Pattle Delamore Partners Limited

TECHNICAL MEMORANDUM

INVESTIGATION	Kingston Wastewater Consent s92 Response Review	**PROJECT**	ORC Consent Reviews
CLIENT	**Otago Regional Council**	**PROJECT NO**	C03263537
CLIENT CONTACT	Sarah Davidson	**PREPARED BY**	Oliver Hunt & Hilary Lough
CLIENT WORK ORDER NO/ PURCHASE ORDER	PO018152	**SIGNATURE**	&
		DATE	14 April 2021

Introduction

Pattle Delamore Partners Limited (PDP) has been engaged by Otago Regional Council (ORC) to review a consent application by Queenstown Lakes District Council (QLDC) to discharge treated wastewater into land from a proposed community reticulated wastewater scheme for Kingston. PDP previously reviewed information on the proposed scheme submitted to ORC for pre-application review in 2018 and completed an initial review of the full consent application in 2020. These reviews were documented by PDP in memorandums dated 1 June 2018 and 24 July 2020, respectively. The consent application has been prepared by Lowe Environmental Impact Limited (LEI).

This discharge will be from the existing township, with allowance for growth, and a new subdivision adjacent to the existing township. At total completion, the proposed wastewater treatment plant (WWTP) and land treatment area(s) (LTAs) are expected to receive an average of 900 m^3/d from 1200 dwellings including 225 existing dwellings within Kingston and 975 new dwellings in the proposed subdivision. The proposed LTAs are located in Kingston Station to the south of the township and the proposed subdivision. Sub-surface drip irrigation is proposed.

In PDP's July 2020 review further information on the following aspects was requested:

- A detailed hydrogeological assessment of the groundwater system beneath the LTA and Kingston, including monitoring of groundwater levels and assessments of flow direction.
- A detailed groundwater quality monitoring scheme analysing both existing groundwater quality at the LTAs and within Kingston.
- A detailed ecological assessment of all surface water bodies which could be affected by the discharge (Refer to e3Scientific review for additional detail).
- Further assessment of a suitable irrigation rate and nitrogen loading rate, considering likely plant nutrient uptake throughout the year.
- Further assessment of the actual and potential adverse effects on the receiving environment(s) including a detailed assessment of the sensitivity of the receiving environment(s).

The applicant has responded to these requests in a letter dated 16 March 2021. The response includes details of comprehensive field investigations undertaken at the site, which are useful in improving the understanding of the receiving environment. This memorandum has been prepared to review the additional information provided and provide comment with respect to the potential effects of the activity.

Groundwater Quality

Effect on Lake Wakatipu

The groundwater sampling results from the new bores that QLDC have had installed at and around the site show that there is some impact from existing land uses on nutrient concentrations beneath the site, with nitrate-nitrogen concentrations around 7 mg/L being measured in bore GW1.

The applicant highlights a 2006 ORC report on groundwater in Kingston and Glenorchy, which showed generally low levels of nitrogen at Kingston, with periodic spikes. Since that 2006 Kingston GW quality report identified average values of 0.44 mg/L Nitrate-Nitrogen and 0.91 mg/L Total Nitrogen, there has been a population increase in usual Kingston residents from 201 to 348 (NZ Stats). Some increase in nitrate-nitrogen concentrations may have occurred. In the lake water quality sampling results provided by Ryder Environmental, nitrate concentrations of 0.17 mg/L were detected at the centre of the lake shore. PDP would expect the groundwater nitrate concentrations in Kingston may be greater on average than 0.44 mg/L based on the population information and surface water quality results, although it is acknowledged that nitrogen contributions from surface water inputs to the lake are also occurring (for example Ryder Environmental report 0.39 mg/L of nitrate-nitrogen for Kingston Creek at the lake in their recent sampling results). For completeness in understanding the current and receiving environment down-gradient of the land treatment areas (LTAs), it is recommended that the Applicant request all currently available water quality data from ORC for the Kingston monitoring bores for review and comment.

