Resource Consent Application

Assessment of Environmental Effects

Discharge of Treated Domestic Effluent into Land
Kingston Township

Prepared for

Queenstown Lakes District Council

Prepared by

LWE Environmental Impact

May 2020

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Quality Assurance Statement		
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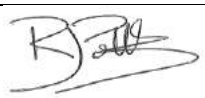
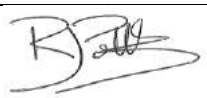
Reviewed by:	Rob Potts	
Approved for Issue by:	Rob Potts	
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Job No.: 10639

Date: 14 May 2020

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APPLICATION FOR RESOURCE CONSENT
UNDER SECTION 88 OF THE
RESOURCE MANAGEMENT ACT 1991

To: Otago Regional Council

1. **We, Queenstown Lakes District Council,**

   C/- Peter Hansby,
   General Manager (Property and Infrastructure)
   Queenstown Lakes District Council

   Mailing Address:
   Private Bag 50072
   Queenstown 9348

   Physical Address:
   10 Gorge Road
   Queenstown 9300

   Apply for the following types of resource consent:

   a) A Discharge Permit to discharge treated domestic effluent to land.

2. **The Activity** to which the application relates (the **proposed activity**) is as follows:

   - To discharge 1,800 m^3/day of treated domestic effluent from Kingston Township and surrounding subdivisions into land.

3. **The site** at which the proposed activity is to occur is as follows:

   Physical Location: 87 Kingston-Garston Highway, Kingston Rural, 9793
   Legal Description: P34 PT RUN 323A KINGSTON SD - BAL AT 284 41/15400, 29300/34601 - KINGSTON STATION
   Title Identifier: ID: 8826
   Map Reference of the site: -45.3453 Latitude 168.7038 Long

4. Owner/Occupier: Kingston Station (Crown Land) , Timothy, Craig and Patricia Tayler hold the Crown pastoral lease

5. There are **no other activities** that are part of the proposal to which this application relates.

6. **Additional resource consents, a Notice of Requirement** from Queenstown District Council is required for the proposal to which this application relates.

7. We attach an assessment of the proposed activity's effect on the environment that:

(a) includes the information required by clause 6 of Schedule 4 of the Resource Management Act 1991; and

(b) addresses the matters specified in clause 7 of Schedule 4 of the Resource Management Act 1991; and

(c) includes such detail as corresponds with the scale and significance of the effects that the activity may have on the environment.

8. We attach an **assessment of the proposed activity against the matters set out in Part 2** of the Resource Management Act 1991.

9. We attach an **assessment of the proposed activity against any relevant provisions of a document referred to in section 104(1)(b)** of the Resource Management Act 1991, including information required by clause 2(2) of Schedule 4 of that Act.

10 The **value of the investment** of the existing consent holder is: n/a, no existing consent.

11 Omitted.

12 Omitted.

13 Omitted.

14 We attach the following further information required to be included in this application by the District Plan, the Regional Plan, the Resource Management Act 1991, or any regulations made under that Act:

(a) Location Plan.
(b) Certificate of Title.

Dated 13 May 2020.

Consultant's Signature

Brian Ellwood
Senior Environmental Engineer
Lowe Environmental Impact Limited

Applicant's Signature

Peter Hansby
General Manager (Property and Infrastructure)
Queenstown Lakes District Council

Contact Details
Address for service of applicant

Queenstown Lakes District Council
C/- Lowe Environmental Impact
P O Box 29288
CHRISTCHURCH, 8540

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1 INTRODUCTION

1.1 Overview

Queenstown Lakes District Council (QLDC) propose to develop a community wastewater treatment scheme for Kingston Township (Kingston) and apply for resource consent for the discharge of treated wastewater effluent into land.

Kingston does not currently have a community sewerage scheme and all residences are responsible for the treatment and disposal of their own wastewater on-site. The existing management of wastewater is not considered by the community to be satisfactory in terms of:

- The environmental impact on water quality;
- Public health risks associated with uncontrolled wastewater discharges;
- The overall level of service provided to the community; and
- Otago Regional Council Water Plan.

At the same time, there is a proposed new subdivision near Kingston that requires wastewater treatment facilities. The proposed treatment facilities are part of the Housing Infrastructure Fund (HIF) financing request that is in progress, and that is supported by ORC (Gavin Palmer ORC, sits on the HIF Governance Group). The proposed new QLDC treatment plant and the discharge of the treated wastewater will have the capacity to treat wastewater from both the proposed subdivision and the existing township, with allowance for some future growth.

QLDC has assessed a number of options relating to the possible implementation of a Community Sewerage Scheme and proposes the development of a treatment plant and land treatment area (LTA or "land application area") on land known as "Kingston Station", located on the south side of the township. The overall system layout will likely comprise of hybrid gravity/pressure sewer reticulation, a package treatment plant and effluent application into land via subsurface pressure compensating drip irrigation.

The following information can be located in the report appendices.

Appendix A: Soil Site Investigations – Hadley Consultants Ltd (2018) and LEI (2018);
Appendix B: E3 Scientific – Aquatic Ecological Review; and
Appendix C: Surface and Groundwater Monitoring Location Plan.

1.2 Project Scope

Lowe Environmental Impact (LEI) has been engaged to undertake the following work:

- Site investigation of Kingston Station land, to confirm suitability for the siting of a LTA;
- Preparation of a conceptual LTA design;
- Undertake an Assessment of Environmental Effects; and
- Prepare a resource consent application for the discharge of treated community (domestic) effluent into land.

This resource consent application has been prepared in accordance with the requirements of the Resource Management Act 1991 (RMA) and sets out a consideration of the actual and potential effects of the proposed works on the environment.

The scope of this application is for the LTA and its air discharge that is assessed as a permitted activity. The associated wastewater treatment plant may require an Air Discharge consent depending on configuration which will be confirmed as part of preliminary design.

2 SITE CHARACTERISTICS

2.1 Locality and Surrounding Land Use

Kingston Township is a small town on the southern end of Lake Wakatipu, nestled between the Eyre Mountains and the Hector Ranges. The township is approximately 40 kilometres drive to Frankton or 47 kilometres drive from central Queenstown. Figure 2.1 shows the location of Kingston Township.

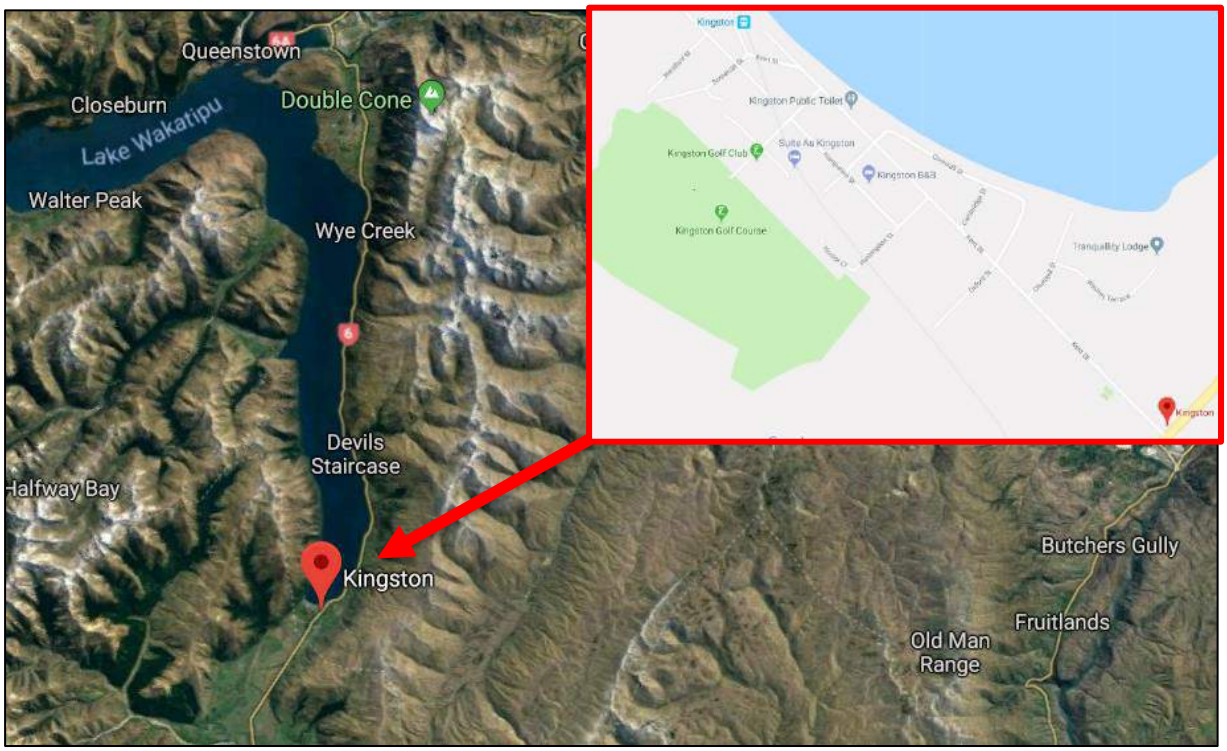

Figure 2.1: Kingston Township Location Relative to Queenstown

A report by Selvarajah, S (2015) states that Kingston (Figure 2.1) is a septic tank township which has many permanent residents and holiday visitors. There are not many commercial or retail outlets except for a camping park facility and a café/store. There are an estimated 270 dwellings in the wider Kingston area with simple individual septic tank systems. Some properties located near the lakeshore are prone to flooding when the lake level is high. It is likely that when flooding occurs, septic tanks may operationally fail and release contaminants to groundwater. It is estimated that approximately 225 septic tanks could be connected to a new wastewater reticulation system.

Since there is no reticulated water supply, properties rely on shallow groundwater and rain water collection tanks for drinking purposes. Shallow groundwater is likely to be contaminated with faecal bacteria given the shallowness (2 - 4 m) of the groundwater combined with the old septic tank systems (Selvarajah, 2015).

2.2 Treatment and Land Application Area

QLDC propose to site the wastewater treatment plant (WWTP) and land treatment area (LTA) within a parcel of land known as "Kingston Station", is owned by the Crown and managed by Land Information New Zealand (LINZ). Timothy, Craig and Patricia Tayler hold the Crown

pastoral lease. This land is to the south of Kingston. The proposed site is located adjacent to State Highway 6 and the Kingston Flyer railway line.

The proposed LTA irrigation command area available on Kingston Station is approximately 25ha (Figure 2.3). The LTA area is proposed to be developed in several stages allow development flexibility and to match the number of properties serviced by the treatment system. The land application area required at full development is a minimum of 15 ha within the full 25 ha that is available . It is proposed that there will be no less than 5ha during the initial stage of development.

The LTA is proposed to be managed as a cut and carry system. The existing land use is predominately pasture with some forage crops planted previously. Due to the relatively shallow soil depth and low water holding capacity of the soils, the surrounding area is not generally intensively farmed. However, winter grazing of dried-off dairy cows occurs from the beginning of June each year for 2 – 3 months on up to 170 ha of winter crops (such as kale and swede) and grass pasture. The remainder of the large run property is grazed by sheep and beef on pasture at relatively low intensity. Figure 2.2 shows a concept design of the proposed housing development and existing Kingston village. The proposed location of the land treatment area on Kingston Station to the south of Kingston is shown in Figure 2.3.

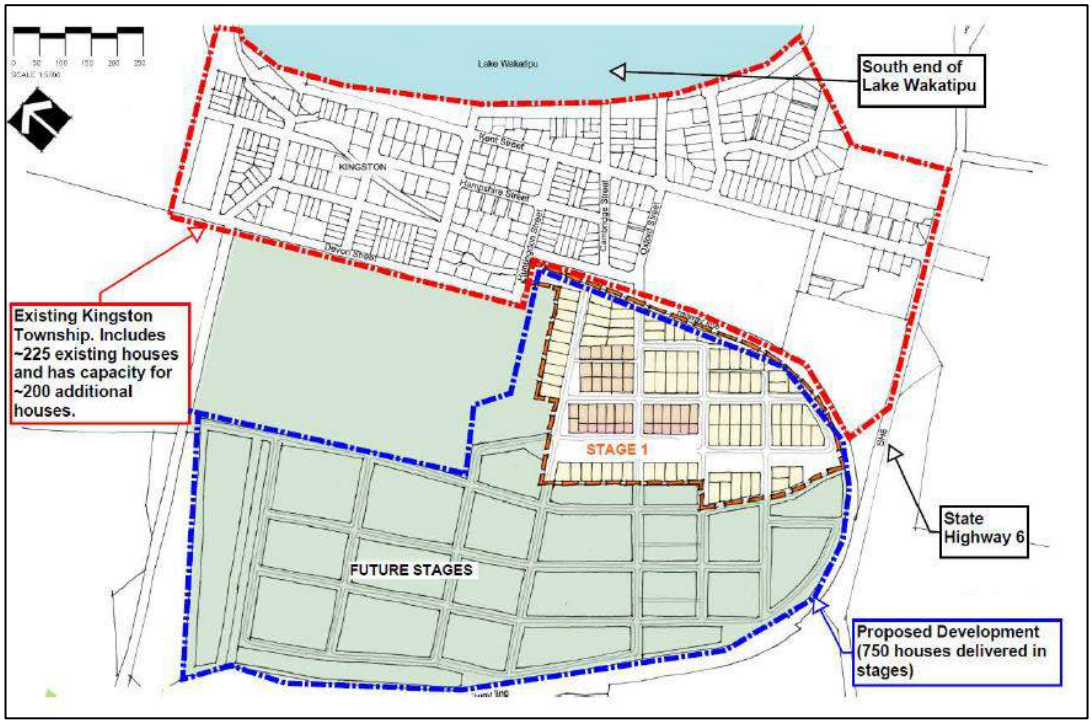

Figure 2.2: Kingston Township Proposed Development Area

Figure 2.3: Kingston Proposed Land Treatment Command Area

Table 2.1 provides a summary of the proposed WWTP and LTA location on Kingston Station.

Table 2.1: WWTP/LTA Location and Surrounding Land Use

Parameter	Parameter Description
WWTP & LTA location	Kingston Station; 87 Kingston-Garston Highway, Kingston Rural, 9793; Queenstown Lakes District
Existing land use pasture	Dairy grazing, sheep and beef
Total land area	The proposed LTA will be a minimum of 15 ha at full development. The LTA potential command area is approximately 25ha. The WTTP is outside of this area.
Legal description	P34 PT RUN 323A KINGSTON SD - BAL AT 284 41/15400, 29300/34601 - KINGSTON STATION
Title identifier	ID: 8826
Surrounding land use	Grazed farmland. Kingston township to the north.
Topography	Flat terraced pastureland, with some rolling undulations between terraces
Onsite activities	Farming, railway passes adjacent to the property. There have been no HAIL activities within the proposed LTA, but there is a registered HAIL site on the title associated with the historic landfill.
Surface waters	Lake Wakatipu

2.3 Existing Environment

The existing environment includes all development and activity currently on site and in the surrounding environment which has been lawfully established.

In this case the existing environment comprises of the long-established Kingston township adjoining the lake, which is currently zoned 'Township' zone under the Operative District Plan.

This zoning is proposed to be changed to 'Settlement zone' by the QLDC through the District Plan review. Both the Township and Settlement zones seek to retain 800 m^2 residential sections for the entire township area, and the proposed Settlement zone will enable one residential dwelling and one residential flat on each property. This is an increase in density as the current Township zone only enables one residential dwelling on each property. Most of the township has been developed, however more recently some smaller residential developments have been approved in the township area which enables further development to occur on vacant sites, i.e. Glendinning Crescent- RM170870- 32 Lot subdivision approved; Hector Close- RM041101- 11 Lot subdivision approved.

Between the existing township to the north, and the subject LTA site to the south is a large area zoned for urban development- Kingston Village Special Zone, owned by Kingston Village Limited. This zone enables the future growth of Kingston village and consists of Low, Medium and High-Density development, employment areas, an education precinct, a village clubhouse precinct, a visitor accommodation precinct and open space areas. A subdivision application has been lodged and partially processed by the QLDC for developing this land (RM181534) into 217 residential lots and associated infrastructure. Although this is a helpful context, this proposed development does not form the 'existing environment', as it is not yet lawfully established.

The Kingston Flyer train has historically circumnavigated the Kingston area, and the tracks are a protected historic feature. There are other historic features around the Kingston area protected through the District Plan.

The subject LTA site is used for farming purposes and contains no relevant resource consents for development.

As shown on the District Plan zone map Figure 2.4 below:

- The subject site is zoned Rural, and is within the Outstanding Natural Landscape (yellow with brown ONL line);
- The Kingston Village Special Zone (green) is zoned for a mixed density/use of urban development as above; and
- The Kingston township is zoned 'Township' (light pink/white) and is proposed by the QLDC to be rezoned to 'Settlement' zone.

Figure 2.4: District Planning Zoning for Site

2.4 Climate

2.4.1 Overview

Hot dry summers and cold winters are the general climatic characteristics for the Kingston District. In winter, snow can reach the Lake Wakatipu shoreline. During times such as spring, heavy rainfall or rapid snowmelt can cause flooding around the shore of Lake Wakatipu, approximately 1.3 km to 1.5 km from the LTA. The prevailing weather comes from the NW or SE, channelled between mountains and along the valleys.

2.4.2 Rainfall and Potential Evapotranspiration

There is limited recent weather information from weather stations near Kingston. The closest weather station (Kingston AWS: Station Number 5467) is 4.5 km away from the LTA, but this station only has weather recordings from 2012. A report by NIWA (2013) summarised the data from this weather station, with the Kingston mean monthly rainfall for the period 1981 – 2010 and mean monthly soil moisture deficits for the same period displayed in Table 2.2. The average annual rainfall for Kingston is 944 mm and the average annual soil moisture deficit is 208 mm.

Table 2.2: Kingston Monthly Mean Rainfall and Soil Moisture Deficit (mm)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Rainfall	88	61	74	75	84	85	70	79	79	87	67	96	944
Soil Moisture Deficit	62	45	20	4	0	0	0	0	0	3	23	46	208

This is comparable to the rainfall range for the Kingston area provided in the GrowOtago (2016) online maps, which map Kingston as having an annual rainfall of between 901 – 1000 mm. The GrowOtago online maps also suggest an annual average temperature between 10.1 - 10.5 °C.

The nearest weather station with comprehensive climate data is Queenstown (Station Number 5446) located 31 km away from Kingston Station. The average monthly data for this station from 1998 – 2017 is summarised in Table 2.3.

Table 2.3: Queenstown AWS Monthly Mean Rainfall, Potential Evapotranspiration and Air Temperature

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tot
Rainfall (mm)	75	56	57	57	91	81	67	71	87	82	68	67	865
Potential Evapotran (mm)	121	91	57	20	0	0	0	8	32	67	98	116	610
Surplus/ Deficit (mm)	-46	-35	0	37	91	81	67	63	55	15	-30	-49	
Mean Air Temp (Celsius)	17	17	15	11	8	6	5	6	9	11	13	16	11

2.4.3 Wind

There is limited wind data available for Kingston; the wind direction is generally from a northerly or southerly direction, due to the funnelling action of mountains either side of Lake Wakatipu. No wind gauging stations are located within the locality, however, GrowOtago (2016) suggests an annual average wind speed of 8.1 km/hr – 10.0 km/hr.

2.4.4 Soil Temperature (10 cm)

There are no soil temperature monitoring sites within a 30 km radius of Kingston. Cromwell Ews is the nearest site with recent data over 10 years and is located approximately 50 km to the northeast of the proposed WWTP & LTA. It has been used to give an approximation of the likely Kingston LTA 10 cm soil depth temperatures (for the period 1996 – 2018), as summarised in Table 2.4.

Table 2.4: Cromwell Ews 10 cm Soils Temperature (2004 – 2015)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Average °C	20	19	15	11	6	3	2	3	7	10	15	19

The GrowOtago maps (2015) suggest a winter soil temperature range of 3.6 ^{O}C to 4 ^{O}C at the proposed LTA zone, which is comparable with the average recordings shown in the Cromwell Ews data for June, July and August.

Based on the information available, it is considered that the average winter 10 cm soil depth temperature will be within the range of 2 ^{O}C and 4 ^{O}C and it is unlikely that the temperature will fall below 0 ^{O}C for any extended period.

2.5 Soils and Geology

2.5.1 Geology and Geomorphology

Kingston Township sits within a steep sided glaciated valley at the southern end of Lake Wakatipu. Valley deposits comprise of glacial till, lacustrine alluvial (beach) deposits and alluvial glacial outwash deposits. Basement rock beneath the alluvial soil deposits is

comprised of Schist and this Schist extends up into the mountains that lie either side of the valley floor. Geology is summarised in IGNS Q-map series Wakatipu (Scale 1:250,000), Figure 2.5, with the LTA site shown by the red ellipse.

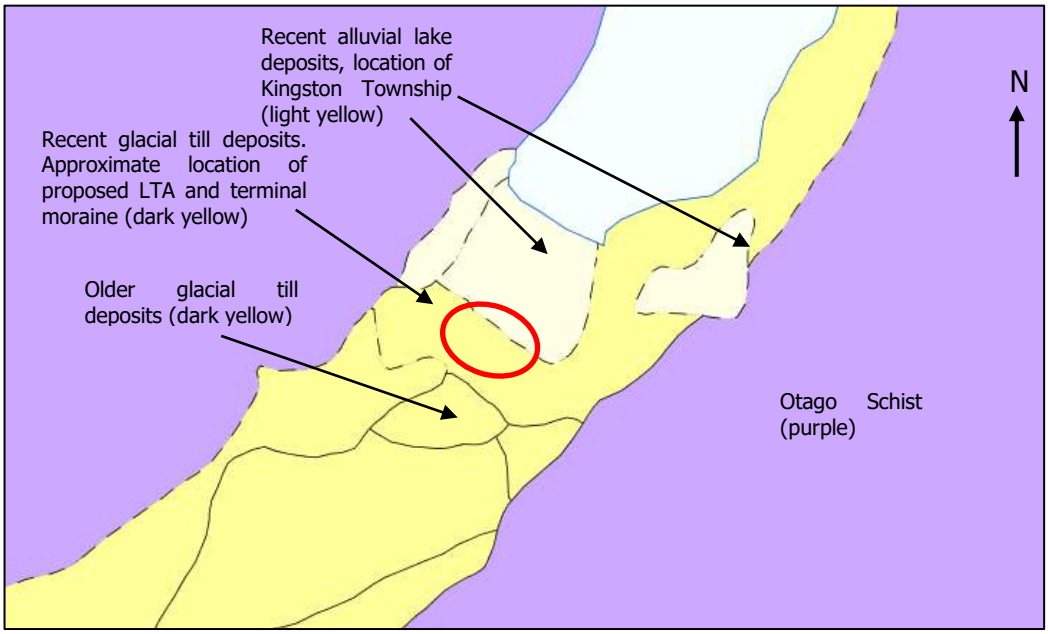

Figure 2.5: Geology of the Kingston Township Area (IGNS Map: Wakatipu)

Moving south from the lake shore, the township extends approximately 1 km on land that is underlain by lake deposits (beach gravel/sands etc). Further to the south, a glacial till mound (terminal moraine) extends across the valley, essentially cutting off any lake flow that could potentially empty to the south, thus creating a catchment divide. This till mound is the proposed location of the land treatment area (Figure 2.5). It sits approximately 30 m to 60 m higher than the township to the north, and 20 m to 40 m higher than the pastureland to the south.

2.5.2 Soils' Characteristics

The soil within and around the proposed LTA zone on Kingston Station is mapped as a pallic orthic brown, well drained shallow Maude silty loam (Landcare Research, 2018). Figure 2.6 shows photographs of the soils taken by LEI in 2018 from the proposed Kingston LTA.

Figure 2.6: The Soil Profile from the Proposed Kingston LTA

Hadley Consultants Ltd carried out a site investigation in May 2017. There were 19 soil test pits dug to a depth of 1.5 m - 2.7 m below ground level (m bgl). Figure 2.7 presents the testing locations.

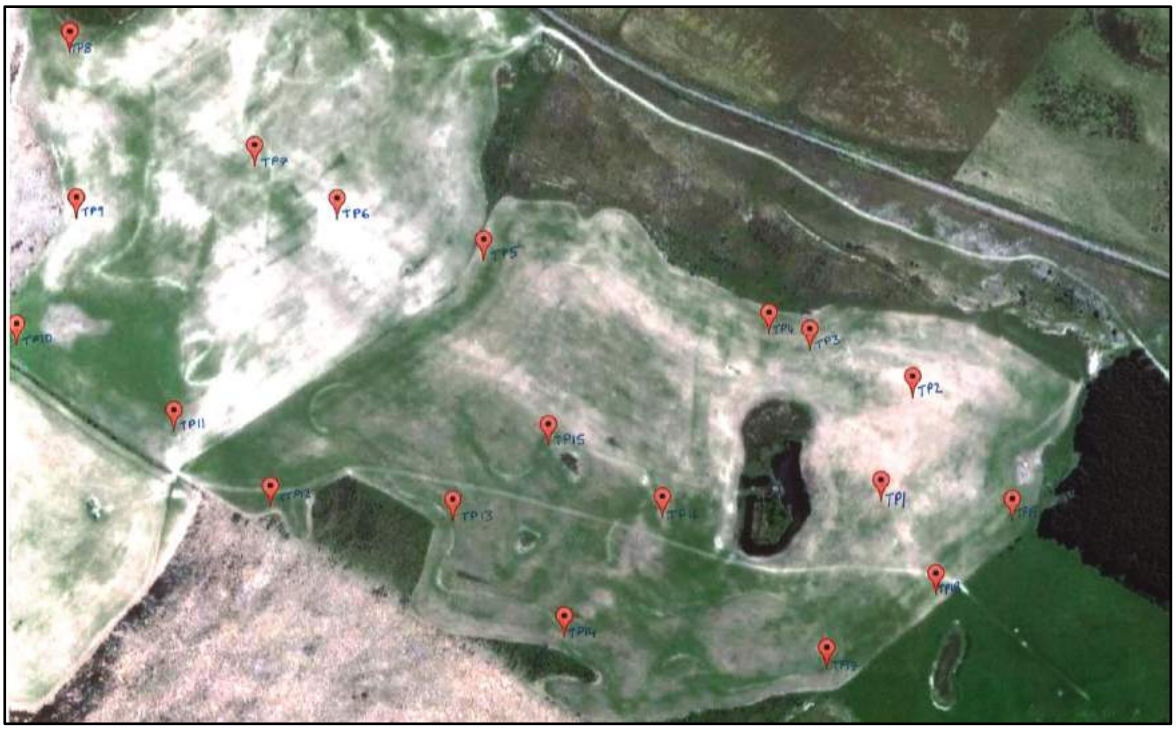

Figure 2.7: Kingston Station Soil Testing Locations

The soils across the site generally comprised of 100 mm - 300 mm depth of organic/silt loam topsoil, overlying a silt loam with varying amounts of sand and gravel. This silt loam layer generally extends down to depths of approximately 0.2 m to 2.5 m. Beneath this loam, glacial till was encountered at depths of between 0.9 m and 2.0 m. Not all test pits encountered the till, however. The investigation by Hadley Consultants Ltd indicated that across the site, soils were somewhat variable. The test pit logs from this soil investigation are presented in Appendix A.

2.5.3 Hydraulic Conductivity

In 2018, LEI carried out both saturated (K_{sat}) and unsaturated (K_{-40mm}) infiltration and hydraulic conductivity testing across the proposed Kingston LTA. The testing sites are shown in Figure 2.8. This was required to determine the suitable application depth of the land application site to receive effluent with respect to the full soil matrix infiltration characteristics. The unsaturated test at a matrix potential of – 40 mm assimilates flow through the meso and micro-pores of the soil and is therefore not influenced by flow down root and worm holes as saturated infiltration and conductivity tests can be.

Figure 2.8: Kingston Station Soil Testing Locations by LEI, 2018

Soil K measurements were performed using double rings (K_{sat}) at the soil surface and the plate permeameter (K_{-40mm}) method of Perroux and White (1998) at 150 mm depth below the soil surface. Four replicate tests were carried out for each K measurement at each field test site (e.g. 4 x K_{sat} & 4 x K_{-40mm} tests). The Landcare Research Laboratory test results were undertaken on one core for sites 1 to 4 and two cores for sites 5 and 6 with the cores taken at 150 mm depth reported. Table 2.5 provides a summary of the results.

Table 2.5: Field and Laboratory Measurement Hydraulic Conductivity Results

Location	Saturated (K_{sat}) (mm/hr)	Unsaturated (K_{-40mm}) Field test (mm/hr)	Unsaturated (K_{-40mm}) LandCare (mm/hr)
Site 1	60	3.82	12
Site 2	156	2.96	50
Site 3	90		19
Site 4	45	4.52	27
Site 5	25.5	1.10	10
Site 6	122.5	1.78	7
Average	**83.17**	**2.83**	**20.13**

In addition to allowing for the ability of water to enter the soil, consideration should be given to the effect of wastewater constituents, as opposed to clean water effects which are typically observed during field measurements. Organic material, solids and nutrients in the wastewater can allow the development of microbial growth commonly referred to as biofilm, which in turn can result in a 'clogging' effect of the soil pores, particularly near the irrigation line outlets. This, in turn, reduces the soil's infiltration capacity. In addition, the salt concentration will influence the soil wetting by altering water tension. Design Irrigation Rates (DIR) are based on the following methodologies.

- Crites and Tchobanoglous (1998) recommend a value of 10% - 30% of the K_{sat} to provide a DIR;

- LEI has adopted the more conservative 30% of K_{-40mm} as a design standard.

Determination of the DIR is presented in Table 2.6.

Table 2.6: Design Irrigation Rate

Location	Saturated (K_{sat})	Field Unsaturated (K_{-40mm})
Field Measurement (mm/day)	1,996	68
Adjustment (%)	10	30
DIR (mm/day)	199	20.4
Recommended DIR (mm/day)	Maximum of 20	

The difference between K_{sat} and K_{-40mm} indicate that saturated flow is substantially higher than unsaturated flow. This is an important consideration when designing an irrigation regime where macro pore drainage is to be minimised and full matrix flow through the soil is encouraged. The DIR should be based on K_{-40mm} rather than K_{sat} to avoid excessive drainage occurring and to maximise contact with the soil. Therefore, LEI has taken the lower infield measured unsaturated flow to base a conservative maximum irrigation rate of an average of 20 mm/day; this is considered suitable for long term application on the site with regard to absorbance, infiltration and adsorption. This can be applied as a peak wet weather application depth of 36 to 48 mm to a block, with a 3 - 4 day return period to average 12 mm/d. Normal dry weather depth of application is approximately 6 mm/day and up to 18 to 24 mm per return period.

2.5.1 Soil Testing Phosphorus

In 2018, soil samples were collected at the same time as LEI carried out hydraulic conductivity testing across the proposed Kingston LTA. The testing sites are shown in Table 2.7. For three sites, phosphorus storage capacity was assessed to determine the likely long-term retention of phosphorus. Soil analysis results from Hills Laboratory and Landcare Research are provided in Appendix A.

Table 2.7: Phosphorus Storage Capacity

Sample	Smax	Olsen P	Volume Weight	Olsen P	P Saturation	P Storage Capacity over 1.5 m depth
	(mg/kg)	(mg/L)	(kg/m^3)	(mg/kg)	(%)	(kg P/ha)
K Site 2:	728	9	1,090	8.3	1.13	11907.30
K Site 3:	570	15	1,090	13.8	2.41	9323.76
K Site 5a:	550	10	1,090	9.2	1.67	8987.14

2.6 Hydrogeology and Hydrology

2.6.1 Groundwater

The LTA area is located on the northern side of the catchment boundary between the Wakatipu and Mataura catchments. The LTA location on the saddle between the catchments means there is likely to be little groundwater movement across the site. Groundwater was not encountered in any of the test pits across the potential LTA during soil testing, indicating that groundwater is at least 2.5 m or more below ground level at the LTA site.

