CHAPTER 7
SUSPENDED GROWTH AEROBIC TREATMENT SYSTEMS

A suspension of wastewater and treatment organisms in an aerated tank is known as the activated sludge process. The activated sludge process can be used for onsite wastewater treatment, generally requiring the addition of an air pump to deliver oxygen to the system and provide mixing energy. Suspended growth treatment systems can be secondary only (require supplemental primary treatment) or combined primary and secondary treatment processes. Designs typically consist of aeration, clarification, and sludge return processes. Some systems operate under an extended aeration mode for enhanced constituent transformation.

Types of processes

The principle types of processes may be classified as (1) continuous flow, (2) sequencing batch, and (3) membrane bioreactor.

Continuous flow reactors

Continuously mixed systems keep the bacterial culture that provides treatment in suspension by adding mixing energy to the system. Mixing and aeration are often supplied with air compressors that introduce air into the reactor through a diffuser mechanism. Wastewater flows through the treatment process as fresh wastewater enters the system. The complete-mix system is similar in function and operation to the conventional activated sludge system used at many municipal treatment facilities.

Sequencing batch reactors

In the sequencing batch reactor, wastewater is stored in the reaction chamber of the treatment system until sufficient volume (a batch) is collected at which point the treatment process begins. The batch of wastewater is seeded with an active bacterial culture and aerated for the treatment period. After the reaction is complete, aeration and mixing are stopped the flocculated bacteria and other solid particles settle out. The clear layer (supernatant) is discharged from the reaction chamber and wastewater to be treated begins to flow into the reaction chamber again. The fill, react, settle, discharge cycle is repeated continuously.

Membrane bioreactors

Submerging a fine pore membrane in an activated sludge process is known as a membrane bioreactor. Membrane bioreactors are used for wastewater treatment and reclamation at communities of various sizes.

System components

Important components of aerobic suspended growth treatment systems are the reactor (container), the aeration and mixing devices, the outlet structure, and the control system. Each of these components is discussed below.

Container

The process tank is generally divided into three compartments, the primary separation chamber, the aeration chamber, and the settling chamber. Some systems accomplish primary treatment in a standard septic tank, making them suitable for upgrading sites which already have an existing septic system. The primary separation chamber is designed to separate settable and floatable substances from the influent wastewater. The primary separation compartment should be designed to have capacity to retain materials that may interfere with downstream processes. The aeration chamber is designed to provide sufficient volume for contact between the wastewater and the microbial biomass. The distribution of the fixed film media, placement of the aeration device, and hydraulic flow paths are important criteria for effective treatment. Clarification is the separation of wastewater solids (particles and microbial cells) from the treated water. The

secondary settling chamber is used for clarification of the wastewater and should be sized to have adequate detention for secondary separation before discharge of the treated water.

Aeration and mixing devices
Mixing and aeration are, in most cases, accomplished by the same device. Generally, air is delivered to the bottom of the aeration tank and released through a diffusing mechanism to increase the surface area and, thus, oxygen transfer efficiency, to the aerobic treatment process. As the air bubbles move up the water column, oxygen is consumed and the contents of the tank are mixed. Important factors to be considered for the aeration mechanism are the (1) maintenance requirements, (2) expected lifespan and reliability, (3) the noise generated during operation, (4) access to the device, and (5) durability under adverse conditions. The common types of aeration and mixing devices are presented in Table 7-1. Because these treatment processes are aerobic, the device or method used to compress and deliver the air to the aeration tank are critical elements.

Outlet structures
The outlet is designed to release clarified, treated water from the treatment system. The outlet structure should be designed to keep residual particles from exiting with the process effluent. Commonly used devices are baffled outlet structures, outlet (effluent) filters, and floating and fixed overflow weirs.

Control systems
Process control is generally accomplished by float switches to monitor water level, pumps to transfer water between processes, and timers to regulate the treatment process. Many systems are incorporating programmable logic controllers to make the treatment process more adaptable to the challenges of onsite treatment.

Operational parameters
Operational parameters are used to define system application. Most treatment processes are rated based on the daily hydraulic capacity for wastewater with an assumed composition. In some of the processes, the solids retention time (SRT) is also used as a control parameter. Because onsite treatment systems are often exposed to highly variable loading, processes are often oversized. A robust treatment process should provide design performance under a range of adverse loading conditions. The parameters used to categorize system operation include the loading rate, retention time, surge capacity, aeration characteristics, flow configurations, and process failure.

Table 7-1
Mixing and aeration devices used for onsite wastewater treatment systems

Device	Description
Air diffusers	Air diffusers are porous fixtures located in the aeration tank. Compressed air is pushed through the holes in the diffuser, causing the formation of discrete air bubbles. The compressed air may be supplied by a diaphragm, rotary vane, or piston pump (rated for continuous use).
Aspirators	Aspirators have a small impeller below a hollow shaft (draft tube), when the propeller and shaft are rotated, a vacuum is created that draws air down the draft tube into the aeration tank and is simultaneously dispersed by the impeller into the water.
Air lift pumps	The air lift pump operates by injecting air into the bottom of a vertical submerged column (hollow shaft). The air that is released moves up the column and forces water to move upwards with it, accomplishing aeration and mixing.

Retention time

Each process within a treatment process has a liquid retention time based on the effective volume of the process and the expected hydraulic loading rate (HLR). The various treatment processes and the importance of proper retention time are presented in Table 7-2. Most aerated onsite treatment processes are extended aeration (i.e., long SRT) to reduce the overall sludge volume due to the inability to regularly remove this material.

Loading rate

The loading rate is the flow of a material, such as liquid or a specific constituent, through the system. The HLR is often defined as the daily volume of wastewater that the system is able to process. The organic loading rate (OLR) is defined as the daily BOD_5 input to the system. For residential applications, the constituent concentrations for typical domestic wastewater are used to estimate the OLR. Activities that can affect the loading rate include (1) variable loading, (2) over loading, (3) extended periods of non-operation, (4) electricity outage, and (5) equipment failure.

Table 7-2
Treatment processes and the importance of design retention time

Treatment process	Importance
Primary	Primary treatment processes require liquid retention time to accomplish solids separation from the water to be treated. If an adequate volume of hydraulic overload occurs, solids may be carried over into subsequent processes, reducing the overall effectiveness of the treatment process.
Aeration	Contact time in the aeration cycle is needed to ensure design oxidation of the process water. If the water is not in the aeration process for a sufficient length of time, the effluent discharged may have an increased BOD or ammonia concentration.
Secondary	Secondary processing is designed to separate the biomass and other suspended materials from the wastewater to be discharged. If not given enough time for settling, these solids will be discharged with the wastewater and may interfere with downstream processes. Outlet filters have reduced the possibility of inadvertent solids discharge.
Solids	The solids retention time is related to the length of time that the microbial biomass is kept in the treatment process. Because it is not realistic to remove solids from onsite treatment systems on a regular basis, solids are often recycled back to the primary treatment process or the aeration process for digestion. Solids recycling is accomplished by allowing the settled solids to flow back into the aeration process by gravity or with a submerged pump that periodically activates and discharges the solids to a specified location.
Disinfection	For systems that incorporate a disinfection step, adequate contact time with the effluent needs to be ensured to accomplish design performance.

Process failure

Process failure occurs when the treatment system discharges water with constituent concentrations that are above the acceptable limit as determined by the effluent management system. The failure of an aerated treatment process is often caused by (1) inadequate maintenance of the treatment system, (2) the discharge of toxic substances (such as chlorine) to the biological treatment system, and (3) failure of a component (such as an aeration device) needed for proper operation. Of these, proper maintenance is believed to be the most important aspect of long-term success of onsite treatment systems.

Monitoring and maintenance

The ongoing monitoring and maintenance of aerated treatment systems is important for keeping

these devices operating as designed. Monitoring and maintenance activities should be conducted regularly by a certified individual.

System components
The system components that should be inspected include the aeration device, the packing materials (if applicable), the inlet and outlet structures, pumps, and the air diffusers. Additional components may also need servicing as determined by the manufacturer. The system components and standard maintenance needs are presented in Table 7-3

Table 7-3
Recommended maintenance activities for aerated treatment systems

Component	Typical maintenance needs
Aeration device	Check air filters and clean if necessary. Also check oil seals, noise level, abnormal vibration, and heating output.
Inlet and outlet structures	Remove floating debris and scum that accumulates around outlet structures.
Process tanks	Check for excessive solids accumulation and remove as needed.
Pumps	Confirm that pumps are operating correctly.
Diffusers	Inspect diffuser for solids buildup and clean as necessary.
Timers	Check system timers and other control devices for correct settings as determined by manufacturer or system installer.
Float switches	Observe float switches to confirm proper operation.
Alarms	Confirm that alarms are functioning.
Effluent quality	Qualitative assessment of odor, color, and turbidity. Qualitative assessment may depend on the discharge location and can include BOD, TSS, nitrogen, phosphorus, and fecal coliform bacteria.

