Auckland Hamilton Tauranga Wellington Christchurch Invercargill

PATTLE DELAMORE PARTNERS LTD

Baseline Ecological Report – Awanui River at Kaitaia Wastewater Treatment Plant

Far North District Council

Baseline Ecological Report - Awanui River at Kaitaia Wastewater Treatment Plant

Prepared for

Far North District Council

August 2021

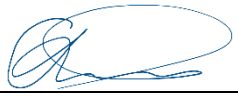
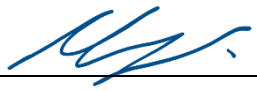
PATTLE DELAMORE PARTNERS LTD
Level 5, PDP House
235 Broadway, Newmarket, Auckland 1023
PO Box 9528, Auckland 1149, New Zealand

Tel +64 9 **523 6900**
Website **http://www.pdp.co.nz**
Auckland Hamilton Tauranga Wellington
Christchurch Invercargill

Quality Control Sheet

TITLE	Baseline Ecological Report - Awanui River at Kaitaia Wastewater Treatment Plant
CLIENT	Far North District Council
VERSION	Final
ISSUE DATE	19 August 2021
JOB REFERENCE	A03576804
SOURCE FILE(S)	A03576804R001v2.docx

DOCUMENT CONTRIBUTORS

Prepared by		
SIGNATURE		
	Amber Simmonds	Steve White
Reviewed by		Approved by
SIGNATURE		
	Emma Willmore	Hamish Jones

Limitations:

This report has been prepared by Pattle Delamore Partners Limited (PDP) on the basis of information provided by Far North District Council and others (not directly contracted by PDP for the work), including Analytica Laboratories Ltd, Watercare Laboratories Services Ltd and Environmental Impact Assessment Ltd. PDP has not independently verified the provided information and has relied upon it being accurate and sufficient for use by PDP in preparing the report. PDP accepts no responsibility for errors or omissions in, or the currency or sufficiency of, the provided information.

This report has been prepared by PDP on the specific instructions of Far North District Council for the limited purposes described in the report. PDP accepts no liability if the report is used for a different purpose or if it is used or relied on by any other person. Any such use or reliance will be solely at their own risk.

Executive Summary

Far North District Council (FNDC) engaged Pattle Delamore Partners (PDP) to undertake ecological and water quality investigations to assess the effects of the Kaitaia Wastewater Treatment Plant (WWTP) discharge on the receiving environment (Awanui River). These investigations are required to support the renewal of the Northland Regional Council resource consent AUT.000932.01.03 which authorises existing discharges from the WWTP.

PDP conducted baseline ecological and water quality surveys on the 6th and 7th of April 2021 across six representative reaches of the Awanui River. Three replicate upstream control sites were selected to represent baseline conditions within the receiving environment and three replicate downstream impact sites (two within the mixing zone and one at the end of the mixing zone) were selected to assess effects from the current WWTP discharge. In addition, samples were collected from two downstream sites on the Awanui River and within the Waihoe Channel for analysis of cyanobacteria concentrations.

Results of water quality and ecological surveys at the control sites above the WWTP discharge show degraded water quality and stream health in the receiving environment, which is likely attributable to long-term agricultural land use in the wider Awanui catchment. A comparison of control and impact sites demonstrates that ecological effects on the Awanui River from the current discharge are minimal at the end of the mixing zone (120 m downstream). Water quality results at the end of the mixing zone are compliant with the NPRP water quality standards, with the exception of *E. coli* (which also exceeds the NPRP water quality standards upstream of the discharge point).

An assessment of current and historic cyanobacteria monitoring results from the past 9 years shows that cyanotoxin levels have generally been very low. There has never been a recorded exceedance of the Red Mode alert level, specified in the New Zealand Guidelines for Cyanobacteria in Recreational Freshwater - Interim Guidelines (MfE and MoH, 2009). A variety of algae and cyanobacteria species were identified in the current investigation however all cyanotoxins analysed for were below the minimum levels of detection for the methods used. Overall, the potential effects of cyanobacteria (cyanotoxic compounds) on people and animals at the current levels discharging from the Kaitaia WWTP are considered to be minimal. Upgrade programmes for the WWTP should consider the advice provided in the Interim Guidelines (i.e., maintenance of available phosphorous concentrations in treatment ponds below 10 mg/m^3 and water temperatures below 15 degrees) in order to avoid ongoing cyanobacterial proliferation during summer.

A detailed assessment of effects from the proposed WWTP discharge, following upgrades to the Kaitaia WWTP cannot be undertaken at the time of writing, as no quantitative or qualitative data has been provided to PDP. Given the assessment of effects from the current discharge, and assuming the discharge continues in the future to the Awanui River, it can be assumed that the WWTP upgrades should improve the quality of the discharge into the Awanui River, however this will ultimately be dependent on the proposed contaminant concentrations and loads from the WWTP. If increases to either concentrations or loads are proposed, further assessment of effects will be required.

Table of Contents

Table of Figures

Table of Tables

Appendices

1.0 Introduction

Far North District Council (FNDC) has engaged Pattle Delamore Partners (PDP) to undertake ecological and water quality investigations to assess the effects of the discharge from the Kaitaia Wastewater Treatment Plant (WWTP) on the receiving environment (the Awanui River).

The Kaitaia WWTP is located approximately two kilometres (km) to the west of Kaitaia township and consists of three ponds in series. The discharge of treated wastewater from the WWTP into Awanui River is currently authorised by Northland Regional Council (NRC) resource consent AUT.000932.01.03 (NRC discharge consent), issued in 2005. This consent is due to expire in November 2021. In preparation for the renewal of the resource consent, an assessment of the ecological effects of the discharge on the receiving environment is required.

The Proposed Regional Plan for Northland (appeals version) (NPRP) regulates the discharge of treated wastewater from wastewater treatment plants and sets the water quality treatment standards for discharges. The standards are currently subject to appeals and not yet operative, however it is assumed by FNDC that appeals will be resolved and that these standards will be made operative over the next 12 months.

Harrison Grierson Ltd (HG) were commissioned by the FNDC to produce a high-level investigation (Options Report) to identify a preferred WWTP upgrade option to achieve compliance with the new water quality treatment standards of the NPRP and inform the renewal of the resource consent.

1.1 Background

FNDC hold monthly water quality compliance data from a downstream monitoring location, immediately upstream of the Waihoe Channel, as required by the NRC discharge consent. This distance has been calculated by PDP to be approximately 90 metres (m) downstream of the discharge point.
Based on the recent mixing zone definition in the NPRP, the zone of reasonable mixing has been calculated to reach 120 m downstream of the discharge point, extending immediately downstream of the Waihoe Channel. This means that FNDC's current downstream monitoring location is actually within the mixing zone for the discharge.

Compliance monitoring requirements include pH, temperature, dissolved oxygen (DO), ammoniacal-nitrogen and *Escherichia coli (E. coli).* The NRC discharge consent also requires weekly sampling in the Awanui River for blue-green algae (cyanobacteria) toxicity during periods when this is prominent in the pond discharge (summer season). It is understood that FNDC carry out an Algae Torch test programme for field measurements of blue green algae (measuring the fluorescence of the algae pigments), in addition to external lab cell counts (total and toxic cell counts).

The NRC undertake regular water quality and ecological monitoring on the Awanui River as part of their water quality monitoring network of sites (State of the Environment Monitoring). These sites are located on the Awanui River downstream of the WWTP discharge (upstream of the Waihoe Channel) and in the vicinity of NRC's public water supply take site (upstream of Kaitaia).

NIWA prepared an Assessment of Environmental Effects (AEE) to support the Awanui River public water supply take consent renewal in 2017, which reports on key freshwater values in the upper Awanui catchment (fish, macroinvertebrates, periphyton and macrophytes).

These previous ecological investigations and compliance monitoring data have been reviewed in detail and results summarised in Section 2.0 - Desktop Review.

1.2 Project Scope

The scope of PDP's investigation to assess the effects of the WWTP discharge on the Awanui River is outlined below.

- A review of existing information pertaining to the ecological value of the Awanui River and historical water quality monitoring data for the WWTP discharge.
- An ecological and water quality investigation of the Kaitaia WWTP wastewater discharge to assess effects on the receiving environment. Specifically, this included the following tasks:
  - Effects of the current discharge;
  - Potential effects of the proposed discharge;
  - Consideration of applicable work that has already been undertaken;
  - Identification of strategies to avoid, remedy or mitigate any significant adverse effects on ecological values associated with the discharge; and,
  - Recommendations for on-going monitoring to establish any trends in respect of any potentially significant long-term effects on the discharge on the receiving environment.
- An investigation into the effects of cyanobacteria contained within the WWTP discharge, including the following tasks:
  - Potential effects of cyanobacteria on people and animals, and downstream cyanobacteria populations;
  - The identification of strategies to avoid, remedy or mitigate any significant adverse effects on ecological values associated with the discharge of cyanobacteria (i.e., confirmation that the proposed WWTP upgrades will result in the avoidance of significant ecological effects); and

- Recommendations for on-going monitoring to establish any trends in respect of any potentially significant long-term effects of the discharge of cyanobacteria on the receiving environment.

2.0 Desktop Review

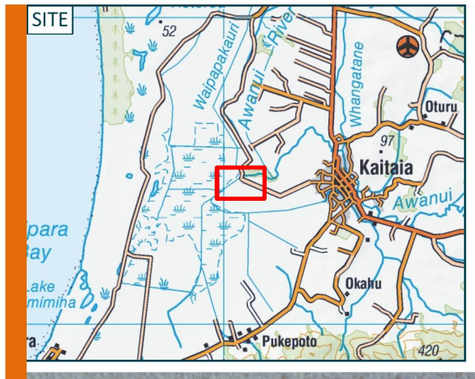
A desktop review of existing information was undertaken to provide background data on the current condition and ecological values of the Awanui River. This included a review of previous reports, WWTP compliance and NRC monitoring data, literature and database searches of water quality and ecological parameters.

2.1 Physical Environment and Water Quality

The Awanui River is a low elevation rural watercourse draining a 222 km^2 predominantly rural catchment, approximately 1 km west of Kaitaia (Ministry for the Environment (MfE), 2010 and Land, Air, Water, Aotearoa (LAWA), 2021). The mean flow and 7-day mean annual low flow in the vicinity of the discharge point is estimated at 8,053 l/s and 892 l/s respectively (LAWA, 2021). The Awanui River originates from Raetea Forest and meanders north for a significant distance through pasture and the Kaitaia township, eventually flowing into the Rangaunu Harbour (LAWA, 2021). The location of the WWTP discharge is shown in Figure 1.

