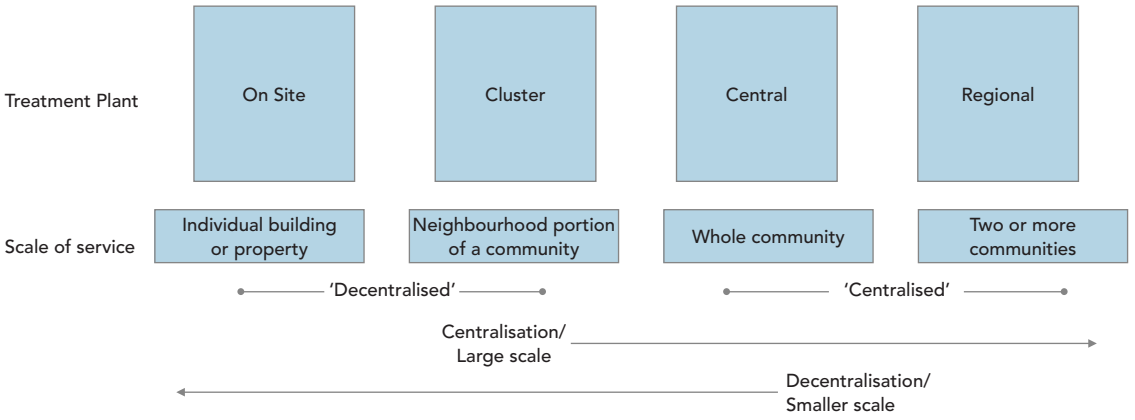


Figure 1: The wastewater scale continuum between centralised and decentralised approaches. (Source: Valuing Decentralised Wastewater Technologies, Rocky Mountain Institute November 2004.)

DECENTRALISED WASTEWATER MANAGEMENT

A SOLUTION TO INFRASTRUCTURE BOTTLENECKS?

Decentralised wastewater management is an alternative approach to centralised wastewater management which encourages the use of satellite and catchment based treatment options. As urban centres around the world continue to expand, the decentralised model is gaining the attention of planners and engineers worldwide as a more sustainable and cost-effective method of managing water resources and is challenging the paradigm that 'Big Pipe' is the only viable option. In this article Paul O'Callaghan of O2 Environmental, discusses some of these issues and presents five reasons to consider decentralised management options when planning for the future.

So what does the term 'Decentralised Wastewater Management' mean? It means different things in different scenarios. For instance, in the context of the greater Dublin area, having multiple satellite treatment plants to serve various catchments, as opposed to conveying water from the suburbs of Dublin, and areas of Kildare and Meath, to centralised treatment facilities would be a decentralised approach. In a rural town, it can mean on-site systems, or cluster systems for groups of houses. **Figure 1** presents varying degrees of centralisation or decentralisation and shows the continuum between the two approaches.

Properly managed, these systems can represent a viable alternative to a central treatment option. In a 1997 report to Congress, the U.S. EPA reported that "adequately managed decentralised systems are a cost-effective and long-term solution for many communities".

The modern day sewage collection system has its origin in the large sewerage projects developed in Paris and London during the 1850s. The objective at that time was to get sewage out of cities to protect public health. The word sewer is apparently derived from the old English word 'seaward' as the objective was to convey material into a surface water body, river or estuary. As time went on, into the early 1900s, it became apparent that discharge of untreated sewage was having a detrimental effect on the receiving environment and this led to the construction of wastewater treatment plants at the end of these collection systems. As cities expanded due to urbanisation, plants became larger and larger and so today we have a largely centralised model for wastewater management. The collection and treatment of sewerage has delivered huge improvements in public health but there is a degree of revisionism occurring at the moment and a debate as to whether the centralised model is necessarily the most cost-effective or sustainable way of doing things in the 21st century. The conventional wisdom in the lay population and among many professionals in the wastewater field is that centralising treatment is the best wastewater management strategy for most communities—the most reliable, easiest to manage, and least costly per capita. Here I would like to present five reasons why a decentralised strategy can have advantages over the traditional centralised system.

