Sensitivity: General

# Water Quality and Ecology Effects Assessment

Kaikohe Wastewater Treatment Plant

Prepared for Far North District Council
Prepared by Beca Limited

**9 June 2023**


Creative people together transforming our world

# Contents



# Appendices

## Revision History

| Revision Nº | Prepared By | Description | Date |
|---|---|---|---|
| 1 | Kimberley D’Souza and Farza Feizi | Draft for Internal Review | 08/06/2023 |
| 2 | Kimberley D’Souza and Farza Feizi | Draft for Client Review | 09/06/2023 |
| 3 | Kimberley D’Souza and Farza Feizi | Final | 20/09/2023 |
| | | | |
| | | | |

## Document Acceptance

| Action | Name | Signed | Date |
|---|---|---|---|
| Prepared by | Kimberley D’Souza and Farza Feizi | | 09/06/2023 |
| Reviewed by | Raymond Chang and Garrett Hall | | 09/06/2023 |
| Approved by | Garrett Hall | | 09/06/2023 |
| on behalf of | Beca Limited | | |

# Executive Summary

The existing Kaikohe Wastewater Treatment Plant (WWTP), owned and operated by Far North District Council (FNDC), comprises an inlet screen, an anaerobic pond, an oxidation pond and a series of constructed wetland cells. The treated wastewater from the Kaikohe WWTP is discharged to a tributary of the Wairoro Stream which eventually feeds into the main stream channel. Discharges associated with the operation of the Kaikohe WWTP are authorised by resource consent AUT.0002417.01.03 which expired on 30 November 2021; however a replacement consent application was lodged prior to expiry to continue to exercise the resource consent under section 124 of the Resource Management Act 1991 (RMA).

Beca Ltd (Beca) was engaged by FNDC to undertake an assessment of ecology and water quality within the Wairoro Stream at and around the location to provide an improved understanding of the current conditions and characteristics of the receiving environment of the Kaikohe WWTP and to assess the effects of the existing discharge during summer conditions.

Following desktop investigations, field surveys were undertaken at the Kaikohe WWTP on 18 April 2023 to conduct high level freshwater ecology assessments and water quality investigations. This included a dye dilution and dispersion study in Wairoro Stream, which was undertaken to visually define the mixing zone (the point at which full mixing of treated wastewater with the stream occurs) and guide appropriate monitoring locations. Based on the results of the dye dilution study and the available information about the proposed monitoring locations, water quality samples were collected at three upstream and three downstream monitoring locations. One sample also was collected from the discharge point in the un-named tributary.

In summary, the assessment of the effects of the current discharge on the receiving environment indicate that:

- Dissolved inorganic nitrogen (DIN) and total nitrogen (TN) concentrations downstream of the discharge point and after the mixing zone indicated increases compared with the upstream dataset. Although DIN and TN concentrations were already elevated above the guideline values at the upstream monitoring locations, the overall effect on these parameters is considered moderate because of resulting higher concentrations at downstream monitoring locations.

- There was a marked increase in the concentrations of total phosphorus (TP) and dissolved reactive phosphorus (DRP) downstream of the discharge point compared with the upstream dataset. These concentrations exceeded guideline values, therefore the overall water quality effect of DRP and TP is considered to be significant.

- Concentrations of *Escherichia coli* (*E. coli*) at downstream monitoring locations indicated minor increases in *E. coli* levels. Therefore, the discharge effect on this contaminant is considered to be low.

- There have been minor changes in levels of total suspended solids (TSS), dissolved oxygen (DO), pH and temperature between the upstream and downstream sites. As the changes are minor, the overall effect of the discharge on these parameters is negligible.

- Fauna surveying indicates the presence of sensitive macroinvertebrate species both within the upstream and downstream reaches of the WWTP discharge in the Wairoro Stream.
- Surveying undertaken between 2014, 2020, and 2023 indicate that % of EPT taxa records for the downstream reaches has increased over this time.
- The results from the 2023 sampling indicate that the treated wastewater discharge does not appear to be having an impact on the structure and species composition within this stream system when comparing the upstream and downstream sampling results, and therefore, is assessed as a Low magnitude of

effect, with an overall Low level of adverse effect. It is important to note that the magnitude and overall level of effect may be different during base flow/low flow conditions.