NRC maintains a State of the Environment (SoE) monitoring site directly downstream of the discharge point and upstream of the Waihoe channel. At this point the Awanui River has flowed through over 30 km of agricultural land and the Kaitaia township.

Land, Air, Water Aotearoa (LAWA) contains results of the data collected by NRC for water quality and ecological indicators, analysed as state (compared to other comparable sites) and trend (change in quality over time), and provides a grade (A 'good' to E 'poor'). The Awanui River at the Waihoe Channel has 'very likely degrading' water quality according to long-term monitoring data (LAWA, 2021), provided in Table 1.



KEY :

- SAMPLE LOCATION
- RIVERS/DRAINS

0 60 120
METRES

SCALE : 1:4,000 (A3)

NO.	REVISION	DATE	BY
A	FINAL	JUL 21	MS
A	ISSUED FOR REVIEW	MAY 21	MS

SOURCE:
1. AERIAL IMAGERY (FLOWN SEPT 20) DERIVED FROM GOOGLE EARTH PRO (MAY NOT BE SPATIALLY ACCURATE).
2. CADASTRAL/TOPOGRAPHICAL INFORMATION AND INSET DERIVED FROM LINZ DATA.

CLIENT

Far North District Council

FIGURE

FIG 1: SITE AND SAMPLE LOCATION

PROJECT

KAITAIA WASTEWATER TREATMENT PLANT DISCHARGE – ASSESSMENT OF ECOLOGICAL EFFECTS

A03576804.aprx - A03576804SI001

Table 1: LAWA State and Trend Data for Awanui at Waihoe Channel

Analytes	5 Year Median (2015 -2019)	Grade	Trend
Ammoniacal nitrogen toxicity (mg/L)	0.044	C	↓↓
Total Nitrogen (mg/L)	0.53	-	NA
Total Oxidised Nitrogen (mg/L)	0.052	-	↓↓
Dissolved Reactive Phosphorus (mg/L)	0.04	D	↓↓
Total Phosphorus (mg/L)	0.093	-	↓↓
MCI Score	75.1	D	↕
MCI Taxonomic richness	15		
MCI % EPT taxa	20.8		
E. coli (n/100 ml)	270	E	↓

Notes:
Data for Awanui at Waihoe Channel obtained from LAWA (1/06/2021).
Grade refers to the National Policy Statement for Freshwater Management 2020 National Objectives Framework band.
Arrows indicate 5-year trend direction: ↑↑ = 'Very likely improving'; ↑ = 'Likely improving'; ↕ = 'Indeterminate'; ↓↓ = 'Very likely degrading'; ↓ = 'Likely degrading'; NA = 'Not assessed'.

In 2015, NRC completed a SoE Report for Northland's Environment, including the state of the Awanui River (NRC, 2015). Across all parameters there was a mix of deterioration and improvements in Northland as a whole. Data was collected monthly from the SoE site in the Awanui River between 1 January 2012 to 31 December 2014 and compared to the National Objective Framework (NOF) or ANZECC 2000.

This study reported the Awanui River to be degrading in 2015, particularly with increases in ammoniacal nitrogen over the past ten years. However, a review of water quality results over a shorter period (for the years 2012 -2014) showed an improvement in ammoniacal nitrogen concentrations (from 0.104 to 0.049 mg/L 1 year median). The remaining results show an overall decrease in water quality. A summary of data provided for the years 2012 to 2014 is provided below (Table 2).

Table 2: State of Environment grades for Awanui at Waihoe channel

		2012	2013	2014	Trend
Ammoniacal nitrogen toxicity (mg/L)	**1 year median**	0.104 (B)	0.04 (B)	0.049 (B)	↓
	1 year max	0.240 (B)	0.088 (B)	0.086 (B)	↕
Nitrate Nitrogen toxicity (mg/L)	**1 year median**	0.035 (A)	0.056 (A)	0.058 (A)	↑
	1 year 95th %	0.208 (A)	0.169 (A)	0.210 (A)	↑
MCI	**3 year mean**	75.72 (D)	70.55 (D)	61.01 (D)	↓
***E. coli*/100 ml**	**1 year median**	238 (A)	195 (A)	260.5 (A)	↑

Notes:

Arrows indicate trend: ↑ = 'Increase'; ↕ = 'Indeterminate'; ↓ = 'Decrease'.

Red denotes a negative change; green denotes a positive change.

Grade refers to the National Policy Statement for Freshwater Management 2020 National Objectives Framework band.

Grade 'D' is considered below bottom line.

2.2 FNDC Compliance Monitoring

2.2.1 Historic Water Quality Monitoring

FNDC is required to monitor the effects of the Kaitaia WWTP discharge on the Awanui River. Since 2010, FNDC has been monitoring wastewater discharges in accordance with the conditions stipulated in the NRC discharge consent.

Conditions 3 and 8 of the NRC discharge consent require monthly water quality monitoring at three locations:

- Effluent discharge from treatment plant (outlet from treatment system);
- 50 metres upstream of the Kaitaia WWTP discharge (upstream site); and,
- Immediately upstream of the confluence with the Waihoe channel (downstream site). This is specified in the consent as the downstream boundary of the mixing zone.

Water samples from the upstream and downstream sites are required to be analysed for *E. coli,* total ammoniacal nitrogen, temperature, dissolved oxygen (DO) and pH. Mean values for these parameters over the monitoring period 2016-2021 and comparison to the NRC discharge consent standards is presented in Table 3.

Mean water quality monitoring results over this period indicate that discharges from the Kaitaia WWTP are compliant with the NRC discharge consent limits. A few exceptions include an increase in water temperature in October 2017 of 5 °C, and four events of *E. coli* more than doubling in value at the downstream location (latest event was November 2019). Overall, exceedances have been few with no exceedances in the last year.

Mean concentrations for *E. coli,* ammoniacal-nitrogen and temperature were marginally higher, and concentrations for DO and pH marginally lower at the downstream site compared to the upstream site. No significant differences were noted between the two sites.

Table 3: Summarised mean monthly water quality monitoring data for the 2016-2021 period

Parameter	Upstream site (US)	Downstream site (DS)	Difference	NRC Discharge Consent Limits
E. coli (cfu/100 mL)	1283 SEM 400	1287 SEM 402	5	No significant increase
Ammoniacal-N (mg/L)	0.03 SEM 0.01	0.09 SEM 0.02	0.06	<1.6 difference between US and DS
Temperature (°C)	18.01 SEM 0.46	18.12 SEM 0.47	0.12	<3°C difference between US and DS
Dissolved oxygen (mg/L)	8.85 SEM 0.12	8.82 SEM 0.13	1[1]	<20% decrease
pH	7.56 SEM 0.05	7.54 SEM 0.04	-	6.5 – 9.0

Notes:
Data provided by FNDC.
***Bold** values indicate exceedance of Resource Consent.*
1. Ratio (DS/US)

2.2.2 Historic Cyanobacteria Monitoring

The NRC discharge consent requires FNDC to undertake testing for cyanobacteria toxicity at the downstream site during the summer months when cyanobacteria growth in the treatment ponds is a recurrent issue. If cyanotoxins are present in the discharge, downstream users are required to be contacted. FNDC has in the past supplied downstream users with freshwater when cyanobacteria are considered to pose a risk to the wellbeing of stock.

FNDC has supplied historic data for water quality analyses related to cyanobacteria. These data are expressed in terms of phycocyanin concentrations. Phycocyanin is a pigment-protein complex that is found in cyanobacteria, however the New Zealand Guidelines for Cyanobacteria in Recreational Freshwaters - Interim Guidelines (MfE and MoH, 2009) do not consider phycocyanin. The Interim guidelines are expressed in terms of three alert levels: surveillance (green mode), alert (amber mode) and action (red mode). The alert levels are determined according to various measures of cyanobacteria abundance (provided in Table 4 below).

For some samples, the historic results also have total cell counts, toxic cell counts and/or toxin concentrations. Of these, only the total cell count data can be used to compare against the guidelines, and only the Surveillance (Green Mode) alert level guideline uses a total cell count guideline. Over the period from 9 January 2012 to 9 February 2021, a total of 164 samples were collected from the downstream site and analysed for total cyanobacterial cell count (c/mL). Total cyanobacterial cell counts ranged from 0 to 140,000 cells/mL. Of these 164 samples, 149 of the samples (or approximately 91%) exceeded the Surveillance (Green Mode) alert level guideline of 500 total cyanobacterial cells per mL.

Table 4: Cyanobacteria Interim Guidelines (MfE and MoH, 2009)

Alert Level	
Surveillance (Green Mode)	Situation 1: Total cyanobacteria cell count does not exceed 500 cells/mL
	Situation 2: Biovolume equivalent for total cyanobacteria does not exceed 0.5 mm^3/mL
Alert (Amber Mode)	Situation 1: Biovolume equivalent for potentially toxic cyanobacteria lies between 0.5 and <1.8 mm^3/mL
	Situation 2: Biovolume equivalent for total cyanobacteria lies between 0.5 and <10 mm^3/mL
Action (Red Mode)	Situation 1: ≥ 12 µg/L total microcystins; or biovolume equivalent ≥ 1.8 mm^3/mL of potentially toxic cyanobacteria
	Situation 2: Biovolume equivalent for total cyanobacteria ≥ 10 mm3/L

Over the period from 17 February 2014 to 9 February 2021, a total of 241 samples were collected from the sampling site 1.5 km downstream of the WWTP discharge (Farm Intake) and analysed for toxic cell count (c/mL). Toxic cell count does not relate to MfE and MoH guidelines.

Many of the samples collected from the Downstream site, and some (45) of the samples collected from the Farm Intake site, were also analysed for toxin concentrations. Although the database (FNDC Logbook) does not make it clear what type of toxins were measured, PDP confirmed with the laboratory that the toxins are total microcystin cyanotoxins. The toxin concentrations recorded were all very low, most were recorded as being less than 0.1 µg/L with a maximum recorded toxin concentration of 0.62 µg/L. The guidelines list a total microcystin cyanotoxin concentration equal to or exceeding 12 µg/L as triggering the Action (Red Mode) alert level. All of the toxin concentrations recorded for the Farm

Intake site were below the method minimum detection limits of the analysis. If the toxin concentrations refer to total microcystin cyanotoxin concentrations, then the maximum concentrations of cyanotoxic compounds were significantly less than guideline values that would trigger management action.

While it appears that the Awanui River immediately downstream from the Kaitaia WWTP discharge has had total cyanobacterial cell counts that would exceed the Surveillance (Green Mode) guideline, the concentrations of cyanotoxins have not reached levels that would breach the Action (Red Mode) guideline over the period from January 2012 to February 2021.

