Connell Wagner Limited
Old Bank Chambers
102 Customhouse Quay
Wellington
New Zealand

Telephone: +64 4 472 9589
Facsimile: +64 4 472 9922
Email: cwwel@conwag.com
www.conwag.com

Preliminary Infrastructure Report Plan Change 25, Kingston Village Special Zone

22 October 2008
Reference 209F40
Revision 6

Connell Wagner

Document Control

Document ID: M:\209F\40\REPORTS\INFRASTRUCTURE REPORT REV 6.DOC

Rev No	Date	Revision Details	Typist	Author	Verifier	Approver
1	3 March 2006	Initial Draft	HW	HW	MMF	BAM
2	14 March 2006	Revised Draft for Discussion	HW	HW	MMF	BAM
3	22 February 2008	Revised report based on current status	CMS	CMS	MMF	MMF
4	9 May 2008	Final Report	CMS	CMS	HBW	MMF
5	17 October 2008	Re-issue of Final Report	CMS	CMS	MMF	MMF
6	22 October 2008	Approved Final Report	CMS	CMS	MMF	MMF

Table of Contents

1. Executive Summary

1.1 Potential Plan Change

The Queenstown Lakes District Council (QLDC) is considering a plan change in the Kingston area to expand the Kingston Township. The plan change site is approximately 82ha and is bounded by the Kingston Flyer railway tracks on three sides and the Eyre Mountains to the west. The site is located directly to the south of the existing Kingston Township and is currently zoned Rural General in the Partially Operative District Plan (the Plan). The site is mainly utilised for farming and there is also a golf course on the site.

This report has been prepared for two purposes:

1) To establish that the plan change site can be serviced
2) To identify how the bulk infrastructure for the Kingston Township and the plan change is best undertaken/provided.

The existing Kingston Township is not currently reticulated and has no bulk infrastructure. The intention is to provide new bulk infrastructure for both the plan change site and the existing Kingston Township. Due to the economies of scale this will result in considerable infrastructure savings overall.

The Master Plan for the development of the plan change site is outlined in concept design drawings by the Urban Design consultant Woods Bagot. The current plan can be found in Appendix B.

1.2 Basis of Preliminary Infrastructure Design

Based on the preliminary design the plan change site will provide up to 744 residential lots. The ultimate population of the existing Kingston Township area has been estimated by GHD Ltd (GHD) at 379 lots. In addition to this GHD have confirmed the ultimate Kingston Township commercial accommodation is estimated at 404 people and the ultimate visitor population is estimated at 57 people.

This infrastructure report is based on Queenstown Lakes District Council's (QLDC) Development and Subdivision Engineering Standards (the QLDC Code). The QLDC Code is based on NZS 4404:2004 New Zealand Standard for Land Development and Subdivision Engineering (NZS 4404). Several other New Zealand standards and widely accepted technical publications have also been considered in the formation of this report.

The total ultimate population assumed for this report is between 3,800 - 4,400 people (the number of people per dwelling varies within the QLDC Code, 3.0 for water assessment and 3.5 for wastewater assessment). This is based on the ultimate lot numbers outlined above.

1.3 Stormwater

There is currently no formal stormwater reticulation within the plan change site. Three recorded streams of varying size originate in the surrounding western hills and drain through the plan change site and the existing Township through to Lake Wakatipu. The quality of this runoff has a direct link to the water quality in Lake Wakatipu. There are also several wet areas within the site where the topography is quite flat and the ground permeability poor.

Sustainable urban drainage systems (SUDS) are proposed to be incorporated into the development of the plan change site to provide both source control of stormwater quality and quantity (flow rates). The features proposed include infiltration trenches and swales, limited (or no) use of kerb and channel and maintaining open watercourses where possible.

Management of the stormwater within the plan change site is proposed such that the development will effectively be stormwater neutral to downstream watercourses. This is achieved through the swale system as described above to assist in the management of peak flows, incorporating stormwater attenuation in certain areas and splitting the stormwater flows within the plan change area. A key feature of the stormwater management system proposed for the site is that it does not increase the peak flows within the existing under-sized stream that runs through the west of the site and through the Kingston Township. Only the outlet of the Kingston Stream will be affected by the development. This stream outlet will be upgraded as part of the development works, which will likely result in an improvement on the current situation.

With the management measures proposed and the proximity of Lake Wakatipu, the development of the plan change site will have minimal downstream impact on the existing Kingston Township stormwater infrastructure, and on the water quality of Lake Wakatipu.

1.4 Water supply

There is no reticulated water supply in Kingston at present with existing dwellings supplied by roof water or private bores. Any future development within the plan change site must be serviced with a reticulated water supply that meets Council standards. Therefore, as part of the plan change a reticulated water supply is proposed, along with water extraction, treatment and storage infrastructure. This infrastructure can be sized to provide for both the plan change site and the ultimate Kingston Township.

There are two potential source options for bulk water supply to the Kingston Township:

1. Groundwater bore (deep bore, perhaps up to 100m deep)
2. Abstraction from Lake Wakatipu

If a suitable, secure groundwater supply was available for the Kingston area, groundwater would be preferred over abstraction from Lake Wakatipu, due to potential significant advantages and savings in the level of treatment and ongoing monitoring required.

Exploratory drilling to investigate whether there is a secure groundwater resource in Kingston was carried out in June 2008. The testing showed the bore had a yield of approximately 16l/s, which is a good yield for a 150mm diameter bore. However, the water quality testing carried out showed elevated levels of arsenic present in the water, more than double the Maximum Acceptable Values stipulated in the New Zealand Drinking Water Standards 2005 (NZDWS). Review of this water quality testing has led to a preference for abstraction of water from Lake Wakatipu. There are a number of existing lake abstraction sources on Lake Wakatipu, supplying many communities in and around the Queenstown area.

The treatment processes required will depend on the quality and security of the source water selected for the supply. Treatment would be to NZDWS. In the case of a surface water source such as a lake, a Log 3 or Log 4 treatment standard is required, as specified in the DWSNZ. Log 4 (for example filtering of the water as well as UV treatment and chlorine dosing), is a much more costly option than Log 3 treatment and is the default treatment level for a surface water source, without monitoring. It is likely that monitoring of the water quality of Lake Wakatipu in the Kingston area will be carried out as the plan change progresses and this will assist in defining the design criteria.

There has been significant discussion to date regarding the water usage requirements for the Kingston area. There has recently been progression on this issue; in July 2008 QLDC issued a draft Kingston Water Demand Management Plan (DMP), with details of the revised flow demands that are expected for Kingston. This document confirmed that the flows prescribed in the QLDC Code are excessive compared to many New Zealand code requirements, and are not directly applicable to the Kingston

scenario, with the associated lot sizes and the water-conservation habits of the existing community that has no existing water supply. Based on this DMP the average daily flow for the settlement is 1,276 m^3/day, with a peak daily flow of 2,300m^3/day or 32l/s and a peak hourly flow of 59l/s.

Based on the current water demand figures, two reservoirs with a total storage volume of 2,500m^3 are recommended for the ultimate Kingston settlement. Two reservoirs are recommended due to the large storage size required and to facilitate staging of the bulk infrastructure.

1.5 Wastewater treatment and disposal

There is no wastewater network in Kingston at present. Due to potential groundwater contamination new dwellings are required to install holding tanks, which are regularly pumped out and disposed of at a treatment facility. Any future development within the plan change site must be serviced with a wastewater network that meets Council standards. Therefore, as part of the plan change a wastewater network is proposed, along with treatment and disposal infrastructure. This infrastructure can be sized to provide for both the plan change site and the ultimate Kingstown Township. The wastewater treatment facility is proposed for the north eastern slopes, adjacent to the proposed treated effluent disposal location (refer C200, Appendix F). The size of the area required depends on the size of the future development, for the ultimate Kingston settlement it is estimated at 26ha.

All of the wastewater flows within the plan change site will be collected via gravity mains to a central pump station and then pumped up to the treatment plant within a pressure pipeline. GHD's September 2008 Report recommends a hybrid gravity/grinder pump reticulation system for the Kingston Township. This system will involve a number of pump stations, it is expected that one of these pump stations (nominally the pump station proposed for the corner of Kent and Cambridge Streets) will be able to be upgraded to manage all of the Kingston settlement flow and direct it to the treatment plant. The pump station components will be underground with only a small above-ground control cabinet.

The volume of the incoming flow means that a specifically designed wastewater treatment plant is required. There are a number of wastewater treatment process options suitable for the settlement, and selection of a final treatment option will depend upon required effluent quality, environmental factors and preferences from QLDC to keep the treatment plants within the Queenstown Lakes area consistent for maintenance and operator purposes. The treatment plant would likely be constructed in two stages to reduce upfront capital costs and be expanded as development progresses. Initially the plant could be developed for around 600m^3/day; expanding in the future to approximately 1300 m^3/day to cope with the increasing population. This staging could be modified as required.

Disposal of the treated effluent from the wastewater treatment plant is proposed to be via sub-surface irrigation. Filtering and treatment of the effluent is within the biologically active upper layers of the soil. During the detailed design of the wastewater system the effluent disposal field will be designed to ensure all necessary treatment occurs within these layers prior to interception with any groundwater layer. The detailed design of the effluent disposal field will ensure that there are no adverse effects on any parties or the surrounding environment due to the effluent disposal.

Two sites have been evaluated for the disposal field. Constraints on the availability of sufficient area of suitable land within the golf course area mean that it is more cost effective to utilise a single disposal area on the north eastern slopes above the State Highway. Soil and permeability assessments have been carried out within this area to assess the suitable design areal loading rates. The proposed loading rate of 5mm/day requires approximately 26 hectares of land for disposal of the effluent that results from the ultimate Kingston settlement population. It may be possible to increase this loading in the future with monitoring and also with planting of appropriate species. The key issue at this stage is to earmark the land necessary for disposal of the ultimate effluent loads, based on conservative parameters.

1.6 Other services

PowerNet has advised that the electrical network supplying Kingston will need to be upgraded to service the plan change. From expected growth predictions PowerNet had previously identified that upgrades would be required around this area (prior to knowledge of the potential plan change). PowerNet identified a need for a new zone substation closer to Kingston as well as upgrades to the line between Lumsden and Kingston. The location of this substation will likely be outside of the immediate Kingston area; PowerNet will be responsible for this siting.

A new fibre optic cable has been installed by Telecom between Queenstown and Kingston. This cable has more than sufficient capacity to service the ultimate size of Kingston with data and voice.

Rockgas (gas providers in Queenstown and Central Otago) have indicated they are interested in setting up a reticulated LPG (liquefied petroleum gas) network within the plan change site and possibly the existing Kingston Township.

1.7 Earthworks and roading

Due to the relatively gentle contours of the plan change site the earthworks required for its development are likely to be minimal. Draining of some of the wet areas and construction of suitable drainage channels will be required. Any issues associated with the in-situ materials will be able to be managed through earthworks management plans and construction monitoring.

The roading design within the plan change site will follow the QLDC Development and Subdivision Engineering Standards. However, in some specific aspects deviation from the code is proposed, due to the utilisation of sustainable urban drainage systems (SUDS) and in order to enhance the overall sense of community within the plan change site. These proposals retain the overall character of the Kingston Township and assist in creating a stormwater neutral development.

Traffic Design Group (TDG) has produced a transportation assessment for the plan change which provides detail on traffic management issues associated with the potential development.

1.8 Conclusion

The report concludes that the Kingston plan change site can be serviced, and the Kingston settlement can be provided with bulk wastewater and water supply infrastructure.

By constructing a reduced capacity of infrastructure with the corresponding decrease in overall water and wastewater flow rates, water abstraction and storage requirements and wastewater treatment and disposal requirements, the plan change site can be serviced independently of the Kingston Township.

The plan change site can be developed with effectively no negative downstream effects on the existing Kingston Township infrastructure. The proposed development of the plan change site will in fact improve the existing Kingston Township infrastructure, improving on the current stormwater situation and resulting in the installation of a reticulated wastewater and water supply for the Kingston settlement.

2. Potential Plan Change

2.1 Existing Kingston Township

The Kingston Township is at the southern-most tip of Lake Wakatipu, and approximately 50km from Queenstown. The current Township (approximately 208 developed lots) is immediately adjacent to Lake Wakatipu, with the dwellings located no more than 500m from the Lake.

