by Patrick T. Gates and Todd M. Gates

Centralized Sewers Not Always the Best Solution

By strict definition, centralized sewers collect sewage from several different locations (residential, commercial, and industrial) over a relatively large area, and through a network of underground laterals and manifolds, transport the untreated sewage to a large centralized treatment plant for treatment and discharge. In other words, a centralized system is usually comprised of a large collection system plumbed into one large treatment plant serving a relatively small high-density area (Figure 1).

Decentralized sewers refer to a network of individual onsite treatment systems and/or a network of smaller wastewater treatment plants serving several customers, but not an entire community. Similarly, as illustrated in Figure 1, decentralized systems are typically comprised of multiple small treatment systems with a more limited collection system serving a larger low-density area.

Many of the centralized sewers in service today are a direct result of the Clean Water Act (CWA) passed in 1972. Of course, centralized sewers existed before enactment of the CWA, but there was no regulatory mechanism that oversaw their operation or enforced discharge standards until the Environmental Protection Agency (EPA) was established in 1970.

At that time, many of the discharges did not meet NPDES standards. Prior to enactment of the CWA, treatment of sewage was not as important as transporting the sewage to sufficiently sized surface water so that it could be discharged without causing a nuisance (i.e., dilution was the solution).

In order to meet the new standards, upgrades and/or replacements had to be performed on many of the collection and treatment systems that were in use. These new systems and upgrades were expensive, requiring large capital expenditures, primarily derived from the Federal Construction Grants Program (FCGP). The FCGP provided Publicly Owned Treatment Works (POTWs) with at least 50% or more (sometimes as high as 90%) in matching funds.

During the 1970s and 1980s the FCGP provided over $60 billion (Figure 2) in matching funds to POTWs to upgrade and/or replace treatment and collection components (i.e., lift stations, interceptor sewers, trunk lines, treatment systems, etc.).

Benefits of Centralized Sewers

It is undeniable that the enactment of the CWA, in conjunction with centralized sewers, significantly decreased many of the environmental problems that existed in the late 1960s. Prior to enactment of the CWA, only one-third of the surface waters in the U.S. were considered safe for swimming and fishing, while today, two-thirds of all waters are considered safe for swimming and fishing. A large contribution to the improvement of surface waters resulted from centralized sewers and the CWA.

Centralized sewers allow residential, commercial, and industrial development to proceed at a more rapid rate. During any land development process, one of the first hurdles to overcome is addressing the sanitary sewage a development will produce. If the desired location of the proposed development has access to a centralized sewer, the developer simply has to pay the tap-in fee and the problem is solved.

In addition, they allow focused management. Due to typical size and expense, the consistent operation of any electro-

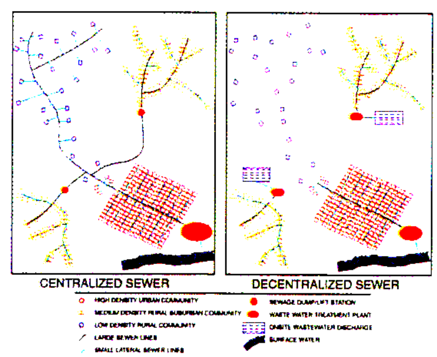

Figure 1

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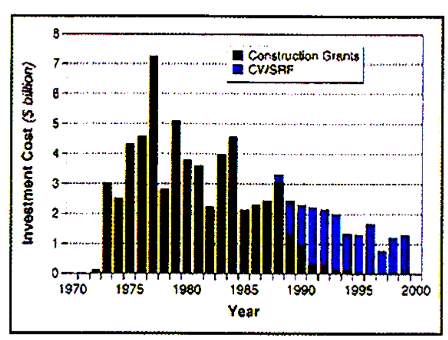

Figure 2: Funding data provided by USPEA's Progress in Water Quality Report.

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mechanical manmade apparatus requires constant maintenance and oversight that are usually operated and maintained by public entities/municipalities that employ licensed qualified operators. Of course, this also makes them easier for regulatory agencies to monitor and oversee.

Problems Associated with Centralized Sewers

In the last 10 to 15 years some unforeseen financial and environmental problems associated with centralized sewers have emerged.

Operation and maintenance of centralized treatment systems is more costly than initially predicted. The financial impact of centralized sewers is most evident in small to mid-sized communities that lack the high population densities found in urban areas.