2.3 Ecology

2.3.1 Fish Assemblages

At the time of writing, 9 native fish species have been recorded within the Awanui River catchment in the New Zealand Freshwater Fish Database (NZFFD, May 2020), in addition to the freshwater shrimp (*Paratya curvirostris*). Details of these species and their conservation status are outlined in Table 5 below.

Three pest species have also been recorded – mosquito fish (*Gambusia affinia),* koi carp (*Cyprinus carpio*), and goldfish (*Carassius auratus*).

Table 5: Native fish species recorded in the Awanui River (NZFFD) and conservation status

Common Name	Scientific Name	Conservation Status
Banded kokopu	*Galaxias fasciatus*	Not threatened
Inanga	*Galaxias maculatus*	Declining
Bluegill bully	*Gobiomorphus hubbsi*	Declining
Common bully	*Gobiomorphus cotidianus*	Not threatened
Cran's bully	*Gobiomorphus basalis*	Not threatened
Giant bully	*Gobiomorphus gobioides*	Naturally uncommon
Long fin eel	*Anguilla dieffenbachia*	At Risk
Short fin eel	*Anguilla australis*	Not threatened
Smelt	*Retropinna*	Not threatened
Freshwater shrimp	*Paratya curvirostris*	Not threatened

Notes:
Conservation status from Dunn et.al., 2017 and Grainger et.al., 2018.

NIWA was engaged by FNDC to prepare an Assessment of Environmental Effects (AEE) for the renewal of the Awanui River public water supply take in 2017. This included an assessment of the ecological values and instream physical habitat of the Awanui River. Although the majority of the investigation sites were located in the upper catchment, one was within the vicinity of the WWTP. Site 1 (Awanui mainstem at Bells Rd) was situated just upstream of the Kaitaia WWTP discharge point.

The report highlighted that fish species richness in the Awanui catchment was high relative to other catchments in Northland. Approximately half of the freshwater fish species recorded in Northland were present in the Awanui catchment, and with the exception of Northland mudfish and black mudfish, all of the 13 most common fish species in Northland were identified in this study (NIWA, 2017). Freshwater fishes found at the Awanui mainstem site at Bells Rd included shortfin eel, longfin eel, inanga, redfin bully (*Gobiomorphus huttoni*), Cran's bully, giant bully, smelt, Gambusia. Eight taxa were found, seven of which were native.

2.3.2 Benthic Macroinvertebrates

Benthic macroinvertebrate sampling at NIWA's Site 1 (Awanui mainstem at Bells Rd) found the site to be dominated by the tolerant species *Potamopyrgus*, followed by EPT taxa. The MCI score was reported to be 95 which is indicative of fair to poor water quality. A greater diversity of taxa, and particularly more sensitive EPT species, were found within hard bottomed streams of the Awanui catchment (gravels and cobbles substrate) compared to soft bottomed sites (NIWA, 2017).

3.0 Methodology

A baseline ecological field survey was carried out at the Awanui River on 6th and 7th April 2021. Representative site photographs are provided in Appendix A. A small rainfall event occurred the week prior, with a cumulative 10 mm of rainfall recorded at the nearest monitoring station (Tarawhataroa @ Larmer Road, NRC). This was not considered to be a 'flushing' event (defined as three times the median flow) that could affect instream communities. Details of monitoring sites and investigations undertaken at each site is included below (Table 6).

Downstream sampling site locations could not exactly replicate the upstream sites (i.e., 50, 100, and 150 m from the discharge point) due to the presence of the Waihoe Channel. Downstream site locations were selected to enable an assessment of water quality in the Awanui River above the confluence with the Waihoe Channel (DS40 and DS80) and at the downstream boundary of the mixing zone of the WWTP discharge (DS120). Water quality samples were collected from the Waihoe Channel to better understand the inputs into the Awanui River from this watercourse.

Table 6: Monitoring Sites and Investigations Undertaken

Site code	Location	Investigations
US 50	50 m upstream of discharge point	Habitat assessment, water quality, macroinvertebrate survey, continuous logger deployment
US 100	100 m upstream of discharge point	Habitat assessment, water quality, macroinvertebrate survey
US 150	150 m upstream of discharge point	Habitat assessment, water quality, macroinvertebrate survey
DS 40	40 m downstream of discharge point, upstream of the Waihoe channel	Habitat assessment, water quality, macroinvertebrate survey, continuous logger deployment
DS 80	80 m downstream of discharge point, upstream of the Waihoe channel. In vicinity of NRC SoE site and FNDC downstream compliance monitoring site.	Habitat assessment, water quality, macroinvertebrate survey, cyanobacteria sampling
DS 120	120 m downstream of discharge point. End of mixing zone and downstream of Waihoe channel confluence.	Habitat assessment, water quality, macroinvertebrate survey

Table 6: Monitoring Sites and Investigations Undertaken		
Site code	**Location**	**Investigations**
Waihoe Channel	100 m downstream of the discharge point	Water quality, cyanobacteria sampling
Farm Take	Approx. 1.5 km downstream of the discharge point	Cyanobacteria sampling

3.1 Physical Habitat Assessment

At each site, Waikato Regional Council (WRC) habitat assessment forms were modified and used to make a qualitative assessment of the stream based on instream, riparian, and bank features. This involved assessing the stream hydraulic conditions, channel and riparian features, stream-bottom substrata, instream plant cover and presence of organic material.

WRC habitat assessment forms were used to assess the reach-scale habitat quality, by scoring the reach out of 20 on the following parameters: riparian vegetative zone width, vegetative protection, bank stability, channel sinuosity, channel alteration, sediment deposition, pool variability, abundance and diversity of habitat, and presence of periphyton (Appendix B).

3.2 Water Quality and Cyanobacteria

Water quality monitoring was conducted while treated wastewater was being discharged into the Awanui River.

Grab samples were taken from within the Awanui River at three replicate sites upstream and downstream of the WWTP discharge point. Samples were collected as per standard procedures in laboratory supplied sample bottles and were sent to Analytica Laboratories for water quality analysis and to Watercare Laboratories for cyanobacteria analysis.

Spot measurements of water quality field parameters (temperature, electrical conductivity (EC), pH, dissolved oxygen (DO), and turbidity) were also taken at each monitoring site to identify broadscale spatial variance in water quality. *In-situ* water quality measurements were collected using a calibrated water quality probe (YSI Pro Plus).

To gain a better understanding of the potential effects of the WWTP discharge on the receiving environment, water quality data was compared to relevant regionally-derived and national water quality guidelines. Specifically, this included the Water Quality Standards for Ecosystem Health in Rivers - NPRP, the Australian and New Zealand Guidelines (2018) Default Guideline Values (ANZG (2018) DGV) and the National Policy Statement for Freshwater Management (2020) (NPS-FM) National Bottom Line values (Table 7).

Table 7: Threshold water quality values following relevant guidelines

Parameter	Water Quality Standards for Ecosystem Health in Rivers -Northland Proposed Regional Plan[1]	ANZG (2018) Default Guideline Values[2,3]	NPS-FM (2020) National Bottom Line
pH	6.0 < pH < 9.0 (Annual minimum and maximum)	7.3 - 7.7	-
Temperature (°C)	< 24[4]	-	-
Electrical Conductivity (µs/cm)	-	115	-
Dissolved Oxygen (mg/L)	≥ 4.0 (1-day min) ≥ 5.0 (7-day min)	-	4.0 (1-day min) 5.0 (7-day mean min)
Dissolved Oxygen (% saturation)	-	92 - 103	-
Turbidity (NTU)	-	5.2	-
Total Suspended Solids (mg/L)	-	8.8	-
Nitrate nitrogen (mg/L)	≤ 1.0 (Annual median) ≤ 1.5 (Annual 95th percentile)	0.065	2.4 (Annual median) 3.5 (Annual 95th percentile)
Total Ammoniacal-N (mg/L)	≤ 0.24 (Annual median) ≤ 0.40 (Annual maximum)[5]	0.01	0.24 (Annual median) 0.40 (Annual maximum) [5]
Total Nitrogen (mg/L)	-	0.292	-
Dissolved Reactive Phosphorus (mg/L)	-	0.014	>0.018 (Annual median) >0.054 (Annual 95th percentile) [6]
Total Phosphorus (mg/L)	-	0.024	-
E. coli (number/100 mL)	≤ 130 (Median concentration/100 mL) ≤ 540 (95th percentile) [7]	-	540[8]
E. coli (%)	≤ 5 (% exceedances over 540) ≤ 20 (% exceedances over 260) [7]	-	-
MCI / QMCI	-	-	< 90 (MCI) / < 4.5 (QMCI)

Notes:

1. *Assumed water quality standards for discharges from Policy H.3.1 of the PRP: water quality standards from continually or intermittently flowing rivers ("Other Rivers" standards). Standards apply after reasonable mixing.*
2. *ANZG (2018) default guideline values are specific to the River Environment Classification (REC) for the study streams: Warm Wet Low-elevation.*
3. *ANZG (2018) default guideline values refer to the 80th percentile reference values, apart from pH and DO which refer to the 20th and 80th percentile.*
4. *Summer period measurement of the Cox-Rutherford Index (CRI), averaged over the five hottest days (from inspection of a continuous temperature record).*
5. *Based on pH 8 and temperature of 20 °C. Compliance with the water quality standard should be undertaken after pH adjustment.*
6. *DRP attribute band D under NPS-FM (2020) Appendix 2B – Attributes requiring action plans.*
7. *Equivalent to Attribute State Band A of the NPS-FM (2020).*
8. *National bottom-line value under NPS-FM (2020) Appendix 2B – Attributes requiring action plans.*

3.3 Sonde Installation

Two calibrated Zebra-tech D-Opto loggers were installed at representative reaches of the Awanui River, 50 metres upstream and 40 metres downstream of the Kaitaia WWTP discharge point. Loggers were used to gather continuous DO (concentration and saturation) and water temperature data from each reach, at 15-minute intervals over a period of a month (7th of April to 6th of May 2021).

3.4 Benthic Macroinvertebrates

Benthic macroinvertebrate samples were collected using Protocol C2 for soft bottomed streams (Stark *et al*., 2001). A total of six macroinvertebrate samples were collected, comprising three replicate samples from both upstream and downstream of the discharge location. A D-net with a 500 µm mesh size was used to collect dislodged macroinvertebrates. Samples were preserved in a 70-80% ethanol solution and sent to Environmental Impact Assessments Ltd for sorting using the 200 fixed count with scan for rare taxa method (Protocol P2; Stark *et al*., 2001).