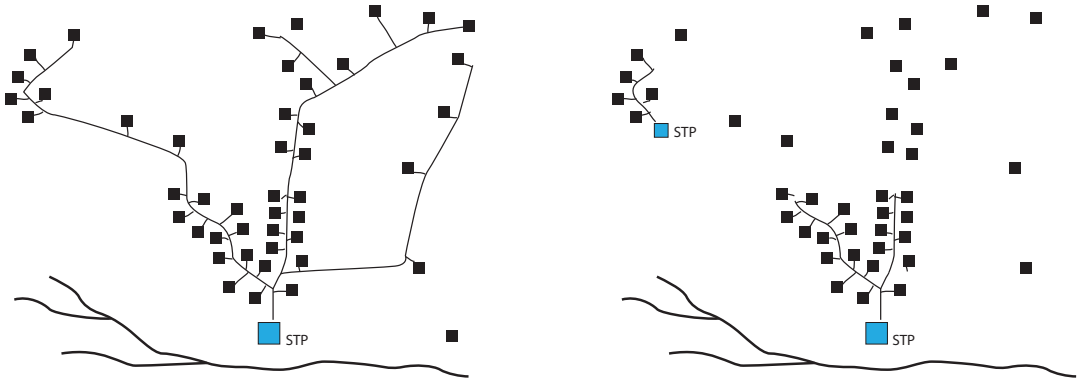
1.Enables 'just-in-time' capacity building

In a centralised model, collection systems and lift stations in particular, and treatment plants to a slightly lesser degree, are typically constructed with spare capacity to accommodate growth over time.

The smaller unit size of the decentralised system allows closer matching of capacity to actual growth in demand. Decentralised capacity can be built cluster-by-cluster, in a "just in time" fashion. This provides a number of important benefits:

It defers capital costs of future capacity to the future. This typically reduces the net present value (NPV) of a decentralised approach and reduces the cost of financing debt. Each individual decentralised system is a smaller project which can be planned and implemented on much shorter lead times than can expansions of regional systems. The management needs of each area can be considered independently, and the costs of systems for a particular area can be more readily assigned to the activity generating the demand. Further, a decentralised or 'distributed system' is expanded by adding more treatment centres, rather than by routing ever increasing flows to the centralised plant, and therefore upgrading lines to increase capacity is never required.

The boom years in Ireland were accompanied by a period of unprecedented building and population expansion



Centralised wastewater treatment

Decentralised approach

Figure 2: Comparison of centralised and decentralised approaches to wastewater service. 'STP' indicates a centralised or cluster sewage treatment plant. Source: Draft Handbook for Management of Onsite and Clustered (Decentralised) Wastewater Treatment Systems (U.S. Environmental Protection Agency 2003a)

in cities and towns. This happened very quickly and with very little warning. The result was that local authorities who had meticulously mapped out their treatment strategies for the next 20 years, and were just commissioning spanking new treatment plants with what appeared to be years of spare capacity, suddenly found themselves scrambling to meet demand and keep pace with development. Nowhere was this more evident than in Dublin. The Ringsend treatment plant, which had a design capacity of 1.7 million population equivalents and a design horizon of 20 years, was at capacity almost as soon as it opened in 1999. In some parts of Dublin sewer capacity issues have effectively placed a moratorium on any further development. I know of at least one proposed commercial development in Sandyford where the developer is evaluating on-site treatment and re-use options as there is no available hydraulic capacity in the sewer system. This type of innovative approach encourages water conservation, reduces water consumption, avoids conveying water long distances and keeps water within the catchment.

Five reasons to consider decentralisation

- Enables 'Just-in-time' capacity building
- Keeps water within the catchments
- Facilitates water conservation and water re-use
- Avoids catastrophic failure
- Reduces costs and issues associated with conveyance to a centralised facility

2. Keeps water within catchments

A decentralised approach can help manage the hydrological cycle within a catchment. It can reduce the draining down of aquifers through infiltration into leaking sewers, thereby providing more groundwater to feed streams and rivers in the catchment. It also makes it more cost effective to look at water re-use options as treated water is close to the point of re-use.

