CHAPTER 6

Alternative Onsite Wastewater Systems

The discharge of partially treated wastewater into the soil for treatment and renovation is the most reliable and inexpensive of onsite wastewater management methods. One reason for this is that little pretreatment of the wastewater is needed before it is allowed to be placed into soil.

The suitability of systems that release wastewater into soil is determined by the characteristics of the soil, slope, available space, soil depth over water tables or bedrock and other site-specific factors. Alternative systems may be used when the characteristics of one or more of these factors make conventional systems inappropriate. Alternative technologies serve one or a few households and dispose of wastewater in the soil on household's property. Many are variations of conventional septic systems.

Many onsite systems require less money per household for operating costs than systems that carry wastewater away to a community treatment facility. The main costs are a one-time purchase of materials and construction. As described earlier, the more complex onsite systems must be maintained by a certified onsite sewage treatment system operator, which will increase the costs.

Some of the technologies described in this section, such as sand filters and spray irrigation systems, may also be used as components of alternative cluster or centralized systems.

Alternating Drainfields

Alternating drainfields uses two fields at different times, allowing one to dry and possibly become useful again while the other is in use. Use of alternating fields extends the operating life of a conventional soil absorption system and may provide successful onsite wastewater disposal in marginally suitable soils. State rules require that each field be sized at 75 percent of the total field area requirement.

A manually operated diversion valve placed between the septic tank and the distribution systems of the two drainfields directs the flow to the desired field. Fields are usually switched every six to twelve months. This technique should be used along with water conservation measures in order to reduce the amount of wastewater that goes into the field. Various valves are available for about $50. There are additional costs for the extra drainfield.

Advantages:

Provides for drainfield resting and possible restoration of natural soil infiltration.

Extends operating life of a conventional soil absorption system on marginal soils.

No maintenance requirements other than switching the valve once a year or once every six months.

The alternating field system lasts longer than conventional absorption fields, due to the rest that is given each field.

Can be used on conventional absorption fields with only small changes. These changes can make onsite wastewater disposal possible where poor soil percolation might make conventional absorption fields impossible.

Potential Limitations:

If a valve is not switched over, one half of the system may become overloaded and fail.

Increased initial costs of additional drainfield.

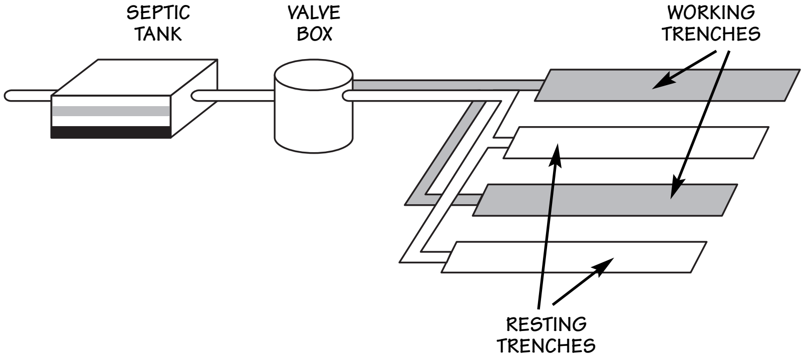
These systems do not change the percolation of the soil, they just allow it to "rest" more often.

These systems require adequate land area.

Dosing Siphon

A dosing siphon is a gravity flow device that delivers wastewater through pipes in controlled amounts, or "doses," to the drainfield, so that all pipes discharge at almost the same time, evenly spreading wastewater throughout the field. A dosing siphon may be an appropriate modification to an existing septic system where site topography is suitable.

The system contains a storage tank



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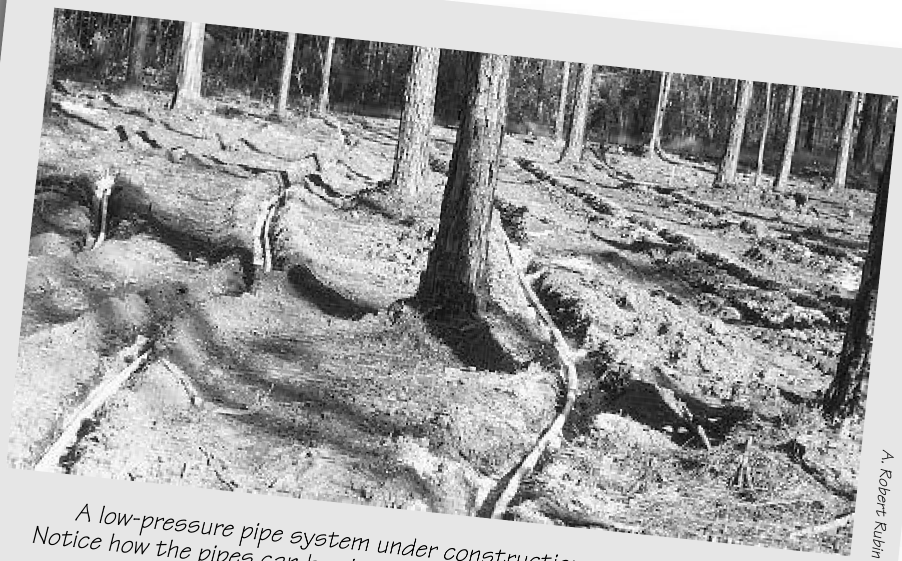
A septic system with alternating drainfields.



A. Robert Rubin

A low-pressure pipe system under construction on a wooded site. Notice how the pipes can be placed around trees and other obstructions.

with an automatic siphon that discharges a measured volume when the effluent reaches a certain level in the storage tank. The siphon is usually an inverted U-shape or bell design. The storage tank-siphon unit is placed between the septic tank and drainfield. There must be enough difference in elevation between the chamber and the drainfield to provide the hydraulic head needed to operate the siphon. Not all sites will have suitable topography.

Basic components include a septic tank, a storage tank equipped with discharging siphon with a pump, controls, and alarms and a conventional soil-absorption system or, at appropriate sites, low-pressure pipe systems. A system with a dosing siphon will cost about 10 to 25 percent more than a conventional onsite system. This cost is for the tank, dosing siphon, pump, controls, and alarms.

Advantages:

Effluent dosing provides a resting period for the drainfield to become re-aerated and partially dried.

Dosing provides more even distribution of effluent over the drainfield than conventional gravity flow.

The gravity siphon does not rely on a mechanical pump.

Can be used on conventional absorption fields with only small changes. These changes can make onsite wastewater disposal possible where poor soil percolation might make conventional absorption fields impossible.

Potential Limitations:

Cannot be adapted to all locations due to the need for sufficient slope.

Needs mechanical parts, maintenance, and constant monitoring.

Additional cost over conventional system.

Low-Pressure Pipe Systems

Low-pressure pipe systems are one of the most commonly used alternative onsite wastewater systems. They were designed specifically to overcome and address soil and site limitations frequently found in North Carolina. They utilize small-diameter pipes, placed in trenches at a shallower depth than conventional systems. Effluent is pumped or siphoned in controlled doses from the pump tank and moved under pressure through small holes in the pipe to ensure uniform distribution throughout the absorption field.

LPP distribution is appropriate for areas with shallow groundwater tables or shallow soils (because it places the treatment near the top of the soil profile) or on steep slopes that require hand excavation and are difficult to design. It is well suited to soil-limited situations that are less severe than those requiring a mound.

The distribution system is virtually the same as that used in a mound system. Unlike the mound system, the LPP system does not require importing large amounts of sand, gravel and topsoil. The LPP system utilizes the upper 24 inches of soil for effluent treatment and disposal.

Basic components include: a septic tank (1,000-1,500 gallons); a pumping tank (same size of septic tank in clay soils); a high water alarm (which sounds if the effluent pump fails); ⅓- to ½-horse power submersible effluent pump; (4) 1½- to 3-in. PVC manifold pipe with "T's" and elbows; (5) 1¼- to 1½-in. PVC laterals with 5⁄32- to ¼-in. holes usually at 3- to 5-ft. intervals; and, (6) gravel backfill for shallow, narrow trenches.

LPP systems can be installed by competent septic tank and landscaping contractors. Special equipment includes a small front-end loader and a trenching machine. Because of the narrow width and shallow depth of LPP trenches, installation of the absorption field does not require a backhoe. The amount of excavation and gravel is much less than for a conventional system.

Particular care and attention must be exercised before and during construction to protect the designated drainfield area from disruption and compaction by heavy equipment, including the septic tank delivery truck. Such site-specific access requirements should be carefully considered during initial site approval and layout of the house and disposal system. Proper drainage and protection of the system from surface runoff must be provided. The absorption field should have a well-maintained and closely mown vegetative cover. Electrical service is needed for pump and control operation.

Installation expenses are higher

than those of conventional septic systems. Although an extra pump tank and pump must be provided, some savings are realized through the reduction of labor and materials needed for excavation and fill of the shallow pipe systems. Installation may require 15 to 40 work hours, depending on size and other site-specific variables. Total capital costs range from $4,000 to $6,000. Maintenance costs are associated with pump maintenance and repair as well as septage removal about every four years. Maintenance by the required certified operator will raise costs as well.

Advantages:

LPP systems overcome many site limitations of shallow soil or shallow groundwater.

LPP systems creates a uniform distribution of effluent, which reduces the likelihood of ponding because effluent is distributed over the entire absorption area.

Dosing and resting cycles help maintain aerobic conditions in the soil, improving treatment.

Shallow placement of LPP systems provides for maximum vertical separation from groundwater and restrictive horizons, and disperses effluent in the most biologically active zone of the soil.

The LPP system's narrow trenches minimize disturbances to soil during installation and utilize sidewall absorption, providing better aeration.

LPP systems require smaller land areas because the sites are more fully utilized for treatment and disposal.

LPP systems are not restricted to gravity flow, allowing the use of dislocated or higher drainfields.

LPP systems allow for unequal lateral lengths, since effluent is discharged at similar rates per unit length of lateral.

Can be installed on a wooded lot without removing all of the trees.

Potential Limitations:

Installation costs are higher than conventional septic systems. LPP systems require specialized design and supervision of site-specific details of topography, drainage and site preparation.

LPP systems involve increased maintenance costs. Maintenance by a certified operator is needed to flush the lines at least annually. They may require substantially more inspection time than conventional systems.

In poorly drained areas, or during periods of wet weather, leaky LPP pump tanks would become sinks for the surrounding ground and surface waters.

Fields must be protected from all surface runoff or trenches may become hydraulically overloaded.

Orifices and laterals can clog if inadequately maintained.

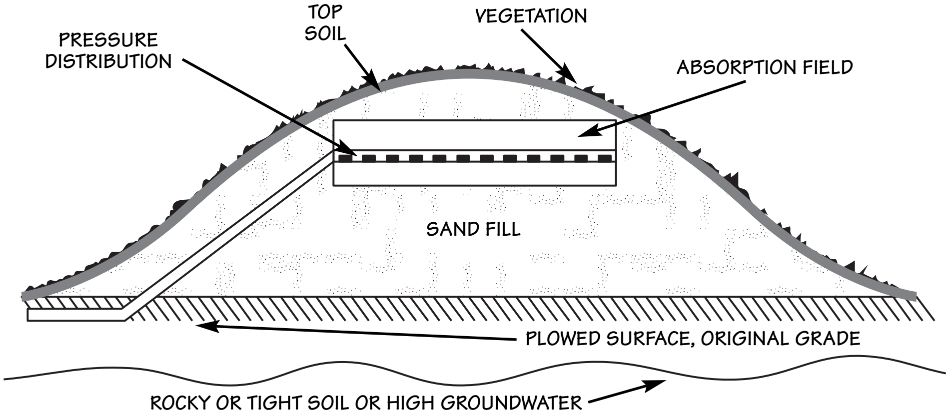
Need for immediate repair (within three days) in case of pump failure.

Mound Systems

A mound system is an elevated soil filter for treating domestic wastewater. Instead of an absorption field with pipes running below the ground, a mound system uses an elevated mound of sandy soil which covers a plowed field. Wastewater is pumped from a pump tank in controlled doses to a manifold pipe that goes into the mound. The wastewater then moves by pressure through a series of drill perforated plastic pipes connected to this manifold and used to distribute wastewater to the soil. Plants on top of the mound absorb some of the wastewater, and then "breathe" it into the atmosphere in a process called evapotranspiration. The rest of the wastewater is filtered and cleaned as it flows through the mound and gravel layer to the soil below.

Mound systems can be used where conventional and low-pressure pipe absorption fields are not possible due to shallow water table, porous bedrock, or shallow, tight or rocky soil. During periods of dry weather some of the wastewater evaporates through the plants and less needs to go to the soil. Wastewater that does enter the soil has already been filtered by the mound. However, there are potential problems between the compatibility of the mound material and the underground soil, which can lead to a leaching of the effluent at the base of the mound. Mound construction and maintenance may involve substantially more time and costs then conventional systems.

If designed and constructed carefully, mound systems can be installed by competent septic tank and landscaping contractors. Tillage of the mound area is required. A front-end loader/backhoe is usually needed. Particular care and attention must be exercised during construction to protect the mound area from the compaction by heavy vehicles. Much of the grading and leveling of fill material (sand, gravel, topsoil) must be done manually to insure protection from the mound. Proper site drainage and protection of the system from surface runoff must be provided. The mound



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A cross-section of a mound system for treatment and disposal of septic tank effluent.

John S. Myers

A mound under construction in eastern North Carolina. Notice the dosing chamber and control box between the mounds as well as the system's close proximity to the house.

surface should have a well-maintained, closely mowed vegetative cover. Electrical service must be provided for the pump and controls.

Mound systems vary in size with site-specific loading and soil criteria, but the basic components are the same: a septic tank (1,000-1,500 gallons); a pumping tank; a ¼- to ⅓-horsepower submersible sump pump; a 2- to 3-in. PVC manifold pipe with "T's" and elbows to connect laterals; 1¼- to 1½-in. PVC laterals with 5⁄32- to ¼-in. holes 3 to 5 feet apart; gravel trenches or distribution beds; sand fill; topsoil; a cap of less-permeable material over the mound; and, a vegetative cover.

Costs of the installed system are higher than conventional and low-pressure pipe systems due primarily to the need for labor and imported sand, gravel, and topsoil. Installation may require 50 to 100 labor hours, depending on site variables. Total capital costs are about $10,000. Maintenance costs are associated with pump service and repair, as well as septage removal every five to eight years or as inspections determine. Maintenance by a required certified operator will raise costs as well.

Advantages:

A mound allows septic systems to be used in places where absorption fields are not possible due to soil that is too thin, too tight or too loose, or due to a shallow water table.

Mound systems can operate in all climates.

Mound systems require little maintenance.

Potential Limitations:

The cost of properly constructing a mound system is about $6,000 to $7,000 over the cost of a low-pressure pipe system.

The mound must be well-constructed relative to site-specific details of topography, drainage, water table fluctuations, and site preparation. The system must be monitored or failure will result, causing "blow-out" of the wastewater through the sides or base of the mound. Monitoring is done by checking to see how "full" of wastewater the mound is. May require substantially more inspection time than conventional septic systems.