Kingston is primarily a summer holiday destination with a small number of permanent residents.

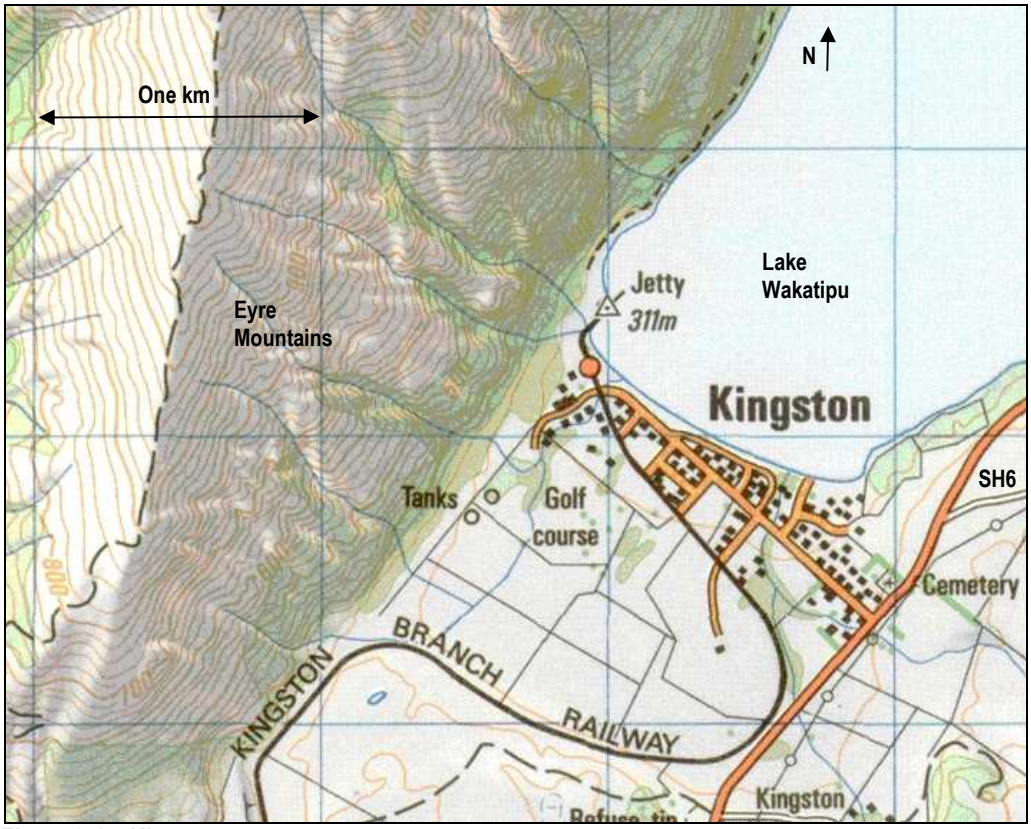


Figure 2-1 – Kingston

The main attractions in Kingston are:

- Kingston Flyer – steam train operating over summer months on railway track between Kingston and Fairlight.
- Lake Wakatipu – recreation and boating opportunities.
- Walking Tracks – a number of Department of Conservation tracks are located near the town.
- Active recreation opportunities – there is a golf course, tennis courts and bowling club in the town.
- Quiet holiday spot – a relaxed atmosphere in comparison to the bustle of Queenstown.

Appendix A contains several photos of Kingston and surrounds.

2.2 Plan Change location

The Queenstown Lakes District Council (QLDC) is considering a plan change in the Kingston area to expand the Kingston Township. The plan change site is approximately 88ha in size and is bounded by the Kingston Flyer railway tracks on three sides and the Eyre Mountains to the west. It is currently zoned Rural General and is used primarily as pastoral farm land.

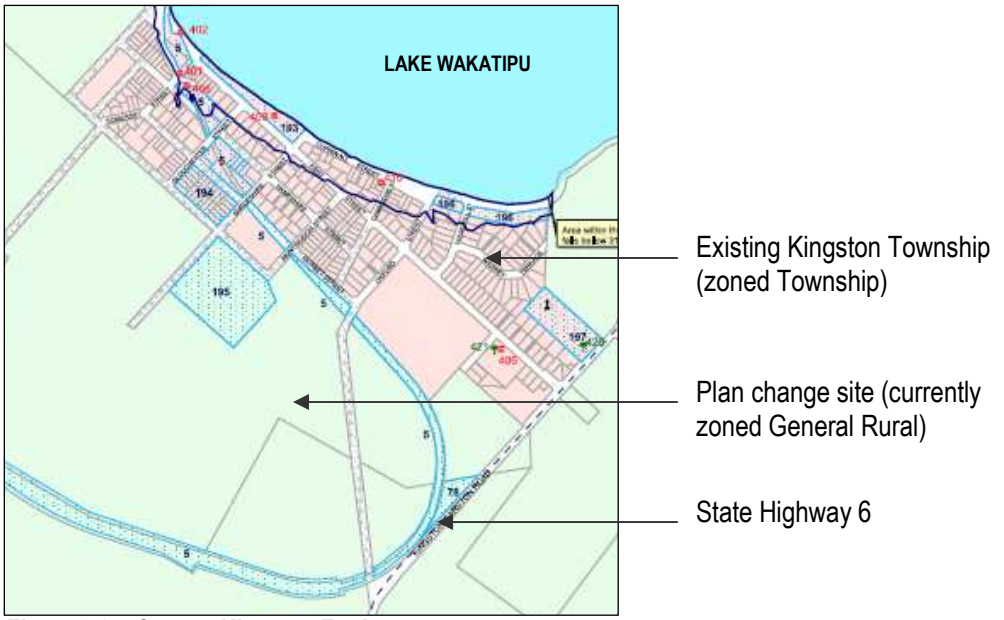


Figure 2-2 – Current Kingston Zoning

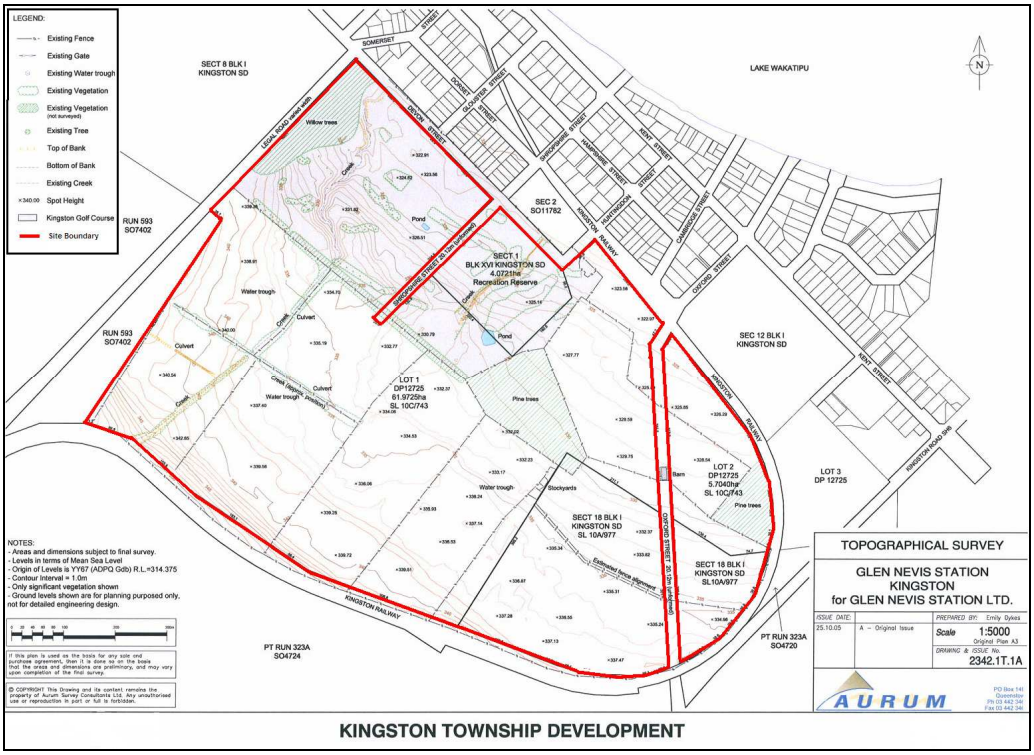


Figure 2-3 – Plan Change Site

There are three areas referred to within this report:

- The current Township area (Kingston Township). This is the entire area currently zoned "Township"; refer Figure 2-2 above.
- The plan change site, refer Figure 2-3 above.
- The combination of the above two areas, referred to as the Kingston settlement.

2.3 Purpose of report

This report has been prepared for two purposes:

1) To establish that the plan change site can be serviced
2) To identify how the bulk infrastructure for the Kingston Township and the plan change is best undertaken/provided.

The existing Kingston Township is not currently reticulated and has no bulk infrastructure. The intention is to provide new bulk infrastructure for both the plan change site and the existing Kingston Township. Due to the economies of scale this will result in considerable cost savings overall and will likely reduce delays in the provision of infrastructure.

This report also shows that the plan change site can be serviced whether developed with or independently of the Kingston Township.

The report will provide preliminary information on infrastructure provision, including:

- Stormwater
- Water supply
- Wastewater
- Other services (gas, power, telecom)
- Earthworks and roading

3. Basis of Preliminary Design

3.1 Ultimate Kingston population

For the purposes of this infrastructure assessment it has been assumed that the plan change site will provide up to 744 residential lots, which is the ultimate number of lots that would be expected within this site under the potential plan change. This is in line with the Queenstown Lakes District Council (QLDC) Development and Subdivision Engineering Standards in that infrastructure design must be to ultimate development levels.

The existing Kingston Township is not currently reticulated and has no bulk infrastructure. The intention is to provide new bulk infrastructure for both the plan change site and the existing Kingston Township. QLDC have engaged GHD to complete the concept design for the Kingston Township, with respect to water supply and wastewater. The ultimate population of the existing Kingston Township area has been estimated by GHD Ltd (GHD) at 379 lots. GHD have also recommended an ultimate commercial accommodation allowance of 404 people be allowed for within the Kingston Township (incorporating a potential development at the western end of the Township) as well as an ultimate visitor population of 57 people. The total ultimate population assumed for this report is between 3,800 - 4,400 people (the number of people per dwelling varies within the QLDC Code, 3.0 for water assessment and 3.5 for wastewater assessment).

This report describes the stormwater, wastewater and water supply flow rates associated with the ultimate Kingston Township, the ultimate commercial accommodation flows and the ultimate development within the plan change site as the ultimate Kingston settlement flows.

3.2 Design standards

The analyses and recommendations within this infrastructure report are based on Queenstown Lakes District Council's (QLDC) Development and Subdivision Engineering Standards (2005), referred to in this report as the QLDC Code. The QLDC Code based on NZS 4404: 2004 New Zealand Standard for Land Development and Subdivision Engineering (NZS 4404).

The following additional documents have been considered in the preparation of this report.

- Drinking-water Standards for New Zealand 2005 (DWSNZ: 2005). The current New Zealand Drinking water standards appropriate for water supply schemes serving over 500 people.
- The Health (Drinking Water) Amendment Act 2007.
- Draft QLDC Kingston Water Demand Management Plan (Kingston Water DMP), Rev 1, July 2008.
- NZS 4509:2003 New Zealand Fire Service Fire Fighting Water Supplies Code of Practice.
- SNZ HB 44:2201 Subdivision for People and the Environment.
- Otago Regional Council Water Plan.

4. Site conditions, Plan Change site

4.1 Topography and site features

The Eyre Mountains form a significant feature to the west of the plan change site. Immediately to the south, the land rises as part of a terminal moraine from past glacial periods. The existing Kingston Township lies adjacent to Lake Wakatipu immediately to the north of the plan change site, with Lake Wakatipu located some 300m north of the plan change site boundary.

The plan change site rises up to the southwest from 323m RL (Reduced Level, Dunedin-Bluff Vertical Datum 1960) at the edge of the existing Township to approx 350m RL in its southwest corner.

The Kingston Golf Course is located in the north west corner of the site. This is a 9-hole course over gently sloping land, which sits immediately to the south of the existing Township. The Kingston Flyer railway loops around the margins of the plan change site along the north, east and southern boundaries. Further to the east of the railway lies State Highway 6.

