Managed Onsite/Decentralized Wastewater Systems as Long-Term Solutions

by David Geisinger and Gerry Chartier

Introduction

This article discusses the concept of "managed" onsite/decentralized wastewater systems, compares them to conventional centralized collection and treatment systems, and considers funding sources for this alternative utility concept. Figure 1 illustrates this concept.

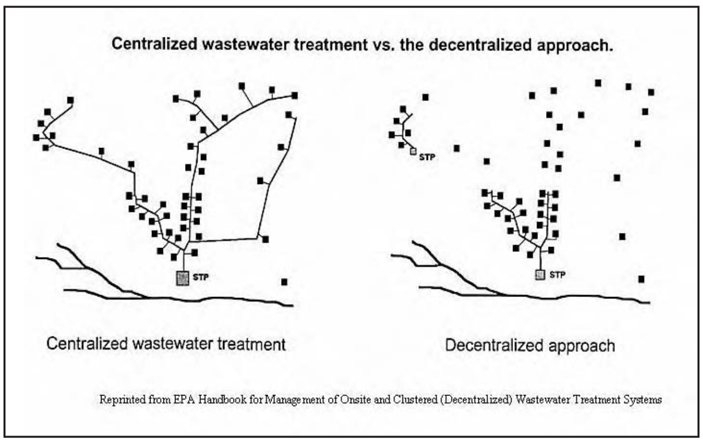

Figure 1. Centralized wastewater treatment versus the decentralized approach

Conventional wastewater collection and treatment system technology has served us well, and with the hard work of the wastewater industry and New York communities, we have made incredible strides in cleaning and protecting New York's waters. However, we are challenged to devise workable solutions for the remaining communities, especially in rural and urban fringe areas that are not presently served by publicly owned wastewater systems that have identified water quality issues. Managed onsite/decentralized treatment systems have the potential to stretch federal/state/local monies to fund more projects by providing the least cost-permanent solution to protect public health and water quality. This adds another option for New York communities. At workshops conducted in 2002 and 2003 at the Water Environment Federation Technical Exhibition and Conference (WEFTEC), speakers emphasized that with better onsite management, onsite/decentralized applications can be very cost effective versus centralized facilities and, if installed and managed properly, can often produce effluent superior to that of conventional sewage treatment plants.

Monetary Shortfall

If current spending continues, wastewater infrastructure needs could face a significant funding gap over the next 20 years per the *Clean Water and Drinking Water Infrastructure Gap Analysis* by the U.S. Environmental Protection Agency (USEPA), made public in 2002. According to the analysis, present trends in capital spending are not adequate to replace the aging systems and make new priority investments, and current federal spending trends make it improbable that the gap in actual spending versus needed capital and operation and maintenance spending will close for a long time. In figure 2, the left bar graph depicts a no-revenue growth scenario. The right bar graph shows that a 3 percent annual spending increase is needed to match projected capital needs. Since late 2003, the New York Clean Water State Revolving Fund (CWSRF) program has had a funding line, meaning that only those communities whose projects score above the funding line are eligible for financing.

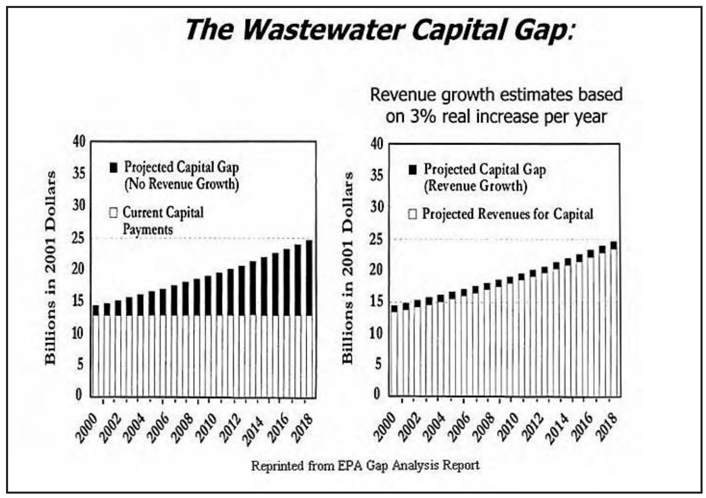

Figure 2. Wastewater capital gap

Small Community Wastewater Needs

Onsite/decentralized systems serve approximately 25 percent of the U.S. population and approximately 33 percent of new development. In New York State, per the 1990 *U.S. Census of Detailed Housing Characteristics,* 1,460,900 households were served by onsite wastewater treatment systems, representing a population of 3,930,000. Similar household characteristics data were not obtained during the 2000 census. Based on accelerated expansion of urban fringe development, it is estimated that by now the population in New York State served by onsite systems is considerably over 4,000,000.

