Choosing an Alternative Septic System for a Homesite with a Steep Slope

WATER RESOURCES CENTER AND BIOSYSTEMS AND AGRICULTURAL ENGINEERING

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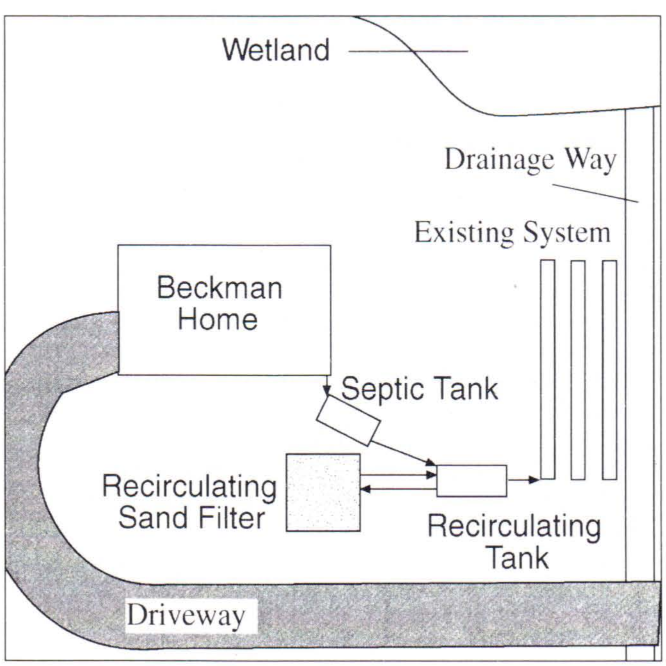
Problem Overview

Homeowners in Apple Valley knew their septic system was not working properly because water surfaced in their backyard. The septic system had been built along a hillside that had been graded and then backfilled with topsoil (figure 1). This caused problems because fill is generally less permeable than the original soil and it is likely that the previously installed trenches were too small to accommodate the load of household wastewater. Water was seeping up to the ground surface, particularly in the winter months.

Although they hadn't been cited for a failing system, the homeowners wanted to do the right thing and decided to upgrade their system to bring it into compliance with current standards. They wanted to minimize the human health and environmental risks that might result from inadequate sewage treatment.

The site in Apple Valley has a steep slope without adequate space in which to locate a new drainfield. Thus, the homeowners' options for a replacement system or additions to the existing trenches were limited. By providing additional treatment for effluent before it reaches the drainfield and conserving water, they hoped to rejuvenate the current trenches.

Figure 1. Map of the site in Apple Valley



Because the City of Apple Valley does not have many on-site systems, the homeowners worked with inspectors from Rosemount to ensure proper installation, inspection, and approval. As a general rule, the local government unit (LGU) should always be contacted early in the process to get approval.

Project Specifications

Location—Apple Valley.

Problem—seepage in backyard, slow acceptance of wastewater.

Reason to upgrade—homeowners wanted to "do the right thing."

Site limitations—steep slope.

Type of system—recirculating sand filter (RSF).

Installation cost—$8,200 including RSF and new septic tank and trenches.

Installation time—two days.

Unit size—10 ft x 10 ft RSF.

Capacity—600 gallons per day.

Effectiveness—excellent.

Monitoring—one hour/month to verify proper operation.

Annual maintenance—tank pumping and cleaning.

Effluent quality goals

- less than 20 mg/L BOD*
- less than 20 mg/L TSS*
- less than 10,000 coliform* bacteria/100mL

* See table 1 on the back page for definitions

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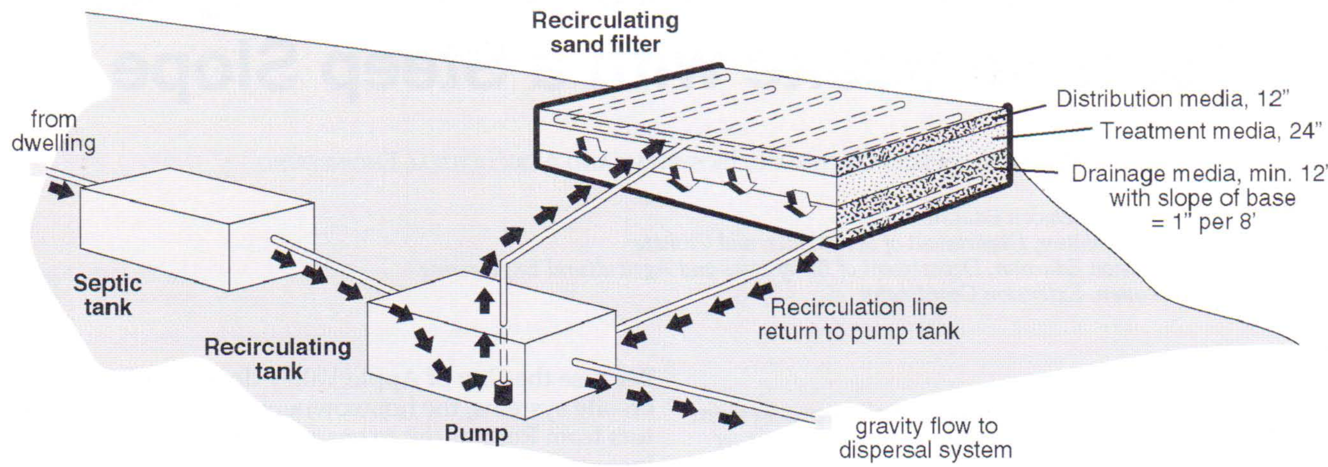
Figure 2. Septic system design using a recirculating sand filter



