22. OPTIONS FOR SEWER REBUILD IN CHRISTCHURCH

General Manager responsible:	Jane Parfitt, General Manager City Environment, DDI 941-8608
Officer responsible:	Manager City Water & Waste
Author:	Mike Bourke, Senior Technician

PURPOSE OF REPORT

1. The purpose of this report is to seek Council approval to use appropriate alternative technologies in the rebuild of sewerage infrastructure following the earthquakes. The systems likely to be used include:

   (a) Pressurised sewer systems (involves a tank on private property)

   (b) Vacuum sewer systems

   (c) Enhanced gravity sewer systems

2. All the above systems are proven wastewater collection technology that is in use and supported in New Zealand and around the world.

EXECUTIVE SUMMARY

3. The rebuild of the sewerage infrastructure following the earthquakes provides the impetus and opportunity to consider alternative technologies that will provide cost effective solutions in the rebuild and at the same time build additional resilience into the network in difficult ground conditions in the event of future earthquakes. These alternate technologies are also considerably quicker to install and commission than conventional deep gravity systems.

4. The three key technologies that could be used in the rebuild are vacuum sewer, pressure sewer and enhanced gravity systems. Use of these systems will be instead of the conventional deep gravity sewers that are usually provided in Christchurch City. The most appropriate system will be adopted in any given area, in light of the ground conditions in that area.

5. It is envisaged that these alternatives will only be deployed where the gravity catchment is severely damaged and the cost and time to reinstate the gravity system make it an undesirable solution. Alternate solutions are likely to be applied on a sub-catchment basis rather than an isolated street basis.

FINANCIAL IMPLICATIONS

6. The key financial implication is that the rebuild option chosen will be the least cost option taking into account whole of life costs, resilience to further earthquakes by ensuring “flexibility” and “fixability” in the event of failure due to earth movement, and to ensure minimum disruption to services.

7. These options will be used in addition to smaller resilience measures that are being put in place on manholes and connections to pump stations.

8. There will also be some small additional administrative cost to the Council in any situation where part of the chosen system must be installed on private property. Consent of the owners needs to be obtained. If consent is not given then there are additional steps required of the Council, including giving public notice and dealing with any objections.

Do the Recommendations of this Report Align with 2009-19 LTCCP budgets?

9. These alternative solutions will be funded as part of the rebuild of the damaged sewerage system. Funding will come from a variety of sources such as insurance (LAPP cover), central government and rates. The cost estimates for these alternate systems have been integrated into the overall sewerage system rebuild estimate.

22 Cont'd

LEGAL CONSIDERATIONS

10. The primary legal consideration relates to the pressurised sewer system option as that involves a tank being located on private property. Section 181 of the Local Government Act 2002 (LGA02) gives Council the mandate to construct works on or under private land that are necessary for sewage. This power cannot be exercised unless the Council has the prior written consent of the owner of the land, or the Council has complied with the process in Schedule 12 of the LGA02, which applies in cases where the Council cannot get a landowner's consent.

11. Schedule 12 requires the Council to take a number of steps, including lodging for public inspection a description of the works and a plan, notifying owners and providing them 1 month in which to lodge any objection, holding a meeting with anyone who objects and if the plan is proceeded with (as proposed or with amendments), any aggrieved person then has the right to appeal to a District Court within 14 days. Pending determination by the Court the Council cannot proceed with the works.

12. Initially Council staff will use the powers available under section 181 to gain entry to private land. However, if large numbers of the pressurised sewer system are to be installed it may be necessary to look at a more streamlined approach to dealing with property owners.

13. Access to private land for the purpose of carrying out works required to assist with earthquake recovery is an issue that will arise more frequently. As well as the pressurised sewer system referred to in this report, land remediation and the repair and replacement of retaining walls are some of the works affecting private property that will be required.

14. It may be that an Order in Council or some other regulatory intervention will be needed to enable community participation in the process without impeding a focussed, timely and expedited recovery (one of the purposes of the Canterbury Earthquake Recovery Act 2011). If the Council adopts the recommendations contained in this report it is intended that steps be taken by staff to investigate the possibility of such intervention being made.

Have you considered the legal implications of the issue under consideration?

15. Council is not required to register an easement on the property if it uses section 181, as that section also gives the Council the right to enter the land, on reasonable notice to the owner to "*inspect, alter, renew, repair, or clean*" any work constructed under section 181, or under the corresponding provision of a former Act.

16. Section 181(6) states that the rest of the section applies subject to the payment of any compensation for injurious affect *to the land* as a result of the works. This would require the Council to carry out work to remediate the landowner's garden/land after installation or maintenance work, and may possibly require additional landscaping works or other payments.