7-1 Complete-mix reactors

Complete-mix reactors utilize some type of mixing device to keep organisms in suspension. In most cases, the device that provides aeration also provides the mixing energy. Some systems are operated as combined primary and secondary treatment systems, while others require a septic tank or other pretreatment device to provide primary treatment.

7-1.1 AeroDiffuser™ wastewater treatment system

Category	Secondary treatment
Technology	Continuous flow, aerated suspended growth, extended aeration
Input	Settled wastewater, septic tank effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The AeroDiffuser system is an extended aeration treatment system. Water moves through the system by hydraulic displacement. A linear air pump is used to supply continuous aeration. A cone shaped compartment is used for clarification of the treated wastewater. Settled solids are returned to the aeration chamber. The control box and air pump are located in an attached compartment located on the top of the unit.

Description of process
The total volume of the unit is 875 gal, total retention time in the system is about 40 hours. Typical design flow rate is 500 gal/d. Primary effluent enters the aeration chamber and is

circulated and mixed with the activated sludge. The process water is then separated from the biomass in the clarifier and discharged through an outlet assembly or outlet filter.

System footprint
Unit is 5.2 ft in diameter and about 7.1 ft tall (total surface area 21 ft^2).

Advantages
Effective treatment, NSF approved, unit is modular and compact.

Disadvantages
Treatment systems requires electricity for proper operation. The air supply will require periodic maintenance for long term operation.

Performance
NSF certified system capable of producing secondary quality effluent.

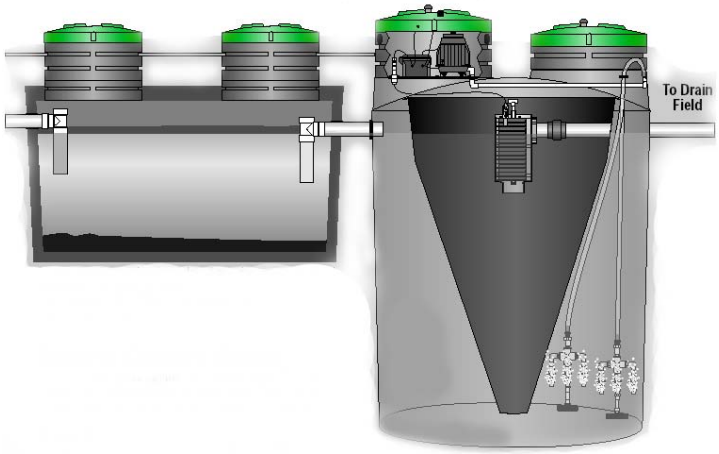

Figure 7-1
Diagram of the AeroDiffuser extended aeration plant. (Adapted from Zabel Environmental Technology.)

Operation and maintenance
Electrical and mechanical components will need to be inspected to confirm proper operation. Sludge accumulation in treatment system will need to be removed occasionally. If an outlet filter is included, it will need to be cleaned periodically. The aeration device will need to be checked for signs of wear and inlet screen cleaned periodically. Periodic inspection of system components and servicing as needed.

Power and control
System includes float switches, linear air pump, control panel, and alarms. Expected annual electrical usage is 2,000 to 3,000 kWh.

Cost
Estimated cost range from $4,500 to 5,000 for typical residential system. Cost estimate includes capital costs for treatment unit and necessary controls and system components only.

Contact
Zabel Environmental Technology
PO Box 1520
Crestwood, KY 40014
Phone (502) 992-8200/(800) 221-5742
Fax (502) 992-8201
Web www.zabelzone.com
Model description
ATS AD 500 (500 gal/d)
ATS AD 500 with effluent filter (500 gal/d)
Manufacturer support
Not determined

References and other resources
NSF (2000) Final Report Zabel Environmental Technology Model ATS-AD-500 Wastewater Treatment System, NSF International, Ann Arbor, MI.

U.S. Patent: 6,096,203, 5,266,239, 6,106,704, Foreign: D423,638, D424,659, D426,866.

7-1.2 AES IDEA BESTEP™

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems and cluster systems, commercial, institutional

Background
The intermittent decant extended aeration (IDEA) process is utilized in several treatment systems developed by Advanced Environmental Systems, Inc. The proprietary treatment system uses several techniques for wastewater treatment including intermittent aeration, continuous flow, and periodic decanting of the process effluent.

Description of process
Raw wastewater enters the treatment system and is dissipated and distributed with deflecting fixtures. A timer operates the aeration system on a predetermined schedule to accomplish the sequencing nature of the treatment process. The AES IDEA system differs from SBRs because influent flow is continuous and the process is modified to compensate for this equalization.

System footprint
Dimensions of treatment unit are equivalent to standard septic tank (10 ft long, 6 ft wide,and 6.5 ft high).

Advantages
All operations occur in a single basin; can be installed into an existing septic tank, relatively small space requirements. Effective treatment system, including potentially for high nitrogen removal.

Disadvantages
Treatment system requires energy to operate. Aeration system will require periodic maintenance.

Performance
System is NSF certified to meet secondary wastewater treatment. Performance specifications of representative research findings are presented in Table 7-4.

Operation and maintenance
Electrical components which will require servicing include the blower, a decanter pump, float switches, and the timer/control panel. Other features that will need to be inspected periodically include the decanting device, the inlet baffle, and the accumulation of sludge in the reactor. Unique technology lease program, AES installs, operates, and monitors (with telemetry) treatment system for monthly fee. Homeowner does not have responsibility for maintenance.

Power and control
Timer system used to control sequencing cycle, effluent discharge pump, blower to supply process oxygen, and float switches to monitor system. Estimated annual power usage in the range of 750 to 1000 kWh.

Cost
AES estimates cost to install denitrification upgrade to existing septic system will cost $1000 per bedroom, $35 monthly charge for lease/operation and maintenance services.

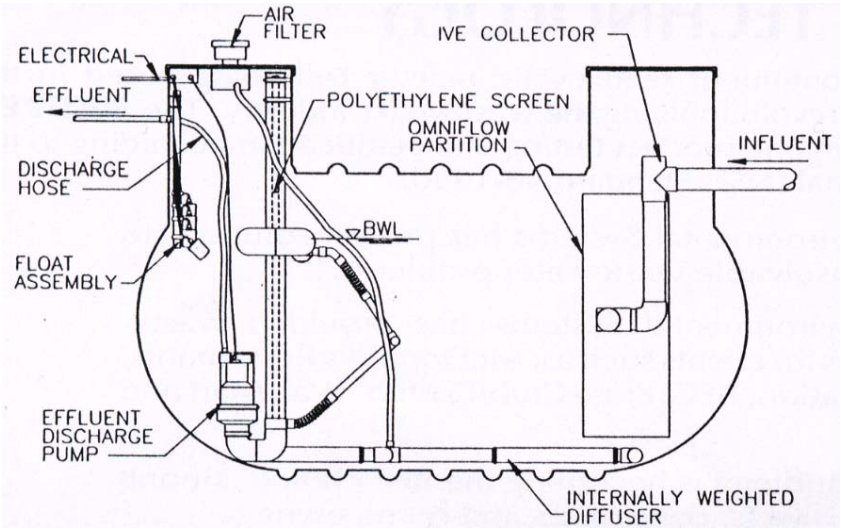

Figure 7-2
The AES IDEA BESTEP treatment system installed at a residential location (left top), installed in a fiberglass septic tank before installation (left bottom), and a diagram highlighting system components. (Adapted from Advanced Environmental Systems, Inc.)

Contact
Advanced Environmental Systems, Inc.
PO Box 2019
Kihel, Maui, Hawaii
Model description
BESTEP 10 (500 gal/d)
BESTEP 15 (750 gal/d)
Other systems can be designed for flows up to 25 mgd
Manufacturer support
Lease treatment system to homeowner for monthly fee, ongoing maintenance contract

References and other resources
Anderson, D.L., M.B. Tyl, R.J. Otis, T.G. Mayer, and K.M. Sherman (1998) Onsite Wastewater Nutrient Reduction Systems (OWNRS) For Nutrient Sensitive Environements, *Onsite Wastewater*

Treatment, Proceedings of the Eighth National Symposium on Individual and Small Community Sewage Systems, American Society of Agricultural Engineers, St. Joseph MI.

