Article 124

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Recirculating Sand Filters: An Alternative to Conventional Septic Systems

by Rich Piluk and Ed Peters, Sanitary Engineering, Anne Arundel County (MD) Health Department

Many water quality problems have been associated with residential septic systems, mostly as the result of poor siting or maintenance. However, even systems operating according to design may discharge excessive pollutant loads that can impact nearby waterbodies (see article 123). In coastal areas, this is often particularly true with nitrogen. As a result, efforts to develop systems which show the potential for improved nitrogen removal potential have been intensified. One residential system which shows promise is the small recirculating sand filter, used primarily in Anne Arundel County for the repair of failing conventional systems (Figure 1).

When used alone, sand filters nitrify septic tank effluent, increasing ground and surface water mobilization. This problem can be resolved if the nitrates are sent through an anaerobic environment rich in organic matter. Under such circumstances, denitrifying bacteria reduce nitrates to nitrogen gas, effectively reducing threats to water quality. Recirculating sand filters, which allow nitrified sand filter effluent to mix with organic-rich septic tank effluent, provide this needed denitrification service.

Traditional waterfront development has often occurred on small lots with high water tables that are now considered unsuitable for conventional septic systems and therefore conducive to their failure. Recirculating sand filter systems can be extremely useful in mitigating this problem; in addition to having denitrifying ability, the systems can be easily placed in areas with slowly permeable soils, inadequate unsaturated soil buffer zones, and/or insufficient room for a conventionally-sized soil absorption area. Some homeowners choose to plant trees and shrubs around the exposed structure or use the wood top as a deck.

Typically, wastewater first enters a 1,500-gallon two-compartment septic tank and then flows to a 500-gallon pump chamber. With a two-compartment septic tank, the second compartment can be used as a denitrification chamber for the mixing of septic and sand filter effluents. It is also possible to use the first compartment of a two-compartment septic tank or a single compartment septic tank for denitrification. Limited observations of these systems have had results similar to the two-compartment design. Mixing and denitrification could also be accomplished in the pump chamber if it is of sufficient size.

It is recommended that a pump chamber of at least 500 gallons be used to permit the use of a timer. Holding capacity in the pump chamber makes it possible to store wastewater surges and dose the sand filter in brief intervals throughout the entire day. A low-level float ensures that the pump does not run dry and a high-water level alarm is used to signal the homeowner that either an abnormally high volume of water is being pumped or there is a pump problem.

The pump then sends treated effluent to the sand filter (Figure 2a). The filter is built for free access and has only 45 ft^2 of surface area when used to treat the wastewater from a single family home. A 2,000-gallon center seamed concrete septic tank was selected as the sand filter container because it was readily available and could be placed completely out of the ground when necessary.

