PRESSURE SEWER INSTALLATION USING DIRECTIONAL DRILLING

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Abstract

South East Water Limited manages a backlog sewer program to provide a sewerage service to residential properties within its unsewered urban areas. Prior to 2002, all backlog sewer projects for South East Water Limited were constructed using gravity sewers which often require a number of re-lift pump stations around the town to prevent sewers from becoming too deep.

In some situations, gravity sewers are very difficult and expensive to install. This was the case in Tooradin, and for the townships of Warneet and Cannons Creek where the area is very flat, and the groundwater table is very high. South East Water decided to install a pressure sewer system to each of these three towns. The flexible polythene mains operate under pressure at all times, can be installed close to the surface (approximately 1m deep), will generally follow the terrain and can easily be curved to avoid significant trees or other vegetation.

This paper discusses how the application of directional drilling techniques enabled the implementation of a pressure sewer system through two environmentally sensitive coastal villages at a lower cost than gravity sewers.

Keywords: pressure sewer, directional drilling.

Introduction

South East Water Limited is one of three retail water companies established on 1 January 1995 to provide water and sewerage services to the Melbourne (Australia) metropolitan area. Serving a population of 1.2 million over an area of 3,640 square kilometres, South East Water has assets totalling almost $1 billion. Gravity sewerage pipelines total more than 6,840 km. The system is currently growing at the rate of approximately 130 km per year.

While gravity sewers have been around since sewers were first developed and installed, networked pressure sewers are a relatively new concept. Pressure sewer systems have been used extensively in the US for up to 30 years, and on this basis they were considered a viable option for the provision of sewerage to the coastal village of Tooradin (228 properties). In 2001, South East Water installed the first Australian pressure sewer system at Tooradin. Since that time, based on South East Water's favourable experience at Tooradin, other Australian Water utilities have adopted pressure sewers as solutions to backlog areas previously considered too difficult to service.

Figure 1. Materials.

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South East Water Limited has recently installed pressure sewers to two other coastal villages - Warneet and Cannons Creek (464 properties). The pressure sewer option was best suited to these towns as it allowed shallow trenching and the opportunity for directional drilling, resulting in minimal disturbance to the environment and the community

What is a Pressure Sewer System?

Pressure sewers consist of a network of pressure pipes and grinder pumps, which integrate to form a collection system.

The pipe network consists of polyethylene pipe that is fully sealed by electrofusion welding of joints. With a pressure sewer system each property is provided with a small tank with a pump unit installed to which all their household waste is diverted. Sewage is then discharged in the form of a finely ground slurry into small-diameter pressure piping (street mains). The pump unit comprises a pump, storage tank, electrical switchgear, pump protection devices and any guide rails required to assist with the removal of the pump. The pumps are designed to be able to transport the waste 6km away to the treatment plant.

The selected pipe and fittings material for the pressure sewer collection system is black PN12.5 PE80 polyethylene. In addition to the polyethylene pipe, the system comprises of isolation valves, flushing points, air release valves, and check valves at the junction of each house connection with the pressure sewer main. The system is very similar to a watermain network. (Figure 1)

The reticulation street mains are generally 50mm to 110mm diameter

polyethylene pipe and are installed in shallow narrow trenches or by means of directional boring. Since excavations are minimised, minimum disruption is caused to existing landscaping and natural flora. Roads and footpaths are generally left intact or minimally disturbed. Where ground conditions are appropriate, directional boring techniques are easily employed reducing site damage and restoration costs. This means less silty runoff, fewer access problems, less construction noise, etc.

The use of pressure sewers creates the opportunity to locate the sewer line in the road reserve wherever possible, thereby eliminating direct impacts to private property except for the installation of the house service line.

In operation, the grinder pump station, located in each backyard, will handle sewage and many items that should not, but often do, appear in domestic wastewater. The grinder pump will discharge this slurry at a maximum rate of about 0.7 L/s. Transporting sewage several thousand metres to a discharge point at a higher elevation is possible as along as the sum of the static and friction losses does not exceed design limits of 45m Total Dynamic Head.