The report also noted some elevated iron concentrations, which the applicant has stated could be associated with improved denitrification rates. This may be true; however, the existing septic tanks likely provide a source of organic carbon which, with or without iron, is required for denitrification to occur. While the report does not make any assumption that this elevated iron will reduce impacts from the proposed discharge to the LTAs, we would note that the treated wastewater applied to the LTAs is expected to have a lower C:N ratio and over the distance to the lake there would not be significant organics remaining. As a result, if all the septic tank discharges cease, the potential for denitrification in the shallow aquifer under Kingston may be reduced, depending on other organic sources.

In terms of effects on nitrogen concentrations in groundwater and the lake, a key aspect is whether there is an increase above the baseline in terms of nitrogen leaching and how the discharge may impact on the ability to meet Schedule 15 targets for the lake. This is further discussed in the subsequent section of this memorandum.

Effect on Groundwater Users

The applicant states that the majority of Kingston is supplied from rainwater tanks. Based on aerial imagery, this generally appears to be true. However, from the original AEE there are around 30 completed bores within the vicinity of Kingston with the majority in the township. No information has been provided regarding how many of the existing dwellings will connect to the reticulated network. In PDP's experience with other small communities, there is often resistance to the financial cost of connecting to a reticulated scheme. Unless all well owners are using rainwater or connect to the proposed community reticulation then it is important that the discharge does not result in exceedances of the Drinking Water Standards New Zealand 2005 (Revised 2018) (DWSNZ) limit for nitrate in these downgradient bores.

Given some of the recent sampling of the new bores shows nitrate concentrations are already greater than 50% of the limit with leaching from current land use, increasing the leaching rate to 140 kg N/ha/y could have a significant impact if the nitrogen leached from the proposed LTAs is not diluted sufficiently before reaching downgradient bores. However, considering the proposal to not increase baseline nitrogen leaching and the OVERSEER modelling which indicates concentrations in the drainage water beneath the LTA's are expected to be below the MAV of 11.3 mg/L (page 22 of the LEI response dated 15 March 2021), we would agree that no

additional adverse effects (in terms of potable supply) are likely to occur but it will be important that ongoing monitoring occurs as part of consent conditions, together with provision for mitigation as required.

Based on the treatment proposed, the depth to groundwater reported below the LTAs and the information provided in the s92 response on the strata, we agree that there is unlikely to be any significant risk from pathogens to the bores near Kingston as a result of the discharge, even allowing for some variability in the travel time. The potential for effects due to pathogens on existing groundwater users is considered low based on the information provided, but it will be important for ongoing groundwater and surface water monitoring for pathogens (E. coli) to occur.

We recommend the applicant continue to collect groundwater quality samples to provide a longer-term record of the existing groundwater conditions. This should consist of 12 monthly samples to provide a baseline record of the existing effects. It would also be beneficial to sample a selection of the existing bores within Kingston to provide a baseline of the existing groundwater quality adjacent to the lake unless ORC has more recent data available.

Groundwater Level and Flow

The applicant, in line with recommendations from PDP and ORC, has drilled a number of wells near the proposed LTA sites. Water level readings show that the groundwater likely flows towards Lake Wakatipu with depths of around 15 to 40 m or more to groundwater generally occurring beneath the LTAs. The bore records and water level results show that the groundwater system below the proposed LTAs is complex with a range of strata types, which is not unexpected for the moraine. There is some ambiguity on whether there may be a flow divide beneath the LTAs, with the implication being that some water may flow to the south away from Lake Wakatipu. The bores also show there is the potential for perched groundwater as summarised on page 12 of the LEI response. This has implications in terms of potentially being less dilution available for nutrients leached from the LTAs and the potential to recharge surface water, as noted in the LEI response including on page 16 in reference to the flow gaugings undertaken by NIWA suggesting groundwater inflows to the tributaries. It will be important that appropriate surface water monitoring occurs in light of this.

Overall, the information provided has been very useful in terms of characterising the receiving groundwater environment. We recommend the applicant continues to monitor the groundwater levels to provide a longer-term record of the existing groundwater conditions and provide further information on flow directions. Ongoing monitoring of the discharge, if consented, will be important, including the groundwater quality monitoring which may also provide further information on flow directions.