17. The pressure sewer system requires a power supply to operate. The Council is proposing that the land owners will pay the minimal cost of any electricity charges involved in operating the system. The need to pay for the power is not an injurious affect to the land so would not have to be paid by the Council under section 181(6). The advantage to the owner if this system is used is that the owner does not have to meet the cost of the conventional gravity lateral (about $2,000). The Council will meet the cost of maintaining the equipment and pipes on the property.

ALIGNMENT WITH LTCCP AND ACTIVITY MANAGEMENT PLANS

18. Aligns with 2009-19 LTCCP for the provision of Wastewater Collection.

Do the recommendations of this report support a level of service or project in the 2009-19 LTCCP?

19. Yes. Activity 11.0 Wastewater Collection – KPI's 11.0.1, 11.0.3 and 11.0.4

22 Cont'd

ALIGNMENT WITH STRATEGIES

20. Yes. Wastewater Strategy still under development but aligns with Wastewater Asset Management Plan.

Do the recommendations align with the Council's strategies?

21. Yes.

CONSULTATION FULFILMENT

22. It is proposed that where sewer sub-catchments are identified by the Alliance as suitable candidates for these alternate technology solutions, information evenings would be held with residents in the affected catchments to explain how the systems will be different to their current gravity system and whether the Council will need to install council assets on private property (pressurised sewer systems that utilise tanks).

23. Where Council needs to install Council assets on private property a process for gaining the property owners consent will be required. This process will be developed by council staff and implemented by the Alliance.

STAFF RECOMMENDATION

It is recommended that the Council:

(a) Agree to the use of alternative sewer rebuild technologies that include vacuum sewer, pressure sewer, and enhanced gravity systems.

(b) Delegate power to the General Manager City Environment Group to approve the use of an alternative technology in any given area if the alternative technology provides cost or time benefits and service resilience advantages over conventional gravity systems.

(c) Request that staff, with assistance from the Alliance, develop the necessary communication and information tools and procedures to ensure residents living in areas where these new systems are installed are familiar with the new technologies and all necessary consents are gained from property owners where Council needs to install new Council assets on private property.

(d) Authorise staff to investigate the possibility that an Order in Council or other regulatory intervention can be made to enable community participation in the process without impeding a focussed, timely and expedited recovery.

22 Cont'd

BACKGROUND (THE ISSUES)

24. The flat topography of most of Christchurch dictates that gravity sewers are laid at minimum grades to achieve sufficient flow rates and that there is a trade off between increasing depth at which sewers are laid and the frequency of pumping stations required in the network. Most of the Christchurch reticulation resembles a saw tooth pattern of flow by gravity to a pumping station where the flow is then lifted up and flows by gravity again to the next pumping site. The flow can be pumped up to seven times before reaching the treatment plant. In many situations the flow may be pumped all the way to the next pumping station. There are 100 sewer pumping stations in the city, currently 5 of which are terminal stations that pump direct to the treatment plant.

25. Due to the high cost and complexity of laying deep sewers the maximum depth that sewers are normally laid at in Christchurch has been in the range of 4 to 5 meters deep. The high cost is driven largely by high water table and the lack of strength of the soils to maintain a near vertical face during excavation to lay the sewer pipes. Construction of sewers in these conditions necessitates trench support, usually in the form of driven steel sheet piling, and dewatering of the ground using multiple small wells and vacuum pumps. Once gravity sewers have reached this depth the cost dictates that pumping from that point is required.

26. Following the earthquakes, replacement of the damaged deep sewers will be expensive, slow, disruptive and difficult. (Land has settled, effectively raising groundwater levels, and soils have been disturbed making them less able to stand on their own as a cut vertical face.) Therefore other options for providing the service need to be considered and this consideration will also include, where possible, increasing the resilience of the service to future earthquakes. Increased resilience to future disasters will include more flexible piping materials laid at shallower depths. Typically the worst damage has been sustained by brittle earthenware pipes laid in the older parts of the city.

27. It is likely that increased resilience will also see a greater number of smaller pumping stations that will effectively spread the risk of future failures. These measures will result in piping systems that will be much less likely to be damaged, and if damaged, much easier to repair as they will be shallower, ensuring less loss of service and quicker service recovery if service is lost. A significant advantage of these systems will be a marked reduction in ground water infiltration into these pipes, fewer pipe joint failures and therefore fewer sewer repairs and consequent road surface disruption.

28. Repair and replacement of shallower sewers is a simpler process than replacement of deep sewers as mobile trench support can be employed (movable shield) and ground water is easier to control in a shallower trench (up to 2.5 m deep).

