COMMUNITY ENVIRONMENTAL SERVICES, INC.
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Community Environmental Services, Inc. (CES) is a small civil-environmental engineering firm specializing in decentralized and small community wastewater systems planning and design. The company is owned and operated by Susan M. Parten, P.E., with engineering services provided by Ms. Parten and James Griffith, P.E. CES is based in Austin, Texas, and conducts business in both Texas and the U.S. Virgin Islands. CES designs wastewater systems ranging in size from single family residential to large commercial or community scale systems serving hundreds of properties. CES works with design clients to determine the most appropriate and cost-effective method of wastewater service, depending upon specific conditions and local regulatory requirements. The firm has conducted a variety of research and monitoring project work associated with decentralized and small community wastewater systems. CES also works with state/territiorial and local governments in wastewater planning and regulatory efforts such as the development of technical standards and rules/policies.

Information about several types of treatment systems has been provided on the following pages. The most suitable type(s) of treatment needed for a particular site or setting will depend on a number of factors and site conditions. Therefore, a physical engineering site evaluation should be conducted in the preliminary planning phase. For individual residential sites and larger commercial projects, it is best if the wastewater engineering design consultant can coordinate early in the planning stages with the architect to determine the best and most cost-effective locations for the wastewater system components and the building structures on the site.

Any of the treatment processes described herein may be used for small or larger scale decentralized wastewater systems, including clustered or small community systems, although some systems may be better suited for a particular application or setting. Advantages and potential disadvantages of the various processes are provided for each type of system. Systems and controls can be configured to meet the specific needs of the site and seasonal conditions, including power outages. Subsurface dispersal of effluent using dosing siphons, and controls on timers can be used effectively if configured properly for power outages and other abnormal operating conditions.

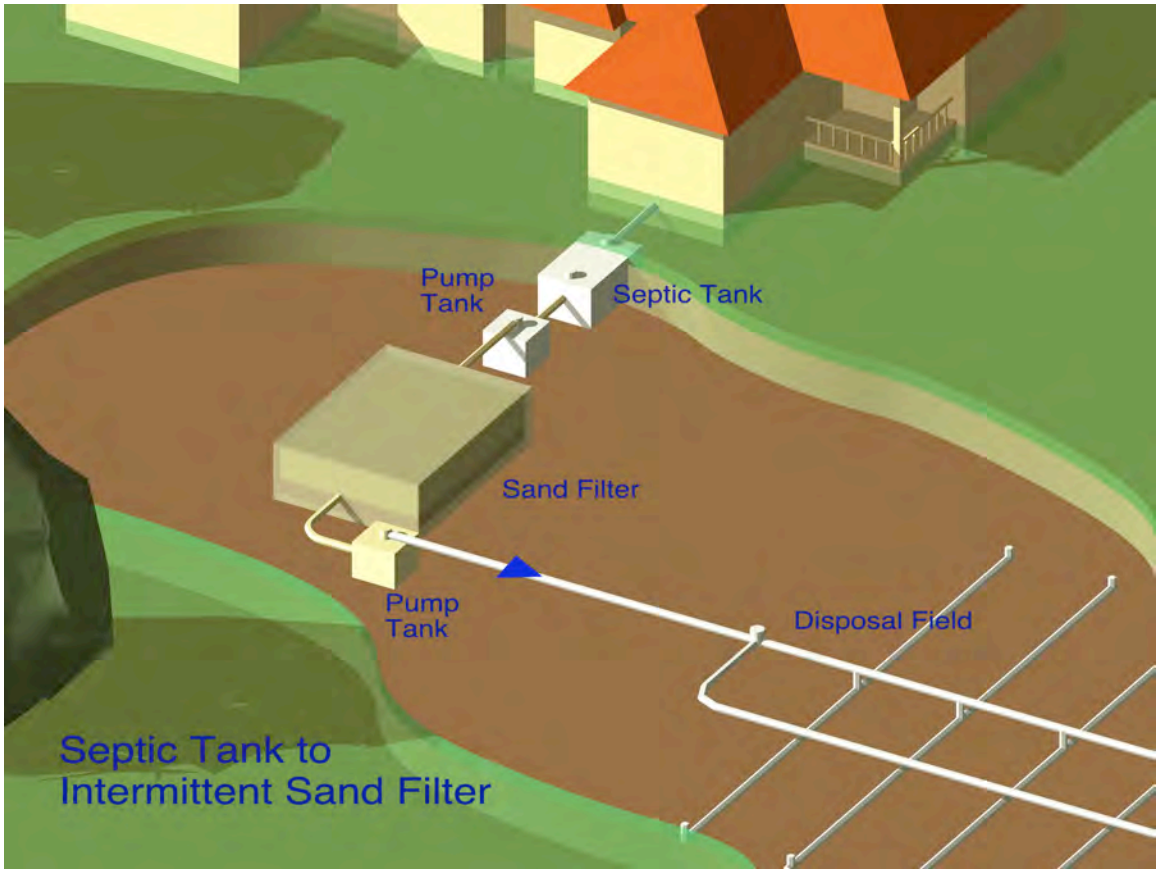
Ms. Parten owns property on St. Thomas and is on-island varying times during the year. Clients are encouraged to coordinate in advance so that she can be available to the project site as needed during the evaluation, planning and construction phases. For project inquiries, she may be reached at (800) 654-3342, or by email at sueparten@aol.com