Florida Department of Health (2000) *Florida Keys Onsite Wastewater Nutrient Reduction Systems Demonstration Project – Phase II Addendum*, Florida Department of Health.

NSF (1995) *Final Report Advanced Environmental Systems Inc*., Mini IDEA Model BESTEP 10, NSF International, Ann Arbor, MI.

Table 7-4
Reported results from of BESTEP performance[a]

		Location of study
Parameter	Unit	Florida[b]
Description of system		Demonstration site
System performance		
BOD_5	mg/L	4.16 (98%)
TSS	mg/L	6.85 (94%)
TN	mg/L	15.46 (60%)
NO_3-N	mg/L	14.3
TP	mg/L	6.24 (27%)

[a] Anderson *et al*. (1998).
[b] Performance reported as average effluent concentration with average removal in parentheses, where applicable.

7-1.3 Alliance wastewater treatment systems

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The Alliance wastewater treatment system is an extended aeration process housed in a concrete tank. Air is supplied by a blower and released through air diffuser located on the bottom of the aeration chamber. The distribution of this treatment system and the availability in California is not known.

Description of process
Process composed of two chamber (aeration and clarification) basin. Wastewater flows into the aeration basin and is circulated by air released from a diffuser placed at the bottom of the unit. Aerated water then flows into clarifier for sedimentation. Treated wastewater is discharged from outlet tee.

Performance
NSF certified for production of secondary quality wastewater (NSF 2000).

Contact
H.E. McGrew, Inc.
3508 Industrial Drive
Bossier City, LA 71112
Phone (318) 746-5122
Model description
Alliance 500 (500 gal/d)

References and other resources
NSF (2000) *Final Report HE McGrew Inc., Alliance 500 Wastewater Treatment System*, NSF International, Ann Arbor, MI.

7-1.4 B.E.S.T. 1

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
Extended aeration package plant.

Description of process
System consists of a three chamber (primary treatment, aeration, and secondary settling) tank. Wastewater flows through the system, receives treatment and is discharged.

Performance
NSF certified for production of secondary quality wastewater (NSF 2000).

Operation and maintenance
Standard inspection and maintenance of system components, including ¼ hp rotary vane blower and sludge removal.

Contact
American Wastewater Systems
917 Fieldspan Rd
Duson, LA 70529
Phone (337) 873-3128

References and other resources
NSF (2000) Final Report American Wastewater Systems, Inc., BEST 1 Wastewater Treatment System, NSF International, Ann Arbor, MI.

7-1.5 Bi-A-Robi

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, upgrade of existing systems

Background
Basis of the Bi-A-Robi system is the conversion of a septic tank to an aerobic reactor by the addition of an air compressor and circulation pump.

Operation and maintenance
Standard inspection and maintenance of mechanical devices (air pump and submerged circulation pump).

Contact
Bi-A-Robi Systems, Inc.
P.O. Box 133
Hamlin, PA 18427
Phone (717) 689-2307
Fax (717) 689-3089
E btraverse@aol.com

References and other resources
Ohio Department of Health (2001) *Individual Aerobic Wastewater Treatment Plants Approved By The Ohio Department Of Health*.

7-1.6 Brooks Anti-septic sewage treatment plant

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Domestic wastewater, individual residences

Background
The Brooks Anti-septic system was developed in the 1970s and manufactured in St. Louis, Missouri. Several units have been installed in California. The basis for the Brooks design is a unique basin geometry (oblique baffle) to optimize secondary settling.

Description of process
The system has three compartments, aeration, clarification, and outlet filtration. Domestic wastewater enters and moves through the aeration compartment, into the clarification compartment. Solids are settled out and are passively returned to the aeration compartment. The water is then discharged after flowing through an outlet filtration compartment. Air is supplied to the aeration tank by a remote blower.

Performance
Performance data supplied provided by the manufacturer is summarized in Table 7-5.

Table 7-5
Reported results of Brooks system performance

Parameter	Unit	Without outlet filter	With outlet filter
BOD	mg/L	41 (81%)	26 (83%)
TSS	mg/L	5 (95%)	1.4 (99%)

[a] Waste Not Inc. (2001)

Operation and maintenance
Standard maintenance requirements for the Brooks system include (1) cleaning of blower air intake filter every 6 months, (2) blower maintenance every two years (replacement of worn vanes), (3) fine adjustment of blower timer to optimize treatment, (4) removal of surface solids from treatment unit, and (5) cleaning of outlet filter as needed.

Contact

Waste Not, Inc.
32700 Albion Ridge Rd; PO Box 339
Albion, CA 95410
Phone (707) 937-5735
Fax (707) 937-3426
E paulex@mcn.org

Model description

Rated for single dwelling unit (1 to 12 people), if more than 12 people, may be arranged in parallel.

References and other resources

Waste Not, Inc. (2001) *Brooks Anti-Septic Sewage Treatment Plant Owners Manual*

7-1.7 Clearstream™ wastewater systems

Category	Secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Primary treatment
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, cluster systems

Background

The Clearstream wastewater treatment system is an extended aeration package plant. The system is typically housed in a concrete or fiberglass tank. Wastewater is pretreated in a septic tank before entering the Clearstream system. Wastewater is aerated in the outer chamber of the system and clarified in the inner chamber.

Performance

NSF certified for production of secondary quality wastewater (NSF 2000).

Figure 7-3

Diagram of the Clearstream wastewater treatment system. (Adapted from Clearstream Wastewater Treatment Systems, Inc.)

Operation and maintenance
Air supply pump will need to be serviced or replaced as needed. Air filter and diffuser will need to be cleaned. Alarm should be checked for proper operation. System will need to be shut down for periodic solids removal.

Contact
Clearstream Wastewater Systems, Inc.
P.O. Box 9337
Beaumont, TX 77709
Phone 409.755.1500
Fax 409.755.6500
Web www.clearstreamsystems.com
Model description

Model 500N	500 gal/d
Model 600N	600 gal/d
Model 750N	750 gal/d
Model 1000N	1000 gal/d
Model 1500N	1500 gal/d

References and other resources
NSF (2000) *Final Report Clearstream Wastewater Treatment Systems, Inc.*, NSF International, Ann Arbor, MI.

7-1.8 Envirocycle® USA advanced wastewater treatment

Category	Primary and secondary treatment, disinfection optional
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The Envirocycle wastewater treatment system is based on the Biocycle wastewater treatment system. The technology was developed in 1982 and patented in 1989 in the United States. More than 20,000 of these systems have been installed worldwide. The Envirocycle system includes drip dispersal of the process effluent, telemetry for continuous monitoring, and a quarterly service contract.

Description of process
The system is composed of a four compartment tank with an optional disinfection step. Wastewater is treated by primary settling, aeration, and clarification. An additional compartment with a submerged pump is used to store and distribute water to subsequent soil based system. The system has a design flow rate of 600 gal/d and large capacity (2378 gal) providing an additional 600 gal of storage capacity after activation of the high water alarm.

System footprint
Unit is 7.7 ft in diameter and 8.8 ft in height. Effluent management depends on characteristics of receiving area. Effluent typically dispersed with drip irrigation system.

Advantages
Effective treatment of domestic wastewater. Optional nitrogen reduction and disinfection. Mandatory service contract and telemetry systems ensure long-term management and performance.

Disadvantages
Treatment process requires electricity for proper operation. Required maintenance for long-term performance.

Performance
The Envirocycle unit has not been evaluated by NSF, however, its ability to produce secondary quality water has been verified by other researchers sampling from units installed at residential locations. In general, BOD_5 and TSS concentrations of less than 20 mg/L can be expected. The unit can be operated in a nitrogen reduction configuration and/or with an optional UV disinfection unit (Salcor Engineering, Inc.)

Operation and maintenance
A quarterly inspection and preventative maintenance contract is required for the life of the system. The service contract covers all maintenance activities associated with the treatment system, including blower and effluent pump replacement and solids removal. The current annual cost of this contract is $360.

Power and control
System includes telemetry system, blower for aeration, and 0.5 hp effluent pump. During normal operation, aerator is on for 30 minutes and off for 30 minutes, reducing overall electricity usage. Estimated annual electricity usage is 1,000 to 1,500 kWh.