A variety of commonly used metrics were used to assess the relative health of the macroinvertebrate communities, a description of the metrics used for the samples is provided below:

- Taxa richness: the number of different taxonomic groups present in a sample. Streams supporting a high number of different taxa generally indicate healthy communities;
- The number of and percent abundance of Ephemeroptera, Plecoptera, Trichoptera (EPT abundance and %EPT taxa, respectively) EPT abundance measures the number of these pollution sensitive taxa in a sample, while %EPT taxa measures the proportion of EPT within the sample. Both metrics have been calculated with the pollution tolerant *Hydroptilidae sp.* removed;
- Macroinvertebrate Community Index (MCI-sb): is designed for soft-bottomed streams and allocates macroinvertebrate taxa a score between 1 (pollution tolerant) and 10 (pollution intolerant) depending on each taxon's tolerance to organic enrichment and is based on presence/absence data; and
- Quantitative Macroinvertebrate Community Index (QMCI-sb): is designed for soft-bottomed streams and utilizes the same macroinvertebrate taxa scores as MCI. The QMCI gives an average score per taxon and is more sensitive to changes in abundance or sample size.

Stream health can be inferred from MCI and QMCI using the following table from Boothroyd & Stark (2000) (Table 8).

Table 8: Benthic Macroinvertebrate Indices			
Stream Health	**Descriptions**	**MCI**	**QMCI**
Excellent	Clean water	>120	>6.00
Good	Doubtful quality of possible mild pollution	100-119	5.00-5.99
Fair	Probable moderate pollution	80-99	4.00-4.99
Poor	Probable severe pollution	<80	<4.00

4.0 Results

4.1 Physical Habitat Assessment

Upstream

The riparian zone above the discharge point was generally suboptimal with sections of mixed native and exotic mature canopy present on the true right bank and rank exotic grass dominant on the true left bank (Photo 1 of Appendix A).

The channel was approximately 10 m wide and > 1 m deep with natural meanders. Riverbed substate was predominantly silt sand. Bank stability was moderate with some bare sections subject to erosion.

Periphyton presence was very high, with filamentous periphyton covering 50 to >75% of available substrates including woody debris within the stream channel (Photo 2 of Appendix A). Habitat for instream fauna was diverse, including undercut banks and woody debris of various sizes.

Upstream habitat quality on average scored 117.5 out of a possible 180, which falls within the suboptimal category (Appendix B).

Downstream

The riparian zone of the downstream reach below the discharge point ranked similar to the upstream site. This was again generally suboptimal with sections of mixed native and exotic mature canopy on the true right bank and rank exotic grasses on the true left bank (Photo 3 of Appendix A). More exotic shrubs and weeds were prevalent on the true right bank and canopy cover was slightly less than further upstream.

The channel was approximately 10 m wide and over >1.5 m deep. The natural meanders were less prevalent through the downstream reach as the channel was widened and straightened below the most downstream sampling point.

Periphyton was prolific through the downstream reach and appeared to have marginally less cover than the upstream site. Woody debris was less prevalent and habitat for instream fauna was slightly reduced compared to the upstream site.

Downstream habitat quality, on average, scored 103.5 out of 180, also falling within the suboptimal category (Appendix B).

4.2 Water Quality

Water quality was measured during the field survey with handheld meters and grab samples were analysed at the laboratory. There was some expected discrepancy between results from parameters analysed both in the field and in the laboratory, and field results are preferentially reported on. A summary of water quality data is presented in Table 9, full results are provided in Appendix C.

Table 9: Awanui River and Waihoe Channel - Water Quality Data

Parameter	Awanui River - Upstream			Awanui River - Downstream			Waihoe Channel	Average Upstream	Average Downstream
	US150	US100	US50	DS40	DS80	DS120			
Field measurements									
Temperature (°C)	20.2	19.5	19.7	19.7	20.0	19.2	19.7	19.8	19.6
Dissolved Oxygen (% saturation)	110.8	108.3	109.6	108.0	102.6	**72.5**	**55.7**	109.6	94.4
Dissolved Oxygen (mg/L)	10.97	9.95	9.96	9.22	9.37	6.63	5.09	10.29	8.41
Electrical Conductivity (µS/cm)	**221**	**220.4**	**222.2**	**235.3**	**236.3**	**265.4**	**282**	**221.2**	**245.7**
Turbidity (FNU)	0.94	**28.12**	1.85	**9.55**	4.40	3.32	0.67	**10.3**	**5.76**
Laboratory analysis									
Turbidity (NTU)	1.96	1.95	1.40	**5.40**	**5.36**	2.32	1.21	1.77	4.36
pH	**8.0**	**8.0**	**8.0**	**7.9**	**8.0**	7.6	**7.8**	**8**	**7.8**
Total Suspended Solids (mg/L)	<3	<3	<3	4	4	5	<3	<3	4.3
Total Nitrogen (mg/L)	<0.10	0.19	0.13	**0.38**	**0.32**	**0.32**	**0.28**	0.14	**0.34**
Total Ammoniacal-N (mg/L)	<0.005	<0.005	<0.005	**0.07**	**0.04**	<0.005	<0.005	<0.005	**0.038**
Nitrite-N (mg/L)	<0.0010	<0.0010	<0.0010	0.0185	0.0114	0.0012	<0.0010	<0.0010	0.01
Nitrate-N (mg/L)	<0.0020	<0.0020	<0.0020	0.0219	0.0092	<0.0020	<0.0020	<0.0020	0.011
Total Kjeldahl Nitrogen (mg/L)	<0.10	0.19	0.13	0.34	0.30	0.32	0.28	0.14	0.32
Dissolved Reactive Phosphorus (mg/L)	0.005	0.005	0.006	**0.022**	**0.016**	0.002	0.003	0.005	0.010
Total Phosphorus (mg/L)	0.011	0.011	0.010	**0.040**	**0.035**	0.015	0.0020	0.011	**0.03**
Biochemical Oxygen Demand (mg O_2/L)	<1	<1	<1	<1	<1	5.38	<1	<1	2.46
E. coli (MPN/100 mL)	*170*	*170*	*200*	*170*	*140*	78	16	*180*	*129.3*

Notes:

Italics indicate water quality exceeds the Northland Proposed Regional Plan standards.

***Bold** values indicate exceedance of ANZG (2018) DGV for the Warm Wet Low-elevation REC code.*

Grey shaded values indicate below 'national bottom-line' values or lowest attribute band specified in NPS-FM (2020) (where available).

Field measurements of DO show an exceedance of the ANZG default guideline value (20th percentile) below the discharge point and at the end of the mixing zone (DS120), however this is likely to be influenced by the very low DO saturation levels within the Waihoe Channel, which also exceeds ANZG (2018) DGV. Turbidity exceeds the ANZG default guideline at two locations (US100 and DS40), with higher average concentrations measured above the discharge.

Water quality analytical results show an increase in nutrient concentrations below the discharge point. Within the mixing zone (sites DS40 and DS80) concentrations of total nitrogen (TN), total ammoniacal nitrogen (NH3-N), dissolved reactive phosphorous (DRP), and total phosphorous (TP) exceed default guideline values for ANZG. DRP exceeds NPS-FM (2020) directly below the discharge point at site DS40. However, at the end of the mixing zone and downstream of Waihoe Channel, nutrient concentrations generally decrease to below default guideline values, with the exception of TN, which still exceeds ANZG (2018) DGV. It is noted that TN also exceeds ANZG (2018) DGV within the Waihoe Channel, which may be contributing to elevated concentrations at this location.

Turbidity and total suspended solids (TSS) are reported to be marginally higher at the end of the mixing zone compared to upstream sites, and pH is marginally lower. These values are compliant with relevant default guidelines at the end of the mixing zone.

Biochemical Oxygen Demand (BOD) is below detection limits within the mixing zone. A higher concentration was reported at DS120; however, this is inconsistent with other results and is unlikely to be attributable to the WWTP discharge.

E. coli concentrations are lower below the WWTP discharge compared to the upstream control reach. All *E. coli* results reported in the Awanui River exceed the NPRP water quality standard of 130 mpn/100 (median concentration) which is equivalent to the Attribute A Band of the NPS-FM (2020). It is noted however that this comparison is indicative only due to spot measurements and is not directly comparable to default guidelines. Attribute states should be determined by using a minimum of 60 samples over a maximum of five years.

4.2.1 Continuous Diurnal Water Quality Monitoring

Water Temperature

Water temperature at both upstream and downstream sites decreased during the monitoring period and this decrease followed a diurnal cycle (i.e., peak daily temperatures were recorded in the afternoon and minimum temperatures recorded around sunrise) as shown in Figure 2. Diurnal variation was the most notable variation with little difference between the upstream and downstream

locations. For example, values recorded from the upstream site ranged between 12.9 and 20.0°C, while values recorded from the downstream reach ranged between 13.1 and 20.1°C. A steady decline in temperature also corresponds with the expected seasonal change. The peak daily temperatures recorded from both reaches were below the NPRP standard for water temperature for the entire continuous monitoring period.

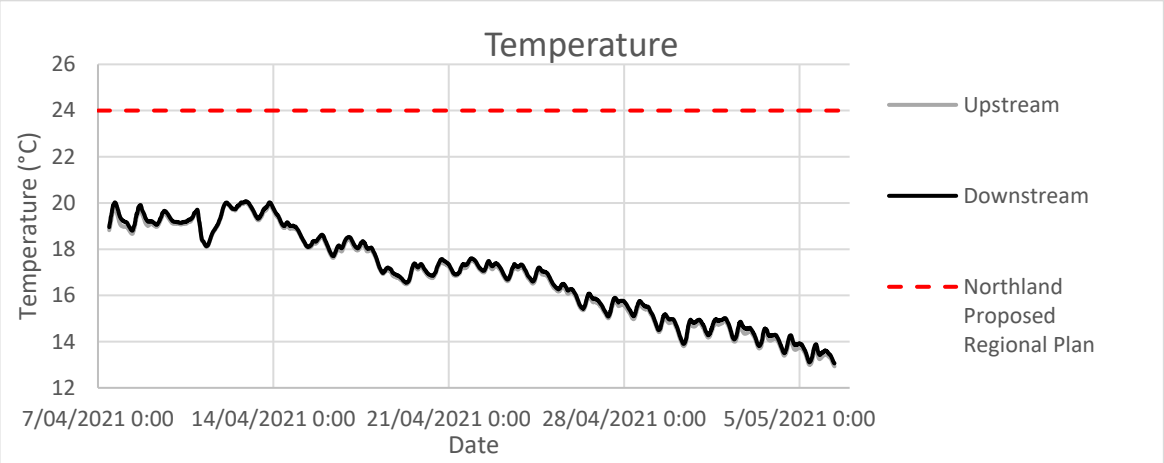


Figure 2: Awanui River continuous water temperature data

Dissolved Oxygen

Continuous DO concentration and saturation data are presented in Figures 3 and 4. A diurnal pattern was evident at both upstream and downstream reaches over the first 12 days, steadily cycling to peak in the afternoon and reaching a daily minimum soon before sunrise. Sensor fouling occurred on the downstream sensor after this point which was unable to be retrieved for cleaning due to high water levels.