The majority of the site is currently utilised as stock grazing with a small pocket of radiata pine in the northeast and a pocket of Douglas fir located at the south - east boundary of the golf course.

There are several drainage courses running down the western Eyre mountainside (approximate locations shown on C101, Appendix C). These drainage courses flow in existing deep drainage channels across the western part of the plan change site. The majority of the flow then merges into a stream that passes through the Kingston golf course, and along an alignment adjacent to Somerset Street. There is also another smaller stream that runs along the eastern side of the golf course, along several drainage channels and through the existing Kingston Township via a drainage channel adjacent to the Kingston railway line. These streams then join up at the junction of Kent St and Somerset St, passing through a triple culvert under Kent Street and then discharging to the Lake east of the Kingston Flyer terminal.

Wet areas within the plan change site are found within an area at the south eastern corner and several isolated areas within stands of Pine and Douglas Fir trees. These sites have standing water most of the year due to flat topography and poor permeability soils.

For the rest of the plan change site, rainfall that is not infiltrated currently sheets across the site and into a drainage channel that runs alongside the Kingston railway line. This drainage channel then converges with the smaller stream described above between Shropshire and Gloucester Streets.

There are several drainage courses that run down the mountains to the east of the plan change site, the most notable of which becomes the Kingston Stream. These streams do not enter the plan change site and are not part of the plan change catchment.

4.2 Site geology

Reference should be made to the Connell Wagner Geotechnical and Contamination Hazard Appraisal, which provides detail regarding the site geology.

In general, the plan change site is identified on geological maps as well sorted fine gravel with an area to the west at the foot of the hills noted as gravel and sand in alluvial fans.

A site inspection of the surface soils indicated a variation across the site including fine sands to silts to silty gravels. Exposed faces in the central area of the site show silts extending beyond 1m below ground surface while in the southwest area the topsoil is underlain by silty gravel.

There are isolated areas across the site with relatively impermeable shallow subsoils where the ground appears soft and continuously saturated. Two of these areas are currently planted with radiata pine and Douglas fir, with the other two wet areas interspersed with reeds that favour saturated areas.

4.3 Groundwater

Site investigations indicated areas of perched groundwater table with underlying poorly draining silts / clays. Test pits excavated around the site generally indicate the groundwater table to be less than 5m. Subsurface drainage may be required in some areas to manage perched water tables.

4.4 Climate

The table below provides general climate data for Queenstown, which can be used as a guide to climatic conditions in Kingston. Significant points to note from an infrastructure perspective are the high temperature range and high number of ground frost days. On a national basis the number of wet days and annual rainfall is lower than average.

Location	Rainfall	Wet-days	Sunshine	Mean Temp	Very Highest Temp	Very Lowest Temp	Ground frost days	Mean wind speed
	[mm]	*[>=1.0mm]*	*[hours]*	*[°C]*	*[°C]*	*[°C]*	*[days]*	*[km/h]*
Queenstown	913	100	1921	10.7	34.1	-8.4	107	12

Table 4-1: Queenstown Climate Data (From NIWA website)

Discussion with the farm manager of the plan change site indicated that the site received snowfall typically up to half a dozen times per year but that snow on the ground did not last long.

Ground temperature monitoring is currently in place at several locations in the Kingston area to provide information on the expected ground frost depth for the wastewater effluent disposal line. This is discussed in Section 7.

4.5 Precipitation

Average monthly rainfall for the Kingston meteorological station was obtained from NIWA and is shown below. The figures show that mean monthly precipitation is fairly evenly distributed throughout the year.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Depth [mm]	81.6	70.0	82.8	75.3	87.3	79.4	65.1	67.3	73.6	80.7	77.1	76.7

Table 4-2: Average Monthly Rainfall [mm] (From data supplied by NIWA for Kingston)

Values for peak rainfalls were obtained from NIWA's HIRDs software for Kingston. The results are shown in the table below.

ARI	10 min	20min	30min	1 hour	2 hour	6 hour	12 hour	24 hour
2 yrs	3.5	5.4	7.0	10.8	15.4	26.9	38.3	54.6
10 yrs	5.5	8.2	10.4	15.7	21.8	36.9	51.4	71.5
20 yrs	6.9	10.1	12.7	18.9	26.0	43.2	59.5	81.9

50 yrs	9.7	14.0	17.4	25.1	34.0	55.0	74.5	100.8
100 yrs	13.2	18.6	22.9	32.4	43.2	68.2	91.0	121.4

Table 4-3: Rainfall Depths [mm] (Data from HIRDs v2)

4.6 Evaporation

Average monthly raised pan evaporation for the Cromwell meteorological station was obtained from NIWA and is shown below. The figures show mean monthly evaporation peaks over December/January with winter values roughly 10% of summer figures. Figures for Cromwell were provided as this was the nearest raised pan evaporation data available from NIWA records.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Depth [mm]	225.7	179.7	140.8	78.4	43.7	21.3	23.3	45.5	90.5	142.7	182.9	219.9

Table 4-4: Raised Pan Evaporation Data for Cromwell [mm] (supplied by NIWA for Cromwell (nearest available pan evaporation data).

5. Stormwater

5.1 Recommendations

Refer to the Stormwater Assessment (Appendix C of this document) for the evaluation of the stormwater issues and options within the plan change site, as well as the associated recommendations. For completeness, a summary of the stormwater assessment has been included within the body of this report.

The Stormwater Assessment in Appendix C also contains the Stormwater Scheme Plan (C101), as well as the associated stream and swale engineering cross sections (C102 and C103). These plans and sections provide a visual representation of the below recommendations.

Sustainable urban drainage systems (SUDS) are proposed to provide both source control of stormwater quality and quantity (flow rates). The features included are infiltration trenches and stormwater polishing swales, very limited or no use of kerb and channel and a system of open watercourses throughout the development.

The proposed stormwater system has been developed to effectively ensure there is no adverse affect on the downstream Kingston Township stormwater infrastructure. A key feature is that it does not increase the peak flows within the existing under-sized stream that runs through the west of the site and through the Kingston Township. The overall peak flow within this stream will actually be reduced as a result of the proposed development, as the catchment for the stream will be reduced. In addition to this, 10,000m^3 of stormwater attenuation is proposed within the golf course area as part of the development works, to assist with the buffering of the peak flows and to provide some improvement of the existing situation.

It is proposed to connect the 1500mm diameter pipeline proposed for the eastern side of the site (passing through Kingston Township) into the Kingston Stream immediately prior to its Lake Wakatipu outlet. This will minimise the number of stream outlets into Lake Wakatipu. It is likely that this section of the Kingston Stream will be upgraded as part of the development works, which will likely result in an improvement on the current situation. All other sections of the Kingston Stream will not be impacted by the stormwater resulting from the development of the plan change site.

The following is a summary of the flood management and stormwater drainage facilities recommended for the development of the plan change site. For further detail please refer to Appendix C.

- The addition of a channel / bund along the western boundary of the plan change site, that extends just north of the residential area located in the south west corner of the golf course, to separate existing flows from the Eyre mountains from the development.
- Upgrade of the existing stream (and associated culverts) through the Kingston Township area that are currently under capacity (this stream is currently being assessed as part of the Stormwater Management Plan being completed by QLDC for the Kingston area).
- Attenuation of approximately 10,000m^3 of stormwater runoff on site (within the golf course) to assist with the management of peak stormwater flows that discharge into an existing stream.
- Sustainable urban drainage systems (SUDS) are proposed to provide both source control of stormwater quality and quantity (flow rates). The stormwater will be managed with a network of minor swale drains connecting to stormwater pipes, which then discharge into a series of major streams and swales around the site.
- Drainage of the major swales described above into the existing stream through the golf course or to a new 1500mm diameter drainage pipe along Oxford St that is proposed as part

of the development. This pipeline would discharge at the existing Kingston Stream outlet into Lake Wakatipu, with the stream outlet being upgraded as part of the works.

- Realignment of western stream so that it is combined with a buffer strip between planned residential and commercial areas before continuing through the golf course.
- Drainage (and in some areas relocation) of wet areas through earthworks and the swale network as above.

It should be noted that the cross sections in Appendix C depict the engineering requirements only, for the actual cross sections proposed within the site (incorporating environmental and aesthetic inputs) refer to the Woods Bagot plans.

Management of stormwater within the plan change site is proposed such that the development will effectively be stormwater neutral to downstream watercourses. This is achieved through the swale system as described above to assist in the management of peak flows, incorporating stormwater attenuation in certain areas and splitting the stormwater flows within the plan change site. With the management measures proposed and the proximity of Lake Wakatipu the development of the plan change site will have minimal downstream impact on the existing Kingston Township stormwater infrastructure and on the water quality of Lake Wakatipu.

Otago Regional Council has been consulted on the proposed stormwater solutions for the development of the plan change site, and has agreed in principle to the concepts presented in this report.

6. Water

6.1 Existing Situation

There is no water reticulation system currently in place for Kingston and instead the existing Kingston community currently uses either roof tank water or shallow private bores to meet their water needs. Tankard water is available to be purchased to 'top up' low rain water collection tanks.

As there is no wastewater reticulation within Kingston and septic tank disposal is used, there is the potential for the groundwater to be contaminated, which could impact on the quality of the private water bores.

The size of the plan change site and potential level of development demands a reticulated water system to service future development enabled by the Plan Change. It is therefore logical that when considering options for the plan change site consideration is given to the ability to provide a system that caters for both the plan change site and the Kingston Township.

6.2 Proposed System

As part of the plan change it is proposed that a reticulated potable water supply system be provided for the Kingston settlement. The following provides detail on the design of this water supply system, including water sourcing, treatment standards and methods and peak flows and storage requirements.

6.3 Bulk water source

There are two potential source options for bulk water supply to the Kingston settlement:

1. Groundwater bore (deep bore, perhaps up to 100m deep)
2. Abstraction from Lake Wakatipu

If a suitable, secure groundwater supply was available for the Kingston area, groundwater would be preferred over abstraction from Lake Wakatipu, due to potential significant advantages and savings in the level of treatment and ongoing monitoring required.

Exploratory drilling to investigate whether there was a secure groundwater resource in Kingston was carried out in June 2008. An exploratory bore of 82m depth and 150mm screen diameter was drilled, pumping tests were carried out and water samples taken for analysis. The testing showed the bore had a yield of approximately 16l/s, which is a good yield for a 150mm diameter bore. However, the water quality testing carried out showed elevated levels of arsenic present in the water, more than double the Maximum Acceptable Values stipulated in the NZDWS. The water also had high levels of iron and a high turbidity. Further testing confirmed that the arsenic was in dissolved form, complicating the potential removal options.

The review of this water quality testing has led to a preference for abstraction of water from Lake Wakatipu. It is noted that there are documented cases of bores being within several hundred metres of each other and containing water that has a completely different quality profile (effectively with one being contaminated with unwanted elements such as arsenic and the other not). This can be the case if the two bores are effectively sourcing water from independent paths. However, it is important to assess the benefit of doing further groundwater drilling. Groundwater drilling is costly and there is no guarantee that a drilled bore will be a productive bore (or have a different water quality profile).

From review, it was expected that the proposed drilling location was the most likely place to encounter water in the Kingston area. With the results of the water testing, the potential that there is a suitable town-supply groundwater resource available in the Kingston area has reduced. It is considered that investing more money into further investigation is not warranted.

A second opinion has also been sought from GHD's Chris Taylor who is closely involved with the existing QLDC water supply. It is agreed that given the results to date it is wise to progress the lake extraction option and not pursue the potential for a suitable groundwater resource or try to treat the water with the dissolved arsenic in it, which can be tricky, costly and would be an ongoing operating issue for QLDC (with the infrastructure being vested in Council).

It is anticipated that a 225mm diameter lake abstraction intake will be needed to provide the required water volumes, with an associated wet well pumping station. The potential site nominated for the lake abstraction is to the north east of Kingston, away from the existing Township, the existing boat ramp and the associated potential for recreational damage and contamination. The location also keeps the lake extraction point to one side of the bay, offset from stream outlets (which have an associated sediment load), and places it relatively close to the proposed reservoir location. An access track will need to be formed down to this location, for construction and maintenance. It is noted that the wastewater disposal field is proposed for the same side of the bay (refer Section 7). Given the proposal level of wastewater treatment and the offset distance of the proposed field (more than 400m) there are no engineering concerns with this.

