CENTRALISED MANAGEMENT: THE KEY TO SUCCESSFUL ON-SITE SEWERAGE SERVICE

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Abstract

A large percentage (10-80%) of on-site sewerage systems are failing, not just in Australia, but also overseas (Hawkesbury-Nepean catchment councils, pers. comm.. & USEPA 2000). In a 1997 Report to Congress the US EPA presented its findings on the state of on-site systems across the country and solutions for improving sewerage services. It was recognized that it is not simply that the technology is at fault, but that the equipment requires more professional maintenance than the householder is willing or able to provide. The US EPA found that for many communities, properly managed on-site systems or decentralised systems using on-site technology, could protect the environment and public health "over the long-term and do so at a lower cost than conventional systems" (EPA 2000). The US EPA has developed guidelines to support stakeholders to better manage on-site systems. The foundation is a five-tier management structure ranging from a simple inventory of the number and performance of on-site systems through to utility ownership and management of the systems. Centralised management of advanced on-site systems can achieve the same (or better) water quality levels as many conventional municipal STPs, but with the added feature of being a local, more sustainable solution. Centrally managed watertight on-site systems utilising advanced technology is the paradigm that has been adopted in the US to successfully service rural and suburban wastewater needs at an affordable cost. The technology has been embraced by private and public water utilities. Previously seen as alternatives, on-site and centralised sewerage are now viewed as a continuum of technologies under central management. Technology is now being selected for the situation where it best fits, and satisfies the triple bottom line of selected economic, environmental and social criteria.

Keywords

centralised management, decentralised, on-site, sand filters, sewage treatment

1 Introduction

Sewerage systems are failing. No matter whether they are centralised reticulated sewerage systems in cities and towns or individual household on-site systems after 25 to 30 years these systems begin to fail and need repair and replacing. This is a global phenomenon. All countries, especially the developed countries, are grappling with this challenge of upgrading failing centralised and on-site sewerage systems. (Developing countries have a larger suite of sanitation challenges that will not be addressed in this paper). Coupled with this infrastructure need, is the realisation that in order to create a sustainable future, we as a society need to improve the quality of our sewerage practices, reuse our effluent and promote an integrated catchment based, water cycle approach to water management.

Many communities want a local sustainable and affordable solution to their sewage issues. On the social side many people in small rural communities do not want to be linked to a city sewerage service, they want to deal with their own waste and recycle what they can. On the economic side, providing centralised reticulated sewerage systems to outlying communities is very expensive. Estimates of $16,000 – $70,000 per household for the 4,912 lots in the 16 villages in Sydney Water's seven Priority Sewerage Program (PSP) areas were documented in the corresponding seven environmental impact statements. These figures only include the cost of supplying the sewerage pipeline to the front gate. It does not include the $3,000 (or more) for connection from the house to the pipeline in the street. Providing a sewerage service to these communities is subsidised, with the real cost being passed on to all Sydney Water's ratepayers, thus increasing the cost of sewerage for everyone.

In the USA an affordable solution has been found to upgrade failing on-site, and in some instances reticulated, sewerage systems and to service new housing developments. The solution includes installing technically advanced on-site sewage treatment systems for individual homes, or decentralised systems for clusters of homes, coupled with a centralised management service. Centralised management takes the responsibility for system monitoring and maintenance out of the hands of the householder. The householder, of course, still has responsibility for what goes down the sink. The key to providing good quality, affordable sewerage treatment is not the technology, it is service. Many wastewater treatment systems in the hands of the householder will eventually fail due to neglect, disdain or lack of expertise. Richard Otis (1998) explains the issue succinctly when he says "the problem is not that on-site systems are inadequate; it is that we have not accepted the fact that on-site systems are treatment plants that must be designed and maintained by qualified people".

2 Discussion

2.1 1997 Report to Congress

In 1993 the Congress directed the US EPA to conduct an inventory of on-site systems across the country to determine the rate of failure, the degree of environmental and public health impact and to propose solutions to upgrading unsewered communities. Although the US EPA found that on average 25% of on-sites were failing on any one day, and discharging 4,000 ML of raw sewage into the environment, the subsequent 1997 Report to Congress stated "…decentralised [and on-site] systems, where properly managed, could protect water quality over the long term and do so at lower cost than conventional systems in many communities". This endorsement of 'properly managed' on-site and cluster sewerage systems effectively legitimised the use of on-site technology.