Cost
$14,900 Includes capital and installation costs for complete system, including telemetry monitoring and drip distribution of effluent

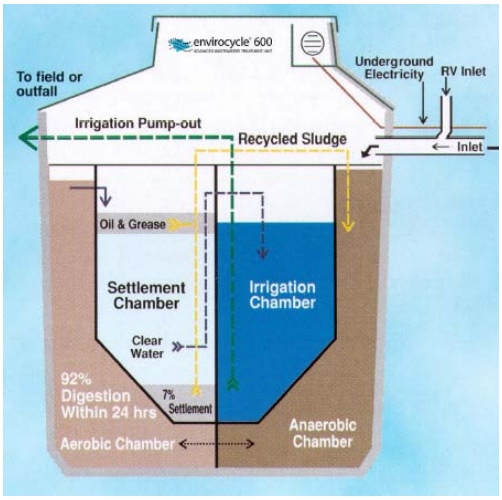

Figure 7-4
Diagram of the Envirocycle treatment system.
(Adapted from Envirocycle USA LLC.)

Suppliers
Envirocycle® USA LLC
PO Box 5698
Auburn, CA 95604
Phone (888) 694-4633
Fax (888) 694-4829
E sales@envirocycleusa.com
Web www.envirocycleusa.com

Model description
Model 600 (600 gal/d)
Manufacturer support
Manufacturer ensures long-term operation and maintenance through required service contract and telemetry monitoring

7-1.9 Hydro-Action®

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, cluster systems

Background
The Hydro-Action wastewater treatment system is an extended aeration package plant. The system consists of a trash tank, a combination aeration tank and cone type clarification chamber, and an effluent chlorine contact pump basin.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000).

Operation and maintenance
Manufacturer recommended service needs (and service intervals): repair or replace aerator (2 to 10 y), clean filters on aerator (6 mo to 2 y), break up scum on aerator (6 mo to 2 y), pump sludge from aeration tank (2 to 5 y), pump sludge from trash tank (2 to 5 y), check aeration diffuser (annually), check surge control weir (6 mo). If system is equipped with chlorination device, will also require periodic replacement of chlorine tablets and monitoring.

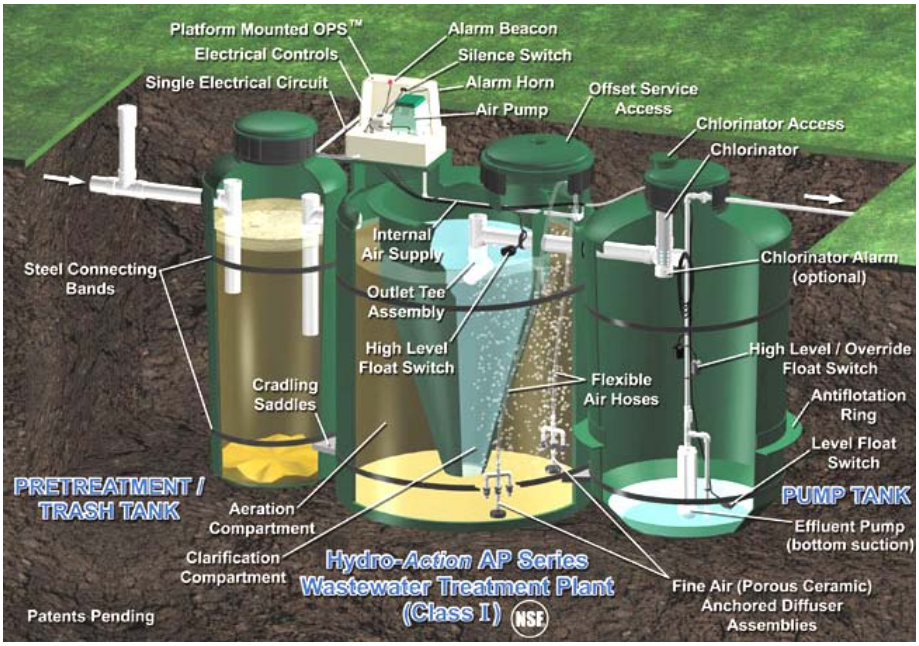

Figure 7-5
Diagram of the Hydro-Action wastewater treatment system. (Adapted from Hydro-Action, Inc.)

Contact
Hydro-Action, Inc.
8645 Broussard Rd.
Beaumont, TX 77713
Phone (409) 892-3600
Fax (409) 892-0005
Web www.hydro-action.com
Model description
500N (500 gal/d)
600N (600 gal/d)
750N (750 gal/d)
1000N (1000 gal/d)
1500N (1500 gal/d)
Manufacturer support
Guaranteed two year service period followed by optional extended service contract.

References and other resources
NSF (2000) *Final Report Hydro-Action, Inc. Model AP500 Wastewater Treatment System*, NSF International, Ann Arbor, MI.

7-1.10 JET commercial

Category	Primary and secondary treatment, disinfection optional
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	commercial and institutional facilities

Background
Jet Inc. manufactures package plant wastewater treatment facilities featuring a patented aeration diffuser. The units are modular in design and housed in pre-cast concrete tanks.

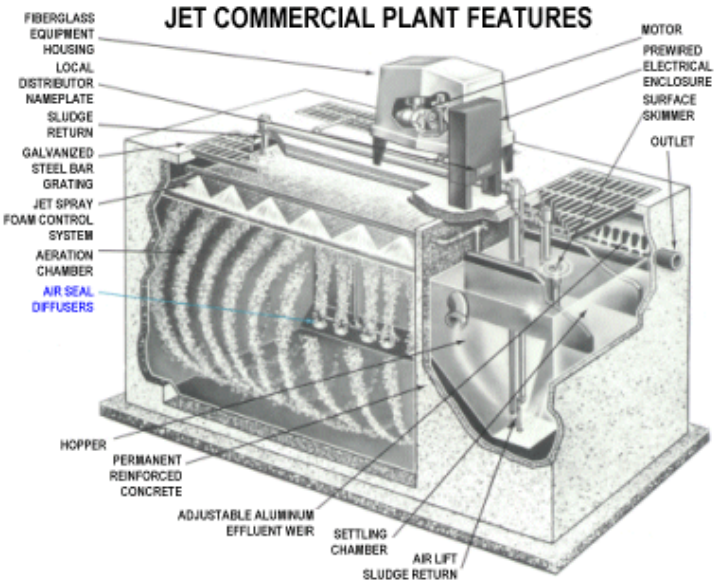

Figure 7-6
Diagram of the Jet commercial package plant. (Adapted from Jet, Inc.)

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000).

Contact
JET, Inc.
750 Alpha Dr.
Cleveland OH 44143
Phone (440) 461-2000
Fax (440) 442-9008
Web www.jetincorp.com

References and other resources
Jet Inc. (2001) *Jet commercial plant operator's manual.*

7-1.11 Mighty Mac wastewater treatment systems

Category	Secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Primary effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The Mighty Mac treatment system is an extended aeration process designed for ease of installation. The basic process configuration is an aeration system and interior cone clarifier. The unit has a float switch, air blower, and high water alarm.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000).

Operation and maintenance
Standard inspection and maintenance of mechanical devices (air pump). Sludge removal from aeration tank and primary treatment tank.

Contact
H.E. McGrew, Inc.
3508 Industrial Drive
Bossier City, LA 71112
Phone (318) 746-5122

References and other resources
NSF (2000) *Final Report H.E. McGrew, Inc., Mighty Mack 500 Wastewater Treatment System*, NSF International, Ann Arbor, MI.

7-1.12 Modulair® treatment systems

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Commercial systems

Background
The Modulair treatment system is an extended aeration package plant for the treatment of wastewater from residential communities and commercial facilities.

Contact
Norwalk Wastewater Equipment Company, Inc.
220 Republic Street
Norwalk OH 44857-1196
Phone (419) 668-4471
Fax (419) 663-5440
Web www.norweco.com
Model description
Flow rates from 1,500 to 500,000 gal/d

References and other resources
Norweco (2001) Manufacturer product brochure, downloadable from www.norweco.com

7-1.13 Mudbug wastewater treatment system

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The Mudbug wastewater treatment system is a flow through, two compartment concrete tank. Wastewater enters directly into the aeration tank and then into the clarification tank. An outlet filter and secondary effluent filter are used to improve effluent quality.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000).

Operation and maintenance
Standard inspection and maintenance of mechanical devices (air pump). Removal of sludge from the aeration process will be needed periodically. Outlet and effluent filters require servicing for optimal performance.