Further investigation into the profile of the Lake in this location and the water quality will need to be carried out in the future, however it is anticipated that the abstraction intake would be at least 30m out into the Lake, just above the Lake bed and at a minimum of 5-6m depth, preferably 10-20m deep.

It is anticipated that all water infrastructure (abstraction infrastructure, treatment plant, reservoirs, public reticulation etc) will be vested in QLDC and will be QLDC owned and operated.

6.4 Water supply standard

Because the proposed Kingston settlement water supply scheme will provide water to more than 500 people the treatment plant and reticulation needs to comply with the Ministry of Health guidelines New Zealand Drinking Water Standards for New Zealand 2005 (DWSNZ). This standard sets levels of treatment and monitoring required for water supply schemes throughout New Zealand and ensures that safe, consistent potable water is available year round.

The DWSNZ specify Maximum Acceptable Values (MAVs) for the microbial, chemical and radiological determinands of public health significance in drinking-water and also provide compliance criteria and procedures for verifying that the water supply is not exceeding these values. As discussed under Section 6.3 the tested groundwater exceeded the DWSNZ MAV for arsenic and would have required specialist targeted removal.

The DWSNZ are applicable to water intended for drinking irrespective of its source, treatment or distribution system, whether it is from a public or private supply, or where it is used.

6.5 Water treatment options

The treatment processes required depend on the quality and security of the source water selected for the supply.

With the lake abstraction option now being preferred, chemical and biological testing will be undertaken on Lake water samples, including measurement of the manganese, iron, arsenic and turbidity levels. In the case of a surface water source such as a lake, a 3 Log or 4 Log treatment standard (as defined in DWSNZ) is likely required. 3 Log indicates a 99.9% reduction in the concentration of a contaminant, and 4 Log indicates 99.99% reduction. 3 Log treatment is only acceptable with one year of monitoring results, focussing on E-coli monitoring. 4 Log is a much more costly option and is the default treatment level for a water source where the intake water protozoal risk category is not determined using the appropriate process (as defined in the DWSNZ). Turbidity

fluctuations of the surface water should also be monitored to assess effectiveness of UV disinfection. It is proposed that water quality monitoring be carried out for a year on the Lake at the proposed abstraction location in order to confirm the required treatment level.

This water quality monitoring will likely be carried out following progression of the plan change through the first schedule process. It should be noted that there are a number of existing lake abstraction sources on Lake Wakatipu, supplying many communities in and around the Queenstown area. These sources are for the most part only being chlorine dosed at present, although QLDC is about to commence monitoring of the lake water quality in these areas, in preparation for an upgrade in the water treatment to meet the new DWSNZ. It is considered reasonable to postpone the water quality monitoring for Kingston until the next stage of the plan change, although the benefit of carrying out the testing at the same time as the QLDC testing will also be assessed (this could result in useful water quality correlations).

For an average treatment situation the process required would likely include:

- Softening
- Filtration
- Iron removal
- Ultraviolet disinfection
- Chlorine dosing

Information on suitable treatment products is included in Appendix G.

As an alternative to the treatment option above a membrane filtration plant could be used depending on the raw water quality monitoring results, although chlorination would still be recommended. QLDC will be assessing their water treatment preferences following the results of the monitoring work and the intention will likely be to provide a standardised approach across the District. Final selection of the treatment process will be completed following water quality testing and capital and operational expenditure considerations.

6.6 Daily flow estimates

There has been significant discussion to date regarding the water usage requirements for the Kingston settlement. As above, there is no existing reticulation, with the existing Township using private shallow water bores and water tanks, topped up by tankards where necessary.

The peak flows required by the QLDC Code (as clarified in the MWH New Zealand Ltd – MWH memo circulated on 27 November 2007, attached in Appendix D) are very large for the ultimate Kingston settlement, due to the large QLDC Code peaking factors. No diversity of peak flow is incorporated into the QLDC peaking factors; this would normally be expected in a water network supplying over 1000 lots. This has been the subject of ongoing discussion and there has also been ongoing monitoring of the actual water usage within the QLDC area.

In July 2008 QLDC issued a draft Kingston Water Demand Management Plan (DMP), containing details of the revised flow demands that are expected for Kingston. This document confirmed that the flows prescribed in the QLDC Code are excessive compared to many New Zealand code requirements, and are not directly applicable to the Kingston scenario, with the associated lot sizes and fact that there is no existing infrastructure in place. This document is currently being reviewed but it has been agreed that the demand figures discussed in this document appear more suitable to the Kingston situation than what is required by the QLDC Code. A copy of the DMP is attached in Appendix D.

The DMP also describes that water metering and water restrictions will likely be utilised for the Kingston settlement. QLDC monitoring of existing townships that are similar to Kingston have shown

that these measures have proved beneficial to ensuring the proposed demands are managed in the future.

Table 6.1 depicts the water demand requirements, based on the various population areas, as detailed in the DMP. The full details of the water demand calculation, including the flow rates and peaking factors are included in Appendix D.

Ultimate development	Lots	Population	Average Daily Flow (ADF m^3/day)	Peak Daily Flow (PDF over 20 hrs m^3/day)	Peak Hourly Flow (PHF l/s)
Kingston Township (including visitors)	379	1,194	400	720	18.5
KT Commercial	-	404	94	170	4.4
Plan change site	744	2,232	781	1,406	36.2
Total	**1,123 lots**	**3,830 ppl**	**1,276 m^3/day**	**2,300 m^3/day or 32l/s**	**59 l/s**

Table 6-1: Water demand assessment summary, Kingston Settlement Ultimate

The above figures are significantly different from the flows required by the QLDC Code. It is expected that Otago Regional Council (ORC) will view the proposed DMP flows more favourably that the current QLDC design flows as required in the QLDC Code.

The table below provides a comparison between:

- NZS 4404 flows with NZS 4404 peaking factors ("NZS 4404")
- Full QLDC Code and the MWH clarification memo (as above) ("QLDC Code")
- DMP flows and peaking factors ("DMP")

Ultimate development	Lots	Population	Average Daily Flow (ADF m3/day)	Peak Daily Flow (PDF m3/day)	Peak Hourly Flow (PHF l/s)
NZS 4404 (peak factors 1.8 for PDF, 4 for PHF)	1,123 lots	3,830 ppl	962m^3/day	1,731m^3/day or 24 l/s (20 hrs[1])	45l/s
QLDC Code (with recommended peaking factors, 3.3 and 6.6)	1,123 lots	3,830 ppl	2,518 m^3/day	8,310 m^3/day or 115 l/s (20 hrs[1])	192 l/s
Draft Kingston DMP (with peaking factors recommended, equivalent to NZS 4404 peaking factors)	1,123 lots	3,830 ppl	1,276 m^3/day	2,300 m^3/day or 32l/s (20 hrs[1])	59 l/s

Table 6-2: Comparison of water demand assessment using different methods, Kingston Settlement Ultimate *([1] Note peak flow spread over 20hrs to enable shut down especially as single extraction source most likely)*

6.7 Alternative system options

There is the opportunity to separate the water supply for potable water and irrigation water supply. According to the QLDC Code the potable water demand would be 350 litres per person per day (l/p/d) with the irrigation supply making up the remaining water demand of 350 l/p/d. In this situation, assuming the potable and irrigation water was extracted from the same source the raw water could then be pumped up to the treatment plant adjacent to the reservoirs, treated to two different levels, and transferred to the two independent reservoirs.

However, this option would then involve two separate sets of reticulation from the reservoirs and the ultimate population size of Kingston, at approximately 3,800 people, makes this option cost prohibitive. With the progression towards agreement of the reduction in water flow this option has even less appeal and therefore it has not been considered further.

Another option would be to try and rely on rain water tanks for irrigation, thereby reducing the total potable water reticulation whilst removing the need for a separate irrigation system (or having a reduced system). The problem with this approach is that it would be difficult to police the restriction into the future. For example in ten years time when a landowner has to replace a costly part of the water tank system as part of the overall maintenance they may decide not to do so, and instead to use the potable water supply to irrigate their land like elsewhere within the District. The cost savings associated with the bulk infrastructure also get offset quickly with the installation of water tanks within properties (as well as maintenance of those water tanks). The installation of a new water tank with connecting pipework etc could be in the order of $3,000 - $5,000, the cost of installing these systems quickly becomes cost prohibitive over a large settlement area. Again, with the progression towards agreement of the reduction in water flow this option has less appeal. However, those existing residents with rainwater or bore supplies may wish to retain these for an irrigation source alternative to the potable supply.

6.8 Storage requirements

As per the MWH memo of 27 November 2007, the minimum reservoir volume is the sum of the following:

1. Fire fighting reserve (W4, classification from NZS 4509:2003, to be conservative in allowing some future commercial areas - 180m^3);
2. Emergency Storage of 4 hours of the Peak Day Flow rate (1,385m^3, based on QLDC Code Requirements);
3. Working Storage of 8 hours of Average Daily Flow rate to the network (839m^3, based on QLDC Code Requirements).

The above components result in a minimum reservoir volume of approximately 2,400m^3 (rounded to 2,500m^3). For a settlement of 3,800 people a 2,500m^3 reservoir storage volume is a reasonable size. Other Councils around New Zealand use the 24 hours peak daily flow to calculate their necessary storage volume, this would be 2,311m^3 under the new flow rates. It is considered that 2,500m^3 is a suitable storage volume and this volume should not be decreased due to a change in the peak flow volumes.

Due to the large storage size of the reservoirs and to facilitate staging of the bulk infrastructure two reservoirs are recommended. The reservoirs are nominated as 1,250m^3 and 1,250m^3, however this can be confirmed at a later date when the staging is confirmed. Storage of 1,250m^3 is the combined storage requirement for one third of the development of the plan change site, three quarters of the ultimate Kingston Township and half of the proposed Kingston Township ultimate Commercial population.

The proposed reservoir site is to the north east of the existing Township, within gently sloping land (400m RL) owned by Kingston Village Ltd. The location of the reservoirs is depicted on plans C300 and C301 (Appendix E). A number of reservoir locations were reviewed with the proposed site being chosen because it is at the necessary height above Kingston (the reservoir needed to be located between 390m and 420m RL to provide the necessary supply pressures without pumping), it is relatively close to Kingston (approx 1.5km), and it is within relatively gently sloping topography, away from the steep, unstable hillside further south and east.

Plan C301 includes typical details associated with the two above-ground reservoirs. Scalar penetrometer testing has been undertaken at the reservoir sites and testing indicates that the underlying material at both sites is of good bearing capacity, being 100kPa. The test logs have been included within Appendix E. Further geotechnical design would be necessary at the design stage to confirm the geotechnical design parameters.

The proposed location of the reservoir sites is visible from Kingston and State Highway 6. It is expected that vegetation screening will minimise their visual impact.

6.9 Reticulation

As per the MWH memo of 27 November 2007, the reticulation must be sized to convey the greater of:

1. Peak Hour Flow rate
2. Fire fighting flows plus Peak Day Flow rate

For the bulk water supply pipeline and the ring mains that would serve the plan change site and the Kingston Township, the peak hourly flow rate of 59l/s will be the greater of these two flows.

Modelling of the necessary flows within the ultimate Kingston settlement (ensuring supply and pressure demands are met) shows a 250mm diameter bulk water main is required from the two reservoirs. NZS 4404 recommends the maximum friction losses within the pipe should be under 3m/km. At the peak flow rate of 59l/s a 250mm diameter pipe has friction losses of around 5.2m/km. These slightly higher line losses than those recommended in NZS 4404 are considered acceptable as there will be more than adequate pressure within the system, the bulk water main length is only 1.5km and the design criteria is the ultimate Kingston settlement peak hourly flow (it is considered unlikely there will be significant future development in this area, that places substantial additional demand on the bulk supply pipeline). The bottom water level (BWL) of the reservoirs is 401.9m RL and the highest point of construction within the plan change site (which is also the furthest away from the reservoir site) will be 350m RL. This gives a minimum height differential of 50m. Allowing for a conservative approach to frictional losses the minimum supply pressure will exceed the necessary 25m during peak flows.

The ring main associated with the development in the plan change site is also sized as a 250mm diameter pipe.

6.10 Kingston plan change site independent servicing

By constructing a reduced capacity of infrastructure with the corresponding decrease in overall water flow rates, water abstraction and storage requirements, the plan change site could be serviced independently from the Kingston Township.