Intermittent (Buried) Sand Filters (ISF's)

Intermittent sand filters are aerobic, fixed film bioreactors which provide advanced secondary treatment of septic tank (or primary treated) effluent. Sand filters tend to have relatively low maintenance requirements if designed and constructed properly, and reliably produce very low levels of BOD, TSS and ammonia. Decentralized wastewater systems utilizing intermittent sand filtration generally consist of septic tank pretreatment, followed by dosing of the effluent into a network of distribution piping located in the upper layers of a contained unit with a specific gradation of filter sand. The filtered effluent is then collected at the base of the filter with drain pipe, and is either pumped or drains by gravity to the dispersal field. A conceptual illustration of this type of system is provided below.

A properly designed and constructed system of this type is capable of reliably producing an effluent with low levels of BOD_5 and TSS, and excellent NH_3 reduction (nitrification). Average BOD_5 and TSS levels are less than 10 mg/L (and usually approximately 5 mg/L). NH_3 levels are typically on average less than 1 mg/L, and average fecal coliform levels less than 200 CFU/100 ml. Average total nitrogen reductions of 20-30% can be produced by intermittent sand filters.

CONCEPTUAL LAYOUT OF A
RESIDENTIAL INTERMITTENT SAND FILTER TREATMENT SYSTEM



RESIDENTIAL INTERMITTENT SAND FILTER SYSTEM

Photo by Community Environmental Services, Inc.

The above intermittent sand filter treatment system with low pressure dosed final subsurface dispersal was designed for rocky site conditions in a sensitive watershed. The sand filter is located in the raised landscaped bed on the left of the photo, with the effluent pump tank beneath the green riser lid beside the sand filter. A portion of the LPD dispersal field is shown on the right side of the photo in the xeriscaped garden area. The system was monitored for over two years, with average TSS and BOD_5 levels of 6.5 mg/L and 5.8 mg/L, respectively (34 samples collected). Average fecal coliform levels for that same period were 87 Col./100 ml.

LARGER SCALE INTERMITTENT SAND FILTER SYSTEM

Photo by Community Environmental Services, Inc.

The above intermittent sand filter treatment system with low pressure dosed final subsurface dispersal was designed for shallow rocky soil conditions over fractured bedrock, and is located in a state park in west Texas (Fort Griffin State Historical Park). The system is designed to treat approximately 2,000 gallons per day from the park's visitor center and headquarters.

The sand filter was fenced to prevent the public and grazing animals in the park from entering this area. This photo was taken prior to establishment of the grass cover over the filter. The green lids on the left of the photo cover distributing valves leading to the sand filter, and the row of small utility covers on the upper right side of the photo allow access to flushing ball valves in the sand filter effluent distribution lateral lines.