It is not likely that mound systems can be adapted to high density developments with adjacent lots of less than one acre.

Prefabricated Permeable Block Panel Systems

Prefabricated permeable block panel systems (PPBPS) replace the conventional drainfield trenches with a series of panels of specially designed hollow concrete blocks in gravelless trenches. Effluent passes through the porous walls of the blocks and infiltrates into the adjacent sand. Panel block systems are commonly used in rural areas on sites where space is limited for conventional systems.

Basic components include a conventional septic tank and porous block panels joined together in a two-foot wide trench system backfilled with sand. The special blocks must be ordered through the manufacturer, and carefully installed by a competent septic tank installer. Panel block systems may be used in conjunction with low-pressure pipe systems.

The cost of a porous block system alone is usually at least 50 percent more than a conventional septic system.

Advantages:

Blocks may filter out suspended matter before effluent enters the soil.

Based upon the premise that pretreatment is affected, system size is reduced by more than half compared to a conventional system, under state rules.

May improve sidewall distribution of effluent.

Patented block panels are readily obtainable.

Potential Limitations:

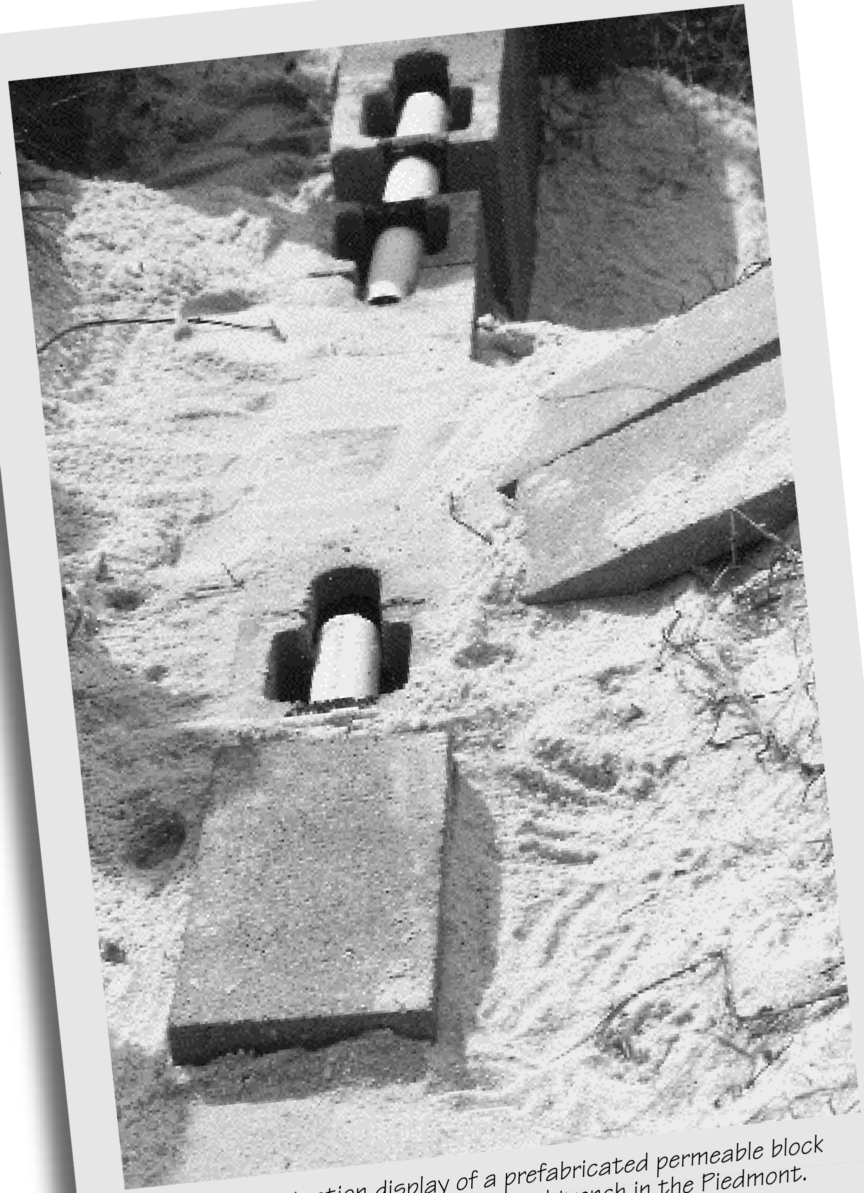
Installation cannot be done by septic tank contractors lacking training.

Relatively high cost.

Requires deeper soils with suitable characteristics compared to some other alternative systems.

Leaching Chamber Systems

Other types of gravelless drainfield systems have drainfield chambers with open bottoms and a variety of technologies



Stephen J. Dear

A demonstration display of a prefabricated permeable block panel system installed in a sand trench in the Piedmont.

at the sidewalls. These technologies have included concrete and plastic chambers used extensively in the north eastern United States.

Gravel drainfield systems perform three functions: defining the area where the soil contacts and absorbs the effluent; distributing the effluent along the length of the trench; and, providing a storage volume for the effluent. Gravelless systems are designed to provide the same functions as drainfields with gravel while overcoming potentially damaging impacts of gravel such as compaction of moist soil during installation and reducing infiltration by obstructing the soil. The leach chambers create a larger contact area for the effluent to infiltrate into the soil, providing more efficient treatment. Some of these systems can be combined with mounds and pressure distribution systems as well. Some can also be used for stormwater management applications.

Advantages:

Installation is generally faster, easier, and less messy than using gravel.

Soil at the trenches is not as likely to be compacted by gravel placement.

May be less expensive in areas where gravel must be trucked in, such as parts of eastern North Carolina.

Some chambers limit soil and silt intrusion into the leaching chambers.

Some have storage volumes that are significantly greater than gravel trenches or beds.

Inspection of the chambers is generally easy.

Eliminates the need for gravel.

Potential Limitations:

Cost may be high compared to conventional drainfield systems.

Large-Diameter, Fabric-Covered Pipe

Another gravelless drainfield system uses large diameter corrugated plastic tubing covered with a permeable nylon filter fabric not surrounded by gravel or rock. The area of fabric in contact with the soil provides the surface for the effluent to infiltrate the soil. The pipe is a minimum of 10 to 12 inches in diameter covered with a spun bonded nylon filter fabric, which together are meant to wick water around the pipe. The pipe is placed in a 12- to 24-inch trench.

These systems can be installed in areas with steep slopes with small equipment and in hand dug trenches where conventional systems would not be possible, which may also save money and reduce the number of trees to be removed from the lots. However, while possibly saving on labor and gravel costs, fabric-wrapped pipe cannot overcome unsuitable site conditions and should not be installed in areas where gravel systems would not be expected to function properly.

Advantages:

Installation is generally faster, easier, and less messy than using gravel.

May be appropriate for a site with steep slopes.

Soil at the trenches is not as likely to be compacted by gravel placement.

May be less expensive in areas where gravel must be trucked in, such as

A leaching chamber system being installed in a heavily wooded area.

parts of eastern North Carolina.

Ports in the pipelines make inspection easy.

Eliminates the need for gravel.

Potential Limitations:

The pipe wrapping may have a permeability and pore size similar to that of a medium sand, which has lead to premature failures in some coastal installments in sandy soils.

These systems require more precise installation than gravel systems.

To effectively utilize all of the trench-sidewall interface the pipe must be at least half full of effluent.

The fiber wrapping may become sealed by a slime called ochre, which reduces permeability through fiber. This problem can be treated by trained personnel.

RUCK System

The RUCK system is an underground system of wastewater treatment designed to improve upon the performance of conventional septic systems in removing nitrogen, phosphorous and bacteria. The system uses separate blackwater and greywater influent and requires no energy supply. Blackwater flows through a septic tank for pretreatment, then through a sand filter with vents and in-drains for aeration, is introduced into another septic tank along with greywater, and the effluent later flows to a drainfield. Soap has been used in place of greywater as an organic carbon source for commercial systems where no greywater is available. The RUCK system is reported to have been used at over 80 homes, shopping centers, condominiums, office buildings and schools elsewhere in the United States but has not yet been proposed for use in North Carolina. Test data on the system's performance is very limited.

Drip Systems

Using drip systems, treated wastewater effluent can be distributed at low rates either below or onto land surfaces. Drip systems may be appropriate in conditions where conventional drainfields are not acceptable. Drip systems can be used for final disposal of treated effluent or for irrigation and tertiary treatment and disposal of effluent. Most drip irrigation systems are used for subsurface applications. Drip irrigation systems may also provide supplemental irrigation for crops. Drip disposal systems are designed based upon a maximum hydraulic or nutrient loading rate without exceeding the assimilative capacity of the soil.

In drip systems wastewater flows to a dosing tank. When filled to a certain level the dosing tank begins to pump the effluent to distribution lines in controlled doses. The distribution line provides for an exact amount of wastewater to be discharged from each of its emitters, which are normally spaced at two-foot intervals along its entire length. The pressure of the effluent in the lines can be adjusted so that large quantities of wastewater may be distributed over long periods of time without saturating the surrounding soil, thus eliminating the possibility of run-off or wastewater forming ponds on the surface. These systems may also contain back-flushing equipment which removes the filtered materials and discharges them into a collector manifold and returns them for pretreatment. Some versions of this system may also automatically flush and clean the dripper lines at regular intervals to avoid clogging. North Carolina currently requires that drip irrigation systems use a sand filter prior to effluent entering the system.

Drip systems will permit wastewater disposal in land areas that are used for such purposes as parks, athletic fields, groves, or highway right-of-ways. This system is especially suited for landscaped or wooded areas around buildings, trailer parks, apartment complexes or residential subdivisions.

The cost of these systems for individual households is about $6,000 each.

Advantages:

Topography is not a limiting factor for use of drip systems.

No gravel is required.

May be used where poor soils, shallow water table, or lack of space limit conventional onsite systems.

Installation of the system has little impact on the site, even on established lawns and gardens, because the field distribution lines require very little soil disturbance and the volume of discharge from each emitter hole is small.

Potential Limitations:

Sites with heavy clay soils may limit the effectiveness of drip systems.

Very small openings in emitter lines leave a potential for clogging.

Drip systems require reliable maintenance monitoring and the backup support of the manufacturer.

Care must be taken not to damage the emitter lines and the connections between the manifolds and the drip lines by driving trucks or heavy equipment over fields containing the lines.

Drip lines on ground surfaces are more susceptible to vandalism.

Steven J. Berkowitz

Drip emitters showing a controlled discharge of 0.5 gallons per hour.

A. Robert Rubin

A drip disposal system under construction in eastern North Carolina. Note the feeding of emitter lines and minimal site disturbance.

Sand Filters

Sand filters are slow-to-moderate-rate filtration systems (1.5 to 5 gallons per square foot per day) using beds of granular materials. Sand filters have been used in Europe for nearly 200 years, predating modern conventional wastewater treatment systems. Sand filters are useful in cases where the soil is too thin or too permeable or where the water table is shallow. Sand filter systems require minimal operator attention and skill.

Sand filters may use stabilization ponds or septic tanks to first remove the solids from the wastewater. The wastewater then flows from the pretreatment unit into a filter with two to three feet of clean, graded sand and one foot of gravel on the bottom. The treated water can be collected in a pipe in the bottom of the sand filter tank and discharged into the soil, or disinfected and reused in irrigation, or, if clean enough, discharged into rivers or streams. During its passage through the filter, the wastewater is treated further by biological and physical processes that remove harmful dissolved constituents.

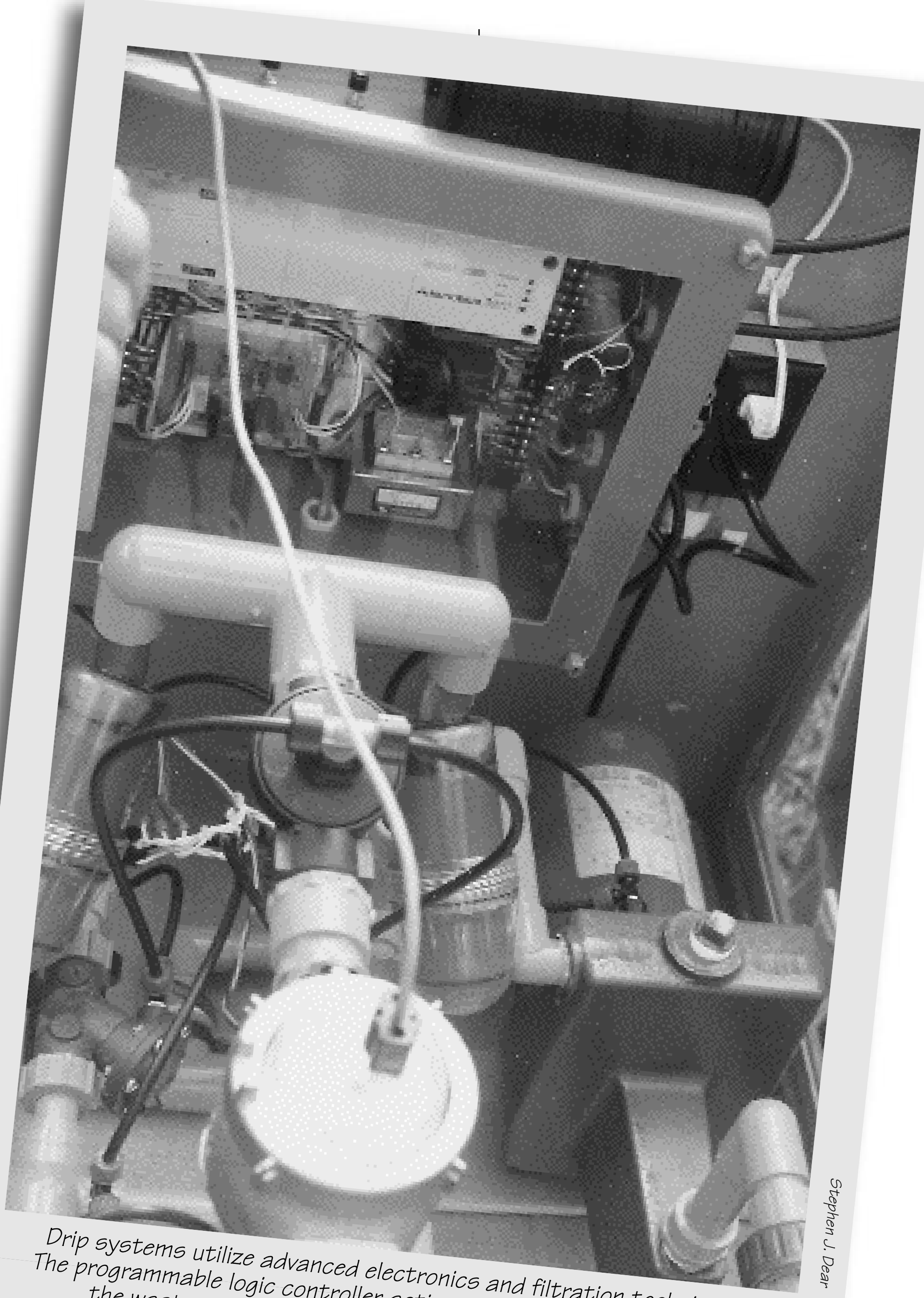
The sand filter can be built above or below ground. Some sand filters return the wastewater back through the filter a second time in order to provide even cleaner wastewater. These are called recirculating sand filters (RSFs).

