Decentralized sewer solutions

Onsite wastewater treatment offers options for utilities and communities

BY DENNIS F. HALLAHAN, M.S.P.E.

Effective, long-term wastewater management solutions incorporating onsite treatment are saving municipalities and taxpayers significant costs compared with large, regional sewer construction programs. The U.S. Environmental Protection Agency (EPA) and Congress spurred acceptance of these solutions in 1997 by officially recognizing onsite wastewater treatment systems as "a potentially viable, low-cost, long-term, decentralized approach to wastewater treatment if they are planned, designed, installed, operated, and maintained properly." Today, public health and environmental officials acknowledge that onsite systems are not just temporary solutions to be replaced eventually by centralized sewage treatment services, but are permanent wastewater treatment approaches, resulting in the release and reuse of water in the environment. Regional sewers remain an effective solution for metropolitan areas, but extending service to suburban and rural areas is not the only solution.

Financial opportunities for districts

In the United States, expanding regional sewer service is expensive — and costs are increasing. The cost to tie in a single home can be $15,000 to $30,000. Yet, the cost of a septic system is only $2,000 to $4,000 per home. As a result, clustered systems, which are a type of onsite treatment that typically serve groups of 20 to 500 people with one collection, treatment, and disposal system, are being installed to serve groups of homes or businesses that are managed by a utility district.

Water, wastewater, and even electric utility districts have recognized onsite wastewater treatment as a means to expand their financial base. The districts already have the required support in place, such as personnel for billing and tracking and knowledgeable field technicians. Additionally, they have a history of protecting public health and represent a viable, long-term entity with which homeowners feel comfortable.

To address the need for rules and regulations to govern this growing field, the EPA published in March 2003 the Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems. The guidelines were created to assist states, tribes, communities,

Above: A state park installed an evapotranspiration bed using chamber technology. The system has a design flow of 19,500 gallons per day.

and other entities in developing effective management programs. The EPA considers onsite wastewater treatment systems a permanent component of the nation's infrastructure; therefore, the performance of these facilities is a national issue of great concern. The agency continues to support the most environmentally sound and cost-effective approach to implementing water pollution control solutions, whether centralized or decentralized.

Evolution of onsite chamber technology

Onsite wastewater treatment systems serve more than 37 percent of new developments and 25 percent of existing homes in the United States. A conventional septic system, which is the most common type of onsite treatment solution, consists of a septic tank and an aggregate-filled trench leachfield. A modern approach is to use an aggregate-free chamber to achieve the required amount of infiltration.

During the past 30 years, chambers have evolved dramatically in design, and now commonly are used for onsite treatment in basic and advanced applications. Widely accepted by installers, designers, and regulators, it is estimated that one in every four systems constructed in the United States today is a chamber system.

The first chambers used commercially were constructed of concrete and installed in New England in the early 1970s. These initial, concrete "gallery" chamber systems, or "ameration chambers," were more efficient than traditional stone and pipe systems. However, because they were unwieldy to transport, and labor intensive to install, engineers and designers began to look for alternative materials that would not sacrifice chamber strength, durability, nor treatment performance.

A large chamber system provides final disposal and treatment for a constructed wetland treatment system.

Rapid advancements in plastics made them the next logical material in the evolution of chamber technology. Several years of research and design culminated in 1987 with the introduction of plastic chambers, which are open-bottom structures with louvered side openings. While the principles of treatment remain the same, plastic chambers offer advantages unmet by their concrete predecessors.

Recognized benefits of chamber technology include the following:

- chambers are a "gravel-less" technology, thereby eliminating aggregate fines and aggregate compaction and embedment problems that reduce soil permeability;
- lightweight plastic chambers significantly reduce site disturbance and minimize soil compaction caused by heavy equipment needed to haul and place aggregate;
- chambers provide up to twice the infiltrative capacity of aggregate trenches and up to 67 percent more storage capacity;
- chambers are easy to install, resulting in time and labor savings; and
- chambers made from recycled materials positively impact the environment.

Performance data and research related to onsite wastewater treatment demonstrate the true efficiency of chamber systems, compared with aggregate-laden trenches. Following research and documented system trials, appropriate sizing regulations were created. These activities and peer-reviewed, published papers support chamber technology and recognize that chamber lengths do not need to be as long as aggregate trenches. Regulations governing these sizing reductions are based upon university laboratory research, side-by-side comparisons, and extensive field studies that compare throughput and failure rates of chamber systems with those of aggregate systems.

Common chamber applications

With familiarity of the technology, engineers found that chambers are highly adaptable to many special applications. They have been installed in sand filters, mound systems, and evapotranspiration beds. They also are used in conjunction with pretreatment devices, cluster wastewater treatment systems, constructed wetland projects, wastewater treatment plants, stormwater detention/retention facilities, and even toxic waste remediation sites. The most common applications are described below in more detail:

Sand filters — Sand filters are a type of packed-bed filter that have been used for more than a century. Engineers were quick to design sand filters using the benefits of chamber technology because chambers provide increased distribution coverage, allowing application of the effluent over the entire sur-

Exfiltration bed replaces expensive outfall

In Bayham, Ontario, Canada, the Port Burwell Sewage Treatment Plant outfall discharges to a creek in close proximity to Lake Erie. Expansion of the plant required a major upgrade that originally would have extended the outfall a distance into the lake. The creek could not assimilate the increase in minimum contaminants and, therefore, an outfall to the lake was proposed. After an extensive investigation of options, an onsite solution was recommended to convert the outfall to an exfiltration bed using chambers.

