Hawea Wastewater Treatment Plant

Annual Report 2018 - 2019

Prepared for

Queenstown Lakes District Council

Prepared by

L E
Environmental
Impact

December 2019

Hawea Wastewater Treatment Plant
Annual Report 2018-2019

Queenstown Lakes District Council

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1 BACKGROUND

The Hawea wastewater treatment plant (WWTP) comprising of an oxidation pond started operation in 1988 and treats wastewater originating from the Hawea township and the Timsfield subdivision. It is located adjacent to the true left bank of the Hawea River, approximately 600 metres south of the intersection of Domain Road and Cemetery Road (Figure 1.1). The legal description of the land parcel is Lot 1 DP 20555 and Lot 1 DP 24534. The map reference for the oxidation ponds is NZMS 260 G40: 128-137.

Figure 1.1: Hawea Township Reticulation

An upgrade to the discharge systems was made in 2010 when the overflow to the river was ceased, the trench disposal system enlarged (doubled in size) and a spray irrigation area was installed to reduce the nitrogen load entering groundwater and into the Hawea River. Discharge Permits RM10.308.01 and RM10.308.02 were issued by the Otago Regional Council (ORC) on the 15 November 2010. The consents are due to expire on the 12th November 2022.

Wastewater enters the oxidation pond (Figure 1.2) which is 1.2 m deep and 0.94 ha and maintained in an aerobic state with the use of three mechanical aerators. The volume of the pond is 10,250 m^3 and has a hydraulic retention time of 50 days.

The wastewater is then discharged to land via either a spray irrigation system or a low-pressure disposal trench (Figure 1.2). The disposal trench is 150 metres long and 2 metres wide and is only meant to be used during periods when it is not suitable to use spray irrigation, that is when the soil is saturated, frozen, harvesting is occurring, or during periods of high wind speed. The disposal trench is to be used for a maximum of 4 months in any calendar year.

The land treatment area (LTA) on which treated wastewater is evenly applied by spray irrigation consists of a 2.33 hectares area planted with ryegrass. The LTA is also connected to a weather station that shuts it down in winds over 29.9 km/hr. The spray irrigation comprises of sprinklers on 1 m high risers with medium pressure lateral pipes at 20 m centres. The harvesting equipment drives around the risers during harvesting. The LTA is only used between the hours of 11 pm to 5 am due to the presence of an adjacent cycle/walking track (Figure 1.2).

Figure 1.2: Overview of Wastewater Treatment Plant

Veolia operates and maintains the oxidation ponds as part of the 3-Waters operations and maintenance contract.

2 PURPOSE AND SCOPE OF REPORT

The purpose of this report is to report to the Otago Regional Council (ORC) in accordance with Condition 13 of Resource Consent RM10.308.02 (Table 2.1) and covers the period 1 December 2018 to 30 November 2019.

The scope of the Annual Report comprises of the following:

- Summary of all analytical results for the year;
- Summary of the year's monitoring results and assessment against trigger levels in Resource Consent RM10.308.02, comparison against previous year's results;
- Nitrogen Mass Balance as required by Condition 12;
- Comments on compliance with the conditions of the discharge permits;
- Summary of any malfunctions or breakdowns and the corrective action taken;
- Summary of any complaints received, the validity of each complaint and the corrective action taken; and
- Any other issues considered relevant.

Table 2.1: Discharge Permits

Consent Number	Description	Issue Date	Expiry Date	Reference
RM10.308.01	To discharge contaminants to air for the purpose of discharging treated wastewater.	15 Nov 2010	12 Nov 2022	Appendix A
RM10.308.02	To discharge contaminants to land for the purpose of discharging treated wastewater.	15 Nov 2010	12 Nov 2022	Appendix A

3 MONITORING REQUIREMENTS

An overview of the monitoring requirements for Resource Consent RM10.308.02 is given in Table 3.1. The results of the wastewater quality monitoring for the 2018-2019 sampling period are presented in tabular format in Appendix B and a copy of the laboratory results received from Watercare Laboratories for the 2018-2019 period is presented in Appendix C. The wastewater flow results are presented in Appendix D.

Table 3.1: Wastewater Quality Parameters to be Analysed

Parameter	Frequency	Resource Consent Trigger Level	Consent Conditions	Reporting Requirements
Flow (wastewater)	Daily	775 cubic metres/day	2, 9	Annual
Total Nitrogen	Monthly*	Mean**: 35 mg/L 95th percentile**: 40 mg/L	10, 11	Monthly
Ammoniacal Nitrogen	Monthly*	Mean**: 25 mg/L 95th percentile**: 30 mg/L	10, 11	Monthly
Total Phosphorus	Monthly*	Mean**: 8 mg/L 95th percentile**: 10 mg/L	10, 11	Monthly
BOD_5	Monthly*	N/A	10	Monthly
Total Suspended Solids	Monthly*	N/A	10	Monthly
Escherichia coli	Monthly*	95th percentile**: 250,000 cfu/100 mL	10, 11	Monthly
Nitrogen Loading	Annual	1,223 kg/ha/year	7, 12	Annual

**Last week of each month ** Calculated on a 12 Month Rolling Mean or 95th percentile*

All sampling is carried out by Watercare to the required Standards specified in Condition 11 (Watercare Laboratory Services is IANZ accredited to NZS/ISO/IEC 17025).

4 WASTEWATER FLOWS AND SAMPLING

4.1 Wastewater Flows

The daily wastewater flow rates (m^3/day) from the oxidation pond are tabulated in Table 4.1Figure 4.1 and graphically represented in Figure 4.1. The total wastewater flow for the year is 92,333 m^3, up 5,929 m^3 (or nearly 7%) from the previous period of 86,404 m^3 and up 17,863 m^3 (24% increase) from 74,470 m^3 during the 2016-2017 period.

The wastewater discharge flow rate has a consented maximum volume of 775 cubic metres per day. Discharge volumes greater than this were recorded on 01/06/19, 07/06/19, 23/08/19 and 24/08/19. The elevated volumes recorded in June were due to the ponds reaching critical level and the discharge valve needing to be operated manually. Leading up to these dates, blockages in the discharge pipes resulted in lower discharge volumes than usual, with the pond then reaching critical level. The discharge valve was operated manually on the two dates to reduce the level and protect the integrity of the pond. The elevated volumes recorded in August were due to a high-level alarm and the valve on the pipe to the trench not being closed fully after being opened manually.

The annual average was 253 m^3/day for the 2018-2019 monitoring period.

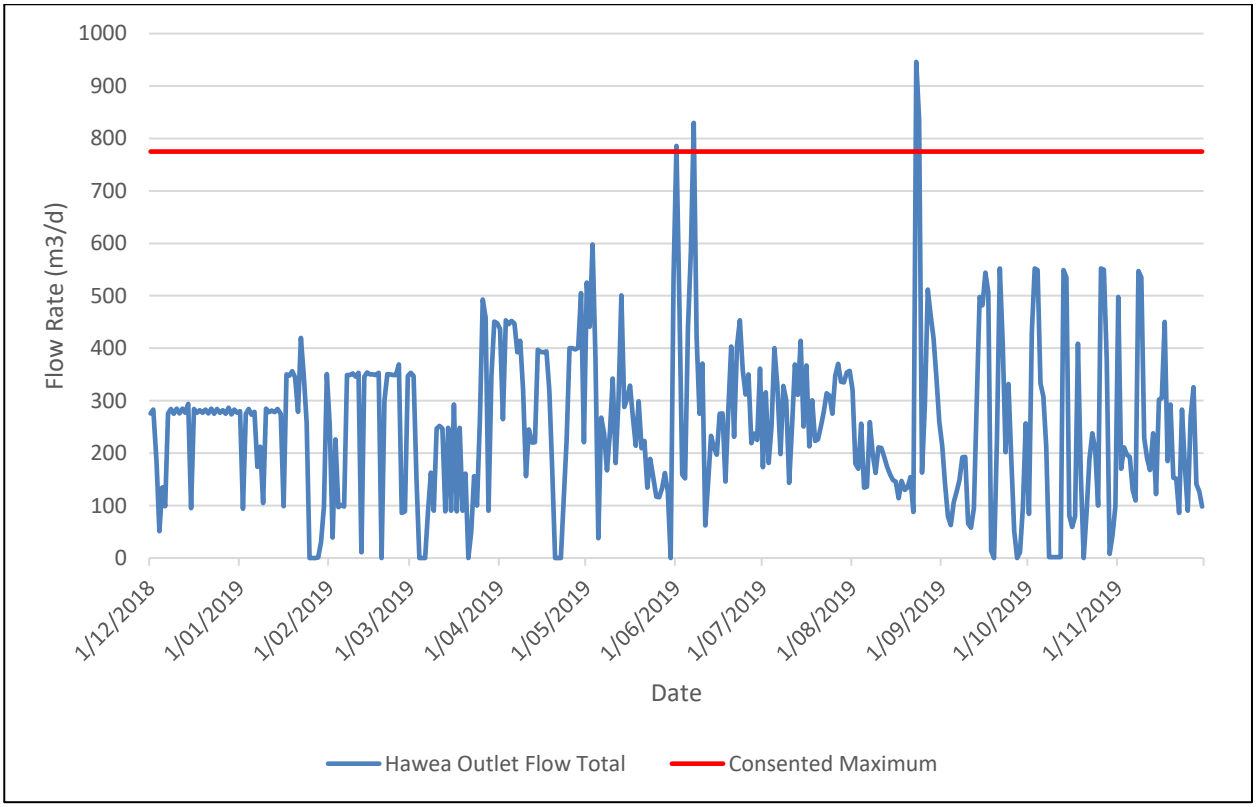


Figure 4.1: Wastewater Flows from Outlet Pipe 2018-2019

Table 4.1: Wastewater Flows 2018-2019

Date	Hawea WWTP Trench Discharge Flow (m^3)	Hawea WWTP Irrigation LTA (m^3)	Irrigation (mm) *	Hawea Outlet Flow Total (m^3)
December	101	7,752	332.7	7,853
January	299	6,641	285.0	6,940
February	483	6,785	291.2	7,268
March	669	5,432	233.1	6,101
April	354	8,841	379.4	9,195
May	6,206	1,821	78.2	8,027
June	9,890	0	0.0	9,890
July	9,075	0	0.0	9,075
August	8,062	0	0.0	8,062
September	2,080	4,070	174.7	6,150
October	771	6,029	258.8	6,800
November	4,429	2,543	109.1	6,972
Total	**42,419**	**49,914**	**2,142.2**	**92,333**

* Is the irrigation depth over the 2.33 ha LTA.

The treated wastewater has been evenly split between the disposal trench and the spray irrigation system. The number of days (>10 m^3) discharging to spray irrigation has been 176 and to the disposal trench was 186 (note that both the trench and irrigation can be used the same day with a total daily discharge limit of 775 m^3). This is compared to the 2017-2018 period when the spray irrigation was only used for 115 days and the disposal trench was used 268 days.

However, the activity is still non-compliant as the disposal trench has been used for more than four months in the calendar year. QLDC are aware of this issue and are working with the contractors (Veolia) to remedy this. Veolia have commented that they are limiting the use of spray irrigation when the wind is =/> 10 km/hour or if rainfall is >15 mm/day. The 10 km/hr limit is lower than what is required by the consent at 29.9 km/hr. QLDC are working with Veolia to determine if spray drift is occurring at winds over 10 km/hr or if it should be used up to 29.9 km/hr consent limit and therefore require less discharge to disposal trench.

4.2 Wastewater Sampling

Treated wastewater from the outlet of the pond is sampled on a monthly basis. A representative sample is collected and analysed for a total of six parameters (total ammoniacal nitrogen, total phosphorus, total nitrogen, total suspended solids, BOD_5 and *E. coli*) as per Resource Consent RM10.308.02. Those parameters that have consent limits in Resource Consent RM10.308.02 are presented in tabular (refer to Table 4.2) and graphical (Figure 4.2 and Figure 4.7) format.

Table 4.2: Summary of Wastewater Monitoring Results for 2018-2019

Parameter	Consent Limit (calculated on a 12-month rolling period)	Rolling 95th Percentile mg/L	Annual Mean mg/L	Max mg/L	Min mg/L
BOD_5	-	-	29	48	8.1
Total Suspended Solids	-	-	99	280	35
Total Nitrogen	Mean: 35 mg/L 95th percentile: 40 mg/L	**89**	**55**	110	22
Total Phosphorus	Mean: 8 mg/L 95th percentile: 10 mg/L	10	8	11	6.1
Ammoniacal Nitrogen	Mean: 25 mg/L 95th percentile: 30 mg/L	**46**	**35**	50	4
E. coli	95th percentile: 250,000 cfu/100 mL	168,500	57,308	240,000	3,000

The rolling 12 month 95th percentile for *E. coli* remained well within the consent limit of 250,000 CFU/100 ml during the 2018-2019 monitoring period (refer to Figure 4.2). The maximum concentration of *E. coli* over the year was 240,000 cfu/100 mL with a count reduction to 20,000 cfu/100 mL the following month. The annual mean of 57,308 cfu/100 mL was noted to be higher than the 2017-2018 count of 38,175 cfu/100 mL.

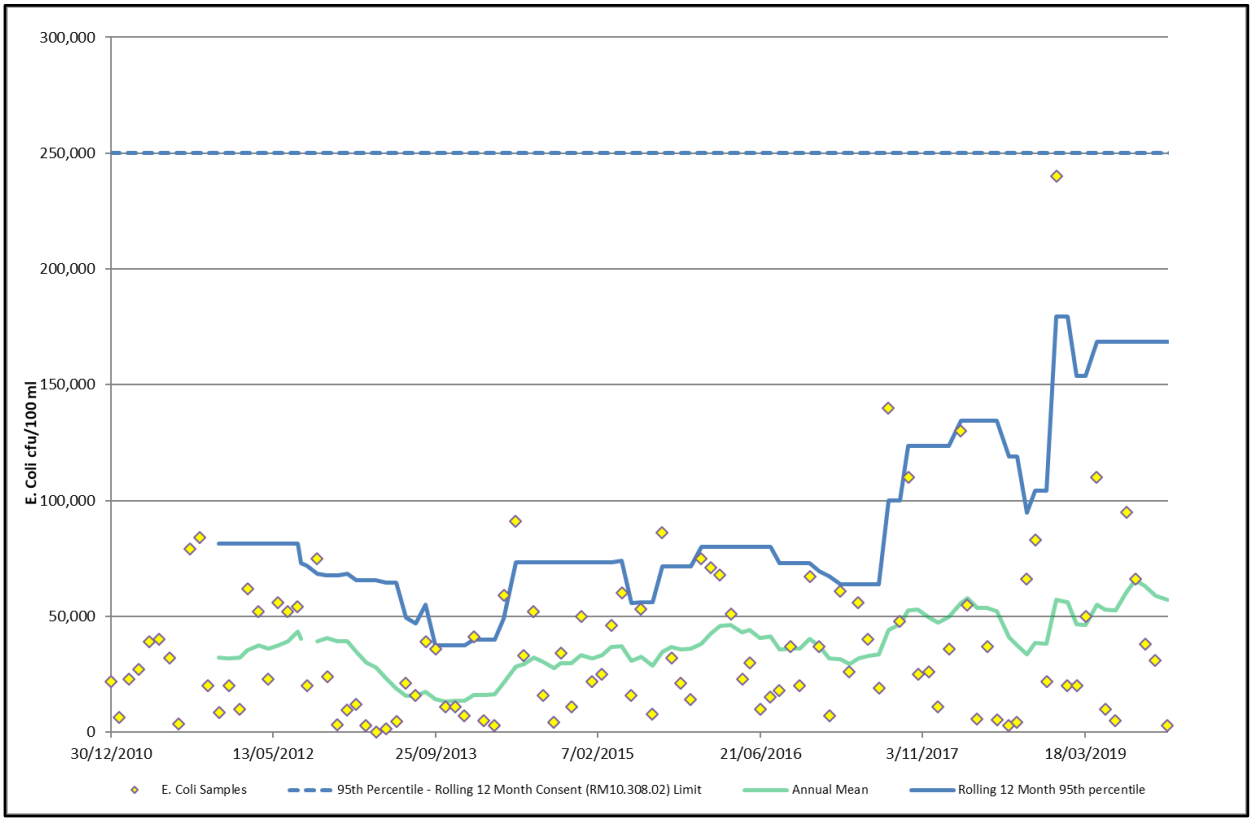


Figure 4.2: *E. coli* in Wastewater

The rolling 12 month 95th percentile of 46 mg/L and the annual mean of 35 mg/L for total ammoniacal nitrogen exceeded the consent limit (30 mg/L and 25 mg/L respectively) in the 2018-2019 monitoring period (refer to Figure 4.3). The 95th percentile has exceeded the consented limit since 2011-2012 monitoring period (8 calendar years). The annual mean was 11 mg/L higher

than the 2017-2018 monitoring period. Measures to address this have been outlined in the sections below.

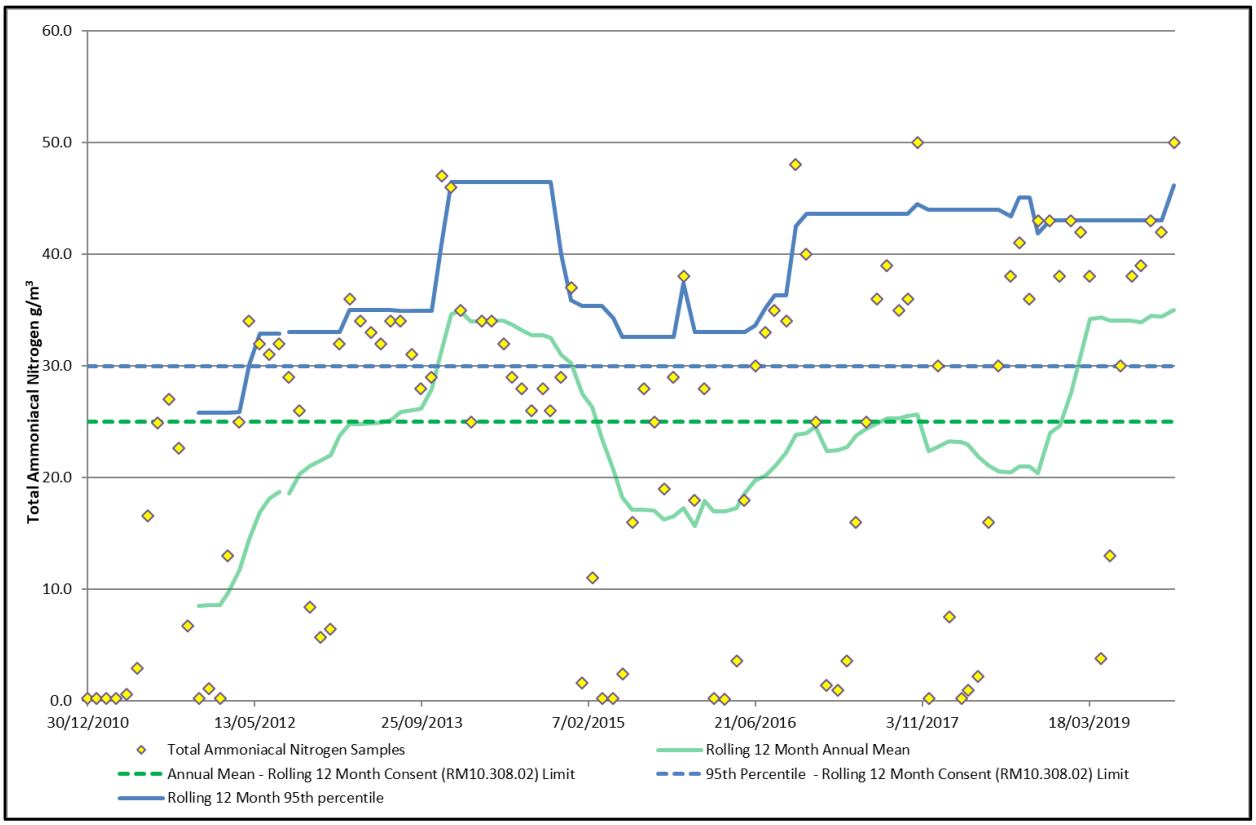


Figure 4.3: Ammoniacal Nitrogen in Wastewater

The rolling 12 month 95th percentile of 89 mg/L and the annual mean of 55 mg/L for total nitrogen exceeded the consent limit (40 mg/L and 35 mg/L respectively) in the 2018-2019 monitoring period (refer to Figure 4.4). The maximum concentration of total nitrogen over the year was 110 mg/L. The annual 95th percentile and annual mean have also been exceeded the consent limits in 2015-2016, 2016-2017 and 2017-2018. Measures to address this have been outlined in the sections below.