DO measurements recorded from the upstream reach were consistently higher than those downstream. The range of DO concentrations and saturations recorded for the upstream reach prior to fouling were 7.68-11.64 mg/L and 82-127.28%, respectively. In contrast, downstream DO concentrations and saturation ranged between 6.48-9.42 mg/L and 70.2-103.36%. Downstream DO concentrations and saturations were above the NPRP standard of 4.0 mg/L early in the month and would likely have stayed in this range, in line with upstream concentrations had sensor fouling not occurred.

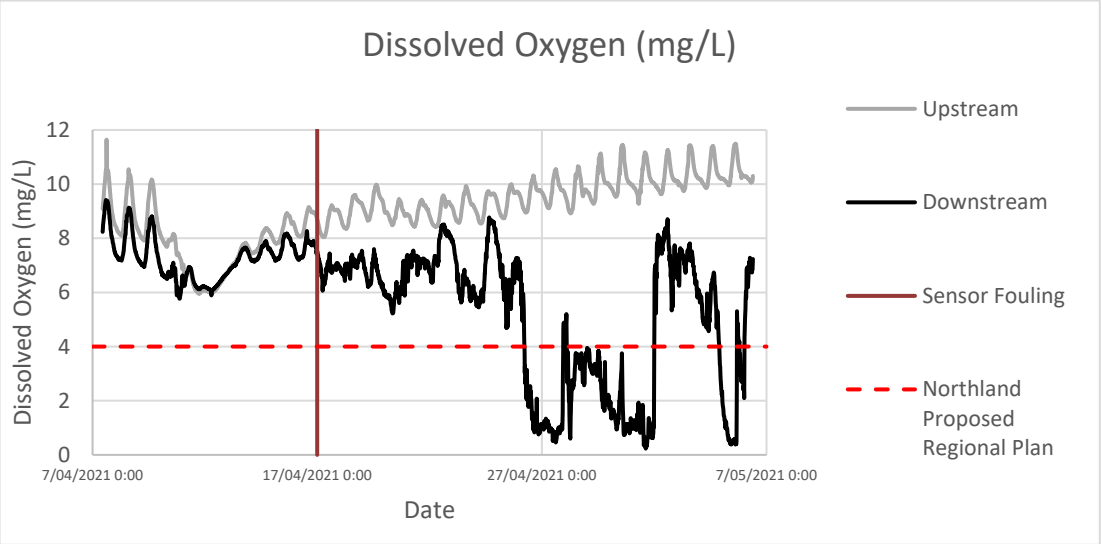


Figure 3: Awanui River continuous dissolved oxygen concentration data

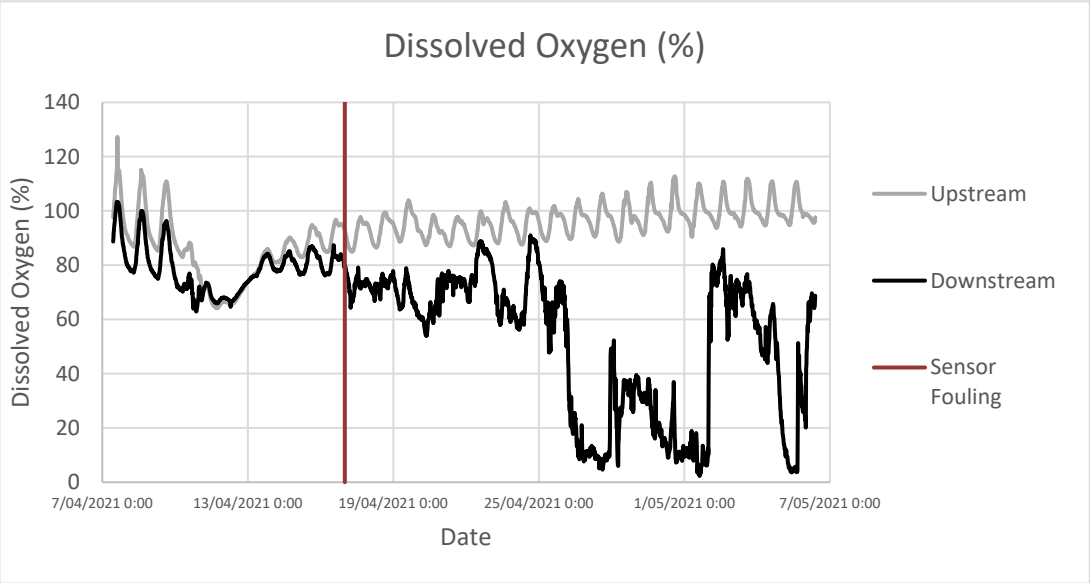


Figure 4: Awanui River continuous dissolved oxygen saturation data

4.3 Cyanobacteria

Samples were collected 40 m downstream (Downstream) and approximately 1.5 km downstream (Farm Intake) of the WWTP discharge. A sample was also collected from the Waihoe Channel for comparison. The results of the cyanobacteria analyses are presented in Table 10.

The sample collected from the site immediately downstream of the WWTP discharge showed the highest total cyanobacteria count (12,000 cells/mL). Further downstream the cyanobacteria count was lower (5,300 cells/mL). The Waihoe Channel had the lowest cyanobacteria count with 200 cells/mL. As discussed, the Cyanobacteria Interim Guidelines are expressed in terms of three alert levels: surveillance (green mode), alert (amber mode) and action (red mode). The alert levels are determined according to various measures of cyanobacteria abundance, outlined in Table 4.

Table 10: Cyanobacteria Results

Stream Health	Downstream	Farm Intake	Waihoe
Algae and cyanobacteria cells (cells/mL)	13,000	5800	500
Algae and cyanobacteria colonies (colonies/mL)	550	350	230
Cyanobacteria cells (cells/mL)	12,000	5,300	200
Cyanobacteria colonies (colonies/mL)	110	110	8.3
Biovolume equivalent, total cyanobacteria (μm^3/mL)	300	9	17
Biovolume equivalent, total cyanobacteria (mm^3/mL)	0.0003	0.000009	0.000017

A variety of algae and cyanobacteria species were identified in the samples including toxic species such as *Anthrospia spp., Microcystis spp.,* and *Phormidium spp.*, however, an analysis of samples for concentrations of cyanotoxic compounds showed that all cyanotoxins analysed for were below the minimum levels of detection for the methods used. The results of the cyanotoxin analyses are presented in Table 11.

Table 11: Cyanotoxin Results			
Cyanotoxin compounds (µg/L)	**Downstream**	**Farm Intake**	**Waihoe**
Anatoxin-a	<0.1	<0.1	<0.1
Cylindrospermopsin	<0.02	<0.02	<0.02
Homo-anatoxin	<0.1	<0.1	<0.1
Microcystin-LR	<0.01	<0.01	<0.01
Microcystin-RR	<0.01	<0.01	<0.01
Microcystin-Total	<0.1	<0.1	<0.1
Microcystin-YR	<0.02	<0.02	<0.02
Nodularin	<0.01	<0.01	<0.01

Comparing the cyanobacteria results against the Interim Guidelines, both the Downstream and Farm Intake sites exceeded the Surveillance (Green Mode) guideline under Situation 1, however, under Situation 2, the Surveillance (Green Mode) guideline was not exceeded at these sites. The cyanobacteria results for the Waihoe site fell below the Surveillance (Green Mode) guidelines under both Situation 1 and Situation 2. Cyanobacteria results for both the Downstream and Farm Intake sites fell below the two situations that define the Alert (Amber Mode) guideline.

4.4 Benthic Macroinvertebrates

A summary of calculated macroinvertebrate community metrics are presented in Table 12, full results are provided in Appendix D.

Table 12: Summary of Macroinvertebrate Community Metrics			
Metric	**Awanui River**		**NPS-FM (2020) National Bottom Line**
	Upstream Average	**Downstream Average**	
Taxa richness	4.3	6.3	-
%EPT $_{taxa}$ [1]	23.3	0	-
MCI	**71**	**42**	< 90
QMCI	**2.14**	**2.05**	< 4.5

Notes:

1. *EPT indices exclude the pollution sensitive Hydroptilidae sp.*
2. *Results for each site are an average of three replicates. See Appendix D for lab results.*
3. *Results in bold exceed NPS-FM (2020) National bottom line guidelines.*

Macroinvertebrate community metrics were found to be lower on average in the downstream impact reach compared to the upstream control reach of the Awanui River, with the exception of taxonomic richness. However, the higher diversity (taxonomic richness) reported downstream is expected to consist of pollution tolerant taxa, given that no pollution sensitive (EPT) taxa were identified in this location.

Higher MCI and QMCI scores reported in the control reach compared to the impact reach are likely attributable to the higher quality and greater diversity of habitat identified in this location (i.e., undercut banks and woody debris).

Average MCI and QMCI scores from both control and impact reaches are indicative of 'poor' stream health and fall below the NPS-FM (2020) national bottom line guidelines.

Poor stream health and "probable severe pollution" in the Awanui River is likely a result of agricultural land use in the wider catchment. Benthic invertebrate communities are largely composed of taxa insensitive to inorganic pollution and nutrient enrichment.

5.0 Assessment of Effects from Wastewater Discharge

5.1 Effects of Current WWTP Discharge

Results of water quality sampling, habitat assessment and macroinvertebrate surveys from the control reach located upstream of the WWTP discharge show degraded water quality and stream health in the Awanui River. Upstream MCI scores are below NPS-FM (2020) national bottom line guidelines and *E. coli* concentrations in this location exceed NPRP water quality standards. Filamentous periphyton growth was obvious and prolific covering at least half of available substrates. These results are indicative of nutrient enrichment from long-term agricultural land use in the wider Awanui catchment.