INTERMITTENT SAND FILTER EFFLUENT

Photo by Community Environmental Services, Inc.

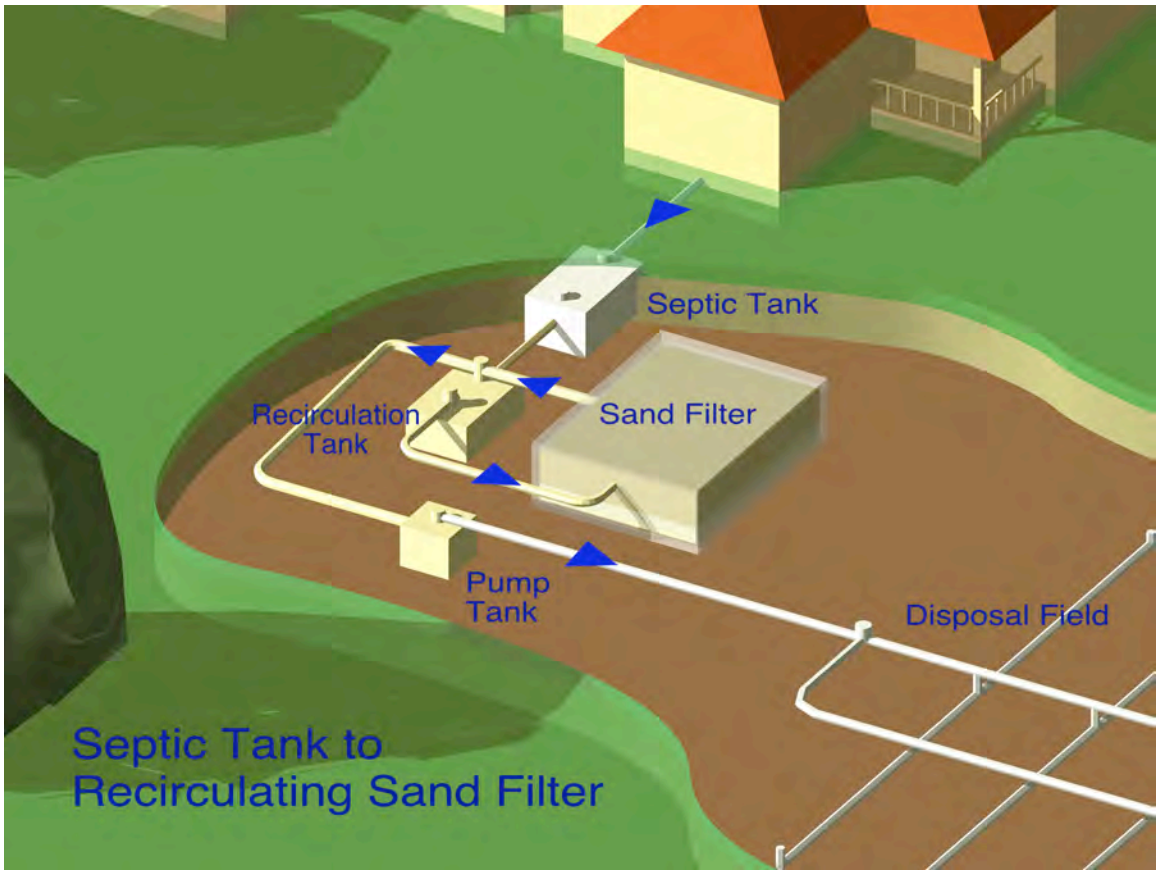
This intermittent sand filter system was monitored for one year (total of 15 samples), with average BOD_5, TSS and Fecal Coliform levels of 2.6 mg/L, 3.5 mg/L, and 137 Col./100 ml, respectively.