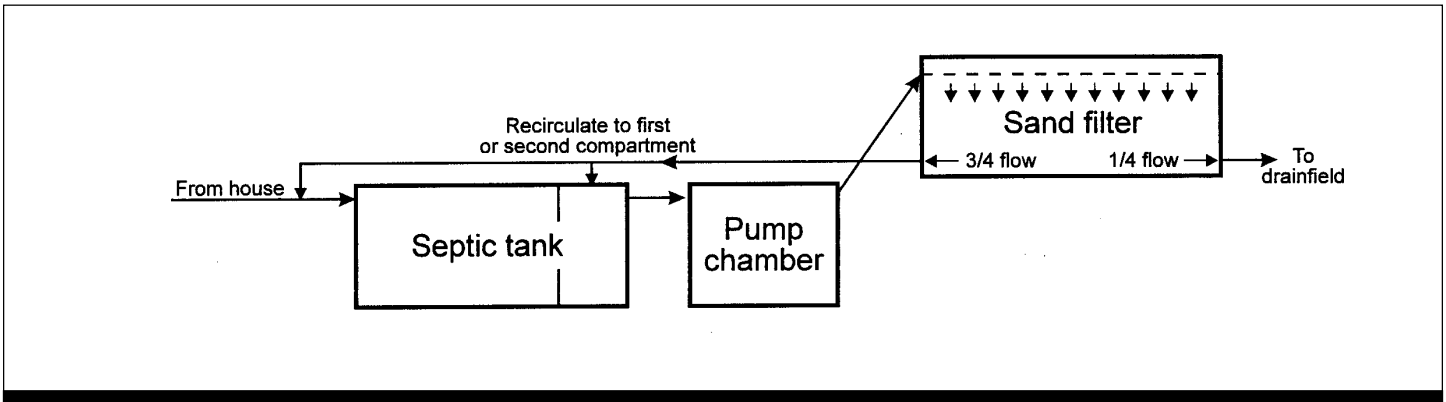

Figure 1: Schematic of a Recirculating Sand Filter

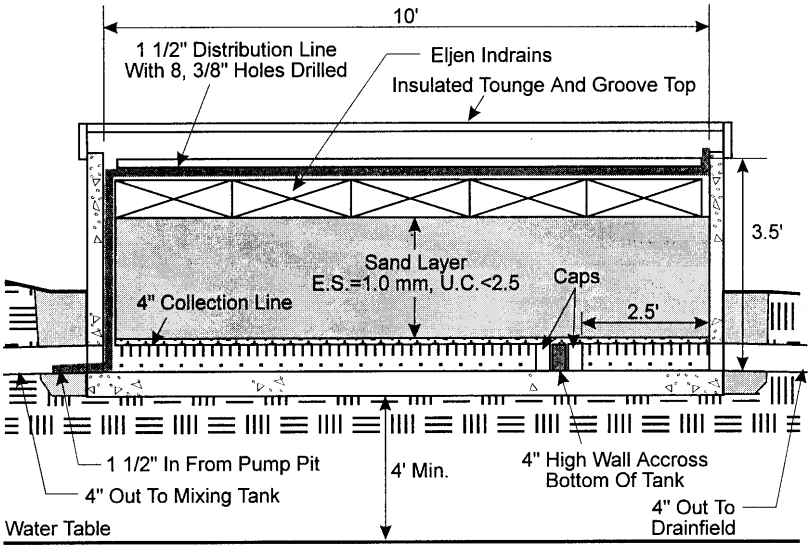

Figure 2a: Sand Filter—Length Cross-Section

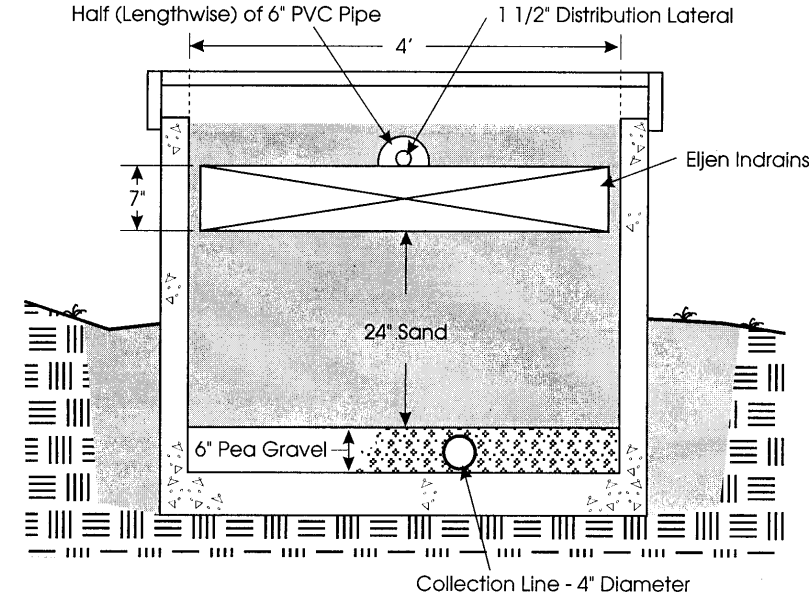

Figure 2b: Sand Filter—Width Cross-Section

Wastewater is pumped into the sand filter through a small diameter PVC lateral pipe that rests on a lightweight wastewater distribution network, such as Eljen indrains (Figure 2b). Relatively large holes are regularly spaced along the top of the lateral, which is covered by a pipe that is cut in half lengthwise. Wastewater is pumped up through the holes in the lateral, hits the underside of the pipe half, and is distributed evenly over the length of the sand filter.