Contact
Rogers Treatment Systems
45232 Rogers Road
Hammond, LA 70401
Phone (985) 345-4096

References and other resources
NSF (2000) *Final Report Rogers Treatment Systems, Inc., Mudbug 5 Wastewater Treatment System*, NSF International, Ann Arbor, MI.

7-1.14 Multi-Flo waste treatment system

Category	Secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Primary effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, cluster systems

Background
The Multi-flo wastewater treatment system is an extended aeration process with a unique filtration mechanism.

Description of process
Wastewater flows into the center of the treatment unit and is aerated by a mechanical aspirating mixing device. The aerated wastewater must then travel upward through submerged filters. After passing through the filters, the water is discharged to subsequent management.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000). Other studies have confirmed effluent BOD_5 and TSS concentrations of less than 10 mg/L and fecal coliform bacteria often less than 1,000 CFU/100 mL.

Operation and maintenance
Manufacturer recommended maintenance is based on the following schedule: 6 to 8 wk startup period, 2 to 4 y pumping frequency, 2 to 4 y filter cleaning frequency, 3 to 4 y aerator replacement, and 6 mo (minimum) routine inspections. The system is equipped with a high water alarm to warn of clogging filters.

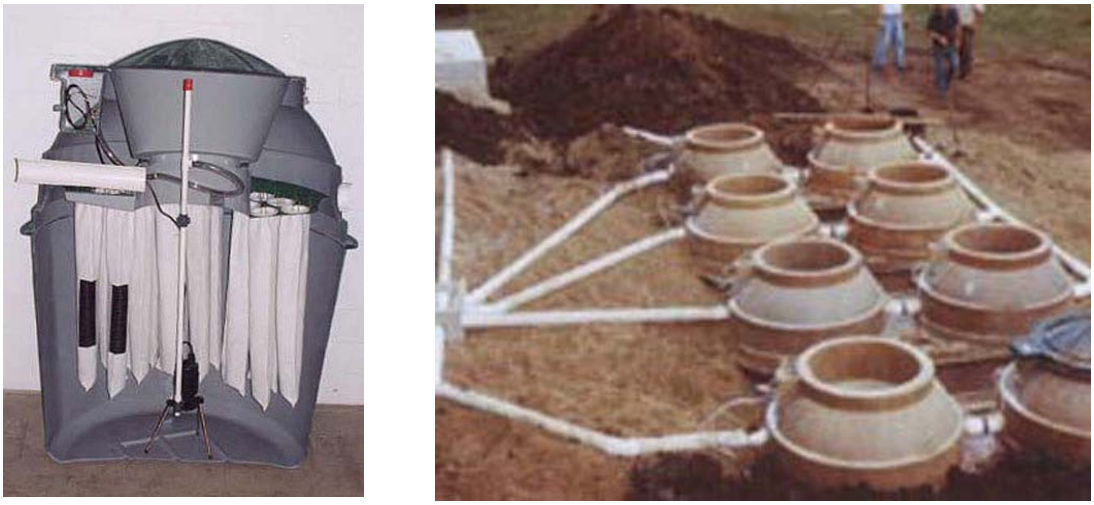

Figure 7-7
The Multi-flo treatment system cut-away view (left) and multiple units configured for treatment of larger flow rates (right). (Adapted from Consolidated Treatment Systems, Inc.)

Contact
Consolidated Treatment Systems, Inc.
2501 Commerce Center Drive
Franklin, OH 45005
Phone (937) 746-2727
Fax (937) 746-1446
Web www.consolidatedtreatment.com
Model description
FTB 0.5 (500 gal/d)
FTB 0.6 (600 gal/d)
FTB 0.75 (750 gal/d)
FTB 1.0 (1000 gal/d)
FTB 1.5 (1500 gal/d)

Manufacturer support

Two year warranty and inspection period after installation. Manufacturer recommends extension of contract after initial period.

References and other resources

NSF (2000) *Final Report Multi-Flo Model FTB-0.5 Wastewater Treatment System*, NSF International, Ann Arbor, MI.

The University of Wisconsin has performed extensive evaluation of the Multi-flo treatment system.

7-1.15 Nayadic

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, cluster systems

Background

The Nayadic wastewater treatment system utilizes the extended aeration process.

Description of process

Wastewater enters the center aeration chamber and is aerated and mixed with a submerged air lift tube. A portion of the aerated effluent is directed into the outer ring of the unit which functions as the clarifier. Settled sludge is picked up and suspended by the air lift. Clarified water flows over a weir around the perimeter of the unit and flows out of the system.

Figure 7-8

The Nayadic wastewater treatment system before installation (left) and shown in a cut away diagram. (Adapted from Consolidated Treatment Systems, Inc.)

Performance

NSF certified for production of secondary quality wastewater (NSF, 2000). In independent research evaluations, the Nayadic effluent typically has concentrations of BOD_5 and TSS less

than 10 mg/L. Recirculation of process water through an anoxic tank has resulted in significant nitrogen removal, often with effluent concentrations less than 10 mg/L TN.

Operation and maintenance
Manufacturer recommended maintenance needs are as follows: 6 to 8 wk start up period, 2 to 4 y sludge pumping frequency, 3 to 5 y compressor replacement, 6 mo routine inspections or as directed by regulatory agency. If an anoxic tank or chemical addition is used for enhanced nutrient removal, addition maintenance actions will be needed.

Contact
Consolidated Treatment Systems, Inc.
1501 Commerce Center Drive
Franklin, OH 45005
Phone (937) 746-2727
Fax (937) 746-1446
Web www.consolidatedtreatment.com
Model description
M-6A (500 gal/d)
M-8A (600 gal/d)
M-1050A (800 gal/d)
M-1200A (1000 gal/d)
M-2000A (2000 gal/d)
Manufacturer support
Two year guarantee on system components

References and other resources
NSF (2000) Final Report Nayadic Model M-6A Wastewater Treatment System, NSF International, Ann Arbor, MI.

7-1.16 Singulair® Bio-Kinetic

Category	Primary and secondary treatment, optional disinfection
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential, cluster, and commercial systems

Background
The Singulair Bio-Kinetic wastewater treatment system utilizes an extended aeration process. The system is composed of four distinct processes, primary treatment, aeration, clarification, and effluent filtration housed in a concrete basin about the same size as a 1500 gal septic tank (Model 960-500). A unique characteristic of the Singulair system is the incorporation of flow equalization to improve process stability during variable flow events. The effluent filter may be operated with optional chlorination/dechlorination system.

Description of process
Wastewater enters the primary treatment chamber where settable and floatable solids are removed. Water to be treated flows into the aeration basin where an aspirator device is used to transfer oxygen into the water, after about 1 day in aeration (design flow), the water flows into a clarification chamber where a sloped bottom draws settled material back into the aeration chamber. Clarified water flows through a Bio-Kinetic effluent filtration device before discharge to subsequent wastewater management system.

System footprint
Unit is 9.25 ft long, 5.5 ft wide, and 6.5 ft in height (height depends on depth requirements.

Effluent management depends on characteristics of receiving area. If acceptable, effluent may be discharged to soil treatment system such as drip irrigation.

Advantages
Effective treatment of domestic wastewater. System is NSF approved. Optional nitrogen reduction and disinfection. Effluent filter and flow equalization improve process stability.

Disadvantages
Requires electricity for proper operation. System requires maintenance for long-term performance. Biological process performance subject to user activities.

Performance
NSF certified for production of secondary quality wastewater (NSF, 1995). Expected effluent composition of BOD_5 and TSS less than 10 mg/L. With the addition of a recirculation component, the Singulair treatment system can be expected to remove 50 to 70 percent of the wastewater nitrogen.

Operation and maintenance
Six month inspection of all system components including power usage, cleaning, and performance testing. Maintenance also includes refilling chlorination/dechlorination devices, completing and mailing maintenance records, and adjustment of systems operation. Aeration device is floodproof in case of high water event. Control system provides timing for aeration cycle, normal cycle is 30 minutes on, 30 minutes off. Audible alarm warns of high water event.

Power and control
System includes high water alarm (optional), aspirating mixer for aeration (floodproof), and timer for aeration cycle. During normal operation, aerator is on for 30 minutes, off for 30 minutes, reducing overall electricity usage. Estimated annual electricity usage is 500 to 1,000 kWh.