Sand filter systems can be constructed for onsite applications or for a community's cluster system. Sand filters may be ideally suited for populations less than 1,000. Filters have also been built using gravel and rocks instead of sand as well as materials such as slag and peat, but the material used will depend on the community's wastewater treatment needs.

Three types of sand filters are described below.

Buried Sand Filters

Pretreated wastewater is distributed through a network of pipes laid above the filter. Perforated piping beneath the filter collects and conveys the effluent for surface disposal. Buried sand filters are best suited for single-family residences and small commercial establishments.



Stephen J. Dear

Drip systems utilize advanced electronics and filtration techniques. The programmable logic controller activates the pumps which equalize the wastewater flow in a 1,000-ft. system in two seconds.

Intermittent Sand Filters

Intermittent sand filters are also known as single-pass, free access, and open sand filters. Wastewater from either an aerobic treatment unit or a septic tank is applied to the filter surface by a distribution pipe. A buried concrete box structure is often used to contain the filter media and can be operated with or without a cover depending on the climate. When septic tank treatment precedes an open sand filter, two independent filters may be required to allow for recovery periods. Intermittent sand filters can handle larger wastewater volumes than buried sand filters and can also be used as small community, cluster, and commercial systems.

Recirculating Sand Filters

Recirculating sand filters are intermittent filters that treat a mixture of the pretreatment unit effluent and recycled filter effluent. When the system is operating properly, odors from the recirculation tank and open filter are usually not objectionable since septic tank effluent is mixed with aerobic effluent returning from the filter. After three or four cycles, the effluent is applied to subsurface or drip systems or disinfected and discharged to an appropriate receiving stream or drainageway. An advantage of the recirculating sand filter over conventional sand filters is that its low-pressure distribution system and effluent recirculation provide substantially better treatment. The RSF does not rely on soil absorption for wastewater treatment and disposal, so it overcomes the restrictions of many soil- or space-limited sites.

Sand filters are suitable for most climates and locations in North Carolina. Permits are required from local health departments if the effluent is disposed below ground and from the N.C. Department of Environment, Health and Natural Resources, Division of Environmental Management, Water Quality Section for all other effluent disposal methods.

Sand filters can be constructed in hilly and flat areas. The top layer of sand may need to be periodically removed or replaced if clogging occurs. A lot size of 0.25 acres is usually large enough for installation of a sand filter, but building a sand filter may not avoid the local zoning requirements for septic tanks.

The RSF may not be a feasible alternative for onsite wastewater treatment at many individual homes because of the need for system maintenance. Still, sand filters do represent a viable method of wastewater treatment for larger sources such as schools, mobile home parks, or clusters of individual homes where the traditional solution may have been an expensive package plant. A formalized management scheme is required by law for sand filter systems in North Carolina.

The installation of sand filters, especially RSFs, requires the careful coordination of system design, layout, excavation, materials, and landscaping. The filter bed must be properly excavated to a level base, and provided with an impermeable clay or plastic liner. The recirculating tank in a RSF must be placed at the proper elevation to accept filter effluent by gravity flow. Electrical service is needed for pump operation. The surface of the filter bed must be kept free from vegetation.

The design specifications for a recirculating sand filter will vary from site to site according to topography, available space, and system size. The components listed here are those needed for a system sized for an individual home: septic tank (1,000-1,500 gallons); a recirculating tank (1,000-1,500 gallons); a ¼- to ½-horsepower submersible sump pump with timer; a PVC distribution manifold and laterals; a filter bed (sand, gravel, underdrain, and liner material); a disinfection apparatus; a discharge pipe; and, a flow splitter or recirculation device.

The average construction costs of a sand filter that would serve a four-bedroom house having a 1,000-gallon septic tank and a design flow of 480 gallons per day are $3,500 to $5,500 if it is buried; $5,000 if it is open; and $5,500 if it is recirculating. Material costs are increased by the need for imported sand, gravel, pump, and a disinfection system, if necessary. Labor requirements may range from 50 to 100 work hours for installation of a RSF. Operation and maintenance expenses are associated with pump service and repair, periodic replacement of the upper layer of filter media, normal removal of septage from the tank, and appropriate chemicals for the disinfection system. Sand filters require maintenance by a certified operator. The total annual costs of a recirculating sand filter suitable for a cluster of 3 to 25 homes (design flow of 1,000 to 10,000 gallons per day) will be substantially less than for a package plant or lagoon system of equivalent capacity.

Advantages:

Sand filters can be used for onsite, cluster, or community systems.


Steven J. Berkowitz

An intermittent sand filter in the Piedmont.
Note the small-diameter effluent distribution lines which help assure uniform distribution of effluent over the filter surface.

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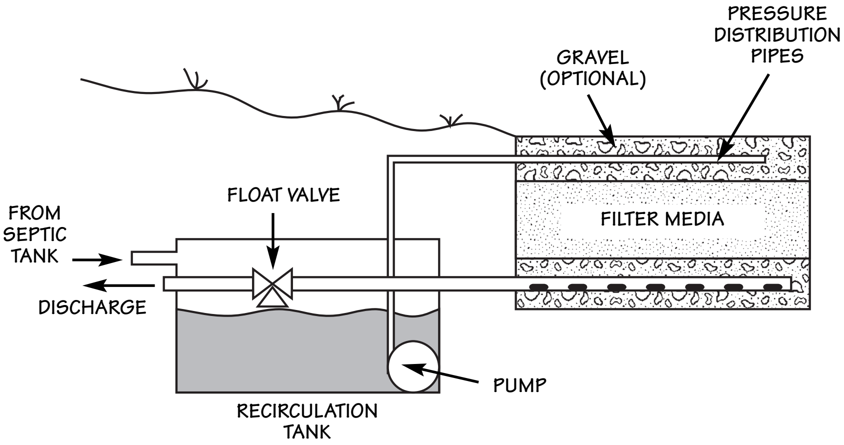

A recirculating sand filter provides excellent treatment.

Sand filters produce high-quality effluents, significantly better than those produced by stabilization lagoons.

RSFs may have lower costs than comparable package plants.

Sand filters require little maintenance or highly skilled personnel.

Filters can be used in combination with existing septic tanks and therefore may provide a low-cost improvement to a system that is not properly treating wastewater.

Sand filters are relatively inexpensive to construct and have low energy requirements.

Sand filters may prolong the usable life of the soil absorption system by reducing clogging of the soil.

Potential Limitations:

Clogging of the sand filter and the resultant maintenance have proven to be a problem in the past. Repair costs of the filter and the additional capital investment involved in construction in some cases may not be justified in terms of the benefits of additional treatment and reduced clogging of the soil absorption system except under extreme circumstances.

Sand filter systems, especially RSFs, require specialized design and supervision of site-specific details such as topography and drainage. Filter materials and depth must be chosen carefully depending on the wastewater treatment needs of the community. These systems may require substantially more layout, design, inspection time and cost than conventional onsite systems.

Adequate distribution of effluent in the filter is difficult to achieve in a gravity-feed system.

The filter sand may need to be replaced periodically.

It is difficult to achieve sufficient fall in some lots to operate as a gravity-feed system.

Open filters may need to be located away and downwind from houses because of possible odor.

Constructed Wetlands and Aquatic Plant Systems

Constructed wetlands and aquatic plant systems are promising and fairly recent systems of wastewater treatment, especially as polishing facilities for tertiary treatment. Wetlands are land areas that are inundated or saturated by surface or ground water for enough of the year to maintain saturated soil conditions and promote related vegetation. One of the first developers of constructed wetlands was the National Aeronautics and Space Administration, which researched the system as a possible means of reusing limited supplies of water in future space stations.

The most appealing aspect of constructed wetlands systems for wastewater treatment is that the system can operate in cold as well as warm climates when the soil is not deep enough for conventional onsite systems or when the water table is shallow. Constructed wetlands systems also need minimum attention, simply plant inspections and harvests at the end of the growing seasons and replanting as needed.

John S. Myers

Three cells of a constructed wetlands operating in eastern North Carolina. Notice the lush vegetation.

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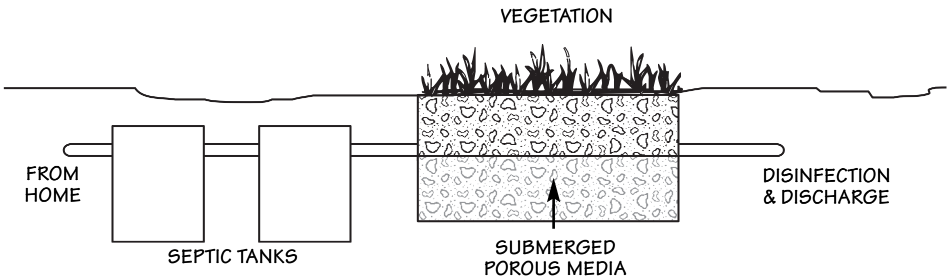
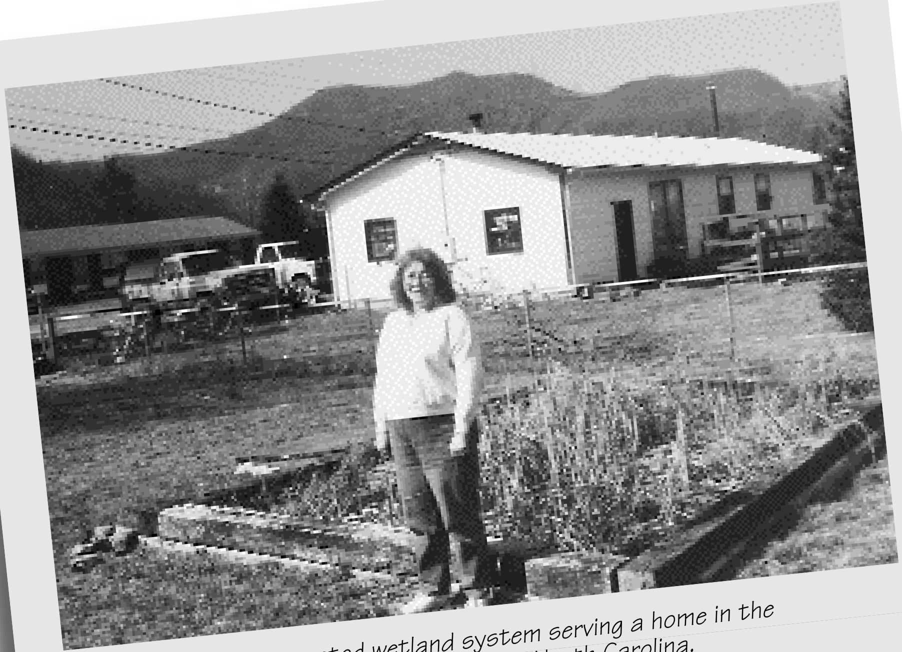


A sub surface constructed wetlands treatment system.

Constructed wetlands known as free water surface wetlands use shallow, swampy marshes to clean wastewater from communities and individual households. Another more common type of constructed wetlands, known as subsurface flow systems, uses water flowing not above but below the surface, flowing horizontally through the substrate and plant roots. A vertical flow constructed wetlands holds wastewater that flows down through the substrate and along plant roots and then moves horizontally when it contacts an impervious liner.

The treatment of the wastewater involves settling and filtering solids, bacterial feeding, and some water uptake and evapotranspiration from plants and soils. Physical, chemical and biological processes develop through the interaction of plants, soil, water and microorganisms.

In aquatic plant systems the plants themselves bring about little actual treatment of the wastewater. Instead, they support components of the aquatic environment that improve the wastewater treatment. Systems using aquaculture include aquatic animals such as fish, mollusks, and crustaceans to aid in treating the wastewater. Experience has shown that constructed wetlands should use aquatic vegetation or water-tolerant plants found locally and preferably grown in nurseries in order to function best. The plants used for constructed wetlands such as cattails, reeds, rushes, sedges, and the various aquatic plants such as water hyacinth, duckweed, and waterweed act as surfaces on which bacteria grow and for the absorption and filtration of solids. The wetlands plants also help reduce the growth of algae, transport oxygen deep into the soil, gravel, or sand, and otherwise help maintain the conditions needed for adequate treatment.



Stephen J. Dear

A constructed wetland system serving a home in the mountains of western North Carolina.

Constructed wetlands require the installation of a liner under the constructed wetlands that is made of a thick plastic material that will not allow the untreated wastewater to flow into the groundwater. In some cases an impermeable layer of compressed clay can act as a substitute. Primary treatment (septic tanks for small-scale systems) or more often secondary treatment is used prior to the constructed wetlands. Onsite constructed wetlands would typically spray irrigate or use subsurface disposal. Disinfection is also required prior to final discharge. In certain situations, the effluent can be disposed in soil.

The climate in most, if not all, of North Carolina is suitable for these systems. Colder climates require larger areas of land for centralized or cluster systems.

Onsite constructed wetlands costs are competitive with other technologies.

Advantages:

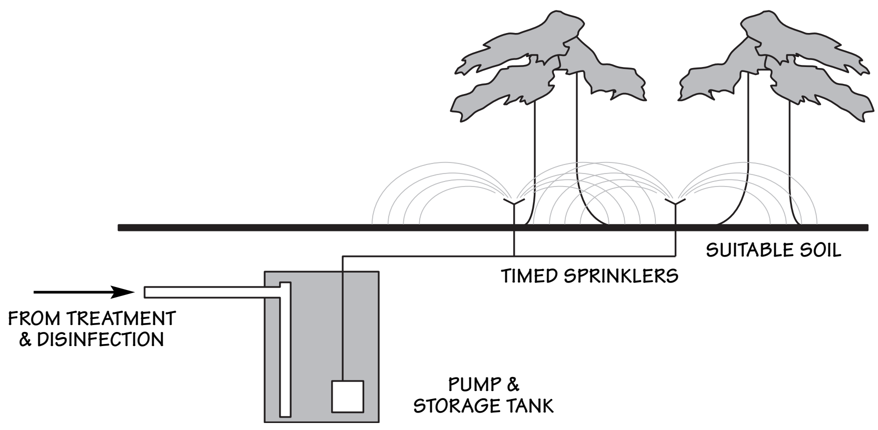
As a “passive” wastewater system, constructed wetlands systems are simple and less costly to design, operate and maintain.

Constructed wetlands and aquatic plant systems require little or no energy or chemical additives to operate.

Constructed wetlands accommodate variations in the organic and hydraulic loading into the system, although the wetlands must be periodically flooded to sustain plant life.

Constructed wetlands can be used for a variety of residential, commercial and industrial applications, including agriculture, animal waste, stormwater runoff, mining leachate, landfill leachate, and aquaculture.

