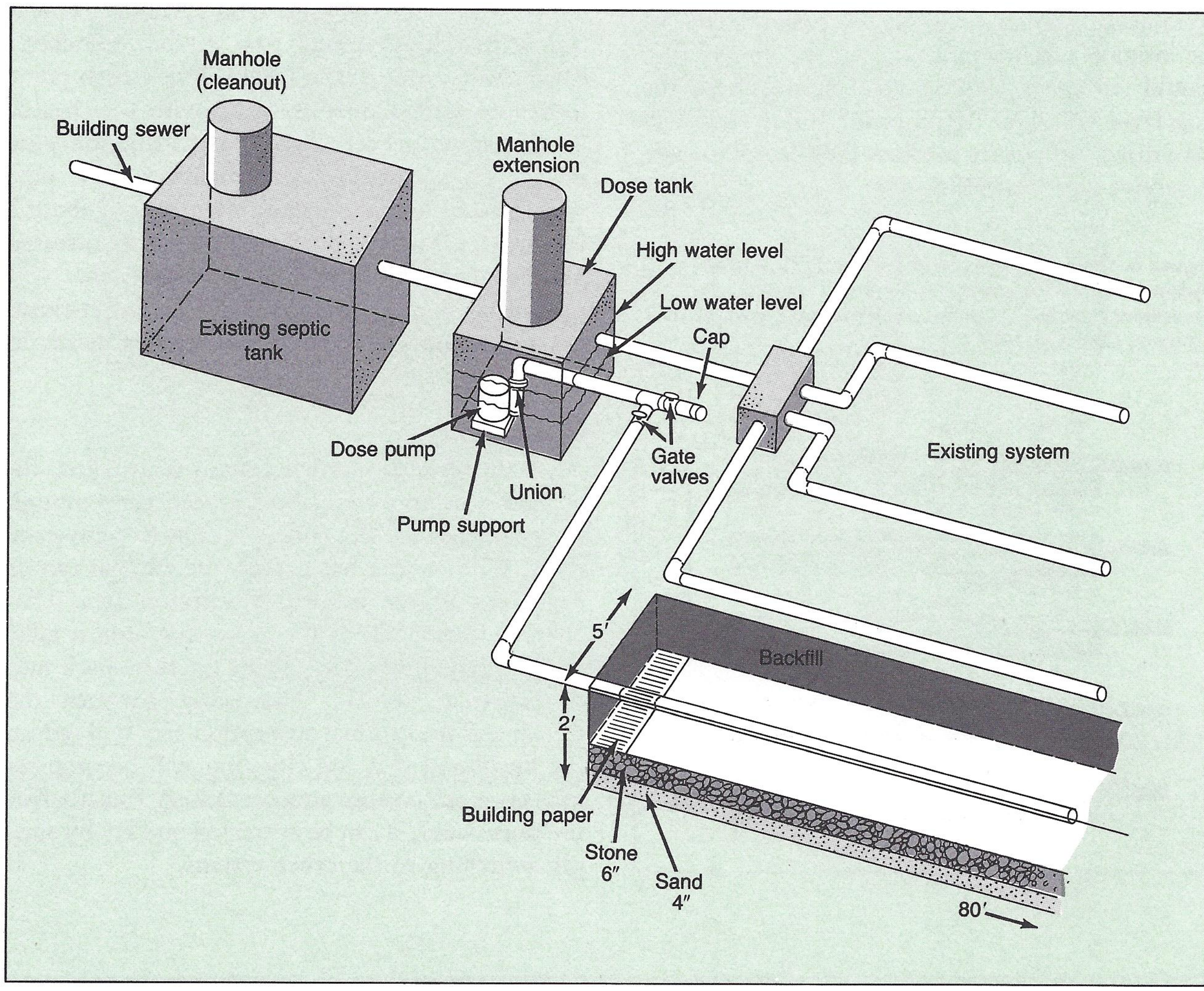
This group of devices reduced water use in the three homes by an average of 16 percent, 19 percent, and 33 percent. During the rest period, effluent was pressure dosed into an alternate trench. The flow of effluent from the septic tank was diverted to a dose tank where a sewage pump periodically moved a dose, or set amount of effluent, into the alternate trench. After the rest, effluent was redirected to the original absorption areas. They worked again — no more swampy yards. And even after more than a year of use, the absorption areas were working properly. Researchers concluded that the test was a success in these three systems.