THE OBJECTIVES

29. The objective is to provide the most economic long term rebuild solution that enhances the resilience of the network wherever it is economical to do so. This has to be balanced against the value of the gravity sewer assets in the ground in any sub-catchment that are still useable (i.e. avoiding massive write-offs of useful assets).

THE OPTIONS

30. The Council held a technical workshop in April 2010 with experts from the operations, construction and design fields which looked at a wide variety of alternate solutions including composting toilets and other on site treatment options. Alternative solutions were evaluated against a weighted suite of 10 criteria. The top six criteria were Level of Service/Reliability, Cost, Resilience, System Integration, Constructability and Operability/Maintainability.

31. From this workshop three key solutions were identified as possible alternatives to straight "like for like" reinstatement of the gravity systems. The alternates chosen were vacuum sewers, pressure sewers and enhanced gravity systems.

22 Cont'd

Vacuum Sewers

32. Vacuum sewer systems best suit a catchment that is of roughly equal dimensions in each direction where the main vacuum pump station can be located near the centre of the area. The vacuum pumping station is a significant structure both above and below ground and provides the "suck" on the network of pipes that radiate out from the station.

33. The pipes are laid on a defined grade but to a shallow depth (< 1.2 m) and the pipe line steps in a "saw-tooth" fashion like a long series of "lift" stations where the vacuum "suck" provides the lift at every 300 mm step in the saw-tooth before the flow then travels by gravity assisted by the drag of the air flow created by the vacuum to be lifted again at the next saw tooth. The main feature of the vacuum system apart from the pumping station is the vacuum valve in a buried roadside tank (similar to a standard manhole) that receives the gravity flow from 4 to 6 houses through the regular 100 mm diameter laterals. This vacuum valve opens in response to sewage level in the tank reaching the preset open level, with the vacuum then sucking the contents out until the level drops to the set point shut off level. The vacuum valve then closes. No electrical components are required to operate the vacuum valve. Early versions of the vacuum valve did have some reliability and blockage issues but the modern versions are much more reliable. Staff have recently visited several vacuum systems on the east coast of Australia along with Waimakariri District Council staff and came back with the clear view that this system would be a viable alternative option for the Christchurch rebuild in certain situations determined by catchment size, layout and topography. The vacuum sewer technology is the same as that used on every dairy farm in New Zealand - just bigger.

34. Customers would see the same level of service as with a conventional system. While the vacuum pumping station, station tanks, equipment and structures will be more expensive than a conventional deep gravity pumping system of similar capacity the clear advantage of the vacuum system is that the fully welded pipes are laid to much shallower depths, at much lower cost than conventional sewers. Maintenance costs are expected to be slightly higher due to more complex vacuum and pumping equipment and the additional maintenance of a large number of vacuum valves. Added advantages are that ground water infiltration is very minimal with the only possible input from the private gravity laterals to the buried roadside tanks that house the vacuum valve. It is this infiltration of water into the Council's conventional gravity sewer system that is the cause of the heavy rainfall event overflows of raw sewage into the city's rivers.

35. Wastewater conveyed by this method is well aerated and therefore produces minimal odour when compared to conventional sewer systems, and diurnal flow variations are somewhat smoothed (smaller variations between peak flow and average flow) by the small amount of storage in the roadside tank. Laying the vacuum pipes needs to be done with reasonable precision as the gradient of the pipe is important to the performance of the system. Skilled contractors are needed for this work as for deep gravity systems.

Pressure Sewers

36. Pressure sewer systems are suited to very flat low lying land in any shaped catchments. Pressure sewer systems in New Zealand are more common in beach side resort or rural situations and can be simply extended and have additional properties added into the system. Council has been considering these systems as part of both the Wainui and Charteris Bay sewer reticulation projects. These systems consist of a small pump and pump chamber on each property, located in an agreed position with the property owner and preferably close to the dwelling to minimise the length of the gravity lateral and potential groundwater leakage into that lateral. The pump operates in response to level in the chamber and discharges through a very shallow (< 0.5m) small bore pipe (40 mm) to a shallow slightly larger common pressure main (65 mm diameter) in the street berm.

22 Cont'd

37. The pressure pipes do not have to be laid at any particular depth or grade. The pressure main in the street increases in size in proportion to the number of properties connected to it. For example 200 properties might be served by a 100 mm diameter pipe. The pipe material is High Density Polyethylene (HDPE), the same material (but different colour) to water pipes in the street. These systems are relatively cheap and quick to install, very resilient to ground movement, simple to repair, and the best system available for eliminating ground water and storm water entry into the sewer system. The pressure sewer system also reduces downstream peak flows due to the available storage on site, which also acts as a buffer in the event of power failure. Areas served by a pressure sewer system do not need manholes so all centre of the street sewer manholes would be eliminated, until the pressure sewer reaches an operating gravity system.