There are no groundwater bores drilled in the glacial till mound or its immediate vicinity. Therefore, no information has been gauged on underlying groundwater within the vicinity of

the LTA. There are a number of groundwater takes within the Kingston Township (Figure 2.9), but none within the LTA on Kingston Station. The nearest bore to the LTA is F42/0136 owned by QLDC. This bore is approximately 300 m from the LTA and is described as a council monitoring bore for a closed landfill, however, no depth or water level information is given. Based on the geology and soil types, topography, an examination of the surrounding lower elevation hillside and proximity to Lake Wakatipu, it is unlikely a shallow (less than 5 m) groundwater table is present, although there may be pockets of perched groundwater within the till mound itself. It is expected that the regional groundwater will be at an elevation similar to that of the lake level and therefore is in the order of between 40 and 60 m bgl of the proposed LTA. However, it is difficult to determine whether groundwater will flow north to Lake Wakatipu or south towards the Mataura catchment; with either being possible.

There are 36 bores which have been identified between the proposed LTA and Lake Wakatipu on the ORC database. The location of these bore and the indicative LTA command area is presented in Figure 2.9, with well information provided in Table 2.8.

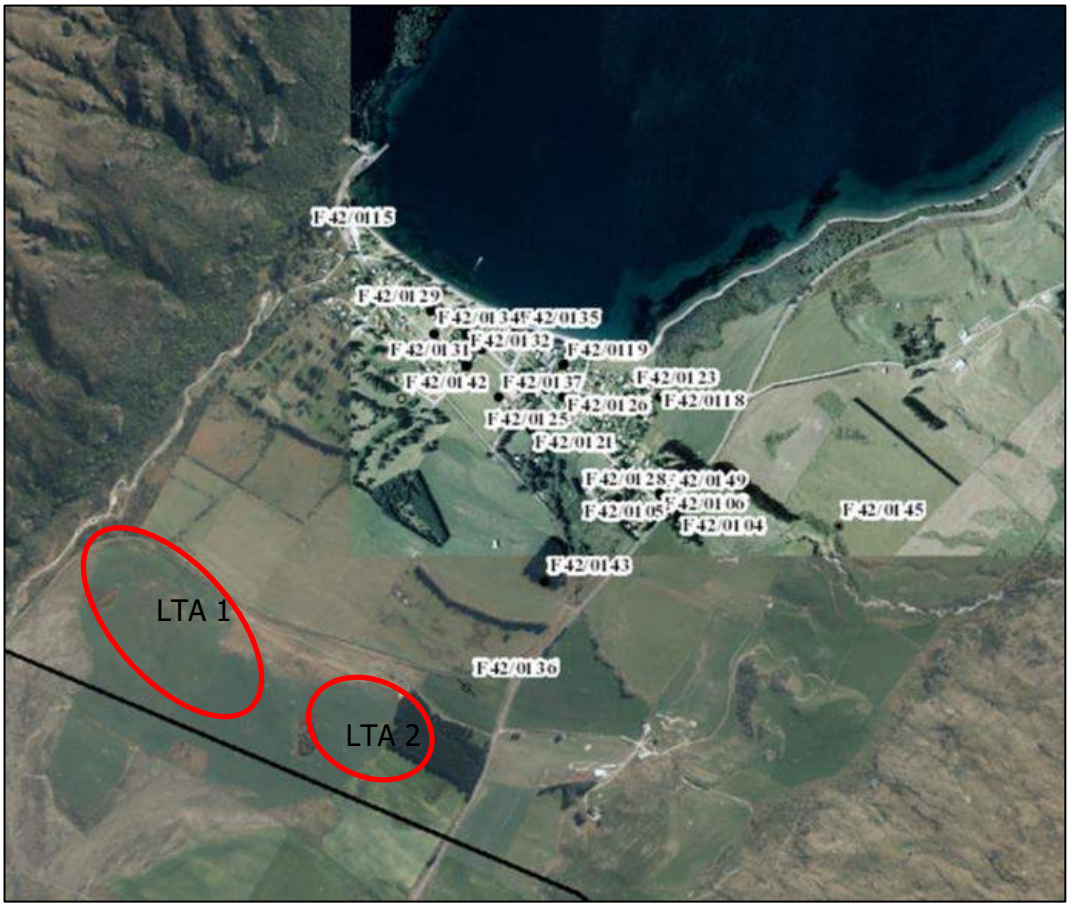

Figure 2.9: ORC Listed Bores within 5 km Radius of the LTA (ORC, 2018) (Red Oval indicative LTA location)

Table 2.8: Kingston Bores with 5 km Radius of LTA Zone

Well Number	Status[1]	Bore Depth	Depth to Water (m)	Elevation (m RL)	Owner	Use[2]
F42/0104	Comp	9.3	4.5	355	Leighton J	DO/IR
F42/0105	Comp	2.1	0.38		Donaldson S & G C/- Kingston Stream Holiday Camp	SC
F42/0106	Comp	2.65	0.7		Watson R & G	CM/DO
F42/0107	Comp	3.72	2.645	315	Collinson G	DO
F42/0108	Comp	4.45	2.3	414.66	Beaton J	DO
F42/0109	Comp	4.68	2.1		Hilston P	DO
F42/0110	Comp	3.22	1.62		Hardy N	DO
F42/0111	Comp	3	2.195		Gibson M	DI
F42/0112	Comp	4.1	1.315		Cochrane S	DI
F42/0113	Comp	4.4	1.2	320	Gore Power Boat Club	DO
F42/0114	Comp	1.75	0.625		Edgley N	DI
F42/0115					Miller C H	DI
F42/0116	Comp	4.5	1.32		Mcdonald G	DO
F42/0117	Comp				Mcdonald G	DI
F42/0118	Comp	2.2	1.28	416.06	Mcclelland A & E	DO
F42/0119	Comp				Mcfadzien D	DO
F42/0120	Comp	3.25	1.31		Ward A	DI/DO
F42/0121					Mcrae A F	DO
F42/0122	Comp	4			Coyle J	DI
F42/0123	Comp	4			Coyle J	DI
F42/0124	Comp	2.95	1.97		Morris M	IR
F42/0125	Comp	2.95	1.97		Morris M	
F42/0126	Comp	3.6			Coleman H	DO
F42/0127	Comp	3.5			Clark J	DO
F42/0128	Comp	1.83			Johnson B	DO
F42/0129	Comp	2.85	1.1	315	Longstaffe B	DO
F42/0130	Comp	2.45	1.32	411.55	Leighton J	DO
F42/0131		2.8			Carlin Enterprises Ltd	SC
F42/0132	Comp	2.8	1.4		Moroney K & P	DO
F42/0133	Comp	3.5	2.1		Love R	DO
F42/0134	Comp	3.3	2.285		Stroud E	DO
F42/0135	Comp	2.2	0.98		Ottley Estate C/- Mathieson D	DO
F42/0136					Q L D C	MO
F42/0137		10			Meechang M	DO
F42/0142		5			Club 120 Limited	SC
F42/0143	Comp		1.74		Kingston Village Ltd	DO/MO
F42/0145	Comp	59.9	40.4		Glen Nevis Station Ltd	CM
F42/0149	Comp	10.1	2.37		Kingston Cafe and Bar	DO/CM

Blanks are where the information is not available

[1] COMP shows that the bore has been completed and installed[2] CM is Commercial, DO is Domestic Supply, DI is Disused, IR is Irrigation, SC is Scheme, and MO is Monitoring.

A specific groundwater quality study conducted by ORC in Kingston township itself within 2002 - 2003 indicated 4 bores out of 19 sampled had faecal bacteria contamination (ORC, 2006). These bores were centrally located within the township. Kingston groundwater had slightly elevated nitrate-N levels compared with many Queenstown-Lakes District aquifers (the highest being 2.4 mg/L). This is despite the reducing conditions characterised by high iron levels prevailing in many of the bore sites which are conducive to reduce nitrate in groundwater (Selvarajah et al., 1994). The ORC technical report attributed the elevated levels of ammoniacal-N (average of 0.213 mg/L) found in one bore to septic tank effluent contamination and the generally elevated nitrate-N level to garden fertiliser or septic tanks.

More recent analysis has measured quarterly water quality data from bore F42/0113 (4.4 m depth). Table 2.8 presents the key water quality data. Bore F42/0113 location is presented in Figure 2.9 above.

Table 2.9: Average Water Quality Data for Bore F42/0113

Parameter	Units	Average (2010 to 2018)
E-Coli	(cfu/100 mL)	1.41
Nitrate Nitrogen	(g/m³-N)	0.06
Ammoniacal Nitrogen	(g/m³-N)	0.27
Dissolved Reactive Phosphorus	(g/m³-P)	0.09
Total Phosphorus	(g/m³-P)	0.10
Conductivity [Conductivity (Lab)]	(mS/m)	13.72
pH		6.81

Upper Mataura River groundwater contributions to the river were investigated by Environment Southland in 2008 (Wilson, 2008). The report investigated groundwater level, surface water flows and rainfall. A significant contribution (60%) to the Upper Mataura River comes from Brightwater Spring located approximately 10 km south of the LTA. Wilson (2008) reports that it has been suggested that the Brightwater Spring is sourced from Lake Wakatipu, but Wilson's analysis disproved this hypothesis using observations of catchment yield, flow loss or hydrochemical sampling.

Wilson (2008) used Oxygen isotope samples to distinguish rainfall from different altitudes as a natural tracer in identifying groundwater recharge sources. Results of the δ18O samples collected from the Upper Mataura Catchment are shown in Table 2.10. Wilson reports that these results show significant differences in δ18O values between Lake Wakatipu and Brightwater Spring, even allowing for seasonal variation.

The δ18O values from the Mataura River are of a similar magnitude to those observed in Brightwater Spring but are comparatively lower. Wilson suggests that the Mataura River and Brightwater Spring are sourced from rainfall from a similar altitude. The slightly higher δ18O values from Brightwater Spring may reflect the contribution of run-off generated at altitude on the surrounding hills to recharge of the unconfined aquifer underlying the Mataura River floodplain and ultimately to Brightwater Spring discharge.

Table 2.10: Oxygen-18 Isotope Measurements from the Upper Mataura Catchment (Wilson 2008)

Site	δ18O
Lake Wakatipu at Kingston	-9.23
Mataura River at Fairlight	-9.79
Mataura River at Pyramid Bridge	-9.87
Brightwater Spring	-10.11

2.7 Community Drinking Water Supply

While there are several private bores in the Kingston Township currently used for domestic purposes, no specific community supply bore exists for the entire township. As part of the proposed infrastructure development, a community supply bore is planned to be established at a site close to bore F42/0145. This bore is proposed to be established on Glen Nevis Station, northeast of the proposed LTA area, and east of Kingston Creek and Lake Wakatipu Kingston foreshore. The location of the planned community supply bore in relation to the proposed LTA is shown in Figure 2.10. It is expected that this bore and associated reticulation to the township and developments will be commissioned in as part of development of community infrastructure.

Figure 2.10 Proposed Location of Community Drinking Water Supply Bore

2.8 Existing Water Takes

There are two existing water take permits in Kingston. One groundwater take (RM17.100.01) and a surface water take (2004.926), as shown in Figure 2.11 below. The groundwater take RM17.100.01 is for the take and use of water for community supply for up to 57 households. The bore is 4 m deep from an unnamed aquifer. Whilst unconfirmed, it is likely that the bore is taking water from a shallow aquifer that is hydraulically connected to surface water. The bore is located 5 m west of an unnamed surface water tributary of Lake Wakatipu. The tributary flows west down the slopes of Flat Rock. The surface water take (2004.926) is for the purpose of irrigation of a golf course and club house supply. The water is sourced from a

spring-fed unnamed tributary of Lake Wakatipu, with the take point located approximately 400 metres south-west of the Kingston Railway Station, Kingston.

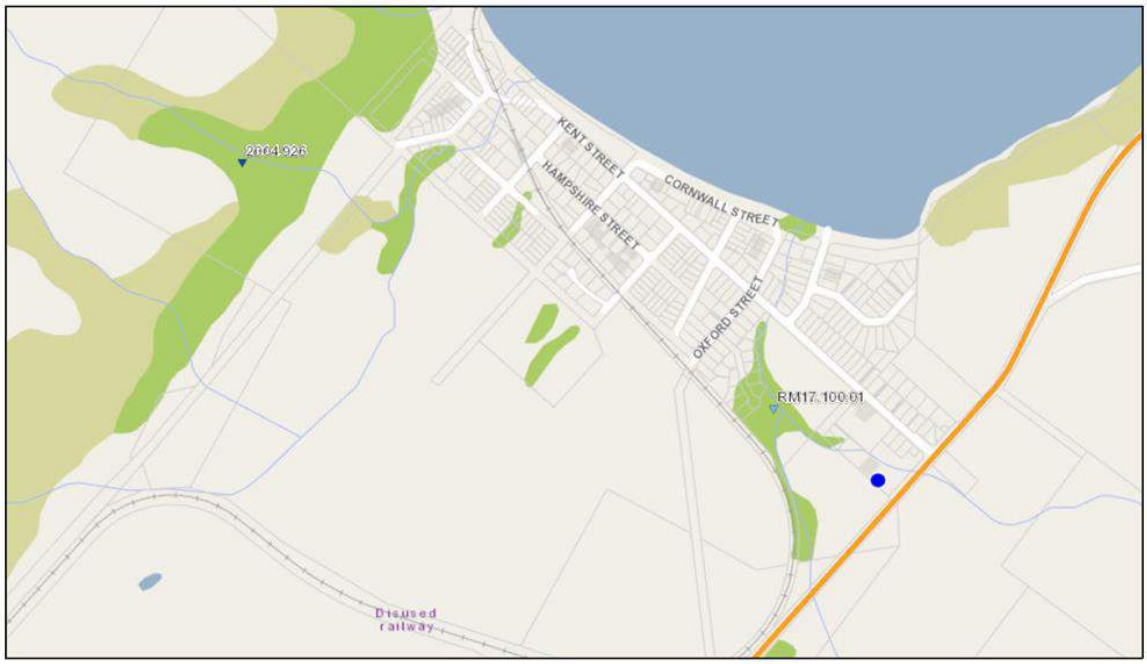

Figure 2.11: Current Water Permits in Kingston

2.9 Natural Hazards

Kingston Township itself has been historically prone to surface flooding when water levels in Lake Wakatipu are high. Figure 2.12 indicates the area with flooding hazards near the edge of Lake Wakatipu. However, Kingston Station, where the proposed WWTP and LTA are to be located, is elevated approximately 60 m above lake water levels and therefore is not located within a flood hazard zone.

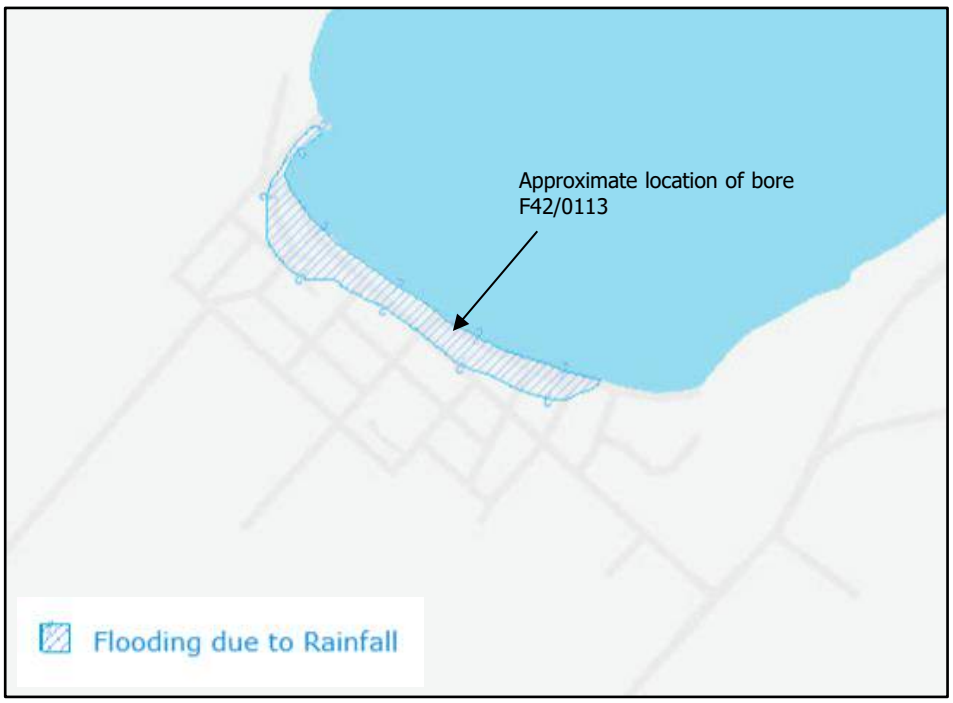

Figure 2.12: Flooding Hazard Areas near Kingston Township

Figure 2.13 below, from ORC's Otago Natural Hazards Portal identifies other natural hazards in the area. It shows that there are no known active faults in the area of the LTA. The LTA location is outside of any an avalanche risk area, is not on an active alluvial fan and the liquification risk is Nil to Low or Probably Low.

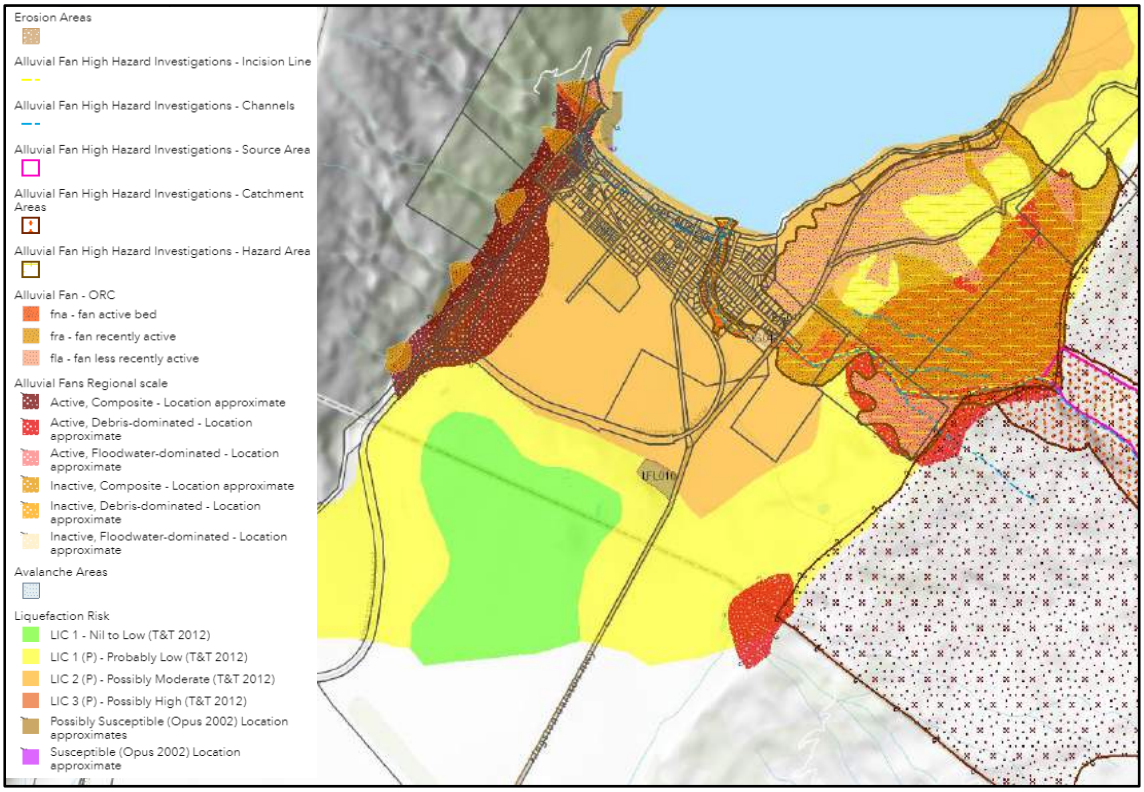

Figure 2.13: Natural Hazard Risk

2.10 Culture and Heritage

There have been no sites identified as having cultural significance within the direct vicinity of the proposed land application area. This is confirmed through consultation with Aukaha who work on behalf of Kai Tahu. Furthermore, the location of the LTA is outside Wahi tupuna.

The site has been subject to investigation by WSP Archaeologists (Kingston Archaeology Scoping Report - 2019) and while the report identified areas of interest closer to Kingston township where the works for a proposed housing development may occur, there are no archaeological sites of interest in the direct area of the proposed LTA site. The area of the proposed LTA is therefore considered low risk.

Accidental Discovery Protocols are proposed to be in place for any physical investigation and/or construction works related to the LTA.

2.11 Contaminated Land

There have been no HAIL activities within the proposed LTA area, but there is a registered HAIL site on the title associated with the historic landfill. This is located in the "blue oval", at least 600 m from the propose LTA site. Figure 2.14 below shows that the location of the LTA has been grazing farmland since at least 1958.

Figure 2.14 Proposed LTA General Site in 1958 and in 2019

Figure 2.15 shows the identified hail sites within the wider project area. Site 7 is the location of the closed landfill. Table 2.11 provides details of the contaminated land assessment provided by Otago Regional Council (ORC).

It is proposed to monitor groundwater levels and quality parameters at the Closed Landfill site prior to commencement of wastewater application to land directly south of the Landfill

Figure 2.15: Identified HAIL Sites

Table 2.11 Contaminated Land Parcel Details (ORC2019)

Number	Address	Legal Description	HAIL information supplied by ORC	HAIL Reference Number
7.	Kingston Closed Landfill		This land has a HAIL Status of Verified HAIL and a Contamination Status of Managed for Agricultural	HAIL.00486.01

2.12 Surface Waters

2.12.1 Overview

Lake Wakatipu is located to the north of the proposed WWTP and LTA locations. The LTA site is approximately 60 m above this surface water body (at the lowest LTA elevation), with the closest point being approximately 1.5 km from the Lake Wakatipu southern shoreline. Within the Kingston area, there is an unnamed tributary on the western side of the village and Kingston Stream, which is located approximately 650 m to the north/ north-east of the LTA. There are also two small ponding areas on Kingston Station, with one being within the

area that could become the LTA. Figure 2.16, Figure 2.17 and Figure 2.18 provide photographs of all surface waters looking from the LTA area.

To the south of the LTA area beyond the terminal moraine, the surface flow drains south into the Mataura River catchment.

Figure 2.16: Lake Wakatipu from LTA

Figure 2.17: Ponding Area Located Near the Proposed LTA

Figure2.18: Pond Located Between the Proposed LTA of Kingston Station

2.12.2 Lake Wakatipu

Lake Wakatipu is the second largest of the southern glacial lakes. The lake is 75.2 km long and up to 5 km wide, covers a total area of 289 km^2. The lake is 310 m above mean sea level (AMSL), with a depth of 389 m, and occupies a single elongated glacial trench which has a gently sloping flat floor.

The Dart and Rees Rivers flow into the northern end. The lake then runs south for 30 km before turning abruptly to the east. Twenty kilometres further along, it turns sharply to the south, reaching its southern end 30 km further south, near Kingston. The lake is drained by the Kawarau River, which flows out from the lake's Frankton Arm, 8 km east of Queenstown. At the foot of the lake is a natural dam of moraine.

Lake Wakatipu has a number of natural values, including a significant presence of trout and salmon. It is an outstanding natural feature for many reasons (listed in the Water Plan). Cultural values associated with food gathering and processing (mahika kai), the protection of nursery and breeding areas for native fish and birds (kohanga) and the recognition of the lake as a treasured resource (waahi taoka) have been identified as important in Lake Wakatipu. These and other cultural values are listed in the Water Plan. Water quality has a major impact on these values. Lake Wakatipu is a popular holiday and visitor destination. All forms of recreational boating are undertaken on the lake. The shores of the lake are popular for picnicking, swimming, fishing and passive recreation.

Schedule 1A of the ORC Regional Water Plan sets out: (a) ecosystem values; (b) outstanding features or landscape; and (c), significant indigenous vegetation and habitat of indigenous fauna for Lake Wakatipu. It states that the lake is:

a) A large water body that provides diverse life cycle requirements for a particular species or range of species, has important macrophyte bed composition for resident biota, is weed free, has juvenile rearing areas, riparian vegetation of significance to

aquatic habitats, has significant presence of eel, salmon and trout, significant range of indigenous fish diversity including rare fish and indigenous aquatic vegetation.

b) Outstanding as a fishery, for its scenic characteristics, scientific value (in particular water clarity and bryophyte community), recreational and historical purposes, significance in accordance with tikanga Maori. Scenic values including clear blue colour of the water, river deltas and beaches.

c) Significant habitat for koaro and rare association of aquatic plants.

2.12.3 Water Conservation (Kawarau) Order 1997

Lake Wakatipu is listed in Schedule 2 of the Water Conservation (Kawarau) Order 1997, which sets out the characteristics of the waters to be protected because they are considered outstanding. Outstanding characteristics are listed above. Restrictions and prohibitions include: fish passage to be maintained; and water quality to be managed to Class AE (for aquatic ecosystem purposes), CR (for contact recreation purposes), F (for fishery purposes), and FS (for fish spawning purposes) standards.

2.12.4 ORC Water Quality Monitoring

ORC carries out long-term water quality monitoring as part of its State of the Environment programme and short-term monitoring programmes are also carried out in some catchments to provide more detailed information. These programmes assist regional planning and provide an understanding of the need to protect water quality.

Lake Wakatipu's average water quality readings from between 2004 and 2016 can be seen in Table 2.12 below. There is no ORC monitoring site near Kingston, with the closest being adjacent to Queenstown. However, it is considered the water quality from this area will provide an indication of the overall lake water quality and is likely to be representative of the upper lake. The water quality data is taken from a site named 'Lake Wakatipu at Outflow' and the NZTM map reference for the monitoring site is E1263310 N5005041. The monitoring site is located within the Frankton Arm, just prior to the outfall to the Kawarau Falls.

The water quality data from Lake Wakatipu has been compared to the National Policy Statement for Fresh Water (Table 2.12) and all determinants are lower than those limits given in the National Policy Statement. This indicates that Lake Wakatipu has high water quality.

Table2.12: Lake Wakatipu Median Water Quality at the Kawarau River Outlet

			NPS-FW Limits	
	Unit	**Water Quality**	**Annual Median**	**Annual Max or *95%tile**
DRP	g/m^3	0.002	-	-
ECOLI	n/100 ml	0.002	130	540*
NH_4-N	g/m^3	0.004	30	50
NO_3-N	g/m^3	0.023	1	1.5
TN	g/m^3	0.054	0.3	-
TP	g/m^3	0.002	0.010	-

Trophic level index (TLI) is a common method for describing the health of lakes. It is an indicator of how much growth or productivity occurs in the lake, productivity being directly related to the availability of nutrients. A microtrophic lake is a lake with a trophic level of less than 2. This indicates that the lake has low productivity, water quality is very good with very low levels of nutrients and algae. Oligotrophic lakes have relatively low levels of nutrients, sparse growth of algae and a high oxygen level. They have good water quality, with a trophic level of 2 – 3.

The current TLI of the Lake Wakatipu in 2018 is microtrophic (LAWA, 2018). It appears to be in a stable state near the mircotropic- ologotropic boundary, with little change in water quality occurring since 2004. Figure 2.19 presents the annual average TLI using TN, TP and Chlorophyll A data from Lake outlet.

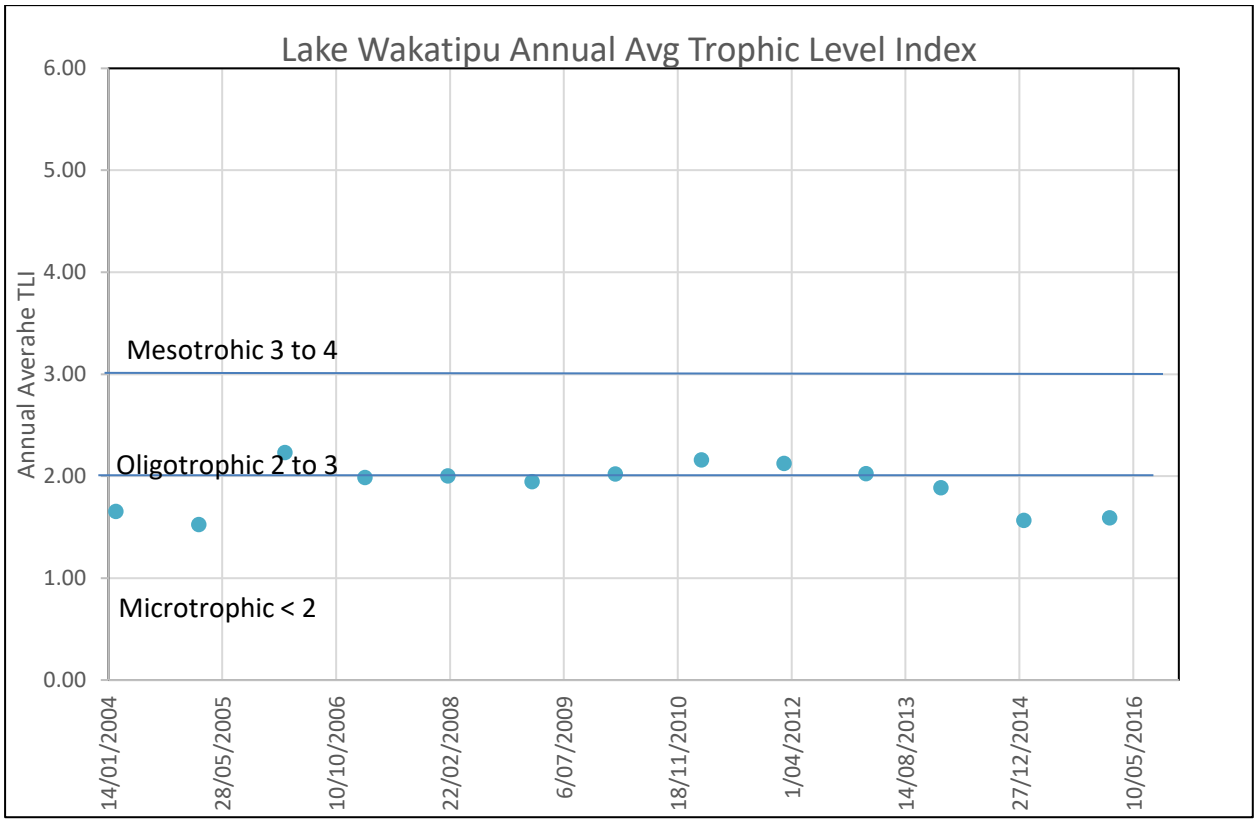

Figure 2.19: Lake Wakatipu Trophic Level Index (2004 to 2016, LAWA Data)

2.12.5 Kingston Village Waterways

Analysis of the contour data has been used to select the proposed LTA area. Figure 2.20 shows the River Environment Classification (REC) catchment centrelines, near the LTA. To the east of the LTA is Kingston Creek flows from the slopes of Lorn Peak under State Highway 6, through the Kingston Campground and village, and down to the lake. The REC catchment centrelines also shows an unnamed tributary starting in/near the proposed LTA. This tributary is ephemeral on Kingston Station and is bisected by the railway before starting with the proposed subdivision area and golf course. The stream is more defined within the village area where it receives water from the west during rainfall events and has a more permanent flow.

The railway line to the north of the LTA diverts the little surface drainage that does occur to flow eastwards and infiltrate into the soil. During the site visit there is was no observed

physical connection from the LTA area to the Kingston Creek or the unnamed tributary. The flow within the both creeks is not monitored and it is unknown if the creeks receive groundwater sources from land surface recharge falling on the terminal moraine. They do appear to have flows dominated by runoff from the surrounding hill catchments.