LTA Design and Hydraulic Loading Rates

The applicant has provided satisfactory evidence that the 200 mm drip line depth is appropriate. PDP still considers that the hydraulic loading rate is too high given that it will not promote maximum uptake of nutrients, which is discussed further in this memo. However, we agree with the applicant that the likelihood of runoff from the LTAs is low given the current high infiltration rates described in the soil testing information provided. There is some risk that the infiltration rates could be reduced over time due to the high wastewater application rates, however, this risk can likely be mitigated by on-going conductivity testing as per proposed consent condition 16.

Pre and Post Development Scenarios

The s92 response provides additional scenarios as recommended in PDP's original consent review. In PDP's opinion, some of the key scenarios that should be considered, and the associated assumptions are the following:

A. Predevelopment:
    a. Septic tank discharges (recommended 5.2 kg N/dwelling/yr as per Table 1 below); and,

   b. 15 kg N/ha/y leaching from undeveloped subdivision and LTA areas as stated by LEI in the s92 response (noting that actual leaching may be higher or lower in different parts of the overall area).

B. Full development with current township connection:
   a. Total of 1200 dwellings (975 subdivision and 225 township) with 3 persons/dwelling occupancy; and,
   b. Conservative winter leaching.

C. Full development with full township connection:
   a. Total of 1400 dwellings (975 subdivision and 425 township i.e. 200 new, as there does not appear to be a proposed cap on number of connections) with 3 persons/dwelling occupancy; and,
   b. Conservative winter leaching.

D. Full development, current township not connected:
   a. Septic tank discharges (recommended 5.2 kg N/dwelling/y as per Table 1 below); and,
   b. Total of 1200 dwellings (975 subdivision connected, 225 township not connected) with 3 persons/dwelling occupancy.

E. Full development, full township not connected:
   a. Septic tank discharges (recommended 5.2 kg N/dwelling/y as per Table 1 below); and,
   b. Total of 1400 dwellings (975 subdivision and 425 township i.e., 200 new) with 3 persons/dwelling occupancy.

It is not entirely clear how many empty sections could be developed in the existing township. Scenario 6, Table 4 of the RFI response states there are 200 empty lots which could be developed. Scenarios C and E should consider the maximum number of potential infill dwellings within Kingston Township.

PDP has provided Scenario A in the following section. Based on the information currently provided by the applicant, it appears that all of the future scenarios would result in an increase in nitrogen leaching. However, it would be helpful if the applicant specifically provided the following information for each of the post development scenarios described above:

- Total nitrogen applied to LTAs (kg N/y)
- Areal loading rate of nitrogen to LTAs (kg N/ha/y)
- Total nitrogen leached from LTA areas (kg N/y);
- Areal nitrogen leaching from the LTAs (kg N/ha/y);
- LTA area used in the scenario (ha); and,
- Nitrogen leached from subdivision area, e.g., gardens, stormwater (kg N/y);
- Total annual nitrogen leached (kg N/y);
- Change in total nitrogen leached from Scenario A (kg N/y).

PDP has recommended a nutrient mass balance condition as part of the consent conditions to help ensure the leaching of nitrogen does not increase with this proposal. However, these scenarios are still important for all parties to understand how nutrient leaching could change within the catchment and to provide evidence that the system is capable of at least maintaining the existing nutrient leaching at full development.

Assessment of Pre and Post Development Septic Tank Leaching

PDP has provided an assessment of the pre-development scenario in Table 1 using two methods to determine the likely leaching from the existing septic tanks. Based on these methods, PDP recommends a predevelopment septic tank leaching allowance of 5.2 kg N/y/dwelling or 1170 kg N/y from the 225-dwelling township, although acknowledges that there are different ways in which this could be calculated.

