DISTRIBUTED SYSTEMS OVERVIEW

Water Environment Federation
the water quality people

THE Water Research FOUNDATION

IN COLLABORATION WITH EPA's Decentralized Wastewater Management Memorandum of Understanding (MOU) Partnership

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Decentralized systems can be located in a different geographical location, but **are not linked** physically, or are not managed under the umbrella of a centralized system.

What is a Distributed System?

There are many ways in which to define a distributed system. Typically, distributed systems are in different geographical locations, but are linked to a central system either physically, or by management. The most likely is a "distributed management" scenario, wherein distributed management provides the opportunity for overall single-entity management of disparate or remote systems. "Distributed wastewater management is an approach to wastewater collection, treatment, and disposition (discharge, reuse, dispersal) that uses appropriately scaled systems—which can vary from onsite to cluster to centralized—across a service area, watershed, or other political or natural boundary." [D'Amato, *et al.*, p. 3]

An array of decentralized wastewater technologies are considered and implemented in small to mid-sized municipalities, as well as large municipalities, and in new land development projects. These technologies can supplement service areas for municipalities that have an existing centralized wastewater system. This application of multiple systems under a single management entity is called distributed wastewater management. [WEF, Kreissl, et al., p.2]

On the other hand, a decentralized system can be located in a different geographical location, but is not linked physically, or is not managed under the umbrella of a centralized system.

Effectively planned, implemented, and managed distributed or decentralized water systems are critical elements of sustainable infrastructure in the United States. These systems can be in rural or urban settings and range from small systems found on homeowner properties to small-system water resource recovery facilities (average daily flow of less than 1 MGD and serving a population of less than 10,000). The systems can be either discharging (surface or subsurface) or reuse systems. As noted in Charting New Waters, using the term 'distributed' in an urban environment places the focus on what the systems are instead of what they are not as the term 'decentralized' does. [The Johnson Foundation at Wingspread, p.3]

Population and Treatment System Statistics

- One third of new development is served by decentralized systems due to population migration away from urban centers [U.S. EPA Primer]
- In the U.S., approximately 11,257 or 72 percent of the 15,617 operational public water resource recovery facilities are classified as small systems – EPA considers these systems small if the population served is 10,000 or fewer, and the average daily wastewater flow is less than one million gallons per day. [U.S. EPA Water Research]

Rural Communities and the Use of Distributed or Decentralized Systems

The development of large-scale water resource recovery facilities is often not necessary for rural (non-urban) communities. Rural communities may lack the financial resources, as well as personnel to manage and operate a large system, and in many cases face challenges due to geography or climate. There are a variety of distributed or decentralized systems that can provide rural communities with wastewater treatment for either discharge or reuse.

Implementation of distributed or decentralized systems is not limited to new development. From the cluster system on up, distributed or decentralized systems can be used to supplant septic systems serving individual homes in communities where septic systems are failing. Modern small community and suburban approaches consider distributed or decentralized systems as a better approach than pumping wastewater from a natural basin to facilitate the use of a single more complex, treatment facility. [Kreissl, p. 25]

Urban Communities and the Use of Distributed or Decentralized Systems

Extending a collection system to areas outside an existing sewer boundary can be a problem in urban areas from both an environmental and/or a financial standpoint due to associated costs. Some facilities have implemented distributed systems as a means of extending service area. HRSD's small treatment systems on Virginia's Middle Peninsula and the cluster systems of Mobile, AL are examples of distributed systems. Distributed systems are also finding their way inside centralized system sewer boundaries due to implementation of on-site non-potable water systems (ONWS) within buildings or through district-scale projects.

Value of Distributed or Decentralized Systems

Economic – Economic challenges to constructing a conventional, centralized facility in a rural setting include difficulties caused by terrain, climate, lack of personnel, and an inability to achieve the economies of scale needed to support a centralized facility. Urban communities must address the infrastructure, maintenance and energy costs of extending the collection systems network to connect outer city developments to a centralized facility. Distributed or decentralized systems can be a lower-cost alternative due to smaller infrastructure and reduced energy, operations and maintenance costs. Distributed or decentralized systems can be 'modular' in nature and allow communities to increase treatment capacity as the community grows thereby avoiding larger up-front financing costs. Decentralized collection systems generally come at a lower cost.