Wetlands attract desirable wildlife,



A spray irrigation system.

EPA

and have been used to create wildlife refuges and city parks.

Constructed wetlands are aesthetically pleasing.

The methane from harvested water hyacinths in aquatic plant systems can also be used for energy or the water hyacinths turned into fertilizer.

Constructed wetlands and aquatic plant systems in Europe and California have been used for the production of fish, representing a step toward the production of useful materials from waste as well as creating areas with diverse habitats and allowing increases in assorted animal species.

Potential Limitations:

As with any emerging technology, lack of familiarity among designers, regulators, and contractors with constructed wetlands and aquatic plant systems and a lack of generally agreed-upon design factors may currently inhibit full consideration of these technologies as options.

Constructed wetlands may not meet stringent limits on impurities such as nitrogen and phosphorous.

Some types of constructed wetlands may provide breeding grounds for disease-producing organisms and insects and may generate odors if not properly maintained.

Wetlands treatment may not be suitable for wastewaters containing high levels of pesticides, industrial chemicals, or heavy metals.

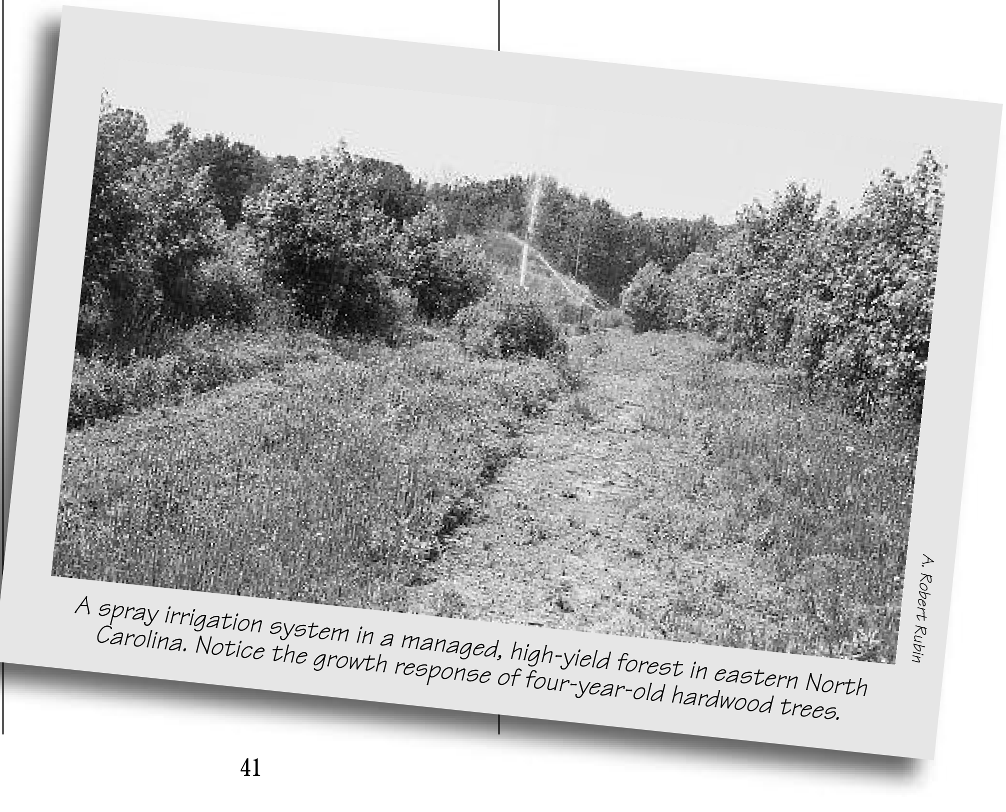
Slow-Rate Spray Irrigation

Slow-rate spray irrigation systems apply pretreated wastewater through flood or sprinkler irrigation to woodland or cropland. Wastewater irrigation is one of the oldest and most reliable alternative treatment technologies and can be used for both onsite and larger applications. Slow-rate spray irrigation is particularly appropriate where strict surface water discharge regulations would require a costly facility. It is also a relatively simple process.

After removing most solids by septic tank or settling pond and disinfecting, the wastewater is pumped into an irrigation system for use on crops or trees. The wastewater is further treated in all of the soil layers through a process of filtering and chemical reactions and by plants absorbing the wastewater. The treated wastewater does not generally result in a surface discharge, but sometimes percolation through the soil is followed by gravity drain recovery of the wastewater and surface discharge of the treated effluent.

Slow-rate spray irrigation treatment systems can turn millions of gallons of industrial and municipal wastewater into irrigation water. Crop and forest irrigation is the most commonly used land-application technique. It not only reuses the water but the minerals and nutrients in it. After extensive preapplication treatment and disinfection treated effluent may be used on golf courses. In some cases annual revenues from the sale of irrigated corn crops have resulted in much lower sewer bills, 30 cents per thousand gallons of treated sewage.

Slow-rate and other irrigation systems can be useful in overcoming site or soil limitations created by slowly permeable



A spray irrigation system in a managed, high-yield forest in eastern North Carolina. Notice the growth response of four-year-old hardwood trees.

A. Robert Rubin

Wastewater irrigation is one of the most reliable alternative treatment options.

soils, shallow soils, shallow water table, or sites with complex slopes. Spray irrigation can be used with lagoon effluent.

The basic components of slow-rate spray irrigation systems serving individual houses usually consist of a septic tank, a sand filter, a disinfection unit, a pump tank with a minimum five-day storage capacity, and the wastewater irrigation system with manifold and spray heads. Spray unit alternatives include center pivots, solid set sprinklers, or traveling guns.

If the system serves an individual house the field must be at least 200 feet from the house served by the facility, 400 feet from the nearest existing inhabited residence, and 150 feet from the property line. Slow-rate spray irrigation systems serving individual houses require a minimum wetted area of 0.2 acres. Sites should be of less than 20 percent slope.

Land, earthwork, distribution system, and storage facilities are the most significant capital costs. The land area required is dependent on the nature of the irrigated crop, soil characteristics, and acceptable application periods. Distribution costs can be affected by the type of system selected and site topography. Storage of up to 90 days may be required on some sites in North Carolina. Other sites require no storage. Other costs that should be considered are underdrain installation, if needed, transmission of wastewater to the treatment site, and pretreatment. The capital costs for spray irrigation systems in forested areas may be slightly higher initially than for agriculturally based spray irrigation systems. But the long-term operational costs are affordable to small rural communities.

Any slow-rate spray irrigation system installed in North Carolina must be approved by the N.C. Department of Environment, Health, and Natural Resources, Division of Environmental Management, Water Quality Section.

Advantages:

Slow-rate spray irrigation is well suited for treatment of wastewater from rural communities, seasonal industries such as vegetable canning, and many other industries operating daily.

This system can provide an economic return for the reuse of water and nutrients for irrigation of landscaped areas or production of marketable, commercially processed crops.

It provides groundwater recharge.

Compared to other land treatment methods, slow-rate spray irrigation is the least limited by surface slopes.

Spray irrigation in managed forests has several advantages, including the availability of large areas of forest land which are well drained and not subject to flooding as well as forests' capability of assimilating large quantities of applied nutrients through macrobial conversion, plant uptake, and soil adsorption.

Potential Limitations:

The soil must be tested annually to monitor soil fertility levels.

Storage areas are needed for wastewater during times when soils are too wet or too cold to clean water properly.

Rivers and streams should be protected from wastewater that may run off from wastewater irrigation before it trickles into the soil.

Soils must not drain too quickly.

These systems need enough land for system buffers and storage area; they need significantly more land than for other land-application methods.

Rapid Infiltration

Rapid infiltration is a successful and cost-effective method for wastewater management where site conditions are suitable. The process is normally used for wastewater disposal following tertiary treatment. It works in cold or wet weather and with porous, sandy soils and deep water tables.

Rapid infiltration uses shallow channels in deep, coarse, rapidly permeable soils, sometimes planted with grasses, that allow for moderate-to-rapid drainage.

Following tertiary treatment the wastewater flows into and through the soil, the soil dries, and is flooded again.

Rapid infiltration systems require less land than other land-application methods. This system returns more water to the groundwater than is evaporated into the air. Another option is constructing the channels with drains that allow for the recovery of filtered water which can then be used for things such as irrigation.

Soils should be deep (five to eight feet) and well drained, and land should be level. Usually the soil type used by a rapid infiltration system is sandy to sandy loam.

Basic components include a pretreatment facility, a basin piping for underdrains and inlet structures, an effluent distribution network, sewer lines to a treatment site, if necessary, and monitoring wells.

Other than the costs for preapplication treatment facilities, costs for a rapid infiltration system are largely affected by the costs of land acquisition and surface preparation, grading, and other earthwork. As with other natural wastewater systems the interrelationships among soil, water, and geohydrology are more complex than they appear, and as such specialized expert assistance may be required during design and construction.

Advantages:

These systems can be modified to operate in cold climates.

The maintenance requirements are minimal.

Potential Limitations:

Clay soils will not be suitable because the wastewater may not filter into the soil and therefore not be properly treated.

Areas with a water table level less than 15 feet deep should be avoided because of the potential for nitrate nitrogen impacts.

Rapid infiltration is not well suited for inorganic industrial wastewaters.

Steven J. Berkowitz

A rapid infiltration system with deep, rapidly permeable sandy soil in eastern North Carolina. Vegetation at these systems must be cut.

Compared to other irrigation systems, the hydraulic loading rates are greater and therefore leave a smaller margin of safety for errors and omissions in its design and construction.

Subsurface flow from one basin may influence the capacity of an adjacent basin.

Aerobic Treatment Units

Aerobic systems differ from septic systems by the introduction of oxygen into the wastewater. While a septic tank is anaerobic (without free oxygen) in nature, an aerobic system uses a tank with an opening or vent pipe above the ground. The aerobic treatment unit (ATU) has a compressor or air pump that forces oxygen into the wastewater, thereby creating an environment for microorganisms to grow 40 to 50 times faster and larger than in a septic tank. The bacteria in an ATU therefore digest the sewage components faster and more thoroughly than in a septic tank. The treated effluent is then pumped or flows by gravity to an absorption field.

Aerobic systems are most useful on sites with shallow water tables. A properly operating ATU system can reduce the pollution load as it relates to BOD and suspended solids by 98 percent, reducing the potential for groundwater contamination. Most ATUs can be fitted with a number of devices for additional treatment.

A variety of aerobic systems are commercially available and can be approved for use. However, ATUs must be maintained by a certified operator employed by or under contract with the county in which the unit is to be installed.

Advantages:

The liquid that comes out of the aerobic tank is cleaner than that coming out of septic tanks because aerobic processes decompose organic waste faster and more completely than anaerobic systems. Consequently, they produce less residual sludge and fewer odor problems.

Because of its higher quality, and increased amount of dissolved oxygen (DO), the liquid released from an ATU needs a smaller absorption field for filtering than is necessary for septic wastewater.

Due to the high dissolved oxygen content of the aerobic effluent, an aerobic system may be able to rehabilitate a failing drainfield by oxidizing soil-clogging organic matter.

A good aerobic system in conjunction with a properly designed filter system, can overcome some of the site limitations imposed by restrictive soils. Some ATU manufacturers will also guarantee the filter bed system as long as it is constructed to their specifications.

Potential Limitations:

Aerobic systems depend on a rather complicated mechanical apparatus that needs conscientious and expert maintenance.

Higher installation and maintenance costs compared to a conventional septic system and alternative systems such as low-pressure pipe systems.

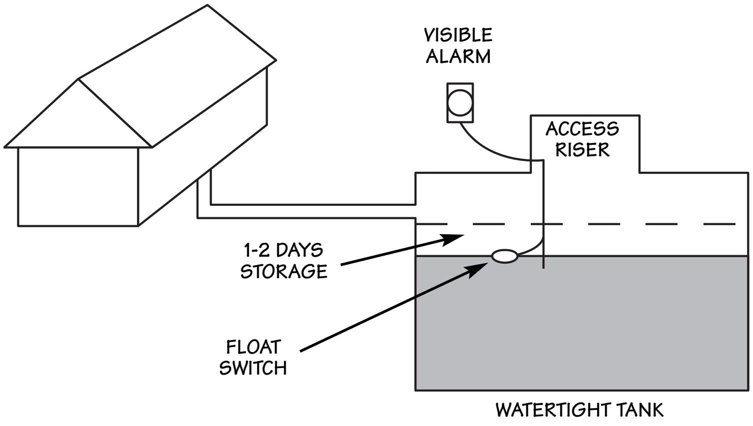
Aerobic systems need energy for the fan and for maintenance, and so they are often more expensive than most septic systems. Their dependence on power makes them more vulnerable to power failures.

ATUs require servicing and maintenance much more frequently than septic tanks. They require pumping about every one to three years.

Aerobic tanks can have problems with bulking of sludge, which can lead to poor treatment.

Aerobic systems may not overcome the site limitations of restrictive soils.

The minimum cost is $3,500 each and this includes only the ATU. Complete systems, including drainfield, may cost up to $10,000 or more.



EPA

A wastewater holding tank.

Holding Tank

A holding tank is an underground, water- and air-tight storage tank that is periodically pumped and the wastewater hauled away at a relatively high cost. This facility is almost never permitted in North Carolina, only as a short-term solution to a wastewater management problem. When a “pump and haul” permit is granted for use with holding tanks its maximum permitted use is six months. Local health departments will only allow a holding tank to be used while the regular onsite system is being repaired.

Other Onsite Systems

Septic systems installed at sites with saprolite, which is geologic material undergoing a slow process of breaking down in place to form soil, must be 50 percent larger than conventional systems or use low-pressure pipe drainfields.

A bermed infiltration pond (BIP) is an elevated mound of soil around an infiltration basin from which effluent slowly leaches into the soil. BIP systems are used in areas of Maryland, South Carolina and other states where there is insufficient soil to allow for treatment. BIPs are usually used for single houses. These systems require a buffer and fencing. Groundwater supplies at some BIP systems have been contaminated. BIPs are currently not approved for use in North Carolina.

CHAPTER 7

Cluster Wastewater Systems

Onsite technologies can be incorporated into systems serving a cluster of two or more houses. Examples include several houses using a common septic tank and absorption field or sand filter, individual houses with separate septic tanks sharing a common absorption field or sand filter, or a system of several homes connected to a small mechanical treatment plant.

Cluster systems are useful for developments, subdivisions or small groups of existing homes in rural areas that are too far from sewer lines or where conditions are not suitable for several individual onsite systems but where local conditions are still suitable for wastewater treatment and disposal and land costs are low. Cluster systems with a community soil absorption field are generally more complex and require more attention than individual septic systems.

A variety of options may be used for collection and treatment in a cluster system. They will depend on the soil suitability, topography, number of homes, proximity of homes to each other, and proximity to the treatment facility. Collection systems might be a combination of conventional gravity and pressure sewers.

Suitable legal and institutional arrangements are essential to specify system ownership and to insure proper operation and maintenance. Cluster treatment and disposal may be more feasible for new, rather than existing developments. These systems generally use more pipe than individual onsite systems, and often use small-diameter sewers.

