In the matter	of the Resource Management Act 1991
And	
In the matter	a resource consent application by Queenstown Lakes District Council to discharge treated wastewater to land for the purpose of disposing of wastewater from Kingston Township

Statement of evidence of Dr Ruth Johanna Goldsmith

23 December 2021

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Statement of evidence of Ruth Goldsmith

1 Executive summary

1.1 Treated effluent will be discharged from the proposed wastewater treatment plant (WWTP) into the land treatment area (LTA). Effluent contains nutrients and faecal bacteria, which at high concentrations can be harmful for aquatic communities.

1.2 There are no existing surface water connections between the proposed LTA and the identified surface water bodies within the vicinity of the area, therefore the most likely way that surface water bodies could be impacted by effluent is via groundwater connections to the proposed LTA. Groundwater quality will be protected by treatment of the (already treated) effluent within the soil profile, the effectiveness of which will increase with increasing distance from the LTA. Most surface water bodies are located at least 40 m away from the LTA boundary, reducing the risk of adverse effects.

1.3 Measurements have indicated that there may be a groundwater connection between the LTA and the two Lake Wakatipu tributaries (an unnamed tributary and Kingston Creek). Existing aquatic communities within the tributaries are expected to be tolerant (to a point) of any potential contaminant input should it occur.

1.4 Queenstown Lakes District Council (QLDC) has proposed consent conditions that ensure effluent discharged to the LTA meets certain quality thresholds. On-going surface and ground water quality monitoring has also been proposed by QLDC, with further mitigation measures to be implemented if monitoring indicates proposed nutrient loading limits are not being met. This will further reduce the risk of adverse effects on aquatic communities within the vicinity of the LTA.

2 Qualifications and experience

2.1 My full name is Ruth Johanna Goldsmith. I am an environmental scientist and hold a BSc. (Zoology, 1998), a Postgraduate Diploma (Wildlife Management, 2000), and a PhD (Zoology, 2004) from the University of Otago. I am a member of the New Zealand Freshwater Sciences Society.

2.2 I have been an employee of Ryder Environmental Limited, an environmental consulting business based in Dunedin, for 17 years.

2.3 I have been provided with a copy of the Code of Conduct for Expert Witnesses contained in the Environment Court's Practice Note 2014. I have read and agree to comply with that Code. This evidence is within my area of expertise, except where I state that I am relying upon the specified evidence of another person. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

3 Role in the project and scope of evidence

3.1 My role in the project is to provide an assessment of the potential effects on surface water bodies that could result from QLDC's proposed WWTP LTA at Kingston Station (Site).

3.2 Ryder was engaged by QLDC to provide a description of existing aquatic habitat and communities in the vicinity of the LTA, and an assessment of the potential effects of the WWTP discharge on the existing environment. In completing my assessment I undertook field sampling at 10 surface water sites on 12-14 October 2020. The sites were located within a pond that is surrounded by the LTA, two small tributaries of Lake Wakatipu located to the north/north-east of the LTA, and in Lake Wakatipu itself.

3.3 Depending on the habitat present, I undertook water quality, benthic macroinvertebrate and/or fish community sampling at each site. I also completed visual investigation of upstream and downstream surface flow paths in order to describe connections between surface water bodies. Water quality samples that I collected were processed by Watercare Laboratory Services (Queenstown and Invercargill), and benthic macroinvertebrate samples were processed at the Ryder Laboratory (Dunedin). Based on results of the field sampling, in November 2020 I prepared a report titled "*Kingston Township Community Wastewater: Aquatic Ecology Assessment*" (Aquatic Ecology Assessment).

3.4 The purpose of my evidence is to summarise the Aquatic Ecology Assessment and respond to matters raised by the Council planner.

3.5 My evidence is set out as follows:

- Description of the existing environment;
- assessment of effects on aquatic ecology; and
- an assessment of matters raised in the s 42A report relevant to my evidence.

4 The Existing Environment

4.1 A map of the Site showing the location of surface water bodies and sampling sites is provided in Figure 1. I discuss the existing environment of each in paragraphs 4.2 to 4.8 below.

Figure 1. QLDC's proposed WWTP LTA (green highlighted areas) at Kingston Station (Site) and surface water quality sampling sites (blue circles).