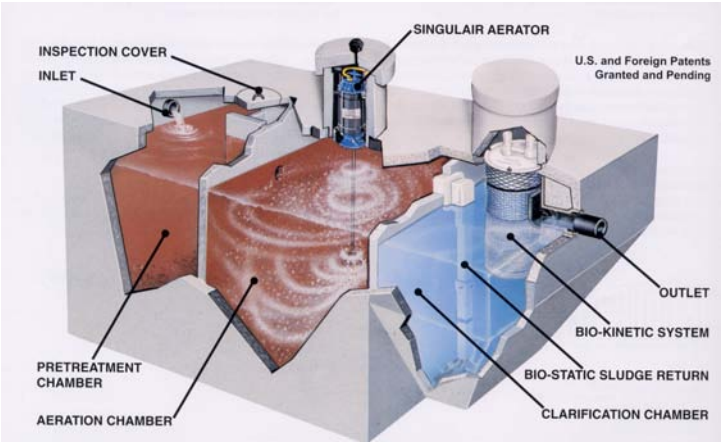

Figure 7-9
Diagram of the Singulair wastewater treatment system (Adapted from Norwalk Wastewater Equipment Company, Inc.)

Suppliers
Norwalk Wastewater Equipment Company, Inc.
220 Republic Street
Norwalk OH 44857-1196
Phone (419) 668-4471
Fax (419) 663-5440
Web www.norwweco.com

Model description
- Model 960-500 (500 gal/d)
- Model 960-750 (750 gal/d)
- Model 960-1000 (1000 gal/d)
- Model 960-1250 (1250 gal/d)
- Model 960-1500 (1500 gal/d)

Manufacturer support

Treatment systems are sold, installed, and serviced by manufacturer trained distributors. Operation and maintenance are covered under a service contract for two years after installation (included with purchase price of the system). Norweco recommends renewal of the service contract after the introductory two year period. All system components are under warranty for this two year period and the system aerator is warranted under a 50 year replacement policy.

References and other resources

NSF (1995) *Final Report Norweco Inc., Singulair Model 960*, NSF International, Ann Arbor, MI.

7-1.17 Solar Air aerobic sewage treatment system

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background

Extended aeration package plant; not currently available in California.

Performance

NSF certified for production of secondary quality wastewater (NSF, 2000).

Contact

National Wastewater Systems Incorporated
6754 HWY. 90 East
Lake Charles, La. 70615
Phone (337) 439-0680
Fax (337) 439-0685
Web www.solarair.net/index.htm

Model description
- SA - 500 GAL/D
- SA - 800 GAL/D
- SA-1000 GAL/D
- SA-1200 GAL/D

References and other resources

NSF (2000) Final Report National Wastewater Systems, Inc., Solar Air Wastewater Treatment System, NSF International, Ann Arbor, MI.

7-1.18 USBF™

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, cluster systems, commercial, industrial

Background
The USBF process is a modification of conventional activated sludge process that incorporates an anoxic selector zone and an upflow sludge blanket clarifier.

Description of process
Wastewater is processed in anaerobic, anoxic, and aerobic treatment zones. Water is filtered thorough a sludge layer for improved clarification and nutrient removal.

Performance
The USBF process is capable of removal of BOD_5 to less than 5 mg/L, TSS removal to less than 10 mg/l without filtration, total nitrogen removal to less than 1.0 mg/L and total phosphorus removal to a range of 0.5 to 2.0 mg/L. Higher levels of phosphorus removal down to 0.2 to 0.5 mg/L can be achieved by metal salt addition to the aeration zone immediately prior to the mixed liquor entering the clarifier.

Operation and maintenance
Standard inspection and maintenance of mechanical devices (air pump).

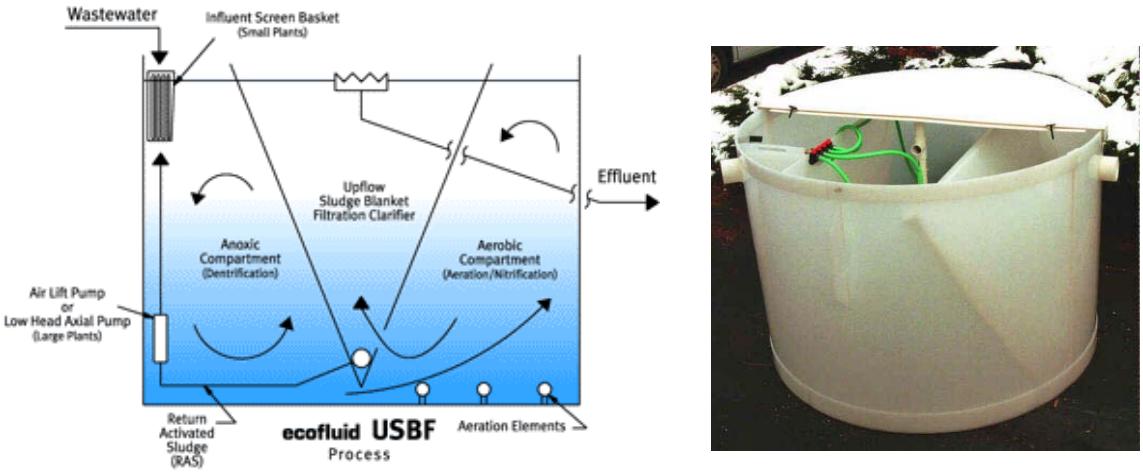

Figure 7-10
Diagram of the USBF reactor by Ecofluid Systems (left) and photograph of the USBF reactor before installation (right). (Adapted from Ecofluid Systems, Inc.)

Contact

Ecofluid Systems, Inc.
101-366 East Kent Ave. South
Vancouver, BC, V5X 4N6 Canada
Phone (604) 662-4544
Fax (640) 662-4564
E info@ecofluid.com
Web www.ecofluid.com

Clearwater, Inc.
3685 Stilesboro Rd
Kennesaw, GA 30144
Phone (770) 427-7091

7-1.18 Whitewater wastewater treatment systems

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems, cluster systems

Background
The Whitewater extended aeration treatment systems are modular treatment units with an internal cone shaped clarifier design.

Description of process
Wastewater enters the aeration chamber and is mixed with air which is pumped to the bottom of the tank and released through air diffusers. A portion of the water in the aeration chamber is directed into the internal cone clarifier and after settling flows out of the system. Settled sludge is returned into the aeration chamber.

Performance
NSF certified for production of secondary quality wastewater with an average effluent concentration of BOD_5 and TSS of 6 and 7 mg/L, respectively (NSF, 2000). The results from an independent study at a residential application in New Mexico are presented in Table 7-6. Additional treatment of effluent from the Whitewater system in a sand biofilter has resulted in a higher quality effluent, often with BOD_5 and TSS concentrations of less than 5 mg/L, and TN less than 10 mg/L.

Table 7-6
Selected representative studies of Whitewater system performance

		Location of study
Parameter	Unit	Bernalillo County, NM[a]
Description of system		Demonstration site
HLR	gal/d	161.8
System performance[b]		
BOD_5	mg/L	36.9 (89%)
COD	mg/L	181.9 (81%)
TSS	mg/L	8.4 (99%)
TN	mg/L	14.2 (77%)
Ortho-P	mg/L	1.5 (69%)
Fecal coliform	CFU/100 mL	2.7E4 (1.3)

[a] Hanson *et al*. (2002)
[b] Performance reported as average effluent concentration with average percent removal reported in parentheses. Fecal coliform removal is reported in log units.

Operation and maintenance
Standard inspection and maintenance of mechanical devices (air pump). Periodic sludge removal from the aeration tank will eventually be needed.

Contact
Delta Environmental Products
P.O. Box 969; 8275 Florida Blvd.
Denham Springs, LA 70726
Phone (800) 219-9183; (225) 665-166
Web www.deltaenvironmental.com

Model description

DF40 (400 gal/d)
DF50 (500 gal/d)
DF60 (600 gal/d)
DF40 (400 gal/d)
DF75 (750 gal/d)
DF100 (1000 gal/d)
DF150 (1500 gal/d)

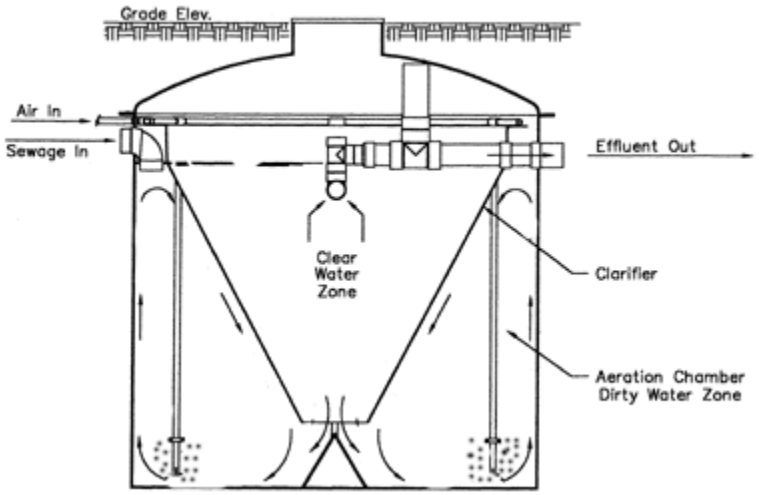

Figure 7-11

Diagram of the Whitewater treatment system. (Adapted from Delta Environmental Products, Inc.)