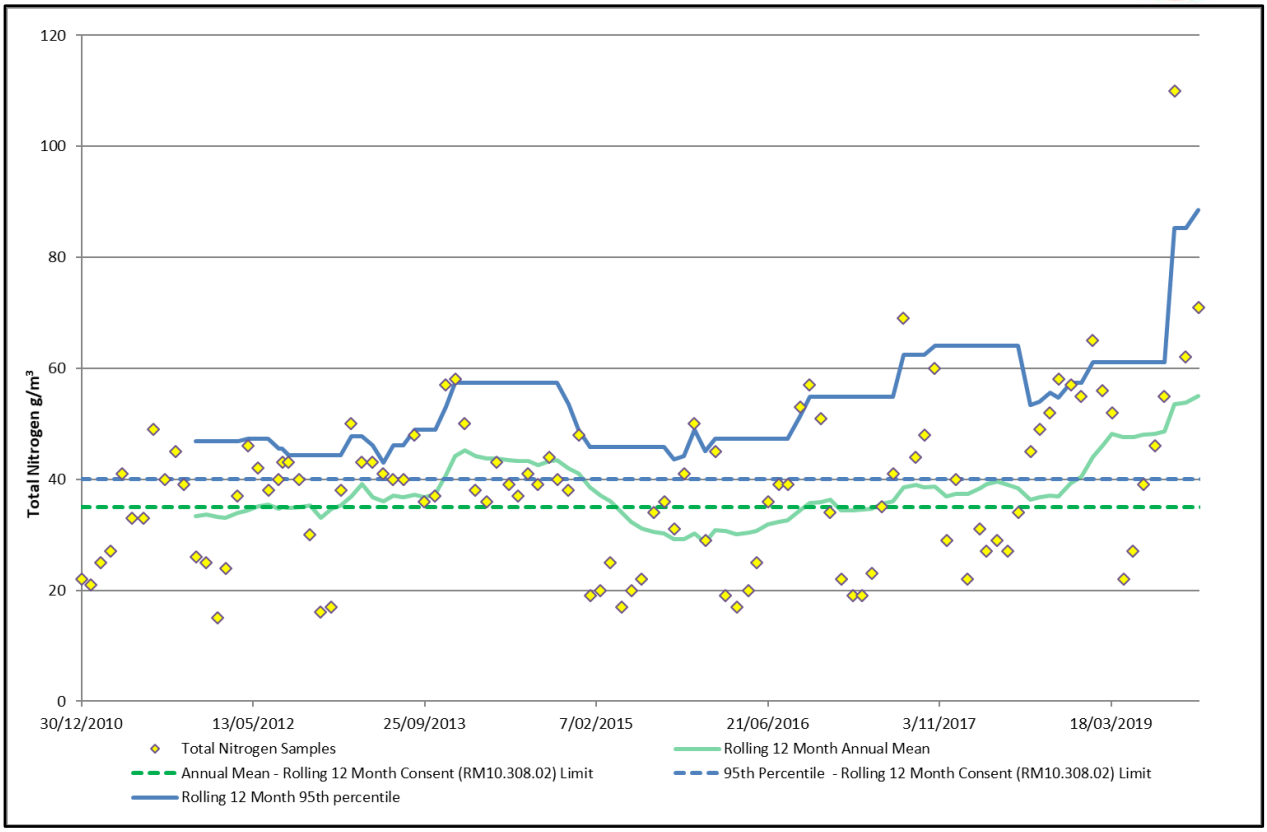


Figure 4.4: Total Nitrogen in Wastewater

Total suspended solids, total phosphorus and BOD_5 are consistent with the results in previous years (refer to Figure 4.5 to Figure 4.7). Total phosphorus remained compliant with the rolling 95th percentile and the annual mean. There are no consent limits for total suspended solids and BOD_5.

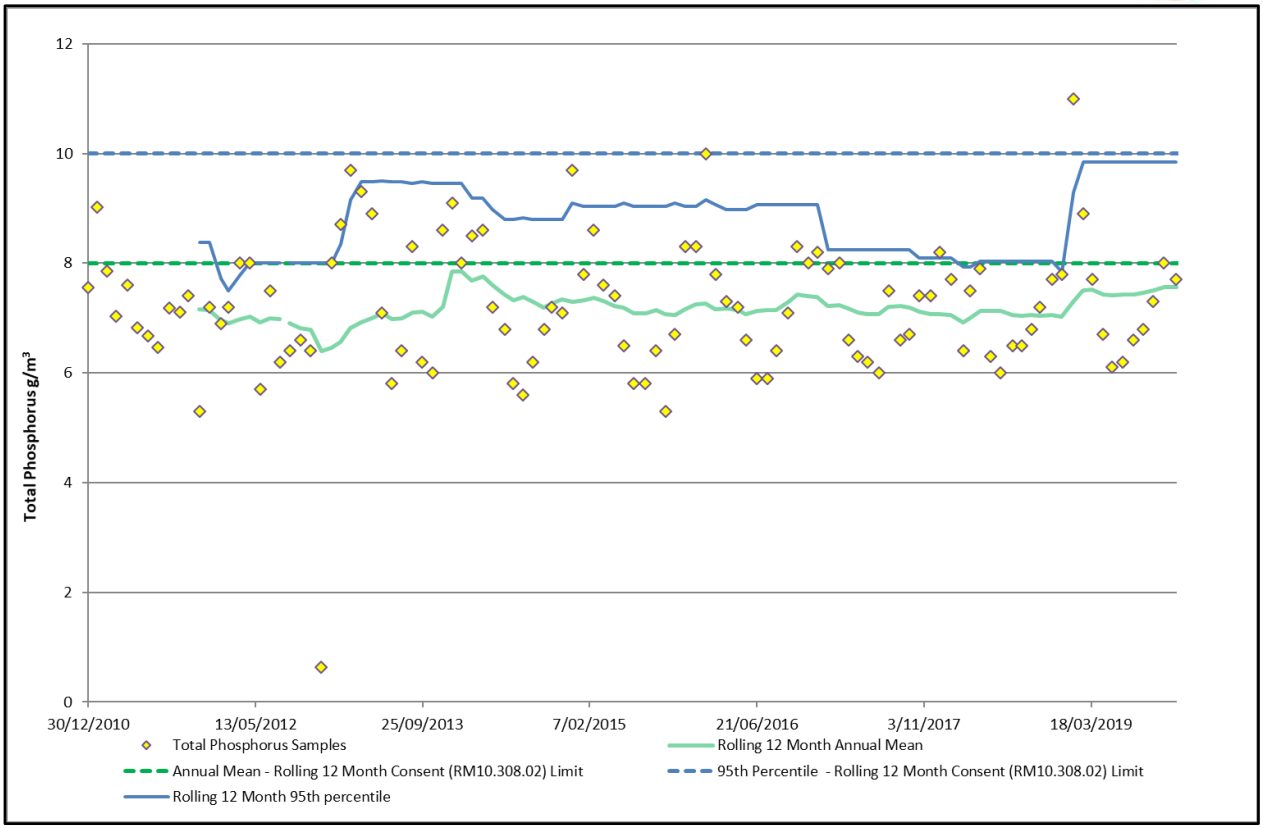


Figure 4.5: Total Phosphorus in Wastewater

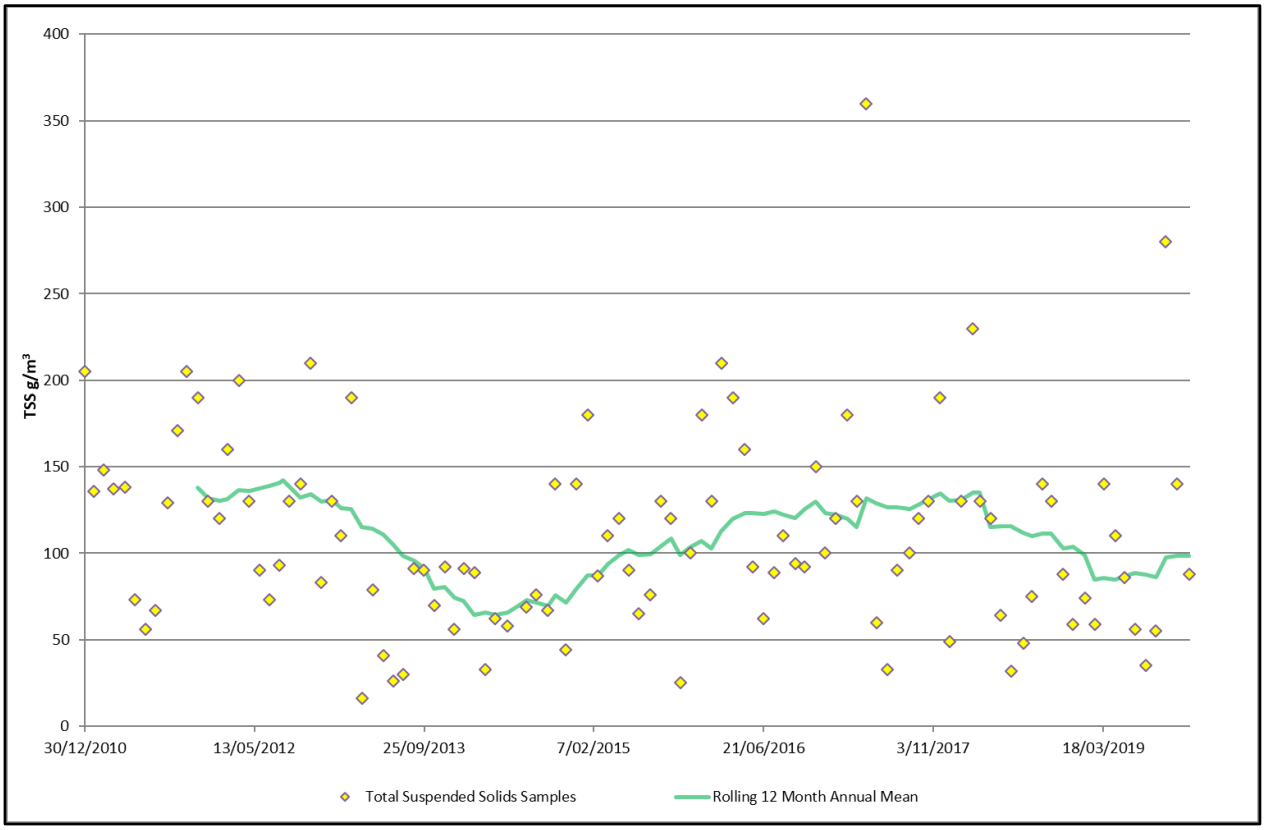


Figure 4.6: Total Suspended Solids in Wastewater

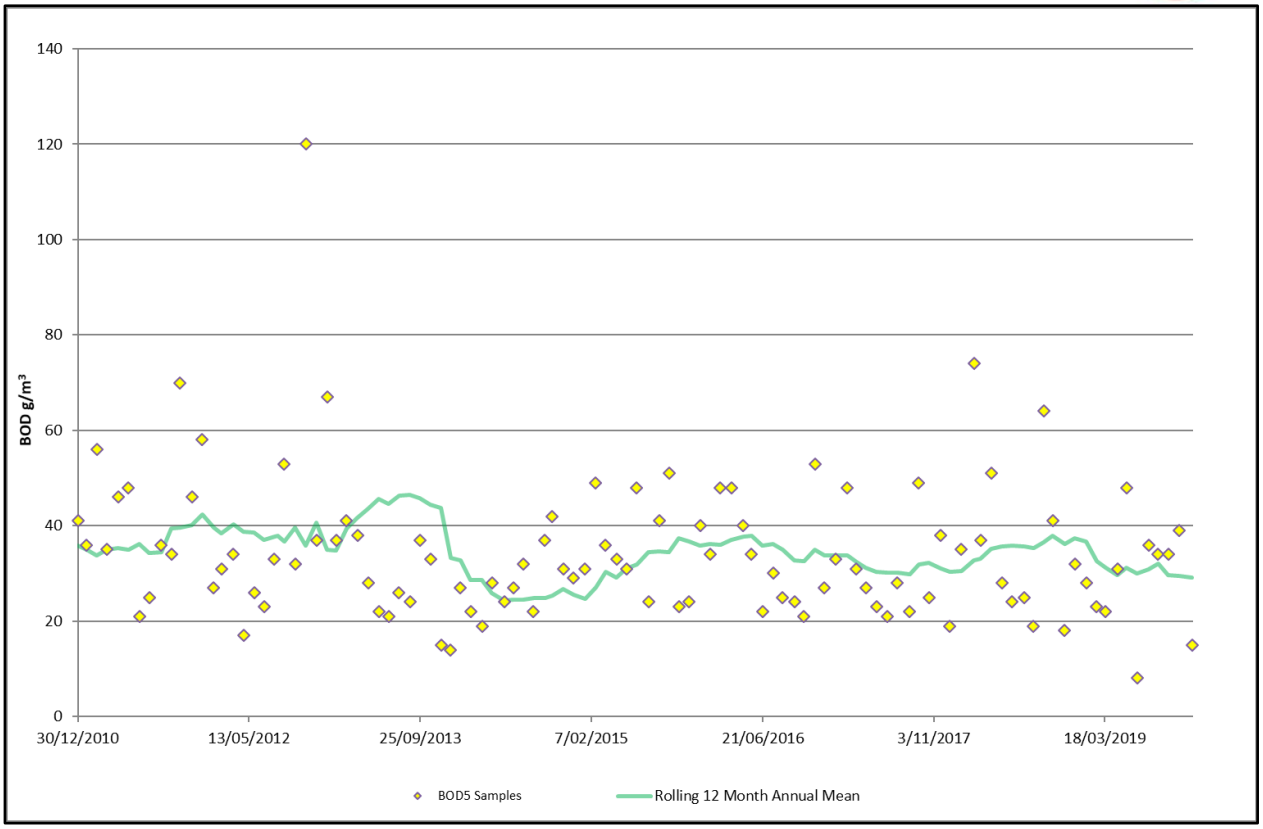


Figure 4.7: BOD_5 in Wastewater

5 NITROGEN MASS BALANCE

Treated wastewater is evenly applied by spray irrigation over 2.33 hectares area planted with ryegrass. The land management regime is cut and carry with no stock grazing.

Condition 12 of Resource Consent RM10.308.02 requires that a nitrogen mass balance for the spray irrigation land application area is prepared annually. This is to include the following:

- *The nitrogen mass balance shall consist as a minimum the total nitrogen applied to land and crop removal of nitrogen.*
- *The total nitrogen applied to the spray irrigation land shall be estimated from the total volume of wastewater applied and the average monthly concentration of total nitrogen in the land applied wastewater.*
- *The crop removal of nitrogen from the spray irrigation land shall be estimated by obtaining dry matter content and total nitrogen content after each crop/plant harvest.*
- *The nitrogen mass balance from condition 12(a) and any other factors such as ammonia volatilisation and denitrification shall be used to calculate the mass of nitrogen leached from the site, using a model acceptable to the consent authority.*

5.1 Mean Wastewater Nitrogen Concentration

The influent loads, operation and performance of the oxidation pond affect the concentration of Total Nitrogen (TN) in the effluent. The input into the nitrogen balance model is based on the average (mean) of the water quality analysis results sampled from the outlet of the oxidation pond prior to application to land for the period under consideration. The values used in the model (Appendix E) are the concentrations measured each month at the outlet of the oxidation pond during the 12-month data analysis period (Appendix B). Quantities of nitrogen applied by spray irrigation to the LTA and discharged to the trench are presented in Table 5.1 below.

Table 5.1: Nitrogen Discharged to Trench and Applied on LTA between December 2018 - November 2019

Date	Nitrogen Concentration at Outlet (mg/L)	Monthly Nitrogen Applied by Spray Irrigation (kg/ha)	Total Nitrogen Applied by Spray Irrigation (kg)	Total Nitrogen Discharged to Trench (kg)
December	55.0	183.0	426.4	5.6
January	65.0	185.3	431.7	19.4
February	56.0	163.1	380.0	27.0
March	52.0	121.2	282.5	34.8
April	22.0	83.5	194.5	7.8
May	27.0	21.1	49.2	167.6
June	39.0	0.0	0.0	385.7
July	46.0	1.2	2.7	417.5
August	55.0	0.0	0.0	443.4
September	110.0	192.1	447.7	228.8
October	62.0	160.4	373.8	47.8
November	71.0	77.5	180.6	315.5
Total	**55.0 (mean)**	**1,188**	**2,769**	**2,100**

Monthly wastewater samples for the reporting period show significant variation in the percentage of Ammoniacal Nitrogen/Total Nitrogen with values ranging from less than 17% (April) to 83% (July). Table 5.2 compares the mean percentage of Ammoniacal Nitrogen/Total Nitrogen over the last three reporting periods. The 2018-2019 reporting period was 63% up slightly at 55% from the 2017-2018 period and the 2016-2017 period. Although ammonia is toxic to aquatic life at certain pH and temperatures, it is not important to remove it for discharges to land and it is actually more beneficial from a nitrogen leaching perspective as ammonia is less mobile in the soil than nitrate.

The percentage of Ammoniacal Nitrogen in the pond system with a theoretical retention time of 50 days, remains high compared to typical municipal treated wastewater values and is likely a result of the temperature being too cold for nitrification to occur in the winter months. However, it could also be a lack of alkalinity as suggested in the ERPRO Report from the 20th September 2019 and earlier LEI Nitrogen Balance Reports.

Table 5.2: Comparison of the Percentage of Ammoniacal Nitrogen in Total Nitrogen Between 2015 and 2019

	2016-2017	2017-2018	2018-2019
December	73.5%	75.0%	69.1%
January	6.4%	34.1%	66.2%
February	5.3%	0.6%	75.0%
March	18.9%	3.5%	73.1%
April	69.6%	7.6%	17.3%
May	71.4%	59.3%	48.1%
June	87.8%	88.2%	76.9%
July	56.5%	84.4%	82.6%
August	79.5%	83.7%	70.9%
September	75.0%	69.2%	39.1%
October	83.3%	74.1%	67.7%
November	1.4%	75.4%	70.4%
Mean Percentage	**52.4**%	**54.6**%	**63.0%**

5.2 Nitrogen Losses

Nitrogen loss to the ground is based on a Loss Factor (LF) and exported nitrogen. LF takes three parameters into consideration: denitrification, soil storage and ammonia volatilisation.