Table 1: Individual Leaching from Existing Septic Tanks in Kingston Township

Method 1: Effluent Concentration

Parameter	Value	Unit	Source
Occupancy	1.5	People/dwelling	*2018 Census[1] with 348 people and 225 private dwellings*
Flowrate	180	L/person/day	*AS/NZS 1547:2012 Table H3*
Effluent Total Nitrogen Concentration	50	mg/L	*Lower end of range (for conservative estimate) from GD06: On-site Wastewater Management in the Auckland Region. Table 28[2]*
Septic Tank Annual Leaching	**4.9**	**kg N/y**	

Method 2: Per Capita Mass Loading

Parameter	Value	Unit	Source
Occupancy	1.5	People/dwelling	*2018 Census[1] with 348 people and 225 private dwellings*
Mass Loading	10	g N/person/day	*Within lower range from GD06: On-site Wastewater Management in the Auckland Region. Table 27[2,3]*
Septic Tank Annual Leaching	**5.5**	**kg N/y**	

Notes:

1. *https://www.stats.govt.nz/tools/2018-census-place-summaries/kingston*
2. *http://content.aucklanddesignmanual.co.nz/regulations/technical-guidance/Documents/GD06%20-%20On-Site%20Wastewater%20Management.pdf*
3. *Recommended range 6 – 17 g/person/day*

Connection of Septic Tanks/Dynamic Leaching Limit

In Section 2.1 of the original application, it is stated that approximately 225 septic tanks could be connected to the new wastewater treatment system. At the meeting between PDP, e3Scientific, ORC, LEI and QLDC on 26/08/2020 it was confirmed by LEI and QLDC that the new reticulated system could be constructed without the existing township being reticulated. From PDP's experience with other small towns, including Glenorchy, there is often strong opposition to the connection costs when new reticulated sewers are established. It is considered very possible that the existing township may not be connected to the reticulated network at least at the start of the subdivision development and potentially not at all during the consent term. This is important to consider in understanding the potential for changes to the total nitrogen load on the catchment.

If the township is not fully connected to the reticulation, then there could be significant increases in leaching as the size and occupancy of the total Kingston area increases. If this occurred, it would not appear to be in line with the objectives and policies of the National Policy Statement on Freshwater Management 2020 (NPS-FM). It is critical to the nitrogen balance being maintained (or reducing) to understand how many existing septic tank

discharges will be removed the catchment. Given the probability of opposition to a reticulated scheme within the existing township, PDP suggests that the leaching limit could be controlled by the number of septic tank discharges removed from the township.

PDP suggests that at the commencement of the consent the total consented leaching from the 70 ha of combined subdivision and LTA area is limited to 1050 kg N/y (average 15 kg N/ha/y), in line with the calculations presented by LEI for the Applicant. For each existing septic tank connected to the reticulation system the pre-development leaching equivalent of one septic tank (5.2 kg N/y) could be added to the LTA leaching total. Note that this does not consider the need to reduce the overall leaching load in the catchment or the potential for new septic tanks within the township, which may also need to be factored in. PDP envisions that once the 'dynamic leaching limit' calculation methodology is agreed upon, then the consented leaching values could be established. This is discussed further in the following sections.

PDP would be happy to consider alternative proposals from the applicant, however, we recommend the approach needs to consider the potential change in the quantity of septic tank discharges within Kingston township over the consent duration and other leaching in the catchment to ensure the target of not increasing current leaching to the lake can be met. PDP consider this approach would at least help maintain the existing freshwater quality. Additionally, it may be appropriate to have the overall load and volumes allowed under the consent to increase over time, as development occurs, rather than permit the maximum volume and nitrogen load sought at the outset. We would also recommend an average flow, in addition to the peak flow, is included in the consent conditions.

Nutrient Balance Consent Condition

PDP recommends a consent condition requiring annual reporting of a nutrient balance over the subdivision/LTA/township area in addition to a condition limiting the application rate. The balance may be completed in OVERSEER, however, it should include actual data on the cut and carry regime including:

1. Total mass/bales harvested;
2. Dry matter (DM) percentage as determined by sampling at each harvest;
3. Total DM harvested as calculated from 1 & 2 above;
4. Nutrient concentrations/percentage of DM harvested as determined by sampling at each harvest; and,
5. Total mass of nutrients removed from the LTAs calculated using 1 – 4 above.