Maintaining and repairing centralized sewers in highly populated areas is typically cumbersome and logistically difficult. Plus, the sewer infrastructure may be extremely difficult and inconvenient to access.

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Estimates indicate that anywhere from $21 to $122 billion will be needed over the next 20 years for capital, operating, and maintenance associated with existing centralized sewers.

After underground gravity sewers were installed, they were "out of sight, out of mind," with the expectation that the concrete and/or plastic piping would last forever and never leak. Replacement and/or refurbishment of underground pipes is expensive, time consuming and inconvenient since many of the pipes are under active streets, along or in creek beds, and in close proximity to other subsurface utilities.

Environmentally, centralized sewers have helped some aspects of the environment while inadvertently harming others. Surface water quality has improved since enacting the CWA, however, groundwater resources are being withdrawn faster than they are being replenished. Over half (53%) of the U.S. population derives its water from groundwater, but 75% of the population uses centralized sewers which discharge to surface waters. As a result, potable water supplies derived from groundwater aquifers are not replenished.

Groundwater can also be withdrawn and/or contaminated from leaky sewer pipes and man ways. During drier periods, untreated sewage can exfiltrate from pipes and contaminate groundwater, while during wet periods groundwater can infiltrate into the pipes and not only overwhelm the treatment plant, but also decrease groundwater levels.

Even though the surface water quality has improved, the majority of treatment plants still discharge effluent high in nitrates that can damage ecosystems. The EPA, along with other regulatory agencies, recognized the need to decrease nitrates from treatment plant discharges. However, the cost to retrofit existing treatment systems that do not address nitrates with tertiary filters used to decrease nitrates would be cost prohibitive.

In many areas, rapid development has resulted in exceeding the original design capacity of the centralized system, causing difficulty in complying with permitted effluent requirements.

With easy access, land development has occurred at a rapid pace, sometimes without preparing for the consequences.

Large treatment plants will occasionally suffer problems that are inherent with any electromechanical system. Since large treatment plants collect and treat large amounts of sewage, there exists the potential for a more significant and expanded environmental impact.

Despite all of these potential problems, eliminating centralized sewers is obviously not a practical or viable option. In high population density areas with a large tax and/or rate base, a centralized sewer system is most probably the best and only cost effective way to address sewage.

Conversely, in a rural low-density area a series of onsite sanitary treatment systems is the most viable alternative to address sewage. This is because the residences are geographically spaced farther apart, and each lot usually has adequate land for an individual onsite discharge. In other words, using a centralized sewer in a low-density rural setting makes as much sense as using multiple onsite treatment systems in a high-density urban setting. The difficult or gray area lies in how to address sewage collection and treatment in a suburban rural setting.

New options for developments located in rural suburban areas include the cluster system concept. Since it is relatively new, some political and technical hurdles have emerged.

Defining a Cluster System

The basic concept of a cluster system is that the homes inside a small community discharge to a treatment plant located inside the development that treats and discharges that effluent onsite (although cluster systems can discharge to surface waters). Some smaller cluster systems are configured to perform primary treatment at individual residences using septic tanks.

Cluster systems are commonly used in developments with greater than 10 homes. Subdivisions with more homes (i.e., greater than 1,000 homes) can often use multiple cluster systems, depending on site conditions.

Following the primary treatment, the solids-free liquid can then be easily transported using gravity, vacuum, or low-pressure sewers to a small secondary treatment plant. From the treatment plant, the effluent can then be land applied inside the confines of the development using one or a combination of technologies (i.e., spray/drip irrigation). Traditionally, land application of liquid sewage effluent has been used as the final step in the treatment process.

For example, traditional subsurface leach fields, Wisconsin mound, or land application systems have served two purposes: to provide tertiary treatment by removing nutrients; and to act as a discharge mechanism.

Ideally, using a cluster system, the treatment plant can be designed so that the effluent it produces needs little or no treatment. In other words, it is intended to produce a high water quality effluent by adding a supplemental treatment stage, and the land application process is solely a discharge device, not a treatment mechanism.

Benefits of a Cluster Treatment System

When well designed and properly installed, cluster sewage systems can be environmentally friendly, create communities that preserve high quality green space, and are cost effective for developers and municipalities.

Cluster sewage systems are inherently more environmentally friendly than centralized sewers since they represent a more sustainable development approach. Cluster systems generate, collect, treat sewage, and discharge treated effluent inside the same development, which has much less of an impact on the surrounding area. Additionally, by using treated effluent (i.e., gray water) in place of potable water for irrigation of common areas, water resources are not depleted.