The ammonia volatilisation percentage of 15% for spray irrigation has been used. This is seen as the mid-range of what would be expected.

Denitrification has been taken as 10% of the applied nitrogen. This is based on the Peer Reviewed Jacks Point model and is considered conservative as the whole soil profile is available here for denitrification and irrigation only occurs in the warmer months, whereas at Jacks Point, the effluent was discharged 200 mm below ground and was also applied all year round.

The total Loss Factor is calculated to be 19.5% in the model which represents an increase of 1.3% compared to the previous period from 18.2%.

5.3 LTA Nitrogen Loading (kg/ha)

This is determined based on the combination of effluent flow, nitrogen concentration in the effluent, effluent irrigated and LTA area.

5.4 Pasture Nitrogen Uptake and Cut & Carry Removal

The amount of nitrogen uptake and the cut & carry removal is calculated as a proportion of the dry matter production, based on a percentage of utilisation. The new sowed ryegrass is cut, baled and weighed. The Dry Matter (DM) nitrogen content is then calculated and entered in the Nitrogen Mass Balance.

Three cuts were taken offsite during the reporting period: February 2019, May 2019 and November 2019 and are shown in Table 5.3.

Table 5.3: Nitrogen Removed by Cut and Carry

Date of Cut	Ryegrass Harvested (kg)	% Dry Matter	Nitrogen Concentration (%)	Nitrogen Removed with the Crop (kg N)	Nitrogen Removed per Hectare (kg N/ha)
Feb-19	22,750	40%	2.3%	209.3	89.8
2-May-19	11,700*	63%	1.6%	121.1	52.0
4-Nov-19	32,500	24%	3.0%	235.1	100.9
Total	**66,950**			**565.5**	**243**

* No data was given on the weight and number of bales exported

5.5 Leached Nitrogen (kg/ha) from Spray Irrigation Area

The overall nitrogen balance for the site is shown in Table 5.4. Other factors have been modelled, such as ammonia volatilisation, denitrification and soil storage. The negative leaching loss from the mass balance reflects the close match between nitrogen added and nitrogen exported in the baleage.

Table 5.4: Overall Nitrogen Balance for LTA

Year	Nitrogen Applied (kg N/ha/yr)	Nitrogen Losses (kg N/ha/yr)	Nitrogen Exported in Plants (kg N/ha/yr)	Nitrogen Leached (kg N/ha/yr)
2015-2016	229	42	194	0 (-7)
2016-2017	223	40	79	104
2017-2018	358	65	158	134
2018-2019	1,188	231	243	714

The nitrogen loading rate to the LTA has significantly increased from previous years due to the increase in flow to the site (up 7% from 2017-2018 and 24% from 2016-2017) and increase in the concentration of nitrogen in the wastewater (up 41% from 2017-2018 and 48% from 2016-2017).

5.6 Overall Annual Nitrogen Mass Balance for the Hawea WWTP

The annual nitrogen mass balance for the Hawea LTA is calculated by multiplying the per hectare results ('N loading', 'Cut and Carry removal', and 'Nitrogen losses') by the area of the LTA (2.33 ha). This gives the 'Total N leached' in units of kg N/yr. The results of the annual nitrogen balance are shown in Table 5.5. Three cuts were taken offsite during the reporting period, in February 2019, May 2019 and November 2019.

Table 5.5: Nitrogen Balance (kg N/yr)

Year	Land use	Nitrogen Applied (kg N/yr)	Nitrogen Losses (kg N/yr)	Nitrogen Exported in Plants (kg N/yr)	Nitrogen Leached (kg N/yr)
2016-2017	LTA	519	93	184	245
	Trench	1,652	0	0	1,652
	Total	**2,171**	**93**	**184**	**1,857**
2017-2018	LTA	834	152	369	313
	Trench	2,580	0	0	2,580
	Total	**3,414**	**152**	**369**	**2,893**
2018-2019	LTA	2,769	538	566	1,924
	Trench	2,100	0	0	2,100
	Total	**4,869**	**538**	**566**	**3,765**

Nitrogen leaching has increased by 30% to 3,765 kg N/yr from the 2017-2018 reporting period (2,893 kg N/yr) and 102% from the 2016-2017 reporting period (1,857 kg N/yr).

The improvement in the operation of the spray irrigation has resulted in a 103% increase in the removal of nitrogen (nitrogen exported and gaseous losses) to 1,104 kg from 521 kg in 2017-2018, that would have otherwise leached through the trench.

During the 2018-2019 reporting period, three cuts of baleage were with an estimated 566 kg N removed from the LTA through the cut and carry of the ryegrass which has increased by 53% from 2017-2018 (360 kg N) and 207% from 2016-2017 (184 kg N).

However, it wasn't enough to balance the increase flow into the plant as well as the increased concentration of nitrogen in the wastewater.

6 RESOURCE CONSENT REQUIREMENTS AND COMPLIANCE

6.1 Consent Compliance for 1 December 2018 to 30th November 2019

Compliance with Resource Consents RM10.308.01 and RM10.308.02 is displayed in Table 6.1 and Table 6.2 by condition.

Veolia is the 3-waters (water, wastewater and stormwater) operators and maintenance contractor for QLDC. In the 1 December 2018 to 30 November 2019 period there were only minor system faults that occurred and were rectified, but no major breakdowns, as shown in Appendix F. Veolia manages programmed maintenance and work orders/ requests for service for breakdowns.

As detailed in Section 4.1 of the report, elevated volumes were recorded in June were due to the ponds reaching critical level and the discharge valve needing to be operated manually. Leading up to these dates, blockages in the discharge pipes resulted in lower discharge volumes than usual, with the pond then reaching critical level. The discharge valve was operated manually on the two dates to reduce the level and protect the integrity of the pond.

There have been some improvements to the use of spray irrigation over the disposal trench when compared to previous years. Over the winter months when spray irrigation can't be used during to freezing conditions, previously it was November in 2018 and October 2017 before they would start using spray irrigation, but this year spray irrigation was started up again in mid-September. However, the disposal trench is still being used too frequently outside of these winter months. QLDC are aware of this issue and are working with the contractors (Veolia) to remedy this. Veolia have commented that they are limiting the use of spray irrigation when the wind is =/> 10 km/hour or if rainfall is >15 mm/day. The 10 km/hour limit is lower than what is required by the consent at 29.9 km/hour. QLDC are working with Veolia to determine if spray drift is occurring at winds over 10 km/hour or if it should be used up to 29.9 km/hour consent limit and less discharge to disposal trench.

As stated in previous reports, it has been determined that the plant is not suitable for the current resource consent conditions. There is no design basis for the oxidation pond to remove nutrients reliably. This calendar year QLDC engaged ERPRO to review the operation of the pond and make recommendations in regard to how the plant could be brought back into compliance. The report is attached as Appendix H for reference. Subsequently QLDC have been assessing the practicalities of implementing the options proposed. They have discounted the option to dose with lime due to difficulties with configuring mixing system, and also the external biotreatment option as a result of the associated costs. As such the preferred option is to dose the ponds with Zeolite to reduce Ammonia levels. QLDC are currently establishing the method to dose the product into the pond and their target completion date is the end of January 2020. This will be a short-term solution to improve nitrogen levels, until the wastewater can be diverted to the Wanaka WWTP around May 2022.

In the meantime, QLDC are also sampling the Hawea River upstream and downstream to determine what the potential effects are of the high Total Nitrogen and Ammoniacal Nitrogen discharge into the downstream environment. They will continue to monitor once the Zeolite has been added into the ponds in January 2020.

Table 6.1: Discharge to Air Permit RM.10.308.01 Conditions

Condition	Clause Condition	Comments	Compliance
1	This consent shall only be exercised in conjunction with Discharge Permit RM10.308.02.		**Achieved**
2	The discharge to air shall be as described in the consent application submitted to the Consent Authority on 31 August 2010 and any subsequent information provided.		**Achieved**
3	Wind cloth shall be installed on the western, southern and eastern-most boundaries of the area on which treated wastewater is to be applied by spray irrigation. This wind cloth shall be maintained until the screen foliage required under condition 4 is fully established.	The wind cloth was installed prior to 1 December 2012 and is still in place.	**Achieved**
4	Suitable screening foliage, that shall be at least 3 metres high but not exceed 6 metres in height, shall be planted on the western, southern and eastern-most boundaries of the area on which treated wastewater is applied by spray irrigation.	to the screen foliage was planted prior 1 December 2012 and is currently 3 metres in height.	**Achieved**
5	A weather station shall be installed in an appropriate location to record, as a minimum, rainfall and wind conditions at the site where treated wastewater is to be applied by spray irrigation.	The weather station was installed in August 2011 and is in good working order.	**Achieved**
6	The spray irrigation system shall not be operated in conditions where wind speed, as measured at the on-site station installed under condition 5, exceeds 29.9 km/hour.	Control system installed to meet this condition.	**Achieved**
7	The consent holder shall keep a record of any complaints received regarding discharges of odour from the site. The record shall, as a minimum, include the following: (a) the time and place at which the complaint was generated; (b) the nature of the complaint; (c) operating conditions at the time of the complaint, including any malfunctioning or breakdown of control equipment; (d) wind and weather conditions at the time of the complaint; and (e) corrective action taken by the consent holder to minimise the risk and extent of the recurrence of the causes of the complaint. The consent holder shall submit a copy of the written record of the complaint to the consent authority within two weeks after any complaint occurring, together with the details of the corrective actions taken.	No odour complaints recorded for the 2018-2019 year.	**Achieved**
8	There shall be no discharge of odour, as a result of the exercise of this consent, that is noxious, dangerous, offensive or objectionable to the extent that it causes an adverse effect beyond the boundary of the site, in the opinion of an authorised officer of the Consent Authority.	No odour complaints recorded for the 2018-2019 year.	**Achieved**

Table 6.2: Discharge to Land Permit RM10.308.02 Conditions

Condition	Clause Condition	Comments	Compliance
1	The discharge shall only be treated wastewater, as described in the consent application submitted to the Consent Authority on 31 August 2010 and any subsequent information provided.		**Achieved**
2	The volume of effluent discharged shall not exceed 775 cubic metres per day.	Refer to Appendix D. Generally compliant, with two days in June 2019 and two days in August 2019 recorded at elevated volumes.	**Non-compliant**
3	The distance the site boundary from any part of the wastewater treatment and disposal system shall no less than 5 metres.	Compliant.	**Achieved**
4	By no later than 1 December 2012, the consent holder shall ensure that the trench utilised for wastewater disposal: a) is at least 150 metres long and 2 m wide in total; and b) is intermittently dosed; and c) is not used for the disposal of wastewater for more than 4 months in total in any one calendar year.	The trench has been used for more than 4 months per calendar year.	**Non-compliant**
5	By no later than 1 December 2012, the consent holder shall install and commission a spray irrigation system for the land application of treated wastewater. The spray irrigation system shall meet the following criteria: (a) the total area on which treated wastewater is applied by spray irrigation shall be no less than 2.33 hectares; (b) treated wastewater shall be applied evenly by spray irrigation to the area defined in appendix I only; (c) the area on which treated wastewater is applied by spray irrigation shall be fenced with a 2 metre high deer fence with appropriate signage warning the general public of the hazard; (d) a weather station shall be installed in an appropriate location to record, as a minimum, rainfall and wind conditions at the site where treated wastewater is to be applied by spray irrigation; (e) wastewater shall not be applied to land by spray irrigation system during the hours outside of 11 pm to 5 am; (f) nozzle pressure must not exceed 400 kilopascals (kPa); (g) there shall be no irrigation of treated wastewater using k-line irrigation systems.	The spray irrigation continues to operate within these criteria. (a) and (b) Spray irrigation is applied to 2.33 hectares in the area shown on the plan; (c) The deer fencing is in place and still intact; (d) The weather station is in good working order; it records as a minimum rainfall and windspeed; (e) Wastewater is not applied during these hours; (f) The nozzle pressure is alarmed so that it does not exceed 400 kPa; (g) There is no k-line used for irrigating.	**Achieved**

Condition	Clause Condition	Comments	Compliance
6	The area on which treated wastewater is to be applied using spray irrigation shall be planted in high growth and nitrogen uptake vegetation (such as lucerne or ryegrass) and shall be managed as far as practicably possible to optimise nutrient removal. A minimum of three harvests per year shall be undertaken.	Harvests were undertaken in February, May and November 2019.	**Achieved**
7	The total nitrogen applied to the spray irrigation area shall not exceed 1,223 kilograms of nitrogen per hectare per year.	The total nitrogen applied to the spray irrigation area was 1,188 kg/ha for the 2018-2019 year. The nitrogen mass balance is provided in Section 5.	**Achieved**
8	The treatment and disposal system shall be constructed and installed in accordance with the details and plans supplied with the consent application submitted to the consent authority on 31 August 2010, and attached to this consent as appendix I.	Spray irrigation system installed 5 December 2012.	**Achieved**
9	The consent holder shall install a flow meter on the outlet pipe from the treatment system and continually measure and record the daily volume (based on a no more than weekly average) of effluent being discharged to the disposal field. The consent holder shall forward the record for the previous 12-month period to the consent authority by 1 December each year, and upon request.	The recorded daily volume is provided in Appendix D.	**Achieved**

<table>
<tr><th>Condition</th><th>Clause Condition</th><th>Comments</th><th>Compliance</th></tr>
<tr><td>10</td><td>(a) from the first exercise of this consent, the consent holder shall collect representative samples of the treated wastewater from the outlet of the oxidation pond in the last week of each month. The samples shall be analysed for: (i) Five-day total biochemical oxygen demand (BOD_5); and (ii) Total Suspended Solids; and(iii) Total Nitrogen; and (iv) Total Ammoniacal Nitrogen; and (v) Total Phosphorous; and (vi) Escherichia coli
(b) from the first exercise of this consent, wastewater discharged from the oxidation pond shall comply with the following criteria:
<table>
<tr><td></td><td>Mean*</td><td>95th percentile (mg/l) *</td></tr>
<tr><td>Ammoniacal nitrogen</td><td>25 (mg/l)</td><td>30 (mg/l)</td></tr>
<tr><td>Total nitrogen</td><td>35 (mg/l)</td><td>40 (mg/l)</td></tr>
<tr><td>Total phosphorous</td><td>8 (mg/l)</td><td>10 (mg/l)</td></tr>
<tr><td>Escherichia coli</td><td>-</td><td>2.5 x 10^5 cfu/100 ml</td></tr>
</table>
*the mean and 95th percentile apply to a rolling 12-month period.

(c) the analytical sample results from the sampling under condition 9(a) of this consent shall be submitted to the consent authority by 1 December each year and upon request.</td><td>Samples have been collected every month.

Section 4 above summarises the results for each of the determinants. Refer to Appendices B and C for full results.

Elevated results have been recorded for the annual mean and 95th percentile for both total nitrogen and ammoniacal nitrogen.</td><td>Non-compliant</td></tr>
<tr><td>11</td><td>All sampling techniques shall be acceptable to the consent authority. All analysis carried out in connection with this consent shall be performed by a laboratory that meets ISO 17025 standards, or otherwise as specifically approved by the consent authority.</td><td>Sampling and lab analysis performed monthly by Watercare Laboratories to meet the required standards.</td><td>Achieved</td></tr>
</table>

Condition	Clause Condition	Comments	Compliance
12	The following information shall be provided in writing to the consent authority by 1 December each year, and upon request, following the commencement of the exercise of the consent: (a) The nitrogen mass balance for the spray irrigation land application area, which shall be determined annually. The nitrogen mass balance shall consist as a minimum the total nitrogen applied to land and crop removal of nitrogen. (b) The total nitrogen applied to the spray irrigation land shall be estimated from the total volume of effluent applied and the average of monthly concentration of total nitrogen in the land applied effluent. (c) The crop removal of nitrogen from the spray irrigation land shall be estimated by obtaining dry matter content and total nitrogen content after each crop/plant harvest. (d) The nitrogen mass balance from condition 12(a) and any other factors such as ammonia volatilisation and denitrification shall be used to calculate the mass of nitrogen leached from the site, using a model acceptable to the consent authority	The nitrogen mass balance is presented in Section 5 and covers requirements outlined in the consent condition.	**Achieved**
13	The consent holder shall forward an annual report in writing to the consent authority by 1 December each year. The annual report shall cover the preceding 12-month period (from 1 December the preceding year until 30 November of the current year) and shall report on compliance with this consent. As a minimum, the report shall include: (a) A summary of all analytical results for the year; and (b) A summary of the year's monitoring results, in context of previous years' results; and (c) Comments on compliance with the conditions of this discharge permit; and (d) A summary of any complaints received, the validity of each complaint and the corrective action taken; and (e) A summary of any malfunctions of breakdowns and the corrective action taken; and (f) Details of the cut and carry operation, including the calculations for nitrogen loading in the spray irrigation land, number of harvests, dry matter and total nitrogen content of the harvest and nitrogen balance for this site. (g) Any other issues considered relevant by the consent holder.	Annual Report submitted for the period 1 December 2018 – 30 November 2019 in December 2019. Please note that the wording of this condition requires an annual report to be submitted only one day following the end of the monitoring period. This is impractical because if sampling is undertaken in the last week of the month as required by the condition 10a, the results wouldn't be available for reporting before the end of November. Furthermore, the report incorporates the flow results right up to the end of November.	**Achieved**

Condition	Clause Condition	Comments	Compliance
14	By no later than 1 December 2012, the consent holder shall prepare and forward to the consent authority an operations and management manual for the wastewater treatment and disposal system to ensure its effective and efficient operation at all times. The system shall be operated in accordance with this manual, which shall be updated as appropriate. The manual and include, as a minimum: (a) A brief description of the treatment and disposal system, including a site map indicating the location of the treatment and disposal system, points of discharge and any monitoring sites; (b) Key operational matters, including weekly, monthly and annual maintenance checks; (c) Monitoring requirements and procedures including a nitrogen balance sheet for the purpose of managing nitrogen inputs and outputs including nitrogen leaching losses; (d) A management plan for the cut and carry operation including procedures for harvesting grass from the site, and maximising grass growth and nitrogen uptake by grass such as soil tests, supplementary nutrient additions and pest and weed control; (e) Management and dosing of trenches (f) Contingency plans in the event of system malfunctions or breakdowns; and (g) The means of receiving and dealing with any complaints; and (h) Emergency contact phone numbers.	The first Operation and Maintenance manual was sent to the ORC on the 7 May 2008, with revisions/updates on the 8th August 2008, April 2010, and 6th December 2017. The have been no further updates to the O&M. Maintenance has been undertaken in accordance with the O&M on a weekly, monthly and yearly basis.	**Achieved**
15	No ponding or surface run-off of effluent shall occur as a result of the exercise of this consent.	No ponding or surface run-off of wastewater.	**Achieved**
16	There shall be no odour emission resulting from the treatment and disposal system that is offensive or objectionable to such an extent that it has an adverse effect on the environment beyond the boundary of the property on which the consent is exercised.	No odour complaints received within the 2018-2019 year.	**Achieved**
17	This permit does not authorise the discharge of sludge to land or water.	No sludge discharged to land or water.	**Achieved**

6.2 Previous Consent Compliance

On the 30 January 2019 Environmental Officer, Stephen Smith from the Otago Regional Council undertook a compliance monitoring audit. The results of that audit were provided to QLDC in a report dated 10 June 2019. The report identifies a number of non-compliances which are considered to have significant actual or potential environmental effects.