The grinder pump is actuated when the depth of the sewage in the tank reaches a predetermined "turn on" level, and pumping continues until the "turn off" level is reached. The pump's running time is short, power consumption is low, and long pump life is ensured. The unit is protected against backflow from discharge lines by an integral check valve.

Construction Methods and Issues

The topography of the two towns is gently undulating with extensive native bush. The roads are generally unpaved. The ground conditions comprised of mud, sand, silt and mangrove swamp along the coast with dune sands further inland. The ground water table was generally located at 1.5 -2m deep. The two towns are separated by the Rutherford Inlet waterway. The new sewer links the two towns via 340m of 110mm diameter pipe which traverses underneath Rutherford Inlet.

There were a number of construction issues associated with implementing a pressure sewer system at Warneet and Cannons Creek:

1. At many locations, excavations will expose a high water table.
2. Discharge of groundwater from open trenches was not permitted to the (limited) stormwater system.

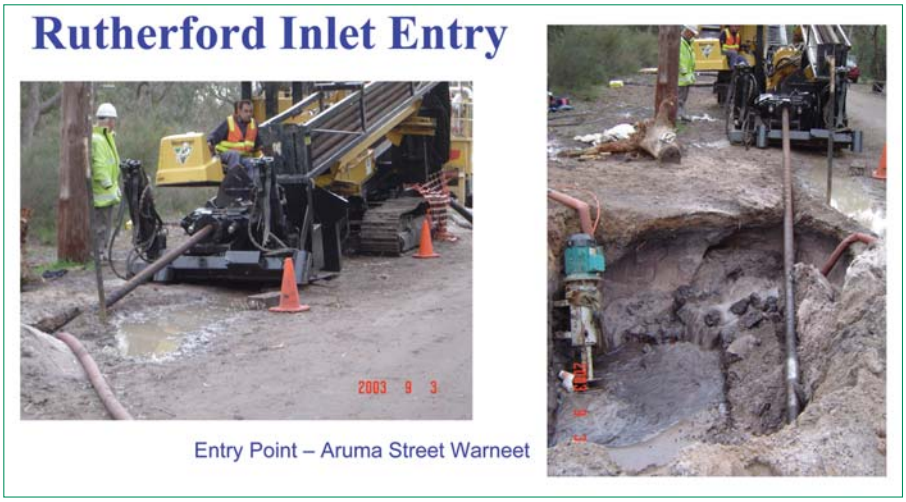

Figure 2. Rutherford Inlet underbore entry.

3. The two coastal villages were subject to an Environmental Planning Overlay. A requirement of the planning permit issued from Council meant that many areas of heavy vegetation required protection during construction. Vegetation disturbance and damage were to be kept to an absolute minimum as per City of Casey, DNRE, and Melbourne Water (for Rutherford Inlet crossing) requirements.
4. The system involved installing South East Water assets on each house lot. Therefore, to undertake the installation of these works required detailed community management and coordination. Construction of the street mains had to be coordinated with the pump unit installation to the house lots.
5. Good pipe laying practices were required to ensure foreign material did not enter the pressure sewer pipes causing blockages. This would be particularly important in all areas upstream of the Rutherford Inlet under bore (in Cannons Creek).
6. The Rutherford Inlet underbore required detailed coordination with existing services including potholing to determine exact locations. Both the entry and exit points of the underbore were in environmentally sensitive areas and required detailed management plans and supervision. In addition, preservation of the marine habitat beside Rutherford Inlet was essential. This was achieved by boring the pipeline beneath the salt marsh and marine sediments.
7. Although Warneet and Cannons Creek roads are generally low volume, traffic management plans and safe work practices were required. Only one lane of the main road to the town could be shut down at any time, as it is the only means of ingress and egress from Warneet. Trenches had to be backfilled at the end of each day's work to reduce or minimise potential car accidents at night.