There is limited available information regarding aquatic ecology in the two creeks. However, creeks flowing into Lake Wakatipu north of Kingston are known to support Koaro *Galaxias brevipinnis*, a native freshwater fish (Natural Solutions for Nature Limited., 2008). This indicates it is likely that they also populate Kingston Creek. Kingston Creek also reported to provide good spawning habitat for brown trout. NZ Fish and Game report local observations of rainbow trout *Oncorhynchus mykiss* upstream as far as the Kingston Campground below the State Highway culvert (Trotter, 2006).

In February 2020, E3 Scientific carried out an aquatic ecology review commissioned by ORC (Appendix B). During associated site visit the wetland area west of LTA area was noted to provide habitat for the endemic paradise shelduck (Tadorna variegata), macroinvertebrates such as dragonflies (Order: Odonata), and native aquatic flora such as red pondweed (Potamogeton cheesemanii) and Juncus rushlands. The MPI fish spawning database identifies the unnamed tributary of Lake Wakatipu (NZ reach: 14044527) as a koaro (Galaxias brevipinnis) and brown trout (Salmo trutta) spawning habitat (https://mpi_nes.cloud.eaglegis.co.nz/NESPF/; accessed 19/02/2020). No records for this unnamed tributary are in the NZ Freshwater Fish Database (NZFFD).

It is unknown whether the wetland conjoins with the unnamed tributary or if it is a perched isolated wetland system. The ephemeral pond appears to be a depression which collects surface water runoff from the surrounding land. The low permeability of the substrate allows for ponding after a rainfall event. From discussion with the Kingston Station, it is reported that tarns have been artificially enhanced to provide duck hunting habitat.

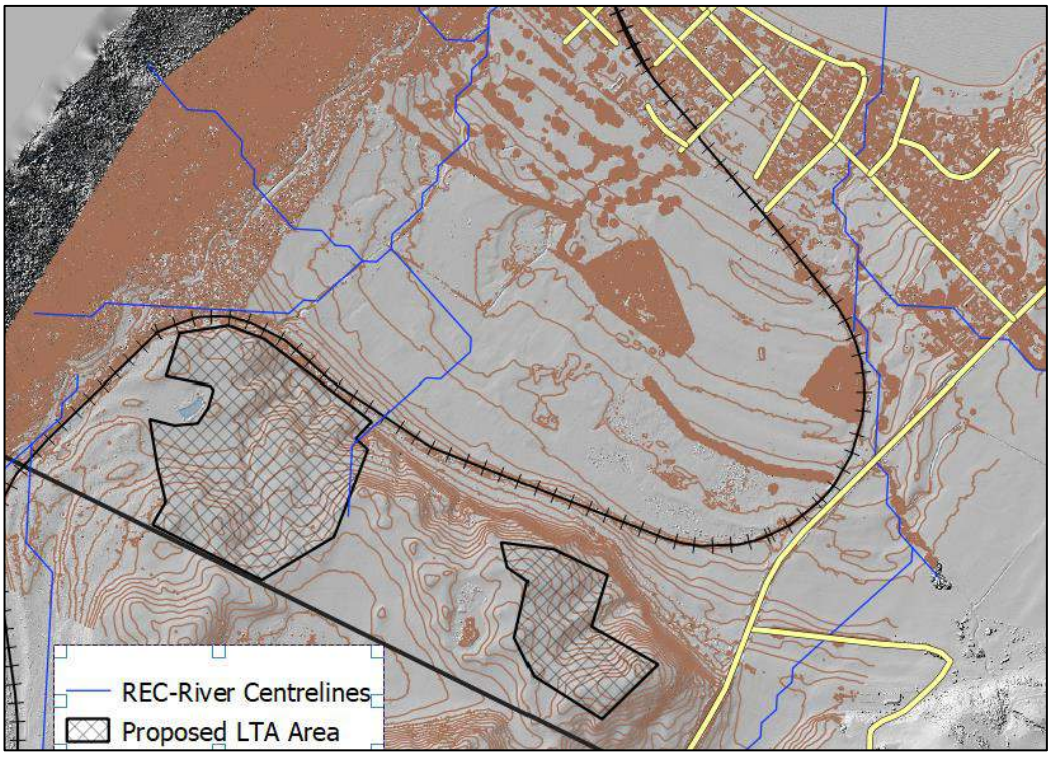

Figure 2.20: REC Surface Water Catchment Centrelines

2.13 Summary

The land treatment areas have been selected due to their compatibility with existing farming activities, surface water catchment topography, distance from lake, distance to groundwater and surface waters. The soils on the site are suitable and there is low risk to cultural, heritage and amenity values. The potential land treatment command area has been broken into two areas. This is to ensure the land treatment area is on the most suitable topography and to fit in with appropriate buffers to existing farm features.

3 PROPOSED WASTEWATER TREATMENT SYSTEM

3.1 Overview

QLDC proposes to install a hybrid gravity/pressure reticulation system within Kingston Township feeding a new wastewater treatment plant, located on Kingston Station. Formal access agreements with the landowner/occupiers are being developed for QLDC to carry out the proposed activities described below. Treated effluent will be discharged into Kingston Station land via subsurface pressure compensating drip irrigation. It is proposed that the LTA management be a cut and carry system to allow for enhanced nutrient uptake.

The hybrid gravity/pressure system is not discussed in detail in this consent application.

3.2 Existing and Projected Wastewater Flow Rates

Hadley Consultants Limited have carried out preliminary design work associated with a wastewater treatment options assessment and has provided estimations of wastewater flow rates (Hadley Consultants Ltd, 2018). The estimated flows have been based on the ultimate development of approximately 1,200 dwellings within the Kingston Township including the new subdivision development. This allows for a degree of infill and rezoning within the Kingston Township once the town becomes serviced with a community wastewater scheme. These estimates assume the existing District Plan provisions remain unchanged and the town boundary remains unchanged. Included but not separately calculated would be an allowance for a small number of new restaurants, cafes and tourist facilities to contribute to the waste flows. These additional sources are not likely to change the overall character of the wastewater from the strength typical of domestic wastewater.

The parameters Hadley Consultants Ltd (2018) used for determining the projected flows are listed below:

Average Day Dry Weather Flow = 250 L/person/day
Average occupancy = 3 people/dwelling
Dry Weather diurnal peaking factor = 2.5
Dilution/infiltration factor for wet weather = 2.0

3.1 provides the Hadley Consultants Ltd (2018) estimated (35-year consent duration) flow rate. The wet weather flows are 2 times dry weather flow; this is considered conservative for the sections of the network that are pressurised as water cannot enter these pipelines.

Table 3.1 Estimated Wastewater Flow Rates

Wastewater Flow Rates	Flow (m^3/day)
Peak (Peak Wet Weather Flow)	1,800
Average (Average Dry Weather Flow)	900

3.3 Proposed Wastewater Treatment Plant

It has been estimated that 225 of the 270 existing individual onsite systems (septic tanks and package aerated) could be decommissioned and replaced by a community treatment plant. The location of the WWTP will be south and eastward of Kingston, accessed off the

State Highway near QLDC's old landfill site (See Figure). This location is considered to have significant advantages including:

- Separation from the residential areas;
- Reticulation alignments both in regard to crossing the railway and access to the land treatment area; and
- Access provisions for construction, operation and supply of power reticulation.

The treatment plant will provide primary, secondary and tertiary treatment in a staged manner to align with the number of properties connected to the scheme. There is likely to be three stages of treatment plant capacity. The actual process adopted will be the subject of a detailed design and procurement evaluation.

Figures 3.1 and 3.2 present the conceptual layout of the treatment plant during the initial Stage 1 of development when connections are less than 450 lots and Stage 2 the full Kingston development of up to 1,200 lots. The design is based on efficient use of infrastructure with an initial system based on an oxidation pond technology that has an ability to handle the initial low flows well. As the number of connections increase, the oxidation pond function for providing wastewater treatment changes to a calamity Pond/emergency overflow storage system necessary to accommodate short periods of treatment system outages in the more mechanised future stage 2 system.

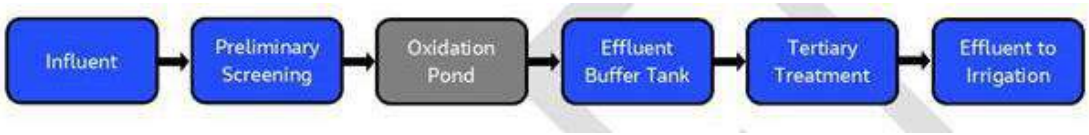

Figure 3.1: Process Flow Diagram for the Stage 1 Treatment

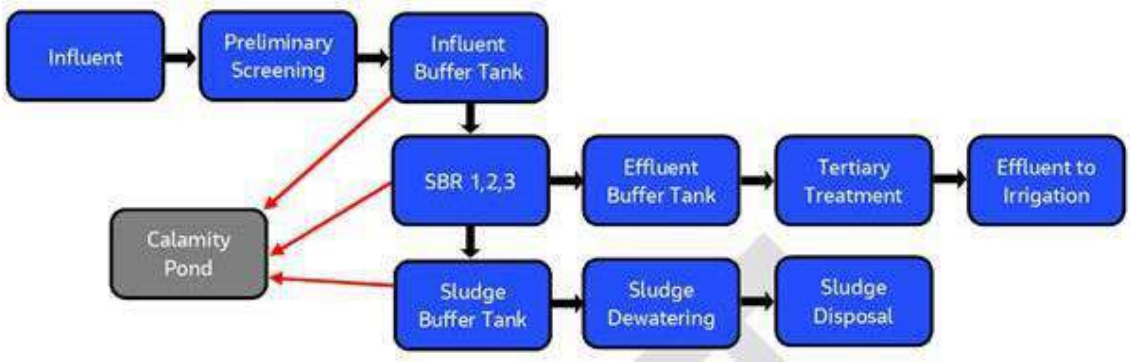

Figure 3.2: Process Flow Diagram for Stage 2 Ultimate Plant Design

A number of different suppliers and treatment processes are currently available that can meet the likely final treatment standards (e.g. MBR, SBR, SAF and rtPBR) with the designers (Jacobs) preferred design being an SBR. The systems generally have a low risk of odour, the treatment processes can be adjusted relatively easily to meet possible future increases in treatment standards, the treatment plant can be readily staged and scaled to suit growth and it is a system that is already used in the district with good results.

The treatment plant and LTA are being considered as an integrated treatment train for the wastewater. It is proposed by Jacob's to adopt for Stage one (up to 450 properties) to have a lower treatment standard for the main parameters (BOD and TN) to accommodate the much lighter loading of the plant and the difficulty of operating a large activated sludge

treatment system with less than 50% design capacity compared to its final expected load. The LTA area nitrogen load proposed cap of 450 kg N/ha would be retained to ensure the same expected environment outcomes in terms of nitrogen loss below the root zone is achieved. Fine filtration following the pond treatment system will be installed to protect the LTA infrastructure.

Potential treatment standards and scenarios for Stage 1 and Stage 2 are outlined in Table 3.2. Stage 1 has options for higher BOD and N up to 450 lots, while Stage 2 has lower BOD and up to 1200 lots.

Table 3.2 demonstrates possible scenarios, with differences in number of lots, effluent loading rate, effluent nitrogen concentration and LTA area. This is to illustrate the options QLDC has to invest in the wastewater treatment plant to improve effluent quality or to retain a lower level of treatment and increase the land treatment area. In Table 3.2 an example is shown using the wastewater volume for 400[1] lots with a WWTP effluent nitrogen concentration of 30 mg/L. At this N concentration and effluent volume, the nitrogen loading rate would exceed the proposed LTA maximum nitrogen loading rate of 450 kg N/ha/yr (red cell showing 469 kg N/ha/yr loading). Prior to this scenario developing QLDC would have to either reduce the applied nitrogen concentration by increasing the WWTP plant capacity / intensity (green cell 20 mg/L) or increase the LTA application area (blue cell 15 ha). Both treatment combinations would achieve a nitrogen loading rate of less than 450 kg N/ha/yr.

Table 3.2 also demonstrates the full development scenario (1200 lots) with either 15 ha of LTA area or an expanded application area of 21 ha. Noting that the assessment of effects is based on a 15ha scenario for full development and minimum area of 15 ha being utilised within a larger LTA treatment command area. The larger treatment command area is shown in Figure 2.3 and there is approximately 25ha of possible LTA area.

[1] In Table 3.2, 400 lots has been chosen for a worked example for the area and nitrogen concentration calculations, while 450 lots is the maximum size for stage 1.

Table 3.2: Stage 1 and Stage 2 Example Scenarios

Consent stage	Stage One: Higher BOD, and N up to 450 Lots				Stage Two: Lower BOD and N			
Treatment system	Pond	SBR	Pond	SBR	SBR	SBR	SBR	SBR
Treatment intensity	Low	Low	Low	High	Low	High	High	High
Lots	200	400	400	400	600	900	**1200**	1200
Design Flow Rate (ADWF) (m3/day)	150	300	300	300	450	675	**900**	900
Nitrogen concentration at WWTP (mg/L)	50	**30**	**50**	**20**	30	20	**20**	20
Nitrogen mass (kg/yr)	2738	3285	5475	2190	4928	4928	**6570**	6570
LTA area required to meet 450 kg N/ha (ha)	6.1	7.3	12.2	4.9	11	11	**14.6**	14.6
Hydraulic loading at minimum LTA area (ADWF) (mm/day)	2.47	4.11	2.47	6.16	4.11	6.16	**6.16**	6.16
Possible LTA area development scenario (ha)	7	**7**	**15**	**7**	12	15	**15**	21
Possible scenario hydraulic loading (mm/d)	2.14	4.29	2	4.29	3.75	4.5	**6**	4.29
Possible scenario nitrogen loading rate (kg/ha/yr)	391	469	365	313	411	329	**438**	313
Proposed Consent N loading limit (kg/ha/yr)	450	**450**	450	450	450	450	**450**	450

By proposing a 450 kg N/ha/yr nutrient limit and a maximum hydraulic loading rate, QLDC is seeking development flexibility by treating the WWTP and LTA area as a treatment train to manage an unknown speed of housing development and occupation in Kingston. This allows QLDC to either improve effluent treatment or increase LTA size as development occurs. Having the input standards for total nitrogen loading of 450 kg N/ha/yr and maximum hydraulic loading rates provides certainty to both ORC as the regulator and QLDC as the owner and operator of the WWTP system.

3.4 Wastewater Characteristics & Effluent Quality

The Kingston wastewater influent will comprise of some blackwater from restaurants, cafes and tourist facilities (toilet/bathrooms) combined with some kitchen and restaurant wastewater. However, the majority of wastewater flows will be ordinary strength domestic wastewater from individual households. Therefore, the influent strength will be primarily standard domestic.

The expected raw wastewater quality and the average effluent quality from the WWTP is summarised in Table 3.3.

Table 3.3: Expected Raw and Final Effluent Quality

Parameter	Typical Domestic Raw Wastewater	Stage 1 Effluent Quality(1)	Full design Treatment Plant Effluent(1)
Biological Oxygen Demand (BOD, mg/L)	200 - 400	50	20
Total suspended Solids (SS, mg/L)	200 - 350	30	30
Total Nitrogen (TN, mg/L)	40 - 85	50	20
Total Phosphorus (TP, mg/L)	8 - 15	10	10
Faecal Coliform (cfu/100 ml)	$10^4 – 10^7$	10^4	10^4

(1) Effluent quality is based on a 12 month rolling mean.

3.5 Land Management

Effluent passing through a soil matrix is subjected to plant and microbial uptake, filtration, sorption and biological and chemical process; all of which reduce the contaminant constituents prior to potential leaching to groundwater or surface waters. Plant uptake results in a reduction of nitrogen and phosphorus; both of which are required for plant growth. An important part of any land application design is choosing the correct vegetation type and maintenance of the established crop. Factors to consider when selecting a vegetation type are:

- Short or long rotation crops;
- Climatic conditions;
- Soil types;
- Environmental constraints;
- Effluent chemical composition;
- Irrigation method;
- Landuse – grazed, cut and carry, or cut and leave (e.g. sports fields);
- Aesthetic requirements; and
- Nutrient and water uptake requirements.

Plant uptake will be higher during juvenile growth when nutrient requirements peak, therefore managing any crop to maintain this phase is essential. When selecting a plant species, consideration must be given to the environmental conditions as well as the hydraulic loading and composition of the effluent. Not all plant species require the same hydraulic or nutrient input for growth. Therefore, fast-growing species (short rotation crops) that require a high nutrient input are usually preferable.

Maintenance of an LTA will depend on landuse, which is generally one of the following three methods:

1. Cut and carry;
2. Sheep grazing; or
3. Cut and leave.

QLDC proposes that land use be a **cut and carry** system. "Cut" refers to mowing grass or grass type crops, tree felling (replanting with juvenile plants) or pruning vegetation back to stimulate regrowth. "Carry" refers to removing produced dry-matter off-site. If vegetation is not removed off-site, biological decay will result in the transfer of nutrients held within the plant back into the soil matrix, with the net plant uptake being near zero.

Discussions with the landowner have confirmed that this type of system would be appropriate for the land, with the need by the landowner to plant at least 50 ha of winterfeed each year in either kale or lucerne outside of the LTA. The subsurface application of the wastewater also removes any potential for harvest material contamination, reducing stand down periods for harvest that could be required for surface application of wastewater.

3.5.1 Land Application Method

The proposed land application method will be subsurface pressure compensating drip irrigation to be buried at a depth of around 200 mm. For conceptual design and assessment purposes, a drip irrigation spacing of 1 m between lines and a 0.6 m spacing between emitters has been adopted. However, the exact requirements will be determined during the detailed design and procurement phase.

3.5.2 Hydraulic Loading Rate

Table 3.4 summarises the required effluent land application rate.

Table 3.4: Effluent Land Application Rate

Parameter	Value
Average Daily Discharge (m^3/day)	900
Available land area for irrigation (ha)	15
Average application rate (mm/day)	6
Maximum Wet weather Daily Discharge (m^3/day)	1,800
Maximum wet weather application rate (mm/day)	12

The topsoil horizon hydraulic conductivity measurements have been used to inform the DIR of 20 mm/day. Based on the maximum daily discharge and available land area for irrigation, the required application rate is an average peak dry weather flow of 6 mm/day.

The required average peak dry weather application rate of 6 mm/day is significantly lower than the topsoil unsaturated capacity and it is within this soil profile that the majority of effluent soil treatment will take place. The low application rate will allow the topsoil to assimilate the irrigation demand via plant uptake, evapotranspiration, without exceeding the soil's capacity to absorb and adsorb contaminates during normal conditions. Plant uptake will inevitably be determined by the grass or crop species grown within the LTA, while evapotranspiration will be dependent on the seasonal climatic conditions, as well as cropping species, growth stage and density.

3.5.3 Nutrient Loading Rate

Table 3.5 shows the expected WWTP effluent annual average total nitrogen and total phosphorus concentrations.

Table 3.5: Kingston WWTP Effluent Quality

Parameter	Stage 1 Development (up to 450 Lots)	Stage 2: Full Development (1,200 Lots)
Total Nitrogen (mg/L)	50	20
Total Phosphorus (mg/L)	10	10

Plant and microbial removal and the soil cation exchange capacity are the primary mechanisms for assimilation of nutrients and water by land application systems. The total assimilative capacity of the plant system is dependent on the land area utilised, with the loading rate refined, based on the crop type and its management. Table 3.6 provides nutrient loading rates for different crop types.

Table 3.6: Crop Nutrient Uptake

Crop / Land use	N uptake (kg/ha/year)	P uptake (kg/ha/year)	Reference
Pasture – irrigated, cut and carry	**500 - 600**	**130 - 160**	Morton *et al.* (2000)
Pastoral – irrigated grazed system	200 - 240	52 - 64	FLRC (2009), Williams and Haynes (1990)
Maize silage	220	40	FAR (2009)
Kale	380	50	Beare *et al.* (2010) Brown *et al.* (2007)
Peas	106	16	Hanson (2001)
Squash	107	20	Fandika et al. (2011) Hortnet (1995)
Sweetcorn	62	9	Hortnet (1995)
Standard Rotation Forestry – Pine	100 (kg/ha/year)	30 (kg/ha/year)	Nicholas (2003)
Standard Rotation Forestry – Eucalypt	50 (kg/ha/year)	10 (kg/ha/year)	Myers *et al.* (1999)
Eucalypt or Willow Coppice Systems	200-300 (kg/ha/year)	75-125 (kg/ha/year)	NZLTC (2000)

Nitrogen Loading Rate

The management of the Kingston LTA will be cropping/cut and carry. Therefore, from Table 3.6, it is considered that a loading rate of between 500 - 600 kg N/ha/yr may be acceptable.

Therefore, based on an full design average nitrogen TN concentration of 20 g/m^3 and an average annual volume of 328,500 m^3 (based on an annual average flow of 900 m^3/day), the minimum size LTA that will be required to keep the nitrogen loading at or below 500 kg N/ha/yr for a cut and carry system is 13 ha. Note that the above assessment considers ultimate development, with all dwellings occupied for 365 days per year. It does not take into account the partial seasonal nature of Kingston occupancy that currently exists; this will mean there is likely to be lower N loading to the LTA area or the ability to reduce the nitrogen quality at the treatment plant. In addition, other losses of nitrogen occur in the soil/plant/atmosphere systems as described in the section on Environmental Effects.

A minimum land treatment area of 15 ha is proposed and if required, this may extend to maximise approximately 25 ha of the proposed LTA that is potentially available (Figure 2.3). The proposed minimum full development area of 15 ha would equate to a nitrogen loading of 438 kg N/ha/yr (based on 20 mg/L wastewater concentration) and full occupancy. A Nitrogen loading rate of 450 kg N/ha/yr is proposed as the key limiting factor determining the minimum LTA area and has been proposed as a consent condition. Flexibility in the size of the LTA area within the larger LTA command area will provide operational flexibility to allow for the staged development of houses connecting, rotation of the application area and flexibility to undertake pasture/lucerne and LTA component renewal when the system is at full capacity.

During the initial stages as connections come online, the ability to remove nitrogen is limited within the full sized WWTP. This is proposed to be managed by applying higher nitrogen concentration wastewater to the LTA over a larger area meeting the capped nitrogen load of 450 Kg N/ha/yr. As the number of connections increase, there will be improved treatment quality so that once there are 450 connections to the system, the system will be operating at the progressively higher treatment standards and ultimately a treatment quality of a 12 monthly average of 20 mg/L Total nitrogen.

Phosphorus Loading Rate

Based on a phosphorus concentration of 10 mg/L and the LTA area of 15 ha, a P loading of 222 kg P/ha/yr is estimated. However, it should also be noted that the phosphorus loading across the site will not only be dependent on plant uptake but also the soil adsorption capacity. The plant uptake and export within the supplement is estimated using Overseer to be 36 kg P/ha/yr. Allowing for plant uptake and export off the LTA area, the full design capacity net P loading to the soil matrix is 186 kg P/ha/yr.

3.6 Operation and Maintenance

For the WWTP system to operate successfully, appropriate operation and maintenance requirements will need to be adhered to. It is envisaged that a suite of resource consent conditions will stipulate the basic maintenance requirements. Suggested consent conditions are included below.

Prior to commissioning the treatment and land treatment system, the consent holder shall prepare and forward an Operations and Management Manual to the Consent Authority for the treatment and land treatment system to ensure its effective and efficient operation at all times.

The system shall operate in accordance with this manual at all times, which shall be updated as appropriate. The manual shall be to the satisfaction of the Consent Authority and include, as a minimum:

a) A brief description of the treatment and land treatment system, including a site map that shows the location of the treatment system, discharge location, sampling sites and the drainage network;
b) Key operational matters including weekly, monthly and annual maintenance checks;
c) Monitoring requirements and procedures;
d) A management plan for the cut and carry operation including procedures for harvesting grass/lucerne from the site and for maximising grass/lucerne growth and nitrogen uptake by grass/lucerne such as soil tests, supplementary nutrient additions and pest and weed control;

e) Contingency plans in the event of system malfunctions (including provision for the removal and disposal of effluent by tanker truck should there be prolonged system failure);
f) The means of receiving and dealing with any complaints;
g) Key personnel and contact details; and
h) Emergency contact phone numbers.

3.7 Monitoring

Monitoring is proposed to ensure compliance with the proposed volume and nutrient loading limits, and to monitor the impact of the proposed activities on the environment.

A flow meter will be installed to monitor the volume of effluent discharged to the land treatment area.

Sampling of the treated wastewater is proposed to occur on one day of January, March, May, July, September and November each year, with the samples being analysed for:

a) Biochemical oxygen demand (5 day);
b) Total suspended solids;
c) Total nitrogen;
d) Total phosphorus;
e) Escherichia coli;
f) Sodium adsorption ration (SAR); and
f) pH.

Environmental monitoring of both surface and groundwater quality in the area is proposed. The location of the proposed water quality testing sites is shown on plan attached to this application as Appendix C. Three of the sites shown are for surface water and four testing sites (piezometers) are proposed for groundwater. The water quality testing should measure:

i) BOD_5;
ii) Total phosphorous;
iii) Total nitrogen;
iv) Nitrate-N;
v) NH_4-N;
vi) E.coli; and
vii) Field measurements of pH, EC and dissolved oxygen.

Soil quality monitoring will be carried out every 2 years. It is proposed that samples will be collected at random from within the LTA, at the following depths: 0 - 20 cm, 30 – 50 cm and 80 – 100 cm. Soil samples will be analysed for the following:

i) Exchangeable Cations (Sodium, Potassium, Magnesium, Calcium);
ii) Olsen P;
iii) Cation exchange capacity;
iv) Base saturation;
v) Total carbon;
vi) Total nitrogen;
vii) Total phosphorus;
viii) Exchangeable sodium percentage (ESP);
ix) Bulk density;
x) pH; and
xi) Seven heavy metals (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Zinc)

Monitoring of the soil's physical condition is also proposed with the soil being tested every second year for infiltration capacity, any indications of oxidation reduction potential (gleying) and an infield assessment of soil structure will be undertaken. These results will be compared to a control site outside of the LTA.

Monitoring results from the proposed sampling above will be reported annually to the Regional Council or for the soil sampling, within 6 months of testing.

4 ALTERNATIVES ASSESSMENT

A number of options have been investigated for the treatment and dispersal of the Kingston wastewater for this application and at the time of Plan Change 25 to the district plan to rezone the land from rural. These are as follows:

- Individual on-site wastewater treatment and discharge;
- Community treatment plant with a different option for the Land application area; and
- Alternative discharge options.

4.1 Individual On-Site Wastewater Treatment and Discharge

The first option considered is a continuation of the current subdivision practices of having individual on-site wastewater systems and land treatment areas on each of the lots. However, this option was not considered any further as the cost of treatment and LTA's for each individual lot would be approximately $20,000 - $25,000 with all of the cost being passed onto the purchasers of the individual sections. The cumulative costs and uncertainty of the system operation mean onsite individual systems are not considered best practice for a subdivision of this size.

4.2 Alternative Land Area

At the time of Plan Change 25, Connell Wagner identified land treatment areas suitable to receive treated wastewater as being the Kingston golf course to the north of the proposed subdivision or the farmland to the east of the Village and State Highway. Both land areas are within the same catchment as the proposed LTA area.

The golf course as least preferred due to complications incorporating the LTA area into the established course avoiding trees and the course tees and greens. The Glen Nevis station land was preferred at the time of the Plan Change, however, this site is now not favoured as it is closer to the lake meaning there is less potential for groundwater attenuation when compared to the proposed site. The proposed site also has secured land access.

Other sites were not considered due to the topography of the land surrounding the new development and the location of the Otago and Southland Regional Zones means there are limited land areas that are available for an LTA.

Overall, the potential effects of the proposed area are lower than both alternative options. The proposed site has an agreement with the Kingston Station. Due to these reasons, the alternative LTA locations were not considered any further.

4.3 Alternative Discharge to Land Options

For completeness we have considered a preliminary assessment alternative discharge options, LEI considered the suitability of a number of discharge options, including:

- Discharge to land via infiltration trenches (LPED-T);
- Discharge to land vial infiltration beds (LPED-B);
- Discharge to land via mounds (LPED-M);

- Discharge to land via evaporation assisted beds (LPED-ETA);
- Discharge to land via surface irrigation methods (LT-S);
- Discharge to land via subsurface drip irrigation (LT-SS); and
- Discharge to land via a combination of drip and surface spray.

In selecting the application method, factors such as soil type and soil profile, soil permeability, cultural, likely consentability and the quality of the effluent from the treatment plant were considered.

Tables K1 and K2 in AS/NZS 1547:2012 summarise common site and soil constraints and provide guidance on the suitability of land application systems. Table 4.1 below is a modified extract from Tables K1 and K2.

Table 4.1: Summary of Common Site and Soil Constraints (Modified extract of Tables K1 & K2 A/NZS1547:2012)

Land Application System	Slope (%)	Soil Depth (m)	Soil Category Number	Comments – Suitability of System at the Applicants Site
Infiltration Trenches	<15%	> 1.2	1 – 4	These methods allow for a high design loading rate (DLR). While they do provide treatment through a sand profile the hydraulic loading rate is such that nutrient removal is poor. These systems are primarily designed for the disposal of wastewater rather than wastewater dispersal and soils treatment. Overall, the treatment outcomes are not as high as for subsurface drip irrigation.
Infiltration beds and evaporation beds	< 10%	> 1.2	4 – 6	
Mounds	< 15%	Not Important	1 – 6	
Surface irrigation systems	< 10%	> 0.4	Any	Surface irrigation will require larger buffer distances due to spray drift than subsurface and an additional disinfection step may be required. Issues can also result due to snow cover or surface freezing. The irrigation equipment can also create a visual effect on the landscape
Subsurface drip irrigation	< 30%	> 0.4	Any	This system is considered for the land application of domestic wastewaters as it provides public protection from pathogens and does not limit land use. The buried drip line is also less prone to freezing but care is required with land management, cultivation and harvesting equipment. The buried nature of the irrigation lines avoids any visual effects from the infrastructure.

Land Application System	Slope (%)	Soil Depth (m)	Soil Category Number	Comments – Suitability of System at the Applicants Site
Combined spray and drip	As above	> 0.4	Any	This system can use drip irrigation in the buffer areas and at times of high winds, frost and snow lie and the lower cost and better distributed spray at other times. The combination does not fully mitigate the potential visual effects and freezing effects on above ground infrastructure.

Table 4.1 indicates that the subsurface drip irrigation system is the most suitable system to use for the land application of Kingston effluent, it is suitable of the soils at the site and will provide the highest level of treatment and public safety of the options.

4.4 Discharging to an Existing Community Network

There is no community reticulation network within the vicinity and the cost required to reticulate wastewater 43 km to the QLDC Shotover WWTP site means that this option is not a viable alternative.

4.5 Discharge to Surface Water

The discharge to surface water or directly into Lake Wakatipu as an alternative receiving environment was not considered due to being deemed unacceptable to the community and iwi.

5 STATUTORY FRAMEWORK

5.1 Introduction

The Resource Management Act (RMA) 1991 sets out a statutory framework for consideration of resource consent applications which includes National Environmental Standards, National Policy Statements, Regional Policy Statements and Regional and District Plans. An assessment of the proposed activity against the RMA and relevant standards, statements, policies and plans is given below.

The proposed Kingston WWTP and LTA are located in the Otago Region. The Otago Regional Policy Statement (ORPS) is the dominant regional planning policy document for the Otago Region. It became operative on 01 October 1998 and is currently in the process of being reviewed. An assessment of the objectives and policies of the ORPS will be provided later in this application document.