- The results from the 2023 sampling indicates that periphyton coverage did not significantly differ between the upstream and downstream sites and no excessive periphyton growths were identified. As such, this was assessed as a Low magnitude of effect with an overall Low level of adverse effect. It is important to note that the magnitude and overall level of effect may be different during base flow/low flow conditions.

# 1 Introduction

## 1.1 Background

Far North District Council (FNDC) owns and operates the Kaikohe Wastewater Treatment Plant (WWTP) servicing a population of approximately 4,250 people. FNDC hold a resource consent (AUT.0002417.01.03, granted by the Northland Regional Council (NRC)) to discharge treated wastewater from the Kaikohe WWTP to a tributary of the Wairoro Stream which eventually feeds into the mainstream channel. The consent expired on 30 November 2021; however a replacement consent application was lodged prior to expiry to continue to exercise the resource consent under section 124 of the Resource Management Act 1991 (RMA). That consent application is currently on hold. To renew the resource consent, FNDC are undertaking an investigation of the future treatment and discharge options at the Kaikohe WWTP. A copy of the expired resource consent (AUT.0002417.01.03) is provided in Appendix A.

## 1.2 Purpose of this Report

Alongside work with FNDC to investigate different treatment process upgrades and discharge options for the Kaikohe WWTP, Beca Ltd (Beca) was commissioned by FNDC to undertake an assessment of ecology and water quality within the Wairoro Stream at and around the location where treated wastewater is discharged from the Kaikohe WWTP into the Stream. The purpose of this assessment is to provide an improved understanding of the current conditions and characteristics of the receiving environment of the Kaikohe WWTP and assess the effects of the existing discharge during summer conditions.

This report is set out in the following sections:

- A description of the receiving environment and ecological context;
- A description of the methodology: desktop review and field investigations;
- A review of existing water quality results (historical data, Cawthron water quality surveys (2014 and 2021), recent water quality investigations (2023));
- An assessment of the WWTP discharge on water quality;
- A description of ecological values and features;
- An assessment of the ecological effects of the WWTP discharge; and
- Summary of water quality and ecological effects of the discharge on the receiving environment.

# 2 Description of the Environment and Ecological Context

### 2.1.1 Description of Environment and Location of the Kaikohe WWTP

The township of Kaikohe is situated along State Highway 12 and the Kaikohe WWTP is located along Mangakahia Road, State Highway 15 (Figure 1). Kaikohe is the largest inland town within the Far North District. The WWTP services the local Kaikohe community, Ngawha, and the Northland Region Corrections Facility.