The non-compliances are for the reporting period of 1 December 2017 to 30th November 2018 and relate to the volume of flow discharged exceeding the limit of 775 m^3 on four occasions, operating the disposal trench for more than 4 months in any one calendar year, only undertaking two harvests of Lucerne and samples of wastewater not meeting consent trigger levels. The report recommended that QLDC prepare a transition proposal to compliance that was suitable to the Manager of Compliance (Martin King).

A formal warning letter was issued on the 17th June 2019 specifically requesting that QLDC undertake the following actions:

1. Undertake regular concurrent sampling of the Hawea River both upstream and immediately downstream of the treatment plan to test for the presence and concentration of ammoniacal nitrogen, total nitrogen and *E. coli* and report the results of this sampling to ORC;
2. Notify ORC immediately if the downstream sample results show greater results than is present in the upstream samples;
3. Implement procedures and systems to ensure the correct operation and management of the spray and trench application systems so that they can comply with the consent conditions;
4. Confirm the date for decommissioning of the plant;
5. Consider and implement as necessary the recommendations specified in the reports from LEI 2014, 2016 and 2018 to ensure compliance with consent conditions.

6.3 Progress Towards Compliance

On 26 July 2019 in a letter to ORC, QLDC acknowledged the seriousness of the non-compliances and prepared a transition proposal to compliance outlining their response to the above actions:

1. QLDC have engaged WaterCare Laboratory Services to take samples of the Hawea River upstream 85 metres upstream of the edge of the disposal trench and 145 metres downstream of the southern edge of the spray irrigation field. Sampling commenced on the 20th May 2019 and are collected on a monthly basis to coincide with wastewater sampling and have been analysed for Ammoniacal Nitrogen (NH_3-N), Biochemical Oxygen Demand (BOD), Dissolved Reactive Phosphorus (DRP), pH, Total Nitrogen (TN), Total Oxidised Nitrogen (TON), Total Phosphorus (TP), Total Suspended Solids (TSS) and *Escherichia coli* (*E. coli*). The results are provided in Appendix G and show that downstream samples in:
    a. June 2019 for TN, DRP and *E. coli* were higher than upstream;
    b. July and August 2019 for TN was only slightly higher than the upstream sample; and
    c. October 2019 for NH_3-N, TN and *E. coli* were higher than the upstream sample;
    d. November 2019 were the same as recorded upstream.
2. QLDC agrees to notify the ORC immediately in the event that the downstream results exceed the upstream results. The results have also been compared against relevant values in the Regional Plan Water and guidelines. QLDC seek to get agreement from ORC regarding suitable guideline values to compare the downstream samples against in the

event of an exceedance to apply context. Furthermore, QLDC will investigate the potential causes of the elevated results and provide a written explanation to ORC within 7 days.

   a. The June, July, August and October river sampling results have been provided alongside the routine wastewater monitoring results monthly to ORC. The results were not provided immediately to ORC as the downstream results were still relatively low when compared to guideline values and there is only a small variation between upstream and downstream.
   b. ORC have provided a verbal confirmation that they accept the proposed guideline value, but as ORC have written a formal warning letter; QLDC require that these GV's are confirmed in writing so an agreement can be reached regarding notification.

3. The following actions to improve the management of the LTA and disposal trenches:
   a. QLDC turned the irrigation system on in September 2019 (compared with November in 2018 and October in 2017). QLDC have queried Veolia as to the disposal trench has been used regularly since the irrigator was turned on. Veolia have commented that they are limiting the use of spray irrigation when the wind is =/> 10km/hour or if rainfall is >15 mm/day. The 10 km/hour limit is lower than what is required by the consent at 29.9 km/hour. QLDC are working with Veolia to determine if spray drift is occurring at winds over 10 km/hour or if it should be used up to 29.9 km/hour consent limit and less discharge to disposal trench.
   b. The LTA was re-sown with ryegrass in October 2018 and the weed managed so that three harvests (January, May and November) were completed for the 2018-2019 reporting period.
   c. Daily discharge volume alarm was installed in October 2018 that notifies the contractor when volumes exceed 600 cubic metres.
   d. An alarm has also been installed to manage the pond below critical level this was completed in August 2019.
4. There are two capital works programmes planned (pump station and pipeline from Hawea to Project Pure, and upgrade of the Project Pure plant to provide treatment capacity) and target completion date is May 2022.
5. The four recommendations from the LEI reports are:
   a. Operation of the LTA and disposal trench – ongoing as discussed above;
   b. Low ammonia removal efficiency – QLDC engaged with ERPRO to review the operation of the pond and make recommendations in regard to how the plant could be brought back into compliance. The report is attached as Appendix H for reference. Subsequently QLDC have been assessing the practicalities of implementing the options proposed. They have discounted the option to dose with lime due to difficulties with configuring mixing system, and also the external biotreatment option as a result of the associated costs. As such the preferred option is to dose the ponds with Zeolite to reduce Ammonia levels. QLDC are currently establishing the method to dose the product into the pond and their target completion date is the end of January 2020.
   c. Operation of cut and carry – has been addressed and is discussed above;
   d. Review of operational flow rate and volume discharge to disposal trench – ongoing as discussed above.
6. Other actions proposed or completed:
   a. Unacceptable weed growth throughout LTA and disposal trench – broom clearance has been undertaken in the vicinity of the disposal trench shown in Figure 6.1, weed control in the LTA is ongoing.
   b. Remove disconnected overflow pipe – QLDC are still committed to removing the disconnected overflow pipe to provide confidence to the public – Veolia will remove the pipe before the end of December 2019.

c. Undertake a performance review of the plant and communicate the findings of this with ORC – this has commenced and is discussed under 5b above.

Figure 6.1: Broom Clearance at the at the Disposal Trench

6.4 Further Works to Transition to Compliance

QLDC is committed to implementing a long-term solution, and the QLDC Long Term Plan includes budget for this in 2021 – 2023. A business case for this project has now been approved, demonstrating that conveying the wastewater from Hawea to the Wanaka WWTP is financially and environmentally beneficial. Detailed design on this project is scheduled to commence in 2019.

In the meantime, QLDC are committed to implementing the transition to compliance plan as outlined above with three key areas of focus being:

1. Increasing the operational time of the LTA so that the disposal trench is only used as the default during periods such as ice or snow lie, extreme wet weather, high winds and harvesting;
2. Continue to harvest the crop at least three times every year; and
3. Improving the efficiency of nitrogen and ammonia removal by adding Zeolite;
4. Continue monitoring the water quality in the Hawea River upstream and downstream against relevant guidelines.

7 SUMMARY AND CONCLUSIONS

The interpretation of and conclusion about, the monitoring results for 1st December 2018 to 30th November 2019 reporting period from the Hawea WWTP and consent compliance are as below.

The total wastewater flow for the year is 92,333 m^3, up 5,929 m^3 (or nearly 7%) from the 2017-2018 period of 86,404 m^3 and up 17,863 m^3 (24% increase) from 74,470 m^3 during the 2016-2017 period.

The annual average was 253 m^3/day. The volume of wastewater discharged generally remained below the consent limit of 775 m^3/day, with four days recorded in excess of this, on 01/06/19, 07/06/19, 23/08/19 and 24/08/19. The elevated volumes recorded in June were due to a blockage in the outlet pipe in the days leading up to the discharges. This was noticed when a high-level pond alarm was activated and took two discharges to return to normal operating level. The elevated levels in August were due to a high-level alarm and faulty swale valve.

The treated wastewater has been evenly split between the disposal trench and the spray irrigation system. The number of days (>10 m^3) discharging to spray irrigation has been 176 and to the disposal trench was 186 (note that both the trench and irrigation can be used the same day with a total daily discharge limit of 775 m^3). This is compared to the 2017-2018 period when the spray irrigation was only used for 115 days and the disposal trench was 268 days.

The rolling 12 month 95th percentile of 46 mg/L and annual mean 35 mg/L for total ammoniacal nitrogen exceeded the consent limit (30 mg/L and 25 mg/L) throughout the 2018-2019 monitoring period.

The rolling 12 month 95th percentile of 89 mg/L for total nitrogen exceeded the consent limit (40 mg/L) in the 2018-2019 monitoring period, up 30 mg/L from the 2017-2018 period. The annual mean consent limit was also exceeded.

The results for *E. coli* remained below the consent limit. Total phosphorus, total suspended solids and BOD_5 are consistent with results from previous years. Total phosphorus was compliant with consent limits, while total suspended solids and BOD_5 do not have consent limits.

The nitrogen loading rate has increased from previous years due to the increase in flow to the site (up 7% from 2017-18 and 24% from 2016-2017) and increase in the concentration of nitrogen in the wastewater (up 41% from 2017-2018 and 48% from 2016-2017).

Nitrogen leaching has increased by 30% to 3,765 kg N/yr from the 2017-2018 reporting period (2,893 kg N/yr) and 102% from the 2016-2017 reporting period (1,857 kg N/yr).

The improvement in the operation of the spray irrigation has resulted in a 111% increase in the removal of nitrogen (nitrogen exported and gaseous losses) to 1,104 kg from 521 kg in 2017-2018, that would have otherwise leached through the trench.

During the 2018-2019 reporting period, three cuts of baleage were with an estimated 566 kg of nitrogen removed from the LTA through the cut and carry of the ryegrass which has increased by 54% from 2017-2018 (368 kg) and 207% from 2016-2017 (of 184 kg).

However, it wasn't enough to balance the increase flow into the plant as well as the increased concentration of nitrogen in the wastewater.

Resource Consent RM10.308.01 was compliant with all of its conditions. There were some non-compliant conditions for resource consent RM10.308.02 in the 2018-19 However, there is a plan which includes:

a. further increasing the operational time of the spray irrigation so that the disposal trench is only used as the default during periods such as ice or snow lie, extreme wet weather, high winds and harvesting;
b. continuing to review the operation of the crop harvest frequency to see if a fourth harvest could be fit in;
c. improving the efficiency of nitrogen and ammonia removal by adding Zeolite;
d. continue monitoring the water quality in the Hawea River upstream and downstream against relevant guidelines; to transition into compliance.

The longer-term solution for Hawea wastewater compliance, is to convey the wastewater to the Wanaka WWTP. This has been budgeted for in 2021-2023, with the detailed design commencing in 2019.

8 REFERENCES

ERPRO (2019) QLDC Lake Hawea WWTP Nitrogen Reduction Implementation.

Otago Regional Council (2019) Hawea Wastewater Treatment Plant. Letter of Formal Warning.

Otago Regional Council (2019) Compliance Monitoring Report. Reference Number A123671.

Otago Regional Council (2010) Discharge Permit RM10.308.01. V1.

Otago Regional Council (2010) Discharge Permit RM10.308.02. V1.

Queenstown Lakes District Council (2018) Hawea Wastewater Treatment Plant Annual Report 2017-2018.

9 APPENDICES

Appendix A Discharge Permits RM10.308.01 and RM10.308.02
Appendix B Wastewater Quality Monitoring Results
Appendix C Watercare Laboratory Results
Appendix D Daily Wastewater Flow Results
Appendix E Nitrogen Mass Balance Spreadsheet
Appendix F Maintenance Records
Appendix G Hawea River Water Sampling Results
Appendix H ERPRO (2019) QLDC Lake Hawea WWTP Nitrogen Reduction Implementation

APPENDIX A

Discharge Permits RM10.308.01 and RM10.308.02

Discharge to Air Permit RM10.308.01

Conditions

Specific

1. This consent shall only be exercised in conjunction with Discharge Permit RM10.308.02.

2. The discharge to air shall be as described in the consent application submitted to the Consent Authority on 31 August 2010 and any subsequent information provided

3. Wind cloth shall be installed on the western, southern and eastern-most boundaries of the area on which treated wastewater is to be applied by spray irrigation. This wind cloth shall be maintained until the screen foliage required under Condition 4 is fully established.

4. Suitable screening foliage, that shall be at least 3 metres high but not exceed 6 metres in height, shall be planted on the western, southern and eastern-most boundaries of the area on which treated wastewater is applied by spray irrigation.

5. A weather station shall be installed in an appropriate location to record, as a minimum, rainfall and wind conditions at the site where treated wastewater is to be applied by spray irrigation.

6. The spray irrigation system shall not be operated in conditions where wind speed, as measured at the on-site station installed under Condition 5, exceeds 29.9 km/hour;

Performance Monitoring

7. The consent holder shall keep a record of any complaints received regarding discharges of odour from the site. The record shall, as a minimum, include the following:
   (a) The time and place at which the complaint was generated;
   (b) The nature of the complaint;
   (c) Operating conditions at the time of the complaint, including any malfunctioning or breakdown of control equipment;
   (d) Wind and weather conditions at the time of the complaint; and
   (e) Corrective action taken by the consent holder to minimise the risk and extent of the recurrence of the causes of the complaint.

   The consent holder shall submit a copy of the written record of the complaint to the Consent Authority within two weeks after any complaint occurring, together with the details of the corrective actions taken.

General

8. There shall be no discharge of odour, as a result of the exercise of this consent, that is noxious, dangerous, offensive or objectionable to the extent that it causes an adverse effect beyond the boundary of the site, in the opinion of an authorised officer of the Consent Authority.

9. 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 become evident after the date of commencement of the consent; or

(b) Ensuring the conditions of this consent are consistent with any National Environmental Standards; or
(c) Requiring the consent holder to adopt the best practicable option to remove or reduce any adverse effect on the environment arising as a result of the exercise of this consent.

Notes to Consent Holder

1. *If you require a replacement consent/permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this permit until a decision is made, and any appeals are resolved, on the replacement application.*

Discharge to Land Permit RM10.308.02

Conditions

Specific

1. The discharge shall only be treated domestic wastewater, as described in the consent application submitted to the Consent Authority on 31 August 2010 and any subsequent information provided.

2. The volume of effluent discharged shall not exceed 775 cubic metres per day.

3. The distance the site boundary from any part of the wastewater treatment and disposal system shall no less than 5 metres.

4. By no later than 1 December 2012, the consent holder shall ensure that the trench utilised for wastewater disposal:
a) is at least 150 metres long and 2 m wide in total; and
b) is intermittently dosed; and
c) is not used for the disposal of wastewater for more than 4 months in total in any one calendar year.

5. By no later than 1 December 2012, the consent holder shall install and commission a spray irrigation system for the land application of treated wastewater. The spray irrigation system shall meet the following criteria:
(a) The total area on which treated wastewater is applied by spray irrigation shall be no less than 2.33 hectares;
(b) Treated wastewater shall be applied evenly by spray irrigation to the area defined in Appendix I only;
(c) The area on which treated wastewater is applied by spray irrigation shall be fenced with a 2-metre-high deer fence with appropriate signage warning the general public of the hazard;
(d) A weather station shall be installed in an appropriate location to record, as a minimum, rainfall and wind conditions at the site where treated wastewater is to be applied by spray irrigation;
(e) Wastewater shall not be applied to land by spray irrigation system during the hours outside of 11 pm to 5 am; (f) Nozzle pressure must not exceed 400 kilopascals (kPa);
(g) There shall be no irrigation of treated wastewater using K-Line irrigation systems.

6. The area on which treated wastewater is to be applied using spray irrigation shall be planted in high growth and nitrogen uptake vegetation (such as Lucerne or Ryegrass) and

shall be managed as far as practicably possible to optimise nutrient removal. A minimum of three harvests per year shall be undertaken.

7. The total nitrogen applied to the spray irrigation area shall not exceed 1,223 kilograms of nitrogen per hectare per year.

Performance Monitoring

8. The treatment and disposal system shall be constructed and installed in accordance with the details and plans supplied with the consent application submitted to the Consent Authority on 31 August 2010, and attached to this consent as Appendix I.

9. The consent holder shall install a flow meter on the outlet pipe from the treatment system and continually measure and record the daily volume (based on a no more than weekly average) of effluent being discharged to the disposal field. The consent holder shall forward the record for the previous 12-month period to the Consent Authority by 1 December each year, and upon request.

10. (a) From the first exercise of this consent, the consent holder shall collect representative samples of the treated wastewater from the outlet of the oxidation pond in the last week of each month. The samples shall be analysed for:
(i) Five-day total biochemical oxygen demand (BOD_5); and
(ii) Total suspended solids; and (iii) Total nitrogen; and (iv) Total Ammoniacal nitrogen; and (v) Total phosphorous; and (vi) *Escherichia coli.*

(b) From the first exercise of this consent, wastewater discharged from the oxidation pond shall comply with the following criteria:

	Mean*	95th Percentile (mg/L) *
Ammoniacal Nitrogen	25 (mg/L)	30 (mg/L)
Total Nitrogen	35 (mg/L)	40 (mg/L)
Total Phosphorous	8 (mg/L)	10 (mg/L)
Faecal Coliforms	-	2.5 x 10^5 cfu/100 mL

*The mean and 95th percentile apply to a rolling 12-month period.

(c) The analytical sample results from the sampling under Condition 9(a) of this consent shall be submitted to the Consent Authority by 1 December each year, and upon request.

11. All sampling techniques shall be acceptable to the Consent Authority. All analysis carried out in connection with this consent shall be performed by a laboratory that meets ISO 17025 standards, or otherwise as specifically approved by the Consent Authority.

12. The following information shall be provided in writing to the Consent Authority by 1 December each year, and upon request, following the commencement of the exercise of the consent:
    (a) The nitrogen mass balance for the spray irrigation land application area, which shall be determined annually. The nitrogen mass balance shall consist as a minimum the total nitrogen applied to land and crop removal of nitrogen.
    (b) The total nitrogen applied to the spray irrigation land shall be estimated from the total volume of effluent applied and the average of monthly concentration of total nitrogen in the land applied effluent.
    (c) The crop removal of nitrogen from the spray irrigation land shall be estimated by obtaining dry matter content and total nitrogen content after each crop/plant harvest.
    (d) The nitrogen mass balance from Condition 12(a) and any other factors such as ammonia volatilisation and denitrification shall be used to calculate the mass of nitrogen leached from the site, using a model acceptable to the Consent Authority

13. The consent holder shall forward an annual report in writing to the Consent Authority by 1 December each year. The annual report shall cover the preceding 12-month period (from 1 December the preceding year until 30 November of the current year) and shall report on compliance with this consent. As a minimum, the report shall include:

    (a) A summary of all analytical results for the year; and
    (b) A summary of the year's monitoring results, in context of previous years' results; and
    (c) Comments on compliance with the conditions of this discharge permit; and
    (d) A summary of any complaints received, the validity of each complaint and the corrective action taken; and
    (e) A summary of any malfunctions of breakdowns and the corrective action taken; and
    (f) Details of the cut and carry operation, including the calculations for nitrogen loading in the spray irrigation land, number of harvests, dry matter and total nitrogen content of the harvest and nitrogen balance for this site.
    (g) Any other issues considered relevant by the consent holder.

14. By no later than 1 December 2012, the consent holder shall prepare and forward to the Consent Authority an Operations and Management Manual for the wastewater treatment and disposal system to ensure its effective and efficient operation at all times. The system shall be operated in accordance with this manual, which shall be updated as appropriate. The manual and include, as a minimum,
    (a) A brief description of the treatment and disposal system, including a site map indicating the location of the treatment and disposal system, points of discharge and any monitoring sites;
    (b) Key operational matters, including weekly, monthly and annual maintenance checks;
    (c) Monitoring requirements and procedures including a nitrogen balance sheet for the purpose of managing nitrogen inputs and outputs including nitrogen leaching losses;
    (d) A management plan for the cut and carry operation including procedures for harvesting grass from the site, and maximising grass growth and nitrogen uptake by grass such as soil tests, supplementary nutrient additions and pest and weed control;
    (e) Management and dosing of trenches
    (f) Contingency plans in the event of system malfunctions or breakdowns; and
    (g) The means of receiving and dealing with any complaints; and
    (h) Emergency contact phone numbers.