Pond

4.2 The closest surface water body to the LTA is a small (0.09 ha) constructed pond (Figure 2), which is surrounded on three sides by the proposed LTA. The pond has no direct connection to any other surface water bodies. Water quality within the pond was the poorest of all the surface water bodies sampled (Table 1). This was expected given that it is a small, artificial pond draining agricultural land. The benthic macroinvertebrate community indicated 'poor' conditions, and netting and trapping overnight found no fish.

Figure 2. Pond, SW6, October 2020.

Unnamed tributary

4.3 A small, unnamed tributary of Lake Wakatipu is located to the north/north-east of the LTA. The unnamed tributary has no surface flow connection with the LTA but skirts the northern side of the area and may potentially receive groundwater inflows. I sampled four sites within this tributary; including a site located upstream of any potential influence of the LTA (SW3, Figure 3), two sites located downstream of the LTA within agricultural land (SW2 and SW1, Figures 4 and 5), and the fourth site (SW7, Figure 5) approximately 1 km downstream of the LTA within the Kingston Township.

4.4 The unnamed tributary has a total length of approximately 2 km, and the channel alternates between being narrow and incised with a gravel and cobble dominated substrate (e.g. Figure 3), and being undefined and heavily vegetated with a soft fine sediment substrate (e.g. Figure 4). At the time of sampling there

was an approximately 10 m long section with no visible surface flow immediately downstream of site SW2. It appeared though that during higher flows this section of channel would have surface flow.

4.5 Of the four sites, the most downstream site (SW7) had the highest nutrient concentrations (Table 1), which is typical, as contaminant inputs tend to increase downstream as development increases (i.e., from native bush to agricultural and residential development). Faecal bacteria concentrations were, however, lowest at the downstream site (SW7) and highest at the most upstream site (SW3). Aside from nutrients and faecal bacteria, other water quality parameters (i.e., dissolved oxygen, pH, conductivity, turbidity, $TBOD_5$[1]) were similar among all four unnamed tributary sites (Table 1). Benthic macroinvertebrate communities indicated 'poor' to 'good' conditions, with taxa that are tolerant of a range of conditions abundant (e.g., true flies, snails, worms). Fish were only caught at the downstream site near the lake: brown trout (introduced), kōaro (native, at risk-declining[2]) and common bully (native, not threatened). In addition to no fish being caught at the upper three unnamed tributary sites, the substrate present is not suitable for kōaro or brown trout spawning (as it is dominated by aquatic plants and soft fine sediments).

Figure 3. Unnamed tributary, SW3, October 2020.

[1] Total biochemical oxygen demand.

[2] Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M. and Rolfe, J.R. 2018. Conservation status of New Zealand freshwater fishes, 2017. New Zealand Threat Classification Series 24. Department of Conservation, Wellington. 11 p.

Figure 4. Unnamed tributary, SW2, October 2020.

Figure 5. Unnamed tributary, SW1, October 2020.

Figure 6. Unnamed tributary, SW7, October 2020.

Kingston Creek

4.6 Kingston Creek is located approximately 500 m north/north-east of the LTA and has no surface flow connection to it. I sampled two sites in Kingston Creek: in a tributary within agricultural land immediately upstream of the State Highway 6 (SH6) road culvert (SW4, Figure 7), and in the mainstem downstream within the Kingston Township (SW8, Figure 8). Nutrient concentrations were higher, and faecal bacteria concentrations lower, at the Kingston Creek downstream site (SW8) than the upstream site (SW4) (Table 1). Benthic macroinvertebrate communities were similar to those in the unnamed tributary and indicated 'poor' to 'good' conditions. Brown trout and kōaro were found in Kingston Creek.

Figure 7. Kingston Creek tributary, SW4, October 2020.

Figure 8. Kingston Creek, SW8, October 2020.

Lake Wakatipu

4.7 Lake Wakatipu is located approximately 1.5 km north of the LTA. Lake water quality has been monitored by the Otago Regional Council (ORC) for over 20 years at a site near the lake outflow to the Kawarau River (approximately 40 km from Kingston), and more recently at a mid-lake site near Jacks Point (approximately 30 km from Kingston). ORC monitoring currently indicates very good water quality (microtrophic) in the lake, with evidence of a decreasing trend in nitrogen concentrations (nitrite-nitrate nitrogen and ammoniacal nitrogen) (ORC 2020[3]).