7. Wastewater

7.1 Existing wastewater systems

There is no existing wastewater system within Kingston. Most existing properties have individual septic tank systems with on-site disposal. Due to concerns regarding groundwater contamination new dwellings are required to install holding tanks, which are regularly pumped out and disposed of at a treatment facility. This is not a long-term solution to the wastewater issue in Kingston; with growth of the area it is going to become more and more important to have a suitable wastewater network and associated wastewater treatment system.

The size of the plan change site and potential level of development demands a reticulated wastewater system. It is therefore logical that when considering options for the plan change site consideration is given to the ability to provide a system that caters for both the plan change site and the Kingston Township.

7.2 Proposed System

As part of the development of the plan change site it is proposed that a secondary treatment wastewater system be constructed for the Kingston settlement. With the economies of scale, it will be possible to economically provide a system that treats wastewater to a high level, consistent with the New Zealand wastewater treatment standards for a settlement of this size. This will ensure the continued health of all residents as well as minimizing the effects on the environment. The following provides detail on the proposed wastewater system, including peak flows, reticulation options, wastewater treatment options and standards and treated effluent disposal options.

7.3 Peak flow estimates

The peak flows for the ultimate Kingston area have been calculated based on the QLDC Code as shown in Table 7-1. Note population is based on 3.5 people per lot, as per the QLDC Code. Flow per person is nominated as 300 litres per day for residents and 180 litres per person per day for commercial users and 40l/p/day for visitors (which is consistent with the QLDC documentation in this regard).

Ultimate development	Lots	Population	Average Dry Weather Flow ADWF (m^3/day)	Peak Dry Weather Flow PDWF (l/s)	Peak Wet Weather Flow PWWF (l/s)
Kingston Township (including visitors)	379	1,384	400	12	23
Commercial (including Kingston Acquisitions)	-	404	73	2	4
Plan change site	744	2,604	781	23	45
Total	**1,123 lots**	**4,392 people**	**1,254m^3/day**	**36l/s**	**73l/s**

Table 7-1: Wastewater demand summary, Kingston (Ultimate development)

7.4 Location of bulk infrastructure

The bulk wastewater infrastructure consists of a wastewater treatment plant and associated disposal area, along with any necessary bulk gravity mains, pump stations and bulk rising mains.

The treated effluent disposal field generally requires a large amount of land. Several options were reviewed regarding the location of this disposal field; this review and the proposed location are discussed in Section 7.8.

The proposed location of the wastewater treatment plant and associated effluent disposal areas are shown on C200, in Appendix F. It is proposed that the wastewater treatment plant is located on the hillside north east of Kingston, adjacent to the proposed effluent disposal area.

7.5 Reticulation options

With the location of the treatment plant on the north eastern slopes, all of the wastewater flow from the developed plan change site and the Kingston Township must be collected and pumped up to the treatment plant.

The required pump station could be located immediately downstream of the lowest lot proposed for the plan change development. However, there are definite economies associated with installing a combined pump station for the developed plan change site and Kingston Township flows. GHD's September 2008 Report recommends a hybrid gravity/grinder pump reticulation system for the Kingston Township. This system would involve a number of pump stations, it is expected that one of these pump stations (nominally the pump station proposed for the corner of Kent and Cambridge Streets) will be able to be upgraded to manage all of the Kingston settlement flow and direct it to the treatment plant. The pump station components will be underground with only a small above-ground control cabinet.

GHD have reviewed the use of a conventional gravity system, a vacuum system and a low pressure pumping system for the Kingston Township (and hybrid systems where suitable).

- Vacuum systems are achieved by the suction of vacuum pumps located at a central vacuum station. In a vacuum system sewage transfer is via gravity within the home and then via a vacuum main, with flow managed with an automatic interface valve, which seals the lines so the vacuum is maintained. Wastewater is moved through to a vacuum station and on to the wastewater treatment plant.
- Low pressure pumping systems comprise a series of small pumping stations (one located at each dwelling) that pump to a reticulated pressure sewer main to transfer the wastewater to the wastewater treatment plant.

These systems could be beneficial for the Kingston Township area as some areas experience high water table and inundation during peak flood events. If a gravity system were utilised, special consideration would be necessary to ensure that high lake levels would not compromise the performance of any pump station and reticulation. If lakewater was to enter the wastewater reticulation during extreme flooding events, the wastewater system would very quickly be overloaded. A vacuum or low pressure system would prevent any inflow issues, and would even reduce the overall peak wastewater flows as the stormwater infiltration that is always incorporated within peak wastewater flow rates could effectively be removed. As above, GHD have recommended a gravity/grinder hybrid system for the Kingston Township.

The plan change site, at its lowest point, is over ten metres higher than the average Lake level, making it clear of inundation issues. The water table is expected to generally be more than two metres below ground level. A high water table can lead to additional infiltration issued in gravity systems. The benefits of a standard gravity system / pump station arrangement include that they are easier to maintain than a vacuum or low pressure system and that they do not rely on mechanical equipment to manage the flow collection (which will need to be maintained). The pressure and vacuum systems have a much higher capital cost than a standard gravity system. There are no major benefits to using a vacuum or pressure system for the development of the plan change site and they are not recommended for the plan change site.

7.6 Volume estimates

The ultimate treatment plant average daily volume is approximately 1,300m^3 / day. A range of different options are available to suit the expansion of the Kingston settlement so that facilities for the ultimate population do not need to be constructed initially, and can instead be constructed in stages.

Treatment of 600m^3/day with flow balancing tanks is the equivalent combined treatment requirement for one third of the ultimate plan change development, three quarters of the ultimate Kingston Township and half of Kingston Township ultimate commercial population. The system would then be expanded to process up to 1300m^3 / day as Kingston grows.

Initially grossly oversizing the treatment plant can lead to energy and treatment inefficiencies and a modular or staged expansion is therefore recommended.

7.7 Treatment options

The scale of the ultimate Kingston settlement is such that a conventional on-site package plant would not be cost effective and therefore full design of a wastewater treatment facility will be required. Given the size, climate, staging, and sensitive receiving environment, a modern biological/treatment plant is considered the most appropriate treatment option. This will enable a high quality of effluent to be achieved utilising a compact plant that has the potential to undergo a staged construction.

Selection of a final option for the wastewater treatment plant for Kingston will require a more detailed evaluation of required effluent quality, environmental factors and preferences from QLDC to keep the treatment plants within the District consistent for maintenance and operator purposes (it is anticipated that the treatment plant and associated disposal fields will be vested in QLDC). QLDC are currently reviewing their system preferences. Within the District a Sequencing Batch Reactor (SBR – as described below) is being installed for Wanaka/Albert Town and potentially for Queenstown (process yet to be confirmed). In Glenorchy and Cardrona the systems are yet to be finalised. Luggate has a private Rotating Biological Contactor – however, this treatment method is not recommended as a process for the Kingston settlement as it is not commonly used technology and as such would increase the operation and maintenance issues. QLDC will be involved in the final treatment system selected.

The following options are considered suitable:

7.7.1 Sequencing Batch Reactor

An SBR is a variation of the conventional activated sludge process where the wastewater is treated by micro-organisms suspended in the wastewater. Wastewater is treated in “batches” rather than by means of a continuous inflow and outflow. The treatment cycle (with anoxic phases if required) is completed in a single tank which eliminates the need for a separate clarifier. The treatment cycle usually consists of aerobic, anoxic, settling and decant stages. Typical treatment standards achieved would be 20:20 BOD/SS and 20mg/l nitrogen (with carbon dosing nitrogen could be almost totally removed). Ultraviolet (UV) disinfection would likely be incorporated within this treatment; this drops the faecal coliform level in the treated effluent to near zero.

7.7.2 Membrane Bio-Reactor (MBR)

Membrane Bio-Reactor (MBR) plants are a combination of standard activated sludge wastewater treatment plants and membrane filtration. The membrane filter replaces the clarifier and disinfection stages of a conventional treatment plant. The membrane provides an absolute barrier and restricts all particles greater than 0.2mm. As the membrane removes almost all suspended solids they also remove pathogens and significant biochemical loads. Typical treatment standards achieved would be better than 10:10 BOD/SS and 10mg/l nitrogen (with carbon dosing nitrogen could be almost totally removed). UV disinfection is not required for this system as the membrane also removes pathogens.

7.7.3 Submerged Aerated Filter (SAF)

SAF plants are a fixed film process that utilise a solid media (typically made of plastic with a large specific surface area) in the process tanks which provides a surface upon which the biomass grows. The biomass treats the wastewater and removes the BOD and solids (as well as reducing ammonia if sized appropriately). The media is submerged in the tanks and air is mixed into the wastewater at the base of the tank using a diffuser/blower arrangement. The media used and the fact that it is submerged allows for substantially higher applied organic loading than more conventional fixed film processes such as trickling filters. Typical treatment standards achieved would be 20:20 BOD/SS and 25mg/l nitrogen (with carbon dosing nitrogen could be almost totally removed). UV disinfection would likely be incorporated within this treatment; this drops the faecal coliform level in the treated effluent to near zero.

7.7.4 Packed Bed Reactor (PBR)

Settleable solids and oil and grease etc are removed within the primary tank. The effluent passes to a recirculation chamber and is either sprayed into the PBR (which is a simple chamber containing a textile type media) or discharged to the disposal area. Flow is passed to the PBR in preference to the disposal field at a ratio of approximately 3:1 – 5:1. Recycled flows pass back into the recirculation chamber/primary tank. Typical treatment standards achieved would be 20:20 BOD/SS and 25mg/l nitrogen (with carbon dosing nitrogen could be almost totally removed). UV disinfection would likely be incorporated within this treatment; this drops the faecal coliform level in the treated effluent to near zero.

While the proposed location is quite a significant distance from existing and new housing, treatment and management processes will be selected to minimise odour and odour reduction measures including the circulation of air through a biofilter may be adopted as required.

Oxidation type pond systems have not been considered due to the potential odour issues, large plant footprint, and inability to respond to peak loadings and the reduced performance during cooler pond temperatures.

Further details on treatment options are included in Appendix H. The wastewater treatment plant location is shown on C200 (Appendix F). This location is preferred for the wastewater treatment plant as the entire disposal field is now located on the north eastern slopes. The reasons for the recommended location are further discussed in Section 7.8.2. This site places the treatment plant away from the Kingston residential area. The treatment plant may be screened with vegetation, minimising any potential visual impact.

All of the above options will produce some sludge material that will need to be transported off site and disposed of in the nearest suitably licensed disposal area.

7.8 Disposal Options

It is recommended that disposal of the treated effluent will be achieved by discharge to land via a subsurface disposal field. Discharge to land is preferred by Otago Regional Council and the local Iwi, and it does not have the human contact and contamination issues associated with spray irrigation and discharge to surface waters.

7.8.1 Subsurface Dripper Line Irrigation

The biggest issue with a subsurface disposal field will be achieving a suitable application rate so that there is further filtering and treatment in the biologically active upper layer of the soil layer prior to interception with any groundwater layer.

During the detailed design of the wastewater system the effluent disposal field will be designed to ensure all necessary treatment occurs within these layers prior to interception with any groundwater layer. This detailed design will include application rate, density, treatment levels within the treatment plant, topsoil depth requirement and so on. The effluent discharge quality (from the treatment plant to the soil) will be a minimum of 20:20 mg/l (BOD:SS), out with a level of 10:10 generally being achieved. Nutrient (nitrogen and phosphorus) levels need to be managed where there is a potential for groundwater to be contaminated. Faecal coliform levels will be minimised with UV filtering or membranes, which will neutralise any hazardous components within the wastewater prior to effluent leaving the treatment plant.

Where there are groundwater quality issues additional separation can be achieved through increasing the topsoil depth or reducing the loading. The disposal line will need to be installed at 150mm-200mm below ground level and include drain down facilities to prevent damage from freezing during winter periods. Ground temperature monitoring is currently being carried out (August to October 2008) at several locations within the preferred disposal area, this should clarify the expected ground frost depth. The ground temperature monitoring locations are depicted on C200 (Appendix F). In some areas cutoff measures are likely to also be undertaken to ensure the isolation of the disposal area from surface flow during extreme events.