General

15. No ponding or surface run-off of effluent shall occur as a result of the exercise of this consent.

16. There shall be no odour emission resulting from the treatment and disposal system that is offensive or objectionable to such an extent that it has an adverse effect on the environment beyond the boundary of the property on which the consent is exercised

17. This permit does not authorise the discharge of sludge to land or water.

18. If the consent holder:
    (a) discovers koiwi tangata (human skeletal remains), waahi taoka (resources of importance), waahi tapu (places or features of special significance) or other Maori artefact material, the consent holder shall without delay:
    (i) notify the Consent Authority, Tangata whenua and New Zealand Historic Places Trust and in the case of skeletal remains, the New Zealand Police.
    (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.
    Any koiwi tangata discovered shall be handled and removed by tribal elders responsible for the tikanga (custom) appropriate to its removal or preservation.

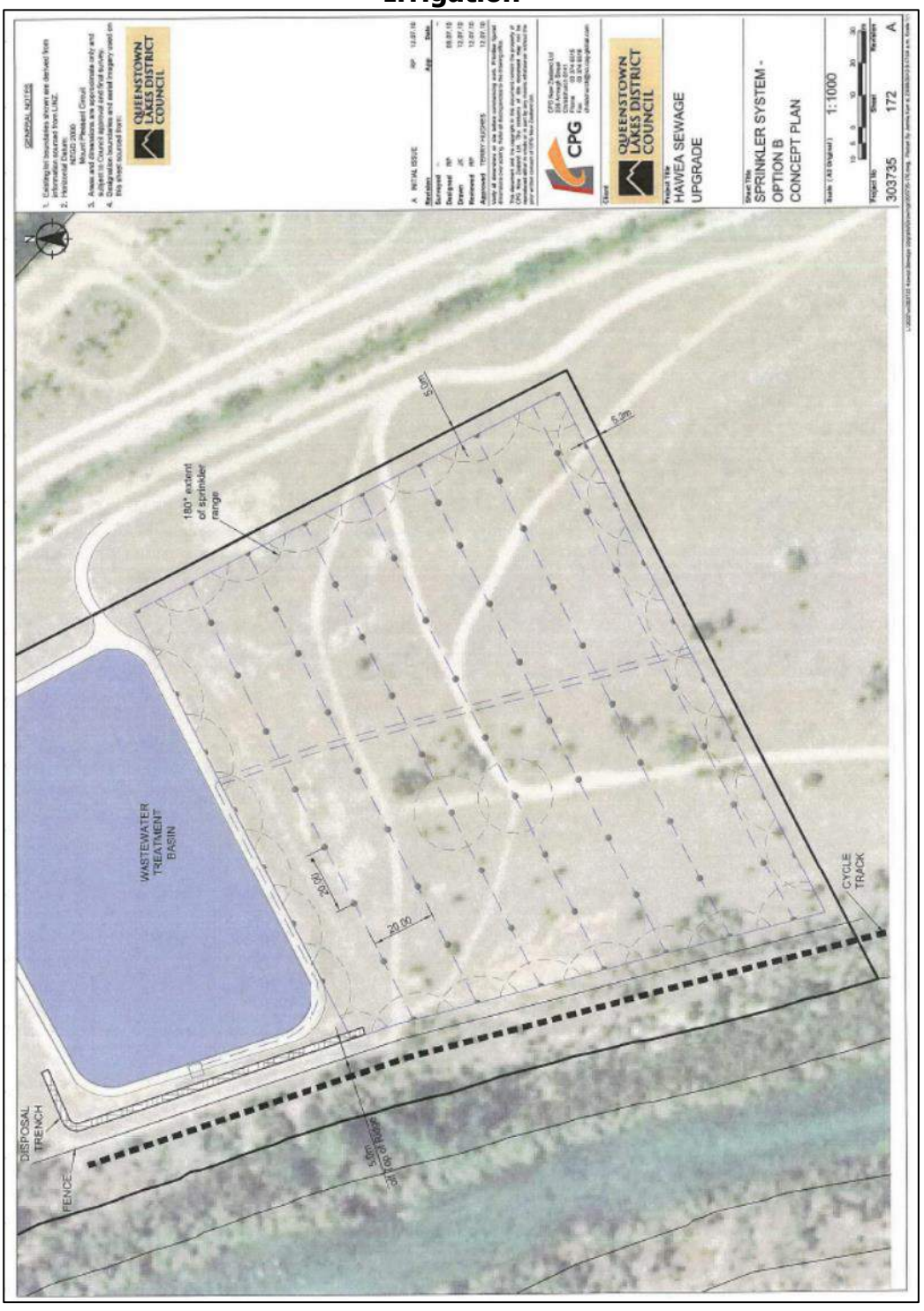
Site work shall recommence following consultation with the Consent Authority, the New Zealand Historic Places Trust, Tangata whenua, and in the case of skeletal remains, the New Zealand Police, provided that any relevant statutory permissions have been obtained.
(b) discovers any feature or archaeological 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 and
(ii) advise the Consent Authority, the New Zealand Historic Places Trust, and in the case of Maori features or materials, the Tangata whenua, 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.

19. 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 become evident after the date of commencement of the consent; or
(b) ensuring the conditions of this consent are consistent with any National Environmental Standards; 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.

Notes to Consent Holder

1. *If you require a replacement consent/permit upon the expiry date of this permit, any new application should be lodged at least 6 months prior to the expiry date of this permit. Applying at least 6 months before the expiry date may enable you to continue to exercise this permit until a decision is made, and any appeals are resolved, on the replacement application.*

Appendix I – Area on which Treated Wastewater is to be applied using Spray Irrigation



APPENDIX B

Wastewater Quality Monitoring Results

	Total Suspended Solids g/m³		BOD_5 g/m³		Total Phosphorus mg/L			Total Nitrogen g/m³			Ammoniacal Nitrogen g/m³			*E. Coli* cfu/100 mL		
	Actual Measured	Rolling 12 Month Annual Mean	Actual Measured	Rolling 12 Month Annual Mean	Actual Measured	Rolling 12 Month Annual Mean	Rolling 12 Month 95th percentile	Actual Measured	Rolling 12 Month Annual Mean	Rolling 12 Month 95th percentile	Actual Measured	Rolling 12 Month Annual Mean	Rolling 12 Month 95th percentile	Actual Measured	Rolling 12 Month Annual Mean	Rolling 12 Month 95th percentile
						8	10		35	40		25	30			250,000
20/12/2017	49	*130*	19	*30*	8.2	7	8	40	37	64	30	23	44	11,000	47,417	123,500
23/01/2018	130	*131*	35	*31*	7.7	7	8	22	37	64	8	23	44	36,000	49,833	123,500
28/02/2018	230	*135*	74	*33*	6.4	7	8	31	38	64	*0*	23	44	130,000	55,583	134,500
20/03/2018	130	*135*	37	*33*	7.5	7	8	27	39	64	1	23	44	55,000	58,000	134,500
20/04/2018	120	*115*	51	*35*	7.9	7	8	29	40	64	2	22	44	5,600	53,800	134,500
21/05/2018	64	*116*	28	*36*	6.3	7	8	27	39	64	16	21	44	37,000	53,550	134,500
20/06/2018	32	*115*	24	*36*	6.0	7	8	34	38	64	30	21	44	5,200	52,400	134,500
26/07/2018	48	*112*	25	*36*	6.5	7	8	45	36	53	38	21	43	3,000	40,983	119,000
21/08/2018	75	*110*	19	*35*	6.5	7	8	49	37	54	41	21	45	4,300	37,342	119,000
20/09/2018	140	*112*	64	*37*	6.8	7	8	52	37	56	36	21	45	66,000	33,675	94,800
16/10/2018	130	*112*	41	*38*	7.2	7	8	58	37	55	43	20	42	83,000	38,508	104,150
20/11/2018	88	*103*	18	*36*	7.7	7	8	57	39	57	43	24	43	22,000	38,175	104,150
20/12/2018	59	*104*	32	*37*	7.8	7	8	55	41	57	38	25	43	240,000	57,258	179,500
23/01/2019	74	*99*	28	*37*	11.0	7	9	65	44	61	43	28	43	20,000	55,925	179,500
21/02/2019	59	*85*	23	*33*	8.9	8	10	56	46	61	42	31	43	20,000	46,758	153,650
20/03/2019	140	*86*	22	*31*	7.7	8	10	52	48	61	38	34	43	50,000	46,342	153,650
23/04/2019	110	*85*	31	*30*	6.7	7	10	22	48	61	4	34	43	110,000	55,042	168,500
20/05/2019	86	*87*	48	*31*	6.1	7	10	27	48	61	13	34	43	9,800	52,775	168,500
20/06/2019	56	*89*	8.1	*30*	6.2	7	10	39	48	61	30	34	43	4,900	52,750	168,500
23/07/2019	35	*88*	36	*31*	6.6	7	10	46	48	61	38	34	43	95,000	60,417	168,500
20/08/2019	55	*86*	34	*32*	6.8	7	10	55	49	61	39	34	43	66,000	65,558	168,500
19/09/2019	280	*98*	34	*30*	7.3	8	10	110	54	85	43	34	43	38,000	63,225	168,500
21/10/2019	140	*99*	39	*29*	8.0	8	10	62	54	85	42	34	43	31,000	58,892	168,500
27/11/2019	88	*99*	15	*29*	7.7	8	10	71	55	89	50	35	46	3,000	57,308	168,500

APPENDIX C

Watercare Laboratory Results

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Certificate of Analysis
Laboratory Reference:181220-142

Attention:	Operations .	*Final Report:*	**299666-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**08-Jan-2019**
Address:		*Received Date:*	**21-Dec-2018**
Client Reference:	**Hawea Ponds Monthly December 2018**		
Purchase Order:	**PO92832**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**181220-142-1**
Client Sample ID:		
Sample Date/Time:		20/12/2018
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	38
CBOD5	mg/L	32
Total Nitrogen (as N)	mg/L	55
Total Phosphorus (as P)	mg/L	7.8
Total Suspended Solids	mg/L	59
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	240000

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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ilac-MRA IANZ ACCREDITED LABORATORY

Report Signatory 08/01/2019
 Marina Fisher KTP Signatory

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Certificate of Analysis
Laboratory Reference:190123-106

Attention:	Operations .	*Final Report:*	**303185-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**01-Feb-2019**
Address:		*Received Date:*	**24-Jan-2019**
Client Reference:	**Hawea Ponds Monthly January 2019**		
Purchase Order:	**PO92832**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190123-106-1**
Client Sample ID:		
Sample Date/Time:		23/01/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	43
CBOD5	mg/L	28
Total Nitrogen (as N)	mg/L	65
Total Phosphorus (as P)	mg/L	11
Total Suspended Solids	mg/L	74
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	20000

*Results marked with * are not accredited to International Accreditation New Zealand*

Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Report Signatory 01/02/2019

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Certificate of Analysis
Laboratory Reference:190221-080

Attention:	Operations .	*Final Report:*	**306977-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**28-Feb-2019**
Address:		*Received Date:*	**22-Feb-2019**
Client Reference:	**Hawea Ponds Monthly February 2019**		
Purchase Order:	**PO7300051656**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190221-080-1**
Client Sample ID:		
Sample Date/Time:		21/02/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	42
CBOD5	mg/L	23
Total Nitrogen (as N)	mg/L	56
Total Phosphorus (as P)	mg/L	8.9
Total Suspended Solids	mg/L	59
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	20000

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Where samples have been supplied by the client they are tested as received. A dash indicates no test performed.

Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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ACCREDITED LABORATORY

Report Signatory 28/02/2019

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Certificate of Analysis
Laboratory Reference:190320-131

Attention:	Operations .	*Final Report:*	**311088-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**27-Mar-2019**
Address:		*Received Date:*	**21-Mar-2019**
Client Reference:	**Hawea Ponds Monthly March 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO100467**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190320-131-1**
Client Sample ID:		
Sample Date/Time:		20/03/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	38
CBOD5	mg/L	22
Total Nitrogen (as N)	mg/L	52
Total Phosphorus (as P)	mg/L	7.7
Total Suspended Solids	mg/L	140
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	50000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Certificate of Analysis
Laboratory Reference:190423-089

Attention:	Operations .	*Final Report:*	**315210-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**29-Apr-2019**
Address:		*Received Date:*	**24-Apr-2019**
Client Reference:	**Hawea Ponds Monthly April 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO7300058275**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190423-089-1**
Client Sample ID:		
Sample Date/Time:		23/04/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	3.8
CBOD5	mg/L	31
Total Nitrogen (as N)	mg/L	22
Total Phosphorus (as P)	mg/L	6.7
Total Suspended Solids	mg/L	110
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	110000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Report Signatory 29/04/2019

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Certificate of Analysis
Laboratory Reference:190521-121

Attention:	Jennifer Mcgirr	*Final Report:*	**319344-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**27-May-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**21-May-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**51CA23B/15708**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**190521-121-1**	**190521-121-2**
Client Sample ID:			
Sample Date/Time:		20/05/2019 12:10	20/05/2019 11:50
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.01	<0.01
CBOD5 (as O2)	mg/L	3.0	2.9
Dissolved Reactive Phosphorus (as P)	mg/L	<0.005	<0.005
pH (at room temp c. 20 °C)	pH unit	7.66	7.65
Total Nitrogen (as N)	mg/L	0.05	0.04
Total Oxidised Nitrogen (as N)	mg/L	<0.01	<0.01
Total Phosphorus (as P)	mg/L	<0.01	<0.01
Total Suspended Solids	mg/L	<2.5	<2.5
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	<10	10

*Results marked with * are not accredited to International Accreditation New Zealand*

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P E	0.005 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Oxidised Nitrogen (as N) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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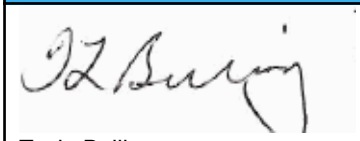
Report Signatory 27/05/2019



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Certificate of Analysis
Laboratory Reference:190520-158

Attention:	Operations .	*Final Report:*	**319460-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**27-May-2019**
Address:		*Received Date:*	**21-May-2019**
Client Reference:	**Hawea Ponds Monthly May 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO7300060462**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190520-158-1**
Client Sample ID:		
Sample Date/Time:		20/05/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	13
CBOD5	mg/L	48
Total Nitrogen (as N)	mg/L	27
Total Phosphorus (as P)	mg/L	6.1
Total Suspended Solids	mg/L	86
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	9800

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

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Report Signatory 27/05/2019

Chandra Sharma
KTP Signatory

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Certificate of Analysis
Laboratory Reference:190620-090

Attention:	Jennifer Mcgirr	*Final Report:*	**323675-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**28-Jun-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**21-Jun-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**51CA23B/15708**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**190620-090-1**	**190620-090-2**
Client Sample ID:			
Sample Date/Time:		20/06/2019	20/06/2019
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.01	<0.01
CBOD5 (as O2)	mg/L	<2.0	<2.0
Dissolved Reactive Phosphorus (as P)	mg/L	<0.005	0.008
pH (at room temp c. 20 °C)	pH unit	7.55	7.50
Total Nitrogen (as N)	mg/L	0.06	0.14
Total Oxidised Nitrogen (as N)	mg/L	<0.01	<0.01
Total Phosphorus (as P)	mg/L	<0.01	<0.01
Total Suspended Solids	mg/L	3.4	<2.5
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	<10	41

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P E	0.005 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Oxidised Nitrogen (as N) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Invercargill

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Report Signatory 28/06/2019

Michelle Donovan
KTP Signatory

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Certificate of Analysis
Laboratory Reference:190620-089

Attention:	Operations .	*Final Report:*	**323566-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**27-Jun-2019**
Address:		*Received Date:*	**21-Jun-2019**
Client Reference:	**Hawea Ponds Monthly June 2019**	*Sampled By:*	**WLS**
Purchase Order:	**109274**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190620-089-1**
Client Sample ID:		
Sample Date/Time:		20/06/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	30
CBOD5	mg/L	8.1
Total Nitrogen (as N)	mg/L	39
Total Phosphorus (as P)	mg/L	6.2
Total Suspended Solids	mg/L	56
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	4900

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

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Report Signatory 27/06/2019

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Certificate of Analysis
Laboratory Reference:190723-094

Attention:	Jennifer Mcgirr	*Final Report:*	**327702-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**30-Jul-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**24-Jul-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**PO028787**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**190723-094-1**	**190723-094-2**
Client Sample ID:			
Sample Date/Time		23/07/2019	23/07/2019
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.01	<0.01
CBOD5 (as O2)	mg/L	<2.0	<2.0
Dissolved Reactive Phosphorus (as P)	mg/L	0.005	<0.005
pH (at room temp c. 20 °C)	pH unit	7.69	7.67
Total Nitrogen (as N)	mg/L	0.07	0.08
Total Oxidised Nitrogen (as N)	mg/L	0.02	0.02
Total Phosphorus (as P)	mg/L	<0.01	<0.01
Total Suspended Solids	mg/L	<2.5	<2.5
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	<10	<10

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P E	0.005 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Oxidised Nitrogen (as N) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Invercargill

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Certificate of Analysis
Laboratory Reference:190723-093

Attention:	Operations .	*Final Report:*	**327714-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**30-Jul-2019**
Address:		*Received Date:*	**24-Jul-2019**
Client Reference:	**Hawea Ponds Monthly July 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO112218**	*Quote Reference :*	**42**

Sample Details	WATERS
Lab Sample ID:	**190723-093-1**
Client Sample ID:	
Sample Date/Time	23/07/2019
Description:	Hawea Effluent (RM 10.308.02)

General Testing		
Ammoniacal Nitrogen (as N)	mg/L	38
CBOD5 (as O2)	mg/L	36
Total Nitrogen (as N)	mg/L	46
Total Phosphorus (as P)	mg/L	6.6
Total Suspended Solids	mg/L	35

Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	95000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603 (2002)	2 cfu/100 mL	All	Invercargill

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Certificate of Analysis
Laboratory Reference:190820-081

Attention:	Jennifer Mcgirr	*Final Report:*	**331932-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**03-Sep-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**21-Aug-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**PO028787**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**190820-081-1**	**190820-081-2**
Client Sample ID:			
Sample Date/Time		20/08/2019	20/08/2019
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.01	<0.01
CBOD5 (as O2)	mg/L	<2.0	<2.0
Dissolved Reactive Phosphorus (as P)	mg/L	<0.005	<0.005
pH (at room temp c. 20 °C)	pH unit	7.70	7.59
Total Nitrogen (as N)	mg/L	0.04	0.06
Total Oxidised Nitrogen (as N)	mg/L	0.02	0.01
Total Phosphorus (as P)	mg/L	0.02	<0.01
Total Suspended Solids	mg/L	3.9	<2.5
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	<10	<10

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P E	0.005 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Oxidised Nitrogen (as N) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Invercargill

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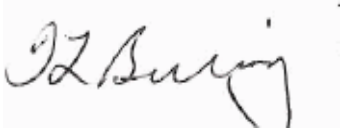

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Certificate of Analysis
Laboratory Reference:190820-080

Attention:	Operations .	*Final Report:*	**331963-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**03-Sep-2019**
Address:		*Received Date:*	**21-Aug-2019**
Client Reference:	**Hawea Ponds Monthly August 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO7300069233**	*Quote Reference :*	**42**

Sample Details	WATERS
Lab Sample ID:	**190820-080-1**
Client Sample ID:	
Sample Date/Time	20/08/2019
Description:	Hawea Effluent (RM 10.308.02)