Downstream of the discharge point there is evidence of further decline in some water quality parameters within the mixing zone, in particular nutrient concentrations. Within the mixing zone concentrations of TN, NH3-N, DRP and TP are elevated and exceed guideline values, however at the end of the mixing zone and downstream of Waihoe Channel (site DS120), concentrations generally decrease to below guideline values, with the exception of TN, which still exceeds ANZG (2018) DGV. This parameter also exceeds ANZG (2018) DGV within the Waihoe Channel. *E. coli* concentrations continue to exceed the NPRP standard below the discharge point. Continuous DO and temperature data recorded across a one month monitoring period showed little difference overall between upstream and downstream locations. The influence of the WWTP discharge appears to reduce DO concentrations slightly at the downstream site. Both parameters were compliant with NPRP water quality standards before the sensor was fouled on the downstream data logger. It is noted however, that direct comparison with the NPRP standard for temperature was not able to be achieved during the timeframe of this investigation, as this requires an assessment of summer temperature data, averaged over the five hottest days (from the inspection of a continuous temperature record).

MCI scores within the impact reach remain below NPS-FM (2020) guidelines and are slightly lower than the control reach. This likely corresponds to the observed reduction in instream habitat quality below the discharge point.

Overall, the results of this assessment demonstrate that effects on the water quality and ecology of the Awanui River from the current WWTP discharge at the end of the reasonable zone of mixing (120 m) is minimal, and water quality parameters are compliant with the NPRP water quality standards, with the exception of *E. coli* (which also exceeds upstream of the discharge point).

Compared to results published elsewhere (NRC, 2015; LAWA, 2021) the downstream results of this investigation showed lower NH3-N, Nitrates, TN, DRP and TP concentrations and lower *E. coli* numbers, suggesting that there may have been some improvement in water quality in this location since these reports

were published (2015 and 2019). The average MCI score reported for the downstream reach was lower than the 3 year mean reported by NRC (2015) and the 5 year median reported by LAWA (2020), indicating potential decline of instream habitat quality over time.

Results are consistent with historical water quality compliance monitoring undertaken by FNDC for the Kaitaia WWTP, which show that overall, mean discharge values from the Kaitaia WWTP are compliant with the NRC discharge consent limits for the 2016-2021 period.

Cyanobacteria was higher immediately downstream of the WWTP discharge compared to the Farm Intake site. The Waihoe Channel had the lowest cyanobacteria count and is unlikely to be contributing significant cyanobacterial numbers to the Awanui River. Some dilution appears to be occurring between the WWTP and the Farm Intake, however, both sites still exceeded the Surveillance (Green Mode) guideline under Situation 1 (out of 2). Both the Downstream and Farm Intake sites fell below the two situations that define the Alert (Amber Mode) guideline. A variety of algae and cyanobacteria species were identified in the samples including toxic species *Anthrospia spp, Microcystis spp,* and *Phormidium spp.* Concentrations of cyanotoxic compounds, however, showed that all cyanotoxins analysed for were below the minimum levels of detection, indicating species with the potential to be toxic are not releasing cyanotoxins. Considering cyanotoxin results from the past 9 years, cyanotoxin levels have generally been very low. There has never been a recorded exceedance of the Red Mode alert level. Overall, the potential effects of cyanobacteria (cyanotoxic compounds) on people and animals at the current levels discharging from the Kaitaia WWTP are considered to be minimal.

It is known that cyanotoxins like microcystin can accumulate in the tissues of organisms that are subjected to elevated cyanobacteria numbers. Wood et al (2006), documented the bioaccumulation of microcystins in the tissues of rainbow trout and while it is acknowledged that trout have not been recorded in this catchment, this study has been used as a comparative example. Dolamore et al (2017) found that cyanotoxins accumulated in eel liver at much higher concentrations than in muscle tissue. This study concluded that while eels may be an important mahinga kai species, provided the liver is discarded, the risk of adverse effects to human health from the consumption of eels is low.

Based on the concentrations of microcystins found in this study, the Cyanobacteria Interim Guidelines suggest it is unlikely that eating fish flesh as part of a regular balanced diet would result in adverse health effects. The Guidelines recommend that fish be gutted and thoroughly washed in clean tap water before eating. The assumption of low human health risk may need to be revisited if intense or prolonged cyanobacterial blooms occur.

Should the action level (red mode) cyanobacteria guideline be triggered as a result of monitoring, then signs should be erected advising the public not to consume fish from the affected areas.

A recent assessment of the effects of trade waste components of the Kaitaia WWTP discharge (PDP, 2021) shows that of the possible toxicants discharged by the treatment plant, none are expected to have an impact on the receiving environment. None of these potential toxicants are likely to result in biological accumulation in fish and the subsequent risks of adverse effects on human health as a result are considered to be minimal.

5.2 Potential Effects of Proposed Discharge

FNDC has confirmed that their preferred option for upgrading the Kaitaia WWTP is Option 1, presented in the Upgrade Options Report (HG, 2020). This option involves the removal of the existing floating wetland, upgrade to septage receiving system, aerators, baffle curtain, clarifier, chemical dosing and UV. FNDC are still to investigate and confirm the preferred combination of tertiary treatment systems as part of the concept design (as outlined in the Recommendations section of the Upgrade Options Report.

A detailed assessment of effects from the proposed discharge, following upgrades to the Kaitaia WWTP cannot be undertaken at the time of writing, as no quantitative or qualitative data has been provided to PDP. A detailed assessment would require knowledge of contaminant concentrations and loads for the proposed increase to the WWTP discharge after reasonable mixing.

Given the assessment of effects from the current discharge, and assuming the discharge continues in the future to the Awanui River, it can be assumed that the WWTP upgrades will only improve the quality of the WWTP discharge into the Awanui River and that adverse effects on the receiving environment will be minimal, however this will ultimately be dependent on the proposed future contaminant concentrations and loads from the WWTP. If an increase in either concentration or load is proposed, an effects assessment is recommended.

WWTP upgrades are recommended that will remove greater concentrations of nutrients (N and P), as a long-term strategy for further minimising potential adverse effects on water quality and ecological values in the Awanui River. According to the Interim Guidelines (MoH and MfE, 2009), control measures that maintain available phosphorus concentrations at or below 10 mg/m^3, and water temperatures at or below 15 degrees C will reduce the probability of cyanobacterial blooms. Any upgrade programme for the WWTP should consider the advice provided in the Interim Guidelines in order to avoid cyanobacterial proliferation.

Cyanobacterial monitoring should be undertaken on the effluent discharge from the WWTP and within the receiving environment. Monitoring should include parameters that reflect the current guidelines issued by MfE and MoH. In terms of planktonic cyanobacteria, this monitoring should include analysis for total cyanobacterial cell counts, biovolume equivalents for combined total of all cyanobacteria, biovolume equivalent of potentially toxic cyanobacteria and total microcystin concentrations. This sampling should be undertaken on a fortnightly basis when there is greatest potential for cyanobacterial proliferation between spring and autumn, i.e., when water temperatures in the receiving environment exceed 15 degrees C, with sampling frequency increasing in response to cyanobacterial monitoring results, as per the MfE and MoH guidelines.

5.3 Conclusion

PDP conducted a baseline ecological and water quality survey in April 2021 to characterise impacts to the Awanui River from the Kaitaia WWTP.

Results of surveys at the control sites above the WWTP discharge show degraded water quality and stream health in the receiving environment. Results are indicative of nutrient enrichment from long-term agricultural land use in the wider Awanui catchment. A comparison of control and impact sites demonstrates that effects on the water quality and ecology of the Awanui River from the current WWTP discharge are minimal at the end of the mixing zone (120 m). Water quality results at the end of the mixing zone are compliant with the NPRP water quality standards, with the exception of *E. coli* (which also exceeds upstream of the discharge point).

Cyanotoxin levels have generally been very low over the last 9 years of monitoring and there has never been a recorded exceedance of the Red Mode alert level. All cyanotoxins analysed for in the current investigation were below the minimum levels of detection for the methods used. Overall, the potential effects of cyanobacteria (cyanotoxic compounds) on people and animals at the current levels discharging from the Kaitaia WWTP, including the threat to human health resulting from biologically accumulated cyanotoxins in fish flesh, are considered to be minimal. The threat to human health from biologically accumulated trade waste toxicants is considered to be minimal.

A detailed assessment of effects from the proposed WWTP discharge, following upgrades to the Kaitaia WWTP could not be undertaken at the time of writing, as no quantitative or qualitative data has been provided to PDP. Given the assessment of effects from the current discharge, and assuming the discharge continues in the future to the Awanui River, it can be assumed that the WWTP upgrades should improve the quality of the discharge into the Awanui River however this will ultimately be dependent on the proposed increase of contaminant concentrations and loads from the WWTP.

6.0 References

ANZG. (2018). Australian & New Zealand Guidelines for Fresh and Marine Water Quality. Accessed 20/05/2020. Retrieved from https://www.waterquality.gov.au/anz-guidelines/your-location/new-zealand

Boothroyd, I., Stark, J. 2000. Use of invertebrates in monitoring. Pp. 344–373 in Collier, K.J.; Winterbourn, M.J. (Eds): New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Christchurch.

Dolamore B., Puddick J., Wood S.A. (2017). Accumulation of nodularin in New Zealand shortfin eel (*Anguilla australis*): potential consequences for human consumption. New Zealand Journal of Marine and Freshwater Research 51:321-332.

Dunn, N., Allibone, R., Closs, G., Crow, S., David, B., Goodman, J., Griffiths, M., Jack, D., Ling, N., Waters, J., and Rolfe, J. Conservation Status of New Zealand Freshwater Fishes, 2017. New Zealand Threat Classification Series 24. New Zealand Government and Department of Conservation.

Grainger, N., Harding, J., Drinan, T., Collier, K., Smith, B., Death, R., Makan, T., and Rolfe, J. Conservation Status of New Zealand Freshwater Invertebrates, 2018. New Zealand Threat Classification Series 28. New Zealand Government and Department of Conservation.

LAWA (2021). Awanui at Waihoe Channel. Land Air Water Aotearoa. Accessed 01/06/2021 via https://www.lawa.org.nz/explore-data/northland-region/river-quality/awanui-river/awanui-at-waihue-channel/).

Ministry for the Environment and Ministry of Health. 2009. New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters – Interim Guidelines. Prepared for the Ministry for the Environment and the Ministry of Health by SA Wood, DP Hamilton, WJ Paul, KA Safi and WM Williamson. Wellington: Ministry for the Environment.

Ministry for the Environment, 2010. River Environment Classification New Zealand. Accessed 1/6/2021. https://data.mfe.govt.nz/layer/51845-river-environment-classification-new-zealand-2010-deprecated/.

National Policy Statement for Freshwater Management (2020).