The dripper irrigation lines will be impregnated with a chemical to prevent root intrusion (root intrusion will not be a major issue within this area, given the availability of water and the light density of vegetation, the chemical impregnation is therefore recommended as a precaution). The groundwater levels in the Kingston valley are likely to fluctuate considerably due to changes in Lake levels, seasonal variation and individual rainfall events and any fluctuation in ground water level associated with effluent disposal in the area is likely to be insignificant compared to these current ground water fluctuations. During detailed design this will be investigated further and modelling of the groundwater conditions in the area would be considered. The detailed design of the effluent disposal field will ensure that there are no adverse effects on any parties or on the Lake, streams and groundwater due to the effluent disposal.

7.8.2 Investigated Effluent Disposal Field Locations

Two areas were shortlisted for potential treated effluent disposal:

1. The existing Kingston golf course (northwest corner of plan change site, owned by Kingston Village Ltd apart from a section of land to the east which is QLDC reserve land).
2. An area of land to the northeast of the Kingston area

These areas were shortlisted due to the availability and suitability of the land, the separation from potential dwellings, the size and shape of the land available and the fact that the owners of the land were amenable to its being used. It was expected that the Kingston golf course would take a portion of the effluent flow, with the balance of the effluent flow being disposed of on the north eastern slopes.

Soil and permeability assessments have been carried out within the above two areas to assist in the assessment of dripper irrigation rates. The depth to groundwater has also been investigated to assist in the loading assessment.

In the last few months there have been further developments in the preferred disposal field location. The golf course was originally nominated for use as an effluent disposal field as it was a reasonably sized, central area which would benefit from the effluent disposal due to water and nutrient loadings. The effluent disposal would effectively act as nutrient rich irrigation. The location of the golf course also minimised the sewage pumping distance and height change

required, which would have some cost savings. However, with the fact that the disposal loading rate in this area is quite low (low permeability soils) and the unavailability of some of the golf course land for stormwater attenuation purposes, the amount of effluent this area could accommodated has decreased, making it a less appealing option for effluent disposal. In construction terms there is a premium associated with constructing an effluent disposal field on an existing, vegetated golf course, having to avoid tees and greens and not being able to install the dripper pipeline in straight lines. Added to this is the fact that the future upgrading of the golf course could be limited by the addition of wastewater disposal as it would require additional reinstatement costs, if any upgrade is not completed prior to wastewater disposal commencing.

For these reasons the preferred disposal site is wholly on the north eastern slopes above Kingston and within the Glen Nevis Station. In construction terms the costs are similar to the golf course option as the costs are on a per hectare rate, with the construction on the open north eastern slopes being cheaper than construction on the golf course. There are long term costs associated with pumping wastewater up, away from the town and to a nearby hillside but the treatment plant will utilise a pressure disposal system which will benefit from the elevation. In terms of the additional annual electricity costs (based on spot electricity costs June 2008) for pumping all (i.e. not just part) of the flow up to the north eastern slopes (approximately 375m RL) it is estimated that this is in the order of $25,000 per annum. This is offset by the reduction in cost associated with the economies of scale with having a single open disposal field and benefits of removing the disposal field from adjacent to a populated area.

7.8.3 North eastern slopes

The site investigations undertaken on the hillside to the north east of Kingston (refer C200 in Appendix F) indicated underlying areas of low permeability. This is likely to be the case throughout the Kingston area. A disposal rate of 5mm/day is recommended in this area. This disposal area will be utilised as Kingston grows, and the necessary effluent disposal volumes increase. The ultimate Kingston flows are estimated at 1,300 m^3/day, which equates to a disposal area of 26ha, based on a disposal rate of 5mm/day.

The above loading rates and areas are summarised in the following table:

Location	Loading rate (mm/day)	Area required (hectares i.e. 10,000m^2)	Total effluent flow disposed (m^3/day)
North eastern slopes	5mm/day	26 ha	1300 m^3/day
Total		**26 ha**	**1,300 m^3/day**

Table 7-2: Effluent disposal summary, ultimate development

It should be noted that as part of any Discharge to Land Consent for the disposal of effluent, the effluent disposal rates and the environmental effects in the area will be continuously monitored following installation of the disposal field. This is necessary to ensure the disposal system is working effectively and the necessary treatment of the effluent within the biologically active layers is occurring, and there is no associated contamination. If the conditions are right, loading rates of up to 25mm/day are suitable in some types of material (free draining materials), however, for these high rates it is necessary to retain an additional 50% reserve area for disposal should there be any issues with the higher disposal rate. This enables the reduction of disposal loading rate should there be any ongoing issues with the disposal field.

A relatively conservative approach has been adopted for the plan change with the disposal rate of 5mm/day, it may be possible to increase the loading rate in the future when the actual soil permeability can be reviewed and also with the planting of appropriate species. However, at any higher rate an equivalent amount of land held in reserve would likely be required by the Otago Regional Council. The

key issue now is to earmark the land necessary for disposal of the ultimate effluent loads, based on conservative parameters, to ensure there are no land issues going forward.

7.9 Kingston plan change site independent servicing

By constructing a reduced capacity of infrastructure with the corresponding decrease in overall wastewater treatment and disposal requirements, the plan change site could be serviced independently from the Kingston Township.

8. Other Services

8.1 Electricity

The lines company covering the Kingston area is PowerNet Ltd, based in Invercargill. The existing electrical network within the Kingston Township is generally overhead lines, however there are buried cables, generally in the vicinity of the state highway. Power reticulation within the plan change site will be via underground cables.

PowerNet has advised that the electricity supply is limited in this area and to service the ultimate size of Kingston will require an upgrade to the lines servicing Kingston. Due to PowerNet's previous assessment of expected growth in the area, upgrades to the electricity network around the area have already been identified. The nearest zone substation is in Lumsden (approximately 55km away). Discussions with PowerNet indicate that they have identified a need for a new zone substation closer to Kingston as well as upgrades to the line between Lumsden and Kingston. The new substation has been included in PowerNet's forward works program however construction dates have yet to be confirmed. The location of this substation will likely be outside of the immediate Kingston area; PowerNet will be responsible for this siting.

Further discussion with PowerNet will be needed once a construction timeline for the entire development has been established, to compare PowerNet's projected growth for the region with the expected growth generated by the plan change.

8.2 Data/Telecom

The Telecom network serves the existing Kingston Township and has recently had a new fibre optic cable installed along the State Highway to Queenstown. This cable has more than sufficient capacity to service the ultimate size of Kingston with data and voice. Telecom reticulation within the plan change site will be via underground cables.

Because of the size of the development (greater than 100 lots), Telecom would install fibre optic cabling within the development as well, making Broadband available for the plan change site.

8.3 Gas

There is currently no reticulated gas supply in Kingston Township. Discussions with Rockgas (gas providers in Queenstown and Central Otago) indicate that they are eager to set up a reticulated LPG (liquefied petroleum gas) network within the plan change site and possibly extend to service the existing Kingston Township.

Rockgas have provided a number of smaller sized communities in the region with gas reticulation, including Luggate (100 lots). They expect to provide gas for other similar sized projects, such as Cardrona (600 lots). Rockgas have an extensive LPG reticulation network in Queenstown which stretches from Jacks Point to Lake Hayes.

To provide an LPG network Rockgas will require approximately 1000m^2 of land area for the provision of a gas tank, vaporisation plant and shut off controls. This could potentially be sited within the plan change site in the proposed employment area (E1 on the Master Plan, Appendix B).

9. Earthworks and Roading

9.1 Earthworks

The development of the plan change site will require earthworks for the creation of house sites, the roading corridors, the construction of a swale and bund along the western boundary, the system of swales across the site and so on. Due to the relatively flat nature of the site, the roading should generally be able to be achieved with minimal earthworks and involve largely reshaping localised high and low spots.

No large cut or fills should be necessary to achieve the subdivision layout as identified in the master plan.

Earthworks will be managed in stages, with topsoil only stripped in working areas, and retained as long as possible in all other areas. This will be necessary for silt and sediment control as well as to assist in the management of the layers of shallow low-permeability fines within the site. Surface water management will be critical to the overall earthworks management, especially during construction in winter. For the western side of the development area it is recommended that the stormwater channel and bund be constructed to manage the stormwater flows from the western mountainside catchments prior to topsoil stripping within this area.

Any issues associated with the in-situ materials will be able to be managed through earthworks management plans and construction monitoring.

There will also be a management plan implemented for any accidental discovery of a site of potential historical or archaeological significance. This management plan will include what to look for, procedures on discovery, who to contact, and the monitoring requirements to ensure compliance with the management plan. This plan will form part of the earthworks management plan and would be overseen by the overseeing engineer on site.

All earthworks would be managed through the resource consent process; through either subdivision or land use (where undertaken separately from subdivision activities and where volumes of material removed are greater than 100m^3).

9.2 Roading

The roading design within the plan change site will be subject to the QLDC Code and the subdivision guidelines prepared for the plan change. These standards detail the road and geometrical design standards for QLDC roads, as well as the specific requirements regarding surfacing and street furniture. The roading design within the plan change site will follow (to a large extent) these expected standards as the roads will be vested in Council. However, in some specific aspects deviation from the QLDC Code is proposed, due to the utilisation of sustainable urban drainage systems (SUDS) and in order to enhance the overall sense of community within the plan change site. These proposals reflect the objective of retaining the overall character of the Kingston Township. The modifications proposed are as follows:

1. To restrict the carriageway widths within the development for traffic calming purposes. The minimum road reserve widths as specified in the QLDC Code will be generally exceeded, with areas of car parking, swale drains, cycle ways and meandering footpaths through open green spaces. There will also be a walking track network developed through the plan change site.

2. To utilise swale drains within the road reserve, instead of standard kerb and channel. These swale drains will provide source control of both stormwater quality and quantity (flow rates). On the lower hierarchy roads the collector swale drains (which will discharge into the system

of main swales / streams through the site, refer C101 in Appendix C) may be lined with grassed concrete gobi blocks (or similar) to enable car parking within the swale zone. This requirement will be confirmed at the time of final design.

The Woods Bagot report contains roading cross sections for the development of the plan change site which illustrate the above concepts.

Traffic Design Group (TDG) has produced a transportation assessment for the plan change: "Transportation Assessment for Plan Change 25", October 2008. This report details the traffic effects of the plan change, as well as making recommendations regarding access to State Highway 6 and the issues associated with the railway crossings. This report, in its entirety, should be referred to as part of the overall roading assessment for the plan change site. This report concludes that "…the traffic effects associated with the potential plan change can be addressed through the development of detailed intersection designs and management plans for the rail corridor. Therefore the plan change can be supported from a transportation perspective."

9.3 Structures on site

Building consent will be required (following detailed design stage) for all structures associated with the Kingston settlement bulk infrastructure. This will include:

- structures associated with the water extraction,
- water treatment and storage reservoirs,
- the wastewater treatment plant.

Any structures, fences, bridges / stream crossings within the site will need building consent. Depending on location they may also require resource consent.

10. Conclusion

10.1 Servicing of site

This preliminary report has covered the various infrastructure elements associated with the development of the plan change site:

- Stormwater
- Wastewater
- Water supply
- Earthworks and roading
- Other Services

The report concludes that the Kingston plan change site can be serviced, and the Kingston settlement can be provided with a reticulated wastewater and water supply.

By constructing a reduced capacity of infrastructure with the corresponding decrease in overall water and wastewater flow rates, water abstraction and storage requirements and wastewater treatment and disposal requirements, the plan change site can be serviced independently of the Kingston Township.

The plan change site can be developed with effectively no negative downstream effects on the existing Kingston Township infrastructure. The proposed development of the plan change site has the ability to improve the existing Kingston Township infrastructure, improving on the current stormwater situation and resulting in the installation of a reticulated wastewater and water supply for the Kingston settlement.

11. Regional Council Consents

11.1 Summary of potential consent requirements

The following is a summary of the potential consents required from Otago Regional Council for the development of the plan change site and associated provision of reticulated services. The information should be used as a guide only, and should be reviewed as planning for and development of the plan change site progresses. This summary has been included to provide an indication of the likely general concerns of the Otago Regional Council. The Regional Council should be consulted about the applicability and interpretation of any regional rules, prior to lodgement of an application.