General Testing		
Ammoniacal Nitrogen (as N)	mg/L	39
CBOD5 (as O2)	mg/L	34
Total Nitrogen (as N)	mg/L	55
Total Phosphorus (as P)	mg/L	6.8
Total Suspended Solids	mg/L	55

Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	66000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603 (2002)	2 cfu/100 mL	All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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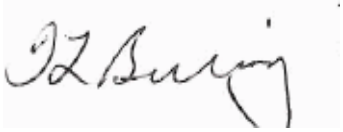

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Certificate of Analysis
Laboratory Reference:190919-093

Attention:	Jennifer Mcgirr	*Final Report:*	**335304-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**27-Sep-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**20-Sep-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**PO028787**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**190919-093-1**	**190919-093-2**
Client Sample ID:			
Sample Date/Time		19/09/2019	19/09/2019
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.01	<0.01
CBOD5 (as O2)	mg/L	<2.0	<2.0
Dissolved Reactive Phosphorus (as P)	mg/L	<0.005	<0.005
pH (at room temp c. 20 °C)	pH unit	7.46	7.51
Total Nitrogen (as N)	mg/L	<0.01	<0.01
Total Oxidised Nitrogen (as N)	mg/L	0.02	0.02
Total Phosphorus (as P)	mg/L	<0.01	<0.01
Total Suspended Solids	mg/L	<2.5	<2.5
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	<1.0	<1.0

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P E	0.005 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Oxidised Nitrogen (as N) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Invercargill

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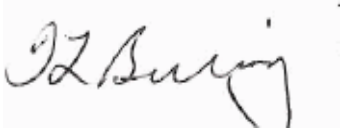

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Certificate of Analysis
Laboratory Reference:190919-092

Attention:	Operations .	*Final Report:*	**335177-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**26-Sep-2019**
Address:		*Received Date:*	**20-Sep-2019**
Client Reference:	**Hawea Ponds Monthly September 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO118591**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**190919-092-1**
Client Sample ID:		
Sample Date/Time		19/09/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	43
CBOD5 (as O2)	mg/L	34
Total Nitrogen (as N)	mg/L	110
Total Phosphorus (as P)	mg/L	7.3
Total Suspended Solids	mg/L	280
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	38000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603 (2002)	2 cfu/100 mL	All	Invercargill

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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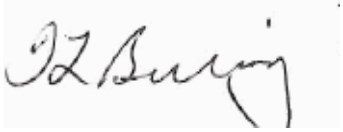

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Certificate of Analysis
Laboratory Reference:191021-127

Attention:	Jennifer Mcgirr	*Final Report:*	**340497-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**06-Nov-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**22-Oct-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**Not Available**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**191021-127-1**	**191021-127-2**
Client Sample ID:			
Sample Date/Time		21/10/2019	21/10/2019
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.005	0.016
CBOD5	mg/L	0.77	0.63
Dissolved Reactive Phosphorus (as P)	mg/L	0.0039	<0.002
Nitrate (as N)	mg/L	0.03	0.02
Nitrite (as N)	mg/L	<0.02	<0.02
pH (at room temp c. 20 °C)	pH unit	7.7	7.8
Total Nitrogen (as N)	mg/L	0.036	0.038
Total Phosphorus (as P)	mg/L	0.004	<0.004
Total Suspended Solids	mg/L	1.6	<1.0
Microbiology			
Escherichia coli by Membrane Filtration			
Escherichia coli	cfu/100 mL	<1.6	4.9

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Flow Analysis	APHA (online edition) 4500-NH3 H	0.005 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P F	0.002 mg/L	All	Auckland
Nitrate (as N) by Ion Chromatography (0.45 µm Filtered)	APHA (online edition) 4110 B	0.02 mg/L	All	Auckland
Nitrite (as N) by Ion Chromatography (0.45 µm Filtered)	APHA (online edition) 4110 B	0.02 mg/L	All	Auckland
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified) (Discrete Analyser)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Auckland

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Preparations

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

Samples, with suitable preservation and stability of analytes, will be held by the laboratory for a period of two weeks after results have been reported, unless otherwise advised by the submitter.

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Certificate of Analysis
Laboratory Reference:191021-126

Attention:	Operations .	*Final Report:*	**340598-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**06-Nov-2019**
Address:		*Received Date:*	**22-Oct-2019**
Client Reference:	**Hawea Ponds Monthly October 2019**	*Sampled By:*	**WLS**
Purchase Order:	**PO7300076673**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**191021-126-1**
Client Sample ID:		
Sample Date/Time		21/10/2019
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	42
CBOD5	mg/L	39
Total Nitrogen (as N)	mg/L	62
Total Phosphorus (as P)	mg/L	8.0
Total Suspended Solids	mg/L	140
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	31000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	HMSO (1981) ISBN 0117516139	0.4 mg/L	All	Auckland
Carbonaceous Biochemical Oxygen Demand, CBOD5 by Electrode	APHA (online edition) 5210 B (modified)	0.5 mg/L	All	Auckland
Total Nitrogen (as N) by Persulphate Digestion and Flow Analysis	APHA (online edition) 4500-P J (modified), 4500-NO3 I	0.010 mg/L	All	Auckland
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J (modified) (Discrete Analyser)	0.004 mg/L	All	Auckland
Total Suspended Solids by Gravimetry	In House based on APHA (online edition) 2540 D, E	1 mg/L	All	Auckland
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603	2 cfu/100 mL	All	Auckland

The method detection limit (MDL) listed is the limit attainable in a relatively clean matrix. If dilutions are required for analysis the detection limit may be higher. For more information please contact the Operations Manager.

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Certificate of Analysis
Laboratory Reference:191118-114

Attention:	Jennifer Mcgirr	*Final Report:*	**343142-0**
Client:	**QUEENSTOWN LAKE DISTRICT COUNC**	*Report Issue Date:*	**27-Nov-2019**
Address:	**PO Box 50072, Queenstown, 9348**	*Received Date:*	**18-Nov-2019**
Client Reference:	**Hawea River**	*Sampled By:*	**Watercare**
Purchase Order:	**PO028787**	*Quote Reference :*	**10284**

Sample Details		WATERS	WATERS
Lab Sample ID:		**191118-114-1**	**191118-114-2**
Client Sample ID:			
Sample Date/Time		18/11/2019	18/11/2019
Description:		Hawea River Upstream	Hawea River Downstream
General Testing			
Ammoniacal Nitrogen (as N)	mg/L	<0.01	<0.01
CBOD5 (as O2)	mg/L	<2.0	<2.0
Dissolved Reactive Phosphorus (as P)	mg/L	0.005	<0.005
pH (at room temp c. 20 °C)	pH unit	7.52	7.90
Total Nitrogen (as N)	mg/L	0.08	0.08
Total Oxidised Nitrogen (as N)	mg/L	0.01	0.01
Total Phosphorus (as P)	mg/L	0.02	0.02
Total Suspended Solids	mg/L	<2.5	<2.5
Microbiology			
Escherichia coli by MPN(Colilert-18)			
Escherichia coli (Colilert-18)	MPN/100 mL	<1.0	1.0

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Dissolved Reactive Phosphorus (as P) by Colorimetry/ Discrete Analyser	APHA (online edition) 4500-P E	0.005 mg/L	All	Invercargill
pH (at room temp c. 20 °C) by Electrode	APHA (online edition) 4500-H B (Tested beyond 15 minute APHA holding time)	0.1 pH unit	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Oxidised Nitrogen (as N) by Colorimetry/Discrete Analyser	APHA (online edition) 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by MPN(Colilert-18)				
Escherichia coli (Colilert-18)	APHA (online edition) 9223 B Colilert Quantitray	1 MPN/100 mL	All	Invercargill
Preparations				
Membrane Filtration (0.45 µm)	APHA (online edition) 4500-P B (preliminary filtration)		All	Invercargill

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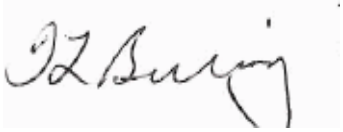

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Certificate of Analysis
Laboratory Reference:191127-191

Attention:	Operations .	*Final Report:*	**345233-0**
Client:	**VEOLIA WATER**	*Report Issue Date:*	**13-Dec-2019**
Address:		*Received Date:*	**28-Nov-2019**
Client Reference:	**Hawea Ponds Monthly Nov 2019 - Resample**	*Sampled By:*	**WLS**
Purchase Order:	**PO7300079228**	*Quote Reference :*	**42**

Sample Details		WATERS
Lab Sample ID:		**191127-191-1**
Client Sample ID:		
Sample Date/Time		27/11/2019 12:30
Description:		Hawea Effluent (RM 10.308.02)
General Testing		
Ammoniacal Nitrogen (as N)	mg/L	50
CBOD5 (as O2)	mg/L	15
Total Nitrogen (as N)	mg/L	71
Total Phosphorus (as P)	mg/L	7.7
Total Suspended Solids	mg/L	88
Microbiology		
Escherichia coli by Membrane Filtration		
Escherichia coli	cfu/100 mL	3000

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Reference Methods
The sample(s) referred to in this report were analysed by the following method(s)

Analyte	Method Reference	MDL	Samples	Location
General Testing				
Ammoniacal Nitrogen (as N) by Colorimetry/Discrete Analyser	ISBN 0117516139 (modified)	0.010 mg/L	All	Invercargill
Carbonaceous Biochemical Oxygen Demand, CBOD5 (as O 2) by Electrode	APHA (online edition) 5210 B	2 mg/L	All	Invercargill
Total Nitrogen (as N) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P J, 4500-NO3 H	0.010 mg/L	All	Invercargill
Total Phosphorus (as P) by Persulphate Digestion and Colorimetry/Discrete Analyser	APHA (online edition) 4500-P B, J (modified)	0.010 mg/L	All	Invercargill
Total Suspended Solids by Gravimetry	APHA (online edition) 2540 D	2.5 mg/L	All	Invercargill
Microbiology				
Escherichia coli by Membrane Filtration				
Escherichia coli	USEPA Method 1603 (2002)	2 cfu/100 mL	All	Invercargill

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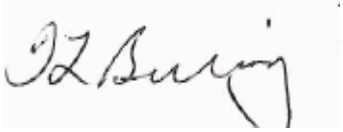

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APPENDIX D

Daily Wastewater Flow Results

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
1/12/2018	0	276	276
2/12/2018	0	283	283
3/12/2018	0	184	184
4/12/2018	51	0	51
5/12/2018	39	96	135
6/12/2018	0	99	99
7/12/2018	0	276	276
8/12/2018	0	284	284
9/12/2018	0	275	275
10/12/2018	0	285	285
11/12/2018	0	276	276
12/12/2018	0	285	285
13/12/2018	0	277	277
14/12/2018	11	283	294
15/12/2018	0	95	95
16/12/2018	0	284	284
17/12/2018	0	277	277
18/12/2018	0	282	282
19/12/2018	0	277	277
20/12/2018	0	283	283
21/12/2018	0	276	276
22/12/2018	0	285	285
23/12/2018	0	275	275
24/12/2018	0	284	284
25/12/2018	0	277	277
26/12/2018	0	282	282
27/12/2018	0	275	275
28/12/2018	0	287	287
29/12/2018	0	274	274
30/12/2018	0	283	283
31/12/2018	0	277	277
1/01/2019	0	280	280
2/01/2019	0	94	94
3/01/2019	0	275	275
4/01/2019	0	284	284
5/01/2019	0	273	273
6/01/2019	0	279	279
7/01/2019	52	122	174
8/01/2019	212	0	212
9/01/2019	4	101	105
10/01/2019	0	285	285
11/01/2019	0	278	278
12/01/2019	0	281	281
13/01/2019	0	278	278
14/01/2019	0	284	284
15/01/2019	0	275	275
16/01/2019	0	99	99
17/01/2019	0	350	350
18/01/2019	0	348	348
19/01/2019	0	356	356
20/01/2019	0	344	344
21/01/2019	0	279	279
22/01/2019	0	420	420

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
23/01/2019	0	348	348
24/01/2019	0	258	258
25/01/2019	0	0	0
26/01/2019	0	0	0
27/01/2019	0	0	0
28/01/2019	0	1	1
29/01/2019	31	0	31
30/01/2019	0	98	98
31/01/2019	0	351	351
1/02/2019	0	254	254
2/02/2019	39	0	39
3/02/2019	226	0	226
4/02/2019	97	0	97
5/02/2019	101	0	101
6/02/2019	0	98	98
7/02/2019	0	349	349
8/02/2019	0	349	349
9/02/2019	0	352	352
10/02/2019	0	346	346
11/02/2019	0	353	353
12/02/2019	0	11	11
13/02/2019	0	346	346
14/02/2019	0	354	354
15/02/2019	0	350	350
16/02/2019	0	350	350
17/02/2019	0	349	349
18/02/2019	0	353	353
19/02/2019	0	0	0
20/02/2019	0	301	301
21/02/2019	0	351	351
22/02/2019	0	350	350
23/02/2019	0	349	349
24/02/2019	0	349	349
25/02/2019	20	349	369
26/02/2019	0	86	86
27/02/2019	0	89	89
28/02/2019	0	347	347
1/03/2019	0	353	353
2/03/2019	0	347	347
3/03/2019	0	151	151
4/03/2019	0	0	0
5/03/2019	0	0	0
6/03/2019	0	0	0
7/03/2019	0	89	89
8/03/2019	0	163	163
9/03/2019	0	90	90
10/03/2019	0	247	247
11/03/2019	0	252	252
12/03/2019	0	247	247
13/03/2019	0	89	89
14/03/2019	0	248	248
15/03/2019	0	90	90
16/03/2019	0	293	293

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
17/03/2019	0	89	89
18/03/2019	0	248	248
19/03/2019	0	90	90
20/03/2019	0	161	161
21/03/2019	0	0	0
22/03/2019	50	0	50
23/03/2019	156	0	156
24/03/2019	13	87	100
25/03/2019	9	253	262
26/03/2019	246	247	493
27/03/2019	195	263	458
28/03/2019	0	90	90
29/03/2019	0	346	346
30/03/2019	0	451	451
31/03/2019	0	448	448
1/04/2019	0	437	437
2/04/2019	0	265	265
3/04/2019	0	453	453
4/04/2019	0	446	446
5/04/2019	0	452	452
6/04/2019	0	447	447
7/04/2019	0	392	392
8/04/2019	0	414	414
9/04/2019	0	320	320
10/04/2019	0	156	156
11/04/2019	0	245	245
12/04/2019	0	220	220
13/04/2019	0	221	221
14/04/2019	0	397	397
15/04/2019	0	393	393
16/04/2019	0	392	392
17/04/2019	0	394	394
18/04/2019	0	319	319
19/04/2019	0	168	168
20/04/2019	0	0	0
21/04/2019	0	0	0
22/04/2019	0	0	0
23/04/2019	114	0	114
24/04/2019	1	224	225
25/04/2019	0	400	400
26/04/2019	0	400	400
27/04/2019	0	398	398
28/04/2019	0	401	401
29/04/2019	239	266	505
30/04/2019	0	221	221
1/05/2019	126	399	525
2/05/2019	0	441	441
3/05/2019	0	598	598
4/05/2019	0	383	383
5/05/2019	38	0	38
6/05/2019	268	0	268
7/05/2019	238	0	238
8/05/2019	167	0	167

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
9/05/2019	238	0	238
10/05/2019	342	0	342
11/05/2019	181	0	181
12/05/2019	302	0	302
13/05/2019	501	0	501
14/05/2019	288	0	288
15/05/2019	304	0	304
16/05/2019	329	0	329
17/05/2019	268	0	268
18/05/2019	214	0	214
19/05/2019	299	0	299
20/05/2019	209	0	209
21/05/2019	223	0	223
22/05/2019	134	0	134
23/05/2019	189	0	189
24/05/2019	156	0	156
25/05/2019	117	0	117
26/05/2019	116	0	116
27/05/2019	133	0	133
28/05/2019	162	0	162
29/05/2019	126	0	126
30/05/2019	0	0	0
31/05/2019	538	0	538
1/06/2019	786	0	786
2/06/2019	491	0	491
3/06/2019	159	0	159
4/06/2019	152	0	152
5/06/2019	440	0	440
6/06/2019	584	0	584
7/06/2019	830	0	830
8/06/2019	421	0	421
9/06/2019	275	0	275
10/06/2019	371	0	371
11/06/2019	62	0	62
12/06/2019	145	0	145
13/06/2019	233	0	233
14/06/2019	211	0	211
15/06/2019	197	0	197
16/06/2019	275	0	275
17/06/2019	276	0	276
18/06/2019	146	0	146
19/06/2019	283	0	283
20/06/2019	403	0	403
21/06/2019	231	0	231
22/06/2019	403	0	403
23/06/2019	453	0	453
24/06/2019	359	0	359
25/06/2019	312	0	312
26/06/2019	350	0	350
27/06/2019	219	0	219
28/06/2019	237	0	237
29/06/2019	225	0	225
30/06/2019	361	0	361

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
1/07/2019	173	0	173
2/07/2019	316	0	316
3/07/2019	181	0	181
4/07/2019	252	0	252
5/07/2019	400	0	400
6/07/2019	330	0	330
7/07/2019	198	0	198
8/07/2019	328	0	328
9/07/2019	300	0	300
10/07/2019	143	0	143
11/07/2019	251	0	251
12/07/2019	369	0	369
13/07/2019	311	0	311
14/07/2019	414	0	414
15/07/2019	251	0	251
16/07/2019	367	0	367
17/07/2019	213	0	213
18/07/2019	301	0	301
19/07/2019	223	0	223
20/07/2019	226	0	226
21/07/2019	251	0	251
22/07/2019	278	0	278
23/07/2019	314	0	314
24/07/2019	310	0	310
25/07/2019	275	0	275
26/07/2019	348	0	348
27/07/2019	370	0	370
28/07/2019	336	0	336
29/07/2019	335	0	335
30/07/2019	354	0	354
31/07/2019	357	0	357
1/08/2019	321	0	321
2/08/2019	180	0	180
3/08/2019	170	0	170
4/08/2019	256	0	256
5/08/2019	134	0	134
6/08/2019	136	0	136
7/08/2019	259	0	259
8/08/2019	199	0	199
9/08/2019	162	0	162
10/08/2019	211	0	211
11/08/2019	210	0	210
12/08/2019	193	0	193
13/08/2019	174	0	174
14/08/2019	160	0	160
15/08/2019	149	0	149
16/08/2019	146	0	146
17/08/2019	114	0	114
18/08/2019	147	0	147
19/08/2019	130	0	130
20/08/2019	135	0	135
21/08/2019	154	0	154
22/08/2019	88	0	88