The chamber system saved considerable cost and provided additional pollutant removal. The exfiltration bed at the treatment plant reduces the amount of phosphorous emissions, which are removed by the soil's natural ability to absorb the nutrient, thereby lessening the impact to the sensitive lake environment. ■

As part of a plant expansion, the Port Burwell Sewage Treatment Plant installed chambers to act as large exfiltration beds.

face area of the chamber bottom. Including chambers on the bottom for wastewater collection increases the oxygen transfer within the sand filter. Newer packed-bed technologies consist of peat, textile, or foam media. These filters generally are reliable and provide good treatment.

Community systems — Decentralized, cluster septic systems that serve multiple, residential dwellings or commercial establishments use technologically advanced filters, pumps, tank configurations, and drainage chambers to provide a higher level of treatment. These cluster systems treat wastewater and return it to the ground near to where the wastewater was generated, as opposed to transporting it long distances to a centralized sewer facility.

The driving force behind this trend is the high cost and scarcity of quality land available nationwide, forcing builders to consider developing sites that previously would have been deemed unusable.

Wastewater treatment facilities — Chambers have begun to be specified in biofilters to reduce the odors emanating from wastewater treatment plants. A biofilter is a bed of organic media that is used to scrub objectionable odors from the air. Odorous air vented from compost facilities, rendering operations, and pumping stations can be passed through a biofilter that removes ammonia and reduced sulfur compounds. In this application, chambers improve air distribution through the media, provide more efficient drainage, lengthen media life, and ease construction of the biofilter and media replacement.

Evapotranspiration systems — In the arid, western regions of the United States, a common application for chambers is in evapotranspiration bed systems. Once ponding occurs in the trench, the effluent flows out the sidewall of the trench, enabling capillary action in the soil. From capillary action, water is pulled outward and upward in the soil matrix. Water then can change to vapor form (gas phase), which enables it to move vertically through the soil to the atmosphere.

Wetland treatment systems — Natural wetlands have been used as convenient wastewater discharge sites for as long as sewage has been collected. By the early 1970s, research into the treatment capabilities of natural wetlands led to development of engineered or "constructed" wetlands that replicated the cleansing capabilities of these natural marsh systems. Current, subsurface-flow wetland designs use shallow water depths and emergent wetland plants as the treatment media. Typically, these systems are used to polish treated wastewater and often are designed as multi-function treatment and wildlife habitat systems.

Remediation site clean-up — Environmental clean up sites have many treatment schemes. In one scheme, known as "pump and treat," contaminated groundwater is

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Utility manages onsite septic systems

In Phelps County, Mo., Public Water Supply District No. 2 is the state's first district to provide clustered wastewater services using centrally managed, decentralized, onsite wastewater treatment technology. Homeowners with failing septic systems turned to their water provider, which they knew and trusted. The district installed a septic tank effluent pumping system and recirculating sand filters as a cost-effective solution. The plan has been so successful that the district has increased service to additional homes and commercial properties. ■

Learn more online from the EPA

The EPA hosts a website for "Onsite and Clustered (Decentralized) Wastewater Treatment Systems" (www.epa.gov/owm/mtb/decent/index.htm). Check out the site to learn why the EPA is promoting the use of onsite solutions; to find out what your state training center offers; and to download the Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems, which were released in March 2003. Also, you can sign up for a listserver, which provides daily correspondence about this topic via e-mail. ■

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pumped to the surface, treated, and then discharged underground to recharge groundwater levels and to maintain flow patterns. Previous methods of recharging groundwater included stone beds; however, the fines associated with the stone can adversely affect the infiltration rate significantly, thereby increasing the required size of the recharge bed. Engineers have determined that chambers installed as the recharge solution minimize concerns about aggregate fines.

Improving management of onsite systems

For onsite septic systems to play a major role in the future of wastewater treatment, the level of standards and professionalism throughout the industry must be raised. As such, education, technology, and regulations related to onsite wastewater treatment have been the focus of much recent attention. For example, state-run, onsite wastewater training centers in the United States and Canada are educating contractors and regulators about new technologies.

Additionally, manufacturers have endeavored to educate contractors about how systems function. State regulatory departments also have increased their level of knowledge and professionalism. Many updated codes now require professionals, such as soil scientists or engineers, to conduct site evaluations and to design systems.

Many new management strategies and regulations are being tested and discussed as well that would enhance post-installation system management beyond the individual system operator (the homeowner). Strategies include fee-based utility oversight of individual systems and mandatory pumping schedules with record keeping by the regulatory department.

While regional sewers will continue to be the design of choice for metropolitan areas, extending sewers to suburban and rural areas is not the only solution. Onsite systems offer numerous advantages, including significant cost savings for new development areas and excellent performance. Advancements in chamber technology, as well as other treatment solutions, have increased the effectiveness and acceptance of standard and advanced onsite systems. Such strides have armed utility management districts with numerous solutions, and many are choosing to expand their services and revenues by managing onsite wastewater systems. ■

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