4.8 I sampled three sites on the shore of Lake Wakatipu: SW9 (Figure 9), SW10 and SW11 (Figure 10). The lake had the overall lowest faecal bacteria concentrations of all surface water bodies sampled (Table 1). Nutrient concentrations varied between the lake sites, with phosphorus highest at SW9 to the east of Kingston Township, and nitrogen highest at SW10 directly adjacent to Kingston Township. Other water quality parameters (i.e., dissolved oxygen, pH, conductivity, turbidity, $TBOD_5$) were similar among the three lake sites (Table 1). Benthic macroinvertebrate communities in the lake include freshwater mussels (native, 'at risk – declining'[4]), and the New Zealand Freshwater Fish Database (NZFFD) and my sampling recorded brown trout, kōaro, common bully and a large longfin eel (native, 'at risk - declining').

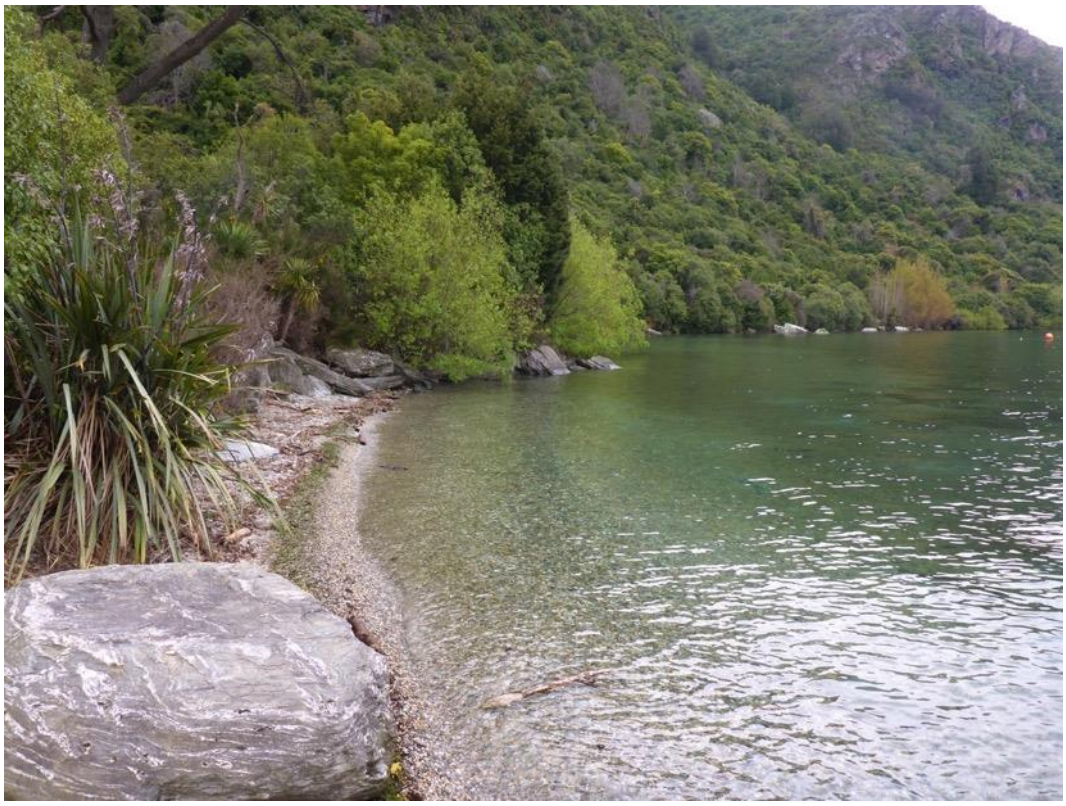

Figure 9. Lake Wakatipu, SW9, October 2020.

[3] ORC. 2020. State and Trends of River and Lake Water Quality in the Otago Region 2000-2020.

[4] Grainger, N., Harding, J., Drinan, T., Collier, K., Smith, B., Death, R., Makan, T. and Rolfe, J. 2018. Conservation status of New Zealand freshwater invertebrates, 2018. New Zealand threat classification series 28. Department of Conservation, Wellington. 25 p.

Figure 10. Lake Wakatipu, SW11, October 2020.

