Shotover Country

Conceptual Study for
Wastewater, Water, Stormwater and Gas

10 February 2010

CPG New Zealand Ltd
A subsidiary of Downer EDI Limited

Shotover Country
Conceptual Study for
Wastewater, Water, Stormwater and Gas

This report has been prepared for Ladies Mile Partnership by CPG. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other parties.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

Quality Assurance Statement		
Task	Responsibility	Signature
Project Manager:	Paul Reed	
Prepared by:	Terry Hughes, Francis Ho, Andrea Jarvis	
Reviewed by:	Paul Reed	
Approved for Issue by:	Rob Potts	

Revision Schedule					
Rev. No	Date	Description	Prepared by	Reviewed by	Approved by
A	18 Jan 2010	Minor Amendments	Francis Ho	Paul Reed	Paul Reed
B	3 Feb 2010	Minor Amendments	Francis Ho	Paul Reed	Paul Reed
C	10 Feb 2010	Minor Amendments	Francis Ho	Paul Reed	Paul Reed

Prepared by:

CPG New Zealand Ltd
236 Armagh Street
P O Box 13-875
Christchurch 8141
New Zealand

Telephone: +64 3 374 6515
Fax: +64 3 374 6516
E-mail: christchurch@nz.cpg-global.com

Job No.: 700562
Date: February 2010
Ref: 700562-Rpt100210 Conceptual Study fh revised.doc

Shotover Country
Conceptual Study
for
Wastewater, Water, Stormwater and Gas

TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

CPG New Zealand Limited (CPG) has been engaged by Ladies Mile Partnership (LMP) through Clark Fortune McDonald to consider infrastructure options for a new development in the Lower Shotover and Ladies Mile area. The site covers approximately 121Ha and is to provide up to 758 residential dwellings. CPG are to consider the supply of water and gas to the proposed development and the removal of wastewater and stormwater from the proposed development. A summary of the report findings are described below:

Wastewater (Section 2)

Following the consideration of wastewater disposal options such as on-site treatment and disposal, community treatment and disposal, land treatment, disposal to adjoining developments and other options, it is concluded that wastewater from the proposed development could be dealt with either on-site or via the Council sewer. However, it is believed that the most appropriate method of managing the wastewater is to discharge the wastewater from the development into the existing Council sewer alongside the highway. This would be achieved by a series of gravity sewers, generally following the roadways, collecting the wastewater and discharging it into a central pump station on the lower terraces. The waste would then be pumped through an approximate 200mm dia rising main to an existing manhole on the Council sewer.

A report from the Council's engineers has confirmed that the pipeline that the development proposes to join into currently has the capacity to receive the wastewater from this development. However, some of the capacity has been delegated to future developments elsewhere in the network. The Council's engineers have, however, also confirmed that the wastewater treatment plant could cope with the additional load from the Shotover Country Development, and therefore if the pipeline does not have sufficient capacity, an independent line through to the treatment plant across the Shotover Bridge may be required at a later stage.

The main cost associated with this option (excluding the cost of an additional pipe) is the capital contribution that will need to be made to Council. This is likely to be in the order of $6,200 (excl GST)per property.

No discharge consents will be required to dispose of the waste in this manner.

Water (Section 3)

A water supply currently exists on the Shotover Country Development land to serve a small 13 lot residential development. The water is sourced from a 150mm dia bore and is of a relatively high quality. The bore would not be able to serve the proposed 758 dwellings development but could be used in combination with another bore. Items to note regarding the new water supply are as follows:

- A water source with a flow of 58L/s (average on peak day) will be required.
- Compliance with the Drinking Water Standards is now mandatory and will need to be complied with for the new water supply as soon as the water supply begins to serve the new development.
- If the new well was proved as 'secure' in accordance with the Drinking Water Standards then no treatment would be required. To achieve this status the well casing would need to be at least 30m deep, the water would need to be age tested and found to be sufficiently old, and 12 months of weekly E-coli tests would need to demonstrate no bacteriological contamination. If the well was not 'secure' then treatment would need to be provided.

- The most suitable treatment system to use for this development would be a UV reactor. However the source water must be consistently below 1 NTU to do this. If the water occasionally rises above 1 NTU then a filtration step will need to be added prior to the UV to reduce the turbidity or a membrane filtration system used instead.
- Chlorine is not an essential step in the treatment process but is encouraged by the Ministry of Health. Gas chlorination is likely to be the best form of chlorination for this development.
- A 1,123m^3 reservoir will be required for this water supply. This volume of storage would best be provided in a reinforced concrete tank at a level of approximately 400m RL. Suitable sites are available north of the development and north of the state highway.

A consent will be required for the new water bore (for drilling and for the water take).

Stormwater (Section 4)

There are a large number of methods available to reduce the quantity and improve the quality of that runoff on an allotment level and a catchment wide level. A combination of these methods is recommended to collect, treat and dispose of the stormwater. In particular, the use of infiltration methods will be used on the middle and upper terrace; however infiltration methods are less likely to be used on the lower terrace due to the high ground water levels.

Disposal to the river is likely to be via one detention pond, which will provide treatment and an attenuation of the flow. It is proposed that one pond located at the most downstream end of the development would serve the whole development.

A consent will be required for the discharge of stormwater to land and to water.

Gas (Section 5)

Gas can be supplied to the development via a bottled supply (arranged by a number of suppliers) or through a reticulated supply (undertaken solely by Rockgas in Queenstown). A 100T storage tank currently serves the Lake Hayes Estate Development which is isolated from the main Queenstown supply. Rockgas propose to connect the Lake Hayes Supply with the Queenstown supply in the near future to provide further security to both supplies. The connecting pipe will be approximately 200mm dia in size and will be run along the state highway. This gas pipeline has been sized to serve the Shotover Country area.

The simplest way to reticulate gas into the new Development will be to provide a ring main connecting to the 200dia main pipe in the state highway at the eastern and western ends of the development. Based on a maximum residential usage of 900kg/lot/year it is expected that a 110mm dia pipe will be required. Connections to residential properties will be via 32mm dia service pipes. It is likely that Rockgas will pay for the reticulation of the gas system but this will most likely be based on a covenant agreement restricting on-site portable gas storage to 10kg per lot.

2.0 WASTEWATER

2.1 Sewage Flows

The peak sewage flow expected to be generated by the proposed development is approximately 48 litres/second. This assumes that the development contains approximately 758 residential dwellings, a school and a small commercial area.

This peak flow is based on the following data:

Number of dwellings:	758	(As advised by the developer)
People per dwelling:	3.5	(QLDC amendments to NZS4404:2004)
Flow per person:	300 l/day	(QLDC amendments to NZS4404:2004)
Average dry weather flow:	795.9 m^3/day	
Allow for community /commercial facilities	26 m^3/day	(Based on 3.0 ha of Activity Area 3 at 0.1 l/s/ha)
Dry weather diurnal peaking factor:	2.5	(QLDC amendments to NZS4404:2004)
Dilution/Infiltration factor:	2	(QLDC amendments to NZS4404:2004)
Total peak flow:	4,109.5 m^3/day	(i.e. ~47.56l/s)

2.2 Disposal Options

There are a number of options for disposal of wastewater generated throughout the development. These include:

- Onsite treatment at each lot.
- Community onsite treatment plant.
- Onsite primary treatment before being pumped via small bore sewers to Council's sewer.
- Discharge directly to Council sewer.
- Discharge to Council sewer via adjacent developments.
- Discharge direct to treatment plant via own main line.

Each of these options is discussed below.

2.2.1 Option 1: Onsite Treatment at Each Lot

Onsite wastewater treatment at each lot would involve individual home owners purchasing and installing a package treatment plant for their home. They would then be responsible for the ongoing operation and maintenance of that treatment plant. This raises a number of issues:

- The lots need to be sized large enough to allow the wastewater to be disposed of to land effectively.
- Controls need to be put in place to ensure a minimum level of treatment for each lot is obtained.
- Land disposal will need to be designed and adequately sized to ensure no negative effects within the boundary, and no effects outside the boundary of each lot.
- No lots would be able to discharge to land within 50m of any waterway or bore.

- Individuals would be responsible for the ongoing operation and maintenance of the treatment plants, with little control from governing bodies.

The amount of land required for each property to adequately dispose of the waste is likely to be in the order of $200m^2$ (including the required reserve area). The cost of an on-site treatment system would be in the order of $16,000 - $20,000 (excl. GST). Therefore, based on 758 dwellings this would equate to $12.1 - $15.1 Million (excl. GST)

The advantage to the developer of this option is that the cost of the sewage scheme is transferred to the individual land owners and there is no large capital outlay during the initial development of the subdivision for sewage disposal. However, it is unlikely that QLDC would accept this type of treatment system for such a large development so close to the municipal treatment plant.