Intermittent Sand Filter Treatment Systems

Advantages	Possible Disadvantages
• Capable of reliably producing a high quality of secondary wastewater effluent, with very high levels of nitrification. • Consistently low organic and suspended solids content of the effluent safely allows for reduction of land area requirements for subsurface disposal systems in certain soil types • Provides significant pathogen reduction (average fecal coliform levels of 200 col./100 ml or less) • Effluent is relatively odorless (faint soil odor) • Considerable performance data is available over 20-30 years and in varying locations and conditions • Non-proprietary system • Should require routine maintenance only once annually • Long useful service lives if properly designed and constructed • Suitable for single family residences or larger flows • Can continue to provide high levels of secondary treatment during periods of sporadic use, or following periods of non-use (such as vacation homes and seasonal business) • Can use area over filter for light foot traffic and yard activities.	• Greater space requirements (footprint) than some other secondary treatment options • Higher level of design detail needed to ensure proper operation and performance, as compared with some proprietary packaged treatment units • To maintain cost-effectiveness, nearby or local sources of filter media of proper gradation needed (manufactured sands from glass or other materials have been used effectively in lieu of natural materials in some cases for these systems) • Infiltration of rainwater into filter during wet weather periods increases effluent loading to dispersal field (though proper grading of soil cover over filter can minimize this)

Recirculating Gravel or Sand Filters (RGF's/RSF's)

Recirculating gravel (or coarse sand) filters are aerobic, fixed film bioreactors which provide advanced secondary treatment of septic tank (or primary treated) effluent. The filters are constructed similarly to intermittent sand filters, although they use a coarser media and the surface of the gravel is left open (unburied), and there is a recirculation tank with a splitter-type valve used for recirculating filters. Recirculation rates of at least 4:1 are typically used for these systems. A properly designed and constructed system of this type is capable of reliably producing an effluent with low levels of BOD_5 and TSS, and 50-60% total nitrogen reduction (with NH_3 levels less than 1-2 mg/L on average). Average BOD_5 and TSS levels are typically less than 10 mg/L, and most often closer to 5 mg/L. Below is a conceptual illustration of an RSF.



Although the above illustration shows the RSF serving a residence, this type of system is more commonly used for larger flows from multiple homes or commercial facilities. Because the surface of the gravel media is left open to maintain aerobic conditions, it may not be desirable to allow general access to the system. An advantage of the system as compared with intermittent sand filters however is that the design loading rate is much higher (up to 5 gallons per day per square foot as compared with up to 1.2 gallons per day per square foot for an intermittent sand filter), which reduces construction costs and requires less area. Recirculating sand/gravel filters have been in use for several decades, with a large body of data available on their performance.

Below is a photo of effluent from a recirculating gravel filter operating in the 1970's, as compared with septic tank effluent.

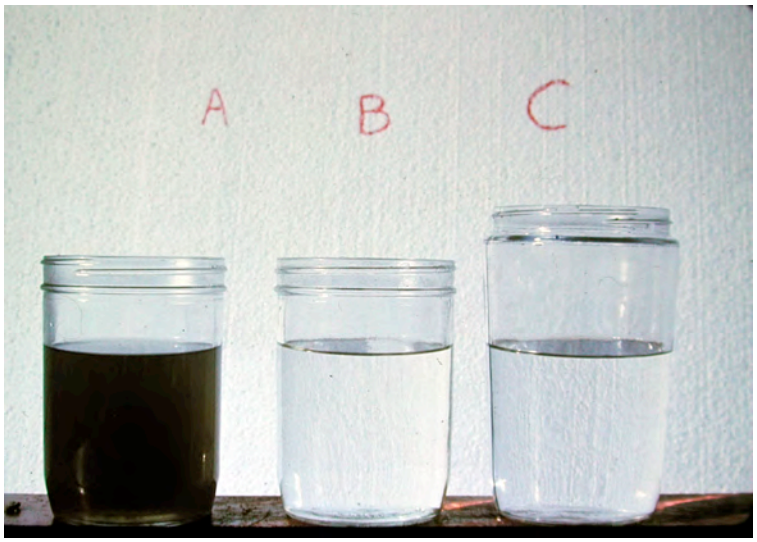


Photo Courtesy of Michael Hines, P.E.
A: Septic Tank Effluent (No effluent filter)
B: Recirculation Tank Effluent
C: Recirculating Sand Filter (RSF) Effluent (from total treatment process)
RSF effluent sampled for this system had average BOD_5 and TSS levels less than 10 mg/L, with values typically closer to 5 mg/L. Total nitrogen removal was on average 50-60%.