Advantages:

Overcomes site limitations of some otherwise unsuitable lots.

Optimizes best uses of land in a subdivision or development.

The system can be maintained and paid for by the group of households, instead of each individual household having to be responsible for its own system. In some cases, small cluster systems can reduce the costs per household compared to larger, centralized systems or some alternative onsite systems.

Adding new users to the system is usually not a problem.

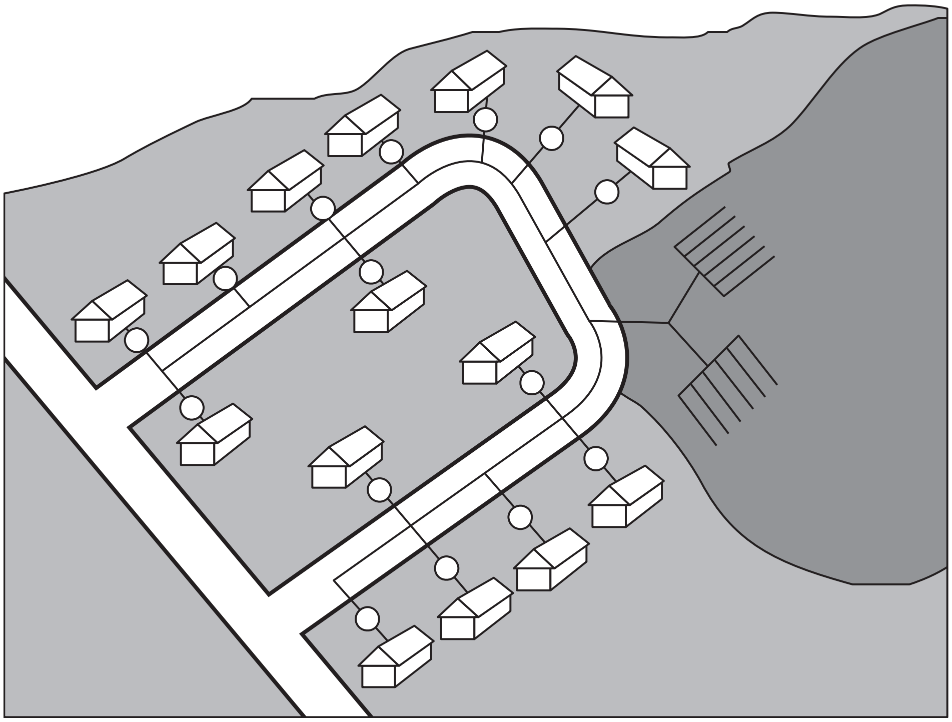
Potential Limitations:

Appropriate institutional arrangements specifying ownership and maintenance responsibility may be difficult to formulate.

Skilled certified operators will be needed for the wastewater treatment facility. This adds to the costs per household.

A soil absorption cluster system will probably require a relatively large plot of land.

A variety of technologies may be used in a cluster system.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A cluster system with a common drainfield.

CHAPTER 8

Disinfection of Treated Wastewater

Disinfection is used to destroy potential disease-causing organisms in the wastewater stream. Since disposal of wastewater to surface water may result in potential contacts between individuals and the wastewater, disinfection processes to reduce the risk of infection will always be required by local or state health departments depending on the type of system used.

Disinfection is not a substitute for other forms of wastewater treatment, and generally requires the addition of special equipment at the end of the treatment process. The most common method of disinfection is chlorination. Ozone and ultraviolet light systems also disinfect wastewaters and destroy or remove harmful organisms.

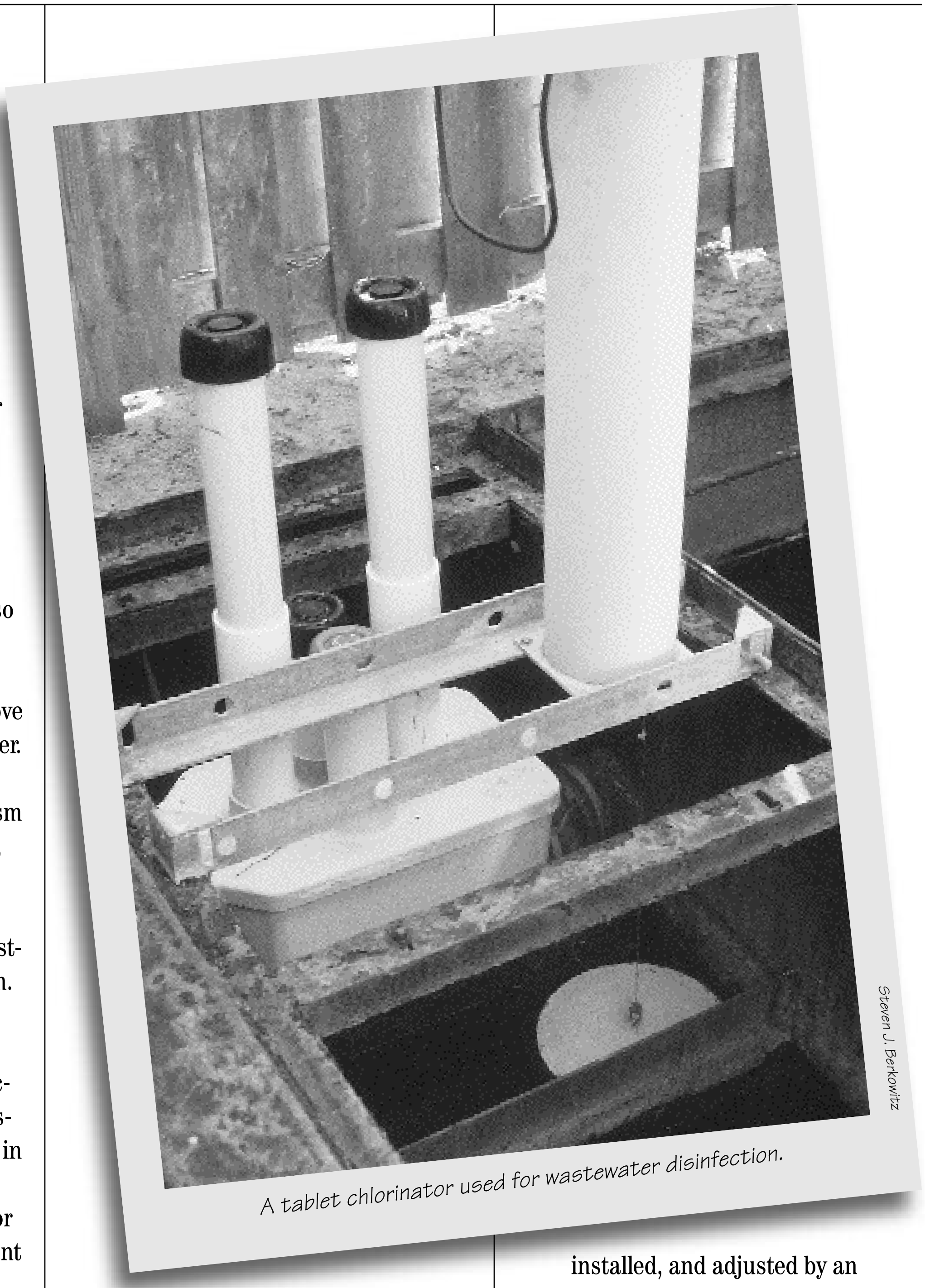
Disinfection does not always remove all of the harmful organisms in the water. For example, chlorination may not remove the eggs or cysts of the organism that causes amoebic dysentery; hence, other forms of disinfection may be required.

Routine maintenance and water testing are needed when using disinfection.

Chlorine

Chlorination is the most cost effective and most widely used means of disinfecting small wastewater discharges in the United States. The application of chlorine is a method that deactivates or kills many of the microorganisms present in wastewater.

Chlorine can be applied in gas or tablet form, or as a liquid solution of hypochlorite salt. The use of solid or liquid chlorine is much more practical for small systems than is chlorine gas.



Steven J. Berkowitz

A tablet chlorinator used for wastewater disinfection.

Chlorine is also often used for disinfection prior to land application of wastewater.

When used in wastewater disinfection, a chlorinator should be selected, installed, and adjusted by an expert in disinfection processes. It is important that enough chlorine is added for proper disinfection, but not so much as to threaten downstream aquatic life. Proper chlorine dosage depends on chemical characteristics (such as BOD and COD) of the wastewater, and requires the judgment of an expert. Effluent should be tested routinely for proper chlorine levels.

The process of dechlorination using sulfur dioxide has come into increased use due to rising concerns over chlorine toxicity and protection of fish and wildlife in sensitive waters. Dechlorination removes all or part of the chlorine residual remaining after chlorination, and reduces or eliminates chlorine toxicity harmful to aquatic life in receiving waters.

Chlorinators suitable for small wastewater flows are available for about $250 to $600.

Advantages:

Chlorine is low cost when compared to other disinfectants.

Chlorine is reliable as a disinfectant in proper dosages.

A variety of chlorination devices are readily available.

Potential Limitations:

Chlorine is toxic to aquatic, estuarine, and marine organisms, so careful, measured dosing is required. An additional hazard is the cancer-causing potential of chlorine after it reacts with decomposing organic material, a combination known as trihalomethanes. Other harmful residual chemicals such as chloroform may be produced and would persist downstream of the discharge. Chlorine gas is potentially toxic when inhaled and chlorine transport is a risk.

Chlorination requires conscientious maintenance, including periodic testing of water for proper chlorine concentration.

Ozone

Ozone has been used as a disinfectant for over a century. A pale blue gas with a pungent odor, ozone is a more potent disinfectant than chlorine and reacts quickly. As an unstable form of oxygen (O3), ozone is produced by the passage of an electric current through a stream of air. Disinfection is achieved by bubbling ozone through wastewater in an appropriate contact chamber. As a high-technology process, ozonation requires expert installation and maintenance.

A. Robert Rubin

A small ozone generator used on an experimental basis for wastewater disinfection.

Small ozone generators cost more than $2,000. Operating expenses are moderate due to the large amount of electrical energy required.

Advantages:

Ozonation is a safe, effective means of disinfection. Ozone does not have a residual and byproducts are considered minimal and far less detrimental than those generated through chlorination.

Ozonation can be economically attractive for treatment plants where oxygen-activated sludge is used since a source of pure oxygen is already available.

Ozone poses no threat to downstream aquatic life.

Potential Limitations:

Ozonation is energy and capital intensive, and generally requires a high quality effluent to be effective. It is not typically considered effective for secondary-level effluents.

As a high-technology process, ozonation requires expert maintenance.

Because of its instability, ozone must be generated onsite using commercially available equipment.

Ultraviolet Light

Ultraviolet rays comprise the shortest wavelength and highest energy band of the visible light spectrum. It is the component of sunlight which produces sunburn.

Disinfection by ultraviolet light is a physical process relying on the transference of electromagnetic energy from a source (a lamp) to an organism's genetic material. The lethal effects of this energy result in the irradiated cell being unable to replicate. In order to properly disinfect wastewater, the water must be relatively free of suspended solids which would otherwise screen the microorganisms from UV light.

The basic components of a UV system are a source of UV light and a wastewater contact chamber which minimizes the depth of water through which the UV rays must pass. If available, a UV system can be attached to a wastewater outfall.

Advantages:

UV light is a safe, clean method of disinfection that leaves no residuals that can become harmful.

UV light does not rely on an external supply of chemicals.

UV light does not pose a threat to downstream aquatic life.

Potential Limitations:

The ultraviolet light must contact the organisms in order to be effective. This can be difficult to achieve by the presence of suspended solids or materials that will interfere with transmission of light through wastewater.

The wastewater feeding into the ultraviolet light unit must be high quality.

UV light requires potentially high capital and operation and maintenance costs. Frequent sampling and analysis is necessary to insure against over- and under-utilization of the system. Over-utilization can increase the costs to operate.

The lamps, ballasts, and reactors must be maintained at peak efficiency.

Disinfection processes reduce the risk of infection for humans and animals.

CHAPTER 9

Septage Management Alternatives

Septage is a high-strength organic liquid and solid material which accumulates in properly operating septic tanks at a rate of approximately 70 gallons per person per year. Every year in North Carolina nearly 400 million gallons of septage is generated. This material is highly variable but typical characteristics include large quantities of grit and grease, a highly offensive odor, a high potential for foaming, poor settling and dewatering characteristics, high solids and organic content, and possibly some accumulation of heavy metals. The average septic tank should be pumped approximately once every five to eight years, not just when a disposal system problem occurs.

Septage handling begins at the home location when the hauler pumps out the septic tank. This material is then transported to a permitted wastewater treatment facility or to a land application site. The septic tank pumpers are required to receive a permit from the Department of Environment, Health, and Natural Resources, Division of Solid Waste Management each year. Fees for pumping septic tanks in North Carolina generally range from $100 to $150 for a 1,000-gallon tank.

Septage Addition to the Liquid Stream of Wastewater Facilities

Septage offloading to wastewater treatment plants will vary depending on the treatment plant. Septage can be introduced to the liquid stream through any manhole in the collection system, at the head of the wastewater plant, or through a separate storage facility at the plant which would then “bleed” septage into the wastewater plant as the plant can handle the wastewater flow. There are advantages and disadvantages to each of these methods. The method used depends on the size of the plant and the preferences of the operator. A separate storage facility and metered addition is often used when funding is available for construction.

Primary considerations at the waste water treatment plant are aeration and solids handling capacity, since septage addition will substantially increase oxygen demand and solids content in the wastewater. Most sewage treatment processes are able to treat septage, some more effectively than others. Extended-aeration plants are generally considered best suited for septage treatment. Activated-sludge and trickling filter plants are suitable if organic design loads are not exceeded. Contact stabilization processes appear least suitable to septage addition.

Advantages:

Easily implemented.

Low capital costs, except for holding facilities.

Convenience due to dispersed plant locations.

Acceptable to the public.

Potential Limitations:

Additional sludge generated at the plant.

Dilution of concentrated septage followed by reconcentration.

Increased operation and maintenance requirements.

Septage Addition to the Sludge Stream of Wastewater Facilities

Septage can be added to the sludge at a wastewater treatment plant at some point between the wastewater treatment phase and the sludge handling phase. This technique continues to have significant potential for application in North Carolina and throughout the country and may be one of the most cost-effective means of treating septage. Since septage is more similar to sludge than to conventional sewage this process is worth consideration. The sludge handling system to which the septage is added may involve thickening, digestion, grinding, and dewatering. Numerous treatment processes exist for each of these stages. The addition of septage must be controlled in order to avoid overloading. A central receiving point with controlled access is the preferred method of offloading the septage. Holding facilities may be needed to allow controlled addition of septage to the sludge stream.

An evaluation of the suitability of each wastewater facility for accepting septage would be necessary. Holding facilities may be required to control the rate and quality of septage addition. A realistic estimate of septage volumes would be required before implementing this technique.

Basic components of this technique include a central offloading facility with controlled access, preferably with holding facilities and metered addition of septage and a well-operated wastewater treatment plant with sludge handling facilities.