2.2.2 Option 2: Community Onsite Treatment Plant

For this option wastewater from each lot would flow to one (or a number of) cluster community treatment plant(s) located within the subdivision. A day's storage would be provided to buffer diurnal variations in flow. The wastewater would then be disposed of via land treatment or discharged to the river.

On site land treatment systems would require large areas of land to ensure appropriate hydraulic, biological and nutrient loading rates. The total amount of land required for wastewater storage and land treatment would be in the order of 19Ha. The land treatment area could, however, be used for other purposes e.g. playing fields and landscape features. Alternatively a higher level of treatment could be employed and land disposal rather than land treatment (at a higher loading rate) may be possible. This would reduce the land area required to approximately 3.5 Ha. Further investigation would be required to determine the final loading rate and thus the area required.

The cost of this option is likely to be in the order of $11 Million (excl. GST).

A resource consent would be required for the discharge of treated effluent to land or to water. Obtaining consent to discharge treated effluent to the river is unlikely, due primarily to cultural concerns, however discharge to land consents could be granted. For discharge to land high standards of treatment will be required. Obtaining these consents could be difficult to achieve due to the availability of other options that are likely to be more favourable to Council. The issue of ongoing maintenance would also need to be addressed through the resource consent conditions.

2.2.3 Option 3: Small Bore Sewers to Council Sewer

For this option each property would have an individual pumping system that would deliver the wastewater through small bore rising mains directly to the Council main. The two possibilities within this option are:

1. Pumping the raw wastewater via grinder pumps at each lot.
2. Providing primary treatment of the wastewater using a septic tank to remove the solids before pumping the liquid to the Council Sewer.

This option has the advantage of reducing wet weather flows, as the sewer network is pressurised and infiltration into the mains is difficult, and also to some degree the peak daily flows. This in turn reduces the instantaneous flow to the Council sewer.

As with Option 1 the cost of the on-site pumping system would normally be paid for by the individual land owner. The cost of the system would be in the order of $6,200 (excl. GST) per property or based on 758 dwellings approximately $4.69M (excl. GST). This does not include the cost of the reticulation network. This option is unlikely to be feasible unless there are no capacity issues at the municipal treatment plant or in the line the wastewater is being discharged into. It is a more suitable system when there are a small number of properties too far from the sewerage network to connect easily using standard gravity sewers.

2.2.4 Option 4: Discharge Directly to Council Sewer

In this option collection of all wastewater within the development would occur via a standard gravity sewer network to a common point on the lower sections of the subdivision. A pump station would then feed the wastewater via a 150mm dia rising main to one of the existing manholes on the 300mm dia Council Sewer which runs along the highway on route to the Queenstown wastewater treatment plant.

The most feasible manhole to connect to already accepts the flow from the neighbouring Lake Hayes Estate connection. Rationale, the Council's engineers for sewage reticulation, have advised that surcharging of this manhole has occurred in the past, and as a result, the manhole is now sealed to allow the gravity system to surcharge. The section of sewer, from the Bendemeer Pump Station to the treatment plant, has an upgrade underway. An allowance of at least 400 dwellings from the Shotover Country has been included in the design of the new pipe, although at present there is capacity in the pipe for the entire development. This pipe capacity is partly allocated to other developments in the network, and thus council may restrict the connected volumes in the future. Should this be the case, the proposed development has the option of constructing an independent line across the Shotover Bridge to the treatment ponds at a later stage. Communications with Rationale have suggested that the treatment plant capacity is also not an issue at this stage, for the same reasons outlined above.

The capital contribution to connect to the Council's network will need to be negotiated with Council however it is understood that the current policy for financial and development contribution requires contributions of $6,153 (excl. GST) per lot for connection to the Lake Hayes wastewater network.. For 758 dwellings this equates to a total of $4.66 Million (excl. GST). The cost of constructing an independent line through to the Shotover Treatment plant would be higher than connecting into the manhole above the proposed development, however this could be partially offset against the Capital Contribution in negotiation with council, as the development would be using capacity at the plant, but not in the reticulation.

2.2.5 Option 5: Discharge to Council Sewer Via Another Subdivison

There are a number of other developments in the area with existing connections to the council sewer. Lake Hayes Estate is the closest of the subdivisions. Other subdivisions in the area include Quail Rise. Lake Hayes Estate is located to the North East of the proposed development, whereas the municipal treatment plant is located to the West. Quail Rise is to the North, across SH6 from the proposed development and beyond the Council Sewer.

Using one of these existing connections assumes there is capacity in their system for the flow from the Shotover Country development. The pumps required to connect into either of these systems would be the same or larger than those required to connect directly into the Council Sewer. It is therefore not considered a cost effective solution to connect to one of these subdivisions, especially if an upgrade to the infrastructure of the other subdivisions was required.

2.2.6 Option 6: Discharge Direct to Municipal Treatment Plant Via Own Main Line

If the existing Council sewer was found to have insufficient capacity to convey the wastewater flows from the proposed Shotover Country development, it would have been necessary to construct a new line from the development through to the Queenstown wastewater treatment plant. This would involve a new line (approximately 200mm dia) from the pump station within the development up to the road and then crossing the Shotover River before connecting to a manhole directly adjacent to the treatment plant. Due to the allocated capacity of the main pipeline, this may be required and would need to be negotiated with Council at the time of construction.

2.3 Preferred Concept

After consideration of the above options and discussion with Council's engineers, the preferred concept is connection directly into the Council Sewer, via a pump station within the development connecting to existing manhole 500046, the same manhole which accepts the feed from Lake Hayes Estate. This option is the favoured option as it is likely to:

- Have the lowest capital cost.
- Use the least amount of land.
- Have the lowest ongoing cost for Council.
- Require the least number of consents. The only consent required will be in relation to the construction of the pump station.

For this option, it is likely that sewage within the development will be collected by conventional 150mm dia/200mm dia gravity sewers and directed to a single pump station at a low point within the development. A rising main (approximately 200mm dia) from this point will head towards manhole 500046. Depending on the final layout, a second pump station may be required due to the large elevation difference (approximately 50m) between the lower pump station and Manhole 500046. The pump station(s) will incorporate emergency storage to cover the situation of mechanical failure or power failure. It is unlikely that an emergency overflow from the pump station to the river will be included or would be approved. An odour control system (i.e. bark filter or carbon filter) may be required at the receiving manhole due to the additional flow.

A drawing outlining the concept described above is enclosed in Appendix 1.

2.4 Cost Estimates

As the roading layout is not currently known, it is difficult to estimate reticulation costs. Guideline estimates for the pump station and rising main would be in the order of $280,000 for the pump station, with the rising main estimated at $250/m, and an additional $70,000 for odour control. More accurate cost estimates can be provided during the detailed design phase of the project, when roading layouts and exact development figures are known.

2.5 Consents

The preferred option does not involve discharge of treated wastewater to land or water, therefore a discharge consent from the Otago Regional Council is not required. A consent is not required to connect to the council reticulation, although permission is required, and connection fees are payable to Council as outlined above. As the development is located outside of the current zoning for connection to the council sewer, connection fees have not been assessed for the area. Such fees would not be assessed by Council until such time as the plan change has occurred and detailed information about the development is known.

3.0 WATER

3.1 Introduction

The following section investigates the options for supplying water to the proposed Shotover Country Development. It includes the following:

- A description of the existing water supply on site.
- An estimate of the water demand from a 758 dwellings development in Queenstown.
- A brief description of the Drinking Water Standards and the Health (Drinking Water) Amendment Bill and its effect on the water supply.
- A description of the water supply options.
- An estimate of the reservoir storage required.
- A description of the treatment options.
- A prediction of the cost of the system.

3.2 Existing Infrastructure

The proposed development area currently has a thirteen lot subdivision with an associated water supply. The existing system is described below.

3.2.1 Existing Bore

The site currently has one bore, consented for communal domestic supply. The bore has been given the Otago Regional Council bore number F41/0310. Bore F41/0310 is 22.75m below ground level (mbgl) and has been screened from 21.52m mbgl and down. The bore has a 150 mm casing. A 9 kW pump is installed in the bore and can pump a maximum of 4.6 L/s through a 100mm diameter riser. The static water level when drilled was noted to be 1.66 mbgl.

Photo 1: Height of Ground Water Table is Apparent from this Gravel Extraction Pit on the Lower Terrace

Bore F41/0310 is present in the middle of an old river flat, clearly visible on an aerial photo of the site where remnant river braids are visible as darker areas of pasture. Groundwater is present in an unconfined gravel aquifer that has been deposited by the Shotover River. Borelogs supplied by Otago Regional Council suggest that few fines are present and that the gravel package is likely to be highly transmissive. The bore was pumped at approximately 4.5

l/s with an accompanying drawdown of 2.9 m. Water sourced from this bore is likely to be river recharge from the Shotover River and represents plentiful source of water.

This bore has been consented by Otago Regional Council to take 300 m^3 per day to supply water for communal supply.