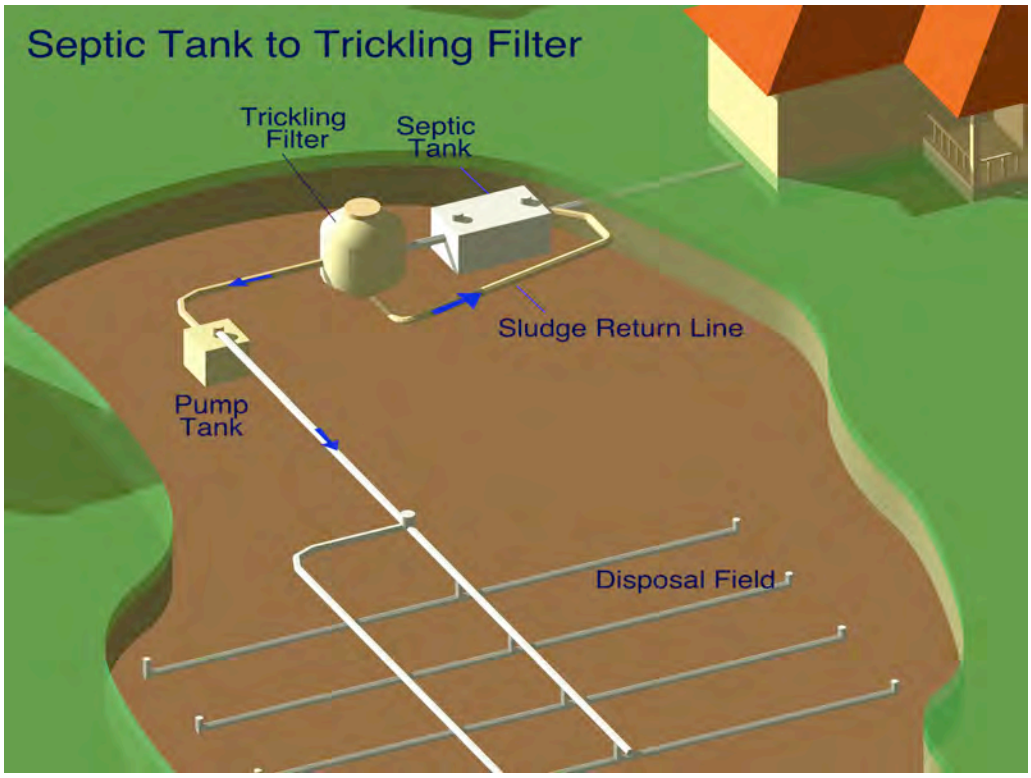
Advantages and potential limitations generally associated with recirculating gravel filters are provided below.

Advantages	Possible Disadvantages
• Capable of reliably producing a high quality of secondary wastewater effluent, with very high levels of nitrification • Consistently low organic and suspended solids content of the effluent safely allows for reduction of land area requirements for subsurface disposal systems in certain soil types • Can provide 50-60% total nitrogen removal • Provides significant pathogen reduction (2-3 log reduction for fecal coliform) • Considerable performance data is available for varying locations and conditions • Non-proprietary system • Should require routine maintenance only once to twice annually • Long useful service lives if properly designed and constructed • Natural treatment process that can be constructed using locally available materials.	• Greater space requirements (footprint) than some other advanced treatment options (though significantly less than others such as intermittent sand filters) • Higher level of design detail needed to ensure proper operation and performance, as compared with some proprietary packaged treatment units • Local sources of filter media of proper gradation needed • Infiltration of rainwater into filter during wet weather periods increases effluent loading to dispersal field • Most suitable for non-public use areas (best suited for clusters of homes or public/commercial applications) • Cannot use area over filter for residential yard activities or foot traffic