38. The pumps provided for the chamber on the property are small devices either mounted near the top or at the bottom of the tank depending on the system supplier. The types of pump vary depending on supplier and single dwelling systems are less than 1 kilowatt power requirement, and run for approximately 10 minutes per day.

39. It is common for the Network operator (CCC in this case) to own and maintain the pump, piping and chamber on each property. It is also common for the power supply for the pumping system to be taken off the property supply and the power costs to be met by the property owner (estimated to be approximately $20 per year). The ideal location on the property for the pumping chamber is close to the house so lateral length and power supply run is minimised however location would be by agreement with the individual property owner. This arrangement means that the property owner has to meet the additional cost of the power but on the other hand the Council meets the cost of maintaining the equipment and pipes on the property, and the property owner does not have to meet the cost of the conventional gravity lateral of about $2,000.

40. It is proposed that if pressure sewers are approved as an option in the rebuild that these arrangements then apply. It should be noted that individual pressure sewers are common on the hills of Christchurch where houses are below the level of the road and the nearest sewer main is above the house in the roadway.

41. Pressure sewer systems can be set up with full SCADA systems that control and monitor the system in the same way as conventional sewer pumping stations, or they can be equipped with less sophisticated monitoring systems such as automatic download of alarms and information by using the cellular networks, or they can be set up with a flashing light to warn the property owner of an alarm condition. In the first instance it is proposed that the basic alarm warning light be used, to keep costs to a reasonable level. More sophisticated systems can be retrofitted at a later date.

Enhanced Gravity Sewers

42. The concept of enhanced gravity sewers is simply to reduce the depth of the replacement sewers laid in the damaged areas to less than 2.5 m depth, and provide a greater number of smaller pumping stations at closer intervals than previously. These systems also significantly reduce the number of direct household pipes to the main sewer pipe connections on the deeper and larger mains which are the source of many repairs needed normally, this has been a major source of damage and loss of service in the recent earthquake events.

43. This system results in the same service for the customer. The cheaper capital cost to install is off set by some additional operating and maintenance costs of the additional pumping stations. The clear advantage is the resilience of shallower sewers that are easier to replace in future events. These sewers are generally laid at a steeper grade and therefore less susceptible to service failure (eg blockage) in a future event. In most installations these enhanced gravity sewers can be designed to overflow at a high level into the next gravity sewer without the need for the usual standby pumping arrangements. This will simplify the pumping control system and reduce the number of pumps required. These additional pump stations will have quite a small footprint, and it is anticipated could be sited within a narrowed portion of the roadway, and they would be underground. The control cabinet would need to be sited above ground (similar in nature to small pump stations on the Banks Peninsula).

22 Cont'd

44. In many situations of this type of installation the main gravity pipe can be converted to a trunk main with no lateral connections (that is only having connections at the manholes). Therefore the trunk main is much less susceptible to service failure and subsequent silt inundation in future aftershocks. Similarly, no lateral connections mean no sand and silt ingress from broken laterals into the main. The laterals are connected to the shallower "enhanced gravity" sewers where repair is much simpler, cheaper and quicker.

THE PREFERRED OPTION

45. In the options outlined above there is no single preferred option as each is capable of providing a cost effective, more resilient alternative to conventional deep gravity sewers in certain circumstances. In some situations renewal of the existing deep gravity sewer may provide the best long term solution and if that is the case would be used in that situation. An example of this might be where the deep gravity system only needs replacing in a single manhole length (100 m) out of 2 kilometres of fully serviceable gravity main. In this case it would clearly be more cost effective to replace just the one manhole length

46. The economics of retaining existing gravity assets is dependent on a large number of factors including sewer depth, type of pipe, ground water levels, susceptibility to liquefaction etc. A technical and financial analysis will be done on a case by case basis prior to deriving the best option for individual areas.

ASSESSMENT OF OPTIONS

47. As the existing pumping stations and pressure mains are restored to full service (target end August 2011) the network can then be pumped down and better assessment of full damage to the gravity pipes ascertained. This will then provide the full information against which the various options for renewal, where necessary, can be assessed. Each catchment and sub-catchment area will be assessed and the renewal options compared on the basis of cost and future resilience. It is proposed that this assessment include comparative assessment of the "like for like" deep gravity with the options of vacuum systems, pressure sewers and enhanced gravity.