The operative regional plan in terms of water quality is the Regional Plan: Water for Otago (ORPW) and the operative regional plan in terms of air quality is the Regional Plan: Air for Otago (ORPA). These two regional plans include the rules governing the discharges of contaminants into water or air and will be discussed further below.

In addition to these regional documents, the National Environmental Standards (NES) for Sources of Human Drinking Water Regulations 2007, the National Policy Statement for Freshwater Management 2014 (amended 2017) and the NES for Air Quality 2004 may have an influence on this resource consent application.

5.2 RMA and National Policies

5.2.1 Section 104 of the RMA

It has been determined that the application is required to be assessed under the provisions of Section 104 of the Resource Management Act, whereby the ORC shall give due regard to the following:

- Any actual or potential effects on the environment of allowing the activity (section 104(1)(a));
- The relevant objectives, policies, rules and other provisions of national environmental standards, other regulation, national policy statements, regional policy statements (proposed and operative), proposed plans and plans (section 104(1)(b)); and
- Any other matter that the Council considers relevant and reasonably necessary to determine the application (section 104(1)(c)).

The above matters have been addressed in the Assessment of Effects presented in Section 6.

5.2.2 105 and 107 of the RMA

Section 105 (as well clause 6(1)(d) of Schedule 4 of the RMA) identifies that where an application relates to a discharge permit of any contaminant, the consent authority must, in addition to the matters in section 104(1), have regard to-

- The nature of the discharge and the sensitivity of the receiving environment to adverse effects;
- The applicant's reasons for the proposed choice; and

- Any possible alternative methods of discharge, including discharge into any other receiving environment.

The nature of the process wastewater and the effects of the discharge on the receiving environment are described and assessed in the AEE in Section 6 of this report where it is concluded, given the limits and controls proposed for the proposal that any adverse effects associated with the activity being sought will be less than minor.

Section 107(1) of the RMA specifies that a discharge permit to discharge to water or land is not to be granted if, after reasonable mixing, the discharge gives rise to any of the following effects:

b) The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
c) Any conspicuous change in the colour or visual clarity;
d) Any emission of objectionable odour;
e) The rendering of freshwater unsuitable for consumption by farm animals; and
f) Any significant adverse effects on aquatic life."

As assessed in Section 6 of this report and given the controls in place, there will be no adverse effects on surface water, while no objectionable odour will be created. Therefore, the discharge of wastewater at the assigned land treatment area will not give rise to any of the above effects.

5.2.3 National Policy Statement for Freshwater Management 2014 (amended 2017)

The National Policy Statement for Freshwater Management (NPS-FM) sets out objectives, limits, and policies that direct regional councils to manage water in an integrated and sustainable way for ecosystem health and human health values, while providing for economic growth within set water quantity and quality limits. The 2014 NPS-FM replaced the 2011 version, and in August 2017 it was amended again to clarify the national importance of recognising and providing for Te Mana o Te Wai values, to better define the goals of water quality improvements, and to describe the types of monitoring required (mainly to address recreational and cultural values). The 2017 amendments also clarified that providing for the economic well-being of communities was to be considered by Councils as a factor when making decisions while ensuring that minimum flows and water quality standards are met.

ORC has implemented the NPS FM within the Regional Policy Statement (RPS) and the Regional Plan - Water for Otago. ORC are currently in the process of updating its RPS, which is at the appeal stage. Therefore, an overview of the key relevant provisions of the NPS-FM as it relates to QLDC's application to discharge treated wastewater to land has been carried in the following paragraphs.

The NPS-FM contains objectives and policies for Te Mana o te Wai (Part AA), water quality (Part A), water quantity (Part B), integrated management (Part C), the national objectives framework (Part CA), monitoring plans (Part CB), accounting for freshwater takes and contaminants (Part CC), tangata whenua roles and interests (Part D), and the progressive implementation programme (Part E). These objectives and policies are then supported by: national values and uses for freshwater (compulsory national values and other national values) and attribute tables that provide a range of attribute states for river and lakes, including national bottom lines, for different attributes and associated values (e.g., for an ecosystem

health value, attributes for periphyton are identified). Appendix 5 of the NPS-FM identifies surveillance monitoring requirements for *E.coli* at primary contact sites, and Appendix 6 of the NPS-FM identifies the national target for water quality improvement from 2017, 2030 and 2040.

Given that QLDC is seeking a discharge of treated wastewater to land, the water quality objectives and policies are relevant to the application. The water quality objectives of the NPS-FM, relevant to QLDC's application, aim to:

- Safeguard and protect the natural values of freshwater, particularly significant values, and the health of people and communities using water while maintaining water quality, or improving water quality where it is degraded (**Objectives A1 to A3**); and
- Enable communities to sustainably utilise freshwater, within limits, to provide for their economic well-being, including productive economic uses (**Objective A4**).

Policies A1 to A7 outline specific actions that regional councils are to take in order to achieve the objectives of the NPS-FM as they relate to water quality. NPS-FM policies have been incorporated into the Regional Plan: Water for Otago (RPWFO) with relevant policies assessed within Section 7 of this assessment.

As outlined in Section 6 below, given the inclusion of controls incorporated into the proposed consent conditions, the water quality of the area's groundwater resource will be maintained and improved. Therefore, as water quality will be maintained and improved, the values associated with the area's groundwater resource will be safeguarded and protected.

In addition, the National Objectives Framework (NOF) aims to provide a nationally consistent approach to managing freshwater values, while recognising regional and local circumstances (**Objective CA1**). This includes identifying relevant 'attributes' for identified compulsory or other national values identified in Appendices 1 and 2 of the NPS-FM and managing freshwater to maintain or achieve these attributes. As the RPWFO contains regionally specific limits for water bodies, including groundwater, and given that Appendix 2 of the NPS-FM only specifies attributes for surface water bodies, the NOF provisions of the NPS-FM are not assessed further.

Given the above assessment, it is considered that QLDC's application to discharge treated wastewater to land onto 30 ha is consistent with the relevant policy framework of the NPS-FM.

5.3 Otago Regional Policy Statement

Otago Regional Council has provided two regional policy statements in its existence. The first was confirmed in 1998 and the second is in its appeal stage and partially operative (2016). The RPS provides an overview of the resource management issues in the region and provides a policy and regulatory framework to achieve integrated management of natural and physical resources, including directions for provisions in the district and regional plans.

As the Regional Plan – Water for Otago (RPWFO) gives effect to the current RPS (as assessed in Sections 5.5 below), it is not necessary to provide a full assessment of the relevant objectives and policies of the 1998 RPS in relation to this application. However, an overview has been provided. A more detailed assessment of the relevant objectives and policies of the second RPS for Otago (2016) that is partially operative has also been provided below:

1. Regional Policy Statement for Otago (1998)

Section 6.4 of the 1998 Regional Policy Statement outlines objectives for water quantity and quality. Objectives 6.4.2 through to 6.4.5 are considered relevant to this proposal and relate to maintaining water quality in the Otago Region. Given the improvement of treatment proposed by QLDC and the reticulation of other on-site less stable/functioning systems, it is considered that this proposal is consistent with these objectives.

Policy 6.5.5 is considered relevant to this proposal and promotes the reduction in contaminant discharges by maintaining and improving water quality throughout the Otago Region. The proposal is considered consistent with this policy due to the total reduction in reducing nutrient loading to the environment and by utilising land treatment.

2. Regional Policy Statement (2016) – Partially Operative

The chapters and associated objectives and policies deemed to be relevant to this application are assessed in Table 5.1 below.

Table 5.1 Relevant Objective and Policies of the RPS for Otago (2016).

Provision Number	Provision	Assessment
PART B, CHAPTER 1- RESOURCE MANAGEMENT IN OTAGO IS INTEGRATED		
Objective 1.2	Recognise and provide for the integrated management of natural and physical resources to support the wellbeing of people and communities in Otago.	The use of land to receive the treated wastewater at sustainable nutrient loading rates allows the community to meet its housing needs.
Policy 1.2.1- Integrated resource management	Achieve integrated management of Otago's natural and physical resources, by all of the following: a) Coordinating the management of interconnected natural and physical resources; b) Taking into account the impacts of management of one natural or physical resource on the values of another, or on the environment;	The proposal allows for integrated management of natural and physical resources. The impacts of the proposal on the environment and the values of others have been considered.
PART B, CHAPTER 2- KAI TAHU VALUES AND INTERESTS ARE RECOGNISED AND KAITIAKITAKA IS EXPRESSED		
Objective 2.1	The principles of Te Tiriti o Waitangi are taken into account in resource management processes and decisions	Existing regional plans incorporate the principles of Te Tiriti o Waitangi. Iwi Management Plans have been considered and the application will be sent to Iwi for comment.
Policy 2.1.2- Treaty obligations	Ensure that local authorities exercise their functions and powers, by: a) Recognising Kāi Tahu's status as a Treaty partner; and b) Involving Kāi Tahu in resource management processes implementation;	Existing regional plans incorporate the principles of Te Tiriti o Waitangi. Iwi Management Plans have been considered and the

Provision Number	Provision	Assessment
	c) Taking into account Kāi Tahu values in resource management decision-making processes and implementation;	application will be sent to Iwi for comment.
Policy 2.2.1- Kai Tahu wellbeing	Manage the natural environment to support Kāi Tahu wellbeing by all of the following: a) Recognising and providing for their customary uses and cultural values in Schedules 1A and B; and, b) Safe-guarding the life-supporting capacity of natural resources.	Iwi Management Plans have been considered and the application will be sent to Iwi for comment. The proposal will have less than minor impact on the life supporting capacity of the natural resources in the area.
Policy 2.2.2- Recognising sites of cultural significance	Recognise and provide for the protection of wāhi tūpuna, by all of the following: a) Avoiding significant adverse effects on those values that contribute to the identified wāhi tūpuna being significant; b) Avoiding, remedying, or mitigating other adverse effects on the identified wāhi tūpuna; c) Managing the identified wāhi tūpuna sites in a culturally appropriate manner.	There have been no sites identified as having cultural significance within the direct vicinity of the proposed land application.
Objective 4.1	Risks that natural hazards pose to Otago's communities are minimised	Natural hazard risks in the area have been identified and the proposal will not in any way increase the risk from natural hazards to the community.
Policy 4.1.1- Identifying natural hazards	Identify natural hazards that may adversely affect Otago's communities, including hazards of low likelihood and high consequence by considering all of the following: a) Hazard type and characteristics; b) Multiple and cascading hazards; c) Cumulative effects, including from multiple hazards with different risks; d) Effects of climate change; e) Using the best available information for calculating likelihood; f) Exacerbating factors.	Potential natural hazard risks in the area have been identified.
Policy 4.1.5- Natural hazard risk	Manage natural hazard risk to people, property and communities, with particular regard to all of the following: a) The risk posed, considering the likelihood and consequences of natural hazard events; b) The implications of residual risk;	The proposal will not increase the risk from natural hazards to the community.

Provision Number	Provision	Assessment
Objective 4.3	Infrastructure is managed and developed in a sustainable way	The proposed activity and associated infrastructure require to carry out the proposed activity will be developed and managed in a sustainable way.
Policy 4.3.1- Managing Infrastructure Activities	Recognise and provide for infrastructure by all of the following: a) Protecting and providing for the functional needs of lifeline utilities and essential or emergency services; c) Improving efficiency of natural and physical resource use; d) Minimising adverse effects on existing land uses, and natural and physical resources;	This proposal will minimise the impact of multiple septic tanks on the environment and result in wastewater and sewage being collectively managed. The application provides for a functional essential service, that has improved efficiency and better impact on natural resources.
Objective 4.5	Urban growth and development is well designed, occurs in a strategic and coordinated way, and integrates effectively with adjoining urban and rural environments	The proposed activity allows for urban growth and development in a strategic and coordinated way.
Policy 4.5.2- Integrated infrastructure with land use	Achieve the strategic integration of infrastructure with land use, by undertaking all of the following: a) Recognising and providing for the functional needs of infrastructure; b) Locating and designing infrastructure to take into account all of the following: i. Actual and reasonably foreseeable land use change; ii. The current population and projected demographic changes; iii. Actual and reasonably foreseeable change in supply of, and demand for, infrastructure services; iv. Natural and physical resource constraints; v. Effects on the values of natural and physical resources;	The proposed activity is a strategic integration of infrastructure and land use and has been located and designed to appropriate future population and land use change projections. The system's design considers the natural and physical resource constraints and the potential impacts of the proposed infrastructure on those.
PART B, CHAPTER 5- PEOPLE ARE ABLE TO USE AND ENJOY OTAGO'S NATURAL AND BUILT ENVIRONMENT		
Objective 5.4	Adverse effects of using and enjoying Otago's natural and physical resources are minimised	The proposal will not impact on people's ability to use and enjoy Otago's natural and physical resources. The proposal will result in greater environmental

Provision Number	Provision	Assessment
		outcomes for Lake Wakatipu.
Policy 5.4.1- Offensive or objectionable discharges	Manage offensive or objectionable discharges to land, water and air by: a) Avoiding significant adverse effects of those discharges; b) Avoiding significant adverse effects of discharges of human or animal waste directly, or in close proximity, to water or mahika kai sites; c) Avoiding, remedying or mitigating other adverse effects of those discharges	The proposal manages the discharge to land in an appropriate manner and is designed to apply wastewater onto land without a direct connection to waterways. The proposed mitigations are in place to avoid significant adverse effects.

It is considered that QLDC's application to discharge wastewater to land is consistent with the relevant policy framework of both the current and partially operative RPS.

5.4 National Environmental Standards

There are three National Environmental Standards that may have an influence on this resource consent application:

- The Resource Management (National Environmental Standards for Air Quality) Regulations 2004; and
- The Resource Management (National Environmental Standards for Sources of Human Drinking Water) Regulations; and
- The Resource Management (National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health 2011

The NES for Air Quality includes standards governing ambient air quality, via the imposition of standards for five priority air pollutants (fine particles (PM10), sulphur dioxide, ozone, carbon monoxide, nitrogen dioxide). The standards apply in open air everywhere where people may be exposed in all regions of New Zealand. They do not apply to sites to which resource consents apply, to indoor air or air in tunnels.

The NES also requires air shed definition. ORC has gazetted defined air sheds within the Otago Region. The LTA and WWTP site lie within Air Zone 3 and is not within an identified air shed. The priority pollutants do not include odour or aerosols, which are the primary pollutants of interest in this assessment.

The scope of this application is for the discharge to land of wastewater LTA. The associated air discharge is assessed as a permitted activity. The associated wastewater treatment plant may require consent depending on configuration which will be confirmed as part of preliminary design.

Given the above, on this basis, no further consideration of the NES for Air Quality is required.

The NES for Sources of Human Drinking Water includes standards governing monitoring of water supplies and protection of abstraction points, water treatment plants and distribution networks. These standards tie in closely with the Drinking Water Standards for New Zealand. There are a number of private bores in the Kingston Township currently used for domestic

purposes, no specific community supply bore exists. As part of the proposed infrastructure development, a community supply bore is planned to be established at a site close to bore F42/0145. This bore is proposed to be established on Glen Nevis Station Northeast of the proposed LTA area, and east of Kingston Creek and Lake Wakatipu Kingston foreshore. As the proposed bore is northeast of the LTA and east of Kingston lake foreshore and greater than 1 km from the closest part of the LTA, it is very unlikely the proposed discharge will compromise the abstraction point. Therefore, no further consideration of the NES for Sources of Human Drinking Water is required.

The NES for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 is relevant to applications to subdivide or change the use of land that is identified on the Hazardous Activities and Industries List ('HAIL'). An assessment of the Site has been completed. This assessment has determined that there has been a HAIL activities undertaken on the property land parcel but not on the specific LTA area. The land, while categorised as having a potential contamination the use is production land and with the installation of the subsurface drip irrigation equipment will remain as production land suppling pasture forage material. As such, the establishment of the LTA does not require a resource consent under the NES Contaminated Land.

Production Land

Defined in section 2 of Resource Management Act 1991, as
(a) Means any land and auxiliary buildings used for the production (but not processing) of primary products (including agricultural, pastoral, horticultural, and forestry products):
(b) Does not include land or auxiliary buildings used or associated with prospecting, exploration, or mining for minerals...

If the land that is potentially or actually affected by contaminants is production land, the regulations do not apply to:
a. soil sampling or soil disturbance (except on parts of production land used for residential purposes)
b. subdivision or change of use (except where that would result in production land being used for a different purpose, e.g., for residential land use).

Soil disturbance. This activity includes any disturbance of soil such as levelling, trenching, scraping and excavating that occurs on actually or potentially contaminated land. It does not include soil disturbance associated with the activity of removing or replacing a fuel storage system.
As for soil sampling, in the case of production land, the NES only applies to disturbance of a piece of land in the immediate vicinity of existing or proposed residential buildings, or proposed farmhouse garden areas.

The NES Soil does not apply to this application as the piece of land that the LTA applies to, which is production land, will not be used to undertake an activity that is described in subclause (7) of the NES Soil. Therefore, no further comment is made on this planning instrument.

Given this, it is reasonable to conclude that the Proposal is consistent with the broad policy direction provided by the NPS and NES documents.

As identified in the aerial photos, the proposed LTA has been used for agricultural activities since at least 1958. Whilst there are building within the larger land parcel, there have been

no buildings on the proposed LTA site and there are no airplane landing strips or facilities used for the storage of fertiliser or volumes of other chemicals. There are no sheep dips or sheering sheds/cattle yards in the vicinity of the proposed works. While there is a history of HAIL activities being undertaken on the property land parcel, these are associated with the closed landfill and this is not within the area of the proposed LTA.

An assessment of Section 5 of the NES is provided in Table 5.2 below.

Table 5.2: Assessment of Section 5 of NES

NES section		Assessment	Applies
5(2)	An activity is removing a fuel storage system from the piece of land or replacing a fuel storage system in or on the piece of land, which means— (a) doing any of the following: (i) removing or replacing the whole system: (ii) removing or replacing an underground part of the system: (iii) taking away or putting back soil associated with the removal or replacement of the system or the part: (b) doing any of the following for purposes associated with removing or replacing the whole system or part of the system: (i) sampling the soil of the piece of land: (ii) investigating the piece of land: (iii) remediating the piece of land: (iv) validating the piece of land: (v) managing the piece of land.	No works being undertaken	No
5 (3)	An activity is sampling the soil of the piece of land, which means sampling it to determine whether or not it is contaminated and, if it is, the amount and kind of contamination.	No works being undertaken	No
5 (4)	An activity is disturbing the soil of the piece of land, which— (a) means disturbing the soil of the piece of land for a • particular purpose: (b) does not include disturbing the soil of the piece of land, whatever the purpose, if the land is land to which regulation 33(9) or 36 of the Resource Management (National Environmental Standard for Electricity Transmission Activities) Regulations 2009 applies.	The site is not a Piece of Land	No
5 (5)	An activity is subdividing land, which means subdividing land— (a) that has boundaries that are identical with the boundaries of the piece of land; or (b) that has all the piece of land within its boundaries; or (c) that has part of the piece of land within its boundaries.	No subdivision being undertaken	No
5 (6)	An activity is changing the use of the piece of land, which means changing it to a use that, because the land is as described in subclause (7), is reasonably likely to harm human health.	The site is not a Piece of Land as per S5 (7)	No

NES section		Assessment	Applies
5 (7)	The piece of land is a piece of land that is described by one of the following: (a) an activity or industry described in the *HAIL* is being undertaken on it: (b) an activity or industry described in the *HAIL* has been undertaken on it: (c) it is more likely than not that an activity or industry described in the *HAIL* is being or has been undertaken on it.	There is no history of the LTA specific area being used for a HAIL activity	No
5 (8)	If a piece of land described in subclause (7) is production land, these regulations apply if the person wants to— (a) remove a fuel storage system from the piece of land or replace a fuel storage system in or on the piece of land: (b) sample or disturb— (i) soil under existing residential buildings on the piece of land: (ii) soil used for the farmhouse garden or other residential purposes in the immediate vicinity of existing residential buildings: (iii) soil that would be under proposed residential buildings on the piece of land: (iv) soil that would be used for the farmhouse garden or other residential purposes in the immediate vicinity of proposed residential buildings: (c) subdivide land in a way that causes the piece of land to stop being production land: (d) change the use of the piece of land in a way that causes the piece of land to stop being production land.	The site is not a Piece of Land as per S5 (7)	No

Conclusion

In light of the above information, it is concluded that the provisions of the NES do not apply to this development as the site is remaining as production land and is not a "piece of land" and it is more likely than not that no activity or industry described in the *HAIL* is being or has been undertaken on it.

5.5 Otago Regional Plan

The Operative Regional Plan for water quality and air quality in the Otago Region is the Otago Regional Plan: Water (ORPW) and the Regional Plan: Air for Otago (ORPA) respectively.

5.5.1 Regional Plan: Water for Otago

The purpose of the ORPW is to provide a framework for the integrated and sustainable management of Otago's water resources. The Plan covers all of the fresh water resources in the Otago Region. These include the regions lakes, rivers, groundwater and wetlands.

The planning maps indicate that proposed LTA zone is not located within a significant wetland, additional wetland or groundwater protection zone. The proposed activity is therefore required to be assessed against the general provisions contained within the ORPW.

The relevant sections of importance is **Section 12.A** – Discharge of Human Sewage and **Section 12.B** which includes discharges from specified contaminants and stormwater; and discharges from industrial or trade premises

Rule 12.A.A.1 states:

"The discharge rules in section 12.A apply where a discharge contains human sewage"

Rules 12.A.1.1 to 12.A.1.4 pertain to existing long drops and existing on-site wastewater treatment systems.

Rule 12.A.2.1 states:

*"Except as provided for by Rules 12.A.1.1 to 12.A.1.4, the discharge of human sewage to water, or onto or into land in circumstances where it may enter water, is a **discretionary** activity."*

The discharge of treated effluent into land from the proposed Kingston WWTP is therefore deemed to be a **discretionary** activity.

Rule 12.B.A.2 states that the discharge rule in 12.A applies in addition to 12.B where a discharge contains human sewage.

Rules 12.B.4.1 is the most relevant rule in Section 12.B and it states:

*"The discharge of water (excluding stormwater) or any contaminant from an industrial or trade premises or a consented dam to water or to land is a **discretionary activity**, unless it is permitted by Rule 12.B.1.6, 12.B.1.7, 12.B.1.10 or 12.B.1.11".*

As the activity does not fall under Rule 12.B.1.6, 12.B.1.7, 12.B.1.10 or 12.B.1.11 the proposed discharge is deemed to be a **discretionary activity**.

5.5.2 Regional Plan: Air for Otago

The purpose of the ORPA is to seek the avoidance, remediation, or mitigation of adverse effects resulting from discharges of contaminants into air.

The following rules from the plan are considered to be applicable to this application:

Rule 16.3.7 – Waste Management

Table 5.1 provides an assessment against Rule 16.3.7.1 – Discharges form the storage, transfer, treatment and disposal of liquid borne municipal, industrial or trade water.

Table 5.3: Assessment of Compliance with Rule 16.3.7.1

Condition	Description	Compliance	Assessment
	The discharge of contaminants into air from the storage, transfer, treatment or disposal (including land application of treated effluent and sludge, but excluding the burning of sludge and associated solids) of liquid-borne municipal, industrial or trade waste, where the influent liquid waste does not exceed a BOD_5 of 850 kg per day;	**Complies**	The expected influent BOD_5 is 200 - 400 mg/L (0.2 - 0.4 kg/m^3); therefore, based on a peak flow of 900 m^3/day the BOD_5 will be no greater than 360 kg/day.
(a)	Ponds constructed after 1 January 2002 are located at least 150 metres from the closest part of the boundary of the property; and	**n/a**	
(b)	Land application does not occur within:		
	g) 150 metres from any residential dwelling on a neighbouring property or from a building used for employment purposes on a neighbouring property; and	**Complies**	There is no residential dwelling within 150 m.
	h) 20 metres from a formed public road; and	**Complies**	There is no formed public road within 20 m.
	i) 150 metres from any public amenity area or place of public assembly, excluding formed public roads, and	**Complies**	There is no amenity area or public assembly within close proximity.
(c)	Any discharge of odour, particulate matter, droplets or gases is not noxious, dangerous, offensive or objectionable at or beyond the boundary of the property.	**Complies**	Subsurface drip irrigation will ensure no odour or contaminants leave the application field border. The wastewater treatment plant will be enclosed and can be fitted with carbon/or similar filter if required.

The proposed treatment and land application of effluent from Kingstown Township comply with all conditions of Rule 16.3.7.1 and therefore, the air discharge is assessed as a **permitted** activity.

5.6 Conclusion

The discharge of contaminants to land is considered a **discretionary activity** pursuant to the Otago Regional Plan: Water. The relevant rules relating to the discharge is Rule 12.A.2.1 and Rule 12.B.4.1.
The discharge of contaminants to air is considered a permitted activity, not requiring Resource Consent, pursuant to the Otago Region Plan: Air, Rule 16.3.7.1.

6 ENVIRONMENTAL EFFECTS ASSESSMENT

6.1 Overview

This assessment of environmental effects has been prepared in accordance with the requirements of Section 127 and the Fourth Schedule of the Resource Management Act ("the Act"). Section 127 requires an application for resource consent to include an assessment of environmental effects in such detail that corresponds with the scale and significance of the effects the activity may have on the environment.

The potential adverse effects that may arise from the proposed discharge of treated effluent to land are:

- Effects on soils and plants;
- Effects of ground and surface water quality;
- Effects on amenity values;
- Effects on public and community; and
- Effects on Tangata Whenua values

6.2 Effects on Soils and Plants

Effluent land application is expected to be beneficial for plant growth.

6.2.1 Hydraulic and Nutrient Loading Assessment

Hydraulic Loading Rate

Wastewater is proposed to be applied via drip lines installed at 200 mm depth, to prevent freezing during the winter months while still discharging the water within the plant root zone. The exact requirements for the dripline design will be determined during the detailed design and procurement phase. The drip lines will likely be placed a maximum of 1 m apart, with the drippers spaced at approximately 600 mm intervals. The drippers will likely have an average discharge capacity of 1 to 2 L/hour depending on the type.

It is expected that the area will be divided into 3 irrigation blocks and each will have a number of zones that would be irrigated together. The LTA will be fenced, and there will be no grazing of animals. It is likely that application return will vary depending on inflows and the ultimate design dose volume. There will be capacity within the subsurface irrigation system to irrigate all zones within one day if needed during peak wet weather flows. The irrigation at 24 mm/day, 4 times the average rate on any one day allows flexibility within the system to manage the application from daily to up to a 4-day return period. The low application rate will allow the topsoil to assimilate the irrigation demand via plant uptake/transpiration and evapotranspiration, without reaching saturation.

The proposed peak day average hydraulic loading rate of 12 mm/d is significantly less than the topsoil assimilative (absorption) capacity and that of the lower horizons. S-maps (Landcare Research, 2017) suggest an available water holding capacity (WHC) of 49 mm per 30 cm (between 0 – 30 cm depth). Direct drainage losses are likely when the soil's moisture content is above field capacity and close to soil saturation (-1 KPa) when all soils exhibit a greater degree of preferential flow through large water conducting pores > 300 µm (Jarvis, 2007; Silva et al, 2000) or if application depth exceeds the soil's water holding capacity. It is

good practice to apply less than ½ of the WHC in any application to maintain matrix flow, thus a loading of <24 mm/application is desirable. The annual average application rate is lower at 6 mm/d and proposed condition limits the maximum average weekly application depth to 12 mm/day.

The significance of the soil moisture deficit is such that given appropriate irrigation methods, potential excess water (drainage) to potential groundwater may be minimised for summer periods of the year. Soil moisture retention within the root zone also aids to reduce nitrogen losses to groundwater by making the nitrogen more bioavailable for plant and soil micro-organisms.

Overseer modelling takes into account climate, soils and the application rate when it calculates soil drainage and associated N loss. The model predicts that nitrogen leaching will occur from April to November. The N leaching rate reported by Overseer takes drainage within each month into account and the potential effects of this N loss have been assessed in the sections below.

The LTA will be managed as a cut and carry system. This means that grass or lucerne will be grown and regularly harvested to increase the removal of nutrients. Three harvest events of 4,000 kg dry matter per ha per year have been modelled, with this silage/baleage being used by Kingston Station.

6.2.2 Treatment through the Soils Assessment

Land treatment of wastewater will assimilate BOD_5, Total Suspended Solids (TSS), Total Nitrogen (TN), Phosphorus (P) and pathogens contained in the wastewater and this is discussed in more detail below.

TSS

The effluent will be low in TSS (30 mg/L) after secondary treatment. This will be further reduced via a fine tertiary filter at the WWTP and then further filtered by the rubber diaphragm in the dripper filter to prevent the drippers from blocking. Any residue at the drippers is flushed out during the routine system maintenance. Therefore, the TSS entering the soil matrix will be very low and will not cause soil pore blockages. Any TSS that may enter the soils will have a less than minor effect on the soils as the soil has the ability to buffer moderate TSS loads as the sediment is incorporated into the soil matrix along with humus.

BOD

A healthy soil environment can assimilate up to 600 kg BOD_5/ha/d (NZLTC, 2000). The fully developed discharge field covers a proposed area of at least 15 ha (9,000 kg BOD_5/day allowable). The effluent BOD_5 concentration, after treatment, will be on average 20 g/m^3 prior to tertiary filtration and the average flow is estimated as be 900 m^3/day. Therefore, the BOD_5 in the effluent is on average 18 kg BOD_5/day and 45 kg BOD_5/day during the stage 1 early period of uptake; both these loading rates are significantly less than the 9,000 kg/day the soil can assimilate. Therefore, the LTA has the required capacity to assimilate BOD_5 and the effects of BOD from the discharges on the soil will be less than minor.

Drainage and Runoff

The hydraulic loading rate will increase drainage through the soil profile, however, ponding is not expected to be a concern given the low application rate in comparison to the soil's unsaturated hydraulic conductivity capacity, along with the soil's drainage status. Subsurface

drip irrigation will also be located 200 mm below the topsoil. Therefore, no surface runoff is expected from the site as a result of the drip irrigation.

From the NZ Guidelines for the Utilisation of Sewage Effluent on Land (NZLTC, 2000), the sodium adsorption ratio (SAR) is likely to be in the order of 4 – 7. The SAR is the ratio of sodium ions to calcium and magnesium ions in the soil. When the SAR is greater than 9, the soil's infiltration rate can be affected due to dispersion of clay particles. As the expected SAR ratio is less than 9, it is expected that the soil's drainage capability will not be affected by the discharge.

Heavy Metals

The accumulation of heavy metals or pesticides within the soil profile will not be an issue of concern as the wastewater is domestic in origin. Heavy metals and pesticides are not found in significant quantities in domestic wastewater that has no significant industrial component.

6.2.3 Effects on Soils – Summary

The irrigation of Kingston (domestic) effluent to land will be controlled by a suitable effluent management plan, taking into consideration the hydraulic and nutrient limitations of the soils and climatic fluctuations within the region. It is assessed that the application of effluent to land has the potential to enhance soils allowing for improved plant growth. It is also concluded that the proposed hydraulic and nutrient loading rates for a cut and carry regime are within the soil and plant assimilation capacities. Therefore, the potential effects on the soils will be less than minor.

6.3 Effects on Ground and Surface Water Quality

6.3.1 ANZECC Water Quality Guidelines Assessment

The revised ANZECC water quality guidelines (2000) require a more detailed assessment of the ecosystem into which a potential discharge will be introduced. Primary management aims are required to be defined, as well as an assessment of the ecosystem type and level of protection required (depending on the level of disturbance). Trigger values are then set for the effects of the discharge. No recommendations are made, however, for the size of mixing zones downstream of discharges into receiving environments.

The revised ANZECC guidelines do not recommend a single set of nitrogen and phosphorus concentrations that will prevent nuisance algal problems in fresh water because many other factors (e.g. ecosystem condition, environment, poor light, high turbidity, temperature, poor attachment substrates) can also limit the development of nuisance growth. Nuisance growths may occur downstream in a river system because of some limiting factor in an upstream section.