Throughout the country, more than half of the existing systems are over 30 years old, and surveys indicate that at least 10 percent of these systems back up onto the ground surface or into the home each year. Other data have shown that at least 20 percent of systems are malfunctioning to some degree. In the USEPA's *Response to Congress on Use of Decentralized Wastewater Treatment Systems* in 1997, state agencies listed septic systems as the second most frequent contaminant source that threaten groundwater resources. It is widely accepted that the primary causes of failure are inappropriate siting or design and inadequate long-term maintenance contributing to major water quality problems. For example, failure on the part of the homeowner to perform routine maintenance, such as pumping out the septic tank every three to five years, can cause solids in the tank to migrate into the drain field and clog the system.

The USEPA's 1997 report to Congress began to set the stage for more widespread acceptance of alternatives to centralized collection and treatment systems. In this report the agency analyzed the benefits of decentralized wastewater system alternatives compared to current centralized systems, listed potential savings associated with these alternatives, described barriers to implementing these alternatives within current statutory and regulatory structures, and discussed plans to promote alternative measures.

Managed Decentralized versus Centralized Collection and Treatment: Time for a Broader Viewpoint

Since the 1960s onsite or decentralized systems have traditionally been considered only a temporary solution until centralized collection and treatment systems are installed. Most of the facility planning and comprehensive county wastewater studies done for small and medium-sized communities in New York State from the 1970s to the present have generally not considered the retention and use of existing onsite systems in developing wastewater solutions. Often the public, municipal officials, and consulting engineers view centralized collection and treatment systems as being more reliable, cleaner, easier, and more modern than onsite systems.

Increasingly, people are realizing that there just isn't enough money to go around for every community to be served by sewer systems. With advances in onsite treatment technology, it is now possible to design and install onsite systems on marginal or poor soils that will, with proper maintenance, protect public health and water quality.

Onsite/clustered/decentralized treatment systems are a permanent fixture on our landscape. They can protect the environment and have the potential to be the least costly alternative as compared to conventionally constructed collection sewers with a central treatment facility for rural and urban fringe communities.

Public Health and Water Quality Protection

The Clean Water Act (CWA) requires conventional systems' secondary treatment to achieve an effluent concentration of 30 mg/l for both a five-day BOD and TSS. In some cases, stricter discharge standards are imposed.

A well-managed onsite and clustered treatment system can provide adequate treatment of pollutants and contribute to groundwater recharge. In recent times, the onsite treatment industry has developed a variety of treatment units and system components that are capable of meeting even the most stringent performance requirements for sites with significant design limitations. The high rate of onsite failures in some communities is linked to poor siting, design, and system management rather than an overall inability of onsite systems to adequately treat and disperse wastewater.

Conventional onsite systems (typically a septic tank and soil absorption field) work well if they are installed in areas with appropriate soils and hydraulic capacities; designed to treat the incoming waste to meet public health, groundwater, and surface water performance standards; installed properly; and maintained to ensure long-term performance. Alternative systems are installed at sites where conventional, soil-based onsite systems with leach fields are inappropriate because of inadequate soils, excessive slopes, high seasonal groundwater tables, and other climatic or site conditions. With proper management oversight, alternative systems such as recirculating sand filters, peat-based systems, and package aeration units can be installed in areas where soils, bedrock, fluctuating groundwater levels, or lot sizes limit the use of conventional systems.

Groundwater monitoring below properly sited, designed, constructed, and operated subsurface infiltration systems has shown that carbonaceous biochemical oxygen demand (CBOD), TSS, fecal indicators, metals, and surfactants can be effectively removed by the first two to five feet of soil under unsaturated, aerobic conditions. Phosphorus and metals can be removed through adsorption, ion exchange and precipitation reactions, but the capacity of soil to retain these ions is finite and varies with soil mineralogy, organic content, pH, reduction-oxidation potential, and cation exchange capacity. Nitrogen removal rates vary significantly, but most conventional onsite systems do not achieve the 10 mg/l drinking water standard for nitrate. Further, some types of viruses may leach to groundwater. Considering overall water quality issues, the public health and environmental risks from properly sited, designed, constructed, and operated onsite systems appear to be low.

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A septic tank/soil absorption treatment system is nearing completion for the Hamlet of Bovina Center in Delaware County.