3.2.2 Existing Reticulation and Storage

The site currently has a 13-lot subdivision that is supplied with water from bore F41/0310. The supply water is pumped from F41/0310 via a 100 mm diameter PVC pipeline to a 30 cubic metre storage tank. This storage tank is situated on the upper terrace near the intersection of Ladies Mile and Stalker Rd.

3.2.3 Water Quality and Treatment of Existing Bore Water

Samples for water quality have been taken for the existing 300 cubic metre per day consent. Testing concluded that there are no contaminants or substances detrimental to water quality originating from bore F41/0310.

3.3 Projected Demand

3.3.1 Water Demand

The preliminary estimated domestic and commercial demand for this development is as follows:

Table 1: Estimated Demands

No. of residential dwellings	758
No. of people per dwelling	3
No. of people to be served	2274
Estimated water demand per person	700 litres/day
Allowance for losses/leakage	10%
Average Daily Flow*	$74m^3/hr$
Peaking Factor for Peak Day/Average Day	2.35
Peak Daily Demand	$174m^3/hr$
Peak Flow Required from Water Source (assuming 20 hrs/day supply)	58 L/s
Peak hourly domestic demand required from reservoir	82 L/s

***** includes allowance for commercial/communal facilities

3.3.2 Fire Fighting Flows

The flow required for fire fighting is specified in the Fire Service Code of Practice (SNZ PAS 509:2008) and is dependent on the type and size of buildings to be protected. Based on supplying a category FW2 risk only ie residential dwellings, a flow of 25L/s will be required. However, possible education/community activities within Activity Area 3 and small format retailing in Activity Area 2 are possible, it is therefore prudent to make provision for a water supply system with an FW3 classification. An FW3 classification will be suited to:

- Sleeping activities including care facilities, motels, hotels and crowd activities <100 people including cinemas, art galleries, community halls, churches, working/business/storage activities processing non-combustable materials and multi-storey apartment blocks; up to 599m^2 fire cell floor area.
- Crowd Activities >100 people, libraries, book storage, night clubs, restaurants, working/business/storage activities with low fire load such as hair dresses, banks, medical consulting rooms and offices; up to 399m^2 fire cell floor area.
- Working/business/storage activities with medium fire load such as manufacturing, processing and bulk storage up to 3m; up to 199m^2 fire cell floor area.

3.4 Supply Options

Options for supplying water to the Shotover Country Development are outlined below. Generally the most suitable layout for a new water supply is for the source water to be delivered through a treatment plant to a storage tank at a constant flow. The water then flows, preferably by gravity, into the reticulation. The reason for this layout is that:

- The water headworks or treatment plant do not have to be sized to deliver the peak hourly flow as the diurnal peaks are buffered by the reservoir.
- Most treatment plants work better at a constant rate rather than at the varying diurnal flows and therefore the treatment plant is best suited on the upstream side of the reservoir. One disadvantage of this layout is the potential contamination that could enter the water supply through the reservoir following the treatment plant. This is especially true if chlorine is not used as part of the treatment stream.
- The reservoir provides emergency storage in the case of a mechanical failure in the treatment system or in the water headworks.

3.4.1 Connecting to Other Nearby Developments

We have investigated the connection of the proposed Shotover Country Development to the adjacent developments and have been told by QLDC and surrounding subdivision developments that this is unlikely to be possible because they are currently oversubscribed. Any new development must obtain and construct its own water supply.

3.4.2 Surface Water Potential

The Shotover and Kawarau Rivers border the development and provide a potential source of water for the development. There are, however, several difficulties in providing a direct take from either of these rivers as described below:

- The rivers both carry large amounts of silt which are known to be abrasive to mechanical equipment. Supply pumps used on water taken directly from the rivers would have a significantly reduced life.
- Additional treatment stages would need to be incorporated into the treatment plant to remove the sediment from the water.
- Intake structures within the rivers may suffer from moving river beds and changing river paths making them vulnerable to damage.
- An intake structure may be difficult to gain consent for as the rivers are used for recreational purposes, however this can be overcome with good design.

Obtaining water directly from the Shotover or Kawarau Rivers is therefore not a preferred option.

3.4.3 Bore Water Supply

Existing Bore – It is expected that the existing bore pump could be replaced with a larger pump to supply approximately 15L/s of water to the development, however this is not adequate to supply the 58L/s required for the fully developed subdivision. Although the existing bore would be insufficient to service the proposed 758 dwellings it would be capable of supplying 200 dwellings and could be used as part of the overall supply system. The consent currently limits the maximum flow to 6.94L/s and 300m^3/day and is therefore insufficient to supply the projected water demand.

Photo 2: Existing Bore

New Bore – The water quality of the existing bore is high and therefore the installation of another bore (say 300mm dia) to supply the proposed development is a favoured solution. The conditions on the lower terrace are suitable for the installation of a new bore. The issue of water supply for the proposed development can therefore be addressed with the drilling of a new bore. There is likely to be adequate water to serve the new development from a single bore given the ground conditions in the area and the proximity of the development to the Shotover River. A consent would be required for this new bore.

3.5 Drinking Water Standards

3.5.1 Compliance Criteria

The Drinking Water Standards for New Zealand 2005 (Revised 2008) (known hereafter as 'DWS') outline five compliance requirements that must be met to comply with the standard. They are:

Bacterial Compliance: The easiest way to comply with this criterion is to include chlorination as part of the treatment process and to ensure that a contact time of at least 30 minutes is provided. Sampling of the water reticulation is also required on a regular basis to ensure that a chlorine residual remains in the reticulation. It would also be possible to comply with this criteria through the use of UV or ozone treatment without any chlorine but with additional E-coli sampling. The Ministry of Health do however favour the use of chlorine and if a chlorine residual was not provided this would be reflected in the grading provided for the water system. There are many examples of supplies that prefer not to use chlorine and are willing to accept a slightly lower grading for this reason. The use of chlorine at Shotover Country is not imperative however if QLDC are to eventually take over the running of the scheme then they are likely to have a preference for it.

Cyanotoxin Compliance: Cyanobacteria are aquatic organisms that are not a health hazard in themselves and are found in many of our waterways. However, when they exist in large numbers or blooms (e.g. blue-green algae) the toxins they produce (cyanotoxins) can be a health hazard. There have been various cases reported in the media in recent years describing the death of dogs that have drunk from water containing high levels of cyanotoxins. We don't expect that Cyanotoxin compliance will be difficult to achieve at this site as upstream waters are not conducive to algal blooms.

Chemical Compliance: There are a large number of chemicals listed in the Drinking Water Standards with maximum acceptable limits. Testing for all of these chemicals is generally not undertaken due to the cost associated with this however common chemicals are analysed. Testing of the existing bore water was undertaken in March 2004 and the results are included in Appendix 3. The results showed no chemicals of concern.

Also as part of the Chemical Compliance criteria it needs to be assumed that the water is plumbosolvent, that is, it is corrosive to metals and the first 500ml of water need to be flushed from the tap prior to use. Notices need to be sent out every six months advising the consumers to flush the taps prior to use.

Radiological Compliance: Naturally occurring radionuclides occur from the leaching of rocks and from depositions from the atmosphere. Concentrations are likely to be higher when the source water is taken from a bore. It is expected that compliance with radiological limits will be achieved for the proposed Shotover Country water supply.

Protozoal Compliance: In accordance with the DWS a protozoa barrier must be provided in the treatment system. This is to protect the water supply from protozoa such as giardia and cryptosporidium. There is currently no protozoal barrier for the existing water bore. The main function of the treatment plant will be to provide this protozoal barrier.

Small Water Supply: As noted in the previous section, if the population is kept below 500 the water supply can be considered a Small Water Supply as part of the DWS. There are several advantages of having the water supply categorised as a Small Water Supply including less onerous monitoring requirements. Given the size of the land and the proposed number of lots it is not expected that the Shotover Country Development will fall into this category.

Secure Bores: A secure bore, is a bore generally at least 30m deep, that is recharged almost entirely from ground water and has no influence from surface conditions. 99.995% of the water must be at least 1 year old. The advantage of having a bore designated as 'secure' is that no further treatment is required. It is unlikely that a bore on the lower terrace would be designated as a 'secure' bore.

3.5.2 Treatment Plant Requirements

If testing of the bore water indicates that the bore can not achieve a 'secure' status (due to surface water influences) then treatment of the water will be required. As outlined above the main purpose of the treatment plant on the proposed water scheme will be to provide a protozoal barrier. The type of treatment that can be used for providing a protozoal barrier depends on the quality of the source water. The source water is categorized by the water supplier according to rules provided by the Ministry of Health as a low, medium or high protozoal risk depending on the level of contamination in the source water. A catchment risk assessment will need to be undertaken to establish the protozoa risk category. In the catchment risk assessment the catchment for the water is assessed to determine the level of contamination that is likely to be transferred to the water. Catchments with higher levels of risk (e.g. high concentrations of cattle, waste treatment outfalls etc) will require a higher level of treatment.