In addition to the protection of aquatic ecosystems, consideration of water quality for water based recreational activities is necessary. Lake Wakatipu supports sporting activities where the user may come into frequent contact with water, therefore contact recreational faecal coliform water quality guidelines have been adopted.

The removal of microbial contaminants from the wastewater is a high priority. The microbial guidelines for primary contact in recreational river and lake waters, suggests a maximum bacterial content not exceeding 550 *E.coli* /100 ml.

6.3.2 Microbial Contaminants

The effluent discharge could typically have median concentrations in the order of 10^4 cfu/100 ml *E.coli*. However, protection of groundwater and surface water is ensured by treatment of the treated effluent within the soil profile through the mechanisms of filtration, absorption and natural attrition.

The USEPA defines these processes as:

> ***Slow rate land treatment*** *"the application of wastewater to a vegetated soil surface. The applied wastewater receives significant treatment as it flows through the plant root/soil matrix. Solids removal generally occurs at the soil surface and biological, chemical and additional physical treatment occurs as the wastewater percolates through the plant root/soil matrix"*

According to a study by the Florida University (IFAS)

> *"when at least two feet of unsaturated soil exist between the infiltration system and the water table, BOD_5 removals of >90%, TSS removals of >95% and faecal coliform reductions of > 99% can be expected for a functional and properly maintained septic tank. Bacteria and viruses are effectively removed by adsorption and sorption processes in the groundwater and are not transported far from the source"*

In addition to the IFAS study noted above, a number of studies also show that passage of treated wastewater through the soil at a low rate and applied intermittently will enhance the natural pathogen die-off and reduce the number eventually transported into ground/surface water.

The main mechanisms that operate within the soil matrix to ensure pathogen removal are filtration, adsorption and natural attrition. Results from various studies show virus reductions of 99.99% through 0.6 m of 0.12 mm diameter sand and bacteria reductions of 99.998% through 0.9 m of 0.15 mm diameter dune sand, with 92 to 97% reduction occurring in the top one centimetre. In addition, Rubin (2009) (an author of many USEPA publications) in his recent decentralised wastewater workshops in NZ stated that they conservatively use one log reduction of bacteria per 150 mm of travel through the soil and subsoils. Therefore, a high level of pathogen removal will be achieved before such drainage travels through the glacial till soil matrix to reach the groundwater and potentially Lake Wakatipu.

The above studies relate to Low Pressure Effluent Dosing (LPED) systems; however, the Kingston WWTP will be applying treated effluent over a large land area at a low rate. Therefore, it can be expected that the method of land application within the LTA will produce better results over the discharge area as a whole.

A study by Bohrer and Converse (2000) was conducted in Wisconsin which evaluated six drip irrigation systems for the treatment of wastewater by septic tanks and aerobic units in soils that ranged from coarse sand to clay loam. They found that beyond approximately 450 mm of soil depth the faecal coliform count was below detection limits. At 150 to 300 mm soil depth the coliform count ranged from 2 to 24 MPN per gram of soil.

Therefore, as a result of the combination of the proposed secondary treatment plant, the low application rate and the large depth of soil and subsoil; it is considered that the effect of microbes on any potential receiving groundwater and surface water will be no more than

minor. There will be a significant net reduction of FC entering Lake Wakatipu with the decommissioning over time of the Kingston Township existing septic tanks.

6.3.3 Nitrogen

Nitrate-nitrogen is mobile through the soil and has the potential to adversely affect human health if present in high concentrations in drinking water. The Drinking Water Standards for New Zealand (DWSNZ, 2005) specifies a maximum acceptable value of nitrate-nitrogen of 11.3 mg/L.

As discussed in Section 3.4.3, the nitrogen loading rate of 438 kg N/ha/yr is within the range of plant uptake capacity for a cut and carry system. Therefore, nitrogen applied to the soils via effluent land application will provide a beneficial nutrient for plant growth and most, will potentially undergo plant assimilation, immobilisation within the soil matrix or denitrification prior to potential leaching to ground of any surplus.

It is considered that the annual areal loading of nitrogen is more important to managing effects from a land treatment system than controlling the concentration leaving the WWTP. Therefore, an annual N loading per hectare has been promoted; and a condition limiting the nitrogen loading rate to 450 kg N/ha/yr.

Given the nitrogen loading rate and the soil nitrogen deficiency, it is considered that pasture/crop uptake and other loss processes, such as microbe use, immobilisation into soil storage and denitrification will significantly reduce the potential for leaching to groundwater. However, should leaching result, it is considered that given the low nitrogen loading rate and the magnitude of dilution that will occur, the effect of the discharge on water quality will be less than minor. The proposed system represents an improvement over the existing situation of uncontrolled individual treatment via septic tank systems used by a large number of properties in the Kingston Township. The potential improvement over the existing environment is discussed below.

Current Land Use and Permitted Baseline Loss

The Otago Regional Council (ORC) manages small-scale discharges from septic tanks and long drops using Permitted Activity Rules 12.6.1.1 to 12.6.1.4 in the Regional Plan: Water for Otago (RPW) Plan. The permitted activity rules allow discharge of effluent, provided certain conditions are met. These conditions vary depending on whether the discharge predates or postdates the 28th of February 1998. It is considered that the current loading going into the Kingston Aquifer and then Lake Wakatipu from onsite systems fits under the permitted activity status in the RPW, thus is the permitted baseline for on-site discharges.

Rural land's diffuse N loss is managed under RPW Plan Change 6A. Farmland at Kingston is currently permitted to leach 15 kg N/ha/yr under Rule 12.C.1.3 (a) (i) and Maps H1 to H6 of PC 6A RPW. The nitrogen loss of 15 kg N/ha/yr was modelled using OVERSEER® version 6 or later.

This permitted N loss of 15 kg N/ha/yr can be applied to 55 ha of new development and the 15 ha Land Treatment Area (LTA) site that are currently farmed (70 ha in total). The 42 ha of existing township (some allowance for growth) has a current cumulative permitted septic tank loss assessed at 44 kg N/ha/yr.

Given that the new subdivision area and existing township will effectively leach 0 - 3 kg N/ha/yr from stormwater and gardens, the amount that the subdivision area is permitted to

leach via a farming use can be applied to the LTA in addition to the LTA's own agricultural leaching amount. This means that the currently permitted agricultural leaching and current village on-site leaching equates to a mass of 2,898 kg N/yr, being the combination of 1,050 kg/yr (70 ha x 15 kg/ha/yr) from the new subdivision and LTA area and the existing septic tank loss of 1,848 kg N/yr. When applied to the 15 ha LTA only, this equates to permitted baseline leaching of 193 kg N/ha/yr.

Table 6.3 shows the proposed loadings and N losses.

An OVERSEER® nutrient budget cut and carry model was produced to indicate the potential leaching from the proposed application of treated wastewater on the LTA. The input Nitrogen loading was applied at a rate of 438 kg N/ha/yr evenly across the year. The example considered a Maude Silty Loam soil type.

Nitrogen loading was applied as a soluble fertiliser as nitrate to a 15 ha block and is shown below in Table 6.1 for each month. Using nitrate is conservative, as some of the WWTP effluent nitrogen will be in an ammoniacal form, that is more tightly adsorbed onto soil cation exchange sites than soluble nitrate.

Table 6.1: Soluble Nitrogen Fertiliser Application on a Per Month Basis as Modelled in Overseer

Month	Material	NPKS (kg nutrient/ha)
January	Fertiliser form	37 - 19 - 0 - 0
February	Fertiliser form	33 - 17 - 0 - 0
March	Fertiliser form	37 - 19 - 0 - 0
April	Fertiliser form	36 - 18 - 0 - 0
May	Fertiliser form	37 - 19 - 0 - 0
June	Fertiliser form	36 - 18 - 0 - 0
July	Fertiliser form	37 - 19 - 0 - 0
August	Fertiliser form	37 - 19 - 0 - 0
September	Fertiliser form	36 - 18 - 0 - 0
October	Fertiliser form	37 - 19 - 0 - 0
November	Fertiliser form	36 - 18 - 0 - 0
December	Fertiliser form	37 - 19 - 0 - 0

For a 438 kg N/ha/yr load, OVERSEER® modelling applied the wastewater as irrigation in the form of drip irrigation. The total application depth modelled was 2,190 mm for the year.

A cut and carry system involves removing cut pasture and removing it off the site. This can be modelled as silage, baleage or similar. For the OVERSEER model, a total of up to 12 t DM/ha/yr of lucerne silage was cut and exported off the 15 ha irrigated block. This models the effects of a typical cut and carry system. Sensitivity of the N leaching rate to cut and carry dry matter production has also been assessed as low.

The OVERSEER nutrient budget shows a total leaching value of 142 kg N/ha/yr across the 15 ha land treatment area. This is dominated by winter losses as is to be expected, as irrigation is applied all year round. For phosphorus, the total leaching value is 0.6 kg P/ha/yr.

Incorporating headlands and other non-grazing areas into the treatment area would further reduce the average N loss. For instance, having an estimated 5 ha's of headland, then LTA nitrogen loss average reduces to 107 kg N/ha/yr over the 20 ha area. When Kingston is fully developed, there will be a minimum of 15 ha of land treatment.

With the development of the new treatment plant and land treatment area, there will be a reduction of 768 kg N entering the environment every year as a result of this proposal, which amounts to a reduction of 26.5% compared to the Plan Change 6a permitted baseline leaching[2]. The calculation of Nitrogen loading pre and post the proposed development are presented in Table 6.2. During the initial period of the development as stages of the new subdivision are developed, the net reduction is expected to be greater.

Table 6.2: Nitrogen Budget Pre and Post-Development Nitrogen Leaching Estimate Land Use Area (ha) N Leached (kg/ha/yr) (kg/yr)

Pre-Development Nitrogen Leaching Estimate			
Land Use	**Area (ha)**	**N Leached (kg/ha/y)**	**(kg/y)**
Farmed area of subdivision and LTA	70	15	1,050
Kingston town	42	44	1,848
Total:	**112**		**2,898**
Post-Development Nitrogen Leaching Estimate			
Land Use	**Area (ha)**	**N Leached (kg/ha/yr)**	**(kg/yr)**
LTA (now including town and new housing development)	15	142	2,130
Kingston town	42	-	
New housing development	55	-	
Total Post-development	**112**		**2,130**
Net reduction			**768**
Percent reduction			**26.5%**

An alternative analysis to OVERSEER® to estimate the leaching from the land treatment area is to consider research undertaken by Beggs et. al., (2011). Beggs found wastewater applied to land undergoes further biological processes, with research trials indicating that the concentration of nitrogen applied to the soil from wastewater treatment systems via subsurface drip irrigation is not 100% lost via leaching.

In the soil, there are many other processes that utilise the nitrogen that is applied. Secondary treated wastewater systems can be used with sub-subsurface drip irrigation. Subsurface drip irrigation is more effective at removing nitrogen as they are located around 200 mm below ground and apply around 3 – 5 mm of treated wastewater per day to the active subsoil layer. The nitrogen in the sub-surface layer can be further broken down by biological processes and be taken up by plant roots for growth and exported by cut and carry harvesting systems.

The soils of the land treatment area are considered to be equivalent to a silt loam soil (Loam).

[2] ORC Regional Water Plan permits leaching of 15 kg N/ha/yr for agricultural production land in nitrate sensitive catchments and existing loss of nitrate from 225 Kingston Village septic tanks.

Based on the findings of Beggs et. al., (2011) (see Figure 6.1), the fate of wastewater nitrogen applied to land via subsurface drip irrigation in a Loam soil is:

j) 0 – 32% via root uptake from plants;
k) 40 – 62% lost via Denitrification; and
l) 30% lost via leaching

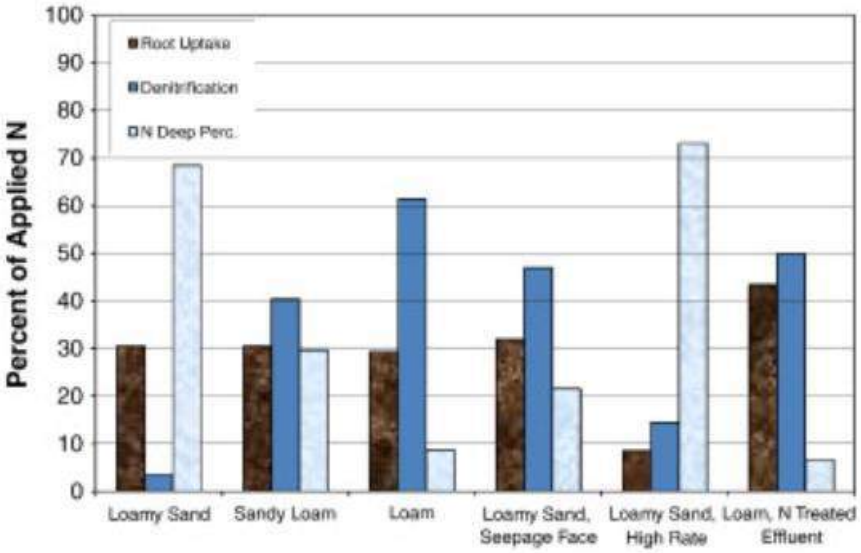

Figure 6.1: Fate of Nitrogen in Wastewater Effluent Applied to Land (Beggs, et. al., 2011)

For the proposed LTA system, if 438 kg N/Ha/yr is applied to 15 ha LTA, using Beggs et al., (2011), 8% to 30% estimation being leached below the root zone equates to 35 to 131 kg N/ha/yr. This is comparable to the OVERSEER® estimate in the section above for cut and carry of 142 kg N/ha.

Table 6.3 shows the nitrogen added to the total 15 ha LTA, the nitrogen that is removed in the cut and carry process, and then the nitrogen that is lost to the water (leached). The difference between the nitrogen gained and lost is due to other losses that occur, for example, the transfer of nitrogen into the atmosphere.

Table 6.3: Nitrogen and Phosphorus Leaching on Kingston Station LTA Scenario

Scenario	Description	N added or removed	(Kg/ha/yr)	P added or removed	(Kg P/ha/yr)
LTA	Kingston Station Land Treatment Area (15 ha)	N Added:	438	P Added:	222
		N removed as supplements:	442	P removed as supplements:	36
		N lost to water:	142	P lost to Water (overland flow)	0.6

The proposed limits and loading result in nitrate leaching 26.5% lower than that allowed as a permitted activity for current on-site systems at Kingston Township and current Kingston

Station farming, based on Plan Change 6A Rule 12.C.1.3 (a) (iii) of 15 kg N/ha/yr (calculations were based on 55 hectares dedicated to subdivision development and the 15 ha LTA).

Not only would the proposed treatment system result in less N being leached from that currently permitted, it also removes the leaching from a number of on-site systems located close to the Lake Wakatipu, overall reducing the total nitrogen load and microbiological contamination of groundwater and the lake. It combines an estimated 225 private on-site systems in one treatment plant that will be managed and operated by QLDC. This will make administration and monitoring of consents much simpler.

6.3.4 Phosphorus

As previously discussed in Section 3.4.3, the proposed application rate will be approximately 222 kg P/ha/yr. This rate is greater than the suggested phosphorus plant uptake capacity of 130 kg P/ha/yr – 160 kg P/ha/yr (Morton, et al., 2000) for a cut and carry regime and that estimated by OVERSEER® of 36 kg P/ha/yr.

To assess the fate of the surplus P (186 kg P/ha if using the 36 kg/ha uptake from OVERSEER®), the soil's P retention properties were investigated as reported in Section 2.41. Phosphorus is a cation, (unlike nitrate an anion) is not very mobile within the soil profile. The soil test analysis shows that the proposed LTA soil profile can retain large amounts of added P before the P migrates further down the soil/subsoil profile. In Table 6.4, the P retention has been calculated for the first 1.5 m of the soil/subsoil profile based on the Landcare Research laboratory analysis. Using 1.5 m is considered conservative. Depending on the depth to groundwater, there is a potential subsoil depth for P storage of 30 to 60 m (approximately height above Lake level/potential regional groundwater depth).

The P retention analysis suggests P supplied over 54 years at full loading rates can be stored within the first 1.5 m of the soil profile before there would be significant P migration to lower subsoils. This storage potential is much greater than the proposed consent duration of 35 years.

Table 6.4: Phosphorus Storage Capacity

Parameter	Site 1	Site 2	Site 3
Bulk Density (kg/m^3)$^{(1)}$	1,090	1,090	1,090
P Sorption (mg/kg)	728	570	550
Treatment Soil Depth (m)	1.5	1.5	1.5
P Storage Capacity (kg P/ha)	11,907	9,324	8,987
Design P Storage Capacity (kg P/ha)	10,073		
P Loading Rate less DM export (kg P/ha/yr)	186		
Site Life (years)	54		

In addition to the likely high P retention at the LTA site, the proposal removes all of the P from the septic tank discharges within the lake foreshore that has a much higher probability of entering Lake Wakatipu. For the 225 septic tanks this is estimated to be 616 kg P/yr (18% of the load).

Therefore, the leaching/runoff of total phosphorus and DRP off the LTA is expected to be less than minor given:

- The conservative average hydraulic rate application rate (average 6 mm/d);

- The large P retention capacity of the soil;
- The added wastewater P is the primary source of phosphorus for the lucerne uptake; and
- The large vertical distance to any ground or surface water.

It is also considered that the proposed land application is a considerable improvement over that of the existing individual dwelling treatment/septic systems. There is a low potential for phosphorous leaching to groundwater due to the large depth of soil matrix prior to any potential groundwater and that most, if not all, phosphorous will be retained within the soil profile and not be leached to groundwater and ultimately Lake Wakatipu.

Based on the preceding analysis the potential for P leaching to ground or surface waters and any potential effects are likely to be less than minor.

6.3.5 Direct Effects on Groundwater

The LTA area is between 40 to 60 m higher in elevation than Lake Wakatipu. No perched or unconfined groundwater has been discovered during site investigations. The underlying soils' formations and lack of wells and groundwater reporting within the area suggest that potentially if any groundwater is present, it is intermittent and not readily available.

The treatment system being proposed provides a much higher level of treatment compared to the current on-site systems in place, which are individual septic tanks for each property. This in itself will have much more benefit on the groundwater as septic tanks are primary treatment systems providing a much lower level of treatment compared with secondary treatment systems and have been susceptible to overflow, especially in times of floods.

The nitrogen leaching rate of 142 kg N/ha/yr predicted by OVERSEER® is at a concentration of 6.0 g/m^3 immediately below the rootzone, this is 54% of the NZ drinking water standard for Nitrate-nitrogen. The 142 kg N/ha/yr takes into account winter drainage. The predicted N concentration is at the root zone prior to any regional groundwater mixing or denitrification. Taking into account the underlying geology and depth of soil matrix prior to any potential groundwater abstraction and given the distance to the closest operative bore is over 800 m it is considered that the effects of wastewater land application will be less than minor.

6.3.6 Direct Effects on Surface Water

It is considered that the proposed discharge to land within the LTA is a significant improvement over the existing individual dwelling septic tank discharge systems. The shift to a community treatment system will mitigate potential environmental and cultural implications of such systems that are potentially uncontrolled and unlikely to meet expected current effluent quality outcomes.

The proposed hydraulic loading rate over the 15 ha LTA will average 6 mm/day, which is significantly below the calculated topsoil unsaturated soil DIR of 19 mm/day. Therefore, with correct management strategies, the hydraulic loading over the application area will be such that the wastewater will assimilate into the soil profile without surface run-off or ponding.

Consideration is given to the potential for surface run-off resulting from either a system failure or excessive rainfall beyond normal expectations causing the soil to become saturated and wastewater to be forced to the surface. This is unlikely as the soil saturated hydraulic conductivity is tested to be around 2 m per day, however, in the event of such an occurrence, any run-off would be significantly diluted, have filtered up through the soil and then

percolating across a vegetated surface that has the ability to remove any remaining suspended contaminants prior to mixed surface water and treated wastewater entering the surface water catchment of the unnamed tributary and potentially to Lake Wakatipu.

Surface emergence of any applied wastewater is very unlikely due to the soil matrix and 200 mm depth of the emitter lines. For those surface water features that are located within the LTA, a 10 m buffer has been provided to distance the subsurface irrigation from the surface waters. Overall, it is considered that in the worst case scenario, resulting in potential up flow and surface emergence and then run-off from the LTA zone, the treatment outcome will still be of a high quality.

It is envisaged that the majority of the treated effluent applied (irrigated) to the land over the summer period may be taken up by evapotranspiration (plant transpiration and soil evaporation) alone.

The proposed change to a community wastewater treatment system and the land management will have little to no effect on or cause additional surface water runoff as the land treatment method is via subsurface drip irrigation. All watercourses in and around the LTA are ephemeral and therefore unlikely to deliver contaminants to Lake Wakatipu from subsurface applied effluent. The main vector for treated wastewater to enter relevant surface water features, such as the unnamed tributaries, is receiving water through groundwater discharging into it. For nutrients that do emerge in the lake, the net reduction in nitrogen load from the current situation and large dilution means that the Lake Wakatipu water nutrient concentrations will maintain at very low levels. An assessment of change in nitrogen concentration at the lake after mixing is presented in Table 6.5. This assessment assumes all the leached nitrogen arrived at the lake for the current scenario and future with the LTA. There is no monitoring data to support the actual concentration calculated, however, it does show the relative difference between the scenarios.

Table 6.5: Nitrogen Concentrations Change in Lake Wakatipu

		Distance from shore (m)				
Lake mixing volume		5	10	25	50	100
*1000 m near shore across bay, 30 degree fall in lake margin (underwater)						
Lake area	m^2	5,000	10,000	25,000	50,000	100,000
Lake average depth that is mixed		2.88	5.76	14.4	28.8	57.6
Number of full mixing events per year		150	150	150	150	150
Lake margin mixing volume	m^3/yr	1,080,000	4,320,000	27,000,000	108,000,000	432,000,000
Pre-development						
Kingston village septic tanks	kg/yr	1,848	1848	1849	1850	1851
Farming 70 ha @15 kg N/ha	kg/yr	1,050	1,050	1,050	1,050	1,050
Total nitrogen discharged per year	kg/yr	2,898	2,898	2,899	2,900	2901
Lake margin concentration	mg/L	2.68	0.67	0.11	0.03	0.01
LTA development						
Kingston village 44 ha @3 kg N/ha	kg/yr	132	132	132	132	132
New subdivision 55 ha @3kg N/ha	kg/yr	165	165	165	165	165
LTA leaching 142 kg over 15 ha	m^3/yr	2,130	2,130	2,130	2,130	2,130
Total nitrogen discharged per year	kg/yr	2,427	2,427	2,427	2,427	2,427
Lake margin concentration	mg/L	2.25	0.562	0.09	0.022	0.006
% Change in Nitrogen concentration		-16%	-16%	-16%	-16%	-16%

An alternative assessment is to look at the potential change in concentration at the lake outlet measuring site. If the existing N loss baseline was disregarded, the calculated increase in concentration for Lake Wakatipu is likely to be less than 0.00087 mg/L (0.87 mg/m^3) at the Lake outlet monitoring site. This is a very low increase in concentration, it is 0.5% of the NPM-FM Total Nitrogen attribute A value for TN (160 mg/m^3) and does not take into account the predicted reduction in baseline N loss of 768 kg N/yr. It is considered that the proposal will result in an improvement in Lake Wakatipu water quality.

The potential for effects of groundwater emerging in the catchment of unnamed tributary or Mataura River tributaries is limited to nutrient impacts of nitrogen. As discussed in Sections' 6.3.2 Bacterial Contamination and 6.3.4 Phosphorus, these contaminants are strongly retained within the soil and subsoil matrix associated with the terminal moraine. With respect to nitrogen entering surface water, consideration is needed to be given to the likely concentration with respect to aquatic toxicity and a nuisance periphyton growths.

Nitrate Toxicity

In the unlikely scenario of the LTA drainage water emerging into surface water without attenuation, groundwater dilution, denitrification or mixing with surface waters, the discharge concertation of 6 g/m^3 would be classed as attribute State C and not breaching NPS-FM National bottom lines. With attenuation and dilution, it is very unlikely that the resulting groundwater, if it did emerge into to unnamed tributary catchment, would be at concentrations that are toxic to more than 5% of sensitive species. The potential for a significant quantity of groundwater to discharge to the Mataura River catchment is assessed

as being low due to the majority, if not all, the land topography of the LTA area falling towards the north away from the Mataura River Catchment, however, the potential effect of a small amount of additional nitrogen into the Mataura River is less than minor and is comparable to current landuse use losses associated with the winter grazing of stock on fodder crops.

Nuisance Periphyton

Nuisance periphyton growth is possible if groundwater does contribute to surface waters provided both N and P are present in sufficient quantities, there is suitable substrate and low level of stream disturbance. Given the steep nature of the surface water catchment and low groundwater resource within the terminal moraine, the hydrology of the Kingston Creek is expected to be highly variable. This means that a small depth of rainfall within the catchment can easily contribute to a flow that is enough to displace the periphyton (2 - 3 times median).

Accounting for the low expected concentration of N and nil additional contribution of P combined with the volatility of the catchment hydrology means that the risk of nuisance periphyton is expected to be less than minor.

6.3.7 Effects on Aquatic Ecological Values

E3 Scientific carried out an assessment in February 2020 of the aquatic ecological values near the site and the effect of the proposed activities on the aquatic ecology. They summaries that the WWTP and LTA is considered to improve the water quality of Lake Wakatipu due to the discontinuation of the current septic tank system, however, there could potentially be unidentified ecological effects on the adjacent wetland and unnamed tributary of Lake Wakatipu. In order to mitigate any potential adverse effects, conditions of consent were recommended. If these conditions are met, the effects of the LTA discharge on the nearby aquatic environment are considered to be detectable and potentially minor. All the proposed conditions recommended in the report have been included in proposed consent conditions within this application. The full report from E3 Scientific can be found in Appendix B.

6.3.8 Effects on Existing Water Takes

As discussed above, there will be less than minor effect from the proposed operation of the LTA on groundwater and surface water quality, therefore the proposed LTA will have a less than minor effect on the two existing water takes (RM17.100.01 and 2004.926).

The existing groundwater take RM17.100.01 is a shallow take that is reported in the ORC officer's report to be hydraulically connected to nearby surface water. The bore is located 5 m west of an unnamed surface water tributary of Lake Wakatipu, which flows west down the slopes of Flat Rock. Water coming down the slopes from Flat Rock do not pass through the LTA area and it is unlikely that any groundwater from the LTA area intercept and end up in this tributary.

The surface water take (2004.926) is sourced from a spring-fed unnamed tributary of Lake Wakatipu and is located on the hillside. The tributary connects to streams feeding into Lake Wakatipu and the take itself is upstream of where any water flowing from the LTA area would reach. Therefore, the proposed LTA will have no impact on this surface water take.

6.4 Effects on Amenity Values

The irrigation system within the proposed LTA will be buried and constructed to blend in with the surrounding environment to reduce visual effects. Any above ground building e.g. control shed, will be sited in such a location as to not to be visible, or only from either Kingston Township or SH 1. Therefore, the effects on visual amenity values will be less than minor. As stated in Section 2.2, the surrounding land use is grazed farmland with Kingston township to the north. The irrigation system proposed is in line with and will not impact on existing land uses in the surrounding area.

6.5 Effects on Public and the Community

It should be noted that currently there is no Kingston community wastewater treatment scheme and each individual property owner is responsible for the treatment and disposal of their household wastewater. As a result, the effluent treatment and discharge is not to a high standard from all properties. Therefore, the proposed treatment scheme is a vast improvement over the existing individual practices.

It is considered that there will be minimal effects on the people in the wider community from the Kingston community effluent discharge because the proposed LTA and treatment plant will be located on private property (Kingston Station). People will be kept out of the LTA by signage and the private property nature of the station. The high-quality treatment of the community wastewater will ensure that there will be no health effects arising from E. coli as a result of the application to land.

Aerosols will not be produced from the wastewater treatment discharge as the application to land will be via subsurface irrigation.

The treatment system will not be odorous when working correctly and robust monitoring and control devices will notify QLDC if any system fails or performs poorly. For these reasons, adverse effects resulting from the wastewater land application system are considered to be no more than minor.

6.6 Effects on Tangata Whenua Values

A major cause of concern for the Runanga is the discharge of human wastewater to water. The proposed discharge of wastewater to land is considered to be an acceptable method of disposal of human wastewater and it has less effect on cultural values than discharge to water.

Of concern is the protection of sites of cultural significance such as Nohoanga sites (traditional camping sites associated with mahinga kai – food gathering), sites of Wahi, Taonga and Tapu (sacred and treasured sites) and "silent files" which are unidentified areas of cultural and spiritual significance. There have been no sites identified as having cultural significance within the vicinity of the proposed land application area. The site is considered low risk and the use of an accidental discovery protocol as written in the proposed conditions is sufficient given this low risk.

The proposed land application area has been selected on the basis of its location and ability to minimise effects on the environment, improve the lake water quality and therefore has the potential to mitigate concerns of Tangata Whenua.

6.7 Summary and Cumulative Effects

The effects of the Kingston proposed land application of treated effluent within the boundary of Kingston Station to the South of Lake Wakatipu has been assessed as having a less than minor impact on the receiving environment.

It is assessed that the proposed application of treated effluent to land is a significant improvement over that of the existing individual dwelling treatment and discharge systems.

With the development of the new treatment plant and land treatment area, there will be an estimated reduction of 768 kg N entering the environment every year as a result of this proposal (Table 6.2), which amounts to a reduction of 26.5% compared to the Plan Change 6a permitted baseline leaching[3]. During the initial period of the development as stages of the new subdivision are developed the net reduction is expected to be greater.

The proposal also takes into consideration the wellbeing of the community, amenity and cultural concerns.

[3] ORC Regional Water Plan permits leaching of 15 kg N/ha/yr for agricultural production land in nitrate sensitive catchments and existing loss of nitrate from 225 Kingston Village septic tanks.

7 OBJECTIVES AND POLICIES

7.1 Overview

The Otago Regional Policy Statement (ORPS) is the dominant planning policy document for the Otago Region. It became operative in October 1998 and is currently being reviewed. The objectives and policies of the Regional Plan: Water have been written to be consistent with the Regional Policy Statement.

Kai Tahu Ki Otago Natural Resource Management Plan 2005 and Te Tangi a Tauira are relevant iwi management plan that relate to the site. The proposal is assessed against all of these documents.

Overall, it is considered that the proposed activity is consistent with the objectives and policies of the Otago Regional Policy Statement, the Otago Regional Plan: Water and iwi management plans.

7.2 Otago Regional Policy Statement

The Otago Regional Policy Statement provides an overview of the resource management issues for the Otago Region and the ways of achieving integrated management of its natural and physical resources. Chapters 4 – 15 of the ORPS describe the regionally significant resource management issues within Otago and the objectives, policies and methods to implement and address those issues. The following sections discuss the relevant objectives and policies as they relate to this application.

7.2.1 Chapter 4: Manawhenua Perspective

*"**Objective 4.4.3** Wai (Water) – To recognise the principle of wairua and mauri in the management of Otago's water bodies.*

***Policy 6.5.1** To recognise and provide for the relationship Kai Tahu have with the water resource in Otago through:*

Working toward eliminating human waste and other pollutants from entering all water bodies; and

Consulting with Kai Tahu over any application that would result in the mixing of waters from different water bodies and the setting of water flows and levels.