References and other resources

Hanson, A., W. Zachritz, R. Polka, Luz-Elna Y. Mimbela, and B. Thomson (2002) Alternative Small-Flow Wastewater Technologies in the Aird Southwest, *Small Flows Quarterly*, Vol. 3, No. 3, Morgantown, WV.

NSF (2000) *Final Report on the Whitewater Wastewater Treatment System*, NSF International, Ann Arbor, MI.

7-2 Sequencing batch reactors

Sequencing batch reactors (SBRs) utilize the activated sludge process for the treatment of wastewater. The basic process is composed of four steps, a volume of wastewater, i.e., batch, is (1) collected, (2) aerated/treated, (3) settled, and (4) discharged. Batch treatment processes typically use the same tank for aeration and clarification. Some systems take advantage of the fluctuating redox conditions to facilitate denitrification.

7-2.1 ABJ ICEAS™

Category	Primary and secondary treatment
Technology	Sequencing batch reactor, aerated suspended growth
Input	Settled wastewater, septic tank effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Community/municipal treatment systems.

Background
The ICEAS process is an intermittent decant process, not a true sequencing batch reactor. The intermittent decant process is believed to have several advantages over the conventional SBR. The ABJ ICEAS process is typically applied for the treatment of wastewater from communities.

Performance
Expected high levels of nitrogen and phosphorus removal.

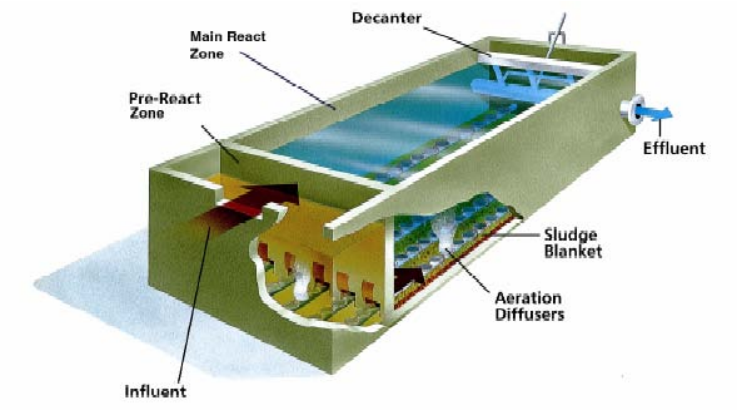

Figure 7-12
Diagram of the ABJ ICEAS wastewater treatment system.
(Adapted from Sanitaire, Inc.)

Contact
Sanitaire Inc.
9333 N. 49th Street
Brown Deer, WI 53223
Phone (414) 365-2200
Fax (414) 365-2210
E sanitaire@fluids.ittind.com
Web www.sanitaire.com

References and other resources
ABJ (2001) *Biological Treatment and the ICEAS Process*

7-2.2 Aquarobic International

Category	Primary and secondary treatment
Technology	Sequencing batch reactor, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential, cluster, community, and commercial systems

Background
Aquarobic International manufactures extended aeration SBRs and add-on attachments for the treatment of wastewater and enhanced nutrient removal from wastewater. Wastewater flows into the reactor and is aerated for a set amount of time. After aeration is complete, the aeration is stopped and the solids settle to the bottom of the reactor. After settling is finished, the supernatant is discharged from the system.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000), additional performance

data reported in Table 7-7. Various add-ons are available from the manufacturer for enhanced nutrient removal.

Table 7-7
Selected representative studiesof Aquarobic Miniplant performance

		Location of study
Parameter	Unit	Virginia Tech[a]
Description of system		Demonstration site
HLR	gal/d	365
System performance[b]		
BOD_5	mg/L	8.5
TSS	mg/L	
TN	mg/L	43
NO_3-N	mg/L	43
NH_3-N	mg/L	0.2
TP	mg/L	6.6
Fecal coliform	CFU/100 mL	1820

[a] Reneau *et al*. (2001).
[b] Performance reported as average effluent concentration.

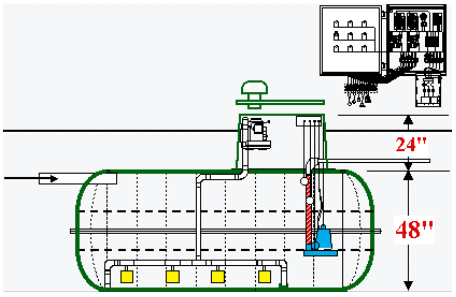

Figure 7-13
Diagram of the Aquarobic Mini Plant. (Adapted from Aquarobic International, Inc.)

Contact
Aquarobic International Inc.
508 Kendrick Lane
Front Royal, Virginia 22630
Phone (540) 635-5200
Fax (540) 635-2277
Web aquarobicinternational.com
Model description
Mini-plant (500 to 5000 gal/d)
Maxi-plant (to 15,000 gal/d)

References and other resources
Reneau Jr. RB, C Hagedorn, AR Jantrania (2001) Performance Evaluation of Two Pre-Engineered Onsite Treatment and Effluent Dispersal Technologies, in *Proceedings of the 9th National Symposium of Individual and Small Community Sewage Systems* - 2001, Fort Worth, TX, American Society of Agricultural Engineers, pp. 271-280, St. Joseph, Michigan.

NSF (2000) Final Report Aquarobic International Miniplant, NSF International, Ann Arbor, MI.

7-2.3 Cromaglass wastewater treatment systems

Category	Primary and secondary treatment, optional disinfection
Technology	Sequencing batch reactor, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The Cromaglass batch treatment system has been installed in every state and in many other countries. The process is housed in a fiberglass tanks and available in various sizes depending on design flow rate and application. The Cromaglass system has been used in water recycling/reuse (irrigation and toilet flushing) situations and at sites with limiting conditions. Cromaglass also manufactures chlorine contact basins, equalization basins, and sludge processing facilities. Systems are installed and serviced by local representatives.

Description of process
Wastewater flows into a three chambered tank. The first section of the tank is for primary settling/grit removal. The wastewater flows through a screen into the aeration section. Aeration is accomplished with an aspirating pump. After aeration (based on process control/timer settings), the contents of the aeration tank are discharged to the clarifier for settling and discharge. Sludge is returned to the aeration tank.

System footprint
Unit has length of 7 ft 11 in and diameter of 5 ft 7 in. Effluent management depends on characteristics of receiving area. If acceptable, effluent may be discharged to soil treatment system such as drip irrigation. Cromaglass has experience with various configurations for wastewater reuse.

Advantages
Effective treatment process. Capable of high nitrogen removal. Process performance documented in multiple studies. Unit is modular and compact.

Disadvantages
Treatment systems requires electricity for proper operation. Periodic sludge removal may be needed. Service contract needed to insure long term operation.

Performance
Although not specifically NSF approved, treatment system has been evaluated independently under NSF guidelines. Typical effluent concentrations of BOD_5 and TSS less than 10 mg/L. System can also be operated in nitrogen reduction mode and often attains effluent nitrogen concentrations less than 5 mg/L.

Figure 7-14
Cromaglass treatment system using multiple units anchored to concrete pad to prevent flotation. (Adapted from Cromaglass Co.)

Operation and maintenance
Basic system operations are controlled through a logic controller and float switches. Using telemetry, Cromaglass is able to provide online (24 h) monitoring. Standard inspection and maintenance of mechanical devices (submerged pumps, control panel, float switches). Sludge removal will be needed on a periodic basis.

Power and control
System includes control panel, float switches, and submerged pumps. Estimated annual power usage is 3,000 kWh.

Cost
$5,000 to 6,000 includes capital costs for treatment unit and necessary components

Contact
Cromaglass Corporation
P.O. Box 3215; 2902 N. Reach Rd.
Williamsport, PA 17701
Phone (570) 326-3396
Fax (570) 326-6426
Web www.cromaglass.com
Model description
CA-5 to CA-150 for flow rates ranging from 500 to 150,000 gal/d. Can also be used in parallel for larger flow rates.