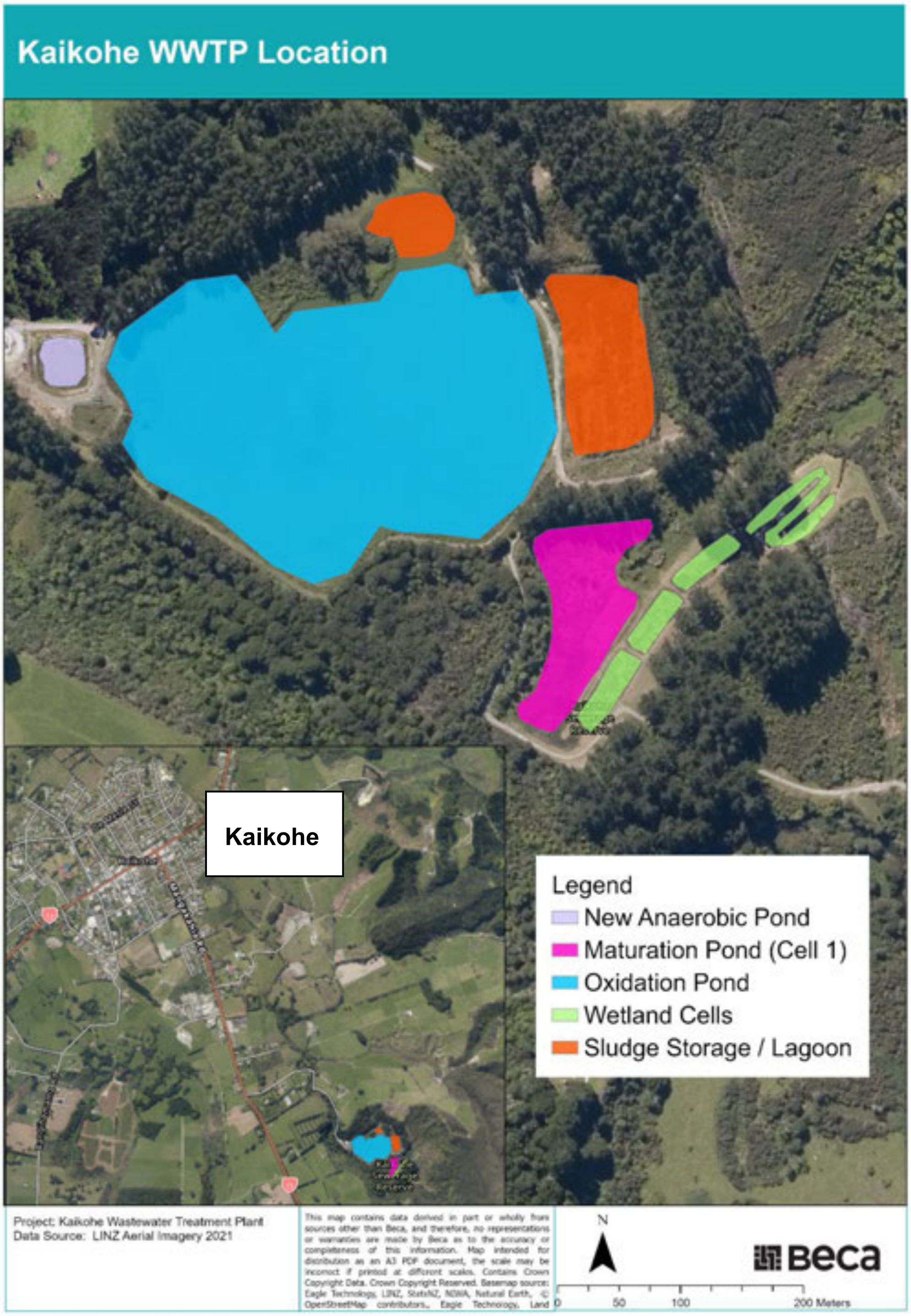



Figure 1. Kaikohe town and Kaikohe WWTP.

Sensitivity: General



The WWTP comprises of an inlet screen, an anaerobic pond, an oxidation pond, a maturation pond, and a series of three constructed wetland (CWL) cells. The final CWL discharges to an area of exotic vegetation growth, hereby referred to as "natural wetland (NWL)" and then from here discharges to the Wairoro Stream via an unnamed tributary. The WWTP also includes a sludge lagoon (to the north) and a geobag storage area (to the east of the oxidation pond) (Figure 2 and Figure 3). The quality of treated wastewater discharged from CWL and NWL are monitored by FNDC as part of the consent conditions every 14 days.

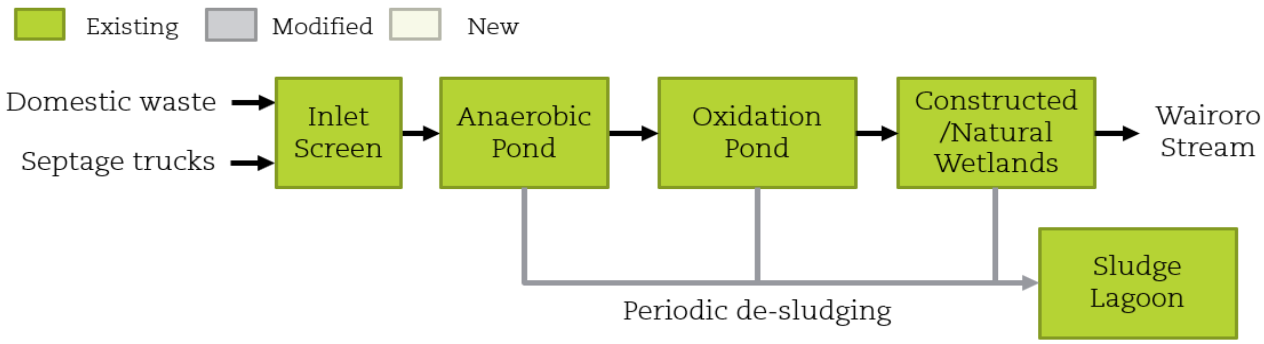



Figure 2. Diagram for the Kaikohe WWTP[1].


Figure 3. Kaikohe WWTP.