As outlined above, the use of chlorine is not an essential part of the treatment system but does add an additional layer of protection from contamination that may be introduced into the water network (e.g. through the reservoir).

3.6 Health (Drinking Water) Amendment Act 2007

Previously there was no legislative requirement to comply with the DWS; however in October 2007 the Health (Drinking Water) Amendment Act was passed which made future compliance with the DWS mandatory.

Relevant aspects of the Act with regard to the Shotover Country water supply are:

- The Drinking Water Standards 2005 came into effect on 1 July 2008; however there is a period of grace before they apply to existing and new water supplies. The extent of that period for existing supplies depends on the size of the scheme.
- New water supplies starting to supply water after 1 July 09 must comply with the DWS.
- Existing 'Minor' water supplies (serving populations between 501 and 5000 people) need to comply with the DWS by 1 July 2011. Based on serving 758 lots this is the most likely population category for the Shotover Country Development.
- Existing 'Small' water supplies (serving populations between 101 and 500 people) need to comply with the DWS by 1 July 2012. It is unlikely that the Shotover Country water supply will fall under this population category.
- A Public Health Risk Management Plan (PHRMP) must be in place on or before the relevant dates above. The drinking water assessor has 20 days to assess the PHRMP. PHRMPs need to be reviewed every 5 years.

Other points of interest relevant to the Shotover Country water supply are:

- The Ministry of Health must consult for at least 3 years if they want to issue, adopt or amend the DWS unless it is put through under urgency. Any new standards or amendments will come into effect 2 years after publication in the Gazette or 28 days if "urgent". According to these guidelines it will be at least five years before a new drinking water standard is implemented, unless pushed through under urgency. It should be noted however, that a revision was published in 2008.
- The Drinking Water Supplier (i.e. LMP/QLDC) must take all practicable steps to ensure that an adequate supply of drinking water is provided.
- Anyone who contaminates raw or drinking water faces a fine of up to $200,000 or 5 years in prison.

3.7 Water Treatment

3.7.1 Introduction

As outlined above a protozoal barrier is required in the treatment system to comply with the DWS. It is expected that the source water selected for the Shotover Country Development (most likely unsecured ground water) will be categorised as a low protozoal risk water. Various treatment options are outlined below that will provide this protozoa barrier for a low protozoal risk water.

3.7.2 Ultraviolet Disinfection

Ultraviolet (UV) disinfection has been used overseas and in New Zealand as an alternative to chlorination. Until recently, however, it was only considered suitable for bacteriological and viral disinfection. More recently, studies have shown its effectiveness in inactivating the protozoa *Cryptosporidium* and *Giardia* assuming water turbidities are kept below 1 NTU. UV disinfection is now widely accepted as being effective.

UV disinfection does not leave a protective disinfection residual in the reticulation system, and therefore, residual chlorination is still encouraged to provide this additional protection.

UV disinfection alone is a suitable method of providing a protozoal barrier if the turbidity is kept below 1 NTU. If the source water quality is occasionally above 1 NTU then some form of filtration will need to be used in conjunction with the UV disinfection. A turbidity measurement was taken from the existing bore in 2004 and given a reading of 0.3NTU.

It is recommended that regular turbidity tests are undertaken from the existing bore to determine if the water meets the turbidity criteria for UV disinfection.

UV disinfection without any other form of filtration would be a suitable method of providing treatment for the Shotover Country Development if a suitable low turbidity water source can be found. It is likely that a new bore onsite could provide the required quality of water.

The rough order cost for a UV treatment system would be $250,000 including pipework, controls and a building to house the reactor. Operating costs are reasonably low and would include power and annual lamp replacement.

3.7.3 Depth Filtration and UV Disinfection

This option consists of a media pressure filter followed by UV Disinfection. The purpose of the filtration stage is to reduce the turbidity of the water down to an acceptable standard so that the UV disinfection can deactivate the protozoa. The most suitable media in this case would be to use the proprietary media called Kinetico Macrolite. This type of media is a more effective filtration media than sand and is likely to effectively filter the water without additional coagulant chemicals.

The filters need occasional (e.g. daily) backwashing. This is achieved by forcing water into the filter from the bottom to stir up the media and carry away the dirt. Sometimes air is pumped through the bed to assist with backwashing. This cleaning process only takes a few minutes and the filter can be used again within a short time. Waste from the backwashing process would be directed to the sewer via a buffer tank.

The rough order cost for this system would be $1,200,000 including pipework, controls and a building to house the equipment.

3.7.4 Membrane Filtration

Membrane filtration consists of very fine filtration down to 0.1-0.01 microns. This type of treatment provides a barrier to the protozoa as the protozoa are too large to pass through the filter. The filter itself consists of bundles of hollow strands, similar in size to spaghetti, in which the water flows from the inside out or the outside in, depending on the manufacturer. The fibres are cleaned periodically by reversing the flows with filtered water. It is unlikely that any coagulant chemicals would be required for this treatment system however this would need to be confirmed through on-site trials. A large building would be required for the installation of the membrane plant and this has been allowed for in the cost estimate below.

With adequate monitoring, membrane filtration systems can meet the current and likely future requirements of the New Zealand Drinking Water Standards.

The rough order cost for this system would be $1,800,000 including pipework and a building to house the equipment.

Membrane Filtration will require the largest foot print of any of the options suggested but would fit within a 400m^2 area.

3.8 Chlorination

As stated above the use of chlorine as part of the treatment system is not essential, if one of the treatment systems described in Section 3.7 is used, however it is encouraged by the Ministry of Health and provides a further barrier against contamination. In addition, if there is no chlorination additional monitoring for E-coli would be required.

The various types of chlorination are described below with comments relating to the Shotover Country Development.

Calcium Hypochlorite (known as HTH)
HTH is typically used for small water supplies and involves the mixing of a solid chemical into a liquid. The system has a relatively low capital cost but is labour intensive and is unlikely to be accepted by QLDC

On-site Sodium Hypochlorite Generation
These systems generate hypochlorite on site from a brine solution. Salt is the only chemical delivered to site. No chlorine gas or concentrated sodium hypochlorite is generated and it is therefore a very safe system. Depending on the size of the supply the generators can sometimes be leased rather then purchased. This system has the lowest operating cost but has a relatively high capital cost of approximately $75,000.

Delivered Sodium Hypochlorite (Hypo)
This system has the highest operating cost due to the cost of chemical delivery but can be set up at a minimal cost, say $40,000. The main disadvantage of this system is that the Hypochlorite solution will degrade with time. A 15% solution may degrade to 8% within a month. It also has the effect of increasing the pH of the water slightly. Water test results from the existing bore indicate that the pH is 8.1 and therefore an increase is not advantageous.

Chlorine Gas
Chlorine gas is delivered to site in 900kg drums or 70kg bottles. This type of system is generally used in other parts of Queenstown and is well accepted by the operators. This system has a moderate operating cost and a moderate capital input of approximately $60,000. The benefit of chlorine gas is the simplicity for the operator – no liquid chemicals to be mixed or managed. A 70kg gas bottle could last a month without any attention by the operator. Chlorine gas is a highly poisonous gas and will need to be treated as such. This is the chlorine method of choice for the Shotover Country Development.

The chlorine system will need to be housed in a separate room to the other treatment equipment to prevent corrosion of electrical and mechanical equipment.

3.9 Reservoir Storage

3.9.1 Volume

There is no New Zealand standard for the amount of water storage to be provided for a new development. The following section rationalises the storage capacity that should be provided for the Shotover Country Development.

Treated water reservoir storage is required for the following reasons:

- To provide operating storage to cover the peak hourly demand periods during the day, as it is not cost effective to design a water treatment plant and a bore to meet instantaneous flow demands. Operating storage is determined from the volume difference between the water entering the reservoir and water leaving the reservoir. This is, therefore, dependent on the size of the water treatment plant feeding into the reservoir and the diurnal variation of water use by consumers.
- To provide emergency storage in case of water supply system failures upstream of the reservoir, e.g. water treatment plant failure, power loss or a burst trunk main.
- To provide fire-fighting reserves of water.
- To provide adequate chlorine contact time (if chlorine is used) before the water enters the reticulation. This criterion is, however, met easily as the other criteria noted above provide more than adequate storage to meet the contact time requirements.

Ideally, 24 hours water storage would be provided in the reservoir. Many water suppliers, however, have viewed this as an unrealistic target and have aimed for lower volumes. QLDC commissioned a design review of Queenstown's Water Supply in 1999 and have adopted the findings from this report as the basis for providing reservoir storage in the Queenstown area.

The criterion used was:

(i) (8DADF + 9 AADF) x 0.75 + Fire
or
(ii) 6PDF x 0.75, whichever is highest.