References and other resources
Cromaglass (2001) Company product brochure and materials package.

7-2.4 EnviroSBR™

Category	Primary and secondary treatment
Technology	Sequencing batch reactor, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Note: process description and data not available

Contact
Earthtek Environmental Systems, Inc.
204 South Street
Batesville IN 47006
Phone (800) 934-5044
Fax (812) 934-5018
Web www.earthtekonline.com

7-2.5 Nitro Raptor™

Category	Primary and/or secondary treatment
Technology	Sequencing batch reactor, aerated suspended growth
Input	Untreated wastewater (raw) or primary effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The Nitro Raptor is an extended aeration, sequencing batch reactor treatment process designed for nitrogen reduction. Limited information has been obtained on this system.

Performance
The 7-H treatment was evaluated at the Ventura Regional Sanitation District Demonstration Project, the results from this study are presented in Table 7-8.

Contact
7-H Technical Services Group
431 Crown Point Circle
Grass Valley
Phone (530) 271-1600 x106
Fax (530) 271-1840

Table 7-8
Selected representative studies of Nitro Raptor performance

		Location of study
Parameter	Unit	Ventura, CA[a]
Description of system		Demonstration site[b]
HLR	gal/d	365
System performance[c]		
BOD_5	mg/L	27 (85%)
TSS	mg/L	42 (81%)
TN	mg/L	16 (47%)
NO_3-N	mg/L	11.1
NH_3-N	mg/L	1.0
TP	mg/L	2.6 (19%)
Total coliform	MPN/100 mL	>1600
Fecal coliform	MPN/100 mL	>1600

[a] Results may not be representative because system was evaluated without the use of a pretreatment (septic) tank
[b] Ventura Regional Sanitation District (2001) Septic Tank Nutrient Removal Project
[c] Performance reported as average effluent concentration with average removal in parentheses, where applicable

References and other resources
Ventura Regional Sanitation District (2001) Septic Tank Nutrient Removal Project, Advanced Onsite Sewage Disposal System Demonstration.

7-2.6 SYBR-AER™

Category	Primary and secondary treatment
Technology	Continuous flow, aerated suspended growth
Input	Untreated wastewater (raw)
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The SYBR-AER process is an extended aeration batch treatment process.

Description of process
Wastewater flows into the single compartment tank and a set aeration schedule is applied. After aeration is complete, mixing is stopped and the process water is settled. After the settling period, the supernatant is discharged from the process.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000).

Contact
Alternative Wastewater Systems, Inc.
1240 Lyon Road
Batavia, IL 60510-1389
Phone (630) 761-8720
Model description
500 to 1,500 gal/d

References and other resources
NSF (2000) *Final Report Alternative Wastewater Treatment System, SYBR-AER 500 (and SYBR 600 to 1,500 gal/d)*, NSF International, Ann Arbor, MI.

7-2.7 Thomas TRD1000

Category	Primary and secondary treatment, disinfection
Technology	Sequencing batch reactor, aerated suspended growth
Input	primary effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual residential systems

Background
The TRD1000 is a computer controlled extended aeration treatment process.

Description of process
Primary effluent flows into the batch treatment reactor and is exposed to anaerobic and aerobic processing. A portion of the batch is returned to the anoxic tank for additional nitrogen removal. After settling, the clarified water is discharged to a filtration and UV disinfection process.

Performance
NSF certified for production of secondary quality wastewater (NSF, 2000).

Operation and maintenance
Systems are fitted with telemetry system for continuous monitoring in addition to standard 6 mo inspection.

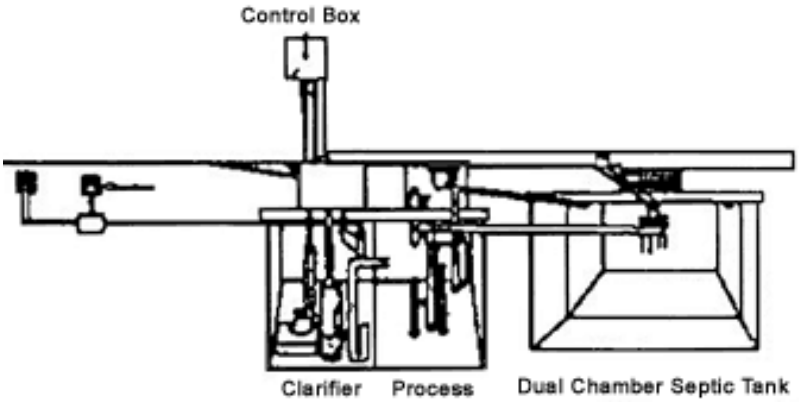

Figure 7-15
Diagram of the TRD1000 SBR. (Adapted from Thomas, Inc.)

Contact
Thomas, Inc.
8000 Parker Rd
Sedro Woolley, WA 98284
Phone (360) 856-0550
Fax (360) 856-0551
Web www.trd1000.com

References and other resources
NSF (2000) Final Report Wastewater Treatment System, NSF International, Ann Arbor, MI.

7-3 Membrane bioreactors

A membrane bioreactor is composed of a membrane filtration system submerged in an activated sludge tank. A vacuum applied to the membrane draws water through, excluding oversized wastewater particles and large molecules. Water that passes through the membrane is discharged as effluent from the system. Membrane bioreactors produce a high quality effluent that is often utilized for reuse applications, however, the cost of these systems may be restrictive.

7-3.1 Kubota

Category	Primary and secondary treatment
Technology	Membrane bioreactor, aerated suspended growth
Input	Settled wastewater, septic tank effluent
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems

Note: process description and data not available.

Contact
Kubota
3401 Del Amo Blvd.
Torrance, CA 90503
Phone (310) 618-6932
Web www.kubota.co.jp/english/division/envi2.html

7-3.2 ZenoGem™ and Cycle-Let™

Category	Primary, secondary, tertiary treatment
Technology	Membrane bioreactor, aerated suspended growth
Input	Primary treated water
Function	Oxidation, nutrient transformation/removal, and pathogen reduction
Applications	Individual, community, and larger systems, water reuse/recycling

Background
The membrane bioreactor developed by Zenon offers are unique treatment process for the recovery and reuse of wastewater. Membrane modules (ZeeWeed) are submerged in a typical aerated processing tank. The influent primary treated wastewater is aerated and then drawn through the membrane. This permeate water is amenable to tertiary filtration, disinfection, and non-potable reuse.

Performance
Expected effluent concentrations of BOD_5, TSS, and TN less than 5 mg/L, TP less than 1 mg/L, and FC less than 2.2 CFU/100mL.

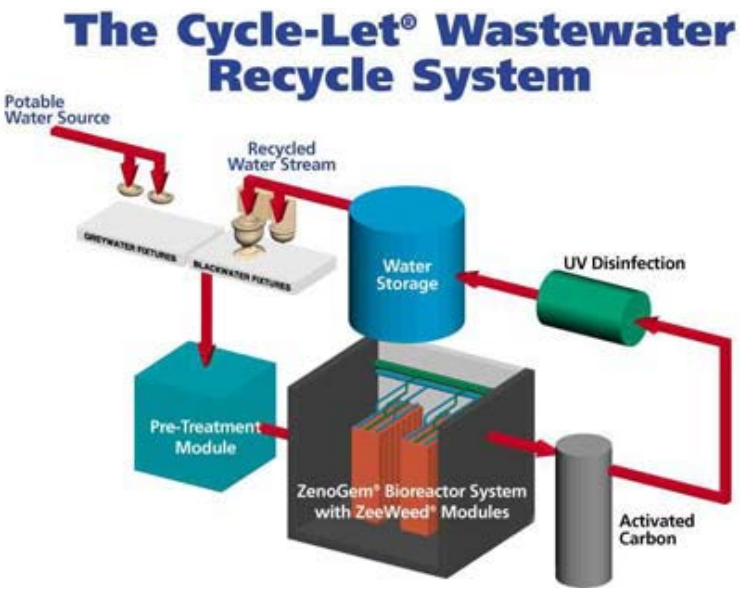

Figure 7-16

The Zenon Bioreactor system used for wastewater reuse applications. (Adapted from Zenon Environemental, Inc.)

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References

Rosenberg, S., U. Kruger, R. Witzig, W. Manz, U. Szewzyk, and M. Kraume (2002) Performance of a bioreactor with submerged membranes for aerobic treatment of municipal wastewater, *Water Research*, Vol. 36, pp. 413-420.