Cost figures for septage addition to the sludge stream vary with the plant’s

Composted septage can be sold as a fertilizer or a soil conditioner.

sludge-handle capacity, mode of handling, type of process employed, and other factors. Increases in labor requirements, power costs, and chemical costs are expected to be proportional to the quantity of septage accepted.

Advantages:

Avoids some problems associated with septage addition to the liquid stream.

Low capital investment.

Potential Limitations:

May result in substantial increases in plant operation and maintenance costs.

Additional equipment may be required.

Septage Composting

Composting involves mixing septage with a suitable bulking agent (woodchips or sawdust), and a method for circulating air through the mixture to insure proper conditions for pathogen dieoff and odor reduction. The major advantage of composting is that the final product is potentially suitable for many more uses than septage. It can in some cases be sold to offset some of the operating costs. Only a few septage composting facilities are currently operating in the United States. Composting of sewage sludge has received wider application.

Septage can be composted in any form. The required bulking agent mixtures will depend on the percent solids. As a result, some pretreatment may be cost effective, particularly if bulking agent costs are high.

The static pile method of composting consists of an elongated ridge-shaped pile over a perforated pipe. Air is pulled through the pipe to provide adequate oxygen in the pile. A three-to-four-week composting period is usually followed by a four-week curing period. Bulking material can be recovered by screening after the composting or curing stage, and then reused.

Basic components of the composting process include: septage handling facilities, including holding facilities and possible dewatering facilities; a bulking agent for composting; an aeration system; and, mechanical mixing equipment required for some composting techniques.

Composting has a low capital cost which would facilitate small operations in rural areas near the septage generation point. A feasibility study on the operation of a composting facility would be necessary. Only minimal effort would be required to make a preliminary decision on cost-effectiveness of composting versus other handling methods. Sale of the compost product could offset some of the operating costs of the process and eliminate disposal costs associated with other treatment methods.

Advantages:

Composting septage produces a stable end product with few pathogens.

Composting is operationally simple, and not affected by weather.

The end product can be marketable, achieving resource recovery.

Potential Limitations:

Requires a stable, long-term supply of bulking agent.

Composting is more expensive than land application.

May require collection and disposal of leachate.

Labor intensive, if materials handling is not mechanized.

Independent Septage Treatment Facilities

If land is not available for land spreading or if an adequate treatment plant capacity is not available within reasonable proximity (10 to 20 miles), independent facilities for the treatment of septage may be warranted, although none currently exist in North Carolina.

Independent facilities can vary in scope from simple lime stabilization systems for land application to complex mechanical septage treatment plants comprising multiple physical and biological processes. Independent septage treatment facilities using technologies compatible with the capabilities of a small community would most likely be aerobic digestion or lime stabilization.

Aerobic Digestion

Aerobic digestion of septage is very similar to aerobic digestion of sewage sludge. An independent septage treatment facility using an aerobic digestion process would employ screening and grit removal as part of a preliminary treatment scheme. Residuals from these processes require regular disposal at permitted sites. Currently, in North Carolina there are no independent facilities for the aerobic digestion of septage in existence.

Although the aerobic digestion process is a relatively simple means of stabilization, there are several important concerns related to its use at an independent septage treatment facility. First, power costs are likely to be quite high to accomplish the transfer of oxygen. Second, supernatant (remaining wastewater liquid) decanted (poured) from the digester must be disposed of properly. Supernatant may require additional treatment prior to introduction to a subsurface disposal system as well as storage prior to use in an irrigation system.

Lime Stabilization

Lime stabilization is among the most cost-effective options for stabilization of septage to meet land-application criteria and conditions of septage prior to dewatering. The process is simple, fully developed, and requires a minimum of operator skill and attention.

Lime stabilization involves addition of sufficient lime or other alkaline material to raise the pH to 12 for a period of 30 minutes. This destroys pathogenic organisms, improves dewaterability, and removes objectionable odors. The stabilized septage may be applied to the land as a liquid or dewatered first, using sand drying beds. If dewatered, treatment and disposal of the filtrate must be considered.

Advantages:

Simple batch processes are used.

Minimal operator skills are required.

It is an economical process.

Lime stabilization meets EPA pathogen reduction criteria.

The process reduces objectionable odors.

The process improves dewatering.

Potential Limitations:

Lime stabilization does not destroy harmful organic compounds.

The process increases the mass of solids to be handled.

If mechanical lime feed systems are used a high degree of operator attention is required.

The operation is dusty.

There is the potential for ammonia releases at high pH levels.

Ultimate Septage Disposal or Utilization Methods

After septage is handled and treated, its liquid and solid components must still be finally disposed of or utilized. At plants with surface discharge permits the liquid portion is frequently incorporated with other treated wastewater and discharged to surface waters. The solid fraction is generally handled by a land disposal method.

Land Surface Application of Septage

The most widely used method of septage disposal is land application. Post-application disking of the disposal site is required within six hours of application if the septage is not lime stabilized.

Land application of septage is commonly practiced by small communities.


A. Robert Rubin

Land application of septage as part of an onsite wastewater management effort in eastern North Carolina.

Lime-stabilized septage can be spread over grassed areas. Slopes may not exceed 12 percent.

Surface application may be implemented at sites permitted for that purpose. Agreements among the N.C. Department of Environment, Health and Natural Resources, Division of Solid Waste Management, and land owners and septage haulers are necessary before a permit to land apply can be obtained from the division. Uses of harvested crops are restricted. Actual application rates are generally determined on the basis of annual nitrogen loading rates for different crops.

Septage offloading at ultimate disposal points can be done at a storage facility during wet weather or the septage can be discharged from the truck onto the disposal site. Septage in the storage facility should be spread on the site as soon as weather permits.

Basic components of the surface application process include: suitable permitted land area; septage stabilization facilities that may be required; and, storage facilities that should be provided for use during inclement weather (or an alternative disposal method should be available). Costs are highly variable, but may be offset by nutrient addition to, and conditioning of, the soil.

Advantages:

Soil conditioning and nutrient addition.

A centralized disposal site is unnecessary.

Minimal labor is required.

Relatively simple procedure.

Generally low cost.

Potential Limitations:

Potential public health hazard if untreated septage is spread.

Potential for surface and groundwater contamination.

Odor and vector problems may occur.

Spreading is restricted during inclement weather.

Storage facilities and stabilization may be required.

Subsurface Application

Subsurface application of septage involves the injection of septage into the soil or burying it within a shallow furrow to reduce the potential for odors, human contact, and vector transmission. This process minimizes odor and vector problems; however, there are fewer sites available for subsurface application. The process is currently not used in North Carolina.

Subsurface disposal may be accomplished using either a farm tractor and tank trailer with the necessary application devices, a tank truck similarly equipped, or tractor-mounted equipment fed with septage from a central holding facility through a flexible “umbilical cord.” Disposal by this method may be implemented in much the same manner as described under surface application.

Basic components of the subsurface application process include: suitable land area(s) permitted by the N.C. Department of Environment, Health, and Natural Resources, Division of Solid Waste Management; distribution equipment (including injection devices); and, septage storage facilities.

Advantages:

Soil conditioning and nutrient addition.

Centralized disposal area unnecessary.

Limited labor is required.

Relatively simple procedure.

Generally low cost.

Odor and vector problems are minimized.

Potential Limitations:

Injection is limited during inclement weather.

Groundwater monitoring is recommended.

Storage facilities or other disposal method is required.

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APPENDIX

Where To Go For Help

Federal Agencies

Appalachian Regional Commission

Administration Building, Suite 5106
116 W. Jones Street
Raleigh, NC 27603-8001
(919) 733-7232

The Appalachian Regional Commission provides grants to communities in the Appalachian region of the United States, including the 29 counties in western North Carolina. Funds from the ARC are limited to water and wastewater projects which involve the creation of economic opportunities .

Economic Development Administration

300 Fayetteville St. Mall, Room 128
Raleigh, NC 27602
(919) 856-4570

The Economic Development Administration distributes grant funds for sewerage projects which will provide economic development opportunities for targeted communities. It also provides technical assistance for economic development planning.

Rural Development Administration/ Farmers Home Administration

In addition to its loan and grants program, the RDA in conjunction with FmHA also provides services for communities which it funds including project planning assistance, engineering and architectural assistance, reviews of financial records, and data collection and analysis. FmHA currently has local offices in most counties in North Carolina as well as nine district offices in the state. The district offices should be contacted for inquiries regarding community wastewater projects. The water and waste disposal programs of the RDA are proposed to be combined into the new Rural Utilities Service of the USDA.

Rural Development Administration/
Farmers Home Administration
State Office
4405 Bland Road, Suite 260
Raleigh, NC 27609
(919) 790-2731

FmHA District Offices:
FmHA District I
400 Dellwood Road
Building E, Suite 1
Waynesville, NC 28786
(704) 452-0319

FmHA District II
Oak Summit Office Park
910 State Farm Rd., Suite 210
Boone, NC 28607
(704) 262-5902

FmHA District III
325 East 4th St.
Lumberton, NC 28358
(919) 739-8194

FmHA District IV
Wrightsville Building
2300 W. Meadowview Rd., Suite 202
Greensboro, NC 27407
(910) 294-7181

FmHA District V
630-A S. Garnett St.
Henderson, NC 27536
(919) 438-3141

FmHA District VI
109 West Blvd. Hwy. 64 Bypass
Williamston, NC 27892
(919) 792-1006

FmHA District VII
4001 Carya Dr., Suite B
Raleigh, NC 27610
(919) 856-4196

FmHA District VIII
New Hanover County
Administration Building
4006 Oleander Dr., Suite 3
Wilmington, NC 28403
(910) 392-5696

FmHA District IX
Executive Sq. Building
2002 S. Glenburnie Rd.
New Bern, NC 28560
(919) 638-4735

Soil Conservation Service

4405 Bland Rd., Suite 205
Raleigh, NC 27609
(919) 790-2909

The Soil Conservation Service is a federal agency under the U.S. Department of Agriculture. The main focus of the water resources planning staff of the SCS is on flood prevention although water supply, land treatment and water quality are major considerations. They provide project planning, engineering and financial assistance.

US Environmental Protection Agency

345 Courtland St., N.E.
Atlanta, GA 30365
(404) 347-7109

The EPA Region IV office has a public-private partnership regional coordinator who could provide assistance in planning public-private partnerships for developing wastewater facilities.

US EPA National Small Flows Clearinghouse

P.O. Box 6064
Morgantown, WV 267506
(800) 624-8301

The EPA National Small Flows Clearinghouse provides a variety of referral and information gathering and distribution services regarding small wastewater systems. The Clearinghouse publishes two newsletters, Small Flows *and* Pipeline, *with free subscription, maintains a computer bulletin board for free, and can provide literature packages and audio-visual materials about virtually all small wastewater systems and technologies as well as planning, financing, and management issues for free or at low cost. The Clearinghouse's literature is geared toward both community leaders who may be unfamiliar with wastewater systems and technical professionals. The Clearinghouse gives toll-free technical assistance and advice on specific problems and makes referrals to other agencies.*

Water Resources Division
U.S. Geological Survey

P.O. Box 30728
Raleigh, NC 27622
(919) 571-4000

Through a 50-50 cost sharing program, the Water Resources Division of the U.S. Geological Survey assists federal, state and local agencies in collecting and analyzing hydrologic data to be used as the basis for sound water management decisions.

State Agencies

Construction Grants and Loans Section

Division of Environmental Management
N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919) 733-6900

General loans, emergency loans, and high-unit cost grants are available through the N.C. Clean Water Revolving Loan and Grants Fund. Also administered by the Division of Environmental Management, the State Revolving Fund is a federally funded program to provide low-interest loans to governments and utility districts for the construction of wastewater treatment facilities. DEM also provides other assistance on wastewater systems for small communities.

Division of Community Assistance

N.C. Department of Commerce
Methodist Building
1307 Glenwood Ave., Suite 250
Raleigh, NC 27605
(919) 733-2850

The Division of Community Assistance distributes Community Development Block Grants for water, wastewater and other community development projects. In addition to providing project planning assistance for municipal and county governments, DCA also conducts water and sewer rate studies.

Division of Soil and Water Conservation

N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919)733- 2302

The Division of Soil and Water Conservation provides planning for small watershed projects, surveying, classification of soil types, and other services. The division's management assistance includes appointing watershed trustees, administering the N.C. Agriculture Cost-Share Program for non-point source pollution control, and assisting local soil and water conservation districts on a broad conservation agenda.

Local Government Commission

N.C. Department of the State Treasurer
325 N. Salisbury Street
Raleigh, NC 27603-1385
(919) 733-3064

The Local Government Commission must approve all debts entered into by local governments in North Carolina. The LRC helps governments to determine the appropriate method of debt financing.

North Carolina Cooperative Extension Service

Box 7602
Raleigh NC 27695-7602
(919) 515-2811

The North Carolina Cooperative Extension Service (NCCES) is an outreach component of the College of Agriculture and Life Sciences and North Carolina State University. The NCCES conducts educational and adaptive research programs in community and rural development, water quality, residential and business, solid waste management, and onsite and community wastewater treatment, disposal and utilization. There are NCCES centers in all North Carolina counties, and there is a specialist staff housed at North Carolina State University. The NCCES provides project planning assistance, educational material and programs, data collection and analyses, public issues education and engineering assistance as resources permit. Some NCCES major projects include: animal waste management, land application of agricultural and municipal wastes, residential septic tank management, residential water conservation, watershed management and water and waste management in the food processing industry. The NCCES is also involved in the areas of ground and surface water quality protection and solid waste recycling. Of particular interest to rural communities is the NCCES development and demonstration of alternative wastewater systems.

Onsite Wastewater Section

Division of Environmental Health
N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687
(919) 733-2895

The Onsite Wastewater Section is the principle agency involved in providing a comprehensive statewide program for the sanitary control of onsite wastewater treatment and disposal as a joint effort among local health departments, regional onsite wastewater specialists (soil scientists), engineers and other professional staff in the Division of Environmental Health. The section provides training and continuing education to local environmental health specialists, private consultants, and firms involved in the onsite wastewater industry. The section is not a source of financial assistance for development of onsite systems. The section will publish a detailed technical manual on onsite wastewater systems in late 1994.

Solid Waste Section

Division of Solid Waste Management
N.C. Department of Environment, Health, and Natural Resources
P.O. Box 27687
Raleigh, NC 27611-7687

The Solid Waste Section is responsible for the proper treatment and disposal of septage and sludge removed from wastewater systems permitted under the authority of the Division of Environmental Health. All land application sites for this septage or sludge from these systems must be permitted by the Division of Solid Waste Management.

Local Health Departments

Local health departments and districts serve each of the 100 counties in North Carolina. They should be contacted for technical assistance and to ensure regulatory compliance regarding onsite or subsurface-disposal wastewater systems. Most health departments provide (and require) multiple site evaluations for soil-absorption systems. In North Carolina, the local health department must approve the application of a technology to a site as well as decide soil loading rates and daily wastewater flow based on proposed use. A small number of health departments are involved in engineering assistance, data collection, and project planning.