Water quality limits

4.9 Schedule 15 of the Regional Plan: Water for Otago (2018) sets water quality limits that are to be achieved in Lake Wakatipu (receiving water group 5) and its tributaries (receiving water group 3). These limits are achieved when 80% of samples collected at a site, when flows are at or below median flow, over a rolling 5-year period, meet or are better than the limits in Schedule 15. There is not sufficient data to assess water quality in Lake Wakatipu, the unnamed tributary and Kingston Creek against these limits, however to provide some context the limits are presented along with the relevant existing values in Table 2. Turbidity limits were met in Lake Wakatipu but at some sites total nitrogen and *E. coli* limits were not met. All limits were met in the unnamed tributary, with the exception of *E. coli* at the upstream site (SW3) and dissolved reactive phosphorus at the lake site (SW7). In Kingston Creek all limits were not met.

Table 1. Water quality at surface water sites, 13 October 2020.

Water quality parameters	Units	SW6	SW3	SW2	SW1	SW7	SW4	SW8	SW9	SW10	SW11
		Pond 2	Unnamed tributary - upstream	Unnamed tributary – downstream 1	Unnamed tributary – downstream 2	Unnamed tributary – at Lake	Kingston Creek tributary – upstream SH6	Kingston Creek – at Lake	Lake Wakatipu - East	Lake Wakatipu - Mid	Lake Wakatipu - West
Time of day	h	1005	0930	1030	1055	1205	1115	1140	1215	1150	1125
Temperature	°C	11.2	8.6	8.6	9.9	9.0	10.6	10.3	10.8	10.8	11.3
Dissolved oxygen	%	64.6	88.7	84.0	81.2	95.2	101.0	98.6	97.9	94.7	97.6
Dissolved oxygen	mg/L	7.04	10.37	9.84	9.16	11.00	11.26	11.04	10.90	10.48	10.80
pH	-	8.6	6.8	7.0	7.1	6.6	7.1	6.6	7.0	6.9	7.1
Conductivity	µS/cm	46.1	40.6	35.9	34.9	38.5	55.9	45.7	49.2	50.6	53.8
Turbidity	NTU	79.7	1.4	2.1	0.6	2.0	16.0	3.9	1.0	1.3	2.0
Dissolved reactive phosphorus	mg/L	<0.005	<0.005	0.005	0.005	0.009	0.008	0.008	0.022	<0.005	<0.005
Nitrate nitrogen	mg/L	<0.01	<0.01	<0.01	<0.01	0.06	0.09	0.39	0.03	0.17	0.07
Nitrite nitrogen	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total nitrogen	mg/L	8.90	0.30	0.35	0.35	0.36	0.37	0.55	0.08	0.22	0.12
E. coli	MPN/100 mL	130	58	18	6	3	190	55	12	3	11
Total coliforms	MPN/100 mL	>2,400	520	1,400	690	1,300	1,600	580	120	140	120
$TBOD_5$	mg/L	41	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0

Table 2. Regional Plan: Water for Otago (2018) Schedule 15 water quality limits and water quality values at surface water sites, 13 October 2020. Values that exceed limits are highlighted in yellow. Note that as the limits only apply to 80% of samples collected at a site, when flows are at or below median flow, over a rolling 5-year period, there is not sufficient data for the surface water sites to provide a true limit assessment.

Water quality parameters	Units	SW3	SW2	SW1	SW7	SW4	SW8	SW9	SW10	SW11
		Unnamed tributary - upstream	Unnamed tributary – downstream 1	Unnamed tributary – downstream 2	Unnamed tributary – at Lake	Kingston Creek tributary – upstream SH6	Kingston Creek – at Lake	Lake Wakatipu - East	Lake Wakatipu - Mid	Lake Wakatipu - West
Turbidity limit	NTU	3	3	3	3	3	3	3	3	3
Turbidity value	NTU	1.4	2.1	0.6	2.0	16.0	3.9	1.0	1.3	2.0
Dissolved reactive phosphorus limit	mg/L	0.005	0.005	0.005	0.005	0.005	0.005	-	-	-
Dissolved reactive phosphorus value	mg/L	<0.005	0.005	0.005	0.009	0.008	0.008	-	-	-
Nitrate nitrogen limit	mg/L	0.075	0.075	0.075	0.075	0.075	0.075	-	-	-
Nitrate nitrogen value	mg/L	<0.01	<0.01	<0.01	0.06	0.09	0.39	-	-	-
Total nitrogen limit	mg/L	-	-	-	-	-	-	0.10	0.10	0.10
Total nitrogen value	mg/L	-	-	-	-	-	-	0.08	0.22	0.12
Escherichia coli limit	cfu/100 mL	50	50	50	50	50	50	10	10	10
Escherichia coli value	MPN/100 mL	58	18	6	3	190	55	12	3	11