NIWA. (2017). Awanui River Public Water Supply Take: Assessment of Environmental Effects. Prepared for North District Council. Prepared by NIWA.

NRC. (2015). State of Environment Report 2015. Northland Regional Council. Accessed on 1/06/2021 via

https://www.nrc.govt.nz/media/opbpljxu/stateoftheenvironmentreport2015website.pdf.

Pattle Delamore Partners (2021). Kaitaia Wastewater Treatment Plant trade water effects assessment. Report prepared for Far North District Council. June 2021. 18 pp + appendices.

Stark, J.D., Boothroyd, I.K.G., Harding, J.S., Maxted, J.R. and Scarsbrook, M.R. (2001) *Protocols for sampling macroinvertebrates in wadeable streams*. New Zealand Macroinvertebrate Working Group Report No. 1. Prepared for the Ministry for the Environment.

Stark J.D. and Maxted J.R. 2007: A biotic index for New Zealand's soft-bottomed streams. *New Zealand Journal of Marine and Freshwater Research* 41: 43-61.

Wood S.A., Briggs L.R., Sprosen J., Ruck J.G., Wear R.G., Holland P.T., Bloxham M. (2006). Changes in levels of microcystins in rainbow trout, freshwater mussels and cyanobacteria in Lakes Rotoiti and Rotoehu. Environmental Toxicology 21: 205-222.

Appendix A

Site Photographs

Photograph 1. Sampling site US 100, looking downstream. Mixed exotic native mature canopy on the true right bank, rank exotic grasses on the true left bank.

Photograph 2. Vicinity of site US 150 showing prolific growth of filamentous periphyton.

Photograph 3. Site DS 80, looking upstream.

Photograph 4. Site DS 120 (below Waihoe Channel confluence) looking upstream.

Photograph 5. Waihoe channel looking downstream towards confluence with Awanui River.

Photograph 6. Waihoe Channel. Looking upstream.

Photograph 7. Cyanobacteria plume observed at the WWTP discharge point.

Photograph 8. Farm intake sampling site, looking upstream.

Appendix B

Habitat Assessment

Table B1: Habitat Assessment - reach-scale habitat quality						
Parameter	Upstream			Downstream		
	US 150	US 100	US 50	DS 40	DS 80	DS 120
1. Riparian Vegetative Zone	16	16	16	16	16	14
2. Vegetative Protection	11.5	11.5	9	10	9	7.5
3. Bank Stability	11	15	15.5	10.5	12.5	14
4 Channel sinuosity	11	11	11	9	11	6
5. Channel Alteration	20	20	20	15	20	12
6. Sediment Deposition	14	14	16	17	13	9
7. Pool Variability	16	14	13	14	14	14
8. Abundance and Diversity of Habitat	16	18	10	11	11	12
9. Periphyton	3	2	1	4	5	4
Total	**118.5**	**121.5**	**111.5**	**106.5**	**111.5**	**92.5**

Appendix C

Water Quality Results

Analytica Laboratories Limited
Ruakura Research Centre
10 Bisley Road
Hamilton 3214, New Zealand
Ph +64 (07) 974 4740
sales@analytica.co.nz
www.analytica.co.nz

Certificate of Analysis

Pattle Delamore Partners Ltd
Level 4, 235 Broadway, Newmarket
Auckland 1149

Attention: Emma Willmore
Phone: 021417519
Email: emma.willmore@pdp.co.nz

Lab Reference: 21-14991
Submitted by: Emma Willmore
Date Received: 08/04/2021
Testing Initiated: 8/04/2021
Date Completed: 16/04/2021
Order Number: Quote_21-14991
Reference: A03576804

Sampling Site:

Report Comments

Samples were collected by yourselves (or your agent) and analysed as received at Analytica Laboratories. Samples were in acceptable condition unless otherwise noted on this report.
Specific testing dates are available on request.

Water Aggregate Properties and Nutrients

	Client Sample ID		DS150	DS100	DS50	US50	US100
	Date Sampled		07/04/2021	07/04/2021	07/04/2021	07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*	21-14991-1	21-14991-2	21-14991-3	21-14991-4	21-14991-5
Total Kjeldahl Nitrogen	g/m^3	*0.1*	0.32	0.30	0.34	0.13	0.19
Total Phosphorus	g/m^3	*0.002*	0.015	0.035	0.040	0.010	0.011
Total Nitrogen	g/m^3	*0.1*	0.32	0.32	0.38	0.13	0.19
Carbonaceous Biochemical Oxygen Demand	g/m^3	*1*	5.38	<1.00	<1.00	<1.00	<1.00
Total Suspended Solids	g/m^3	*3*	5	4	4	<3	<3
Turbidity	NTU	*0.05*	2.32	5.36	5.40	1.40	1.95
pH	pH	*1*	7.6	8.0	7.9	8.0	8.0

Water Aggregate Properties and Nutrients

	Client Sample ID		US150	Waihoe
	Date Sampled		07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*	21-14991-6	21-14991-7
Total Kjeldahl Nitrogen	g/m^3	*0.1*	<0.10	0.28
Total Phosphorus	g/m^3	*0.002*	0.011	0.020
Total Nitrogen	g/m^3	*0.1*	<0.10	0.28
Carbonaceous Biochemical Oxygen Demand	g/m^3	*1*	<1.00	<1.00
Total Suspended Solids	g/m^3	*3*	<3	<3
Turbidity	NTU	*0.05*	1.96	1.21

Water Aggregate Properties and Nutrients

			Client Sample ID	US150	Waihoe
			Date Sampled	07/04/2021	07/04/2021
pH	pH	*1*		8.0	7.8

Nutrients Suite

			Client Sample ID	DS150	DS100	DS50	US50	US100
			Date Sampled	07/04/2021	07/04/2021	07/04/2021	07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*		21-14991-1	21-14991-2	21-14991-3	21-14991-4	21-14991-5
Nitrate-N	g/m^3	*0.002*		<0.0020	0.0092	0.0219	<0.0020	<0.0020
Nitrite-N	g/m^3	*0.001*		0.0012	0.0114	0.0185	<0.0010	<0.0010
Ammonia as N	g/m^3	*0.005*		<0.005	0.04	0.07	<0.005	<0.005
Dissolved Reactive Phosphorus (FIA)	g/m^3	*0.002*		0.002	0.016	0.022	0.006	0.005

Nutrients Suite

			Client Sample ID	US150	Waihoe
			Date Sampled	07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*		21-14991-6	21-14991-7
Nitrate-N	g/m^3	*0.002*		<0.0020	<0.0020
Nitrite-N	g/m^3	*0.001*		<0.0010	<0.0010
Ammonia as N	g/m^3	*0.005*		<0.005	<0.005
Dissolved Reactive Phosphorus (FIA)	g/m^3	*0.002*		0.005	0.003

Receiving Water Microbiology

			Client Sample ID	DS150	DS100	DS50	US50	US100
			Date Sampled	07/04/2021	07/04/2021	07/04/2021	07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*		21-14991-1	21-14991-2	21-14991-3	21-14991-4	21-14991-5
Enumerated E.coli	MPN/100mL	*1*		78	140	170	200	170

Receiving Water Microbiology

			Client Sample ID	US150	Waihoe
			Date Sampled	07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*		21-14991-6	21-14991-7
Enumerated E.coli	MPN/100mL	*1*		170	16

Temperature on Arrival

			Client Sample ID	DS150	DS100	DS50	US50	US100
			Date Sampled	07/04/2021	07/04/2021	07/04/2021	07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*		21-14991-1	21-14991-2	21-14991-3	21-14991-4	21-14991-5
Temp on Arrival*	°C	*0*		10.3	10.3	10.3	10.3	10.3

Temperature on Arrival

	Client Sample ID		US150	Waihoe
	Date Sampled		07/04/2021	07/04/2021
Analyte	Unit	*Reporting Limit*	21-14991-6	21-14991-7
Temp on Arrival*	°C	*0*	10.3	10.3

Method Summary

TKN (Subcontracted)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry, Discrete Analyser, APHA 4500-N_{ORG} D (modified) 4500 NH_3 F (modified) 23rd ed. 2017. Subcontracted to Hills Laboratories.
Total Phosphorus (Subcontracted)	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H 23rd ed. 2017. Subcontracted to Hills Laboratories.
TN	Sum of Total Kjeldahl Nitrogen (Subcontracted), Nitrate-N and Nitrite-N (APHA 4500 NO_3 I - Online edition). (APHA 4500-N A - Online Edition).
cBOD	Dissolved oxygen measured using a dissolved oxygen electrode after addition of the nitrification inhibitior ATU and a 5 day incubation period. (APHA 5210 B - Online edition).
Total Suspended Solids	Measured gravimetrically following filtration through glass micro-fibre filters. (APHA 2540 D - Modified - Online edition).
Turbidity	Samples analysed as received using a conventional turbidimeter. (APHA 2130 B Online edition).
pH	Samples measured as received using a conventional pH electrode. (APHA 4500 H^+ B. Online edition).
NO3-N	Calculated from oxidised nitrogen and Nitrite-N, measured colourimetrically by flow injection analysis. (APHA NO_{3-} I. Online edition)
NO2-N	Samples analysed colourimetrically by flow injection analysis following filtration. (APHA 4500-NO_3 I. Online edition).
Ammonia-N	Samples filtered and measured colourimetrically by flow injection analysis. (APHA 4500-NH_3 H - Modified - Online edition).
Dissolved Reactive Phosphorus	Samples filtered and measured colourimetrically by flow injection analysis. (APHA 4500-P G - Modified - Online edition)
Enumerated E.coli	Enyme Substrate Coliforms and E.coli (APHA 9223 B - Online Edition)
Temp on Arrival	Measured on arrival by a digital infra-red laser thermometer.

