Defying gravity with new pressure systems

Water authorities around Australia are displaying keen interest in the ability of pressure sewerage systems to deal with a range of circumstances.

By **David Fletcher**

Although low pressure sewer (LPS) systems are a relatively new concept in the Australian marketplace, on a global basis the technology dates to the late 1960s.

Australia's first large-scale system was installed and commissioned more than three years ago by South East Water for the town of Tooradin and has proven to be very successful. Since this original installation, South East Water has completed additional schemes for the towns of Cannons Creek and Warneet.

Pressure sewer is a simple concept that involves installing a small holding well on each property to which all the household waste water flows by gravity (see Figure 1). The holding well contains a semi-positive displacement grinder pump and level switches that activate and de-activate the pump at the appropriate levels and provide alarm signals as required. The unit usually operates via the household power supply with an incremental electricity cost normally in the range of $20 to $30 annually.

The wastewater collects in the holding well until the 'pump on' level is reached and the grinder pump activated. The pump then grinds the solids into easily transported slurry that is pumped through small-diameter polyethylene pipe (via a boundary/isolation kit) to the reticulation system, which delivers the wastewater to the discharge point (manhole, pump station or wastewater treatment plant). Once the 'pump off' level is reached, the pump is deactivated until the holding tank again fills to the activation level.

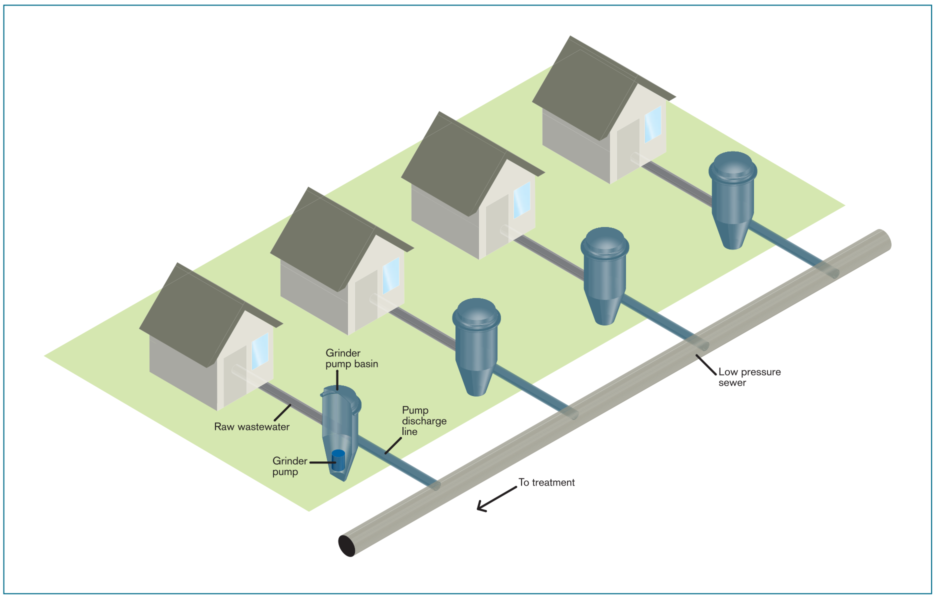

Figure 1. Conceptual realisation of an LPS system.

LPS systems are recommended for flat, wet (high water-table), rocky and hilly regions and these conditions certainly maximise the cost benefits of any LPS application. However, there are many other so-called 'secret' applications, where LPS technology has proven to be the most appropriate option, these well known and not so well know applications are summarised below.

New developments

In the typical 'second home' community, all the lots are plotted, roads built, and some community facilities built initially in order to begin selling lots. This represents a large 'up-front' investment at the start of the project. Since only a few houses are actually built and occupied each year, resulting in a proportionally small revenue stream, the 'up-front' cost of gravity sewers is often prohibitive. On the other hand, if pressure sewers and grinder pumps are chosen, all of the small-diameter, shallow-buried pressure pipes can be installed initially at very low cost per lot. The grinder pumps and headworks charges paid to the water authorities by the developer, which comprise the majority of capital cost, need be bought and installed only as each house is built. This is especially critical in providing affordable sewers initially to the first few houses - often scattered throughout a large tract far from their nearest neighbours.

Rocky soil conditions

Rock can be one of the most costly and difficult factors in construction. In the case of gravity sewers, with their wide trenches, excavated to precise grade and alignment, and going inexorably deeper with each metre of length, the price per metre can easily become orders of magnitude greater than in normal soil. The fact that pressure sewers require dramatically narrower and shallower trenches makes them feasible in locations such as solid rock where gravity is impossible.

First class pressure sewer territory.

High groundwater levels

Locations with high groundwater, whether seasonal or year-round, present other challenges in both construction and operation of gravity sewers. During construction, the work site must be de-watered by generous use of pumps and well points distributed along the proposed trench route, and powered 24 hours a day.

Consider that once the de-watering pumps are shut down and the ground water returns, the sewer must operate in what is tantamount to a submerged condition - this without allowing infiltration and or inflow, both notorious enemies of overall water quality goals.

Lakeside or oceanfront properties

One of the most desirable properties is 'a place beside the water.' It doesn't really matter if it's a creek, a lake, an estuary or the ocean; people will do almost anything to live beside water.

The topographical features that create these precious water bodies are dominated by the fact that the land almost always slopes down toward the shore. When these millions of people use the sanitary fixtures in their waterfront properties, where does the wastewater naturally try to go: down toward the waterfront. It is very expensive, environmentally damaging and seldom entirely satisfactory to put gravity sewers in such waterfront locations.

Flat land

Contrary to common knowledge, flat land is not necessarily an easy or inexpensive place to sewer. There is no doubt that in conventional gravity sewer construction, shallow trenches are the least expensive, but all flat land trenches are not necessarily shallow. In fact, the only way that sewers in perfectly flat terrain can be kept shallow is by the frequent use of lift stations. The profile of such a sewer can accurately be likened to a saw tooth, more specifically a rip saw, with long down ramps (gravity runs) interrupted by nearly vertical sections (lift stations). Since coastal land is often flat, the water table tends to be high and unless gravity sewers are kept above the normal water table, the problems of underwater construction plus a permanent threat of infiltration can be enormous. On the other hand, pressure sewers are, both by definition and in practice, watertight and virtually leak-free. They need never go deeper than what is required for mechanical protection.

Elimination of infiltration

Pressure sewers are constructed of pressure pipe and leak tested; thus, they are, for all practical purposes, watertight. This eliminates most infiltration problems characteristic of old gravity sewers. Since there are no elements corresponding to access manholes, the inflow from street runoff is also virtually eliminated.

In a pressure sewer system, the only element potentially vulnerable to I/I problems is the gravity house sewer connection to the grinder pump inlet. Since this is usually constructed using modern PVC pipe with solvent-welded joints and is often a single length of 100mm pipe, there is little chance for the massive joint infiltration that was commonplace when 600mm sections of clay pipe with bell and spigot joints were used. New collection systems consisting entirely of pressure lines fed by grinder pumps have been shown to be entirely free of extraneous water flows. It has also been well documented that the per capita contribution falls in the range of 100-200L/cap/day if infiltration and/or inflow is rigorously excluded. This has profound and obviously desirable effects on treatment plant capacity, cost and performance.

Conclusion

It has taken three decades for pressure sewers to begin to take their proper place within the public health engineering field. Today, hundreds of thousands of grinder pumps are in routine daily operation in projects ranging in size from a single pump to many with thousands of pumps.

The skeptics have been pleasantly surprised as decades of operating experience pile up with operating and maintenance costs equal to or less than original estimates.

The author

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