5 Assessment of Effects

5.1 Treated effluent will be discharged from the proposed WWTP into the LTA via subsurface drip irrigation[5]. Effluent contains nutrients and faecal bacteria, which at high concentrations can be harmful for aquatic communities. As treated effluent will be discharged subsurface, the most likely way that surface water bodies could be impacted by the discharge of these potential contaminants is via groundwater connections to the LTA. The protection of groundwater quality within and outside of the Site is ensured by treatment of the (already treated) effluent within the soil profile (through the mechanisms of filtration, absorption and natural attrition), the effectiveness of which will increase with increasing distance from the LTA[6]. The risk, and potential effect, of contaminant inputs to each of the surface water bodies within the vicinity of the Site is discussed in the following paragraphs.

5.2 The closest surface water body to the LTA, and therefore the one at highest risk of receiving contaminant inputs, is the small, isolated pond. The pond had the overall poorest water quality of all sites sampled in October 2020. No fish were found and the existing macroinvertebrate community was indicative of 'poor' conditions. As such, it is expected that the community would be tolerant of any potential contaminant input should leaching occur. The establishment and maintenance of a buffer zone between the pond and the LTA has been proposed to reduce the risk of any leaching[7].

5.3 The unnamed tributary is located on the northern side of the LTA, approximately 40 m away from the LTA boundary at its closest point. NIWA measurements have indicated that there may be a groundwater connection between the LTA and the unnamed tributary[8]. The existing aquatic community in the vicinity of the LTA did not include fish, although fish were present near the confluence with the lake. Nutrient concentrations were highest near the lake and faecal bacteria concentrations were relatively high at the site upstream of the LTA. Macroinvertebrate communities were indicative of 'poor' to 'good' conditions. I therefore expect the existing aquatic community of the unnamed tributary to be tolerant of any potential contaminant input should leaching occur. The existing dominance of aquatic plants (macrophytes) in places would also assist with nutrient uptake. The lack of surface flow connection within the unnamed tributary, at times, will minimise the risk of any contaminant transfer (should they enter the tributary) downstream into Lake Wakatipu.

5.4 Kingston Creek is located approximately 500 m north/north-east of the LTA. NIWA measurements have indicated that there may be a groundwater connection between the LTA and Kingston Creek. Benthic macroinvertebrate communities in the creek indicated 'poor' to 'good' conditions, and it is expected that the community would be tolerant of any potential contaminant input should leaching occur. As already noted however, the effectiveness of effluent treatment will increase with increasing distance from the LTA.

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[5] Resource Consent Application Assessment of Environmental Effects: Discharge of Treated Domestic Effluent into Land Kingston Township. Prepared for Queenstown Lakes District Council by Lowe Environmental Impact, May 2020, (**AEE**), Section 3.1, paragraph 1.

[6] AEE, Section 3.5 paragraph 1, Section 6.3.2 paragraph 1, Section 6.3.4 paragraph 6.

[7] Condtion 4, amended conditions Appendix 2 of Mr Henderson's evidence.

[8] Letter from NIWA to Lowe Environmental Impact (Attn: Terry Hughes), dated 20 November 2020.

5.5 There are no existing surface water connections between the LTA and the identified surface water bodies within the vicinity. There is a small risk that surface run-off of effluent could occur from the treatment area, resulting from either a system failure or excessive rainfall beyond normal expectations. However, as explained in the AEE[9] this is unlikely and in any event the resulting run-off would be significantly diluted, having filtered up through the soil and then percolating across a vegetated surface that has the ability to remove any remaining suspended contaminants prior to entering surface water.

5.6 On-going monitoring of both surface and ground water quality has been proposed[10], with further mitigation measures to be implemented (e.g. increase LTA size, increase level of treatment in WWTP) if monitoring indicates proposed nutrient loading limits are not being met[11]. This will further reduce the risk of adverse effects on aquatic communities within the vicinity of the LTA.

[9] AEE, Section 6.3.6 paragraph 3.
[10] Condtion 8, amended conditions Appendix 2 of Mr Henderson's evidence.
[11] Condtion 11, amended conditions Appendix 2 of Mr Henderson's evidence.