A paradigm shift of this magnitude does take time to become commonly accepted, but in many circles on-site technology is no longer seen as a temporary measure, the 'poor cousin' to centralised reticulated services. On-site technology is now viewed as a legitimate alternative to conventional sewerage where applicable. On-site and conventional sewerage, under centralised management, now form a range of technologies that are assessed to find the best solution. As Otis advises (1998)

> "if we are to successfully provide affordable wastewater facilities in unsewered communities, we must stop comparing the two alternatives as either/or options …We must promote wastewater treatment alternatives as a continuum of technologies, under central management."

The 1997 Report to Congress also gave a 'green light' to the wastewater industry to invest more money and resources into research, development, marketing and management services.

2.2 Smart Growth Planning

A flow-on effect from this shift in attitude toward on-site sewerage has been a change in land use planning. Statistics from the US EPA show that thirty-seven percent of all new housing developments are being serviced by on-site systems and decentralised sewerage services using on-site technology, and this percentage is growing (EPA 2000). This is not just in the poorer rural back blocks, many multi-million dollar homes are being serviced by professionally managed on-site systems. Statistics from the US EPA (2000) show that over 50% of on-site and decentralised (using on-site technology) sewerage services are in the cities and suburbs.

A new paradigm in developing greenfield sites has emerged, called 'Smart Growth Planning'. Smart Growth developments incorporate medium density housing with the express purpose of clustering homes together on small lots, leaving land available for parks and sporting fields and retaining natural habitat. Each home has a septic tank connected to a local treatment plant (decentralised) utilising advanced on-site technology. The parks and sporting fields are built into the development for added amenity, increased real estate value and specifically to provide an opportunity for effluent reuse. The decentralised sewerage system is professionally managed. The trend is being 'applauded' by all concerned. The cost to install these decentralised systems is less than conventional sewerage, so developers are able to make more profit. Home buyers are willing to pay more for these homes because the established parks and sporting amenities, and adjacent natural bushland are highly valued, and they have a professionally managed local sewerage service without the inconvenience or risks associated with an infiltration trench in their backyards. In many instances private water utilities have been created to operate the sewerage management service for these developments. More recently, several public water authorities have commenced installing on-site and decentralised systems.

2.3 US EPA Management Guidelines

To support and guide the wastewater industry and regulators in providing managed on-site sewerage services the US EPA has formulated five levels of management. The 'Guidelines for Management of On-site / Decentralised Wastewater Systems' (EPA 2000) lists the five levels as:

1. Systems inventory and awareness of maintenance requirements
2. Maintenance contracts
3. Operating permits
4. Utility operation and maintenance
5. Utility ownership and management

NSW already has Levels 1 and 2 in operation. Since 1998 councils throughout the state have been making an inventory of the on-site systems in their shire. The service contracts that householders have with aerated wastewater treatment systems (AWTS) and 'Ecomax' manufacturers or service providers constitute the second level of management. Level 3 are renewable and revocable permits issued to property owners who must ensure that they meet specific effluent quality limits in environmentally sensitive areas. Levels 4 and 5 are sewage management districts operated by private or public water utilities. The difference between Levels 4 and 5 is that at Level 4 the householder owns the sewerage equipment in their backyards, whereas at Level 5 the private or public water utility owns it. At both levels the utility operates a centralised management service that monitors and maintains the equipment and collects a monthly fee. The fee (US$25 - $30) is roughly equivalent to the monthly fee paid for conventional reticulated sewerage (US$30 - $35). The on-site management fee covers all monitoring and maintenance costs, the cost of repairs and pump-outs and in some cases the replacement cost of the equipment after 20 to 30 years. The householder no longer has to worry about large unexpected bills for the repair of a failed on-site system. The goal of the US EPA is that eventually all on-site sewerage systems will be centrally managed at Level 4 or 5 by sanitation professionals.