Environmental

Distributed or decentralized systems can mitigate aquifer depletion. Effluent is either discharged or reused in the watershed in which it originated. They also help to maintain a community's desired land use patterns. Finally, they can be less energy intensive. The smaller size of distributed or decentralized systems inherently results in less consumption of energy. However, lower energy consumption is also a result of smaller distances over which wastewater is conveyed, reducing pumping needs of the facility.

The relatively compact size of a small distributed or decentralized system allows communities more say in where the system is located and thus lends to better integration with and less disruption to the landscape.

Like centralized systems, distributed or decentralized systems can provide environmental benefits, such as nutrient and pathogen removal and water reuse opportunities through the implementation of ONWS and DPR technologies. Distributed or decentralized systems and small water resource recovery facilities can be designed to remove phosphorus and nitrogen before the effluent is returned to the environment. Nutrient removal technologies can be added to lagoon systems and even conventional septic systems can achieve significant nutrient removal through drainfield design. Distributed or decentralized systems can provide water for direct potable reuse and non-potable water in both rural and urban settings for purposes such as flushing, cooling and heating, landscaping, and subsurface irrigation drip. The New York City Solaire building is an early example of distributed system within a heavily urbanized area effectively rendering the complex as a small community for the purpose of non-potable water reuse.

Technical/Logistical

Due to the smaller size of decentralized systems, installation and implementation can be less intensive. The smaller footprint results in easier layout and siting of the system; alternative sewers can be placed in ground at shallower depths; and these systems can be used in challenging terrain often being routed around obstacles or following the contour of the land.

Sustainability/Resilience – The economic, environmental and technical advantages of small distributed or decentralized systems increase a community's sustainability and resilience through the use of alternate water sources, less need of potable water for non-potable uses, a reduced strain on wastewater systems, energy conservation, and replenishment of the local aquifer.

One recent phenomenon is new housing development that incorporates urban-like housing densities with significant open or common areas. These “conservation style” developments are generally best served by alternative collection systems (ACSs), because distributed or decentralized systems can be built in nearby open spaces for treated wastewater dispersal and/or reuse. This frees such developments from being dependent on costly extensions of existing sewer systems. [Kreissl, p. 27]

Distributed System Technology Snapshot

Two examples of distributed systems are shown in the following technology snapshot. The communities are in different geographic regions.

Piperton, Tn

In 2006, Piperton, TN, an eastern suburb of Memphis, settled on developing a distributed wastewater infrastructure after studying alternatives for increasing the amount of wastewater infrastructure that would be needed to meet growth projections.

The city selected one vendor as its preferred treatment plant provider for all residential developments. This provides consistency across all of the city’s treatment plant facilities. Wastewater is conveyed from homes in each development to each development’s system via a STEP/STEG and low-pressure sewer collection system. The effluent is dispersed through drip irrigation.

Piperton also chose to have the developers fund the installation of the system in each development and then turn over ownership and operation of the system to the city. This distributed system arrangement benefits both the developers and the city of Piperton. Developers can list municipal services when selling homes. The city avoids a large capital outlay while increasing wastewater infrastructure where needed.

Piperton has also signed an agreement to send a portion of its wastewater to its neighbor, Rossville, TN. Additionally, in 2015 and 2017 respectively, Piperton received the results of a sewer master plan and a sewer system rate study in anticipation of a future centralized treatment plant operating in Piperton. After the centralized plant is in operation some of the residential treatment systems will be decommissioned, resulting in a distributed system consisting of a centralized treatment plant and several residential treatment systems.

Howard County, Md

Another example, Howard County, MD, uses cluster development to preserve open spaces and support forest conservation. Cluster developments that use shared sewage disposal facilities (SSDF) must be under the control of a municipality or county according to the Maryland Code of Regulations.

Howard County initially agreed to oversee SSDFs for eight cluster systems outside of its centralized wastewater system. The communities pay for the operation and maintenance of the systems, which is performed by the county. From the eight systems initially constructed, the number of SSDFs under the authority of Howard County has grown to 23 systems.

The systems vary from one development to the next. Some have septic tank effluent from individual lots pumped to a community subsurface disposal area, others use SBRs, etc. Howard County exemplifies the effectiveness of distributed systems to benefit desired land use patterns through the use of centralized wastewater treatment and multiple community-level treatment technologies under one controlling authority.

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