Matthew Counsell, B.Sc.
Inorganics Team Leader

Olivia Matthews, B.Sc.(Tech)
Laboratory Technician

Watercare Services Limited
52 Aintree Ave, Mangere, Auckland, 2022
PO Box 107028, Auckland, 2150
T: (09) 539 7600
clientsupport@water.co.nz
www.watercarelabs.co.nz

Certificate of Analysis
Laboratory Reference:210408-154

Attention:		*Final Report:*	**408916-0**
Client:	**PATTLE DELAMORE PARTNERS**	*Report Issue Date:*	**14-Apr-2021**
Address:	**PO Box 9528, Newmarket, 1149**	*Received Date:*	**08-Apr-2021**
Client Reference:	**Algae & Cyanotoxins**		
Purchase Order:	**Not Available**	*Quote Reference :*	**13143**

Sample Details		WATERS	WATERS	WATERS
Lab Sample ID:		**210408-154-1**	**210408-154-2**	**210408-154-3**
Client Sample ID:				
Sample Date/Time		07/04/2021	07/04/2021	07/04/2021
Description:		Farm Intake	Downstream	Waihoe
Organics				
Cyanotoxins by Liquid Chromatography-Mass Spectrometry (Trace level)				
Anatoxin-a	µg/L	<0.1	<0.1	<0.1
Cylindrospermopsin	µg/L	<0.02	<0.02	<0.02
Homo-anatoxin	µg/L	<0.1	<0.1	<0.1
Microcystin-LR	µg/L	<0.01	<0.01	<0.01
Microcystin-RR	µg/L	<0.01	<0.01	<0.01
Microcystin-Total	µg/L	<0.1	<0.1	<0.1
Microcystin-YR	µg/L	<0.02	<0.02	<0.02
Nodularin	µg/L	<0.01	<0.01	<0.01
Microbiology Special Report				
Planktons (Settled) by Microscopy				
See detailed report below		Y	Y	Y

Microbiology - Algae Details

Phytoplanktons **Sample : 210408-154-1 Farm Intake**
Sample Date : 07/04/2021

Genus	Species	Zooplankton	Cells cells/mL	Colonies colonies/mL	Biovolume µm³/mL	Rel. Total Biovolume
Division: Bacillariophyta						
Acnanthales						
Monoraphid pennates						
Cocconeis	spp.		9	9		
Bacillariales						
Biraphid pennates (external raphe)						
Nitzschia	spp.		25	25		
		Total: Bacillariophyta	34	34		
Division: Chlorophyta						
Chlorococcales						
Monoraphidium	spp.		13	13		
Scenedesmus	spp.		310	79		
Not assigned						
Actinastrum	spp.		19	3.2		
Sphaeropleales						
Null						
Desmodesmus	spp.		32	6.3		
Volvocales						
Chlamydomonas	spp.		82	82		
		Total: Chlorophyta	460	180	34	
Division: Cryptophyta						
Cryptomonadales						
Cryptomonas	spp.		9	9		
		Total: Cryptophyta	9	9	180	
Division: Cyanophyta						
Chroococcales						
Merismopedia	spp.		95	6.3		
Microcystis	spp.		380	6.3		
Refer Legend 1						
Oscillatoriales						
Arthrospira	spp.		50	3.2		
Phormidium	spp.		4,800	95		
		Total: Cyanophyta	5,300	110	9	
Division: Euglenozoa						
Euglenales						
Trachelomonas	spp.		6.3	6.3		
		Total: Euglenozoa	6.30	6.30	110	

Algae & Cyanobacteria cells	5800	
Algae & Cyanobacteria colonies		350
Cyanobacteria cells	5300	
Cyanobacteria colonies		110

Phytoplanktons **Sample : 210408-154-2 Downstream**
Sample Date : 07/04/2021

Genus	Species	Zooplankton	Cells cells/mL	Colonies colonies/mL	Biovolume µm³/mL	Rel. Total Biovolume
Division: Bacillariophyta						
Acnanthales						
Monoraphid pennates						
Cocconeis	spp.		5.5	5.5		
Bacillariales						
Biraphid pennates (external raphe)						

Nitzschia	spp.	130	130		
	Total: Bacillariophyta	140	140	6.30	
Division: Chlorophyta					
Chlorococcales					
Monoraphidium	spp.	16	14		
Pediastrum	spp.	33	2.7		
Scenedesmus	spp.	460	100		
Not assigned					
Actinastrum	spp.	16	2.7		
Sphaeropleales					
Null					
Desmodesmus	spp.	110	27		
Volvocales					
Chlamydomonas	spp.	150	150		
Zygnematales					
Closterium	spp.	5.5	5.5		
Spirogyra	spp.	5.5	2.7		
	Total: Chlorophyta	800	300	140	
Division: Cyanophyta					
Chroococcales					
Merismopedia	spp.	320	11		
Microcystis	spp.	960	8.2		
Refer Legend 1					
Oscillatoriales					
Arthrospira	spp.	43	2.7		
Phormidium	spp.	250	5.5		
Phormidium	spp.	10,000	82		
	Total: Cyanophyta	12,000	110	300	
Division: Ochrophyta					
Fragilariales					
Araphid Pennates					
Synedra	spp.	2.7	2.7		
	Total: Ochrophyta	2.70	2.70	110	
Algae & Cyanobacteria cells		13000			
Algae & Cyanobacteria colonies			550		
Cyanobacteria cells		12000			
Cyanobacteria colonies			110		

Phytoplanktons **Sample : 210408-154-3 Waihoe**
Sample Date : 07/04/2021

Genus	Species	Zooplankton	Cells cells/mL	Colonies colonies/mL	Biovolume µm³/mL	Rel. Total Biovolume
Division: Bacillariophyta						
Bacillariales						
Biraphid pennates (external raphe)						
Nitzschia	spp.		110	110		
Naviculales						
Symmetric Biraphid pennates						
Navicula	spp.		19	19		
	Total: Bacillariophyta		130	130	2.70	
Division: Chlorophyta						
Volvocales						
Chlamydomonas	spp.		14	14		
Zygnematales						
Closterium	spp.		5.5	5.5		
Desmidium	spp.		75	8.3		
Mougeotia	spp.		11	5.5		
Spirogyra	spp.		11	2.8		

		Total: Chlorophyta	120	36	36
Division: Cryptophyta					
Cryptomonadales					
Cryptomonas	spp.		17	17	
		Total: Cryptophyta	17	17	36
Division: Cyanophyta					
Oscillatoriales					
Geitlerinema	spp.		100	2.8	
Phormidium	spp.		98	5.5	
		Total: Cyanophyta	200	8.30	17
Division: Euglenozoa					
Euglenales					
Euglena	spp.		11	11	
Trachelomonas	spp.		19	19	
		Total: Euglenozoa	30	30	8.30
Division: Ochrophyta					
Fragilariales					
Araphid Pennates					
Synedra	spp.		8.3	5.5	
		Total: Ochrophyta	8.30	5.50	30

Algae & Cyanobacteria cells	500	
Algae & Cyanobacteria colonies		230
Cyanobacteria cells	200	
Cyanobacteria colonies		8.3

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

Where samples have been supplied by the client, they are tested as received.

The results of analysis contained in this report relate only to the sample(s) tested. 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
Organics				
Cyanotoxins by Liquid Chromatography-Mass Spectrometry (Trace level)				
Anatoxin-a	Masahiko Takino and Yutaka Kyono, LC/MS	0.1 µg/L	All	Auckland
Cylindrospermopsin	Masahiko Takino and Yutaka Kyono, LC/MS	0.02 µg/L	All	Auckland
Homo-anatoxin	Masahiko Takino and Yutaka Kyono, LC/MS	0.1 µg/L	All	Auckland
Microcystin-LR	Masahiko Takino and Yutaka Kyono, LC/MS	0.010 µg/L	All	Auckland
Microcystin-RR	Masahiko Takino and Yutaka Kyono, LC/MS	0.010 µg/L	All	Auckland
Microcystin-Total	Masahiko Takino and Yutaka Kyono, LC/MS	0.1 µg/L	All	Auckland
Microcystin-YR	Masahiko Takino and Yutaka Kyono, LC/MS	0.02 µg/L	All	Auckland
Nodularin	Masahiko Takino and Yutaka Kyono, LC/MS	0.010 µg/L	All	Auckland
Microbiology Special Report				
Planktons (Settled) by Microscopy				
Algae & Cyanobacteria cells	In-house method (MM50)	5 cells/mL	All	Auckland
Algae & Cyanobacteria colonies	In-house method (MM50)	5 colonies/mL	All	Auckland
Cyanobacteria cells	In-house method (MM50)	5 cells/mL	All	Auckland
Cyanobacteria colonies	In-house method (MM50)	5 colonies/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.

Watercare Laboratory Services is a division of Watercare Services Limited .

Marina Fisher
KTP Signatory

Wellington
Building 25,
480 Jackson Street,
Petone
Lower Hutt, 5012
T: (04) 595 6665

Queenstown
74 Glenda Drive,
PO Box 2614
Wakatipu
Queenstown,
T: (03) 409 0559

Invercargill
142 Esk Street
PO Box 747
Invercargill, 9840
T: (03) 214 4040
F: (03) 214 4041

Appendix D

Macroinvertebrate Results

Taxa	MCI score	MCI-sb score	US 150	US 100	US 50	DS 40	DS 80	DS 120		
			Awanui River							
Mayfly Zephlebia	7	8.8		1						
Caddisfly Triplectides	5	5.7	1	2						
Damselfly Xanthocnemis	5	1.2				1				
Dragonfly Hemicordulia	5	0.4					1			
Bug Microvelia	5	4.6				3				
True Fly Chironomus	1	3.4				103				
True Fly Orthocladiinae	2	3.2				6				
True Fly Tanypodinae	5	6.5				2				
Moth Hygraula	4	1.3	1							
Crustacea Amarinus crabs	3	5.1	2					1		
Crustacea Ostracoda	3	1.9				1				
Crustacea Paratya	5	3.6		1						
SPIDERS Dolomedes	5	6.2	1			1				
Mollusc Glyptophysa	5	0.3					1			
Mollusc Gyraulus	3	1.7					1			
Mollusc Lymnaeidae	3	1.2						4		
Mollusc Physella	3	0.1			1	59	19	11		
Mollusc Potamopyrgus	4	2.1	195	195	196	25	160	191		
Mollusc Sphaeriidae	3	2.9			1					
LEECHES	3	1.2			2		1			
Indices			**US 150**	**US 100**	**US 50**	**DS 40**	**DS 80**	**DS 120**	**DS Average**	**US Average**
Number of Taxa			5	4	4	9	6	4	6.33	4.33
EPT Value			1	2	0	0	0	0	0.00	1.00
Number of Individuals			200	199	200	201	183	207	197.00	199.67
% EPT (taxa number)			20	50	0	0	0	0	0.00	23.33
Sum of recorded scores			20.4	20.2	6.3	29.2	5.8	8.5	14.50	15.63
SBMCI Value			81.60	101.00	31.50	64.89	19.33	42.50	42.24	71.37
Sum of abundance load			432.90	433.30	417.00	463.90	341.50	412.10	405.83	427.73
QMCI-sb Value			2.16	2.18	2.09	2.31	1.87	1.99	2.05	2.14
Sub sampling Notes				5/16 squares examined	5/16 examined	3/9 square examined	1/8 squares examined	7/16 examined		

Notes

Agasicles beetle, 1 found in US100