2.4 Watertight sewerage systems

In order for water utilities to operate a financially viable on-site management business, on-site technology has had to advance to function efficiently with minimal failure rates. This has meant a paradigm shift in the configuration of components of on-site systems and a quantum leap in quality. The key element to this paradigm shift is watertightness. Charles Pickney (On-site Systems Inc) of Tennessee said his family would not be in the business of running a private water utility if they could not guarantee that all systems were watertight. That is, watertight septic tank and watertight PVC (or polyethylene) pipes incorporating heat welded joints. This aspect, eliminates all possibility of infiltration of stormwater and groundwater, and exfiltration of sewage – the factors which cause so much system failure and environmental and public health risk. In a decentralised sewerage system this watertight feature eliminates the need for 'over-designing' the pipe work and treatment plant to accommodate wet weather flows. This greatly reduces capital expenditure due to the reduced size of pipes, trenches and the treatment plant. Conventional centralised sewage treatment plants are designed to take 4 to 6 times the dry weather flow.

2.5 Key Elements of an Efficient On-Site Sewerage System

The following list gives an overview of the key elements needed to provide an extremely reliable on-site treatment system:

1. watertight septic tank
2. septic tank effluent filter
3. watertight small diameter PVC or polyethylene pipes with heated welded joints
4. correctly designed and constructed infiltration trenches
5. on-going education of householders, regulators, real estate agents and other stakeholders
6. remote monitoring
7. interactive databases
8. professional training for on-site service people.

Building on this foundation, high quality effluent can be produced for recycling using advanced treatment systems. In the USA, many of the best practices in on-site treatment technology utilise sand filters, textile filters and trickling filters with plastic or foam substrates. Effluent quality of <10 mg/L biochemical oxygen demand (BOD) and total suspended solids (TSS) and in some cases <1 mg/L is the norm. Effluent of this high clarity can be effectively disinfected with an ultra-violet (UV) filter to produce a product with high reuse potential.

2.6 Private Water Utilities

On-site Systems Inc. in Tennessee have operated as a Level 4 private water utility for the past five years. They primarily install Orenco Systems Incorporated (OSI) equipment (manufactured in Oregon) as well as their own watertight concrete septic tanks in new housing estates. Developers pay for the sewerage systems and recover the cost from the householders. On-site Systems Inc. are licensed by the State to manage on-site districts to specific requirement and to charge a standard fee. All systems, including septic tanks, are continuously remotely monitored, alleviating the necessity of frequent on-site inspections. All valves and pumps, any apparatus that moves or uses electricity as well as flow rates are monitored. In sensitive environments specific water quality parameters can also be monitored. At the first sign of a problem the service operator is paged. The fault is often fixed before the householder is even aware of the fault. This high level of monitoring and service ensures that there are very few system failures. It is in the best (commercial) interests of the private water utility that there are few system failures as well as being necessary for them to meet their licence requirements.

Pegram, Tennessee, a township of 100 households and a school is serviced by a decentralised sewerage system incorporating watertight septic tanks with effluent filters, small diameter watertight PVC pipes and one Orenco recirculating sand filter. The complete system cost just under US$1 million - $350,000 for the school system, and $600,000 for the 100 homes i.e. $6,000 per home. The effluent has a BOD and TSS of 3-5 mg/L and is used to subsurface irrigate an area of farmland. This relatively inexpensive capital cost of $6,000 per lot is largely due to the reduced cost of laying the small diameter pipes and the lower capital cost of the recirculating sand filter compared to a conventional sewage treatment plant (STP).

There are approximately 30 on-site sewerage management districts in the US that have been centrally managed for around 20 years. Stinson Beach, a community 32 kilometres north of San Francisco, is one of the longest established. Twenty-two years ago it was realised that failing septic systems were polluting the groundwater and nearby wetland. The residents decided to upgrade their on-site systems and establish a private water utility to monitor and maintain all on-site systems. Today there are 700 lots at Stinson Beach, most are 800 square metres or less in size. Many are just 250 square metres in area. All lots have a septic tank with effluent filter. (Effluent filters are required by law, in septic tanks in 14 states in the US.) Seventy percent of the households have upgraded to an Orenco intermittent sand filter. Ten percent have other manufacturer's advanced treatment systems and the other twenty percent simply have infiltration trenches following the septic tanks. Notwithstanding the small lot size all wastewater is treated on-site, there are no cluster (decentralised) systems. All properties have 'bottomless' raised infiltration beds after the advanced treatment systems. The treated effluent filters through the infiltration bed into the sand dune below and percolates through to the water table. The groundwater has been continuously monitored since the inception of the private water utility 22 years ago. Since the upgrade of the on-site systems, the faecal coliform count in the groundwater has been zero (Stinson Beach, 2001).