Trickling Filters

Trickling filters are fixed-film biological treatment systems employing media such as rock, plastic or other solid material which supports biomass on its surface and within the porous structure of the media. The process is aerobic, and oxygen is provided to the treatment process by either forced or natural ventilation. Though used for this demonstration project only to accomplish nitrification following the subsurface wetland, trickling filter units can by themselves reliably produce a high quality of effluent, and can be configured to provide for significant total nitrogen reduction. They may be used for a wide range of flows, from single family residences to large developments and commercial facilities. Where trickling filter effluent is recycled to the septic tank (or other anoxic portion of the treatment train with sufficient available carbon), as much as 50-60% total nitrogen reduction can be achieved.

Below are conceptual illustrations of trickling filter units configured to serve single family residences.



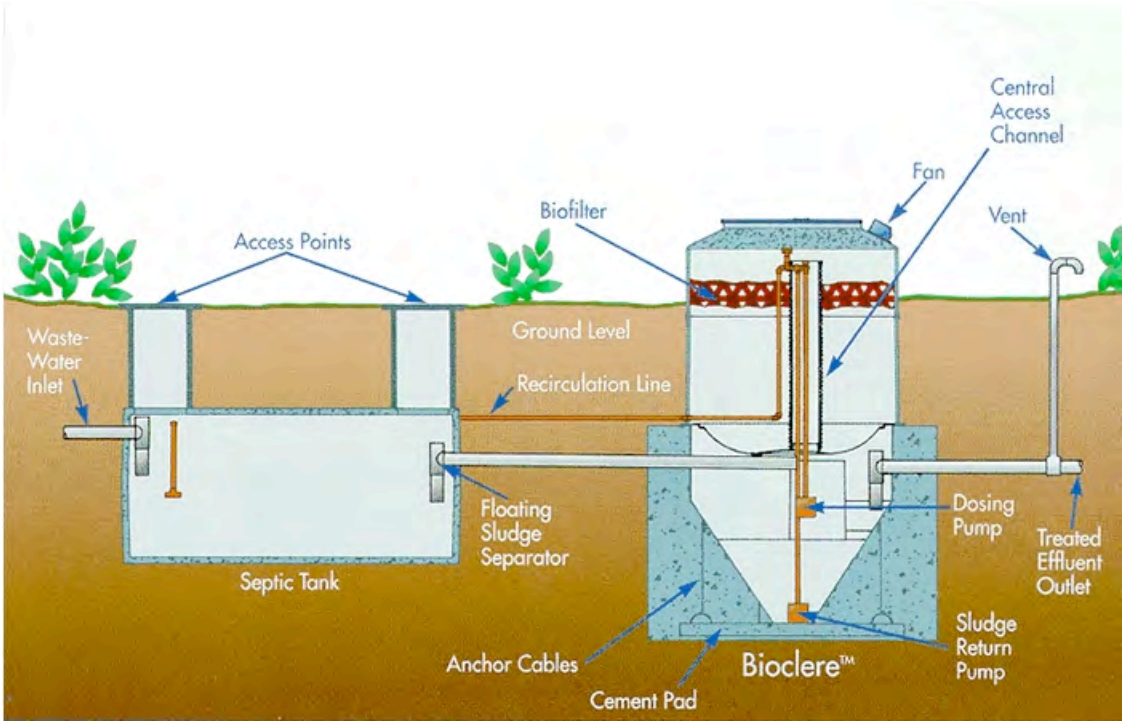


Illustration from EPA website:
http://www.epa.gov/boston/assistance/ceitts/images/techsimgs/bioc1.gif

Below is a table of advantages and possible limitations generally associated with trickling filters.