[1] Kaitaia and Kaikohe WWTP Options Assessment, Harrison Grierson, November 2020.

### 2.1.2 Ecological Context

The Wairoro Stream which the treated wastewater is discharged to, is a fourth-order stream within a predominantly pastoral catchment of 30 $km^2$. The Wairoro Stream originates north and east of the Kaikohe township through four mainstream channels and numerous tributaries. These main channels include Mangamutu Stream, Kopenui Stream, Taikawhena Stream, and a smaller unnamed channel. From there the stream channel flows through the Kaikohe district through many tributaries before eventually discharging into the Hokianga Harbour near the township of Rawene via the Punakitere River (Land Information New Zealand, n.d.). Water quality within rivers and streams across the Far North District and wider Northland region are degraded, mainly through point-source discharges, non-point source discharges, and agricultural/pastoral land uses. In addition to this, land use modification and vegetation clearance over the last 150 years has further degraded stream and river systems through contaminants diffusing into freshwater systems through surface water runoff, erosion of stream banks, increase of water temperatures, decrease of dissolved oxygen, and reduction in habitat availability for indigenous fauna.

# 3 Methodology

## 3.1 Desktop Review

A desk-based study was undertaken using ecological and water quality information from the following sources:

- The New Zealand Freshwater Fish Database: (McDowall & Richardson, 1983);
- iNaturalist: (*INaturalist*, n.d.);
- Assessment of Ammonia Effects on the Wairoro Stream Fauna Near the Kaikohe Wastewater Treatment Plant (Cawthron Institute, 2014); and
- Ecological Survey of the Wairoro Stream Near the Kaikohe Wastewater Treatment Plant (Cawthron, July 2021).

## 3.2 Field Investigations

Following the desktop investigations, field surveys were undertaken at the Kaikohe WWTP on 18 April 2023 to conduct high level freshwater assessments and collect water quality samples. The weather at the time of the visit was fine with scattered showers throughout the day, amounting to 11.6 mm of rain across the Kaikohe region. However, there was approximately 47 mm of rainfall in the two weeks prior to the site visit. This resulted in the Punakitere River (the nearest Northland Regional Council flow telemetered site) flow being 1.68 $m^3$/second at this site lower in the catchment on the day of sampling. Flows at Punakitere River in the two weeks prior to the site visit are shown in Figure 4, indicating higher flows in the river before the site visit. Sampling locations for both ecological and water quality investigations are shown in Figure 5.


Figure 4. Flow at Punakitere at Tāheke[2].

[2] https://www.nrc.govt.nz/environment/environmental-data/environmental-data-hub/?moduleId=5&collectionId=19&displayId=1&siteId=407&measurementId=96 (Punakitere at Tāheke - Flow (nrc.govt.nz).