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Potential Costs and Savings

Sewage collection systems are typically 60 to 70 percent of total project costs for a conventional centralized system, so anything that can be done to reduce these costs is a plus. For example, the construction of a small diameter gravity sewer (SDGS) system for Au Sable Forks in the Adirondacks in 1989–90 for 300 home and business connections resulted in an estimated savings of $600,000, or 18 percent when compared to construction of a conventional gravity system. The community has also seen savings in annual operation and maintenance costs. The SDGS system cost of providing a new septic tank for each property was offset by the shallow trench depths, which reduced rock excavation with less trench footprint, flexible pipe alignment to dodge physical obstructions, fewer manholes, and so forth. The reduced operation and maintenance was the result of having to treat a lower strength sewage, and savings on pumping costs, which offset the cost to pump and dispose of septage every three to seven years, depending on site usage. A feasibility study for 13 Catskill hamlets in the New York City watershed west of the Hudson River (30 to 124 connections serving 80 to 295 people) showed that the SDGS collection systems cost less than conventional gravity sewer systems by about 10 percent.

New York City watershed onsite wastewater treatment systems (OWTS) cost data may be helpful in comparing the cost of conventional wastewater treatment to managed onsite/decentralized wastewater systems. The installed costs, including design and inspection, for nearly 1,200 systems in the Catskill area of the New York City watershed, are as follows for the years 1997–99:

Table 1. Installed Costs for Onsite Wastewater Treatment Systems in the Catskills

Type of System	Number of Systems	Average Cost
Conventional design (CD)	383	$4,536
Modified conventional design (MCD)	216	$9,699
Alternative system (ALT)	575	$13,028

In the above table, CD represents a standard septic tank and leach field system. MCD represents a modified CD and may include pumping, shallow trench, cut and fill, curtain drain, dosing system, or other modifications. ALT represents an alternative system composed of a raised mound, sand filter, peat filter, aerobic treatment unit, and so forth.

Using the above Catskill watershed data, let us assume for illustrative purposes that for a typical community considering a managed decentralized system, replacement of existing failed onsite systems would require that one-third be CD systems, one-third be MCD systems, and one-third be ALT systems. The average cost of a typical onsite system using this cost data would be $9,088. Adding soft costs of 25 to 30 percent to cover engineering, legal, administrative, temporary borrowing costs, and other costs associated with forming a wastewater district potentially would increase the figure to about $11,360 to $11,810 per system. If the solution required some properties to be served by cluster systems, then there is the added cost of land and SDGS sewers. This illustration suggests that if a conventional designed wastewater system was estimated to cost much more than $12,000 to $15,000 per connection, then the community might be wise to do a more detailed study. That study should involve a detailed soil analysis, subsurface borings, hydrological/soils investigations, and development of cost estimates to determine if a managed decentralized wastewater system might be the most feasible, cost-effective long-term solution.

Another way of looking at the cost issue is to review the current cost of providing centralized treatment for small, rural communities. A review of New York Clean Water State Revolving Fund projects shows a dozen recently constructed projects that provided new centralized conventional collection and treatment systems for small rural communities. Below are data for three of these communities, representing the lowest, the median, and the highest cost results of these facilities. These three representative projects were built in 2002 and 2003. In the following table, the total capital cost of each system divided by the equivalent dwelling units (EDUs) in that system resulted in a cost per typical residential property. An EDU represents a typical single-family residence. On an EDU basis, community A represents a low-cost project, community B is an average-cost project, while community C might be a candidate for considering other options.

Table 2. Centralized Collection and Treatment Systems Cost Data

	Capital Cost per EDU*	Population Served
Community A	$12,373	1,691
Community B	17,115	715
Community C	22,148	178

*Grant/loan aid not included

Both centralized and decentralized system alternatives need to be considered in upgrading failing onsite systems to provide the most appropriate and cost-effective solution to wastewater treatment problems. Managed decentralized wastewater systems are viable, long-term alternatives to centralized wastewater facilities in small and rural communities. Small communities, especially those with fewer than 100 proposed connections or those with a low population density (roughly one or two households per acre) may realize significant cost-savings using a decentralized approach. The following table provides a general rule of thumb of where each system may be most appropriate:

Table 3. A General Guide to Cost-Effective Wastewater Systems#+

Low population densities: One dwelling or less per acre	Decentralized system
Moderate population densities: One or two dwellings per acre	Decentralized, centralized, or hybrid system
High population densities: More than three dwellings per acre	Centralized system

#Depending on site conditions
+Serving existing or new development

Funding Sources

In New York State, the primary sources of funding for wastewater projects for small communities has been the Clean Water State Revolving Fund (CWSRF), the U.S. Department of Agriculture (USDA) Rural Development Water and Waste Disposal Grant and Loan Program, and the Governor's Office for Small Cities Community Development Block Grant (CDBG) Program. In addition, the Appalachian Regional Commission (ARC) provides funding to the 14 southern tier counties in the Appalachia region of New York State. In 2003, the Water and Sewer Infrastructure Co-Funding Initiative was put into place to help communities learn about and apply for various financing options. Further information and application materials for these programs can be obtained by phoning 800-882-9721 or by going to www.nycofunding.org.