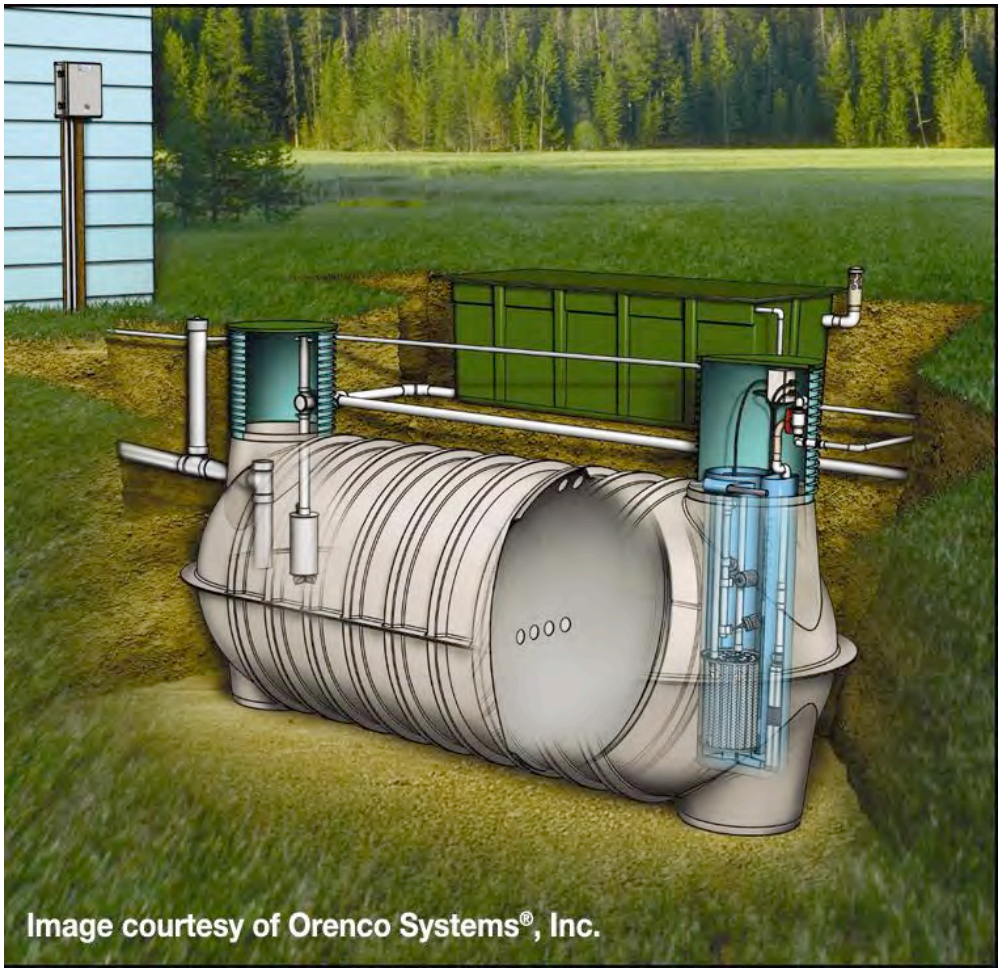
Advantages	Possible Disadvantages
• Capable of reliably producing a high quality of secondary wastewater effluent, with very high levels of nitrification • Can provide 50-60% total nitrogen removal if effluent is recirculated to anoxic zone of treatment process • No rainwater infiltration/collection into treatment unit during wet weather periods • Very low space requirements (small footprint) • Should have long useful service lives if properly designed and installed • Suitable for single family residences or larger flows • Modular type treatment units can be added if design flows increase	• Usually proprietary treatment units are used for small-scale decentralized treatment systems • Requires inspection/maintenance more frequently than some other treatment options, and requires manufacturer-approved service contracts for small proprietary treatment units • More electromechanical components than some other advanced treatment options, with possibly more maintenance/repair needs

A photo and description of a trickling filter treatment system used for a larger scale decentralized system is provided below.