The report should include details of:

1. Applied nitrogen loads;
2. Leaching concentrations, areal leaching and total leached mass of nitrogen and phosphorus from the LTAs and other sources, such as stormwater and gardens, as determined by a nutrient balance;
3. Number of septic tanks connected to the system;
4. Number of septic tanks not connected to the system;
5. Permitted leaching based on the relevant consent conditions and number of septic tanks connected/not connected; and,
6. Compliance based on the results of 2 & 5.

Cumulative Effects/Catchment Assessment

Policy 3 of the NPS-FM states that "freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments".

Based on the surface water divide and an approximation of groundwater flows, the catchment from which leached nutrients are likely to flow beneath Kingston to the lake shore is approximately 320 ha (Refer Figure 1). The proposed subdivision and LTA area make up at least 70 ha and up to 80 ha of this catchment. Kingston itself

is spread over an additional 42 ha. Assuming the approximately 200 ha not within this proposal leaches (or could leach) at a rate of 15 kg N/ha/y (3000 kg N/y total), then under the predevelopment scenario Kingston and the undeveloped subdivision/LTA area contribute a significant portion of the total leaching and is likely to represent the largest 'point' source in the catchment once the WWTP and LTAs are commissioned. The proposed discharge has the potential to have a significant impact on cumulative effects in the catchment.

Figure 1: Estimated area of leaching likely to contribute nutrients to the lakeshore at Kingston.

Requirement for Improvement

The e3s report provides further details on the existing surface water quality. Based on the limited sampling completed to date, there appear to be existing adverse effects on the water quality of Lake Wakatipu at Kingston due to nitrogen (based on comparison with ORC's targets for nitrogen); likely leached from septic tanks in Kingston and surrounding agricultural land use. The water sample collected at the centre of Kingston beach did not meet the Schedule 15 limit or the NPS-FM Attribute State A limit.

PDP notes the following policies of the NPS-FM:

> **Policy 5**: Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.
>
> **Policy 8**: The significant values of outstanding water bodies are protected.

Lake Wakatipu is an outstanding water body as defined in the NPS-FM as it is protected by the Water Conservation (Kawarau) Order 1997. The NPS-FM defines degraded water bodies as those not currently meeting the national bottom line or a target attribute state. Lake Wakatipu has not currently been assigned a target attribute state. However, the existing Regional Plan Water: Schedule 15 targets are within attribute state A for total nitrogen. Based on the sampling completed to date, it is possible that Lake Wakatipu at Kingston is not meeting the Schedule 15 targets and may, in the future, be considered degraded under the National Objectives Framework (NOF) in the NPS-FM. Policy 5 of the NPS-FM requires improvement of degraded water bodies.

PDP recommends that further surface water sampling is carried out to better establish the existing nutrient concentrations from which a reduction in catchment wide leaching, if required, can be based on. Ideally this would be completed prior to granting the consent, however, it may be acceptable to require the sampling to be completed after the consent is granted and before the discharge commences. The baseline should consist of 12 consecutive monthly samples at minimum. The required sampling is detailed further in the e3s review.

Following establishment of the baseline, a percentage reduction, or other method of calculation, may be applied to the leaching values to reduce nutrient concentrations to appropriate targets if they are exceeded. This could be included as a process condition in the consent if the baseline sampling is not complete when the consent is granted. However, it is recognised that careful consideration of other impacts on the lake may be required.

Potential for Improvement

In PDP's view, maintaining the existing water quality is the minimum the proposed system should achieve, in line with the applicant's intentions. As discussed above, improvement may be required under the NPS-FM in the future. Regardless of any specific requirement, there is currently increasing scrutiny on freshwater contamination around the country with growing drive to reduce the effects of nutrient losses in regulations such as the NPS-FM and Freshwater NES and the wider water reform programme.