Why Did the Homeowners Choose this System?

Because the treatment trenches at the Apple Valley site were failing to accept household sewage, the homeowners needed a system that would significantly reduce the pathogens present in the sewage *before* the sewage was discharged to the drainfield. At this location, either an aerobic tank or a recirculating sand filter (RSF) system would be appropriate. Experimental studies have shown that an RSF is very effective at treating wastewater. The treated effluent is dispersed from the sand filter through a drainfield trench system.

The homeowners chose an RSF for several reasons:

- it would provide excellent wastewater treatment in situations where flow varies widely;
- it is the least expensive option for the site;
- it is a small system, so installation would not disturb much of their lawn; and
- it required less mechanical equipment than some aerobic tank systems.

System Design

An RSF was installed into the existing system between the septic tank and the drainfield. Wastewater moves from the house into a septic tank where solids settle out and some of the organic matter decomposes (figure 2).

Liquid effluent then moves to the recirculation tank and from there to the sand filter. The effluent is pumped repeatedly through the sand filter for treatment and then flows out via gravity overflow to the drainfield. The system was designed to recirculate effluent through the filter at least five times before it is discharged into the trenches for final treatment.

When wastewater enters the system from the house, an equal amount is forced out into the drainfield. A gravity overflow system ensures that the recirculating tank does not drain completely and dry out, which would kill the bacteria in the tank and allow the system to freeze in the winter.

Samples were collected from the recirculating tank to verify the system was properly treating the wastewater. Usually, homeowners contract with a professional to collect and analyze samples. For the next two years, however, the University of Minnesota will conduct the sampling.

RSFs require regular observation and maintenance to make sure the timer control is working properly. If the timer control fails, the RSF will *not* treat wastewater, although there may be no obvious signs untreated sewage is reaching the drainfield. Eventually, however, sewage would come to the surface.

If you are considering an alternative system, it is extremely important you estimate typical flows from *your* household and make sure the system you install is properly sized, designed, inspected, and maintained.

Installation and Costs

Installing an RSF at the Apple Valley site caused minimal disturbance to the homeowners' yard. Installation took two days and the system was operational immediately. However, it took several weeks for grass to reestablish over the area where the filter was installed. The final cost of the system was $8,200.

Treatment Effectiveness

To determine whether a particular system is working properly, several laboratory procedures are usually done to determine how effectively the system is treating wastewater. Biochemical oxygen demand (BOD) is the most widely used test. BOD measures the amount of dissolved oxygen used by microorganisms in the oxidation of organic matter in sewage. Total suspended solids (TSS) is a measure of the organic and inorganic solids that remain in wastewater after separation occurs in the septic tank. There are many pathogenic (disease causing) organisms present in wastewater that are difficult to isolate and identify. The human intestinal tract contains coliform bacteria, which are passed with feces, and the presence of these bacteria in wastewater suggests that pathogenic bacteria may also be present.

The treatment goals of the Apple Valley project are to achieve 20 milligrams per liter (mg/L) BOD, 20 mg/L total suspended solids (TSS), and fewer than 10,000 most probable number (MPN) of coliform bacteria per 100 milliliters (mL) of wastewater. To date, the system has performed well but has not reached the desired treatment goals. At present, the median values are as follows: BOD is 21 mg/L, TSS is 25 mg/L, and there are 200,000 MPN coliform bacteria/100 mL. However, a high level of treatment is being achieved in the RSF because 88–93 percent of contaminants are being removed. In addition, 56 percent of the total nitrogen and 32 percent of the total phosphorus are also being removed. The recirculation rate could be increased to improve treatment, and an effluent filter could be added to the septic tank to limit the amount of TSS.

Because the ultimate goal of this system is the renovation of an existing system, the performance of the trenches is the real measure of success. Since installing the RSF in Apple Valley, the trenches and drainfield have operated properly.

On-Going Maintenance

Initially, any RSF will require weekly maintenance, which can be reduced to monthly inspections after a few weeks and an annual inspection after six months—if the system is operating properly. An RSF requires regular attention to ensure the timer control is working. Unlike a more traditional septic tank and drainfield system, an RSF system cannot be completely ignored between maintenance appointments. An alarm was placed on this system to inform homeowners when a problem exists.