To overcome the above issues, the majority of the 12 km of pipelines (90%) were installed using a directional drilling method. Directional drilling is ideally suited to a pressure sewer system. This construction method enabled the protection of the sensitive environment and vegetation, whilst enabling faster construction, and reduced customer impact.

South East Water's directional drilling contractors successfully used directional drilling techniques to install the 340m bore of 110mm diameter polyethylene pipe approximately 2m beneath Rutherford Inlet (Figures 2, 3), as well as the majority of bored street mains within Warneet. A boat was required to monitor the guidance tracker across Rutherford Inlet.

In addition, South East Water's contractors successfully installed the pipelines at Cannons Creek also using directional drilling techniques.

By using the directional drilling process for the street main installation, the construction time for the pipelines was reduced to 3 months in each town. Both companies complied with strict environment controls, and took all necessary care to ensure that bentonite drilling mud and cuttings did not discharge at the surface or into the river. For a traditional gravity system to be installed in the same area, the construction time would be approximately 12 months in each town.

Benefits

The benefits of installing a pressure sewer system using directional boring techniques instead of traditional gravity sewers using open-cut construction are instantly recognisable:

1. Lower capital costs

• South East Water adopted a policy of meeting the costs of connecting customers' blackwater and greywater systems to the sewer up to a cap of $2,500 per property.

• The pressure system in Warneet/Cannons Creek cost $4.7M compared to an equivalent pressure system estimated at $5.6M under the same construction conditions and environmental constraints.

2. Significantly reduced impact on residents.

• The pipelines are usually installed in road reserves rather than backyards. This enables the constructor easier access with minimal inconvenience to residents.

• There are no manholes, and rarely pipelines, in backyards. Residents are therefore less likely to object the sewerage scheme as they would in a traditional gravity sewerage scheme.

• Fewer sewage-pumping stations that can be visually obtrusive require regular maintenance activity and can be the source of odours. Pressure sewers can eliminate many of the pumping stations required with gravity systems. The grinder pumps pressurise the network to approximately 45metres in head. As a result, many re-lift stations prove to be unnecessary. This substantially reduces the cost of construction, land acquisition, and operating and maintenance costs.

3. De-watering costs.

• In areas with high water table problems, dewatering is required only at entry and receival shafts. As the depths of the pressure sewers are shallow (1m), the impact of the high water table is greatly reduced and can usually be controlled using pumps rather than de-watering spears.

4. Faster Construction.

• Speedier construction times lead to reduced project costs, and minimal disruption to traffic and residents.

• Shallow pipelines which are bored also have significantly less restoration costs than open-cut (or bored) gravity sewers.

• As the pipelines are much shallower than an equivalent gravity system, the material and labour costs are greatly reduced. An equivalent gravity system would have been approximately $1.2M more expensive than the pressure system that was installed.

5. Less environmental disruption during construction.

• By utilising the flexibility of a shallow, polyethylene mains are able to change alignments easily to avoid trees and other obstructions. Roads and foot paths are generally left intact or minimally disturbed.

• Less excavation inevitably leads to less environmental impact during the installation of pressure sewers. This means less silty runoff, shorter construction periods, a lower level of property access problems with customers, less construction noise, etc.

6. No infiltration.

• By using polyethylene pipes, the system is fully sealed which eliminates infiltration. By removing the wet weather peak flows, consistent dosing and treatment can be achieved. Wet weather flows do not occur, reducing the annual flows in the system by up to 20%.

7. Minimal Jointing.

• Because the system uses polyethylene pipe on 150m rolls that is electrofusion welded, there is minimal joints and therefore, minimal opportunities for joint failure. This reduces the risks associated with boring under significant areas such as Rutherford Inlet. Traditionally, a redundant "back-up" pipeline would be required to ensure continuity of supply.