Cost

The cost of the alternate trench system used was $2,637 (not including a warning system, at a cost of about $140, for the dose tank and pump). The itemized cost in 1988 was

Pump existing septic tank	$92
Dose tank and sewage pump	678
Plumbing and wiring	790
7 tons gravel and 3 tons sand	93
PVC pipe	37
Excavating, trucking, etc.	902
Alternate trench, subtotal	$2,592

Figure 5. The alternate trench system. (Adapted from: *Restoration of Failing on-Lot Sewage Disposal Areas,* Environmental Resources Research Institute, The Pennsylvania State University, University Park, Pennsylvania.)

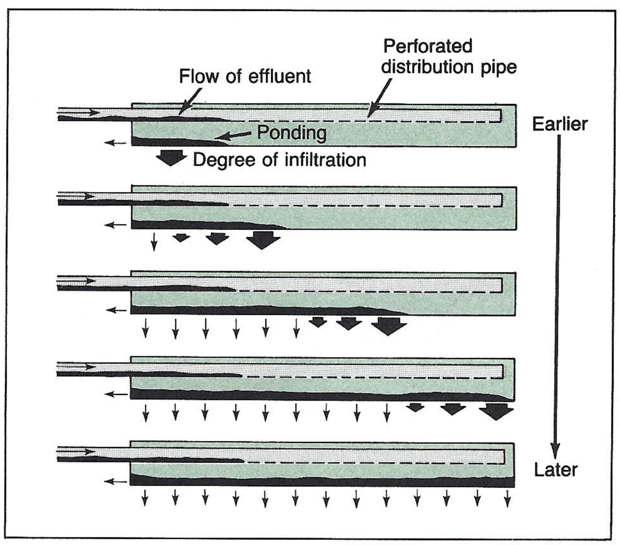


Faucet-flow-control aerators	
bathroom — 0.5 gal./min. (2)	$11
kitchen — 2.5 gal./min.	4
Shower heads — 2.1 gal./min. (2)	16
Toilet dams (2)	14
Water-saving devices, subtotal	$45
Total cost of treatment	$2,637

Advantages of the alternate trench system

The cost of installing an alternate trench system is about the same as constructing a new absorption area, but the problems aren't as severe. First, the alternate trench requires much less space than a conventional absorption area. Second, pressure dosing keeps the trench from being constantly saturated. This method helps prevent soil clogging and a condition known as creeping failure in which the beginning of the trench becomes clogged first and gradually the entire length is affected (see figure 6). Third, the homeowner can periodically switch between the two systems so the original absorption area can be rested if it should fail again. After several months rest, the clog layer will have decomposed and the soil will have dried sufficiently to allow the absorption area to receive and treat effluent.

Figure 6. Creeping failure of an absorption area. (Adapted from: *Alternatives for Small Wastewater Treatment Systems,* U.S. Environmental Protection Agency, October 1977.)



Installation

Before beginning any work you need a permit from your sewage enforcement officer. The permit will be issued for an "alternate sewage system" since alternate-trench design specifications aren't covered by the standard permit.

To install an alternate trench system similar to that shown in figure 5, pump the septic tank and use sewer pipe to connect it to a 500-gallon concrete dose tank. The dose tank houses a sewage pump (see figure 7); consult your sewage enforcement officer to find out what size you need. (The pumps in the EPA study were one-third horsepower and 16 gallon/minute at 16 feet of head.) Set the pumping system so that when a 120-gallon dose of effluent accumulates the pump switches on and empties the dose into the alternate trench. Make the trench one-half the total (in square feet) of the original absorption area or 400 square feet, whichever is greater. For example, a trench with an area of 400 square feet would be 5 feet wide and 80 feet long. (If your yard won't accommodate a trench that long, install two 40-foot trenches.) Over the bottom of the 2-foot-deep trench put 4 inches of sand. Cover the sand with 6 inches of 2B-limestone gravel. Place the distribution pipe on the gravel; use a 2-inch diameter PVC pipe with 3/16-inch holes (facing down) spaced about 3 feet apart. Cover the pipe with a layer of untreated building paper and then backfill the trench.

And finally, install toilet dams, faucet-flow-control aerators, and low-flow shower heads in your home.

Operation

After the alternate trench system is installed, divert effluent into it for about a year, time enough in most cases for the failing system to rejuvenate itself. When a year has passed, the effluent can be redirected to the original absorption area. Discharge effluent into it for a year (or until it fails, whichever is first), then divert the flow back into the alternate trench. Alternating between the trench and the original absorption area will reduce the likelihood that soil clogging will become severe enough to cause another failure. But if a failure does occur, it can be corrected quickly by simply switching to the other system.