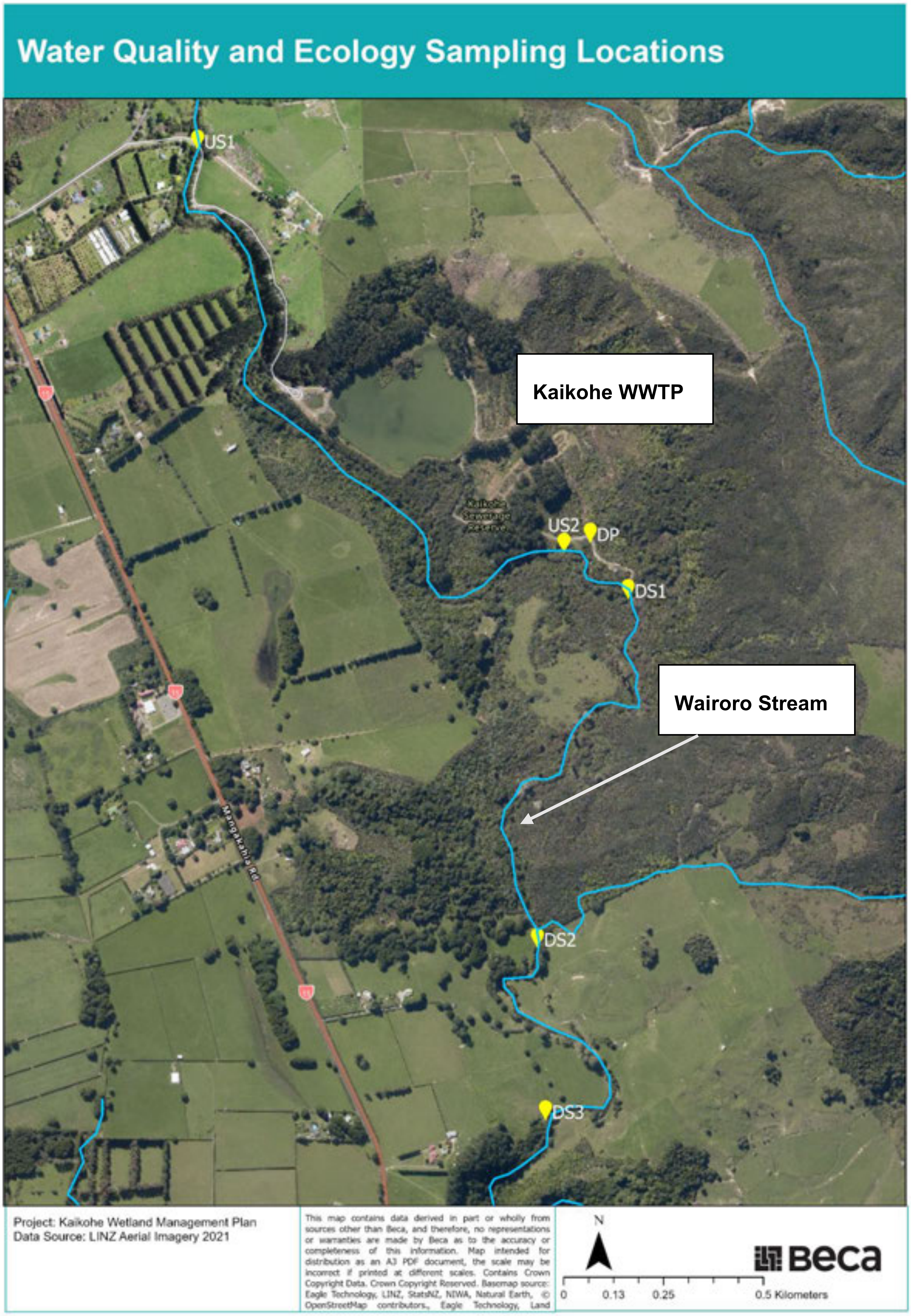



Figure 5. The upstream and downstream sampling locations for the water quality and ecology surveys.

### 3.2.1 Ecological Field Investigations

#### 3.2.1.1 eDNA sampling

Six eDNA sample was taken across the site, two samples from upstream of the discharge point (US1 and US2), one at the discharge point (DP) and three samples downstream of the discharge point within the Wairoro Stream (DS1, DS2, and DS3). Mini eDNA kits with 1.2 μm and 5 μm CA filters were used in accordance with the methodology by Wilderlab Ltd. Multi-species analyses by DNA metabarcoding were undertaken on eDNA samples by Wilderlab Ltd to produce a list of all DNA sequences detected within a broad taxonomic group (e.g., fish, insects, birds, mammals) and the number of times each appears in the sample. These DNA sequences are then compared against a reference database to assign species names and characterise the community as a whole.

#### 3.2.1.2 Macroinvertebrate community index (MCI) sampling

Five samples of MCI were collected across the site, two samples from upstream of the discharge point (US1 and US2) and three samples downstream of the discharge point within the Wairoro Stream (DS1, DS2, and DS3). MCI samples were collected using the foot-kick sampling method for hard-bottomed streams, to dislodge the upper layer of cobbles and gravel, with an MCI net placed downstream of the sampling (Stark et al., 2001). Samples were preserved in ethanol and processed by EIA Laboratory.

#### 3.2.1.3 Stream habitat assessment

Watercourse assessments were completed in general accordance with methods outlined in the Watercourse Assessment Methodology: Infrastructure and Ecology Document (Version 2.0) at each sampling location to provide a high level assessment of the existing watercourses (Lowe et al., 2016). Although this protocol was developed for watercourses in Auckland, the assessment methodology has been applied across New Zealand and provides a good base for describing ecological values of watercourses.

Data collected included: channel condition and morphology, bank and channel modification, stream bank erosion, standing water characteristics, channel shade and riparian vegetation.