DADF = Direct average daily flow/hour.
AADF = All average daily flow/hour – includes flow to other reservoirs downstream.
PDF = Peak daily flow/hour.
Fire = Fire storage relating to the risk zone the reservoir supplies.

Based on 758 dwellings the DADF = AADF = 74m^3/hr, and the PDF = 174m^3/hr.

The 0.75 factor assumes that the peak flows can be reduced by 25% using water conservation measures such as irrigation bans, rainwater tanks, greywater reuse etc.

The fire storage requirement has been calculated from the New Zealand Fire Service Fire Fighting Water Supplies Code of Practice (SNZ PAS 4509:2008). For the purpose of this report, it will be assumed that 180m^3 fire storage will be needed to cover the water supply classification of FW3. This amount of fire storage will cover single family dwellings, multi-unit dwellings and multi-storey apartment blocks.

The preliminary volume of storage required for a 758 dwellings development is therefore:

(8 x 74 + 9 x 74) x 0.75 + 180m^3 = **1,123m^3** (ie approx. 4m high x 19m dia).

3.9.2 Location

Establishing the level of the reservoir is a compromise between:

- Being high enough to serve all parts of the development without the installation of further pump stations. Additional pump stations are costly to install, maintain and run. QLDC stipulate a minimum pressure of 300kPa in the reticulation.
- Being low enough so no part of the development is over-pressurised (QLDC stipulate a maximum of 900kPa in the development). This, however, can be overcome by the installation of pressure reducing valves or break pressure tanks.
- Being as low as possible to reduce on-going pumping station power costs.
- Finding a suitable platform for the reservoir that is visually acceptable.

The highest level of the proposed Shotover Country Development is approximately 350m RL. The lowest level in the development would be at approximately 310m RL. Based on these levels a reservoir height of approximately 400m would be suitable.

Possible locations for the reservoir are:
1. The hill to the east of the development

Photo 3: Looking East Towards a Potential Reservoir Site on the Hill Half-forested.

The hill to the east (Jones' Hill) is closer to the development and is probably the best option purely from a technical point of view but it is understood the site is owned by others would require a higher level of visual screening (possibly by placing the reservoir underground) and would require resource consent. Refer to Appendix 4 for a plan showing this option.

2. The hill to the north of the development

The hill to the north of the development (lower part of Slope Hill) is topographically better for visual screening and is therefore more favourable. Resource consent would be required.

3. Reservoir sited next to proposed bore

Ideally the water would be supplied by gravity to the development from a reservoir at an elevated site. In the event that a sufficiently elevated site is not available, water can be supplied reliably from a reservoir sited within the proposed zone at a lower height via a booster system that relies on pumps and an associated control system. The pumps would be on variable speed drive and would target a downstream pressure. This method of supply is used throughout New Zealand. The disadvantage of this option is that standby power, in the form of a generator, would be required to ensure continuity of supply in the event of a power outage.

3.9.3 Reservoir Material and Cost

A circular reinforced concrete reservoir is considered the most appropriate for this site. Steel tanks are also available but would not offer the life span of the reinforced concrete construction. Timber tanks are also available and have a significantly lower capital cost but the cost of ongoing maintenance means that their present value cost (including maintenance) is similar to that of a reinforced concrete tank. A judicial mix of precast concrete and insitu concrete is likely to provide the most economic design in the long term.

Capital cost of 1,123m^3 reinforced concrete tank $850,000

3.10 Summary

A summary of the conceptual design for the proposed Shotover Country Development is as follows:

- A water source with a flow of 49L/s is expected to be required for the proposed 758 dwellings development.
- The most likely water source will be another bore. The existing bore could be utilised for part of the flow but couldn't supply the full flow.
- Compliance with the Drinking Water Standards is now mandatory and will need to be complied with as soon as the water supply is serving the new development.
- Initially the water from the bore should be age tested to determine if a 'secure' status can be achieved for the bore. If the age of the water is sufficiently old then treatment may not be required, however 12 months of ecoli testing will be required before the bore is confirmed as 'secure'. If the water is not designated as 'secure' then treatment will be required.
- If the bore is not designated as 'secure' a catchment risk assessment will be required to determine the protozoa risk category for the water.
- The most suitable treatment system for this development would be to use a UV reactor. However the source water must be consistently below 1 NTU to do this. If the water occasionally rises above 1 NTU then a filtration step will need to be added prior to the UV or a membrane filtration system used instead.
- Chlorine is not an essential step in the treatment process but is encouraged by the Ministry of Health. Gas chlorination is likely to be the best form of chlorination for this development.
- A 1,123m^3 reservoir will be required for this water supply. This volume of storage would best be provided in a reinforced concrete tank at a level of approximately 400m RL or at ground level in conjunction with a booster system to provide the necessary pressure and volume. The most suitable elevated site is likely to be north of the development and north of the state highway.

4.0 STORMWATER

4.1 Introduction

This section of the report aims to examine the likely stormwater impacts of the Shotover Country Development and considers various possible options for the collection, treatment and disposal of the stormwater. The purpose of this section is to recommend a preferred suite of options and to estimate broad and indicative costs, so that informed decisions on stormwater management can be made.

4.2 Planning Rules and Regulations

4.2.1 Otago Regional Council

Resource consent for stormwater discharge is required under the *Otago Regional Plan (ORP): Water* for both the discharge of stormwater to land and the discharge of stormwater to water.

The discharge of stormwater to water or onto or into land in circumstances where it may enter water is a restricted discretionary activity under the ORP: Water. Under rule 12.4.2 the following items must be considered as part of the stormwater discharge decision:

(a) Any adverse effects of the discharge on:

- *(i) Any natural and human use value identified in Schedule 1 for any affected water body;*
- *(ii) The natural character of any affected water body;*
- *(iii) Any amenity value supported by any affected water body; and*
- *(iv) Any heritage value associated with any affected water body;*

(b) Any adverse effect on a significant wetland value identified in Schedule 9; and
(c) Any financial contribution for Type B wetland values that are adversely affected; and
(d) The volume, rate and method of the discharge; and
(e) The nature of the discharge; and
(f) Treatment options; and
(g) The location of the discharge point or area, and alternative receiving environments; and
(h) The likelihood of erosion, land instability, sedimentation or property damage resulting from the discharge of stormwater; and
(i) The potential for soil contamination; and
(j) The duration of the resource consent; and
(k) The information and monitoring requirements; and
(l) Any bond; and
(m) Any existing lawful activity associated with any affected water body; and
(n) The review of conditions of the resource consent.

4.2.2 Queenstown Lake District Council

Queenstown Lake District Council (QLDC) sets minimum standards and requirements for residential subdivision in a number of Policy documents (e.g. Amendments to NZS4404) and these have been broadly taken into account in the following sections.

4.3 Hydrological Anaylsis

4.3.1 Site Analysis and Assumptions

The total area to be developed covers approximately 121 hectares. The development areas are distributed over three main terraces that characterise the site. A large proportion of the development occurs on the upper terrace. The natural fall of the land in the upper terrace is generally in a south westerly direction. The lower terrace falls in the south easterly direction towards the Shotover/Kawarau River (see Appendix 5). Post-development drainage will take advantage of this natural drainage pattern to collect and drain surplus runoff (i.e. runoff not captured by other methods detailed below) to the proposed stormwater management area located at the most downstream end of the development where a stormwater management facility can be sited for treatment and controlled discharge to the Kawarau River system. This approach makes the best use of the natural features of the site with provisions to limit peak runoff and opportunities to treat the post development runoff.

The proposed development is still in its early planning stage undergoing a private plan change process. As such, no subdivision scheme has been devised. A detailed design of the stormwater management system has not been carried out but broad assumptions have been made in order to provide estimates of runoff from the development area. Main sources of runoff from a residential development will typically come from roads, hardstand areas and roofs.

The Structure Plan for the development is attached in Appendix 5.(Drawing No. 700562-171A) The Activity Areas identified within the Structure Plan are described as follows:

<u>Activity Area 1 – Low Density Living Environment</u>

Activity Area 1 comprises the majority of the area within the zone and provides areas for low density permanent living accommodation. The areas are located around the periphery of the zone where the edges are defined by natural boundary such as terrace escarpments.

<u>Activity Area 2 – Medium Density Living Environment</u>

Activity Area 2 includes the land located around both sides of the central road access in from Stalker Road. Together with the establishment of education facilities within Activity Area 3, it defines the core of the zone and contains a higher density of building development, limited areas for small scale convenience retail to service the immediate needs of the local community and communal areas of public open space.

<u>Activity Area 3 – Education and Community Precinct</u>

Activity Area 3 includes the land around the eastern side of the central core and access in from Stalker Road and is an educational and community precinct. Land within this area is set aside for educational and/or community purposes for a specified period from the operative date of the plan change creating the zone. If after that specified period there is no proven demand for these activities on all or part of the area, the land reverts to Activity Area 2, providing for residential housing.