Regional Plan – Water: **Water Use and Management**	**Comments and Considerations**
The taking of ground water	May be a discretionary activity depending on volume proposed to be taken. The existing groundwater bore may be utilised for construction related activities. The summary of these consenting requirements are as follows. Council, when considering the application will have regard to: • Amount of water to be taken • Effect on a connected surface water body • Effect on quality of groundwater • Means, timing and rate of take • Bond • Quantity
The taking of surface water	Discretionary activity due to the volume proposed to be taken. Considerations: The proposal will have to ensure that there is no more than a minor affect on human and natural values of the water. Council, when considering the application will have regard to: • The amount of water • Any need to prevent fish entering intake • Duration of consent • Bond • Monitoring of effects
Damming or diversion of water	Discretionary activity The biggest stream within the plan change site (on the western side of the site), passes through existing paddocks and the golf course. Because it has a water catchment area of over 50 hectares, diversion of this stream will be a Discretionary activity. The stream to the east of larger stream may need to be included in the discretionary activity consent application for completeness.

Regional Plan – Water: **Water Use and Management**	**Comments and Considerations**
	Some changes to the stream flow are likely to result from the development. There will also be works in the streambed, such as pipe installation for the wastewater system. Such works will require consent if fixed to the river bed or if the Council considers them to have more than a minor adverse effect on the environment. For any diversion, the consent considerations will include flooding, erosion, land instability, sedimentation.
Discharge of Stormwater	Permitted activity if no more than minor adverse effect on the environment. As the development has been specifically designed to have no more than a minor adverse effect on the environment, its assessment as a permitted activity should therefore be possible. However, if the Council considers there to be more than a minor adverse effect on the environment, the activity would be assessed as restricted discretionary.
Discharge of drainage water	There is unlikely to be any discharge of drainage water within the development. Permitted activity provided that there is no change to land in terms of potential flooding, erosion, instability or change in water quality discharge.
Discharge of human sewage	Discretionary activity for setting up a new system. Will need to show (through detailed design and supporting reports) that the proposal would not pose any risk to contamination of water, harm to ecology, or unacceptable human risk.
Discharges from drilling and bore testing	Permitted activity if the discharge does not cause flooding, erosion, land instability, sedimentation, and doesn't affect water quality or aquatic life. Bore drilling has already been undertaken on the site. The intention is to continue to manage any drilling and bore testing discharges such that they will be considered a permitted activity.
Discharge of water or tracer dye	Controlled activity if water discharged contains any other solutions i.e. disinfectant, antiseptic, chlorine, sewage. Otherwise could be a permitted activity (there are a number of conditions that need to be met for this status). Relates to sullage, cooling water, drinking water, water supply pipeline, swimming pool water to water or land. May apply to water scour and overflow from the water reservoirs.

Regional Plan - Land Use: **Lake or River Beds**	**Comments and Considerations**
The erection or placement of a structure	Permitted activity if fence, pipe, line or cable over the bed of a watercourse is not fixed to the bed at all, and does not impede the flow of water, or create erosion problems. Considerations include effect on water quality, ecology, amenity.
Alteration of the bed of a lake or river	With water supply proposed as lake abstraction, alteration of the lake bed could be required (depending on form of water take). Considerations include effect on water quality, ecology, amenity.
Removal of vegetation	Controlled activity consent for removal of some species. From site investigations and results of Ecological Assessment (see report by Natural Solutions for Nature) there are unlikely to be any such species within the plan change site. However, with most vegetation being native to the area, changes to the bed of the stream channel may trigger this rule. Introduction of species is allowed subject to them being native to the area. New species introduction is prohibited.

Regional Plan – Water: **Land Use other than in Lake or River Beds**	**Comments and Considerations**
Bore Construction	Controlled activity Unlikely to now be required given the move to the lake abstraction option. However, the summary of these consenting requirements are as follows. Council may exercise control over method, position, construction etc of the bore. May require a bond to control/ ensure against any adverse environmental affects. Applications will not be notified and there is no need to obtain any written approvals.
Drilling other than for the purpose of creating a bore	Controlled activity Council may exercise control over method, position, and construction etc of the bore. May require a bond to control / ensure against any adverse environmental affects. Applications will not be notified and there is no need to obtain any written approvals. Will apply to geotechnical investigative drilling associated with detailed design stages.

Discharge to air consents may also be necessary for subsequent development within the plan change site and the sewage treatment plant. Depending on the potential tenancies within the employment zone there may be additional consents required for this area, but it is assumed that these will be the responsibility of the tenants.

Appendix A

Site photos

Appendix A

Site Photos

This appendix contains various site photos, pages 1 – 8.

Photo 1 – Existing Kingston Township (looking west)

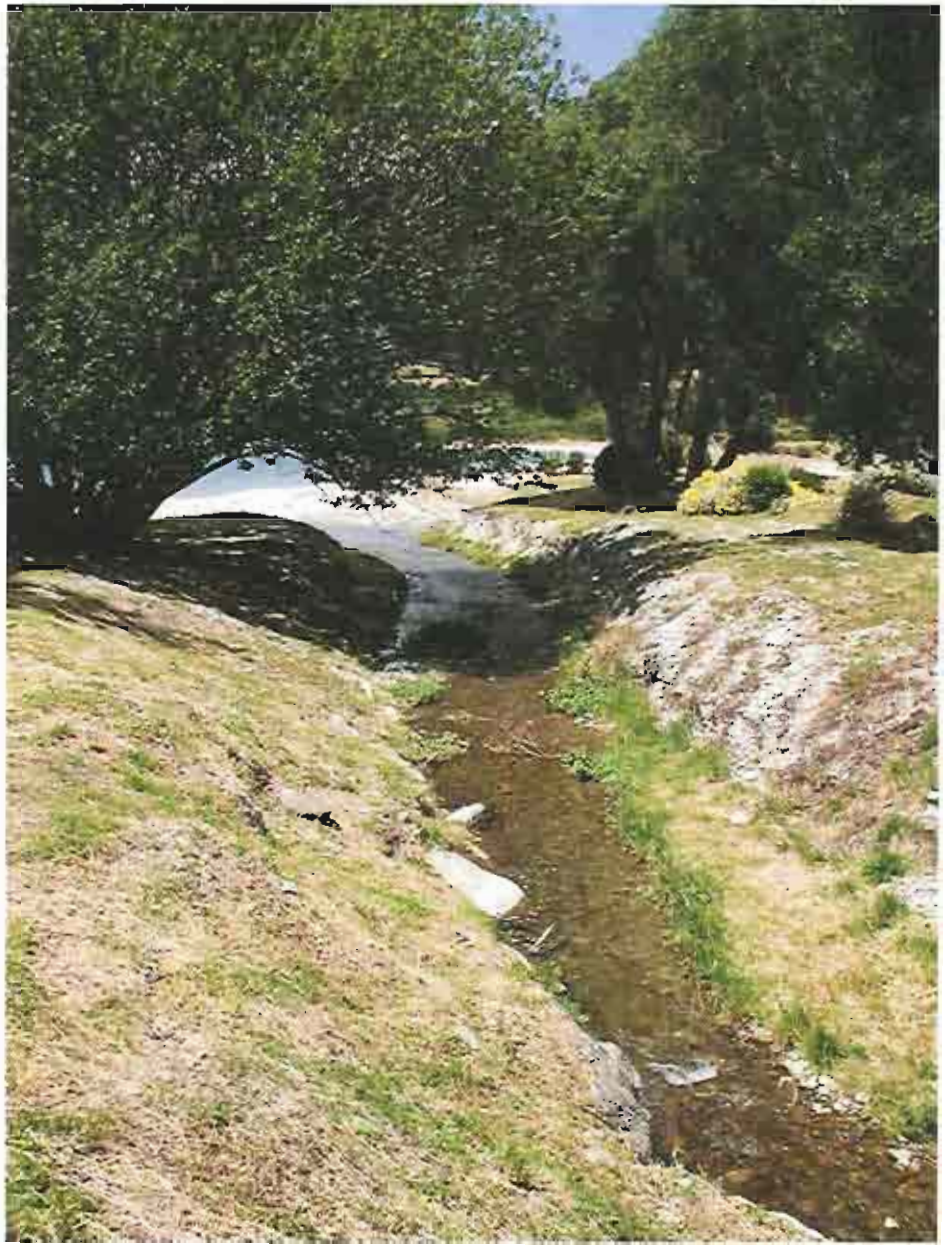


Photo 2 –Kingston Stream

Photo 3 –Stream through Plan Change site passes through existing township, through culverts and under bridge above before discharging to Lake Wakatipu

Photo 4 –Existing Golf Course

Photo 5 –Existing Golf Course

Photo 6 –Plan Change site (from south west corner)

Photo 7 –Plan Change site (from south west corner, showing deeply incised drainage channels)

Photo 8 –Plan Change site (from south west corner, looking northwest, viewing Eyre Mountains)

Appendix B

Woods Bagot Master Plans

Appendix B

Woods Bagot Master Plans

This appendix contains the Woods Bagot Master Plans, for reference.

Land Use

- Activity Area 1A (Higher Density Residential)
- Activity Area 1B (Medium Denstiy Residential)
- Activity Area 1C (Lower Density Residential)
- Activity Area 2 (Employment Land)
- Activity Area 3 (School)
- Activity Area 4A (Village Clubhouse Precinct)
- Visitor Accommodation
- Local Reserve
- Local Reserve (Golf Course)
- Stormwater Management
- Neighbourhood Reserve
- Walkway

Kingston Village Urban Design Master Plan
Kingston Village Limited & Queenstown Lakes District Council

Urban Design Framework Plan
Drawing No. Sk-001 | Revision C | 16th October 2008

Road Hierarchy

- Collector Road (Greenway)
- Local Roads (Business)
- Local Roads (Residential - Primary)
- Local Roads (Residential - Secondary)
- Rear Access Lanes
- Stormwater

LAKE WAKATIPU

SOMERSET STREET

DORSET STREET

GLOUCESTER STREET

DEVON STREET

LEGAL ROAD (varied width)

SHROPSHIRE STREET

HAMPSHIRE STREET

KENT STREET

CAMBRIDGE STREET

OXFORD STREET

KINGSTON RAILWAY

KINGSTON RAILWAY

KENT STREET

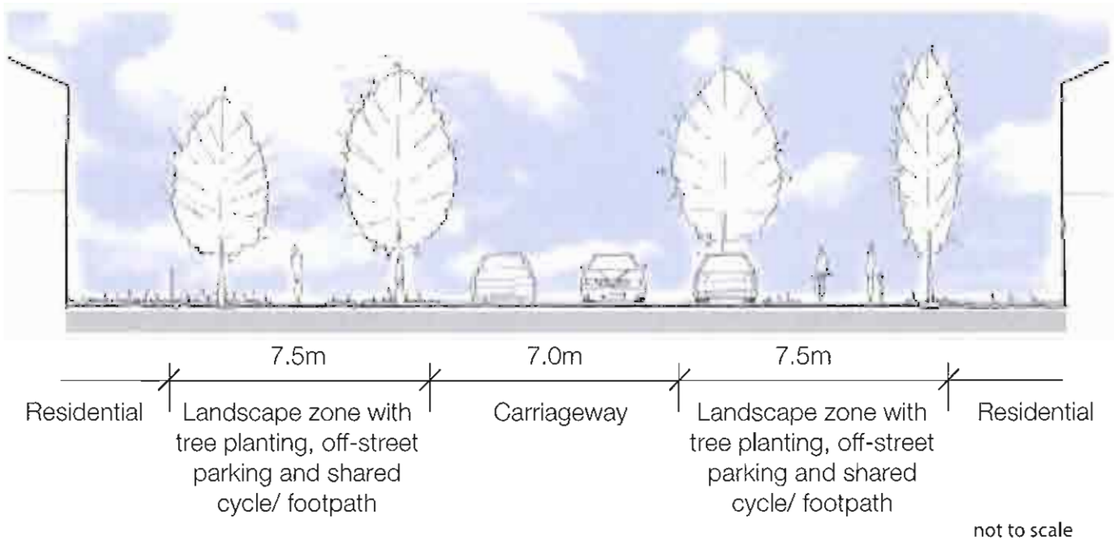
KINGSTON RAILWAY

KINGSTON RAILWAY

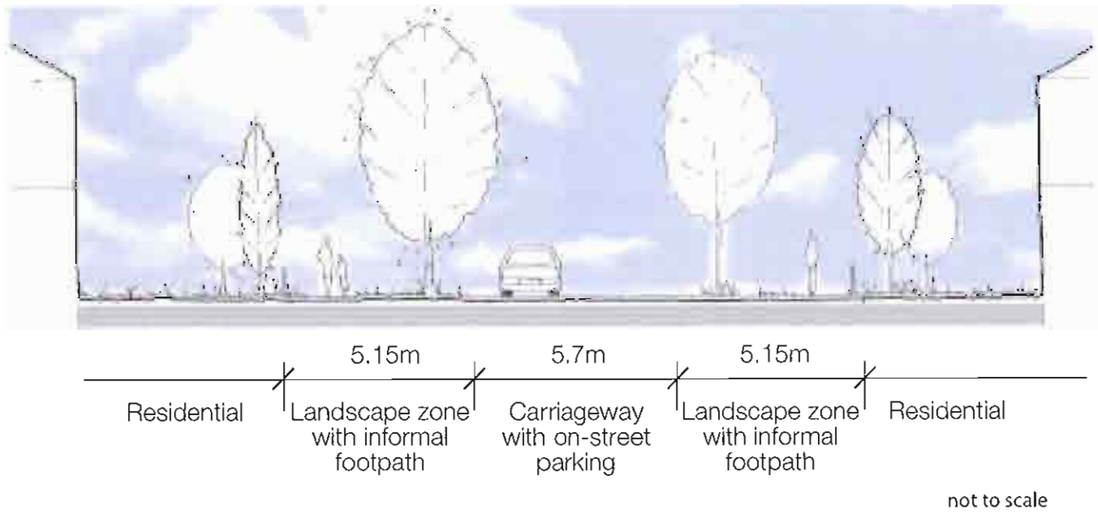
WOODS BAGOT

Kingston Village Urban Design Master Plan
Kingston Village Limited & Queenstown Lakes District Council