The New York Clean Water State Revolving Fund (CWSRF) program identifies "decentralized systems" as an eligible project type. The Federal Fiscal Year 2006 Intended Use Plan includes "decentralized wastewater systems, including costs for new or replacement septic systems, septage trucks, etc." Nationally, several CWSRF state programs have funded decentralized systems. The New York State Environmental Facilities Corporation (NYSEFC), which administers the CWSRF, accepts applications for projects involving decentralized systems—entirely onsite systems, onsite and cluster systems, or hybrid systems—provided that the municipality owns and operates the facilities or operates the facilities under an easement or similar agreement. According to David Miller, community programs director, the USDA Rural Development Rural Utilities Services program also encourages applicants to consider the onsite/decentralized technology option. The applicant must select the most cost effective and publicly acceptable alternative, fully address community needs, document the formation of the wastewater district, and show how the management structure will ensure long-term operation and maintenance needs, based on an engineering report.

Going Forward

Since 1979, the National Small Flows Clearinghouse (NSFC), which was recently renamed the National Environmental Services Center (NESC), in Morgantown, West Virginia, has served as the national repository and referral service for the transfer of information on decentralized, onsite, alternative collection, and small treatment technologies. The section at right entitled "Decentralized Wastewater Treatment Systems Resource List" provides a current list of documents available through USEPA. Many of these can be obtained on the web at www.epa.gov/own/onsite or by phoning the USEPA National Service Center for Environmental Publications at 800-490-9198.

When properly designed, installed, and managed, a decentralized approach to wastewater treatment has several benefits. The primary ones are the following:

- Properly managed decentralized systems protect public health and the environment.
- The capital cost savings may be significant for low-population-density developed areas.
- Annual operation and maintenance costs are often lower for these less complex systems.
- They can be adapted to varying site conditions of high groundwater, impervious soils, and shallow bedrock.

Both centralized and decentralized system alternatives need to be considered in rural and urban fringe communities with failing onsite wastewater systems. For the decentralized concept to take hold here in New York, public officials and engineering professionals must seriously consider, with their clients, whether this is an appropriate option.

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Onsite/Decentralized Wastewater Systems Definitions

Decentralized system: An onsite or cluster wastewater system that is used to treat and dispose of relatively small volumes of wastewater, generally from individual or groups of dwellings and businesses that are located relatively close together. Onsite and cluster systems are also commonly used in combination.

Onsite wastewater treatment system (OWTS): A system relying on natural processes and/or mechanical components to collect, treat, and disperse or reclaim wastewater from a single dwelling or building.

Cluster system: A wastewater collection and treatment system under some form of common ownership that collects wastewater from two or more dwellings or buildings and conveys it to a treatment and dispersal system located on a suitable site near the dwellings or buildings.

Managed decentralized system: The management of a number of onsite/clustered systems—as a utility system that includes some or all of the activities of public education, planning, performance, site evaluation, design, construction, operation and maintenance, residuals management, training, inspections/monitoring, corrective actions, recordkeeping/reporting, and financial assistance/funding.

Decentralized Wastewater Treatment Systems Resource List

U.S. Environmental Protection Agency, *Voluntary National Guidelines for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems,* EPA 832-B-03-001, March 2003.

U.S. Environmental Protection Agency, *Funding Decentralized Wastewater Treatment Systems Using the CWSRF,* January 2003.

U.S. Environmental Protection Agency, *Handbook for Management of Onsite and Clustered (Decentralized) Wastewater Treatment Systems,* February 2002.

U.S. Environmental Protection Agency, *Onsite Wastewater Treatment Systems Manual,* EPA 625/R-00/008. February 2002.

U.S. Environmental Protection Agency, *Response to Congress on Use of Decentralized Wastewater Treatment Systems,* EPA 832/R-97/001b, April 1997.

U.S. Environmental Protection Agency, *Guide to Septage Treatment and Disposal,* EPA 625/R-94/002, 1994.

U.S. Environmental Protection Agency, *Wastewater Treatment/Disposal for Small Communities,* EPA/625/R-92/005, September 1992.

U.S. Environmental Protection Agency, *Alternative Wastewater Collection Systems,* EPA/625/1-91/024, October 1991.

U.S. Environmental Protection Agency, *Design Manual – Onsite Wastewater Treatment and Disposal Systems,* EPA 625/1-80/012, October 1980.

USEPA website: www.epa.gov/owm/decent/index.htm

NSFC website: www.nesc.wvu.edu/nsfc_index.htm

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