Inevitably, all wastewater treatment systems, no matter what the size, will malfunction. Since the centralized treatment plant treats and discharges a large quantity of wastewater, it is almost impossible to contain the problem and the volume of inadequately or untreated water discharged into surface water can have a significant environmental impact. However, with managed cluster systems, the environmental impact is not as

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drastic since the flow quantities are less and the system discharges onsite.

Most individual onsite treatment systems (i.e., septic tanks and leach fields) are limited by the soil type and topography and typically require sized lots in the 2- to 5-acre range. Within a 100-acre development, the soil, topographic, depth to bedrock, and groundwater conditions can vary significantly. As a result, cluster systems allow designers to choose the most suitable location in a development to locate the treatment and, more importantly, the discharge systems. Instead of being limited by small individual lots that have separate systems, the system designer has more flexibility and can utilize the best features of an entire development.

From a land development perspective, cluster systems allow developers to create larger and higher quality green spaces. For example, instead of subdividing 100 acres into 20 5-acre lots, the developer/land planner could set aside 20 1.5-acre lots for homes, 10 acres for a sewage treatment and land application area and the remaining 60 acres could be left undeveloped for public green space (Figure 4).

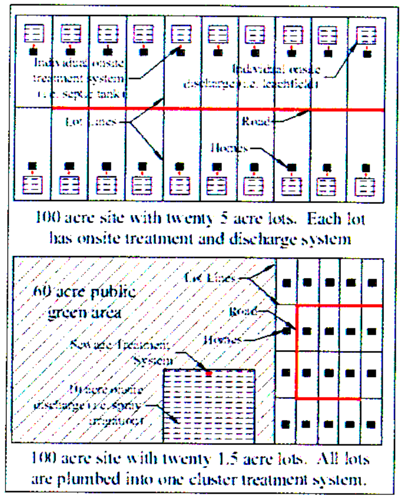

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Figure 4

Since the developed area (i.e., house lots) is smaller in size, there is less environmental impact on the land being developed. Additionally, the land development and infrastructure costs are less, since the lots occupy a smaller area.

Ideally, any mechanical wastewater collection and treatment system should be operated by a competent, accountable municipal, and/or private entity. Proper operation and management of treatment systems help to dramatically improve the longevity and performance of any system.

The absence or presence of sewers affects a community's ability to grow. In order for communities to grow they must increase sewage capacity, which is accomplished by running additional sewer laterals to un-serviced areas and/or by increasing the size of or building new treatment plants.

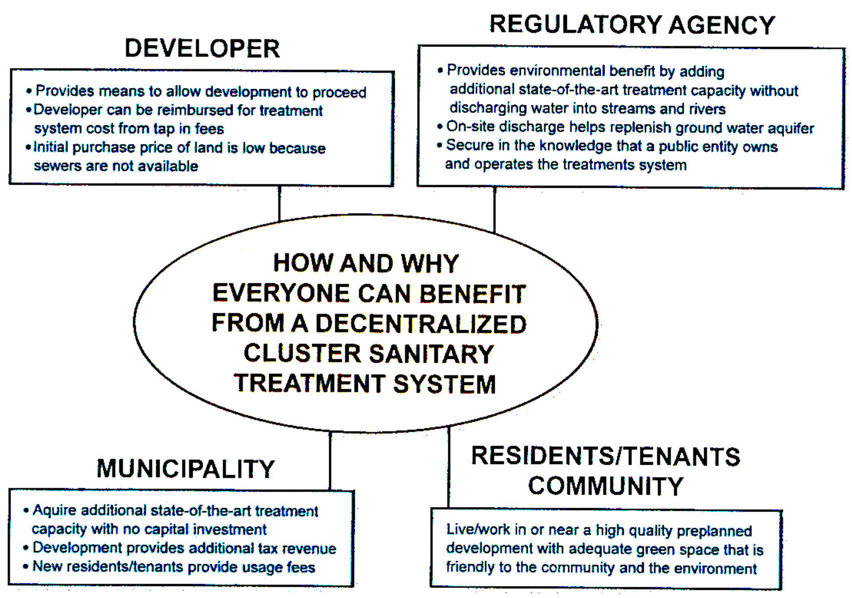
Smaller cluster systems allow developers to pay for not only the collection system but also the treatment and discharge system. Following construction and start-up, the entire system can be transferred to the local municipality, who will maintain and operate the system. The developer is reimbursed for the capital costs by collecting the sewer tap-in fees paid by the homeowners or builders, and the municipality receives a state-of-the-art collection and treatment system.