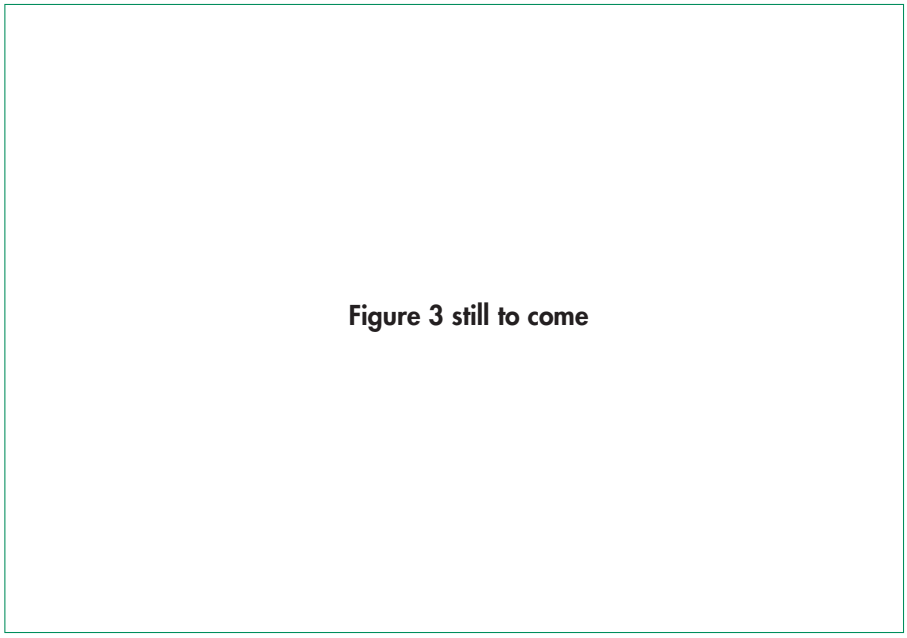

Figure 3. Rutherford Inlet underbore exit.

Lessons Learned

Project Delivery

• Split each pressure sewer projects into separate tenders. One for design and supply of pump units and one for construction. The purpose of this is to have direct control over each aspect of the works and their delivery.

• Construction debris in the reticulation lines will cause blockages almost immediately. Specify flushing of all reticulation lines with high pressure and high volumes prior to connection of any pump units, similar to water reticulation. Consider selecting from contractors that have experience in water main construction where it is mandatory to avoid debris entering the pipelines.

Customer Consultation

• Develop and implement comprehensive consultation and communication plans that involve the use of focus groups.

• Use a variety of media sources to ensure customers and stakeholders are fully informed at all times. This certainly makes life easier during construction.

Power

• Ensure that construction contractors provide a separately wired circuit for the power supply at each property.

• Where any existing domestic electrical system requires major upgrade to facilitate a separate wired circuit, then the costs for upgrade works are borne by the property owner.

• Property owners to pay the annual power cost to operate their property's pump unit.

Conclusion

The conditions in Warneet and Cannons Creek were similar to those encountered in Tooradin since all three townships border Western Port. The ground is difficult to excavate, the groundwater table is very high and the land is generally flat. South East Water's experiences have proven pressure systems are better suited to these conditions over gravity systems. The pressure systems installed did experience few minor commissioning problems in Tooradin that

were not realised in Warneet and Cannons Creek

The pressure sewer system was also chosen as it offered a number of advantages predominantly the lower capital cost due to smaller diameter pipe sizes, shallower construction due to pipes not needing to be laid to grade, easier construction in poor ground conditions due to no dewatering needed. In addition, OH&S benefits, as there are no trench-related accidents, customer connections included as part of the project therefore realising immediate environmental benefits and cash flow and no inflow/infiltration therefore additional benefits for the local treatment plant

To date, the system has performed sufficiently well for us to have assurance that it will provide a safe and reliable service over the long term.

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