***Objective 4.4.5** Kaitiakitanga (Guardianship)*
To incorporate the concept and spirit of kaitiakitanga in the management of Otago's natural and physical resources in a way consistent with the values of Kai Tahu

***Policy 5.5.1** To recognise and provide for the relationship Kai Tahu have with Otago's land resource through:*

- *Establishing processes that allow the existence of heritage sites, waahi tapu and waahi taoka to be taken into account when considering the subdivision, use and development of Otago's land resources; and*

- *Protecting, where practicable, archaeological sites from disturbance; and*

- *Notifying the appropriate runanga of the disturbance of any archaeological site and avoiding, remedying or mitigating any effect of further consultation until consultation with the kaitiaki runanga has occurred."*

The proposed Kingston treatment scheme will produce a high-quality effluent prior to land application and will not result in contamination of ground or surface waters. This is consistent with the values of Kai Tahu and their relationship with the land and water resources. Overall, it is considered that the proposed activity has appropriate regard to these objectives and policies and is consistent with their intent.

7.2.2 Chapter 5: Land

"Objective 5.4.1 *To promote the sustainable management of Otago's land resources in order:*

To maintain and enhance the primary productive capacity and life supporting capacity of land resources; and

To meet the present and reasonably foreseeable needs of Otago's people and communities.

Policy 5.5.4 *To promote the diversification and use of Otago's land resource to achieve sustainable land use and management systems for future generations."*

The proposed wastewater treatment plant and land application (soil treatment) zones will be located on Kingston Station and will not affect the primary productive capacity and life supporting capacity of Otago's land resources. The proposed activity is therefore considered to be consistent with this objective and policy.

"Objective 5.4.2 *To avoid, remedy or mitigate degradation of Otago's natural and physical resources resulting from activities utilising the land resource.*

Policy 5.5.5 *To minimise the adverse effects of land use activities on the quality and quantity of Otago's water resource through promoting and encouraging the:*
Creation, retention and where practicable enhancement of riparian margins; and
Maintaining and where practicable enhancing vegetation cover, upland bogs and wetlands to safeguard land and water values; and

Avoiding, remedying or mitigating the degradation of groundwater and surface water resources caused by the introduction of contaminants in the form of chemicals, nutrients and sediments resulting from land use activities."

The proposed land treatment area has a low application rate and is 50 m from the closest surface water; it is highly unlikely any effluent will percolate into any waterway. Overall, it is considered that the proposed activity will appropriately mitigate any potential degradation of Otago's natural and physical resources and is consistent with this objective and policy.

"Objective 5.4.4 *To ensure that public access opportunities exist in respect of activities utilising Otago's natural and physical land features.*

Policy 5.5.7 *To promote the provision of public access opportunities to natural and physical land features throughout the Otago region, except where restriction is necessary:*
To protect areas of significant indigenous vegetation and/or significant habitats of indigenous fauna; or

To protect Maori cultural values; or

To protect public health or safety; or

To ensure a level of security consistent with the purpose of the resource consent or in circumstances where safety and security concerns require exclusive occupation; or

In other exceptional circumstances sufficient to justify the restriction notwithstanding the importance of maintaining that access."

The proposed land application area (soil treatment area) is located on private property, away from public access or any buildings. The proposed activities are therefore considered to appropriately provide for public access to Otago's natural and physical land features and are considered to be consistent with this objective and policy.

7.2.3 Chapter 6: Water

"Objective 6.4.2 *To maintain and enhance the quality of Otago's water resources in order to meet the present and reasonably foreseeable needs of Otago's communities.*

Policy 6.5.5 *To promote a reduction in the adverse effects of contaminant discharges into Otago's water bodies through:*

- *Adopting the existing water quality of Otago's water bodies as a minimum acceptable standard; and*

- *Investigating and where appropriate, enhancing water quality so that as a minimum standard it is suitable for contact recreation and aquatic life where:*
  - *There is a high public interest in, or use of the water; or*
  - *There is a particular Kai Tahu interest in the water; or*
  - *There is a particular value to be maintained or enhanced; or*
  - *There is a direct discharge containing human sewage or wastes from commercial or industrial activities; and*

- *Requiring that all discharges into Otago's water bodies maintain the standard for the receiving waters after reasonable mixing; and*

- *Promoting discharges to land where practicable and where there are no significant adverse effects on groundwater or surface water resources or soil; and*

- *Preparing contingency responses for accidental pollution spills; and*

- *Investigating and addressing the effects of diffuse source discharges on water quality;*

while considering financial and technical constraints.

Objective 6.4.3 *To safeguard the life-supporting capacity of Otago's water resources through protecting the quantity and quality of those resources."*

The proposed Kingston wastewater treatment scheme is a vast improvement on the existing individual dwelling systems, allows for additional dwellings and the proposed land application area will result in a higher level of treatment through the soil matrix. For this reason, it is considered that the proposed activity is consistent with these objectives and policy.

7.3 Otago Regional Plan: Water

The Otago Regional Plan: Water has been prepared to meet the ORC's responsibilities under the Resource Management Act 1991 ("the Act"). The purpose of the Plan is to provide a framework for the integrated and sustainable management of Otago's water resources including the region's lakes, rivers, groundwater and wetlands. Chapters 5-10 of the Plan identify the water management issues in Otago, and contain the objectives and policies relevant to this application. Sections 7.4.1 to 7.4.3 below discuss the relevant objectives and policies as they relate to this application.

7.3.1 Chapter 5: Natural and Human Use Values of Lakes and Rivers

"Objective 5.3.1 *To maintain or enhance the natural and human use values, identified in Schedules 1A, 1B and 1C that are supported by Otago's lakes and rivers."*

Lake Wakatipu is located approximately 1.2 km from the land treatment area at its closes point. It is not expected that any effluent will enter either surface water and the proposed treatment system is an improvement (net reduction in N loss to the environment) on the current individual (uncontrolled) domestic systems while allowing for the expansion of the number of houses available at Kingston. The proposed activity is therefore considered to have appropriate regard to this objective.

"Objective 5.3.2 *To maintain or enhance the spiritual and cultural beliefs, values and uses of significance to Kai Tahu, identified in Schedule 1D, as these relate to Otago's lakes and rivers.*

Policy 5.4.2 *In the management of any activity involving surface water, ground water or the bed or margin of any lake or river, to give priority to avoiding, in preference to remedying or mitigating:*

- *Adverse effects on:*
  - *Natural values identified in Schedule 1A;*
  - *Water supply values identified in Schedule 1B;*
  - *Registered historic places identified in Schedule 1C, or archaeological sites in, on, under or over the bed or margin of a lake or river;*
  - *Spiritual and cultural beliefs, values and uses of significance to Kai Tahu identified in Schedule 1D;*
  - *The natural character of any lake or river, or its margins;*
  - *Amenity values supported by any water body; and*

- *Causing or exacerbating flooding, erosion, land instability, sedimentation or property damage.*

Policy 5.4.4 *To recognise Kai Tahu's interests in Otago's lakes and rivers by promoting opportunities for their involvement in resource consent processing."*

As previously discussed, the proposed application of wastewater into land will not adversely percolate into any waterbody. This is due to the improved treatment technology and discharge system and the location of the LTA in relation to any surface water. It is considered that the proposed discharge will not adversely affect the spiritual and cultural beliefs, values and uses of significance to Kai Tahu identified in Schedule 1D.

7.3.2 Chapter 7: Water Quality

"Policy 7.7.2 *When considering the discharge of any contaminant to land, to have regard to:*

- *The ability of the land to assimilate the contaminant;*
- *Any potential for soil contamination; and*
- *Any potential for land instability."*

The quality of the proposed wastewater and the application into land at the proposed loading rate will ensure that the land can assimilate the loading and the net reduction of nutrient load with the catchment means less degradation of the environment will occur. The proposed system will be constructed such that any potential for land instability is avoided. The proposed activity is therefore considered to have appropriate regard to this policy.

"Policy 7.7.4 *When considering applications for resource consents to discharge contaminants to water, or onto or into land in circumstances which may result in any contaminant entering water, to have regard to:*

- *The nature of the discharge and the sensitivity of the receiving environment to adverse effects;*
- *The financial implications and the effects on the environment of the proposed method of discharge when compared to alternative means; and*
- *The current state of technical knowledge and the likelihood that the proposed method of discharge can be successfully applied."*

As previously discussed, it is considered that the proposed wastewater land application can be undertaken in a way and at a rate that appropriately avoids, remedies or mitigates, any adverse effects on the receiving environment. The proposed treatment and irrigation method are considered to be more environmentally sustainable than the current individual dwelling systems.

Overall, it is considered that the proposed activity has appropriate regard for this policy as the applicant has considered the sensitivity of the receiving environment and the technical ability to successfully apply the low rate irrigation method.

*"**Policy 7.7.8*** *To require, as appropriate, that provision be made for review of the conditions of any resource consent for discharging a contaminant."*

The applicant accepts that a review condition will be imposed on the consent.

"Policy 7.7.9 *The duration of any new resource consent for an existing discharge of contaminants will take account of the anticipated adverse effects of the discharge on any natural and human use value supported by an affected water body, and:*

- *Will be up to 35 years where the discharge will meet the water quality standard required to support that value for the duration of the resource consent;*
- *Will be no more than 15 years where the discharge does not meet the water quality standard required to support that value but will progressively meet that standard within the duration of the resource consent;*
- *Will be no more than 5 years where the discharge does not meet the water quality standard required to support that value; and*
- *No resource consent, subsequent to one issued under (c), will be issued if the discharge still does not meet the water quality standard required to support that value."*

The proposed Kingston wastewater treatment and land application scheme will provide a significant improvement in terms of the level of treatment and quality of the proposed discharge (in comparison to the existing individual household systems) and allow for the expansion of the community providing a valuable housing resource. Specifically, the proposed treatment and LTA will result in lower levels of nitrogen, phosphorus, faecal coliforms and other contaminants potentially entering ground or surface waters. It is expected that no adverse increase of contaminants will result from the proposed land application scheme, ultimately resulting in a sustainable environmental outcome. Overall, it is therefore considered that a 35 year consent is appropriate for the domestic discharge in this instance.

7.3.3 Chapter 9: Groundwater

"***Objective 9.3.3*** *To maintain the quality of Otago's groundwater.*

Policy 9.4.18 *To identify land of high risk in terms of the vulnerability of underlying groundwater to leachate contamination and to manage, with respect to this land:*

- *Change in land use to the activities which have the potential to result in leachate discharges so that the activities are, where practicable, located elsewhere, or contaminants are contained;*
- *Existing land use activities so that any potential for groundwater contamination is monitored and, where necessary, corrective action is taken;*
- *Point source discharges of water or contaminants to land or groundwater; and*
- *Excavation, sot that any protective soil mantle or impervious stratum is retained, replaced, or alternative groundwater protection is provided."*

As discussed previously, the ground water depth is likely to be at the Lake level and approximately 40 to 60 m bgl or greater at the land treatment area. Accordingly, it is considered that the proposed land application will continue to maintain the quality of Otago's groundwater resource and that appropriate regard has been had to this objective and policy.

7.4 Iwi Management Plans

7.4.1 Kai Tahu ki Otago Natural Resource Management Plan 2005

The Kai Tahu ki Otago Natural Resource Management Plan (NRMP) 2005 contains several objectives and policies of relevance to this application. The main general objectives that relate to this application include that there is no discharge of human waste directly to water and that contaminants being discharged directly or indirectly to water are reduced.

There are specific policies that relate to discharges. The relevant ones to this application include:

- To require land disposal for human wastewater and contamination.
- To require consideration of alternatives and use of new technology for discharge renewal consents.
- To require monitoring of all discharges be undertaken on a regular basis and all information, including an independent analysis of monitoring results, be made available to KTkO.
- To encourage Management Plans for all discharge activities that detail the procedure for containing spills and including plans for extraordinary events.
- To require all discharge systems be well maintained and regularly serviced.
- To require visible signage informing people of the discharge area; such signs are to be written in Mäori as well as English.
- To require groundwater monitoring for all discharges to land.

As high-quality wastewater is to be discharged to land, the discharge is to be monitored and appropriate maintenance conditions have been recommended, the proposed activity is not considered inconsistent with the above management policies. It is not considered appropriate to require groundwater monitoring in this instance due to the nature of the groundwater and high discharge quality.

A condition providing KTkO with an opportunity to inspect the site should any kiowi, waahi taoka, waahi tapu or other artefact materials be discovered has been included in the proposed consent conditions. Also, conditions stating that the LTA must be marked and that a management plan must be submitted prior to commissioning are included.

7.4.2 Te Tangi a Tauira - Ngai Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan 2008

Te Tangi a Tauri (2008) has objectives and policies relevant to this consent. While the proposed LTA relates to section 3.4 of the plan – High Country and Foothills, wastewater disposal is covered specifically in Section 3.4.2 Wastewater disposal (Southland Plains).

The policies outlined in the wastewater disposal section are:

m) Promote the inclusion of Ngāi Tahu ki Murihiku issues and policies in statutory plan provisions and best practice guidelines for managing wastewater disposal.
n) Ensure that Ngāi Tahu ki Murihiku are provided with the opportunity to participate through pre-hearing meetings or other processes in the development of appropriate consent conditions for discharge consents, including monitoring conditions.
o) Require that sufficient and appropriate information is provided with applications to allow tangata whenua to assess cultural effects (e.g. nature of the discharge, treatment provisions, assessment of alternatives, actual and potential effects).
p) Promote education and awareness of Ngāi Tahu ki Murihiku values associated with water, and how those values can be adversely affected by activities involving the discharge of contaminants to water.
q) Assess proposed wastewater discharge activities in terms of:

a. type/ nature of the discharge;
b. location and sensitivity of the receiving environment;
c. cultural associations with location of operations;

d. actual and potential effects on cultural values;
e. available best practice technology;
f. mitigation that can occur (e.g. using plants to filter waste, discharging at specific times to minimise impact, treatment options)
g. community acceptability;
h. cost.

r) Avoid the use of water as a receiving environment for the direct, or point source, discharge of contaminants. Even if the discharge is treated and therefore considered "clean", it may still be culturally unacceptable. Generally, all discharge must first be to land
s) Assess waste disposal proposals on a case by case basis, with a focus on local circumstances and finding local solutions.
t) Wastewater disposal options that propose the direct discharge of treated or untreated effluent to water need to be assessed by the kaitiaki rūnanga on a case by case, individual waterway, basis. The appropriateness of any proposal will depend on the nature of the proposal, and what waterway is involved. Individual waterways possess their individual mauri and values, and kaitiaki rūnanga are in the best position to assess the potential impacts of a proposal on such values.
u) Encourage creative, innovative and sustainable approaches to wastewater disposal that make use of the best technology available, and that adopt principles of waste reduction and cleaner production (e.g. recycling grey water for use on gardens, collecting stormwater for a pond that can then be used for recreation in a new subdivision).
v) Require that the highest environmental standards are applied to consent applications involving the discharge of contaminants to land or water (e.g. standards of treatment of sewage).
w) Require soil risk assessments (type and percolation of the soils) prior to consent for discharge to land, to assess the suitability and capability of the receiving environment.
x) Wastewater loading rates (mm/day) must reflect effluent quality and soil properties.
y) Encourage the establishment of wetland areas, where practical, to improve discharge to land activities, through allowing Papatūānuku the opportunity to filter and clean any impurities.
z) Promote the use of high uptake vegetation (e.g. commercial/production forest plantations) for wastewater disposal, and to ensure that Ngāi Tahu ki Murihiku are involved in decisions relating to such disposal.
aa) Any discharge activity must include a robust monitoring programme that includes regular monitoring of the discharge and the potential effects on the receiving environment. Monitoring can confirm system performance and identify and remedy any system failures.
bb) Require that large scale wastewater disposal operations (e.g. town sewage schemes, industry) develop environmental management plans, including contingency plans to cope with any faults, breakdowns, natural disasters, or extreme weather events (e.g. cash bonds for liability).
cc) Duration of consent for wastewater disposal must recognise and provide for the future growth and development of the industry or

community, and the ability of the existing operations to accommodate such growth or development.

dd) Recommend a duration not exceeding 25 years, for discharge consents relating to wastewater disposal, with an assumption that upon expiry (if not before), the quality of the system will be improved as technological improvements become available. In some instances, a lesser term may be appropriate, with a condition requiring the system is upgraded within a specified time period.

ee) Require conditions of consent that allow for a 5-year review of wastewater disposal activities. During review, consent holders should be required to consider technological improvements. If improvements are available, but not adopted, the consent holder should provide reasons why.

ff) Encourage developers and consent applicants to provide site visits for tangata whenua representatives to observe proposed wastewater treatment systems. Site visits enable ngā rūnanga representatives to see what is proposed "on the ground".

We consider that this application has appropriate information to allow tangata whenua to access cultural effects. ORC provides for Ngai Tahu ki Murihiku issues through its plan provisions. The above AEE has assessed the activity in terms of type of discharge, location and sensitivity of receiving environment, cultural associations, actual and potential effects on cultural values, available best practice technology; mitigation, community acceptability and cost. The discharge is to land rather than to water, meeting iwi objectives and the applicant is not aware of any culturally significant features within the proposed LTA. The proposed activity is a local solution with benefits to the wider community. A high standard of treatment will be achieved proper to land application and soils have been assessed with loading rates the accurately reflect the effluent quality and soil properties.

Appropriate mitigation of using low application rates via subsurface irrigation is proposed to prevent wastewater from entering waterways. The vegetation is proposed to remain as pasture or lucerne. The loading rates are appropriate based on potential uptake from plants. The activity includes a robust monitoring programme and will have a management plan to deal with contingencies. The duration of the proposed consent provides for future community growth. Site visits for tangata whenua are encouraged and available if required. Overall, it is considered that the proposed activity is consistent with the objectives and policies of Te Tangi a Tauira.

7.5 Conclusion

Overall, it is considered that the proposed Kingston treatment and land application scheme is consistent with and that appropriate regard has been had to the objectives and policies of the ORPS, ORPA, ORPW and relevant iwi management plans. Specifically, the proposed activity recognises and provides for the relationship Kai Tahu have with Otago's water resources and promotes the sustainable management of Otago's land resources. The proposed activity has been specifically designed to mitigate any adverse effects on the quality of water in Lake Wakatipu. Finally, it is considered that appropriate review conditions can be proposed to ensure that any unforeseen adverse effects associated with the activity can be dealt with should they arise.

8 CONSULTATION

QLDC is consulting with the Kingston community on an on-going basis.

Consultation with the Kingston Station (T, P & C. Tayler) as the pastoral lease holder is also ongoing. The LTA layout and function has been discussed and agreed in principal and QLDC have sought a signed APA for this application.

QLDC has also contacted:

- LINZ as administrator of the Crown Land who are awaiting the full application to provide their written approval;
- Fish and Game who are awaiting the full application to understand the water quality implications; and,
- DoC who are awaiting the full application to provide any meaningful feedback.

A consent strategy meeting was held and a memo was provided to the Otago Regional Council dated 23rd May 2018. This memo outlined the proposal and described the existing Kingston township sewage treatment, project flows and hydraulic and nutrient loading rates. It also discussed current land use, permitted baseline nitrogen loss, likely leaching loss, and the likely affected parties for consultation. A response to this memo was received by PDP on behalf of the Otago Regional Council and included feedback on the assessment methodology matters to be covered.

Consultation with Te Ao Marama and Aukaha has also begun and includes a cultural values assessment. To date, no specific concerns have been raised with the location and proposal; however, these discussions are ongoing.

9 PART II OF THE RESOURCE MANAGEMENT ACT

The purpose of the Resource Management Act 1991 is to promote the sustainable management of natural and physical resources.

Table 9.1 provides an assessment of the applicant's activity against Sections 5, 6, 7 and 8 of the act.

Table 9.1: Assessment against Part II of the RMA

Section 5 – Purpose and Principles		
Purpose of this Act is to promote sustainable management of natural and physical resources. Sustainable management means managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while:		
Principle	Complies	N/A
(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and	✓	
(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and	✓	
(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.	✓	
Section 6 – Matters of National Importance		
In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:		
Principle	Complies	N/A
(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:	✓	
(b) the protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:	✓	
(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:	✓	
(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers:		✓
(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga:	✓	
(f) the protection of historic heritage from inappropriate subdivision, use, and development:		✓
(g) the protection of protected customary rights:	✓	
(h) the management of significant risks from natural hazards		✓

Section 7 – Other Matters		
In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall have particular regard to –		
Principle	Complies	N/A
(a) kaitiakitanga:	✓	
(aa) the ethic of stewardship:	✓	
(b) the efficient use and development of natural and physical resources:	✓	
(ba) the efficiency of the end use of energy:		✓
(c) the maintenance and enhancement of amenity values:	✓	
(d) intrinsic values of ecosystems:	✓	
(e) [Repealed]		✓
(f) maintenance and enhancement of the quality of the environment:	✓	
(g) any finite characteristics of natural and physical resources:	✓	
(h) the protection of the habitat of trout and salmon:	✓	
(i) the effects of climate change:	✓	
(j) the benefits to be derived from the use and development of renewable energy.		✓
Section 8 – Treaty of Waitangi		
Principle	Complies	N/A
In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi).	✓	

The proposal is consistent with the purpose of the Act in that it enables the applicant to provide for social and economic wellbeing of the community, while avoiding or mitigating any adverse effects on the environment.

The wastewater treatment and land application system are considered to be an efficient and effective use of the land resource. When the various aspects of the proposal are weighed up, it is considered this proposal is consistent with enabling philosophy of the Act and sustains the potential of natural and physical resources to meet the reasonably foreseeable needs of future generations.

10 PROPOSED CONSENT CONDITIONS

The applicant proposes the following consent conditions and seeks consent term of 35 years.

Specific	
1.	If this consent is not given effect to within a period of 10 years from the date of commencement of this consent, this consent shall lapse under Section 125 of the Resource Management Act 1991.
2.	The total volume of wastewater discharged shall not exceed 1,800 cubic metres per day.
3.	The rate of application shall not exceed a 7-day average of 12 millimetres per day in any part of the land treatment area.
4.	Prior to receiving any wastewater, the treatment and land application system shall comprise as a minimum: i. Treatment plant providing primary and secondary treatment; ii. Land treatment area with an initial minimum area of 5 ha available, with a minimum of 15 ha at full development area within a total area of up to 25 ha; iii. Subsurface pressure compensating drip irrigation buried to a depth greater than 150 millimetres below the ground surface; iv. Dripper lines at a maximum of 1 m spacing and emitters spaced at a maximum of 0.6 m centres in accordance with best management practices and supplier recommendations; and v. Management of the land treatment area shall be via a cut and carry management regime.
5.	The land treatment area shall not be used: a) For roading whether sealed or unsealed; b) As a hardstanding area; c) For erecting buildings or any non-effluent systems structures; d) For activities that require intensively manage grass surfaces (e.g. grass tennis courts or bowling greens or golf tees and greens); and e) For grazing stock.
6.	The land treatment area shall be located within the marked area outlined in Plan ORCXXXXX.
7.	Waterbody buffer zones shall be established and maintained as follows: a) A 10 m non irrigated planted buffer of native riparian vegetation shall be established around any permanent wetland 6 months prior to application of wastewater in any zone adjacent to that wetland buffer; b) A 5 m non irrigated buffer shall be established around the any ephemeral pond prior to application of wastewater in any zone adjacent to the ponding area; and c) Permanent wetland buffer planting shall be maintained for the duration of the consent.

8.	The total nitrogen loading of the land treatment area shall not exceed 450 kg N/ha/yr. ***Advice note**: The Land treatment area loading rate of 450 kg N/ha/yr is calculated based on the daily flow data collected under Condition 9 multiplied by the Total Nitrogen sampling collected under Condition 12 of this consent and divided by the Land Treatment area. At a design flow of 900 m^3/day average dry weather flow, to achieve Total nitrogen load of 450 kg N/ha/yr or less, the average Total nitrogen equals 20 milligrams per litre.*
Performance Monitoring	
8.	Prior to commissioning the land treatment system, the land treatment area shall be marked out by any means that ensure the extent of the areas are identifiable on the ground surface and shall remain marked out for the term of the consent.
9.	a) Prior to commissioning the land treatment area, the consent holder shall install a flow meter and data logger on the outlet pipe from the treatment system to record the volume of effluent discharged to the land treatment area. The flow meter shall have an accuracy range of +/- 5%. b) Once the flow meter and data logger is installed, the consent holder shall measure and record the daily volume of effluent discharged to the land treatment area. c) The flow records shall be forwarded to the Consent Authority with the annual report required under Condition 18 of this consent and upon request.
10.	Prior to commissioning the treatment and land treatment system, the consent holder shall establish adequate facilities and access for wastewater quality sampling, such as a hand operated tap/valve that is on the outlet pipe from the treatment system before the wastewater discharges to the land treatment area.
11.	Prior to commissioning the treatment and land treatment system, the consent holder shall provide as-built construction plans and a Producer Statement or Certificate of Compliance and photographs of the treatment and land treatment system. These shall include, but are not limited to, the following: a) Plans of the treatment system described in Condition 4 of this consent; b) Plans of the land treatment area clearly showing all the irrigation zones; c) Details of the area of each zone, the maximum volumes of wastewater discharged to each zone (litres per second), and the duration (hours) and daily frequency of each application to the zones; and d) Photographs of each of the irrigation zones.
12	Prior to application of wastewater to Land Treatment Area One (LTA !as shown on plan ORCxxxx, Appendix C), the consent holder shall install groundwater monitoring piezometers labelled GW 1, GW 2 and GW 3. and Prior to application of wastewater to Land Treatment Area Two LTA 2 as shown on plan ORCxxxx , Appendix C), the consent holder shall install groundwater monitoring piezometers labelled GW 4 and GW 5.

13.	Following the commissioning of the treatment and land treatment system, the consent holder shall in any one day of January, March, May, July, September and November each year, obtain representative samples of the treated wastewater from the tap/valve installed under Condition 9 of this consent. The samples shall be analysed for the following parameters and results submitted with the annual report required by Condition 18: a) Biochemical oxygen demand (5 day); b) Total suspended solids; c) Total nitrogen; d) Total phosphorus; e) Escherichia coli; and f) pH.
14.	a) The analytical results for the samples collected under Condition 13 of this consent shall not exceed the following 12 month rolling mean limits when the number of property connections to the wastewater treatment plant is less than 450: ii. 50 milligrams per litre of biochemical oxygen demand (5 day); iii. 30 milligrams per litre of total suspended solids; iv. 10 milligrams per litre of total phosphorus; v. 10,000 colony forming units per 100 millilitres of Escherichia coli (rolling 12-month geometric mean). b) The analytical results for the samples collected under Condition 13 of this consent shall not exceed the following 12 month rolling mean limits when the number of property connections to the wastewater treatment plant is greater than 450: i. 20 milligrams per litre of biochemical oxygen demand (5 day); ii. 30 milligrams per litre of total suspended solids; iii. 10 milligrams per litre of total phosphorus; iv. 10,000 colony forming units per 100 millilitres of Escherichia coli (rolling 12-month geometric mean).
15	A water quality monitoring program shall be established within the unnamed tributaries and piezometers at locations shown on plan ORCXXXX (Appendix C) . The water quality monitoring program should include the following: a) Water quality sample analysis at an accredited laboratory testing for i. BOD5; ii. Total phosphorous; iii. Total nitrogen; iv. Nitrate-N; v. NH4-N; and vi. field measurements of pH, EC and dissolved oxygen; b) Seasonal sampling (i.e. spring, summer, autumn and winter) PRIOR to the establishment of the WWTP and ongoing after operation commences. The seasonal sampling should include at least one wet weather event. c) An estimate of flow from the tributary at the time of sampling using an appropriate method; d) The monitoring piezometers cap are to be surveyed, and water level measurements taken at the time of water quality parameter sampling e) A report to ORC providing the results and interpretation of the monitoring within 18 months after the WWTP becomes fully operational. The sampling plan should be reviewed one year after the WWTP is fully operational i.e. after commencement of the proposed subdivision. The consent holder may apply to review the future monitoring frequency based on the results.

16	An assessment of the soil conditions shall be undertaken by a suitably qualified and experienced practitioner on a biennial basis until such time as the consent authority determines the effects of the disposal to land are acceptable. The assessment shall include: a) Four soil samples shall be collected at random from within the LTA, at the following depths i. 0 -20 cm ii. 30 – 50 or at the application depth iii. 80 – 100 cm b) The four soil samples from each depth shall then be composited and analysed for the following: i. Exchangeable Cations (Sodium, Potassium, Magnesium, Calcium); ii. Olsen P; iii. Total P iv. Cation exchange capacity; v. Base saturation; vi. Total carbon; vii. Total nitrogen; viii. pH; and ix. Suite of seven heavy metals (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Zinc) c) At the application depth, soil shall also be tested for: i. in situ infiltration capacity (Ksat) at the application depth; ii. indications of oxidation reduction potential (gleying) of the soil; iii. an infield assessment of soil structure d) A control site shall be chosen outside of the LTA, and samples collected and tested in accordance with condition's 16.A, 16.B, and 16.C. The control samples shall not be composited with the LTA samples. e) The results of the soil assessment shall be submitted to the consent authority within 6 months of undertaking the field work.
17.	All sampling techniques employed in respect of the conditions of this consent shall be acceptable to the Consent Authority. All analyses undertaken in connection with this consent shall be performed by an IANZ registered laboratory or otherwise as specifically approved by the Consent Authority.
18.	The consent holder shall following commissioning of the wastewater treatment plant forward an annual report in writing to the Consent Authority by 1 September each year. The annual report shall cover the preceding calendar year 1 July to 30 June and shall report on compliance with the consent. As a minimum, the report shall include: a) A copy of all analytical results for the year; b) A summary of the year's monitoring results, in context of the previous years' results; c) Comments on compliance with the conditions of this discharge permit; d) Details of the cut and carry operation including the number of harvests, mass harvested, dry matter N concentration; e) A summary of complaints received, the validity of each complaint and the corrective action taken; f) A summary of any malfunctions or breakdowns and the corrective action taken; and g) Any other issues considered relevant by the consent holder.

19.	Prior to commissioning the treatment and land treatment system, the consent holder shall prepare and forward an Operations and Management Manual to the Consent Authority for the treatment and land treatment system to ensure its effective and efficient operation at all times. The system shall operate in accordance with this manual at all times, which shall be updated as appropriate. The manual shall be to the satisfaction of the Consent Authority and include, as a minimum: a) A brief description of the treatment and land treatment system, including a site map that shows the location of the treatment system, discharge location, sampling sites and the drainage network; b) Key operational matters including weekly, monthly and annual maintenance checks; c) Monitoring requirements and procedures; d) A management plan for the cut and carry operation including procedures for harvesting grass/lucerne from the site and for maximising grass/lucerne growth and nitrogen uptake by grass/lucerne such as soil tests, supplementary nutrient additions and pest and weed control; e) Contingency plans in the event of system malfunctions (including provision for the removal and disposal of effluent by tanker truck should there be prolonged system failure); f) The means of receiving and dealing with any complaints; g) Key personnel and contact details; and h) Emergency contact phone numbers.
20.	At all times, the consent holder shall ensure that the Consent Authority has a copy of the most recent version of the Operations and Management Manual.
21.	Records of maintenance, complaints, malfunctions and breakdowns shall be kept in a log and be made available on request.
22.	The wastewater treatment and land treatment system shall be serviced at least once every 12 months by a qualified person with at least two years' experience in the maintenance of such systems. The servicing shall be in accordance with the Operations and Management Manual.
General	
23.	No ponding or surface run-off of effluent shall occur as a result of the exercise of this consent.
24.	This permit does not authorise the discharge of sludge to land or water.