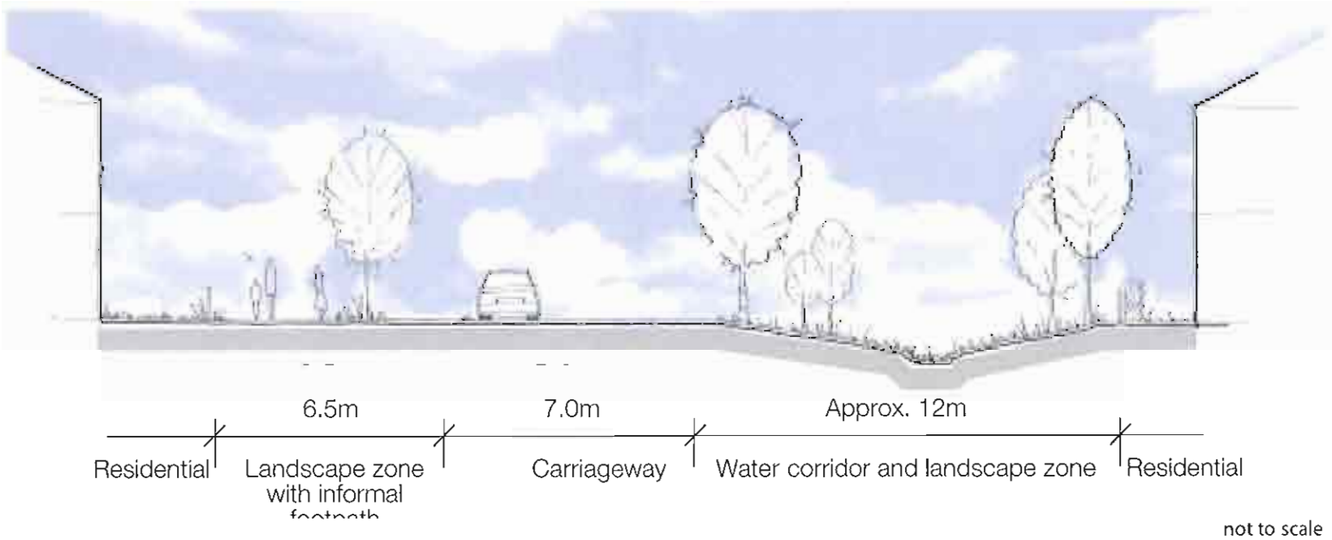
Street Hierarchy Plan
Drawing No. Sk-002 | Revision C | 13th October 2008



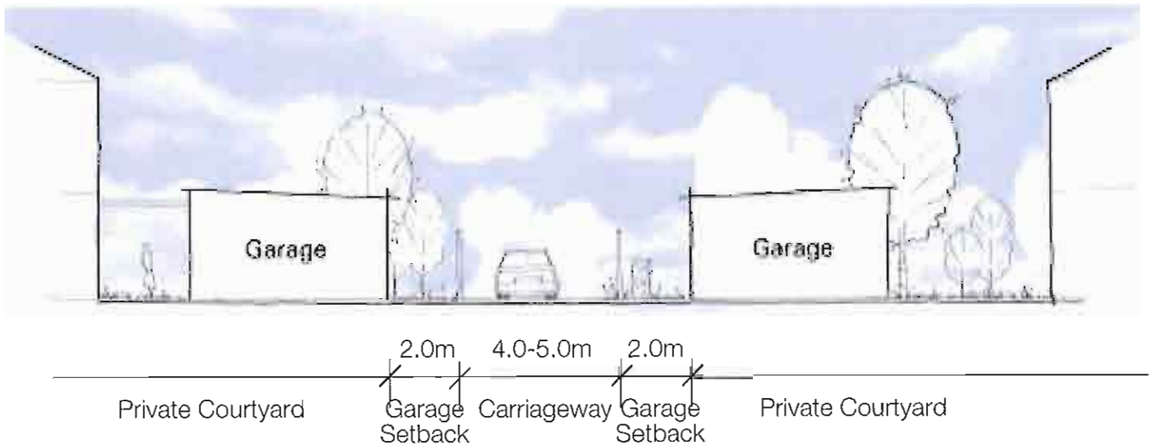
Typical Section A - Kingston Greenway (22m)



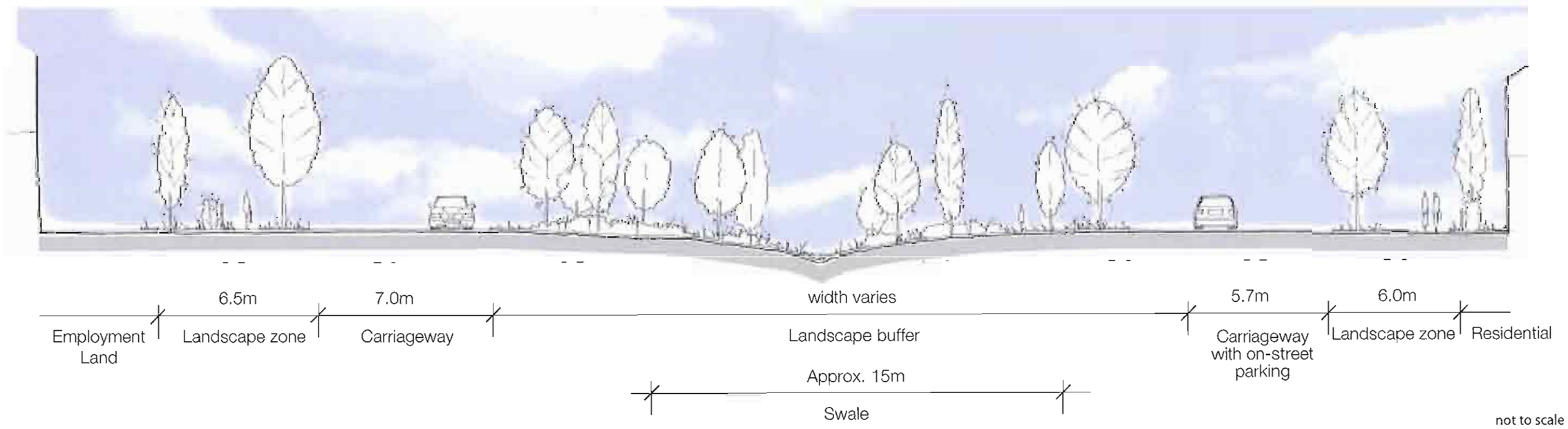
Typical Section B - Local Road - Residential Secondary (16m)



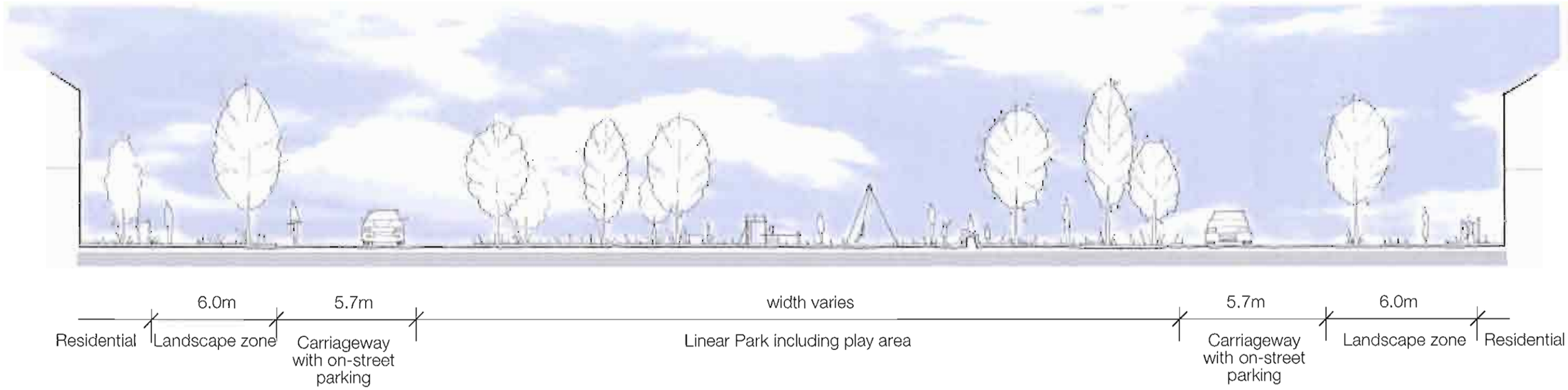
Typical Section C - Local Road - Residential Primary (20m) and Swale (width varies)



Typical Section D - Rear Access lane (4-5m)

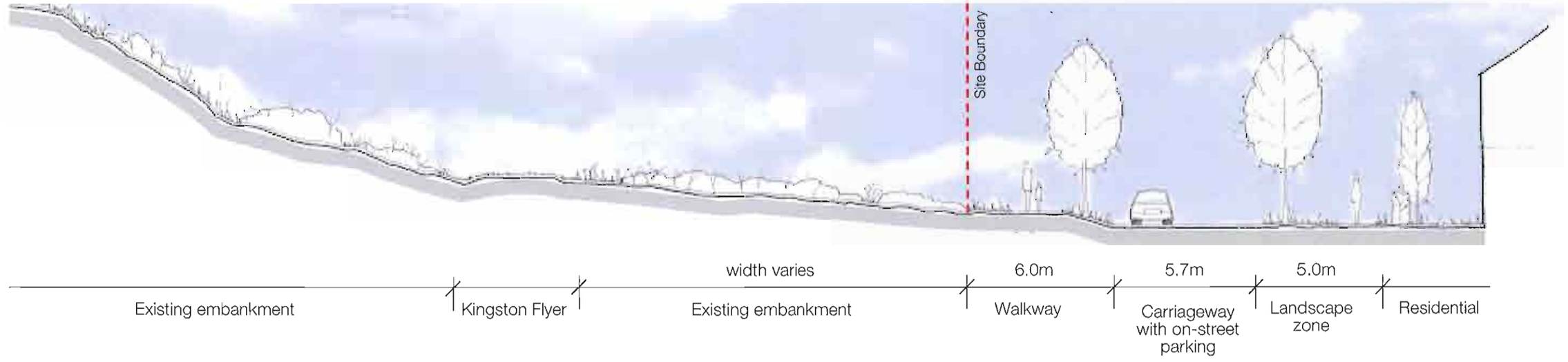


Typical Section D - Water Corridor and Landscape Buffer to Employment Land (width varies)



not to scale

Typical Section E - Linear Park (width varies)



not to scale

Typical Section F - Kingston Flyer Embankment and Walking Trail (width varies)