Septic tanks need regular cleaning, just like a traditional system. The *Septic System Owner's Guide* can help you calculate the required pumping frequency—based on how much water your household uses.

The pump (costing $400–500) will probably need to be replaced at some time in the next 20–30 years. Because an RSF is so effective at treating waste, the life of the drainfield may be extended.

In addition, homeowners will have to pay for regular monitoring of effluent. Because an RSF is designed to treat wastewater *before* it enters the drainfield and groundwater, you must make sure the system is working correctly. Check with your LGU to find out whether it requires a contract agreement for monitoring.

County Contact

For more information about requirements and guidance concerning alternative systems in your county, contact your county planning and zoning department. In the seven-county Twin Cities metropolitan area, you may call the Metropolitan Council at 651-602-1005 for assistance in identifying the correct local office. In greater Minnesota, check with your county Extension office.

Additional Resources

Septic Systems Revealed: A Guide to Operation, Care, and Maintenance. Item number: VH-6768-WRC. $15.00.

This video describes the basics of septic systems, including system features, safety, use, operation, maintenance, and troubleshooting. It also serves as a stand-alone resource, or may be purchased in a package along with written material titled *Septic System Owner's Guide*, item number EP-6769.

Septic System Owner's Guide. Item number PC-6583-WRC. $4.00.

A fully illustrated guide for owners of septic systems. Includes information on safety, system features, use and operation, maintenance, and troubleshooting.

Ordering Information

To order Extension educational materials, call 1-800-876-8636 or contact your county Extension office.

To find more information about Extension publications (including quantity discounts), point your browser to www.extension.umn.edu.

Septic System Package Available

A video was developed to accompany this and other septic system publications, or is included if you ordered package EP-7572. The video documents the construction of three alternative systems (including the one described here) and the reasons for selecting each type. It also includes interviews with homeowners and experts.

Table 1. Summary of Alternative Treatment Options

Single-Pass Sand Filters

Single-pass sand filters treat pathogens well, which is especially important when a system must be placed less than three feet above the water table or bedrock. Because sand filters have been in use for a long time, system design and reliability are well established. The materials needed to make a sand filter are readily available in Minnesota.

Recirculating Sand Filters

RSFs use similar principles as sand filters—with a few differences. The materials in an RSF are coarser (in comparison to a single-pass sand filter) and do not remove feces as effectively. A fine gravel is often used. They are also loaded at a much higher rate and are therefore smaller. RSFs remove a significant amount of nitrogen.

Peat Filters

Peat filters remove pathogens effectively and remove some nutrients as well. They are sometimes sold as manufactured containers, allowing for flexibility of design. Because the medium has an organic base, it breaks down over time and will need to be replaced every 10–15 years, which is significantly more often than a sand filter. A disadvantage of peat filters is that the ready-built containers must be placed above the ground surface to breathe, where landscaping may be required to disguise them.

Constructed Wetlands

Constructed wetlands use native plants to aid in treatment of wastewater. A wetland system is not as effective as a sand or peat filter, and requires a significantly larger area. It may not be as effective as some of the aerobic tanks. Performance varies seasonally and, in Minnesota, a wetland system performs much better in the summer than in the winter. Vegetation is a significant part of the treatment process and therefore must be maintained and managed.

Aerobic Treatment Units

Aerobic treatment units (ATUs) are single tanks that require less space than sand and peat filters or constructed wetlands. They can handle different strengths of wastewater with adjustments to air flows and configuration. However, all of the mechanical pieces need to be correctly maintained for proper treatment to occur. Studies done in Wisconsin have shown a large degree of variance in terms of ATU operation and maintenance that greatly affected how well they perform. Electrical costs are usually higher than those of the other systems.

Separation Technologies

Separation technologies and non-water toilets allow homeowners to reduce water use and install a smaller system. Reducing water use may provide a cost savings in itself. Taking toilet waste out of the system through a composting toilet removes about 70 percent of the nitrogen along with other nutrients. These systems may require extensive plumbing changes in an existing residence. A significant increase in management is needed to operate the unit and handle the solids from the composting tank.

Treatment options	BOD (mg/L)	TSS (mg/L)	Coliforms (MPN/100mL)	Nitrogen (% removal)	Phosphorus (% removal)
Septic tank effluent	175	60	1 million to 1 billion	0	0
Aerobic tank	25	30	200–10,000	0**	0
Sand filter	10	10	0–1,000	10–15	10
RSF	10	20	200–100,000	30–40	10
Peat filter	10	10	0–1,000	5	10
Constructed wetland	20	20	200–10,000	30–40	30–40
Separation technology	150*	50*	1,000 to 1 million*	70	0

* greywater

** Some ATUs may remove nitrogen, but not all are designed to do so.

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