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
23/08/2019	946	0	946
24/08/2019	835	0	835
25/08/2019	163	0	163
26/08/2019	293	0	293
27/08/2019	512	0	512
28/08/2019	463	0	463
29/08/2019	419	0	419
30/08/2019	344	0	344
31/08/2019	259	0	259
1/09/2019	215	0	215
2/09/2019	141	0	141
3/09/2019	79	0	79
4/09/2019	63	0	63
5/09/2019	106	0	106
6/09/2019	126	0	126
7/09/2019	149	0	149
8/09/2019	192	0	192
9/09/2019	193	0	193
10/09/2019	66	0	66
11/09/2019	58	0	58
12/09/2019	95	0	95
13/09/2019	233	66	299
14/09/2019	0	498	498
15/09/2019	0	482	482
16/09/2019	0	544	544
17/09/2019	0	507	507
18/09/2019	0	14	14
19/09/2019	0	0	0
20/09/2019	0	225	225
21/09/2019	0	552	552
22/09/2019	0	411	411
23/09/2019	0	202	202
24/09/2019	0	332	332
25/09/2019	0	186	186
26/09/2019	0	51	51
27/09/2019	0	0	0
28/09/2019	11	0	11
29/09/2019	96	0	96
30/09/2019	257	0	257
1/10/2019	0	84	84
2/10/2019	0	431	431
3/10/2019	0	552	552
4/10/2019	0	549	549
5/10/2019	0	333	333
6/10/2019	0	308	308
7/10/2019	0	212	212
8/10/2019	0	2	2
9/10/2019	0	2	2
10/10/2019	0	2	2
11/10/2019	0	2	2
12/10/2019	0	2	2
13/10/2019	0	549	549
14/10/2019	0	535	535

Date	Discharge to trench (m^3)	Irrigation discharge (m^3)	Total discharge (m^3)
15/10/2019	0	81	81
16/10/2019	0	59	59
17/10/2019	0	79	79
18/10/2019	0	409	409
19/10/2019	0	159	159
20/10/2019	0	0	0
21/10/2019	87	0	87
22/10/2019	189	0	189
23/10/2019	238	0	238
24/10/2019	206	0	206
25/10/2019	0	100	100
26/10/2019	0	552	552
27/10/2019	0	550	550
28/10/2019	0	378	378
29/10/2019	8	0	8
30/10/2019	43	0	43
31/10/2019	0	99	99
1/11/2019	46	452	498
2/11/2019	170	0	170
3/11/2019	211	0	211
4/11/2019	197	0	197
5/11/2019	193	0	193
6/11/2019	130	0	130
7/11/2019	0	110	110
8/11/2019	0	547	547
9/11/2019	0	535	535
10/11/2019	54	175	229
11/11/2019	190	0	190
12/11/2019	168	0	168
13/11/2019	130	108	238
14/11/2019	122	0	122
15/11/2019	225	77	302
16/11/2019	142	163	305
17/11/2019	450	0	450
18/11/2019	185	0	185
19/11/2019	293	0	293
20/11/2019	153	0	153
21/11/2019	151	0	151
22/11/2019	86	0	86
23/11/2019	186	97	283
24/11/2019	175	0	175
25/11/2019	90	0	90
26/11/2019	163	106	269
27/11/2019	153	173	326
28/11/2019	141	0	141
29/11/2019	127	0	127
30/11/2019	98	0	98

APPENDIX E

Nitrogen Mass Balance Spreadsheet

Total N_{tot} input on LTA (kg/ha)	1,188
Total N_{tot} input on LTA (kg)	2,769

Mean % NH4-N in tot N	63%
Ammonia Volatilisation (%)	15
Soil Loss Factor	19.5
Nitrogen Losses (kg)	538.7

Total N_{tot} discharged into Trench (kg)	2,100

N exported (Dry Matter) kg/ha -1st cut	89.8
N exported (Dry Matter) kg/ha -2nd cut	52.0
N exported (Dry Matter) kg/ha -3rd cut	100.9
N exported (Dry Matter) kg -1st cut	209.3
N exported (Dry Matter) kg -2nd cut	121.1
N exported (Dry Matter) kg -3rd cut	235.1

	Yes	No
Number days of trench discharge	189	176
Number days of irrigation	182	183

Quantity WW discharged to trench (m^3)	42,419
Quantity of Tot. Nitrogen discharged to trench (kg)	2,100
Quantity WW irrigated (m^3)	49,914
Total Volume (m^3)	92,333

Date	Outlet Nitrogen conc. Average (mg/L)	Hawea WWTP Irrigation LTA (m3)	NH4-N conc. Outlet (mg/l)	Total Nitrogen applied by Irrigation (kg)	Monthly Nitrogen applied by Irrigation (kg/ha)	Monthly NH4-N applied by Irrigation (kg/ha)
Dec-18	55.0	7,752	38.0	426.4	183.0	126.4
Jan-19	65.0	6,641	43.0	431.7	185.3	122.6
Feb-19	56.0	6,785	42.0	380.0	163.1	122.3
Mar-19	52.0	5,432	38.0	282.5	121.2	97.9
Apr-19	22.0	8,841	3.8	194.5	83.5	14.4
May-19	27.0	1,821	13.0	49.2	21.1	10.2
Jun-19	39.0	0	30.0	0.0	0.0	0.0
Jul-19	46.0	0	38.0	2.7	1.2	0.0
Aug-19	55.0	0	39.0	0.0	0.0	0.0
Sep-19	110.0	4,070	43.0	447.7	192.1	75.1
Oct-19	62.0	6,029	42.0	373.8	160.4	108.7
Nov-19	71.0	2,543	50.0	180.6	77.5	54.6
Average	**55.0**	**4,160**	**35.0**	**230.7**	**99.0**	**61.0**

Date	Daily Average Nitrogen applied by irrigation (kg/ha/d)	Daily Average NH4-N applied by irrigation (kg/ha/d)	Daily Median Nitrogen applied by irrigation (kg/ha/d)	Daily Median NH4-N applied by irrigation (kg/ha/d)	Hawea WWTP Trench Discharge (m^3)	Nitrogen discharged to trench (kg)
Dec-18	5.9	4.08	6.54	4.52	101	5.6
Jan-19	6.0	3.95	7.76	5.13	299	19.4
Feb-19	5.8	4.37	8.36	6.27	483	27.0
Mar-19	3.9	3.16	3.59	2.90	669	34.8
Apr-19	2.8	0.48	3.36	0.58	354	7.8
May-19	0.7	0.33	0.00	0.00	6,206	167.6
Jun-19	0.0	0.00	0.00	0.00	9,890	385.7
Jul-19	0.0	0.00	0.00	0.00	9,075	417.5
Aug-19	0.0	0.00	0.00	0.00	8,062	443.4
Sep-19	6.4	2.50	0.00	0.00	2,080	228.8
Oct-19	5.2	3.51	2.24	1.51	771	47.8
Nov-19	2.6	1.82	0.00	0.00	4,429	314.5
Average	**3.27**	**2.0**	**2.7**	**1.7**	3,535	175.0

Date	NH4-N discharged to trench (kg)	NH4-N/N Tot	Nitrogen losses (SLF) (kg)
Dec-18	3.8	69.1%	83.0
Jan-19	12.9	66.2%	84.0
Feb-19	20.3	75.0%	73.9
Mar-19	25.4	73.1%	55.0
Apr-19	1.3	17.3%	37.8
May-19	80.7	48.1%	9.6
Jun-19	296.7	76.9%	0.0
Jul-19	344.9	82.6%	0.5
Aug-19	314.4	70.9%	0.0
Sep-19	89.4	39.1%	87.1
Oct-19	32.4	67.7%	72.7
Nov-19	221.5	70.4%	35.1
Average	120.3	63.0%	

APPENDIX F

Maintenance Records

Preventative Maintenance Task Schedule

PM Schedule	PM Description	Perform Every	Period
QTN-HWA-R-0006	1 Monthly Inspection - Hawea WWTP effluent irrigation inspection	1	Months
QTN-QTN-R-0064	1 Monthly Inspection Maintenance - Grounds	1	Months
QTN-QTN-R-0110	1 Weekly Inspection/Validate - Online Analysers - Hawea WWTP	7	Days
QTN-HWA-R-0008	1 Weekly Inspections - Hawea WWTP	7	Days
QTN-QTN-R-0038	1 Yearly Compliance - Service Fire Extinguisher	1	Years
QTN-HWA-R-0002	1 Yearly Inspection - Hawea WWTP effluent irrigation	1	Years
QTN-QTN-R-0049	1 Yearly Inspection - Site Safety	1	Years
QTN-HWA-R-0003	1 Yearly Maintenance - Commission Hawea WWTP effluent irrigation	1	Years
QTN-HWA-R-0004	1 Yearly Maintenance - Decommission Hawea WWTP effluent irrigation	1	Years
QTN-WKA-R-0040	1 Yearly Maintenance - Hawea WWTP Ponds Aerator	1	Years
QTN-QTN-R-0003	2 Yearly Inspection - Electrical Panel	2	Years
QTN-HWA-R-0001	6 Monthly Inspection - Hawea WWTP effluent irrigation	6	Months

Manual Maintenance Tasks

Type	Date Completed	Description
Manual	4/02/2019 10:16	Hawea Ponds - aerators fault 31/1/19
Manual	20/02/2019 14:30	Hawea Ponds Repair lock on shed door Jan 2019
Manual	15/03/2019 7:30	Hawea WWTP RTU signalling alteration 25/2/19
Manual	28/02/2019 15:42	Hawea WWTP investigate comms fault 24/2/19
Manual	9/07/2019 8:59	Hawea WWTP repair irrigation pump 2 - 28/2/19
Manual	15/03/2019 7:31	Hawea WWTP Aerators check 19/2/19
Manual	18/09/2019 14:43	Hawea WWTP Cut and Harvest March 2019
Manual	1/05/2019 12:41	Hawea WWTP irrigation pump 2 high current 1/4/19
Manual	16/04/2019 15:54	Hawea Ponds Replace DO probe cap Apr 2019
Manual	18/09/2019 15:15	Hawea WWTP Cut and Harvest May 2019
Manual	31/05/2019 13:00	Hawea Ponds - high level alarm 30/5/19
Manual	10/09/2019 14:45	Hawea Ponds clear broom August 2019
Manual		Hawea Ponds Investigate faulty aerator August 2019
Manual	10/09/2019 14:46	Hawea Ponds - high level alarm 21/8/19
Manual	10/09/2019 14:46	Hawea Ponds - swale valve fault 24/8/19
Manual		Hawea WWTP irrigation no scada alarm on fault 24/10/19
Manual		Hawea WWTP low flow to irrigation alarm 21/11/19
Manual	3/12/2019 13:46	Hawea Cut and carry Harvest Nov 2019

APPENDIX G

Hawea River Water Sampling Results

Hawea River sample results

Note: Sampling of the river commenced in May 2019 in response to wastewater concentration non-compliances and subsequent discussions with the ORC

Date and Time	Ammoniacal Nitrogen mg/L	Total Nitrogen mg/L	Dissolved Reactive Phosphorus mg/L	E. *coli* cfu/100mL	pH	Total Oxidised N mg/L	Total Suspended Solids mg/L	BOD_5 mg/L	Total Phosphorus mg/L
DWSNZ MAV (GV in italics)	*1.24*								
ANZECC physicochemical (upland river)	0.01	0.295							
ANZECC toxicity 95%ile trigger level	0.9								
Microbiological Guidelines - Recreational				260					
Schedule 15 - ORC Regional Plan: Water for Otago. Receiving Water Group 3			0.005	50					
Upstream Hawea River									
20/05/2019	<0.01	0.05	<0.005	<10	7.66	<0.01	<2.5	3	<0.01
20/06/2019	<0.01	0.06	<0.005	<10	7.55	<0.01	3.4	<2.0	<0.01
23/07/2019	<0.01	0.07	0.005	<10	7.69	0.02	<2.5	<2.0	<0.01
20/08/2019	<0.01	0.04	<0.005	<10	7.7	0.02	3.9	<2.0	0.02
19/09/2019	<0.01	<0.01	<0.005	<1.0	7.46	0.02	<2.5	<2.0	<0.01
21/10/2019	<0.005	0.036	0.0039	<1.6	7.7	0.03	1.6	0.77	0.004
18/11/2019	<0.01	0.08	0.005	<1.0	7.52	0.01	<2.5	<2.0	0.02
Downstream Hawea River									
20/05/2019	<0.01	0.04	<0.005	10	7.65	<0.01	<2.5	2.9	<0.01
20/06/2019	<0.01	0.14	0.008	41	7.50	<0.01	<2.5	<2.0	<0.01
23/07/2019	<0.01	0.08	<0.005	<10	7.67	0.01	<2.5	<2.0	<0.01
20/08/2019	<0.01	0.06	<0.005	<10	7.59	0.01	<2.5	<2.0	<0.01
19/09/2019	<0.01	<0.01	<0.005	<1.0	7.51	0.02	<2.5	<2.0	<0.01
21/10/2019	0.016	0.038	<0.002	4.9	7.8	0.02	<1.0	0.63	<0.004
18/11/2019	<0.01	0.08	<0.005	1	7.9	0.01	<2.5	<2.0	0.02

Downstream samples that are highlighted red are because they are higher than the upstream sample value.

Figure G.1: Map Indicating Location of Upstream and Downstream Sampling Point

APPENDIX H

ERPRO (2019) QLDC Lake Hawea WWTP Nitrogen Reduction Implementation

ERPRO
Assess + Optimise Performance

QLDC

Lake Hawea WWTP

Nitrogen Reduction Implementation

Whitianga, 20/09/2019

Contents

1. Report Structure

Chapter 2 presents a summary and conclusions of the on site assessment of the three options for nitrogen reduction. Chapter 3 contains the commercial assessment of the three options, while Chapter 4 explains the three options including detailed test results.

2. Executive Summary

ERPRO Environmental Ltd was tasked by the Queenstown Lakes District Council (QLDC) to develop the implementation procedure to improve the nitrogen reduction capacity of the Lake Hawea wastewater treatment plant (WWTP) based on the findings delivered in the 19/08/2019 report.

The three options considered for the Nitrogen (N) reduction procedure for the WWTP were

a) Ammonia reduction using Zeolite
b) Ammonia volatilisation by increasing the operational pH combined with intensive mixing
c) Biological N reduction enhancement

Based on a cost benefit analysis (Table 1) the optimum procedure to reduce the ammonia levels is by increased ammoniacal nitrogen volatilisation by raising the pond pH and forced gas stripping using part of the existing irrigation pumping station. This option is the most economical and safe procedure for reducing the increased total ammoniacal nitrogen levels safely below the RC requirements. The initial increase of the pond pH should be generated by addition of quick lime. Later in the process, naturally occurring high pH levels can be utilised for improved ammonia reduction. The required capital expense is small and chemical costs are negligible.

Option	kg N reduced after 21 days	k$ spent	$/kg N reduced
External Bio-treatment	163	107.0	657
pH Increase	144	17.7	122
Zeolite	151	52.6	349

Table 1: Project Summary identifying N reduction by pH increase as preferred option

Appendix 5.3 presents a conceptual set-up using the existing irrigation pump.

3. Commercial Assessment

Addition of Zeolite is a very secure procedure to reduce ammoniacal nitrogen. However minerals are only good for one treatment (waste chemical). After treatment the minerals sink to the bottom and are lost. Furthermore, in case internal biological processes are not ignited, further applications after 2 to 3 weeks would be necessary if nitrogen levels hike up again. Hence the price as quoted by Blue Pacific Minerals makes this option quite expensive.

External biological treatment is considered safe (biomass from Wanaka WWTP) but too expensive to set up.

Reduction of ammoniacal nitrogen was tested successfully and the rates identified suggest that after approximately three weeks of operation (using the existing pump set up for irrigation) RC compliance is achievable.

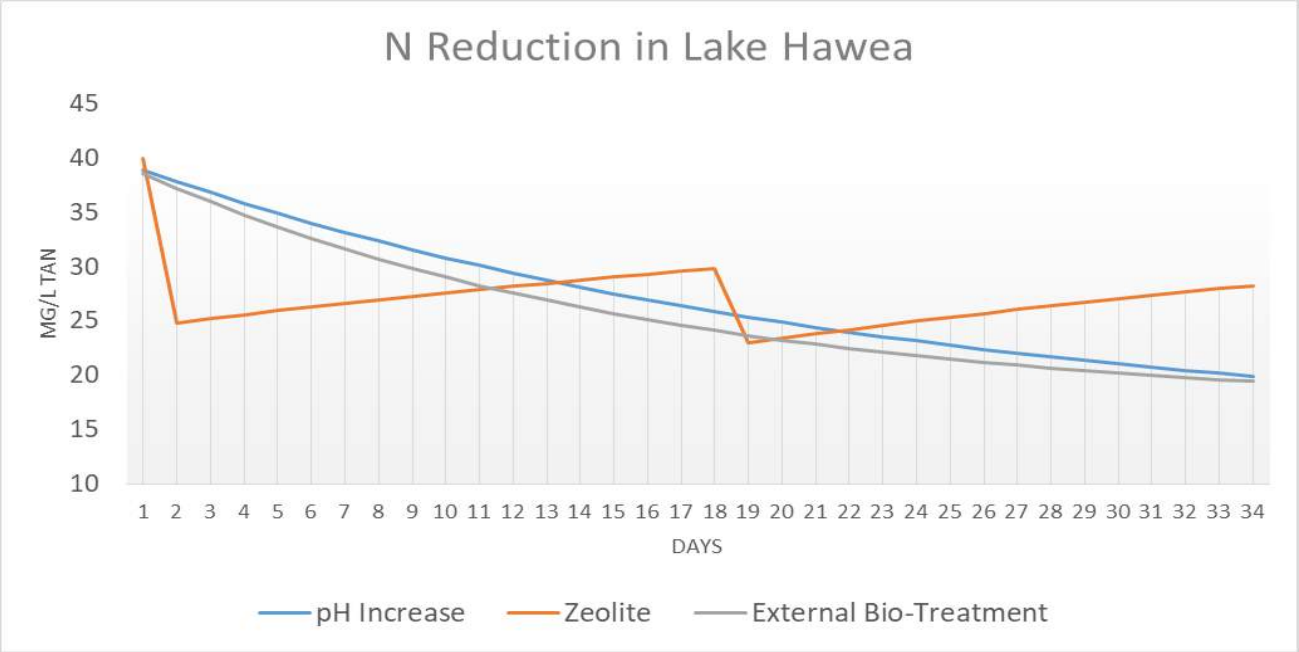


Chart 1: Summary Ammoniacal Concentrations in WWTP during treatment

Chart 2 below shows a commercial comparison including the parameters evaluated during the course of this assessment.

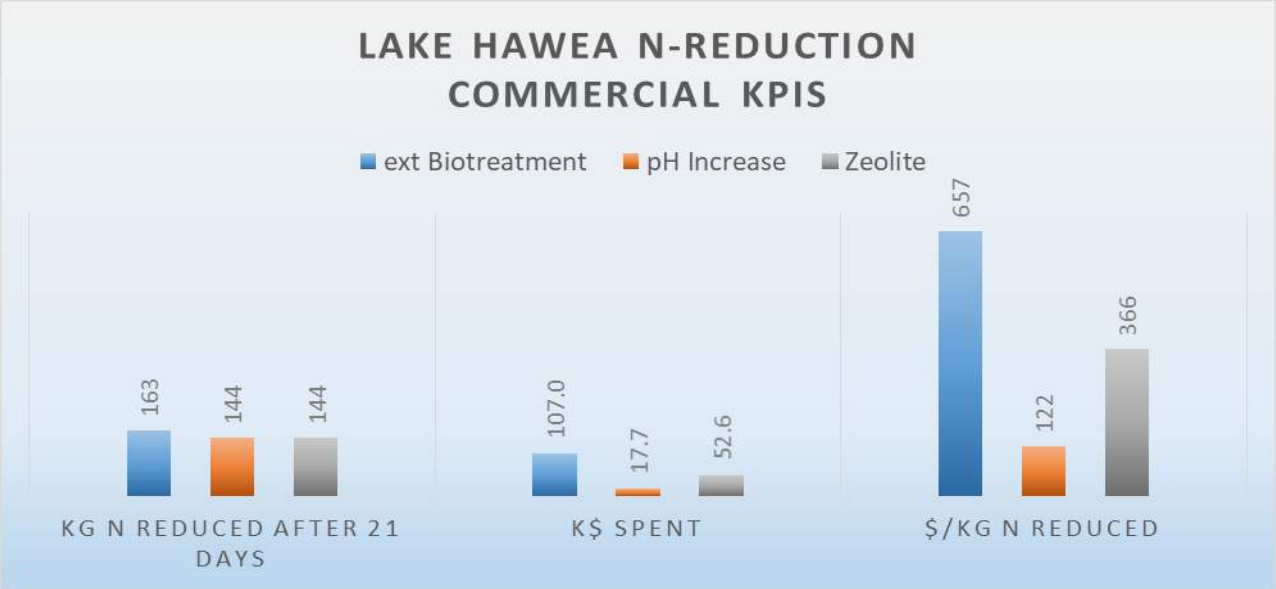


Chart 2: Summary commercial KPIs

4. Technical Assessment of Options

4.1. Zeolite

4.1.1. Background

Zeolite is of volcanic origin and is created when volcanic rock and ash layers react with alkaline ground water. The Zeolite used for the tests is a New Zealand natural product. Zeolites are well known for their high cation exchange capacity (CEC) which allows them to adsorb cations like Ammonia. As there are plenty of ions in wastewater it is better to test the efficacy of Zeolites on site. Zeolites are used in wastewater treatment applications worldwide for improvement of Nitrogen reduction tasks.