25.	If the consent holder: a) Discovers koiwi tangata (human skeletal remains), waahi taoka (resources of importance including Pounamu/greenstone), waahi tapu (places or features of special significance) or other Maori artefact material, the consent holder shall without delay: (i) Notify the Consent Authority, Ngai Tahu and New Zealand Historic Places Trust and in the case of skeletal remains, the New Zealand Police; and (ii) Stop work within the immediate vicinity of the discovery to allow a site inspection by the New Zealand Historic Places Trust and the appropriate Runanga and their advisors, who shall determine whether the discovery is likely to be extensive, if a thorough site investigation is required, and whether an Archaeological Authority is required. Site work shall recommence following consultation with the Consent Authority, the New Zealand Historic Places Trust, Ngai Tahu, and in the case of skeletal remains, the New Zealand Police, provided that any relevant statutory permissions have been obtained b) Discovers any feature or archaeological material that predates 1900, or heritage material, or disturbs a previously unidentified archaeological or heritage site, the consent holder shall without delay: (i) Stop work within the immediate vicinity of the discovery or disturbance; (ii) Advise the Consent Authority, the New Zealand Historic Places Trust, and in the case of Maori features or materials, Ngai Tahu, and if required, shall make an application for an Archaeological Authority pursuant to the Historic Places Act 1993; and (iii) Arrange for a suitably qualified archaeologist to undertake a survey of the site. Site work shall recommence following consultation with the Consent Authority.
Review	
26.	The Consent Authority may, in accordance with Sections 128 and 129 of the Resource Management Act 1991, serve notice on the consent holder of its intention to review the conditions of this consent within three months of each anniversary of the commencement of this consent, for the purpose of: a) Determining whether the conditions of this consent are adequate to deal with any adverse effect on the environment which may arise from the exercise of the consent and which it is appropriate to deal with at a later stage, or which becomes evident after the date of commencement of the consent; or b) Ensuring the conditions of this consent are consistent with any National Environmental Standards, Regulations, relevant plans and/or the Otago Regional Policy Statement; or c) Requiring the consent holder to adopt the best practicable option, in order to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

11 CONCLUSION

Given the above, it is considered that it is appropriate to grant consent to this application in terms of S104, 104B, 105, and 107 of the Resource Management Act 1991 for the following reasons.

The proposed Kingston WWTP and land application scheme will provide a high-quality wastewater and will be a significant improvement on that of the existing individual (and uncontrolled) household discharges to land. Further to this:

- The proposed land treatment area will be no less than 5 ha during initial development, with a minimum of 15 ha at full development;
  b)
- The area will be sited no less than 1 km from Lake Wakatipu.

- The irrigation of wastewater to land will provide beneficial nutrients, to a nutrient deficient soil, allowing for improved plant growth.

- The proposed new scheme will allow QLDC to provide for the wastewater treatment needs of the Kingston township and housing developments in a sustainable manner including an adequate allowance for population growth.

- The proposed activity is consistent with the objectives and policies of the Otago Regional Plans.

- The applicant has undertaken a thorough assessment of alternative methods for the discharge.

- The proposed activity will not, after reasonable mixing, result in the production of any conspicuous oil, grease films, scums, foams or floatable or suspended materials; conspicuous change in the colour or visual clarity of the nearby waterways, any emission of objectionable odour; render fresh water unsuitable for consumption by farm animals or have any significant adverse effects on aquatic life.

This assessment concludes that the proposal will promote the sustainable management of natural and physical resources while avoiding, remedying or mitigating adverse effects on the environment.

A term of 35 years is sought for the resource consent to allow the discharge of wastewater onto land from the proposed Kingston WWTP.

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13 Appendices

Appendix A – Soil Site Investigations – Hadley Consultants Ltd (2018) and LEI (2018)
Appendix B – E3 Scientific – Aquatic Ecological Review
Appendix C – Surface and Groundwater Monitoring Location Plan

APPENDIX A

Soil Site Investigations

Hadley Consultants Ltd (2018) and LEI (2018)

Hadley Consultants (2018)

Kingston Wastewater Scheme Land Treatment Area Soil Test Pit Sites and Test Pit Logs


TP8
TP7
TP9
TP6
TP5
TP10
TP4
TP3
TP2
TP11
TP15
XTP12
TP13
TP16
TP1
TP14
TP18
T.P14
TP17

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34443 Long:168.71056	Test Pit: 01 Sheet 1 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp ~150mm.	
0.5		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with minor fine sand, dry, grey , compact crumbly , rare rock fragments	
2.0			
2.3		Test Pit ends at 2.3m	
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34358 Long:168.71094	Test Pit: 02 Sheet 2 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	
Project No:	142628		
Logged:	ZS		
Checked:			

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp ~150mm.	
0.6		SILT with minor sand, rocks and cobbles light browny orange, slightly damp, very compact	
1.0		SILT with minor fine sand, some cobbles , sub rounded, up to 200mm, dry, grey , compact	
1.3			
1.9		SILT with minor fine sand, dry, grey , compact, crumbly , rare rock fragments	
2.0		Test Pit ends at 1.9m	
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34319 Long:168.70972	Test Pit: 03 Sheet 3 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp ~150mm.	
0.5		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with minor fine sand, dry, grey , compact crumbly , rare rock fragments	
1.5		Test Pit ends at 1.5m	
2.0			
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34305 Long:168.70588	Test Pit: 04 Sheet 4 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp ~150mm.	
0.5		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with some fine sand, dry, grey , compact crumbly , rare rock fragments	
2.0		Test Pit ends at 2.0m	
3.0			
4.0			
5.0			

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Site: Kingston Village Development
Lat: -45.34245
Long:168.70416

Test Pit: 05

Sheet 5 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	

Project No: 142628
Logged: ZS
Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp ~150mm.	
0.5		SILT with minor sand, light browny orange, slightly damp, very compact	
0.8		SILT with some sand and gravel, light browny orange, slightly damp, very compact	Transistion layer
1.0		gravely SAND with some silt, fine, grey, well graded , compact, dry	
1.7			
2.0		silty SAND with some gravel, grey dry, compact	
2.7			
		Test Pit ends at 2.7m	
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34211 Long:168.70416	Test Pit: 06 Sheet 6 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	
Project No:	142628		
Logged:	ZS		
Checked:			

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp ~150mm.	
0.5		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with some fine sand, dry, grey , compact crumbly , rare rock fragments	
1.6		Test Pit ends at 1.6m	
2.0			
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34167 Long:168.70318	Test Pit: 07 Sheet 7 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.3		Thin rich organic top soil with some silt, brown, damp.	
0.9		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0 – 1.4		SILT with some fine sand, dry, grey , compact crumbly , rare rock fragments	
		Test Pit ends at 1.4m	

2.0

3.0

4.0

5.0

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34074 Long:168.70099	Test Pit: 08 Sheet 8 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with minor sand, dry, grey , compact crumbly , rare rock fragments	
1.3		Test Pit ends at 1.3m	
2.0			
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.3421 Long:168.70108	Test Pit: 9 Sheet 9 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	
Project No:	142628		
Logged:	ZS		
Checked:			

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.7		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with minor sand, dry, grey , compact crumbly , rare rock fragments	
2.0			
		Test Pit ends at 2.0m	
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34314 Long:168.70038	Test Pit: 10 Sheet 10 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp. ~150mm	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with minor sand, some rocks , cobbles and gravel dry, grey ,	
1.8		Test Pit ends at 1.8m	
2.0			
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34385 Long:168.70224	Test Pit: 11 Sheet 11 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	
Project No:	142628		
Logged:	ZS		
Checked:			

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with minor sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
1.5		Test Pit ends at 1.5m	
2.0			
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34448 Long:168.70337	Test Pit: 12 Sheet 12 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
1.1		SILT with minor sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
1.9		sandy SILT, with bolders, cobbles and gravel upto 500mm rounded	
2.0		Test Pit ends at 1.9m	Test pit ended as could not ge through rocks without teeth on bucket
3.0			
4.0			
5.0			

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Site: Kingston Village Development
Lat: -45.34459
Long:168.70552

Test Pit: 13

Sheet 13 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	

Project No: 142628
Logged: ZS
Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
0.9		SILT with some sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
1.7		silty, with bolders, cobbles upto 1000mm gravel rounded , well graded	
		Test Pit ends at 1.7m	Test pit ended as could not ge through rocks without teeth on bucket

1.0
2.0
3.0
4.0
5.0

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Site: Kingston Village Development
Lat: -45.34555
Long:168.70683

Test Pit: 14

Sheet 14 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	

Project No: 142628
Logged: ZS
Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
0.9		SILT with some sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
1.5		sandy SILT, with bolders, cobbles up to 1000mm rounded	
		Test Pit ends at 1.5m	Test pit ended as could not ge through rocks without teeth on bucket

2.0

3.0

4.0

5.0

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34397 Long:168.70664	Test Pit: 15 Sheet 15 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp. ~150mm	
		SILT with minor sand, light browny orange, slightly damp, very compact	
0.7			
		SILT with some sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
1.0			
1.9			
2.0		sandy SILT, with bolders, cobbles up to 1000mm, rounded	
		Test Pit ends at 2.0m	Test pit ended as could not ge through rocks without teeth on bucket
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34457 Long:168.70799	Test Pit: 16 Sheet 16 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	
Project No:	142628		
Logged:	ZS		
Checked:			

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp. ~150mm	
0.6		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with some sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
2.0			
2.3		Test Pit ends at 2.3m	
3.0			
4.0			
5.0			

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Site: Kingston Village Development
Lat: -45.34581
Long:168.70992

Test Pit: 17

Sheet 17 of 19

Date:	23/05/2017	Weather Conditions:	Overcast, Showers
Excavator:	4.5T	Location:	See site plan
Other:		Ground Elevation (m):	

Project No: 142628
Logged: ZS
Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.2		Thin rich organic top soil with some silt, brown, damp.	
0.7		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with some sand, some garvel dry, grey , compact, crumbly , rare rock fragments	
1.3			
1.7		sandy SILT, with bolders, cobbles up to 500mm, rounded	
2.0		Test Pit ends at 1.7m	Test pit ended as could not ge through rocks without teeth on bucket
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34587 Long:168.71211	Test Pit: 18 Sheet 18 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
		Thin rich organic top soil with some silt, brown, damp. ~150mm	
0.5		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0		SILT with some sand, garvel dry, grey , compact, crumbly , rare rock fragments	
2.0			
2.5		Test Pit ends at 2.5m	
3.0			
4.0			
5.0			

hadley consultants LTD CONSULTING CIVIL & STRUCTURAL ENGINEERS	Site: Kingston Village Development Lat: -45.34459 Long:168.71211	Test Pit: 19 Sheet 19 of 19

Date: 23/05/2017	Weather Conditions: Overcast, Showers		Project No: 142628
Excavator: 4.5T	Location: See site plan		Logged: ZS
Other:	Ground Elevation (m):		Checked:

Depth B.G.L. (m)	Soil Symbol	Soil Description: Colour, structure, subordinate, main / minor components.	Other: SPT / Scala / notes
0.5		Thin rich organic top soil with some silt, brown, damp. ~150mm	
0.9		SILT with minor sand, light browny orange, slightly damp, very compact	
1.0 – 2.0		SILT with some sand, garvel dry, grey , compact, crumbly , rare rock fragments	
3.0 – 5.0		Test Pit ends at 2.0m	

Lowe Environmental Impact (2018)

- **Site Sampling Map**
- **Infield Hydraulic Conductivity Results**
- **Landcare Research Analysis – Soil Physics:** Unsaturated hydraulic conductivity
- **Hill Laboratories Analysis – Soil Nutrients**
- **Landcare Research Analysis – Soil Chemistry:** Phosphorus absorption results
- **Summary of Calculation for Phosphorus Storage Capacity**

Site Sampling Map

Kingston Station Soils Testing Locations by LEI, 2018

Field and Laboratory Hydraulic Conductivity Results

Soil K measurements were performed using double rings (K_{sat}) and the plate permeameter (K_{-40mm}) method of Perroux and White (1998). Four replicate tests were carried out for each K measurement at each site (e.g. 4 x K_{sat} & 4 x K_{-40mm} tests). Soil cores from each site were also sent to Landcare Research for laboratory testing of unsaturated hydraulic conductivity. The results of the lab testing are attached in section: Landcare Research Analysis – Soil Physics: Unsaturated hydraulic conductivity. The table below provides a summary of the field and laboratory test results. Soil cores measured by Landcare Research that were at a 150mm depth are reported.

Field Measurement Hydraulic Conductivity Results

Location	Saturated (K_{sat}) (mm/hr)	Unsaturated (K_{-40mm}) Field test (mm/hr)	Unsaturated (K_{-40mm}) LandCare (mm/hr)
Site 1	60	3.82	12
Site 2	156	2.96	50
Site 3	90		19
Site 4	45	4.52	27
Site 5	25.5	1.10	10
Site 6	122.5	1.78	7
Average	**83.17**	**2.83**	**20.13**

Soil Physics Laboratory
Analytical Report

Landcare Research
Manaaki Whenua

Private Bag 11052
Palmerston North 4442

phone: +64 6 353 4911
fax: +64 6 353 4801

Job Number: PJ17026

Date Received: 21/06/2018

Customer: Lowe Environmental Impact,
Brittany Paton

Date Reported: 09/07/2018

Sample name	Core No.	ID number	Remarks	Unsaturated hydraulic conductivity at K_{-40} (mm/h)
K Site 1	835	PP17-1128	Labelled 851. Cavity 10mm x 15mm, lower face.	12
K Site 2	779	PP17-1129	Cavity 35mm x 35mm lower face.	50
K Site 3	882	PP17-1130		19
K Site 4	940	PP17-1131		27
K Site 5a	706	PP17-1132	Cavity 20mm x 10mm lower face.	12
K Site 5b	838	PP17-1133	Cavity 25mm x 20mm upper face.	10
K Site 6a	852	PP17-1134		24
K Sire 6b	930	PP17-1135	Cavity 15mm x 20mm lower face. Cavity 15mm x 25mm upper face.	7

Note: cavities filled with soil after stones removed.

Reference:
Cook FJ, Lilley GP, Nunns RA 1993. Unsaturated hydraulic conductivity and sorptivity: Laboratory measurement. In: Carter MR ed. Soil sampling and methods of analysis. Boca Raton, FL, Lewis Publishers. Pp. 615–624.

John Dando
Laboratory manager

Hill Laboratories
TRIED, TESTED AND TRUSTED

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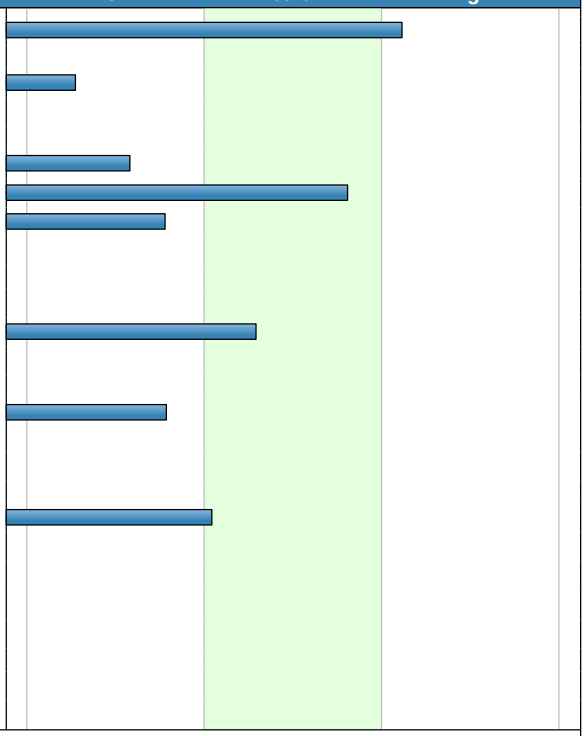
W www.hill-laboratories.com

Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Name: K Site 1 **Lab Number:** 2000775.1
Sample Type: SOIL Mixed Pasture, Dry Stock (Sed.) (S186)

Analysis		Level Found	Medium Range
pH	pH Units	6.3	5.8 - 6.2
Olsen Phosphorus	mg/L	13	20 - 30
Anion Storage Capacity*	%	33	
Potassium	me/100g	0.24	0.30 - 0.40
Calcium	me/100g	8.9	4.0 - 10.0
Magnesium	me/100g	0.38	0.40 - 0.60
Sodium	me/100g	0.06	
CEC	me/100g	16	
Total Base Saturation	%	61	55 - 75
Volume Weight	g/mL	0.86	
Potentially Available Nitrogen (15cm Depth)*	kg/ha	129	150 - 250
Anaerobically Mineralisable N*	µg/g	99	
Organic Matter*	%	7.4	7.0 - 17.0
Total Carbon*	%	4.3	
Total Nitrogen*	%	0.34	
C/N Ratio*		12.8	
Anaerobically Mineralisable N/Total N Ratio*	%	2.9	
Soil Sample Depth*	mm	0-150	
Soil Type*		Sedimentary	



Base Saturation %	K 1.5	Ca 57	Mg 2.4	Na 0.4
MAF Units	K 4	Ca 10	Mg 7	Na 2

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

Hill Laboratories
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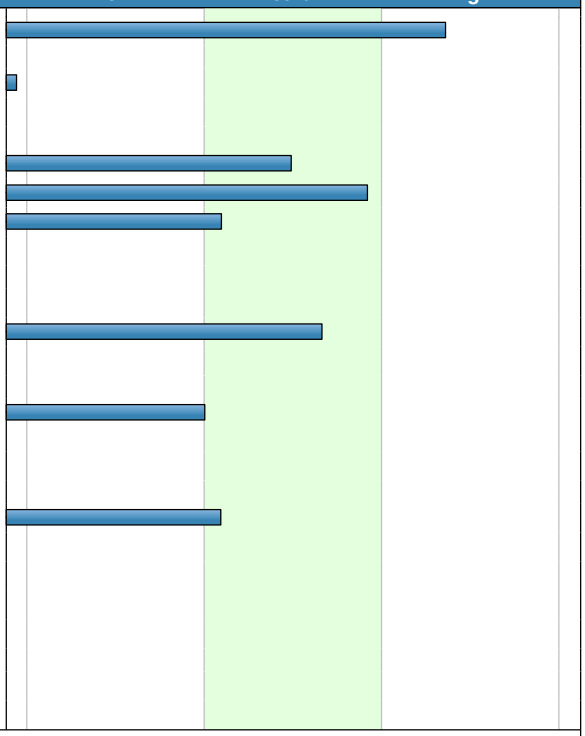
Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Name: K Site 2 **Lab Number:** 2000775.2
Sample Type: SOIL Mixed Pasture, Dry Stock (Sed.) (S186)

Analysis		Level Found	Medium Range
pH	pH Units	6.6	5.8 - 6.2
Olsen Phosphorus	mg/L	9	20 - 30
Anion Storage Capacity*	%	35	
Potassium	me/100g	0.35	0.30 - 0.40
Calcium	me/100g	9.5	4.0 - 10.0
Magnesium	me/100g	0.42	0.40 - 0.60
Sodium	me/100g	0.06	
CEC	me/100g	15	
Total Base Saturation	%	68	55 - 75
Volume Weight	g/mL	0.89	
Potentially Available Nitrogen (15cm Depth)*	kg/ha	150	150 - 250
Anaerobically Mineralisable N*	µg/g	113	
Organic Matter*	%	7.9	7.0 - 17.0
Total Carbon*	%	4.6	
Total Nitrogen*	%	0.38	
C/N Ratio*		12.0	
Anaerobically Mineralisable N/Total N Ratio*	%	2.9	
Soil Sample Depth*	mm	0-150	
Soil Type*		Sedimentary	
Base Saturation %		K 2.3 Ca 63 Mg 2.8 Na 0.4	
MAF Units		K 6 Ca 11 Mg 8 Na 2	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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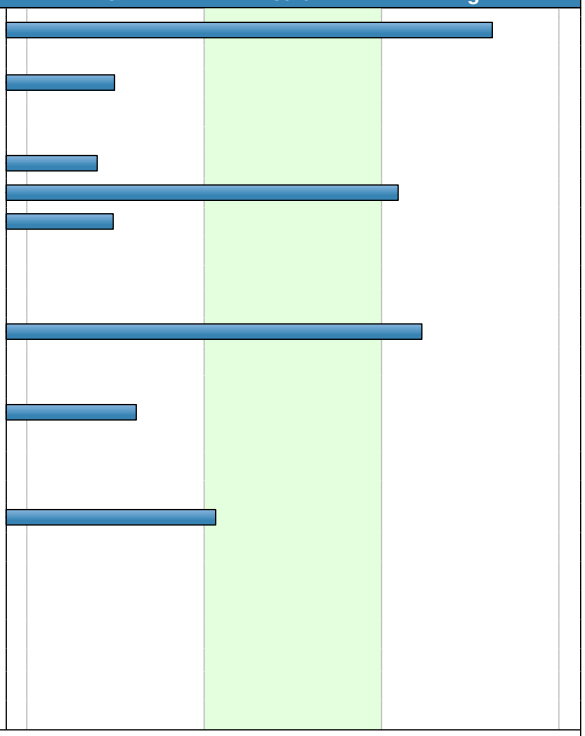
Certificate of Analysis

Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Name: K Site 3 **Lab Number:** 2000775.3
Sample Type: SOIL Mixed Pasture, Dry Stock (Sed.) (S186)

Analysis		Level Found	Medium Range
pH	pH Units	6.8	5.8 - 6.2
Olsen Phosphorus	mg/L	15	20 - 30
Anion Storage Capacity*	%	18	
Potassium	me/100g	0.21	0.30 - 0.40
Calcium	me/100g	10.9	4.0 - 10.0
Magnesium	me/100g	0.35	0.40 - 0.60
Sodium	me/100g	< 0.05	
CEC	me/100g	14	
Total Base Saturation	%	81	55 - 75
Volume Weight	g/mL	0.88	
Potentially Available Nitrogen (15cm Depth)*	kg/ha	112	150 - 250
Anaerobically Mineralisable N*	µg/g	85	
Organic Matter*	%	7.6	7.0 - 17.0
Total Carbon*	%	4.4	
Total Nitrogen*	%	0.36	
C/N Ratio*		12.4	
Anaerobically Mineralisable N/Total N Ratio*	%	2.4	
Soil Sample Depth*	mm	0-150	
Soil Type*		Sedimentary	
Base Saturation %		K 1.5 Ca 77 Mg 2.4 Na 0.3	
MAF Units		K 4 Ca 12 Mg 7 Na < 2	



The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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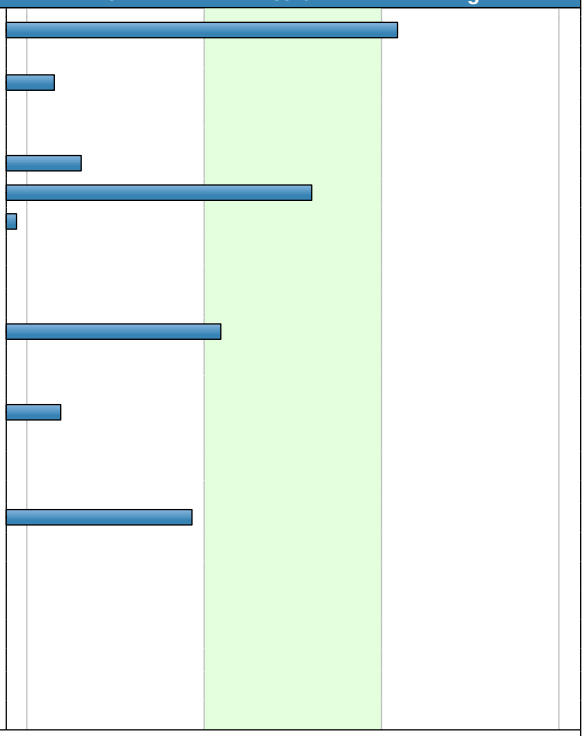
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Name: K Site 4 **Lab Number:** 2000775.4
Sample Type: SOIL Mixed Pasture, Dry Stock (Sed.) (S186)

Analysis		Level Found	Medium Range
pH	pH Units	6.3	5.8 - 6.2
Olsen Phosphorus	mg/L	12	20 - 30
Anion Storage Capacity*	%	29	
Potassium	me/100g	0.20	0.30 - 0.40
Calcium	me/100g	7.7	4.0 - 10.0
Magnesium	me/100g	0.28	0.40 - 0.60
Sodium	me/100g	0.05	
CEC	me/100g	14	
Total Base Saturation	%	57	55 - 75
Volume Weight	g/mL	0.89	
Potentially Available Nitrogen (15cm Depth)*	kg/ha	69	150 - 250
Anaerobically Mineralisable N*	µg/g	52	
Organic Matter*	%	6.5	7.0 - 17.0
Total Carbon*	%	3.8	
Total Nitrogen*	%	0.26	
C/N Ratio*		14.4	
Anaerobically Mineralisable N/Total N Ratio*	%	2.0	
Soil Sample Depth*	mm	0-150	
Soil Type*		Sedimentary	



Base Saturation %	K 1.4	Ca 53	Mg 2.0	Na 0.4			
MAF Units	K 4	Ca 8	Mg 6	Na 2			

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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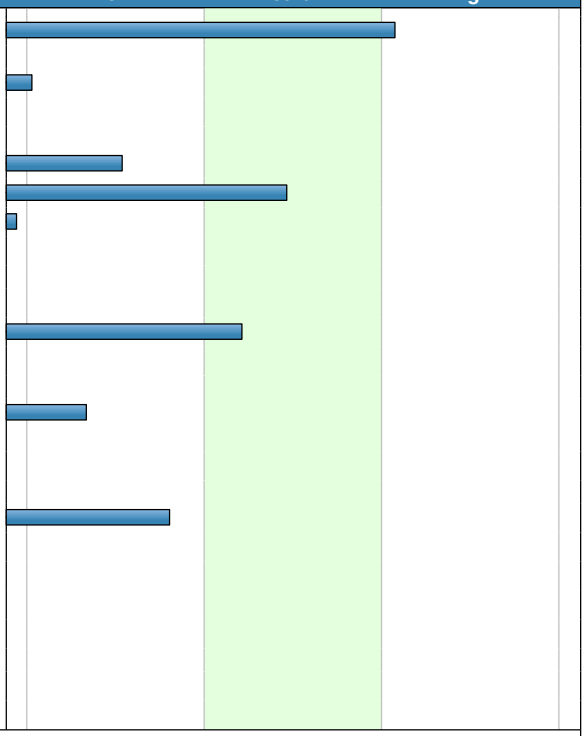
Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Name: K Site 5 **Lab Number:** 2000775.5
Sample Type: SOIL Mixed Pasture, Dry Stock (Sed.) (S186)

Analysis		Level Found	Medium Range
pH	pH Units	6.3	5.8 - 6.2
Olsen Phosphorus	mg/L	10	20 - 30
Anion Storage Capacity*	%	24	
Potassium	me/100g	0.23	0.30 - 0.40
Calcium	me/100g	6.8	4.0 - 10.0
Magnesium	me/100g	0.29	0.40 - 0.60
Sodium	me/100g	< 0.05	
CEC	me/100g	12	
Total Base Saturation	%	59	55 - 75
Volume Weight	g/mL	0.98	
Potentially Available Nitrogen (15cm Depth)*	kg/ha	83	150 - 250
Anaerobically Mineralisable N*	µg/g	56	
Organic Matter*	%	5.6	7.0 - 17.0
Total Carbon*	%	3.3	
Total Nitrogen*	%	0.23	
C/N Ratio*		14.3	
Anaerobically Mineralisable N/Total N Ratio*	%	2.5	
Soil Sample Depth*	mm	0-150	
Soil Type*		Sedimentary	



Base Saturation %	K 1.9	Ca 55	Mg 2.3	Na 0.3
MAF Units	K 5	Ca 8	Mg 6	Na < 2

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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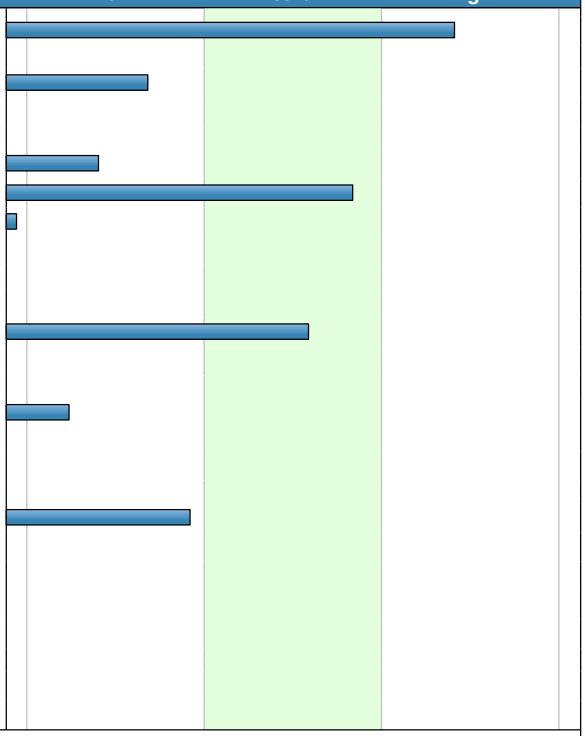
Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Name: K Site 6 **Lab Number:** 2000775.6
Sample Type: SOIL Mixed Pasture, Dry Stock (Sed.) (S186)

Analysis		Level Found	Medium Range
pH	pH Units	6.6	5.8 - 6.2
Olsen Phosphorus	mg/L	17	20 - 30
Anion Storage Capacity*	%	24	
Potassium	me/100g	0.21	0.30 - 0.40
Calcium	me/100g	9.0	4.0 - 10.0
Magnesium	me/100g	0.30	0.40 - 0.60
Sodium	me/100g	0.05	
CEC	me/100g	14	
Total Base Saturation	%	67	55 - 75
Volume Weight	g/mL	0.92	
Potentially Available Nitrogen (15cm Depth)*	kg/ha	74	150 - 250
Anaerobically Mineralisable N*	µg/g	53	
Organic Matter*	%	6.4	7.0 - 17.0
Total Carbon*	%	3.7	
Total Nitrogen*	%	0.26	
C/N Ratio*		14.6	
Anaerobically Mineralisable N/Total N Ratio*	%	2.1	
Soil Sample Depth*	mm	0-150	
Soil Type*		Sedimentary	



Base Saturation %	K 1.5	Ca 63	Mg 2.1	Na 0.4
MAF Units	K 4	Ca 10	Mg 6	Na 2

The above nutrient graph compares the levels found with reference interpretation levels. NOTE: It is important that the correct sample type be assigned, and that the recommended sampling procedure has been followed. R J Hill Laboratories Limited does not accept any responsibility for the resulting use of this information. IANZ Accreditation does not apply to comments and interpretations, i.e. the 'Range Levels' and subsequent graphs.

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Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Analyst's Comments

Samples 1-6 Comment:
The medium or optimum range guidelines shown in the histogram report relate to sampling protocols as per Hill Laboratories' crop guides and are based on reference values where these are published. Results for samples collected to different depths than those described in the crop guide should be interpreted with caution.
For pastoral soils, the medium ranges are specific for a 75mm sample depth, but if a 150mm sampling depth is used the nutrient levels measured may appear low against these ranges, as nutrients are typically more concentrated in the top of the soil profile. These soil profile differences are altered upon cultivation or contouring.

Samples 1-6 Comment:
While soil Mg MAF levels of 8-10 (0.4 - 0.6 me/100g) are sufficient for pasture production, soil levels of 25-30 (1 - 1.6 me/100g) are required to ensure adequate Mg content in pasture for animal health (greater than 0.22% in the herbage).

Samples 1-6 Comment:
The Potentially Available Nitrogen (kg/ha) test above assumes the sample is taken to a 15 cm depth. If the depth is 7.5 cm, then the result reported above should be divided by two.
To calculate Potentially Available Nitrogen (as kgN/ha) for other sample depths use the reported Anaerobic Mineralisable Nitrogen (AMN) result in the following equation:
AN (kg/ha) = AMN (µg/g) x VW (g/ml) x sample depth (cm) x 0.1
Note that the AN and AMN results reported include the readily available Mineral N (NH4-N and NO3-N) fraction, which is typically quite low.