6 Section 42A report

Surface water monitoring sites

6.1 Condition 7. c) of the Recommended Conditions of Consent presented in Appendix 1 of the Section 42A report requires that surface water monitoring sites be established at three locations on the shore of Lake Wakatipu (in addition to the pond, Kingston Creek and unnamed tributary monitoring sites). The three lake sites are the same sites that I monitored in October 2020, i.e. SW9, SW10 and SW11. I recommend that instead of monitoring at these three shore based lake sites, a single mid-lake site be established within Kingston Bay, for both baseline and post-commissioning monitoring.

6.2 A single mid-lake monitoring site within Kingston Bay would provide a better representation of overall lake water quality than the three shore based sites, which may be influenced by local inflows (e.g. from Kingston Creek). A mid-lake monitoring site, including depth-integrated sampling, would also align with the existing ORC monitoring method for Lake Wakatipu. A water quality comparison would therefore be possible between Kingston Bay and the ORC mid-lake site near Jacks Point.

6.3 The mid-lake site should be located a sufficient distance from the shore to allow for full mixing to have occurred between inflows and lake water. The point at which full mixing will have occurred in Kingston Bay is not known. In the absence of this a mid-lake location at least 1km from the Kingston Township shore of Lake Wakatipu is recommended, an approximate location being NZTM E1265394 N4972140.

Surface water level monitoring

6.4 Condition 7. c) of the Recommended Conditions of Consent presented in Appendix 1 of the Section 42A report requires that a water level staff must be surveyed at each site to enable water level measurements during each survey. I do not agree that a water level staff is required at every site.

6.5 Establishing and maintaining an accurate water level staff would be difficult at several of the sites due to the mobile nature of the bed and the effects of high water velocities/waves (e.g. SW8, Figure 8). The water level in Lake Wakatipu is monitored by the ORC/NIWA at Willow Place near Queenstown[12] and this level can be referenced during each survey. Variations in water level in the unnamed tributary and Kingston Creek can be determined by establishing a water level staff at representative sites within each waterbody.

6.6 In Kingston Creek I recommend that a water level staff be installed at the culvert located near SW4. In the unnamed tributary I recommend that a staff be installed at the culvert near SW3 and at the culvert near SW7. These culvert structures will provide stable locations for water level staffs. At SW6 a water

[12] https://www.orc.govt.nz/managing-our-environment/water/water-monitoring-and-alerts/kawarau/lake-wakatipu-at-willow-place

level staff can be installed in a stable location towards the northern end of the pond. These recommendations are included in the amended conditions presented within Appendix 2 of Mr Henderson's evidence (Condition 7. c).

Trigger levels

6.7 Condition 10. a) of the Recommended Conditions of Consent presented in Appendix 1 of the Section 42A report requires preparation of a report that proposes appropriate trigger levels for monitoring of any potential discharge effects. The report is to be prepared within one month of the completion of baseline monitoring.

6.8 To allow sufficient time for sample processing and the interpretation of data required for report preparation I recommend that the time frame for report preparation be increased to within three months of baseline monitoring completion.

6.9 No guidance is provided within Condition 10. a) as to how trigger levels should be determined. To assist with the trigger level identification process I therefore recommend that the process of establishing trigger levels take into account the baseline monitoring data, and relevant Regional Plan Water for Otago Schedule 15 and NPS-FM Appendix 2A limits. I also recommended that the discharge should not result in a reduction in the NPS-FM attribute band baseline for a monitoring site, and the trigger levels be set accordingly to reflect this.

7 Conclusions

7.1 There are no existing surface water connections between the proposed LTA and surface water bodies within the vicinity. The most likely way that surface water quality could be impacted by the input of potential contaminants associated with effluent is therefore via connections between groundwater and surface water. Groundwater quality will be protected by treatment of effluent within the soil profile, the effectiveness of which will increase with increasing distance from the LTA. Most surface water bodies are located at least 40 m away from the LTA boundary, reducing the risk of adverse effects should leaching occur.

7.2 On-going surface and ground water quality monitoring has been proposed, with further mitigation measures to be implemented if monitoring indicates proposed nutrient loading limits are not being met. This will further reduce the risk of adverse effects on aquatic communities within the vicinity of the LTA.

Ruth Johanna Goldsmith

23 December 2021