Nonprofit Organizations

Community Action Agencies

Community action agencies are nonprofit organizations which provide a variety of poverty-relief services to low-income communities. Some provide services related to water and wastewater access for individual households and communities. Some are active in the actual construction of facilities while others provide community support services such as community organizing and grant writing assistance. For more information on community action agencies contact the North Carolina Community Action Association, P.O. Box 98475, Raleigh, NC 27624-8475, (919) 790-8900.

Councils of Government

Councils of Government are regional planning and service organizations. As regional organizations they can often provide more comprehensive services on water and waste disposal issues than can the counties and municipalities within their jurisdictions.

North Carolina Rural Communities Assistance Project, Inc.

P.O. Box 941
Pittsboro, NC 27312
(919) 542-7227

North Carolina Rural Communities Assistance Project, Inc. provides a variety of free onsite technical assistance, training, planning, and other outreach activities on wastewater, water, and solid waste issues for small communities, water and wastewater systems, and individuals across the state. NC/RCAP makes in-kind contributions related to wastewater and other projects and can provide access to a low-interest alternative loan fund and engineering assistance for planning wastewater projects in low- and moderate-income communities at no cost. NC/RCAP also advocates for safe and affordable water and waste disposal for all North Carolinians and educates communities on these issues.

North Carolina Rural Economic Development, Inc.

Four North Blount St.
Raleigh, NC 27601
(919) 821-1154

The North Carolina Rural Economic Development Center, Inc. works to stimulate economic growth in the state's rural areas through research, demonstration projects, and policy and program development. As a clearinghouse for rural development professionals and others, the Rural Center is a source of new ideas and information to assist people in economic development.

North Carolina Rural Water Association, Inc.

P.O. Box 540
Welcome, NC 27374
(704) 731-6963

The North Carolina Rural Water Association, Inc. provides training and onsite technical assistance to rural water and wastewater systems. NCRWA is a membership organization but nonmember systems can also receive free assistance. NCRWA offers a loan program for projects to improve existing water and wastewater system facilities and also offers health insurance, property and casualty insurance, and workers' compensation insurance for systems.

Other Organizations

There are many other organizations in North Carolina that provide assistance related to wastewater systems. The *North Carolina Rural Services Directory,* published by the North Carolina Rural Economic Development Center, Inc., lists nearly 100 organizations that provide assistance on water and wastewater issues. The *Directory of Water, Wastewater, Groundwater, and Solid Waste Resources for Rural Communities*, published by North Carolina Rural Communities Assistance Project, Inc., also provides information on other wastewater-related organizations.

GLOSSARY

Terms Encountered in Wastewater Management

"A" Horizon. The layer of soil formed at or near the soil surface, having properties that reflect the influence of accumulating organic matter or eluviation.

Absorption. The process by which one substance is physically taken into and included with another substance.

Acidity. A measure of the acid character of waters; indicated by low pH's (below 7.0); associated with aggressive and corrosive waters.

Adsorption. The process by which pollutants are attracted to and held on the surfaces of soil molecules, thus immobilizing them.

Advanced waste treatment. Physical or chemical treatment following secondary or biological treatment. Also called tertiary treatment.

Aeration. The exposure to the chemical action of air.

Aerobic. Life or processes that occur in the presence of oxygen. In an aquatic environment such as wastewater, "aerobic" refers to the presence of free or dissolved oxygen.

Aerobic treatment. Process by which microbes consume complex organic compounds in the presence of oxygen and use the liberated energy for reproduction and growth. Types of aerobic processes include aerobic tanks, extended aeration, trickling filtration and rotating biological contactors.

Aggregate, soil. A group of soil particles cohering so as to behave mechanically as a unit.

Alkalinity. The capacity of water or wastewater to neutralize acids. High alkalinities (above 300 to 500 mg/l) are usually associated with hard waters. Alkalinity is not the same as pH because water does not have to be strongly basic (high pH) to have a high alkalinity. Alkalinity is a measure of how much acid can be added to a liquid without causing great change in pH.

Alternating and dosing system. An onsite disposal system that uses tanks, automatic siphons, pumps, or other mechanisms to control the package of waste effluent from the septic tank to the drainfield. The system allows for dose and rest cycles that improve waste assimilation in the drainfield.

Alternative wastewater system. A fully proven system that reclaims or reuses wastewater, productively recycles wastewater components, recovers energy, or eliminates the discharge of pollutants.

Anaerobic. A life or process that occurs in the absence of oxygen. In an aquatic environment such as wastewater, "anaerobic" refers to the absence of free or dissolved oxygen.

Angstrom (Å). One hundred millionth of a centimeter. Expressed as 10-8 cm.

Aquaculture. Developing plants and animals that grow in water or wastewater and cleanse wastewater by digesting pollutants. The harvest is used as fertilizer, food, and so on.

Aquifer. An underground geologic formation, or group of formations, containing usable amounts of groundwater that can supply wells and springs.

Assimilative capacity. The ability of a site to absorb and treat hydraulic and nutrient loading of wastewater effluent.

Attenuation. The process by which a compound is reduced in concentration over time through adsorption, degradation, dilution, and/or transformation.

"B" Horizon. The layer of soil beneath the "A" horizon characterized by a higher colloid (clay or humus) content, or by a darker or brighter color than the soil immediately above or below, the color usually being associated with the colloidal materials. The colloids may be of alluvial origin (left by rivers or floods), as clay or humus; they may have formed in place (clays); or they have been derived from texturally layered parent material.

Backwashing. The operation of cleaning a filter by reversing the flow of liquid through it, washing out matter captured in it, and returning to the wastewater treatment plant for additional treatment.

Bacteria. Microscopic, single-celled living organisms which can aid wastewater treatment systems by consuming or breaking down organic matter in sewage. Bacteria in soil, water or air can also cause human, animal, and plant health problems.

Bedrock. The solid rock beneath the soil and subsoil.

Biochemical oxygen demand (BOD). The rate at which microorganisms use the oxygen in water and wastewater to aerobically decompose organic matter present. The BOD in effluent is used along with suspended solids as a measure of the effectiveness of the wastewater treatment processes. All BOD levels of treated effluent are 30 milligrams per liter or lower as set by state and county health regulations. "BOD5" refers to the biochemical oxygen demand over a five-day period.

Biodegrade. To decompose as a result of the actions of microorganisms.

Biomass. A mass or clump of living organisms feeding on the wastes in wastewater, dead organisms and other debris. This mass may be formed for, or function as, the protection against predators and storage of food supplies. Biomass also refers to trees and shrubs or anything of biological origin.

Biomat. Also known as clogging mat. An organic-rich slime layer that forms on sand filter surfaces or at soil trench interfaces that reduces permeability.

Biosolids. A term referring to sludge.

Blackwater. Any water that carries animal, human, or food wastes.

Bound water. Water contained within the cell mass of sludges or strongly held on the surface of colloidal particles. It is one of the causes of bulking sludge in the activated-sludge process.

Bulk density, soil. The mass of dry soil per unit bulk volume. The bulk volume is determined before drying to constant weight at 105° C.

"C" Horizon. The layer of soil that normally lies beneath the "B" horizon but may lie beneath the "A" horizon, where the only significant change caused by soil development is an increase in organic matter, which produces an "A" horizon.

CFS. Flow rate in cubic foot per second; 1 cfs equals 0.65 million gallons per day.

Capillary action. A liquid's movement over, or retention by, a soil surface, due to the interaction of adhesive and cohesive forces.

Chemical oxygen demand (COD). A measure of the oxygen-consuming capacity of materials in wastewater. COD is expressed as the amount of oxygen consumed from a chemical oxidant in milligrams per liter (mg/l) during a specific test. Results are not necessarily related to biochemical oxygen demand because the chemical oxidant may react with substances that bacteria do not stabilize.

Chlorinator. A device for adding chlorine gas to sewage to kill infectious germs.

Chlorine. A compound added to water and wastewater usually for the purpose of disinfection.

Chlorine residual. The total amount of chlorine (combined and free available chlorine) remaining in water, sewage, or industrial wastes at the end of a specified contact period following chlorination.

Clay. A soil separate that is less than 0.002 millimeters in diameter. Clay has a smooth, sticky and plastic feel when moist. Clay forms very hard clods when dry. Clay particles may remain suspended in water for extended periods of time.

Clay. A soil separate consisting of particles smaller than 0.002 millimeters in equivalent diameter; a textural class of soil.

Clogging mat. Same as biomat.

Closed-loop recycling. Reclaiming or recycling wastewater for nonpotable purposes in an enclosed process.

Cluster system. A system of wastewater collection and treatment facilities in which wastes from numerous homes or their sources are conveyed to a central treatment and disposal facility. Systems generally consist of small collection pipes attached to individual homes that transfer the wastes to the central treatment facility.

Coliform-group bacteria. A group of bacteria predominantly inhabiting the intestines of humans or animals, but also found in soil. Used as an indicator of contamination.

Composting. The natural biological decomposition of organic material in the presence of air to form a humus-like material.

Composting toilet. Any device that is designed to store and decompose human waste by aerobic digestion. These systems may require special venting, plumbing, electrical, and mechanical components, and periodic maintenance.

Conventional wastewater system. One of a variety of standard systems which is commonly used to collect, treat, and dispose of wastewater: sewers, treatment plants and septic tanks with drainfields.

Decomposition. The process of breaking down into smaller particles.

Denitrification. The biochemical reduction of nitrate or nitrite to gaseous molecular nitrogen or an oxide of nitrogen. This condition is often the cause of rising sludge observed in secondary clarifiers or gravity thickeners. Denitrification takes place during the proper balance of nitrate and carbonaceous material and only under anaerobic conditions.

Detention time. The time required to fill a tank at a given flow or the theoretical time required for a given flow of wastewater to pass through a tank.

Dewater. To remove or separate a portion of the water present in a sludge or slurry.

Digestion. The process of dissolving solids in wastewater. Digestion of sludge takes place when the materials decompose, resulting in partial gasification, liquefaction, and mineralization of pollutants.

Dilution. The process of diluting, thinning out, or making less concentrated, as in diluting wastewater by adding it to a river or stream.

Discharge. To release; when used with "wastewater" it usually refers to wastewater released into surface waters (streams and lakes).

Disinfection. The process designed to kill most microorganisms, including essentially all pathogenic (disease-causing) bacteria. Disinfection should not be confused with sterilization.

Dissolved oxygen. The oxygen freely available in water, wastewater, or other liquid. Dissolved oxygen is vital to fish and other aquatic life.

Domestic wastewater. Wastewater that is generated by a residence. These wastewaters generally consist of human wastes and wastewater from washing machines, toilets, showers, and dishwashers.

Drainfield. Also known as absorption field, disposal field, leach field, nitrification field, seepage field, tile field, septic field and others. A system of trenches or beds or combinations of these devices designed for subsurface treatment and disposal of pretreated waters.

Effluent. The liquid that comes out of a septic or aerobic tank, drainfield, basin, or other treatment unit after completion of the treatment process.

Evapotranspiration. The total water removed from an area by transpiration from plants and by evaporation from soil, snow, and water surfaces.

Experimental wastewater system. See "innovative wastewater system."

Filtration. The physical removal of suspended solids or particles from effluent by soil or sand particles of other filter media.

Flood plain. Flat or nearly flat land on the floor of a river valley that is covered by water during floods.

Flow rate. The quantity of water available and/or needed per minute, per hour, or per day to satisfy the requirements of people, livestock, and water fixtures.

GPD. Gallons per day. A measure of water or effluent flow rate.

Greywater. Domestic wastewater composed of washwater from sinks, kitchen sinks, bathroom sinks, and tubs and laundry drains.

Grit. The heavy material present in wastewater such as sand, eggshells, gravel, and cinders.

Groundwater. Water found in cracks, fissures, and pore spaces in the subsurface of the earth below the water table.

Groundwater recharge. Water which flows from the surface, thorough soil, and into the subsurface saturated zone to replenish groundwater sources.

Heavy metals. Mineral elements found in soils that are essential to plant growth but in high concentrations can be toxic to plant and animal life. Typically, the quantity of heavy metals found in sludge from wastewater treatment plants is very low when compared to the quantity of naturally occurring metals in the soil. Some heavy metals such as mercury are toxic in low concentrations to plant and animal life.

Holding tank. An enclosed tank, usually fiberglass or concrete, for the storage of wastewater prior to removal or disposal at another location. Rarely approved in North Carolina.

Hydraulic conductivity. The ability of soil to transmit liquids through pore spaces in a specified direction, such as horizontally or vertically.

Hydraulic loading. The flows to a wastewater treatment plant or treatment process. Detention times, surface loadings, and weir overflow rates are directly influenced by flows.

Hydraulic potential. Also called hydraulic capacity, long-term acceptance rate, or loading rate. The ability of a soil to accept and dispose of a volume of waste effluent over time. It is used as a measure of the proper size for a soil absorption field.

Hydrogeologic characteristics. Characteristics that describe the hydrology (the distribution of water on the surface and below the ground) and the geology (the structure and content of the earth) at a site. Hydrogeologic characteristics include soil type, depth to groundwater, soil permeability, and groundwater recharge rate. These properties control the entrance of water to the subsurface and the capacity to hold, transmit, and deliver water.

Hydrology. Surface and ground water conditions at a site.

Imhoff tank. A two-story tank used for onsite and cluster wastewater systems. Sedimentation is accomplished in the upper compartment and digestion of settled solids is accomplished in the lower compartment. Not permitted for use in North Carolina.

Impervious. Resistant to penetration by fluids or by roots.

Inert. Without active chemical or biological properties, as in inert particles in wastewater.

Infiltration. The penetration of water through the ground surface into the subsurface soil or the penetration of water from the soil into a pipe through such means as defective pipes, connections and manholes.

Infiltration/Inflow. The total quantity of water entering a sewer system. Infiltration means entry through such sources as defective pipes, pipe joints, connections, or manhole walls. Inflow signifies discharge into the sewer system through service connections from such sources as area or foundation drainage, springs, and swamps, storm waters, street wash waters, or sewers.

Influent. Water, wastewater, or other liquid flowing into a septic tank, treatment plant, basin, or other treatment unit.

Innovative wastewater systems. Systems that use technologies that are developed but not yet fully proven. Also known as experimental wastewater systems.

Irradiation. See ultraviolet light.

Irrigation. A land-application technique wherein wastewater is applied to land to supply the water and nutrient needs of plants.

Land application. Also known as land treatment, it is method of treatment of wastewater in which soil, air, vegetation, bacteria, and fungi are employed to remove pollutants from wastewater. Some of the applied wastewater evaporates and the remainder may be allowed to percolate to the water table, discharged through the drain tiles, or reclaimed by wells.

Leachate. The solution formed when water percolates through solid wastes, soil, or other materials, and extract soluble or suspended substances from the materials.

Leaching. The process by which soluble constituents (tiny particles) are dissolved and carried down through the soil by a percolating fluid.

Licensed professional engineer. An engineer who has been certified or approved by a state authority.