The tests that were conducted show that the Zeolites are capable of reducing approximately 2.3 g N/kg Zeolite within 2 hours of contact time. The biggest portion of the cation exchange (about 2/3 of the total capacity) happens within the first 15 minutes.

The initial treatment of the pond would need to lower the existing level of Ammonia from 40 ppm to approximately 25 ppm to achieve RC compliance. As the pond holds a total capacity of approximately 9,500 m^3 of water this equates to approximately 148 kg of N which need to be removed. Given the capacity of the Zeolite this results in approximately 64 tonnes of material.

The initial application of Zeolite should only be 50% of the calculated mass, which is 30 tonnes of Zeolite. The reason being is:

- Zeolite reacts as an alkaline with wastewater, this means that Ammonia volatilisation will further improve the N reduction
- Zeolite dramatically reduces Oxygen Reduction Potential (ORP), either by increased pH or by naturally occurring processes at the surface of the minerals
- Subsequently Zeolite sparks biological processes like naturally occurring oxygenation

The above factors were identified during the tests and there is good reason to conclude that this can be replicated at full scale in the pond. We expect

a) a reduction of levels of Ammonia by volatilisation of about 2 - 3 ppm (currently 0) without additional mixing after a few weeks of operation
b) a reduction of the ORP to approximately 300 mV (currently 500 mV) igniting biological N reduction
c) an increase of oxygen levels to saturation (currently 30 %)

4.1.2. Technical Details

Mixing of Zeolite is a straightforward task. The amount applied needs to be spread out evenly over the pond which is 30,000 kg per 9,500 m^2 or 3.2 kg per m^2. The material consists of a mix of small and bigger particles with the bigger particles sinking to the bottom within a few minutes and the smaller particles (less than 20 µm) staying in suspension for hours or days. Even though the water turns “milky” it will produce ample oxygen within hours due to algal activity. Small particles (5 µm and less) could remain floating in the pond for weeks. We expect that there will be no interference with the irrigation system in case this would need to be in operation any time soon. The particles which stay in suspension are too small to cause a problem with above ground irrigation equipment (cut off point for irrigators usually 100 µm).

The advantage of this application is that no capital expense is required. This is relevant as the Lake Hawea WWTP will cease its operation within the next couple of years.

Once the Zeolite is applied into the pond the capacity to adsorb cations is gone. The material sinks to the bottom and stays there for good. Other options which use Zeolite in a filter type set up were discarded due to significant capital expenses. Such set up would allow to change the filter media once it is exhausted.

The material would be sourced form Blue Pacific Minerals (BPM) which have also provided materials for many other environmental projects in NZ e.g. the restoration project lead by NIWA at Lake Okaro (Rotorua). The material would be of milled grade so that only a small amount of big particles would be allowed to sink fast. A specification sheet is attached (Appendix 5.1).

4.1.3. Project Costs

BPM have sent through costs for delivering the required grade to Lake Hawea at the nominated quantity. The costs for the total of 64 tonnes which are required to achieve a compliant effluent are:

Item	Unit	Cost Item	Quantity	Cost Total
Zeolite	to	495	64	31,680
Delivery	to	210	64	13,440
Total Material				45,120
Application estimate	Lump sum	7,500	1	7,500
Cost Total				52,620

Table 2: Project Cost Summary Zeolite Addition

The load reduction in the pond within 2 days (achievement of RC compliance level) is 144 kg N. The specific costs for 1 kg of N reduced is 366 $/kg N.

We expect that naturally occurring N reduction processes would take over and only one application using 64 tonnes would be required. As mentioned earlier it seems preferable to apply only half of the material first and monitor the pond to check whether it comes back into action.

In case no biological activity is initiated another dose of approximately 30 tonnes would need to be administered within a fortnight (this is based on 350 g N increase per day in the pond leading to 150 kg of Zeolite requirement daily).

The same procedure would need to be applied every year as there will be no change in water chemistry of the wastewater inflow.

4.2. Ammonia Volatilisation

4.2.1. Background

Ammonia volatilisation is the process referring to stripping ammoniacal nitrogen as gas out of the water phase. This phenomenon depends on the pH of the media. The higher the pH the more ammoniacal nitrogen is in solution and can be stripped out. The process is also temperature dependent (the higher the temperature the bigger the efficacy).

Gas stripping requires an intense exchange between the outer gas phase and the media. Stirring and natural gas exchange via the pond surface is not sufficient.

We recommend to target a pH level of 9.5 as this is still a natural range for pond environments but also allows significant N stripping results.

4.2.2. Technical Details

The tests that were performed showed that at pH of 9.5 and 18 °C 1.8 g $N/m^3.h$ was eliminated when starting the procedure at 38.7 g N/m^3. After 4 hours a reduction of 7.2 g N/m^3 or 18.6% (stripping efficiency of 36%) was achieved.

Heavy mixing is key for effective ammoniacal stripping and the only powerful equipment available on site is the irrigation pump. The conceptual set up includes this pump as key driving force. The discharge pipe will be connected to the irrigation piping inside the pump house leading to the SW corner of the pond where a nozzle manifold creates a water droplet shower back into the pond. This droplet shower acts as water/gas exchange tool similar to a spray tower used in water treatment.

The chemical recommended for pH increase is quick lime or $Ca(OH)_2$. The simple method of using caustic soda (sodium hydroxide) is technically possible and most likely the easiest application option. However, pond health requires more than just an increase of pH and the availability of di-valent ions e.g. Calcium or Magnesium is essential. Dosing of lime will not only increase pH but will also improve structure and morphology of the benthic sludge which is key for healthy pond operation.

The amount required to achieve a pH of 9.5 is approximately 1 mM. The initial dose to increase the whole pond to a pH of 9.5 is around 700 kg. Provision of 1 tonne is recommended to allow for continuing dosage to adjust the pH on an ongoing basis. Additional 100 – 125 kg a week are required to maintain pH levels.

Quick lime is a staple chemical for soil improvement in agriculture and horticulture. It can be purchased at agriculture centres and easily transported by light truck.

Dosing of the material could be as simple as sprinkling 70 – 75 g/m^2 (700 kg/9500m^2) by hand. Alternatively dosing of lime-milk could be arranged and the aerators could be used for mixing-in the emulsion. The accuracy of the dosing activity is not that critical compared to Zeolite as the material will mix with the entire pond body by means of dispersion.

It is also important to note that an increase of pH will reduce the ORP by 59 mV per pH unit. In our case an increase by approximately 2 pH units will bring the ORP down by 120 mV. This results in an ORP at the 300 mV mark which is good to get natural N reduction going.

4.2.3. Project Costs

The lime used for the application would be the smallest expense for the project, estimated at this stage with $ 1.50 per kg including transport or pick up. The bigger costs are the modification of the pump house to allow the pump to be used for gas stripping. The majority of the piping can be made of PVC pressure pipes, the nozzles are off the shelve 20 mm reel nozzles. Set up requires no electrical and control equipment.

Item	Unit	Cost Item	Quantity	Cost Total
Pipe Modifications	ea	11,000	1	11,000
Lime	kg	1.50	1,000	1,500
Application	ea	1,500	1	1,500
Power	$/kWh	0.17	21,600	3,672
Cost Total				17,672

Table 3: Project Cost Summary pH Increase / Volatilisation

The load reduced in the pond within 3 weeks (achievement of RC compliance level) is 144 kg N. The specific costs for 1 kg of N reduced is 122 $/kg N.

4.3. Biological Nitrogen Reduction

4.3.1. Background

Biological nitrogen reduction is currently impaired at the pond due to water chemistry. This was tested again using the pond biomass and the pond water from the WWTP. To allow further inclusion of a biological option in our assessment we have conducted a paper exercise and assumed that setting up a little external plant for nitrification / ammonia reduction using biomass from the local SBR plant could achieve reduction of ammonia without addition of chemicals. A few 30 m^3 PE rainwater tanks set up as simple SBRs could work as nitrification plants as well as external bio-augmentation systems (spilling nitrifiers back into the pond).

4.3.2. Technical Details

A total of 4 x 30 m^3 tanks would be sufficient to process approximately 350 m^3 of pond water daily. The nitrified water would get flushed back into the pond, excess sludge would also get flushed out, seeding the pond with biomass.

It is obvious that such a system requires a higher capital expense. Operational costs are moderate (seeding, maintenance and power consumption). Plant control would be based on simple timer settings. The impact should one of the tanks fail is small with regards to environmental effects which classifies this operation as low risk.

4.3.3. Project Costs

The biggest component for this option is set up and installation. No external chemicals would need to be procured.

Item	Unit	Cost Item	Quantity	Cost Total
Nitrification SBR mini tanks	ea	23,000	4	92,000
Operation incl. power	Lump sum	15,000	1	15,00
Cost Total				107,000

Table 4: Project Cost Summary external nitrification

The load reduced in the pond within 3 weeks (achievement of RC compliance level) is 163 kg N. The specific costs for 1 kg of N reduced is 657 $/kg N.

5. Appendix

5.1. Zeolite Specifications

Blue Pacific MINERALS

PO Box 67, Tokoroa 3444, New Zealand
Phone +64 7 885 0550 Fax +64 7 886 0024
Email info@bpmnz.co.nz. Website www.bpmnz.co.nz

ZEOLITE
Technical Data

PLANT Tokoroa

DESCRIPTION BPM Zeolite Products are produced from quality Hydrated Ca-Na-K Aluminosilicates / mordenite and clinoptilolite zeolite

TYPICAL CHEMICAL ANALYSIS – XRF - %

SiO_2	71	Na_2O	2.0
Al_2O_3	13	K_2O	4.0
Fe_2O_3	1.2	TiO	0.2
MgO	0.6	LOI	6.5
CaO	1.5		

TYPICAL PHYSICAL PROPERTIES

Bulk density	0.53-0.67gm/cm^3
Porosity	60%
Slurry pH	8.65 (10% aq. suspension)
CEC	100-120meq/100gm
Surface area	120-130m^2/gm
Pore size	7 Angstroms
Colour	Off white

Grade	Size Range	
	(mm)	Typical % within
Z1 DC*F	0.5-2.0	95
Z1 DAB	0-1	99
Z1 DAB+	0.5-1.2	98
Z1 DBC	1-2	95
Z1 DBDW	1.2-3.5	90
Z1 DBD	1-3	80
Z1-DBG	1-6	90
Z1 DBI	1-8	80
Z1 DCG	2-6	90

Analysis - Under

THE UNIVERSITY OF WAIKATO

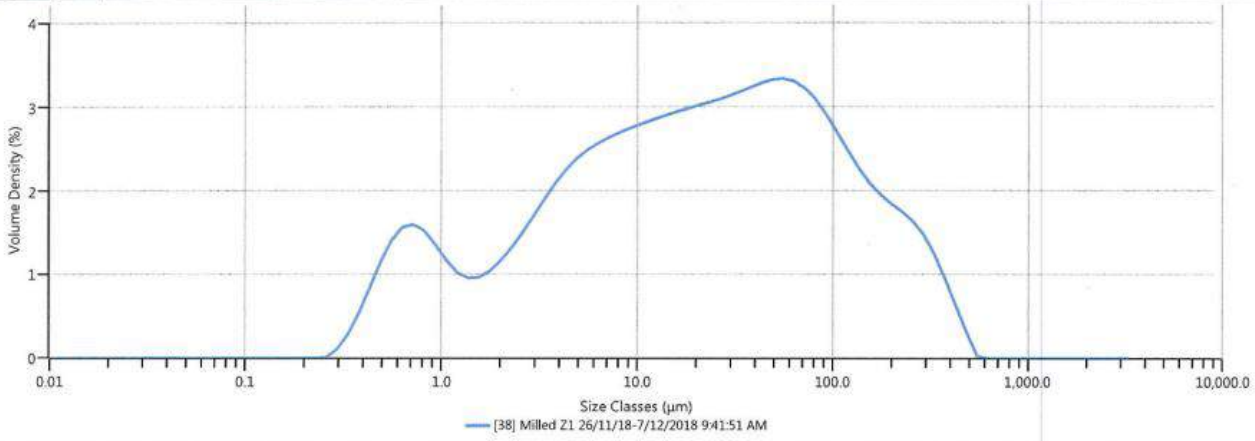
Measurement Details	
Sample Name	Milled Z1 26/11/18
SOP File Name	Zeolite.msop
Lab Number	2018277/1
Operator Name	rodgers

Measurement Details	
Analysis Date Time	7/12/2018 9:41:51 AM
Measurement Date Time	7/12/2018 9:41:51 AM
Result Source	Measurement

Analysis	
Particle Name	Zeolite A
Particle Refractive Index	1.446
Particle Absorption Index	0.010
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.49 %
Laser Obscuration	16.14 %

Result	
Concentration	0.0183 %
Span	7.718
Uniformity	2.345
Specific Surface Area	1497 m²/kg
D [3,2]	4.01 µm
D [4,3]	55.7 µm
Dv (10)	1.18 µm
Dv (50)	20.9 µm
Dv (90)	162 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0500	0.00	7.80	31.62	88.0	80.07	350	98.37	1410	100.00
0.0600	0.00	15.6	44.36	105	83.34	420	99.42	1680	100.00
0.120	0.00	31.0	57.97	125	86.26	500	99.94	2000	100.00
0.240	0.00	37.0	61.66	149	88.84	590	100.00	2380	100.00
0.490	1.94	44.0	65.34	177	91.13	710	100.00	2830	100.00
0.980	8.58	53.0	69.37	210	93.23	840	100.00	3360	100.00
2.00	13.46	63.0	73.13	250	95.20	1000	100.00		
3.90	20.52	74.0	76.56	300	97.06	1190	100.00		

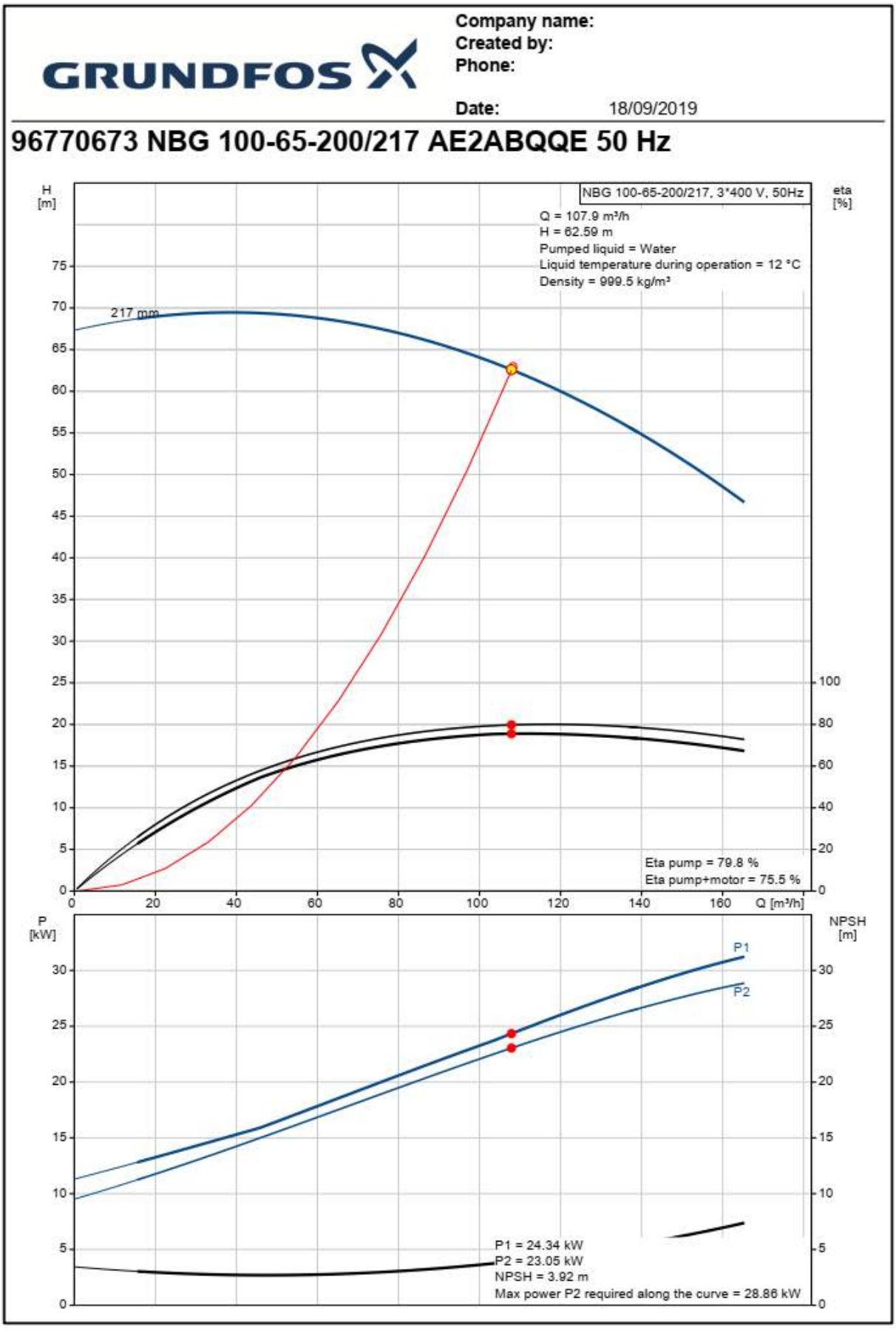
5.2. Pump duty point

GRUNDFOS

Company name:
Created by:
Phone:

Date: 18/09/2019

96770673 NBG 100-65-200/217 AE2ABQQE 50 Hz



5.3. Piping set up

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Specifications

Body : Glass Fibre Reinforced Nylon
O Ring : Nitrile Rubber
Nut & Bolt : 302 Stainless Steel
Threads: BSPT
Recommended Lubricant: Rocol MX22 Silicone Grease

Maximum Working Pressure : 7 bar (700 kpa – 100 psi) @ 20°c

Product Codes
Sizes Available:

Hose Nozzles

Code	Size
AHNS 20	20mm (3/4")
AHNS 25	25mm (1")
AHNS 32	32mm (11/4")
AHN 32	32mm (11/4")
AHN 40	40mm (11/2")
AHNT20	Trigger 20mm