<u>Activity Area 4 – Heritage Precinct</u>

Activity Area 4 provides for the protection of heritage features within the site, being the early settlers' cottage and the open space surrounding the building.

Activity Area 5 – Open Space

The open space area provides the basis for pedestrian connections to existing communities outside of the zone, existing public utility corridors and to recognise and provide for the protection of areas of ecological importance.

Buildings are strongly discouraged, other than those associated with the functioning of the community. Buildings that may occur within this Activity Area are therefore restricted to those associated with the provision of access to the surrounding activities, the provision of small utility structures and the provision of small scale buildings associated with recreation activities.

4.3.2 Peak Discharge Estimates

The development of the site will cause an increase in the peak stormwater runoff when compared to its pre-development state. Estimates of this future discharge can be made based on the likely percent impervious area of the site and an estimate of the time of concentration. For the purpose of this report, the peak runoff for the site has been calculated using the rational method described in Section E1 of the New Zealand Building Code. A return period of 1 in 10 year has been adopted in the estimates and for the design of the primary stormwater drainage system. To avoid potential adverse effects of flood damage, stormwater management facilities such as the detention pond, are sized to handle storm events up to a 1 in 50 year annual recurrence interval (ARI). The site has been assessed as consisting mainly of soil of medium soakage capability with pasture and shrub cover. The contributing catchment to the pond is assessed to be 121 ha consisting of all landuses as shown on Drawing No. 700562 -171A including the areas designated as Open Space (no building except small utility structures and small scale building associated with recreational activity).

The pre-development peak discharge during a 10 year ARI event is approximately 1.04 m^3/s based on a runoff coefficient of 0.3 and a time of concentration of 188 minutes.

The post-development discharge is estimated to be 4.23 m^3/s during a 10 year ARI event using a runoff coefficient of 0.65 and a time of concentration of 90 minutes. The increase in post-development peak discharge is the direct result of building roads and permanent dwellings which increases the site imperviousness causing a shorter time of concentration and more intense storm flows. This issue of environmental effects of stormwater discharge as a result of the development can be adequately addressed by designing a stormwater management system with the following features:

- Drainage of road runoff to grassy swales. Excess runoff to a pond located in the most downstream end of the development for treatment and release in a controlled manner.
- Incorporation of WSUD principles wherever practical in the subdivision and building design (e.g. rainwater harvesting for non-potable use).
- Courtyard areas adjacent to houses will be drained to sumps with pipe connections to roadside swales or on-site infiltration device.
- Landscaping.
- Grassy swales or other roadside bioretention devices.

In formulating the stormwater management strategy and design, the following has been taken into account:

- Regulatory compliance.
- Avoid significant increase in downstream peak flows.

- Manage the effects of the proposed development in a sustainable way.
- Minimise the pollution of receiving waterways by reducing contaminants in stormwater runoff from the roading area.
- Prevent erosion of the slopes where discharges are directed.
- Attenuate peak flows, where necessary, from additional runoff derived from the increased impervious area post development.
- Management system adopted should be economical to construct and maintain.

4.3.3 Quality of Stormwater Discharge

Stormwater can contain a number of contaminants that may adversely affect the receiving environments. Studies in New Zealand and overseas have identified urban development as a major contributor to the declining quality of aquatic environments. It is estimated that upwards of 40% of the contaminant content of this run-off can be attributed to run-off from roads. There is a large number of continually varying factors controlling the makeup of stormwater.

At this site the stormwater will be generated by runoff from the roofs of residential buildings, roads, footpaths and other hard-standing areas. Based on the available information, it is expected that stormwater from this site could contain the following contaminants:

- Suspended Solids.
- Oxygen Demanding Substances.
- Pathogens.
- Dissolved Contaminants.

The dissolved stormwater contaminants of concern at this site can cause an aquatic risk to the ecology of the receiving environment. The parameters of concern are discussed in more detail below:

(1) Hydrocarbons and Oils

These are typically associated with vehicle use (e.g. oil leaks) although spillages of hydrocarbon products could potentially occur. They may be in solution or absorbed to sediments. Routine stormwater discharges are likely to have low concentrations ranging between 1 and 5 g/m^3 total hydrocarbons over each storm event.

(2) Toxic Metals

A variety of persistent trace metal compounds are carried in stormwater in both solid and dissolved forms. The most commonly measured metals of concern are zinc, copper and chromium (mostly associated with vehicles and roads).

(3) Nutrients

Fertiliser application and animal wastes associated with the current agricultural use of this site have the potential to generate high levels of nutrients such as phosphorus and nitrogen within the stormwater runoff. High nutrient levels are not anticipated within the stormwater runoff generated by this residential development as agricultural activities such as grazing in particular will cease.

Expected Levels of Contaminants

Both the Auckland Regional Council (TP 10 and 53) and NIWA's Urban runoff data book (Williamson 1993) provide a range of contaminant levels for various land uses. This data can be used to predict (either heuristically or in some detail) likely land change results in contamination loading.

The contaminant levels anticipated for this development have been estimated from TP10 data charts to give an indication of the impacts in this case of changing the land use from pastoral-rural farming to urban development for the 121 ha that is to be developed. A summary of some of these contaminants is provided in Table 2 below.

Table 2: Contaminant Loading Ranges for Various Land Uses (kg/ha/yr)

Land use	Total Suspend. Solids	Total Phosph.	Total Nitrogen	BOD	Lead (median)	Zinc	Copper
Road	281-723	0.59-1.5	1.3-3.5	20-33	0.49-1.1	0.18-0.45	0.03-0.09
Residential (low)	60-340	0.46-0.64	3.3-4.7	12-20	0.03-0.09	0.07-0.20	0.09-0.27
Pasture	103-583	0.01-0.25	1.2-7.1	NA	0.004-0.015	0.02-0.17	0.02-0.04
Grass	80-588	0.01-0.25	1.2-7.1	NA	0.03-0.10	0.02-0.17	0.02-0.04

Construction Stage Stormwater

At the current stage of the study, it is premature to address stormwater effects due to activities associated with the construction stage of the subdivision. Suffice to mention that the construction activities will have the greatest potential to cause sediment laden runoff to be discharged to the environment. The writing of a robust Erosion and Sediment Control Plan is particularly important during the consenting stage of the development.

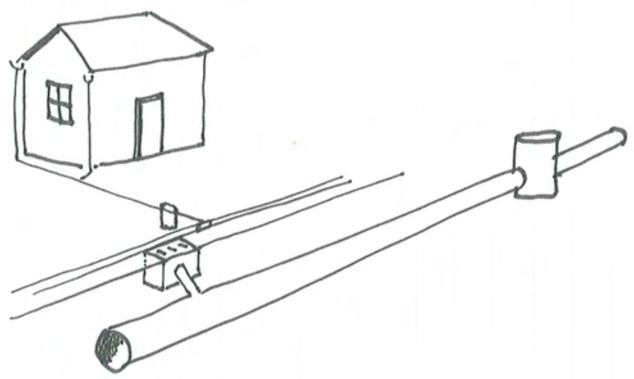
4.4 Stormwater Management Options

Stormwater management generally involves controlling, either or both, the quantity and quality of runoff. Quantity control practices regulate the peak flow rate and, depending on the practice and any rules, the total volume of runoff.

Water quality control practices prevent the initial release of contaminants into receiving systems, or once they are released reduces the quantities released to either surface or ground waters. Quality control criteria depends on the nature of the receiving water bodies, type of landuse and type of contaminates likely to be associated with the runoff

There are numerous collection, treatment and disposal methods that provide for stormwater quality treatment as well as having water quantity benefits. Various treatment options can be used in combination (treatment trains) or as stand alone features as determined by the project proponent (LMP) as the best fit for the proposed development.

4.4.1 Traditional Approaches



The Traditional Approach is for the rainwater from the roof to be piped under the ground and discharged into the gutter by the street. The roof water, together with runoff from the roads flow down the gutter and then into a big pipe which eventually carries all surface runoff into the nearest receiving water body which ultimately empties into the sea with no treatment. Sometimes water from the roof is put directly into a stormwater pipe which sends the water into a stream, or a man-made channel aiming at letting the stormwater flow as fast as possible to the sea. The speed at which this stormwater is being discharged brings about erosion which is quite damaging to the natural streams and its aquatic life.

The traditional kerb and channel and big pipes solution to stormwater collection, treatment and disposal is no longer acceptable to the community, local authorities and the environment. A more sustainable approach is required.

4.4.2 Low Impact Development (LID) Approaches

An alternative to the traditional approach is the Low Impact Development (LID) approach. Some LID options are presented below for discussion and are sourced from the *Low Impact Design Manual* for the Auckland Region TP124 (Shaver et al., 2000), the On-site Stormwater Management Guideline (NZWERF, 2004) and the Waterways, Wetlands and Drainage Guide (CCC, 2003).