Samples 1-6 Comment:
Anion Storage Capacity (also known as Phosphate Retention) is an inherent property of the soil type and does not change. Phosphorus and sulphur fertiliser recommendations should take this value into account. Soils may be classified as Low (less than 30%), Medium (30-60%) or High (greater than 60%) ASC.

Samples 1-6 Comment:
For intensive farm systems with high stocking-rate and/or high-production/ha, increasing the soil Olsen P optimum ranges to 30-40 (ash and sedimentary soils) and 45-55 (pumice and peat soils) may be justified.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Sample Registration*	Samples were registered according to instructions received.	-	1-6
Soil Prep (Dry & Grind)*	Air dried at 35 - 40°C overnight (residual moisture typically 4%) and crushed to pass through a 2mm screen.	-	1-6
pH	1:2 (v/v) soil:water slurry followed by potentiometric determination of pH.	0.1 pH Units	1-6
Olsen Phosphorus	Olsen extraction followed by Molybdenum Blue colorimetry.	1 mg/L	1-6
Potentially Available Nitrogen*	Determined by NIR, calibration based on Available N by Anaerobic incubation followed by extraction using 2M KCl followed by Berthelot colorimetry. (Calculation based on 15cm depth sample). Note that any Mineral N present is included in the AN/AMN result reported.	1 mg/L	1-6
Anaerobically Mineralisable N*	As for Potentially Available Nitrogen but reported as µg/g.	5 µg/g	1-6
Organic Matter*	Organic Matter is 1.72 x Total Carbon.	0.2 %	1-6
Anion Storage Capacity*	Determined by NIR, calibration based on; Equilibration with 1000 mg/L P solution followed by colorimetric analysis.	10 %	2

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Client:	Lowe Environmental Impact Limited	**Lab No:**	2000775 shpv1
Address:	PO Box 29288 Christchurch 8540	**Date Received:**	16-Jun-2018
		Date Reported:	22-Jun-2018
		Quote No:	
		Order No:	
		Client Reference:	LEI
Phone:	03 359 3059	**Submitted By:**	Brian Ellwood

Sample Type: Soil

Test	Method Description	Default Detection Limit	Sample No
Anion Storage Capacity	Equilibration with 1000 mg/L P solution followed by colorimetric analysis.	3 %	1, 3-6
Total Carbon*	Determined by NIR, calibration based on Total Carbon by Dumas combustion.	0.1 %	1-6
Total Nitrogen*	Determined by NIR, calibration based on Total N by Dumas combustion.	0.04 %	1-6
Potassium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.01 me/100g	1-6
Calcium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.5 me/100g	1-6
Magnesium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.04 me/100g	1-6
Sodium	1M Neutral ammonium acetate extraction followed by ICP-OES.	0.05 me/100g	1-6
CEC	Summation of extractable cations (K, Ca, Mg, Na) and extractable acidity. May be overestimated if soil contains high levels of soluble salts or carbonates.	2 me/100g	1-6
Total Base Saturation	Calculated from Extractable Cations and Cation Exchange Capacity.	5 %	1-6
Volume Weight	The weight/volume ratio of dried, ground soil.	0.01 g/mL	1-6

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the client.

W.M.Homewood.

Wendy Homewood
Operations Support - Agriculture

Environmental Chemistry Laboratory
Analytical Report - Soils

Landcare Research
Manaaki Whenua

Private Bag 11052
Palmerston North 4442

Phone: +64 6 353 4800
Fax: +64 6 353 4801

Job Number: LJ17146

Customer: Brittany Paton, Lowe Environmental Impact
PO Box 29288, Christchurch 8440

Date Received: 28th June 2018

Date Reported: 3rd August 2018

Client ID	Sample No.	Final conc with 2 mg/L added mg/L	Final conc with 5 mg/L added mg/L	Final conc with 10 mg/L added mg/L	Final conc with 20 mg/L added mg/L	Final conc with 50 mg/L added mg/L	Final conc with 100 mg/L added mg/L
K Site 2: Soil Core #779	M17/8076	0.007	0.006	0.164	0.433	4.41	28.0
K Site 3: Soil Core #882	M17/8077	0.000	0.007	0.227	1.05	10.9	41.0
K Site 5a: Soil Core #706	M17/8078	0.009	0.007	0.281	0.878	12.0	40.4

Client ID	Sample No.	P sorbed with 20 mg/kg added (mg/kg)	P sorbed with 50 mg/kg added (mg/kg)	P sorbed with 100 mg/kg added (mg/kg)	P sorbed with 200 mg/kg added (mg/kg)	P sorbed with 500 mg/kg added (mg/kg)	P sorbed with 1000 mg/kg added (mg/kg)
K Site 2: Soil Core #779	M17/8076	19.9	49.9	98.4	196	456	720
K Site 3: Soil Core #882	M17/8077	20.0	49.9	97.7	189	391	590
K Site 5a: Soil Core #706	M17/8078	19.9	49.9	97.2	191	380	596

Note: Zero values above indicate the value was below detection limit.

N Foster

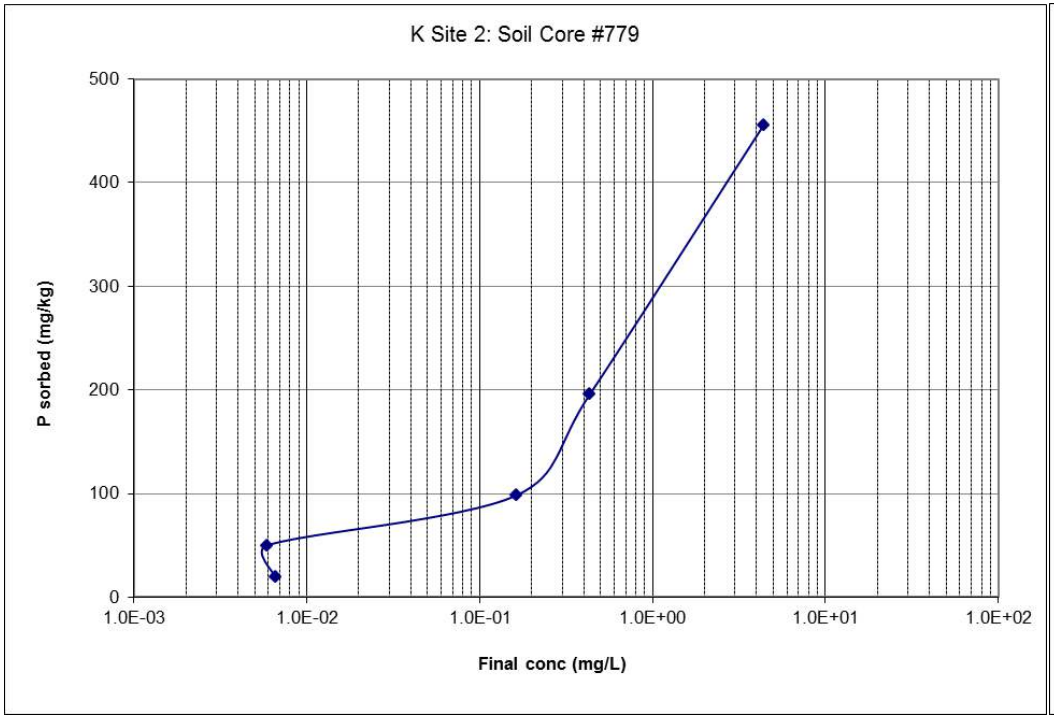
Ngaire Foster, Laboratory Manager

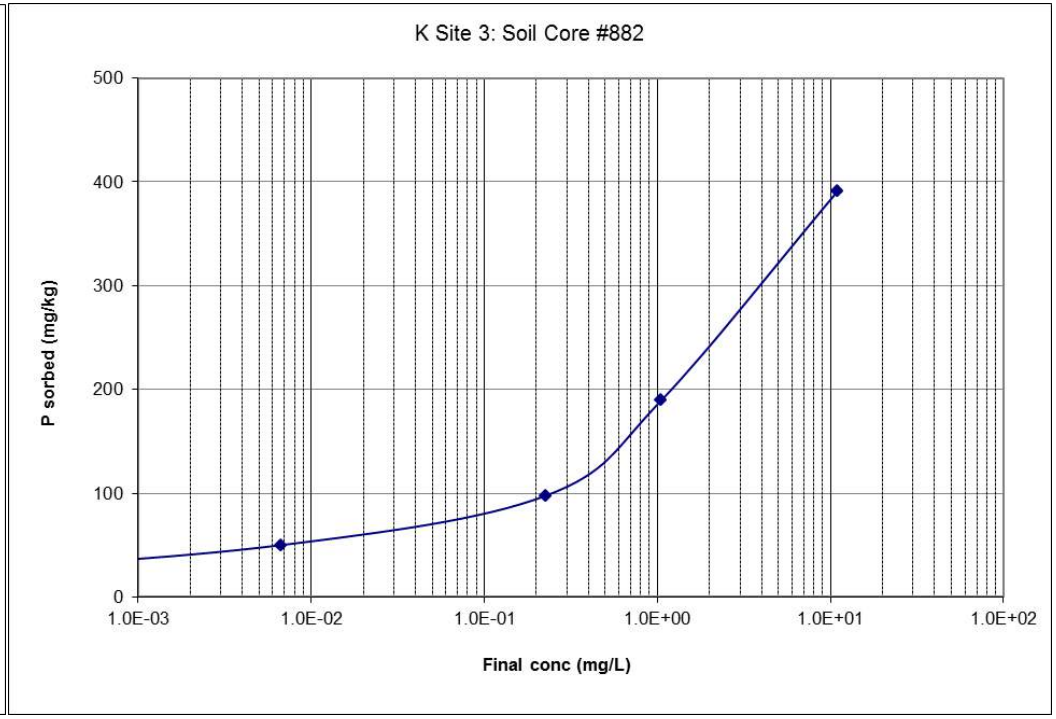
Results apply to the samples as received and are expressed on an oven-dry (105°C) basis. Details of method codes are available online at http://www.landcareresearch.co.nz/resources/laboratories/environmental-chemistry-laboratory/services.

Job Number: LJ17146

Date Reported: 3rd August 2018

Landcare Research
Manaaki Whenua





Job Number: LJ17146

Date Reported: 3rd August 2018

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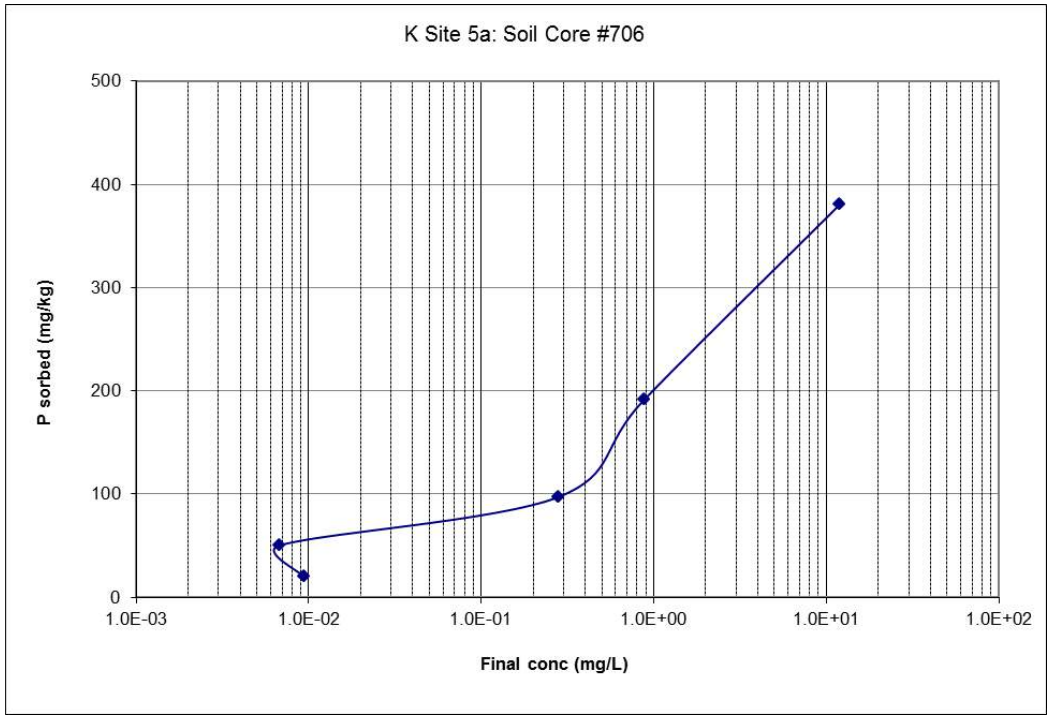

Phosphorus Storage Capacity Calculation Summary

Sample	Smax	Olsen P	Volume Weight	Olsen P	Phosphorous Saturation	P Storage Capacity over 1.5 m
	(mg/kg)	(mg/L)	(kg/m3)	(mg/kg)	(%)	(kg P/ha)
K Site 2: Soil Core #779	728	9	1,090	8.3	1.13	11907.30
K Site 3: Soil Core #882	570	15	1,090	13.8	2.41	9323.76
K Site 5a: Soil Core #706	550	10	1,090	9.2	1.67	8987.14

Parameter	Site 1	Site 2	Site 3
Bulk Density (kg/m^3)$^{(1)}$	1,090	1,090	1,090
P Sorption (mg/kg)	728	570	550
Treatment Soil Depth (m)	1.5	1.5	1.5
P Storage Capacity (kg P/ha)	11907	9324	8987
Design P Storage Capacity (kg P/ha)	10073		
P Loading Rate less DM export (kg P/ha/yr)	186		
Site Life (years)	54		

APPENDIX B

E3 Scientific: Aquatic Ecological Review

Ref: 19038
21st February 2020

Natasha Pritchard
Otago Regional Council
natasha.pritchard@orc.govt.nz

RE: Kingston Township Wastewater – Discharge Treated Effluent into Land AEE: Aquatic Ecological Review

1 Introduction

Queenstown Lakes District Council (QLDC) (hereafter the applicant) is applying for resource consent to develop a community wastewater treatment scheme for Kingston Township (Kingston) and discharge treated wastewater effluent to land. Lowe Environmental Impact (LEI) (2020) have completed a draft Assessment of Environmental Effects (AEE) on behalf of the applicant. Kingston currently use individual septic tank systems to treat wastewater, which is believed to adversely affect the groundwater quality in the area and subsequently the receiving water body of Lake Wakatipu (LEI, 2020).

The wastewater treatment plant (WWTP) and land treatment area (LTA) are proposed to be situated within a parcel of land approximately 1.2 km south of Lake Wakatipu and the Kingston lake margin, known as "Kingston Station" (Figure 1). The LTA site is adjacent to the Kingston Flyer railway line and an un-named tributary of Lake Wakatipu and is approximately 15 ha. The LTA is proposed to be managed as a "cut and carry" system whereby grass pasture is grown, harvested and removed from site. The WWTP site is not included in the assessment of environmental effects.

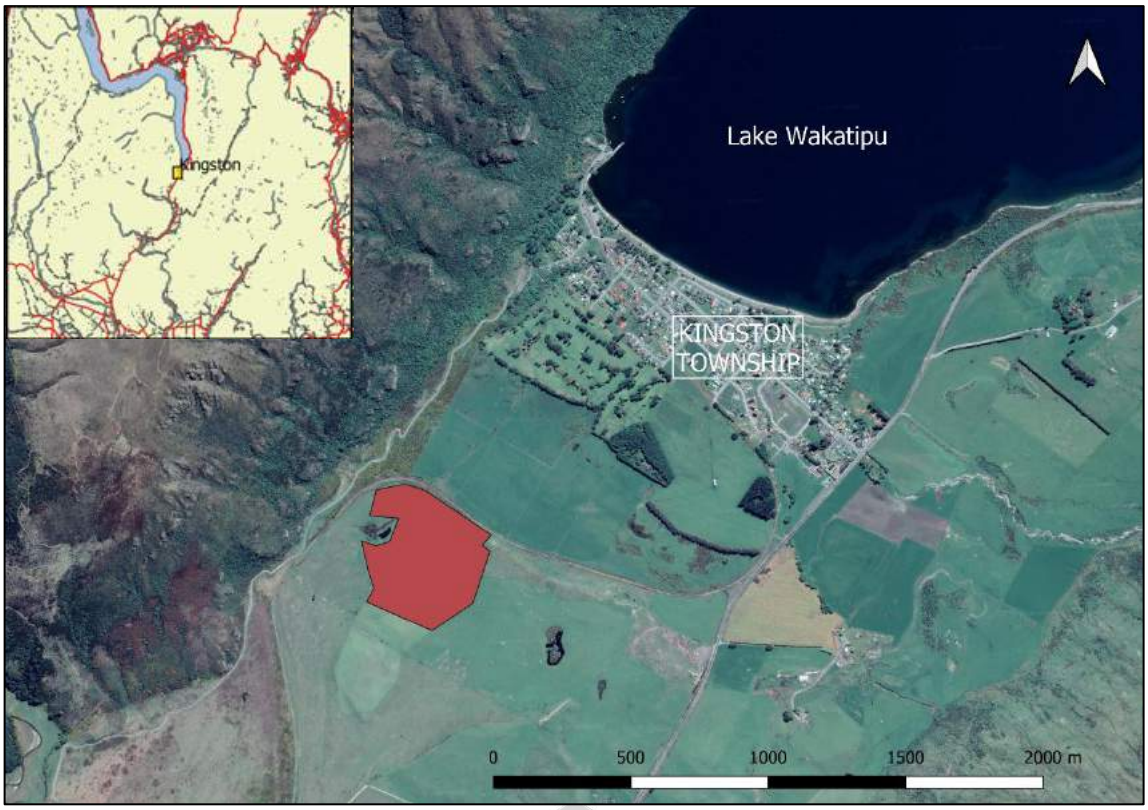

Figure 1: Location of proposed land treatment area (LTA) (red) and Kingston township.

1.1 Scope of Work

This report provides a brief review of the draft AEE (LEI, 2020) with regard to the aquatic ecological and hydrological effects on surrounding water bodies/Lake Wakatipu as a result of the discharge, and provides mitigation options as conditions of consent.

2 Ecological Values

A site visit to the proposed LTA was completed on the 17th February 2020 to establish the spatial relationship of the proposed LTA with the surrounding water bodies. A wetland and an unnamed tributary of Lake Wakatipu adjacent to the proposed LTA site (Figure 2) was noted, as was an ephemeral pond along the northern boundary of the proposed LTA site (Figure 3). The ecological values of the wetland and un-named tributary have not been assessed in the AEE (LEI, 2020).

Figure 2: Wetland area near north west section of LTA boundary. Clockwise from top left: wetland looking west towards the unnamed tributary; wetland looking north towards Lake Wakatipu; wetland area looking south across proposed LTA site.

Figure 3: Ephemeral pond on northern boundary of proposed LTA, looking east. Inset: close up of ephemeral pond with algal growth visible.

During the site visit the wetland area was noted to provide habitat for the endemic paradise shelduck (*Tadorna variegata*), macroinvertebrates such as dragonflies (Order: Odonata), and native aquatic flora such as red pondweed (*Potamogeton cheesemanii*) and *Juncus* rushlands. The MPI fish spawning database identifies the unnamed tributary of Lake Wakatipu (NZ reach: 14044527) as a koaro (*Galaxias brevipinnis*) and brown trout (*Salmo trutta*) spawning habitat (*https://mpi_nes.cloud.eaglegis.co.nz/NESPF/; accessed 19/02/2020*). No records for this unnamed tributary are in the NZ Freshwater Fish Database (NZFFD).

It is unknown whether the wetland conjoins with the unnamed tributary or if it is a perched isolated wetland system. The ephemeral pond appears to be a depression which collects surface water runoff from the surrounding land. The low permeability of the substrate allows for ponding after a rainfall event.

The ecological values of Lake Wakatipu were covered in the AEE (LEI, 2020) and are considered appropriate.

3 Ecological and Hydrological Effects

The effects of the LTA on the adjacent water bodies has not been assessed within the AEE, and LEI have indicated (Brian Ellwood pers. comm. 17/02/2020) that it is preferential to mitigate the effects rather than better understand the ecology and flow paths of these identified waterbodies. With regard to this, the potential ecological effects of the proposed LTA on the adjacent water bodies are unidentified but could include:

1. Habitat degradation from increased nutrient loading and "flipping" of the wetland system via overland and sub-surface contaminant flow;
2. Contaminant pathways to the un-named tributary via the wetland system outflow or groundwater baseflow which would negatively impact trout and koaro spawning habitat; and
3. Groundwater contamination via the ephemeral pond seepage.

No test pits or soil tests were completed near the wetland or depression and there may well be variation in characteristics at the northern and north-western areas of the proposed LTA. As groundwater depths are also unknown, it is unclear if these contaminant pathways are feasible or not. The closest bore with known depth to groundwater is the Kingston closed landfill monitoring bore. The groundwater depth at that site has fluctuated from 11.4 – 15.3 m.b.g., with a median depth of 13.8 m.b.g. (MWH, 2010) (Figure 4). The bore log has layers of pug from 2.2 – 9 m, and silt layers at lower depths. Lower permeability layers such as these may provide paths for throughflow. Given that the ground elevations may be similar, and that there is likely groundwater mounding beneath the ephemeral pond, groundwater depths may be less than 10 m at this location. The site visit, and aerial photos indicates that significant land drainage occurs to this depression.

The ecological effects of the proposed LTA on Lake Wakatipu are believed to improve water quality within the Kingston lake margins. This is due to the removal of the individual septic tank system in Kingston which currently adversely affects the shallow groundwater in this area (LEI, 2020). However, it is also noted that the quantity of effluent disposed will significantly increase with the added subdivision.

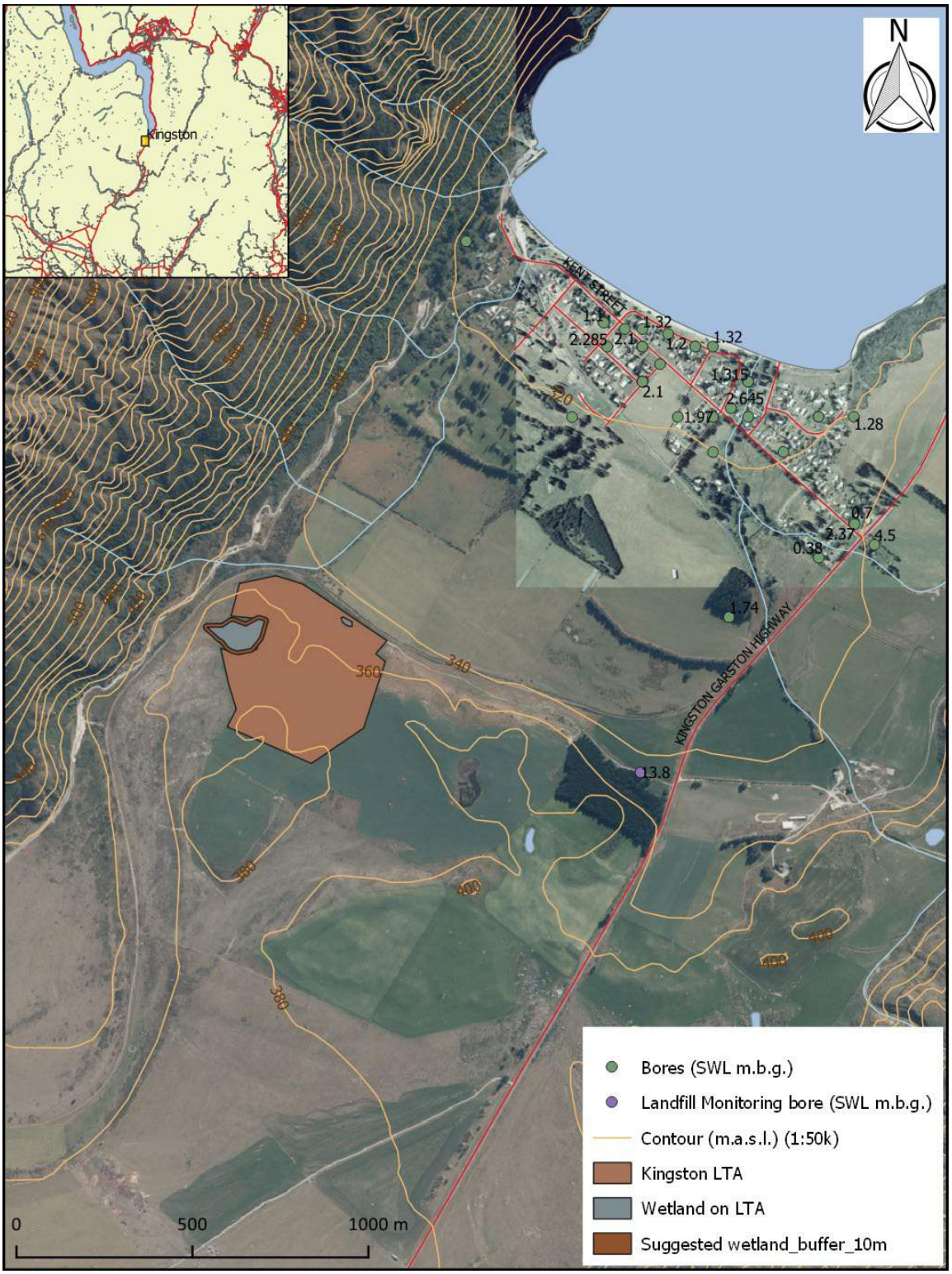

Figure 4: Groundwater Levels and Elevations

4 Recommended Mitigation and Monitoring

Based on the uncertainty of the adjacent waterbodies ecological values and connectivity it is recommended that mitigation and monitoring is undertaken to reduce the advent of any ecological effects on the wetland and unnamed tributary. The following mitigation methods and monitoring regime are recommended as conditions of consent:

1. A 10 m buffer of native riparian vegetation around the wetland and 5 m buffer around the ephemeral pond is recommended (Figure 5) to reduce the contaminant pathway to these waterbodies (see Appendix A for recommended species list).
    a. Currently 600 m^2 of the 10 m buffer of the wetland and all of the ephemeral pond is within the LTA (Figure 5), these zones should be excluded from the proposed LTA.
    b. Riparian planting should occur immediately following agreement from the leaseholder and should be maintained.

2. A water quality monitoring program is established within the unnamed tributary at the provided points on Figure 5, and at two monitoring piezometers. The piezometers shall be screened at the water table and located within 20 m of the southern end of the LTA, and just to the north of the ephemeral pond. The water quality monitoring program should include the following:
    a. Water quality sample analysis at an accredited laboratory testing for: BOD5, total phosphorous, total nitrogen, nitrate-N, NH_4-N, major ions, bromide and field measurements of pH, EC and dissolved oxygen;
    b. Seasonal sampling (i.e. spring, summer, autumn and winter) PRIOR to the establishment of the WWTP and ongoing after operation commences. The seasonal sampling should include at least one wet weather event.
    c. An estimate of flow from the tributary at the time of sampling using an appropriate method;
    d. The monitoring piezometers are to be surveyed, and water level measurements taken at the time of sampling.
    e. A report to ORC providing the results and interpretation of the monitoring within 18 months after the WWTP becomes fully operational. The sampling plan should be reviewed one year after the WWTP is fully operational i.e. after completion of the proposed subdivision. ORC will

review the report and decide upon future monitoring frequency based on the results.

3. An assessment of the soil conditions shall be undertaken by a suitably qualified and experienced practitioner on a biennial basis until such time as the consent authority determines the effects of the disposal to land are acceptable. The assessment shall include:
    a. Four soil samples shall be collected at random from within the LTA, at the following depths
        i. 0 -20 cm
        ii. 30 – 50 or at the application depth.
        iii. 80 – 100cm
    b. The four soil samples from each depth shall then be composited and analysed for the following:
        i. Exchangable Cations (Sodium, Potassium, Magnesium, Calcium);
        ii. Olsen P;
        iii. Cation exchange capacity;
        iv. base saturation;
        v. total carbon;
        vi. total nitrogen; and
        vii. pH
        viii. Suite of seven heavy metals (Arsenic, Cadmium, Chromium, Copper, Nickel, Lead, Zinc)
    c. At the application depth, soil shall also be tested for:
        i. in situ infiltration capacity (Ksat) at the application depth;
        ii. indications of oxidation reduction potential (gleying) of the soil
        iii. an infield assessment of soil structure
    d. A control site shall be chosen outside of the LTA, and samples collected and tested in accordance with condition's 3.A, 3.B, and 3.C. The control samples shall not be composited with the LTA samples.
    e. The results of the soil assessment shall be submitted to the consent authority within 6 months of undertaking the field work.

It should also be noted that LEI (2020) recommended subsurface irrigation depth of 200 mm, however QLDC requires that sub-surface drippers must be a minimum of 300 mm depth to prevent freezing (QLDC AF OSW Rev-3, 2017).

With the inclusion of adequate mitigation and monitoring as conditions of consent, the effects of the proposed LTA on the ecology of the adjacent waterbodies and the receiving aquatic environment of Lake Wakatipu, are considered to be identifiable and potentially minor.

Figure 5: Proposed LTA with wetland and ephemeral pond locations (blue), 10 m riparian buffer (green), and proposed water quality monitoring locations along the unnamed tributary (yellow).

5 Summary and Conclusions

The WWTP and LTA is considered to improve the water quality of Lake Wakatipu due to the discontinuation of the current septic tank system, however there could potentially be unidentified ecological effects on the adjacent wetland and unnamed tributary of Lake Wakatipu. In order to mitigate any potential adverse effects, conditions of consent outlined in Section 4 are recommended. If these conditions are met, the effects of the LTA discharge on the nearby aquatic environment are considered to be detectable and potentially minor.

If you have any questions regarding the information provided in this letter, please contact Bryony Miller on 021 883 381 or via email at bryony.miller@e3scientific.co.nz

Yours sincerely,

Bryony Miller
Senior Marine and Freshwater Ecologist

References

LEI. (2020). *Resource Consent Application: Assessment of Environmental Effects. Discharge of Treated Domestic Effluent into Land, Kingston Township*. Christchurch: Unpublished draft report prepared by Lowe Environmental Impact for Queenstown Lakes District Council.

MWH. (2010). *Kingston Landfill Closure Plan. Prepared for Queenstown Lakes District Council. November 2010.*

All maps were created using Google maps basemap and LINZ river environment classification centrelines.

Appendices

Appendix A: Recommended Riparian Species List

Wetland and Pond riparian area	
Common name	**Latin name**
Wineberry	*Aristotelia serrata*
Hen and chick fern	*Asplenium bulbiferum*
Sedges	*Carex spp.*
Red tussock	*Chionochloa rubra*
Mingimingi	*Coprosma propinqua*
Cabbage tree	*Cordyline australis*
Toetoe	*Cortaderia richardii*
Rush	*Juncus edgariae*
Pohuehue	*Muellenbeckia australis*
Mountain flax	*Phormium cookianum*
Flax	*Phormium tenax*
Kowhai	*Sophora microphylla*
Tree Daisy*	*Olearia spp.*
Lemonwood*	*Pittosporum eugenioides*
Manuka*	*Leptospermum scoparium*

* These species should be planted on raised and drier sites adjacent to the wetland and pond.

APPENDIX C

Surface and Groundwater Monitoring Location Plan

NOTES

L O W E
Environmental
I m p a c t
www.iel.co.nz | office@iel.co.nz

APPROVED	BE	
DESIGNED	BP	
DRAWN	BP	

CLIENT

QUEENSTOWN LAKES DISTRICT COUNCIL

PROJECT
10639 - Kingston Land Treatment

DRAWING TITLE
Surface and Groundwater Monitoring Location Plan

DRAWING STATUS
V3

DATE	SCALE
7/5/2020	NTS

FILE NAME
P:FI-10639-QLDC-Kingston-Monitoring_locations-200507