3. Facilitates water conservation and water re-use

A decentralised system has two advantages when it comes to water conservation and re-use. Firstly, where small diameter pumped lines are used, as opposed to gravity sewers, the system can accommodate any level of water conservation found to be economically attractive or ecologically necessary without the problem of sewers becoming blocked due to inadequate flushing volume (In cities where drought restrictions on water use have been implemented it has been found that the volumes of water discharged were not sufficient to flush the sewers and convey water to the treatment facilities).

Secondly, decentralised wastewater systems provide opportunities for cost-effective water re-use within individual catchments. Under the decentralised management concept, effluent is produced at many points throughout the overall service area, potentially closer to points of re-use. In many cases, this can render re-use more cost-efficient by minimising the cost of redistribution infrastructure to substitute reclaimed water for potable water. This practice can also reduce water treatment pumping and storage costs, and can forestall expansions of water treatment and storage facilities.

In many regions of the world where water supplies are being strained, water reclamation is seen as a viable solution and is being implemented for non-potable uses. Now, they say that water has no memory, but the public certainly does and they don't like the thought that what comes out of their tap, might in the not too distant past have disappeared down their toilet, or worse still, someone else's. The thin end of the wedge here may be aquifer replenishment. It is just one degree removed from a closed loop system. Orange County, California was recently awarded the Stockholm Industry Award for its pioneering work to inject treated wastewater into deep wells to re-charge ground water aquifers. What you are seeing here is the start of a convergence in wastewater treatment and water supply.

4. Avoids catastrophic failures

At a large centralised treatment plant when things go wrong, they can go wrong in a big way:

- odour emissions are more significant;
- spills and overflows have a potentially greater impact on the receiving environment; and
- plant upsets or mechanical failures are at a larger scale.

It used to be that larger plants were considered to be more reliable than smaller systems but this has changed. Reliable package plants are now available which can be monitored remotely. Also in an urban setting, such as the Dublin area, a plant with a treatment capacity of 100,000 population equivalents could be considered a 'satellite' plant. In the case of an odour issue, the case could be made that having ten lesser-sized treatment plants, as opposed to one large plant, just increases the number of potentially irate residents who could be affected. However, residents living adjacent to a large plant may feel that their noses are bearing the impact for the entire community.

5. Reduces costs and issues associated with conveyance to a centralised facility

Smaller systems lose the advantages of economies of scale that are achievable in centralised wastewater treatment in relation to capital costs and operational and maintenance costs. However, smaller systems also avoid diseconomies of scale that are inherent in sewer systems. Given that collection system costs can be 80 percent or more of total systems costs, collection diseconomies of scale can overwhelm treatment economies of scale, resulting in decentralised systems being the more economical choice. **Figure 2** provides a graphical depiction of centralised and decentralised approaches to serving a given area and illustrates the difference in the extent of the collection system network required between the two approaches.

Typically, decentralised systems minimise the number of lift stations and eliminate large trunk mains. The collection infrastructure that remains is typically composed of smaller pipes running at shallower depths which also leads to less disruption to the public during construction. There is a social cost benefit inherent in this reduced disruption during construction. If a sewer is leaking, which many gravity sewers are, it leaks in two directions. If sewage leaks out of the system this can result in the discharge of untreated sewage to the environment. More often though, the issue is one of groundwater infiltration into the system, which not only contributes to hydraulic overloading at the treatment plant but also takes water out of the catchment which would otherwise replenish groundwater aquifers and feed streams and rivers. This article has set out some of the advantages of a decentralised approach. Naturally there are also disadvantages to this approach and the overall benefits need to be weighed up on a case-by-case basis. Too often, any debate between the proponents of centralised versus de-centralised becomes an "all or nothing" debate. The right solution for a community may well be a combination of options including both centralised and decentralised treatment systems. Φ

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Paul is an associate member of Engineers Ireland.