Lineament analysis. An analytical technique that uses aerial photographs to detect linear features in the landscape that are indicative of solution zones in karst terrain.

Manifold. A pipe fitting with several openings and numerous branches used in wastewater drainfields to convey wastewater between a large pipe and several smaller pipes, or to permit choice of diverting flow from one of several sources or to one of several discharging points.

Mapping unit. A soil or combination of soils delineated on a map where possible. Mapping units on maps principally depict soil types, phases, associations, or complexes.

Mastic. A scaler used to seal septic tank joints.

Media. The material that serves as a physical foundation for fixed biological processes.

MGD. Flow rate in million gallons per day; 1 mgd equals 1.5 cubic feet per second.

Microorganisms. Also know as microbes. Minute plant and animal life, some of which exist in sewage and can cause disease.

Milligrams per liter (mg/l). The weight of a substance, in milligrams, found in a liter of water. One mg/l equals 1 oz. per 7,5000 gallons. It is also equivalent to one part per million (ppm).

Monitoring well. A well used to collect groundwater samples for the purpose of physical, chemical, or biological analysis. They are generally installed where groundwater contamination exists or has a potential to exist.

Mottles. Spots or blotches of different color or shades of color interspersed with the dominant color. Mottles indicate the depth of the seasonal high water table.

Mound system. An alternative system design in which fill material, generally sand, is laid on top of plowed soils that alone are unsuitable for wastewater treatment. Mound systems are generally used where there is an inadequate thickness of acceptable soil to support a conventional soil absorption system.

Municipal wastewater. Water containing pollution resulting from domestic wastes, typically feces and laundry wastes.

Nitrate (NO3). The most oxidized form of inorganic nitrogen and a contaminant commonly associated with septic systems. High concentrations of nitrate and nitrite (NO2) in drinking water are known to cause methemoglobinemia (a poisoning similar to that caused by cyanide) in young babies. The EPA sets a limit of 10 mg/l for nitrates.

Nitrification. The biochemical oxidation of ammonium to nitrate.

Non-functional water use. Excessive water use that is a result of malfunctioning or poorly maintained plumbing, high water pressure, or wasteful water-use habits.

Non-point source. A general source of pollution, such as surfacing effluent from a failing septic system.

NPDES. National Pollutant Discharge Elimination System, the federal government's system of controlling all discharges of pollutants from point sources into U.S. waterways. NPDES permits discharges into navigable waters from all point sources of pollution, including industries, municipal treatment plants, large agricultural feed lots, and return irrigation flows.

Nutrients. Fertilizers; any substance absorbed by living things that promotes growth. The term is generally applied to nitrogen and phosphorous in wastewater which contributes to eutrophication of water supplies.

Onsite system. A wastewater treatment and disposal facility located at or near the source of the wastewater.

Operation and Maintenance (O&M). Functions that result in expenditures during the useful life of the treatment works for materials, labor, utilities, and other items necessary for managing and maintaining the facility.

Organic. Referring to or derived from living organisms containing carbon and hydrogen.

Organic waste. Waste materials which come mainly from animal or plant sources. Organic waste generally can be consumed by bacteria and other small organisms. Inorganic wastes are chemical substances of mineral origin.

Parasites. An animal or plant that lives on or in another organism from which it draws its nourishment.

Pathogens. Microorganisms potentially harmful to humans and animals, including parasites, bacteria, and viruses and other disease-causing microorganisms.

Ped. A unit of soil such as an aggregate, crumb, prism, block, or granule formed by natural processes (in contrast with a clod, which is formed artificially).

Perched water table. A discontinuous, saturated area of soil which exists in the unsaturated zone (above the normal water table) as a result of a low permeability layer. Often occurs after heavy rain.

Percolation. The movement of water downward and radially through pores between the particles of soil, filtering wastewater through subsurface soil layers, usually continuing downward to the groundwater.

Percolation test. A test used to estimate the percolation rates of water through soils. Unlike most states, onsite systems in North Carolina are approved based on a comprehensive soil morphology rather than the traditional percolation test.

Perforated. Having holes, as in perforated pipe.

Performance standard. A standard that is used to judge whether predetermined requirements have been met, such as the necessary level of treatment for a waste stream, after the completion or initiation of operation. Performance standards generally are in the form of a pre-determined level of concentration of a particular compound or constituent that is allowed in a waste effluent.

Permeability. The rate at which liquids pass through soil in a specified direction. Permeability is expressed in inches per hour. Generally, fine textured soils have slower permeabilities than coarse-textured soils. Information on soil permability can be found in the Soil Conservation Service interpretation sheets or county soil surveys.

pH. A term used to describe the hydrogen-ion activity of a system; a measure of the acidity or alkalinity or water, wastewater, or other solution.

Phosphorous. An element that while essential to life, contributes to the eutrophication of lakes and other bodies of water.

Point source. A stationary source of a large individual emission. Wastewater treatment plants are ordinarily considered point sources of pollution.

Pollution, water. Results when something animal, vegetable, or mineral makes it more difficult or dangerous to use for drinking, recreation, agriculture, industry or wildlife.

Ponding. The accumulation of septic tank discharge in soil absorption drainfields. (Same as surfacing).

Porous. Having or full of pores that admit the passage of gas or liquid.

PPM. Parts per million, 1 ppm equals 1 part of the substance concentrated in one million parts of water (by weight).

Precipitation. A chemical reaction formed when chemicals are added to alter physical states of dissolved or suspended solids to aid in their removal during wastewater treatment. Examples of precipitation include water softening, phosphorous removal and heavy metal removal.

Pressure. The force needed to move water.

Pressure distribution. A system that uses a pump and special piping to evenly distribute waste flow from a septic tank over a drainfield. The system can improve upon gravity flow by distributing the effluent over a wider area and by permitting resting cycles.

Primary treatment. A first and basic stage in the treatment of sewage that removes by screening or sedimentation nearly all solid material that floats or will settle. Septic tanks provide primary treatment onsite and in conventional centralized sewerage systems screens remove floating solids and settling tanks remove heavy material.

Protozoa. A group of microscopic animals that sometimes cluster into colonies and often consume bacteria as an energy source.

Public-Private Partnership. A contractual relationship between a public and private partner that commits both to providing an environmental service. The private sector can be involved in a variety of ways, from the initial design of a facility to its daily operation and maintenance.

Pump. A mechanical device for causing flow, for raising or lifting water or other fluid, or for applying pressure to fluids.

PVC. Polyvinyl chloride. A type of plastic commonly used in the pipes of water and wastewater systems.

Receiving waters. Rivers, lakes, oceans, or other water courses that receive treated or untreated wastewaters.

Recharge. To replenish or refill, as in groundwater recharge.

Renovation. To renew or repair. Renovation of wastewater refers to the treatment processes that cleanse wastewater before it is reintroduced into the water supply.

Rejuvenate. To renew or restore to a previous condition, as in rejuvenating septic systems to make them usable again.

Residuals. A term referring to sludge.

Restrictive horizon. A soil layer that limits or restrains movement of water through the soil.

Sand. A soil separate whose particle sizes range from 2 to 0.05 millimeters in diameter. Sand is gritty when soil is rubbed between the thumb and forefingers.

Sand filters. Biological and physical wastewater treatment units utilizing filter tanks that remove some suspended solids from sewage. Air and bacteria decompose additional wastes filtering through the sand. Cleaner water drains from the bed. Liquid passing through the filter may be discharged to a soil absorption system or to surface water after chlorination. The sludge accumulating at the surface must be removed from the bed periodically.

Sandy loam. Soil composed on approximately equal parts of sand, silt and clay.

Sanitary district. A local public authority with a local mandate to manage and operate water and/or wastewater systems.

Saprolite. Geologic material breaking down in place which will ultimately form soil.

Saturation zone. The area below the water table where the soil pores are fully saturated with water.

Scum. A layer of light solids (such as hair, grease, and soap) which accumulates at the surface of the wastewater in a septic tank.

Secondary treatment. The second stage in most conventional centralized wastewater treatment systems in which bacteria consume and decompose the organic parts of the wastes. It is accompanied by bringing together wastewater, bacteria, and oxygen in trickling filters or the activated-sludge process. Effective secondary treatment processes remove nearly all solids as well as 90 percent of BOD and suspended solids. Disinfection of the effluent by chlorination is usually the last step in this process.

Seepage. The slow movement of water through small cracks or pores of a material, through the soil, or into or out of a body of surface or ground water.

Septage. An anaerobic slurry of solid wastes, including scum, sludge, and liquid contents of a septic tank at the time of pumping. The septage must be periodically pumped from the septic tank. Also called scavenger wastes, septic tank pumpings, residuals.

Septic system. An onsite wastewater management system. Septic systems are constructed using conventional, alternative, or experimental system designs.

Septic tank. A treatment receptacle that receives wastewater and is designed and constructed to separate the liquid and solids in the wastewater. Organisms in the tank anaerobically treat and digest organic matter prior to discharge, generally to a subsurface disposal system. Sludge settles on the bottom of the tank.

Service charge. A charge levied on a user of the treatment works which includes a user charge, a charge for capital reserve, and debt service.

Settleable solids. That matter in wastewater which will not stay in suspension during a preselected settling period, such as one hour, but either settles to the bottom or floats to the top.

Sewer. A system of pipes that collects and delivers wastewater to treatment plants or receiving streams.

Shallow water table. The underground supply of fresh water located near the surface of the ground.

Short circuit. In a water or wastewater system, a flow of liquid that follows a path of lesser resistance, flowing by a shorter route than the normal one.

Silt. A soil separate consisting of particles between 0.05 and 0.002 millimeters in diameter. Silt has a smooth, baby powder feel when rubbed between the thumb and fingers and is not plastic or sticky when moist.

Slope. Deviation of a plane surface from the horizontal.

Sludge. A semi-solid residue of raw wastes from wastewater and water treatment processes. Sludge needs to be pumped and removed from facilities such as septic tanks periodically. Also known as residuals and biosolids.

Slug load. A higher than usual load of influent in a wastewater treatment process.

Soil. A complex, heterogeneous, porous mixture of particulate mineral solids and organic matter between which are spaces that are filled with air and water. It provides a three-phase treatment system: the solid phase consists of soil particles; the liquid phase consists of water containing dissolved substances; and, the gaseous phase consists primarily of soil air and other gases.

Soil absorption field. The area of ground to which wastewater is released from a septic tank through a series of perforated pipes.

Soil absorption system. A system consisting of trenches or beds, together with piping or gravel, installed in appropriate solids for the purpose of receiving wastewater flow from a septic tank or other treatment device and transmitting it into soil for final treatment and disposal.

Soil borings. Soil samples taken where the septic tank or soil absorption system is to be located. Samples may be tested for various soil characteristics.

Soil characteristics. Relevant properties of soil, including its clay content, texture, particle size, classification, structure, permeability, and other relevant properties.

Soil horizon. A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics such as color, structure, texture, consistence, pH, and so on.

Soil map. A map showing the distribution of soil types or other soil mapping units in relation to the prominent features of the earth's surface.

Soil morphology. The physical constitution, particularly the structural properties, of a soil profile as exhibited by the kinds, thickness, and arrangement of the horizons in the profile, and by the texture, structure, consistence, and porosity of each horizon.

Soil profile. The natural appearance and layering of soil.

Soil separates. Groups of mineral particles separated on the basis of a range in size. The principal separates are sand, silt, and clay.

Soil series. The basic unit of soil classification, and consisting of soils which are essentially alike in all major profile characteristics, although the texture of the "A" horizon may vary somewhat. See soil type.

Soil structure. The combination or arrangement of individual soil particles into definable aggregates, or peds, which are characterized and classified on the basis of size, shape, and degree of distinctness.

Soil texture. A relative proportion of various soil components, including sands, silts, and clays, that make up the soil layers at a site. Soil textural analysis can be used to determine a soil's ability to treat and dispose of septic tank effluent and in sizing the soil absorption system.

Soil type. In mapping soils, a subdivision of a soil series based on differences in the texture of the "A" horizon.

Sole-source aquifer. A groundwater aquifer which is the sole or principal drinking water source for an area and which, if contaminated, would create a significant hazard to public health.

Sorption. A process by which suspended solids and colloidal particles in waste effluent become attached to soil particles. In general, soils high in clay or organic content have high sorptive capacities.

Sterilization. The removal or destruction of all living microorganisms, including pathogenic (disease-causing) bacteria and saprophytic (living on or decaying organic matter) bacteria, vegetative forms, and spores. Sterilization should not be confused with disinfection.

Subsoil. In general concept, that part of the soil below the depth of plowing.

Subsurface. Below ground.

Sump pump. A mechanism used for removing water or wastewater from a sump or wet well. It may be energized by air, water, steam, or electric motors.

Surfacing. Excess ponding resulting in introduction of partially treated effluent to the soil surface above a soil absorption system. There is a potential for disease transmission through contact with the surface effluent.

Suspended solids. The small particles of solid pollutants which are present in sewage and which resist separation from the water by conventional means. The amount of suspended solids in effluent is used along with BOD as a measure of the effectiveness of the treatment process.

Tertiary treatment. See advanced waste treatment.

Tight soil. A compact, relatively impervious and tenacious soil or subsoil.

Topography. The general shape of the ground surface at a site (such as hilly, rolling, level).

Topsoil. (1) the layer of soil moved in cultivation, (2) the "A" horizon, (3) presumably fertile soil material used to top dress road banks, gardens, and lawns.

Transpiration. The process by which water vapor is lost to the atmosphere for living plants. The term can be applied to the quantity of water thus dissipated.

Triassic basin. A geologic basin formed during the Triassic period, composed primarily of sand stone, mud stone and silt strate.

Turbidity. The turbidity of water is attributed to suspended or colloidal matter, the effect of which is to reduce clarity and light penetration.

Ultraviolet light. A disinfection technique that utilizes a wavelength that is slightly shorter than that of visible light rays.

Unsaturated zone. The area above the water table where the soil pores are not fully saturated, although some water may be present. Also called the "vadose zone."

Vector. An organism that carries pathogens from one host to another.

Virus. The smallest form of microorganism capable of causing disease.

Volatile. Capable of being evaporated or changed to a vapor at relatively low temperatures.

Wastewater. A combination of liquid and water-carried wastes from residences, commercial buildings, industrial plants, and institutions, together with any groundwater, surface water, and storm water that may be present.

Wastewater reuse. The use of treated wastewater for a beneficial use such as agricultural irrigation or industrial cooling.

Wastewater treatment plant. A series of tanks, screen, filters or other processes by which pollutants are removed from water.

Water table. The dividing line between the soil's saturated and unsaturated zones.

Waterless toilets. Any one of a number of types of toilets that do not use water, including composting toilets.

Watershed. The land area drained by a stream or by an entire river system.

Weir. A wall or plate placed in an open channel and used to measure the flow.

Wetlands. Areas or ground that are swampy or marshy for at least part of a year that are usually protected by federal regulations to safeguard sensitive wildlife and vegetation.

Zero Discharge. A theoretical no-discharge system.