The municipality can then charge usage fees to pay for the operation and maintenance of the system. Since the capital costs for the system have already been paid for by the developer, the municipality does not have to service any long-term debt. Decentralized cluster systems can benefit municipalities, regulatory agencies, developers, and communities (Figure 5).

Obstacles for Cluster Sewage Systems

With all the apparent benefits that a cluster sewage system possesses, one would-speculate that there should be more systems currently in use. However, that is obviously not the case. Although the cluster system concept is gaining acceptance, the majority of system designers and regulatory personnel prefer centralized sewers. The reasons for this preference are simple.

Figure 5



First, the components and management structure associated with centralized sewers are familiar. In addition to potential regulatory hurdles, design engineers who have been designing and installing centralized treatment systems for the last 30 years are often reluctant to embrace new concepts and technologies.

Second, on a technical level, the majority of collection, treatment, and discharge components that comprise a cluster system are relatively simple. However, the true technical challenge is correctly applying the right combination of technologies to achieve a low capital, low maintenance, and environmental-friendly system from collection point to discharge point.

It is generally perceived to be easier to manage and/or regulate one large treatment plant versus several smaller plants.

One large obstacle is that many states do not possess specific regulatory guidelines, policies, and an administrative framework for design, permitting, and operation of cluster systems, particularly with onsite discharge.

Treatment system designers are often intimidated by the perceived professional liability associated with using alternative technologies or concepts.

Helping to further this argument is the fact that several small treatment systems installed in the last 30 years have failed prior to their anticipated life expectancy. In some cases the systems were poorly designed, or improperly installed.

However, the majority of failures resulted from either an inadequate, or in some cases, total absence of proper preventative maintenance. In some cases, the failure of these poorly maintained systems was blamed on the design of the system. This fact again underscores the importance of utilizing a competent reliable entity that will maintain and operate the system consistently.

As for political hurdles, most large-lot zoning codes do not allow small lots even if the arrangement of the entire development would not exceed the zon-

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ing. For example, if a 100-acre development is zoned for 5-acre lots, the developer is often not able to build 20 2-acre lots and leave 60 acres as green space even when the total 100-acre development would not violate the pre-approved density.

In addition, some municipalities do not allow private developers to collect tap-in fees for sewers. The financial incentive vanishes if the developer cannot recoup the capital costs to build the cluster system.

Many regulatory officials and municipalities are under the impression that several smaller treatment and collection systems are more difficult and more expensive to operate and maintain. However, within the last 15 years, the capability, reliability, and cost of telemetry devices and remote monitoring technologies have significantly improved, which makes multiple system monitoring and operation possible from a centralized location.

Finally, obtaining public acceptance can be as difficult as political approval in some areas of the county where potable water is abundant and the public has not fully accepted using gray water for irrigation.

Conclusion

When initially designing a cluster system, it is important to obtain the early involvement of the stakeholders in the development, including the permitting regulatory agency, the entity responsible for long-term operation and maintenance of the system, the developer, the land planner, and the design engineer.

Currently, regulatory agencies, municipalities, and system designers have a unique opportunity to explore decentralized sanitary treatment concepts in rural suburban areas (such as cluster systems) or continue to embrace the centralized sewer concept.

If the latter is chosen, one of two scenarios may occur: either the public will suffer by having to pay for the improvements necessary to operate and maintain a large centralized sanitary system; or the environment will suffer because of inadequate treatment and subsequent discharge.

One must question whether it is even possible to maintain, much less expand, our existing centralized treatment systems to keep pace with population growth and economic development without the utilization of alternative technologies. **LDT**

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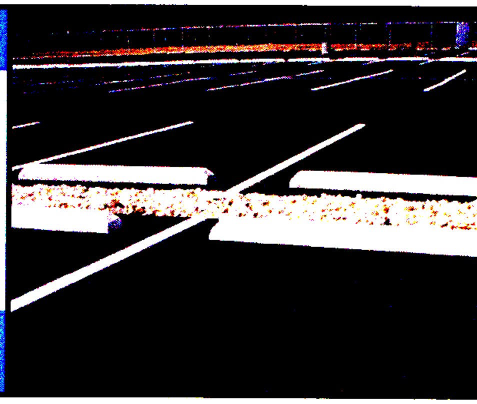

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