(i) Clustering and Alternative Lot Configuration

The aim of this design approach is to concentrate buildings and impervious areas within the development. This leads to less site and soil disturbance, a reduction of the impermeable surfaces and therefore a reduction in the runoff volume and contaminant loading. It also provides for increased open space.

This concept requires more effort from the developer and is often perceived to be less profitable as a result of smaller lot sizes or less land area allocated for allotment. Clustering, however, can reduce stormwater generation as well as lowering development and maintenance costs due to reduced land clearance and reduced road and pathway construction.

(ii) Reduction in Setbacks

The setback of residential houses from the roads directly relates to the proportion of impervious surfaces on a section such as the length of driveways. A reduction in the minimum as well as maximum setback might be possible for new developments. There is, however, a need to take account of the New Zealand Building Code provisions for fire and other safety purposes.

(iii) *Reduction in Site Imperviousness*
A reduction in site imperviousness is the most effective means of reducing the stormwater flows and volumes and contaminant loadings. It is mainly transport-related aspects that can allow the reduction of imperviousness as follows:

Road Design - The current engineering design standard promulgated by QLDC and current operative planning provisions contains rules outlining the prescribed minimum width of carriageways for each level of road. A review of the required minimum carriage way widths, particularly for cul-de-sacs and roads of lower orders could result in considerably less impervious surfaces in new developments. Road length is also a significant contributor to imperviousness and can be addressed during the structure planning process wherever possible.

Kerbing - Kerbing (kerb and channel) concentrates stormwater flows along the kerb and largely precludes anything but a piped drainage system. An alternative option is to permit flexibility in the management of road runoff and consider alternatives such as grassed swales to collect and convey road runoff or to allow road runoff to discharge across buffer strips into heavily vegetated areas.

Turning Heads - The required impervious areas can be reduced by careful design of turning heads in cul-de-sacs. The District Plan Roading Standards prescribe a turning head with a minimum radius of 11m measured from kerb to kerb. Figure 4.1 shows different turning head options and the corresponding impervious area surfaces. Careful consideration must however be given to the types of vehicles that frequently use the turning-head such as waste collection trucks.

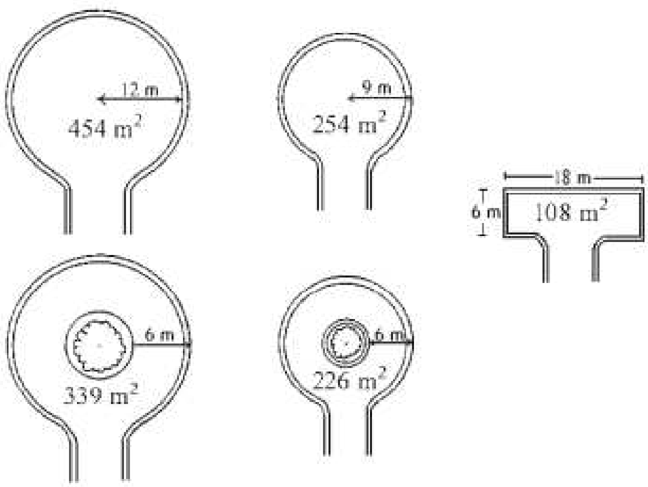


Figure 4.1 Options for Turning Head

Parking - Examples of low impact design approaches to reduce the required impervious area of car parking are listed below:

- adjustment of parking ratios
- parking space surface material selection and pavement design
- sharing of parking areas with pairing of users
- spill-over parking in areas which have less paving and greater perviousness.

(iv) *Vegetated Filter Strips and Swales*
These options rely on the passage of water across areas of dense vegetation cover to reduce contaminant loading. Swales are mainly used for stormwater conveyance, but they also have

contaminant removal benefits, such as a sediment removal efficiency of 20 to 60% (Waterways, Wetlands and Drainage Guide, CCC, 2003).

Vegetative filter strips and swales also aid in the infiltration of stormwater runoff and slow down the velocity. They can be aesthetically appealing. The devices are particularly appropriate for use around heavily trafficked roads, carparks and storage areas.

Figure 4.2 Road Side Swale

(v) Rain Gardens

Rain gardens are small depressions filled with an organic filter medium such as top soil or planting soil. The garden is planted with small shallow rooting plants which protect the filter medium and also provide for evapotranspiration of the stormwater. Treatment is by filtration and bioretention. In good soakage areas, the water is allowed to infiltrate into the underlying groundwater while excess stormwater is collected and conveyed to the reticulated stormwater drainage system or surface waters (NZWERF, 2004).

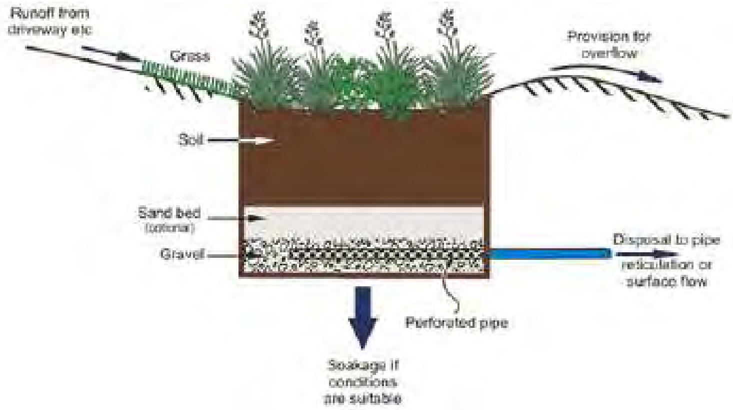


Figure 4.3: Rain Garden Operating Principles (Source NZWERF, 2004)

(vi) Water Reuse / Rainwater Tanks

Rainwater tanks provide stormwater quantity and quality benefits. They can also be considered as a possible stormwater treatment device. When roof runoff is collected and used in the househould for non-potable water uses such as toilet flushing, laundry and outdoor use then the contaminants carried by it do not enter the stormwater system.

The use of rainwater tanks in new subdivisions is not new but the adoption of such a concept in New Zealand has lacked behind in comparison to overseas practice partly due to water being available in abundance in most places and a lack of incentive to conserve water. As shown in Figure 4.4 below, the use of a rainwater tank does not necessarily have to compromise the aesthetic aspect of a residential subdivision.

Figure 4.4 Rainwater Tank

(vii) Infiltration Trench

An infiltration trench is a trench backfilled with stone or scoria media. Stormwater entering the trench trickles through the trench media before entering in-situ soils. This option can only be applied where the natural soils have sufficient drainage capacity. This device can be located on sites with limited available space. It is suitable to treat discharge from impermeable hardstand ground surfaces in commercial, residential and industrial areas but in some cases may need pre-treatment to avoid groundwater contamination (NZWERF, 2004).

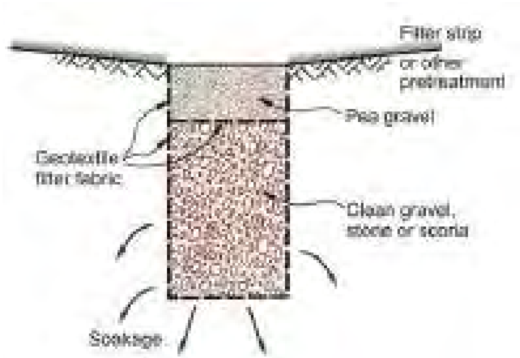


Figure 4.5: Infiltration Trench Operating Principles (Source: NZWERF, 2004)

(viii) Infiltration Basin

Infiltration basins provide for the storage of stormwater runoff with infiltration into the surrounding soil. The suitability of this option also depends on the presence of free-draining soils and an adequate depth to the groundwater level. The rate of infiltration should not be greater than 50mm/hour in order to adequately remove contaminants, and is pre-determined through good design, specification and testing of the filter bed. Vegetation of the infiltration basin assists in slowing down flows, removing sediments and maintaining the porosity of the soils (Waterways, Wetlands and Drainage Guide, CCC, 2003).

Figure 4.6: Infiltration Basin in a local park along Roydon Drive, Christchurch
(Source: Waterways, Wetlands and Drainage Guide, CCC, 2003)

(ix) Soakage Chambers
Soakage chambers allow the direct discharge of stormwater to groundwater or free draining soils at soakage rates greater than 50mm/hour, but need to receive either clean or pre-treated stormwater. In many cases roof stormwater is discharged directly into soakage chambers or trenches via sealed pipework excluding surface runoff stormwater that may contain contaminants.

(x) Permeable Paving
Paving material and pavement construction techniques has been developed to reduce the rainfall runoff volume by infiltration into the pavement layers. Permeable pavements are most economic for low-traffic areas with low groundwater tables and free-draining non-cohesive soils, but can be just as effective in the traffic lanes local roads and bus routes with clay subsoils (Fassman et al, 2007).