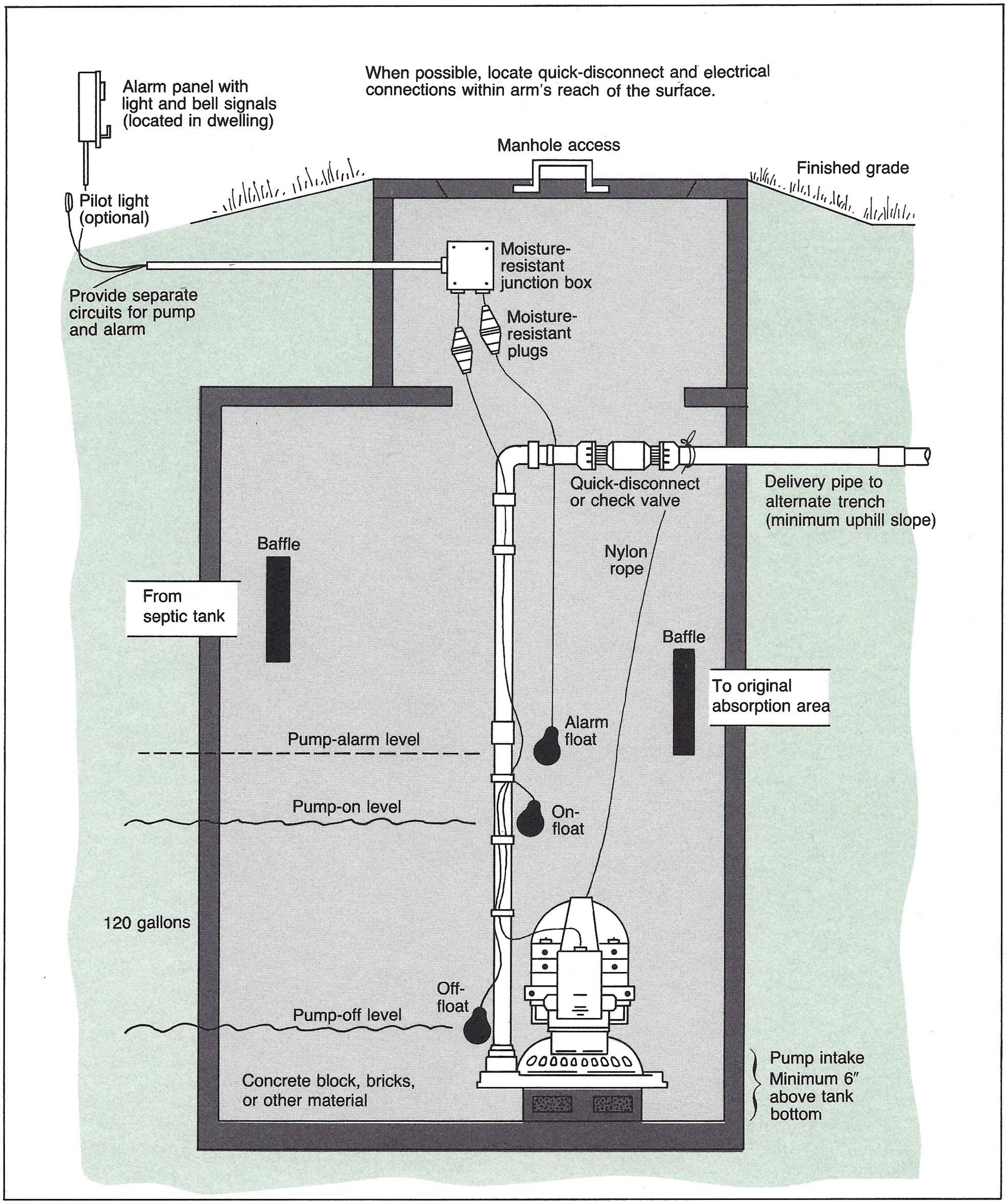


Figure 7. Cross section of a 500-gallon dose tank with pump. (Adapted from: *Technical Manual for Sewage Enforcement Officers,* Commonwealth of Pennsylvania, Department of Environmental Resources, 1983.)

Additional information can be obtained from the following publications:

Saving Money with Home Water Conservation Devices: Environmental Resources Research Institute
The Pennsylvania State University
University Park, PA 16802.

Listing of Water-Saving Plumbing Fixtures:
Department of Environmental Resources,
Office of Resources Management,
P.O. Box 2063,
Harrisburg, PA 17120.

Prepared by Joseph R. Makuch, water quality project associate; William E. Sharpe, associate professor of forest hydrology; and Albert R. Jarret, professor of agricultural engineering.

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