This arrangement of on-site systems on small blocks of land is only applicable to sand based terrain, clay soils would require larger lot sizes. However, creative use has been made of the raised infiltration beds by planting them with attractive plants that like to have 'wet feet'. This added evapo-transpiration process reduces the amount of effluent flowing to the groundwater by up to 40%. A far greater use of water-loving plants and raised infiltration beds could be made in Australia, especially where the natural soil is not particularly favourable for effluent infiltration.

2.7 Public Water Utilities and Centralised Management

Mobile Alabama Water and Sewerage Service (MAWSS) is an example of a Level 5 management organization where the utility owns and operates the on-site systems (White et al, 2000). Over the last few years this public water authority has worked with developers to build four new housing sub-divisions with decentralised sewerage services based on the new paradigm of a watertight system utilising advanced on-site technology. All four communities (80, 80, 1,000 and 1,500 homes) use Orenco technology. The two communities of 80 homes both use a textile filter called 'AdvanTex' and the two larger communities use recirculating sand filters. All homes have a watertight septic tank with effluent filter in their backyards. Small diameter watertight pipes (25 mm) take the effluent through the property to join a 50 mm common main pipe. These pressurised PVC pipes conduct the effluent to the nearby decentralised treatment system. In the case of the textile filters, instead of 80 AdvanTex tanks being installed in the 80 backyards, when the tanks are clustered together in a decentralised system only 48 units are required. This enables huge savings in capital costs and also operating and maintenance costs as service personnel only have to go to one location instead of 80. Of course, the 80 septic tanks still have to be periodically inspected but this is infrequent due to the remote monitoring surveillance. The complete cost of the decentralised sewerage systems in these four communities is $5,000 per lot. This compares favourably to $10,000 to $15,000 for conventional reticulated sewerage services in the rest of MAWSS's area of operation. Effluent quality is <5 mg/L of BOD and TSS. Developers are very enthusiastic about the technology and the reduced costs, and are eager to work with MAWSS on similar housing projects.

Sydney Water is taking the initiative in NSW to review advanced international and Australian on-site technologies in the light of this new paradigm of centralised management utilising sophisticated remote monitoring. Advanced on-site technology could form a suite or continuum of technologies in addition to the conventional reticulated sewerage treatment systems with which Sydney Water already has expertise. The concept is to use whatever provides the best outcome in terms of the triple bottom line – the specific economic, social and environmental criteria in each situation.

3 Conclusion

On-site sewerage has a poor reputation for performance in the eyes of the public and regulators. Left in the hands of the householder, many on-site treatment systems will continue to fail due to neglect, revulsion, ignorance or lack of skill. On-site equipment requires on-going professional service and maintenance to perform efficiently and reliably. Centralised management incorporating remote monitoring and interactive databases takes on-site sewerage into the professional domain where performance standards are more readily monitored and maintained, and accountability is assured.

That on-site systems can be a high quality, long-term, affordable solution to many sanitation challenges is a paradigm shift for many people. On-going education of all stakeholders will be necessary to highlight the benefits. The benefits of centrally managed on-site systems are many: less expensive high quality sewerage services; watertight systems; short feedback loop between householder's wastewater and effluent quality; local solutions; local reuse potential; sustainable water management; catchment based integrated water cycle management in some cases; resource recovery; reduction of point source discharges; environmental protection; public health protection; data collection on numerous environmental parameters; freedom from uncertainty of performance; professional accountability; integrated systems; education of stakeholders; employment opportunities; research opportunities; targeting treatment upgrades to smaller problematic areas; reduction of forecasting risk; greater control over the waste stream increasing the value and useability of biosolids and effluent (Pinkham, 2000). As a consequence centrally managed watertight on-site sewage treatment systems may be the 'Rolls Royce' of sewerage service in the future, but with an affordable price tag.

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