A four-inch high brick and mortar wall extends across the interior width of the tank, dividing the bottom so that approximately 75% of the area is on one side of the wall. The purpose of the wall is to divide the flow after it has percolated through the sand filter. If the flow is applied evenly over the length of the sand filter, 75% of the effluent can recirculate back to mix with anaerobic wastewater, creating conditions for denitrification.

Effluent treatment in the sand filter depends upon microorganisms; as a result, the process can be adversely affected by cold temperatures. The system has performed well during a month with an average daily temperature of -2˚C. For areas that experience colder monthly temperatures, additional precautions could be taken, such as using better insulating materials at the top of the filter, adding insulation to the internal sides of the filter, placing earth around the sides, or, if site conditions allow, placing the filter deeper in the ground.

More than 150 recirculating sand filters have been installed in Anne Arundel County. Performance data have given promising results, showing pollutant removal efficiencies greater than those observed with conventional systems (Table 1). The performance of these systems is especially encouraging since they can operate for several years without maintenance and cost about the same as conventional systems. Experience with recirculating sand filters has revealed several instructive findings, several of which are listed in Table 2.

It is significant to note that the utilization of advanced septic systems is possible in Anne Arundel County because proposed system sites are thoroughly evaluated and homeowners are given incentives, such as building permit exceptions, for replacing existing systems with recirculating sand filters. If systems were routinely approved without concern for the protection of ground and surface waters, there would be no incentive to advance the design of septic system alternatives. Due to the difficulty of extending sewers in the county, there will be a growing need for septic systems that reduce nitrogen loadings to the environment, require less room to install, and are readily maintainable. Small, free-access, recirculating sand filters suggest a way to address those needs.

However, practitioners should beware of placing all reliance on one type of septic system. As always, site

Table 1: Performance of Three Recirculating Sand Filters in Anne Arundel County, MD

	Pollutant*	System A** (7 residents 340 gal/day)	System B† (2 residents 100 gal/day)	System A†† (2 residents 100 gal/day)	Average
Septic Tank	BOD	215	124	366	235
	Susp. Solids	72	56	97	75
	Total Nitrogen	54	45	71	57
	Fecal Coliform	$3.9x10^6$	$1.7x10^5$	$1.0x10^7$	$1.8x10^6$
Sand Filter	BOD	4	2	8	5
	Susp. Solids	8	5	10	8
	Total Nitrogen	22	17	21	20
	Fecal Coliform	$3.4x10^4$	240	$9.5x10^4$	$9.2x10^3$
Percent Reduction from Septic Tank	BOD	98	98	98	98
	Susp. Solids	89	90	90	90
	Total Nitrogen	59	62	70	64
	Fecal Coliform	99.1	99.86	99.0	99.3

* Fecal coliform is presented as geometric average in organism per 100 ml. All other units are mg/L.
** Average of 28 sampling dates from August 1992 to March 1994.
† Average of 22 sampling dates from July 1990 to October 1993.
†† Average of 39 sampling dates from June 1987 to June 1993.

conditions must take priority when it comes to system selection. Care should also be taken to ensure that the use of recirculating sand filters does not override quality growth management planning.

References

Piluk, R.J. and E.C. Peters. 1994. *Small Recirculating Sand Filters for Individual Homes*. Anne Arundel County (MD) Health Dept.

Table 2: Findings Related to Recirculating Sand Filter Systems

- It is critical to use water-tight septic and pump tanks
- No special media are generally necessary in denitrification areas
- Filter cloths embedded at different depths in a sand filter tend to clog
- Having pumps on timers can warn homeowners of plumbing problems (e.g., leaking toilets) and identify groundwater infiltration problems
- Wastewater rising above the top seam in concrete septic and pump tanks can leak out without causing a clearly observed backup or overflow
- The use of advanced pretreatment can allow the use of smaller final absorption areas