This proposed wastewater treatment system is a prime opportunity for improved freshwater quality in the Kingston area. The original application states that 25 ha of land is available for irrigation. As noted in PDP's previous review, it would be ideal to have more than the 15 ha of LTAs currently proposed to reduce leaching by maximising plant uptake. In LEI Scenarios 2 and 3, increasing the LTA area from 15 ha to 21 ha results in around a 30% reduction in total mass of nitrogen leached. This is a significant reduction and shows the potential for improvement. Overall, more irrigation area would reduce areal leaching and result in reduced leachate concentrations and total leached mass.

Furthermore, the proposed treatment plant is a sequencing batch reactor (SBR). Based on PDP's experience with a SBR in similar if not colder climates, effluent nitrogen concentrations below 10 mg/L are achievable. The leaching from the proposed LTAs could be significantly reduced if the applicant is willing to invest in better denitrification within the WWTP. The nitrogen leaching is dominated by winter drainage where there is minimal plant uptake of nitrogen. Increasing land area will reduce the total mass of nitrogen leached, however, it will not reduce the mass of nitrogen leached during winter. Improved treatment is the best option to further reduce nitrogen leaching and reduce the potential for adverse effects on the lake because of this activity. We would recommend that, in addition to the proposed nitrogen load, a requirement for a nitrogen concentration in the effluent is also included.

Overall, PDP queries the equal or slight improvement approach taken by QLDC when there are practical and readily available options to significantly improve on the baseline. At a minimum, there needs to be confidence in the controls measures, such that the activity can proceed in a manner that does not result in an overall increase in leaching, as per the applicant's intention.

Conclusion

In PDP's original review, additional information on the following aspects was requested:

- A detailed hydrogeological assessment of the groundwater system beneath the LTA and Kingston, including monitoring of groundwater levels and assessments of flow direction.
- A detailed groundwater quality monitoring scheme analysing both existing groundwater quality at the LTAs and within Kingston.

- A detailed ecological assessment of all surface water bodies which could be affected by the discharge (Refer to e3Scientific review for additional detail).
- Further assessment of a suitable irrigation rate and nitrogen loading rate, considering likely plant nutrient uptake throughout the year.
- Further assessment of the actual and potential adverse effects on the receiving environment(s) including a detailed assessment of the sensitivity of the receiving environment(s).

We consider that the information on groundwater and groundwater quality provided is sufficient, however, the groundwater level and quality monitoring should continue until such time as a decision is made on the consent to establish a baseline. PDP has not reviewed the additional information provided about surface water quality in detail as e3Scientific is reviewing this aspect of the consent.

PDP still consider the applicant's proposed nutrient loading rates are not consistent with best practice. However, in our opinion, the primary issue of the consent is accurately determining the pre and post development nitrogen balances. PDP has considered, based on information on leaching provided by the applicant, five scenarios (one pre and four post development) which we recommend should be considered further for this application. PDP has provided the pre-development scenario and an estimated leaching rate for septic tanks in the pre and post development scenarios. We recommend the applicant consider and provide more information on LTA and subdivision leaching for the post-development scenarios.

The connection of the 225 existing septic tanks within Kingston Township is not guaranteed. Understanding the future of these discharges is important in understanding the potential cumulative effects within the catchment. PDP has suggested a baseline annual leaching rate with increases based on the connection of existing dwellings with septic tanks. However, we are open to feedback or alternatives proposed by the applicant. Any proposed alternative should ideally consider the potential for continued septic tank use within the township and the effect of septic tank use on the wider catchment nutrient balance, although we would note that there should be incentives for new on-site systems to achieve a good level of nitrogen removal in tandem with QLDC's management of the reticulated system.

We recommend at least 12 months of consecutive monthly groundwater and surface water sampling are undertaken to provide a baseline of existing effects. From this baseline, both ongoing monitoring requirements and any potential catchment wide reductions in nutrient leaching required can be determined.

Overall, PDP questions the approach taken by the applicant which is only to maintain or slightly improve on the existing leaching rates. With additional land area available and a proposed treatment system capable of high levels of nitrogen removal, we question why the applicant is not striving for a higher level of treatment and greater reduction in nitrogen leaching in the catchment. The current and future residents of and visitors to Kingston would stand to benefit from improved lake water quality.