(xi) Ponds
This option relies on slowing down stormwater runoff to allow settlement of the suspended solids or interception of the suspended solids by plant matter. If properly constructed, these devices can have a high aesthetic and habitat value. There are two types of ponds: dry (temporary storage of water) and wet (permanent standing pool of water). However, wet ponds can have adverse effects on fish passage and stream habitat if placed online in an existing watercourse and therefore should be installed offline wherever possible. A moderately large contributory catchment area or reliable spring flows are necessary to ensure sufficient baseflow passes through ponds during periods of little rainfall.

(ix) Extended Pond / Wetland System
Communal or centralised large ponds and wetland areas could be built to treat and detain runoff from large areas of development as opposed to a site-by-site approach. This gives the opportunity to address the hydrological coincidence of multiple attenuated flows and also to

incorporate reserve areas and provide for amenity values and leisure activities. The following is an overview of the benefits of a large scale wetland/pond system:

- Reduction of peak water levels downstream during flooding
- Flood storage
- Source of base flow (helping to maintain flow in dry weather)
- Contaminant removal
- Sediment trapping
- Creation of aquatic and terrestrial habitats for plants and animals
- Passive recreation, but with a few walkways
- Environmental education community involvement (planting days and maintenance)

The precise location and release rate for attenuation purposes should be considered in the context of the catchment. Care is required where an attenuation device is situated at the lower end of a catchment, as in this site, since runoff may be detained just long enough to coincide with the arrival of the peak flow from the upper part of the catchment. Safety should be a key design consideration for all sustainable urban drainage systems involving standing water such as ponds and wetlands.

(x) Protective Vegetative Cover / Riparian Planting
A good healthy cover of vegetation along natural stream channels can provide effective erosion protection by binding soil particles along the channel banks within the root structure of the vegetation.

Sufficient widths of riparian planting are also beneficial in filtering overland flows as well as improving the aesthetic appeal and ambience of the neighbourhood.

There are numerous possibilities of combining theabove options in treatment trains. Some examples of these are provided in Appendix 5.

4.5 Recommended Concepts and Options

As outlined above there is a wide range of stormwater management and control measures available to mitigate the effects of surface water runoff attributed to an increase in the impervious areas that come with land development.

The increase in the stormwater runoff and its associated impacts on the water quality of receiving water bodies can be addressed by adopting measures that minimise and mitigate the effects of the proposed development.

The management option to adopt depends largely on the operative planning rules with regards to stormwater discharges promulgated by ORC/QLDC, and the site characteristics.

For the Shotover Country development, the recommended strategy for stormwater management is to provide an integrated treatment train approach to water management that is premised on providing control at the catchment wide level, the allotment level and to the extent feasible in conveyance followed by end-of-pipe controls. Management of stormwater within the Shotover Country site is proposed such that the development will effectively be stormwater neutral to downstream watercourses.This combination of controls is the best means of meeting the criteria for water balance, water quality, erosion and flood control (if required).

To summarise, the main recommendations are as follows.

Table 3: Stormwater Management Recommendations

	Recommendations	Remarks
Collection	Use a combination of LID/SUD measures as far as possible to provide both source control of stormwater quality and quantity, kerb and channel where required, swales, pipes and open channels.	1. Direct road runoff to road side swale (primary system) as far as possible and pipe/road network provided for conveyance of secondary flows during a flood event if necessary. 2. Adopt and incorporate LID/SUD measures to the maximum extent possible in the proposed development with emphasis on options for discharge to ground (infiltration) for the upper and middle terrace.
Treatment	Use a combination of swales, infiltration basin, roadside bioretention basin, and detention ponds.	1 Adopt and incorporate LID/SUD measures to the maximum extent possible in the proposed development with emphasis on options for discharge to ground (infiltration) for the upper and middle terrace. 2 Opportunities for infiltration exists for the lower terrace but high ground water table may prove to be a constraint (further field investigation is recommended).
Disposal	Use attenuation prior to discharge to the Kawarau River.	1 The intention is to provide one main pond suitably located above flood levels to serve the whole development to provide the necessary treatment and attenuation function prior to discharge to an existing wetland downstream. The pond intended is a dry detention pond suitably landscaped and dry between rain events.There will be no permanent standing water. The pond is to be equipped with an outlet structure for controlled release of stormwater downstream. The discharge from the pond shall be managed in such a way that the ecological and hydrological values of the existing wetland are adequately protected. The objective of this design configuration is to ensure that the natural values of the final receiving water body (Kawarau River) will not be affected. The final outfall to Kawarau River will be engineered to prevent any erosion and suitably planted to maintain the existing amenity values. 2 A pond sited within an area with a high groundwater table can be engineered with an impervious layer below the pond bed to prevent any interference to the proper functioning of the pond by the groundwater

4.6 Cost Estimate

The final cost of the stormwater management system will depend on the final layout of the development, however rough order cost estimates for the various components has been provided in Table 4 below.

Table 4: Rough Order Costs Estimates of the Proposed Stormwater Management System Components

	Rate ($)
A. Onsite stormwater management system	
Excavation of roadside swale	$6.5/m³
Rainwater tank (25000 litres) and pump combo applicable for single storey residential building (See web site by Bailey Tank. This rain tank system is alternative to the one shown on Figure 1 Accessed 12.12.07)	$3,948
B. Road stormwater management system	
Roadside swales (300 mm deep, 2.5 m top width)	$6.5/m³
Supply and install Class X RCRR Stormwater (pipes, bedding material, trenching and backfill)	
225 ND RCRR pipe	$150/m
300 ND RCRR pipe	$180/m
450 ND RCRR pipe	$250/m
525 ND RCRR pipe	$400/m
Standard roadside sump	$1000/no.
Standard MH	$2500/no.
C. Detention Basin	
Detention basin consisting of open depression (excavation) with outlet control structure, low flow channel, topsoiling, maintenance access and grass over.	$50/m³
D. First Flush Basin	
First flush basin with sub-surface drainage, filter media, and outlet structure	$115/m³

All cost figures are indicative and do not include indirect cost, survey, engineering cost and based on past project figures. It is intended to offer an order of magnitude cost indication and should not be relied upon for budgeting and financial planning.

4.6.1 Operation and Maintenance (O&M)

Communal stormwater facilities within a subdivision scheme are generally designed to local authority specifications and standards with the intention that the be handed over to the authorities for operation and maintenance once the initial defects or maintenance period has expired. Alternatively the O & M of the stormwater infrastructure can be run by a local Residents Society.

5.0 GAS

There are two main options for Gas Supply in the Queenstown Area. The first is to have bottled supply, which a number of suppliers can do. The second is to connect into a reticulated supply. Rockgas is the only company in the Queenstown area that has a supply network. The existing and proposed gas reticulation for the Queenstown area is presented in Figure 1 below. A larger version of this plan is provided in Appendix 8.

Figure 1: Gas Reticulation in the Queenstown Area

As can be seen Figure 1 reticulation has not yet crossed the Shotover River, but this is proposed in the future. The diameter of the pipe proposed to connect the existing Lake Hayes Estate development with the broader Queenstown area will be 200mm. This main will have sufficient capacity to supply the 758 dwellings Shotover Country Development. 50 tonnes of storage has now been installed for the Lake Hayes subdivision and further storage is planned in line with Rockgas' growth projections. In short there will not be any constraints with gas supply for the Shotover Country proposal.

Reticulation from the Shotover Country main into the proposed subdivision will comprise of a 110 mm diameter main to be placed in the same trench as water and power. Gas will be the deepest of the three services requiring a 900 mm depth of placement and will require at least 300 mm separation from the other services. A 32 mm service pipe will then connect to each lot.

Rockgas bases its household supply at 900kg per lot per year and generally has a connection rate of about 80% in any new subdivision development. They consider that any development will be fully connected in their capacity calculations.

Rockgas is likely to agree to the installation of all pipework within the development at their cost. However, they are also likely to have a covenant requirement that restricts portable gas storage to 10kg per lot in any new subdivision development if they are to reticulate throughout this development. Rockgas have advised that, even with this covenant, pricing will remain competitive with a bottled supply.

APPENDIX I

Sewage Disposal Concept Plan

APPENDIX 2

Report from Rationale

Disposal of Wastewater to Council's Sewer

APPENDIX 3

Existing Bore – Water Quality Results

APPENDIX 4

Water Supply Concept Plan

APPENDIX 5

Stormwater Treatment System and Treatment Train Options

APPENDIX 6

Stormwater Component Appraisal

APPENDIX 7

Stormwater Disposal Concept Plan

APPENDIX 8

Rockgas Proposed Reticulation Plan

CPG New Zealand Ltd
A subsidiary of Downer EDI Limited
cpg-global.com
Water Transport Resources Energy Buildings Urban Development Primary Communications