This wastewater treatment system in a suburb south of Boston serves three commercial shopping plazas. The town required the developer to build a treatment system to accommodate an existing supermarket strip mall and a variety of restaurants and retail outlets across the street. The combined flow is 40,000 GPD of high strength wastewater. The system layout includes 3 parallel flow trains of pre-conditioning basins followed by sequential Biocleres and a tertiary anoxic sand filter. The design criteria were (600 mg/l BOD_5 , 250 mg/l TSS & 70 mg/l TKN) The final discharge effluent standard is less than 10 mg/l (ppm) total nitrogen. We anticipate that properly managed this treatment system will produce approximately <5 mg/l BOD, <5 mg/l TSS and <5mg/l Total Nitrogen. Photo and description courtesy of Aquapoint, Inc.

Textile Filter Treatment Units (AdvanTex)

The AdvanTex treatment unit is a proprietary attached growth multiple pass packed bed reactor that has been researched and developed by Orenco Systems, Inc. (OSI) since 1996, and is now marketed and increasingly used nationwide and elsewhere around the world for decentralized wastewater systems requiring advanced treatment. OSI markets AdvanTex treatment units sized for both single family and commercial or larger flow residential systems, with 10,000 units currently in operation. The residential AdvanTex treatment model (AX20N) received NSF certification under the ANSI/NSF Standard 40 for secondary treatment (Class 1 effluent) in 2002. Below is an illustration of the unit as used for a single family residence.



The AdvanTex textile treatment unit is mounted above the septic tank in the above illustration. A screened effluent pump vault is located in the 2nd compartment of the septic tank from which effluent is dosed to the AdvanTex unit. Effluent can be recirculated either to the 1st (Mode 3 operation) or 2nd (Mode 1 operation) compartments of the septic tank, depending on the level of treatment desired from the system. Mode 3 operation allows for total nitrogen reduction of 50-75%.

Design loading rates of approximately 25 gallons per square foot per day are used for this treatment system. The larger AdvanTex unit used for clusters of residences or commercial applications (AX100) can treat design flows of 2,500 gallons per day (4 lbs. BOD_5/ft^2/day organic loading) and is approximately 16'(length) x 7.5' (width) x 3.5' (height) , and the smaller AX20 residential unit is rated for design flows up to 500 gallons per day and is approximately 7.5' x 3.2' x 2.6'. An advantage of this treatment system is that it is modular, and units can be added as development occurs and flows increase when used for clustered residential systems or commercial applications.

Image courtesy of Orenco Systems®, Inc.

The above photo shows the effluent distribution nozzles above the packed hanging textile filter sheets in the AdvanTex treatment unit. The textile filter sheets are easily removed and cleaned if needed.

Below is a photograph showing effluent quality produced from an AdvanTex treatment unit.

(Photo Courtesy of Orenco Systems, Inc., 2005)

Left: Septic Tank Effluent
Right: AdvanTex Effluent (Packed Bed – Fixed Film Media Treatment System)

Advantages and possible limitations associated with packed bed textile treatment systems of this type include the following:

Advantages	Possible Disadvantages
• Capable of reliably producing a high quality of secondary wastewater effluent, with very high levels of nitrification • Can provide 50-75% total nitrogen removal if effluent is recirculated to anoxic zone of treatment process • Less susceptible to reduced performance as compared with some other advanced treatment options during periods of sporadic use, or following periods of non-use (such as vacation homes and seasonal business) • Consistently low organic and suspended solids content of the effluent safely allows for reduction of land area requirements for subsurface disposal systems in certain soil types • No rainwater infiltration/collection into treatment unit during wet weather periods • Very low space requirements (small footprint) • Treatment unit sold as complete package with compatible components, making installation easier than for some other treatment types • Should have a long useful service life if properly designed and installed • Suitable for single family residences or larger flows • Modular type treatment units can be added if design flows increase • Units with hanging textile sheets are relatively easy to service if there is filter clogging or excess oils/grease build-up	• Less performance data is available due to shorter time period on market (since year 2000) as compared with other older advanced treatment options • Proprietary treatment units • Typically requires manufacturer-approved service contracts (though this can be advantageous in terms of regulatory and quality control for the user) • Requires inspection/maintenance more frequently than some other treatment options, and typically requires manufacturer-approved service contracts • More electromechanical components than some other advanced treatment options, with possibly more maintenance/repair needs