#### 3.2.1.4 Periphyton abundance coverage

Periphyton coverage assessments were undertaken at each of the upstream and downstream sampling locations in accordance with the NIWA Stream Health Monitoring and Assessment Kit (SHMAK) (National Institute of Water & Atmospheric Research Ltd, 2020). At each location a transect was set up across the stream and a total of 10 observation points were chosen evenly across the transect. Observations were undertaken, where possible, in riffle and run habitats, using a bathyscope to estimate the approximate coverage of periphyton on the stream base to the nearest 1%.

#### 3.2.1.5 Assessment Methodology

An assessment of ecological effects was undertaken in accordance with Ecological Impact Assessment (EcIA) EIANZ guidelines for use in New Zealand: terrestrial and freshwater ecosystems (Roper-Lindsay et al., 2018).

The EIANZ guidelines set out a methodology to assign ecological value to species and ecosystems based on four assessment criteria which are consistent with significance assessment criteria set out in the Proposed National Policy Statement for Indigenous Biodiversity (2019) Appendix C: Criteria for identifying significant indigenous vegetation and significant habitat of indigenous fauna. These are reproduced in this report as Appendix C: Tables 1.1-1.4. In summary:

- Attributes are considered when considering ecological value or importance. They relate to matters such as representativeness, the rarity and distinctiveness, diversity and patterns, and the broader ecological context.

- Determining Factors for valuing terrestrial species; terrestrial species span a continuum of very high to negligible, depending on aspects such as whether species are native or exotic, have threat status, and their abundance and commonality at the site impacted
- Ecological Values are scored based on an expert judgement, qualitative and quantitative data collected.

Once ecological values have been identified and valued, the severity of potential impacts is assessed by determining the change from baseline ecological values likely to occur as a result of the proposal along the lines of a magnitude of effect as determined by the criteria set out in Appendix C:Table 1.5.

Finally, once these two factors have been determined (the ecological value and the magnitude of effect), an overall level of effect on each of the identified ecological values is determined by applying the matrix shown in Appendix C:Table 1.6.

### 3.2.2 Water Quality Field Investigations

#### 3.2.2.1 Dye Dilution and Dispersion Study

Undertaking a dye dilution and dispersion study during summer in Wairoro Stream was recommended by the Cawthron Institute (July 2021) (Cawthron Institute, 2021) to visually define the mixing zone (the point at which full mixing of treated wastewater with the stream occurs) and guide appropriate monitoring locations. Therefore, the water quality survey undertaken on 18 April 2023 included a dye dilution and dispersion study in Wairoro Stream.

To carry out the dye dilution and dispersion study, the steps below were taken by an environmental scientist during the site visit (18 April 2023):

1) 250 mL of a water tracer dye (Bright Dyes Fluorescent FWT Red)[3] was discharged at the discharge point of the treated wastewater from the Kaikohe WWTP (from the NWLs) in the unnamed tributary of the Wairoro Stream at 8 am. The colour of the water at the discharge point in the tributary changed to bright red and began flowing downstream towards the Wairoro stream.

2) The dispersion of the dye in the tributary and stream was monitored while walking along the tributary and stream.

3) As it was observed from approximately 150 m downstream of the discharge point (DS1), the dye was approaching from upstream, reached the DS1 site by 8:45 am and was fully mixed across the width of the stream. Vertical mixing was not measured. In the few meters upstream of DS1, the dye was mixed almost at a level similar to DS1 point.

According to the dye study, as the dye was fully mixed in the stream at 150 m downstream of the discharge point, that point was considered as the mixing zone. According to consent condition 6d, a downstream sampling point is approximately 80 m downstream of the discharge point from the unnamed tributary. However, during the site visit when Beca staff accompanied the Ventia staff, the point at 150 m downstream of the discharge point (the point which was proposed as a mixing zone by dye study) was shown as the 80 m downstream compliance point.

#### 3.2.2.2 Water Quality Sampling

Based on the results of the dye dilution study and the available information about the proposed monitoring locations, water quality samples were collected (18 April 2023) at three upstream and three downstream monitoring locations: **US1** (at the bridge on the un-named road to the WWTP), **US2a** (the upstream compliance monitoring point, approximately 25 upstream of the discharge point), **US2b** (25 m above upstream compliance

[3] The dye is an especially formulated versions of Rhodamine WT dye for use in water tracing and leak detection studies and are certified by NSF International to ANSI/NSF Standard 60 for use in potable water.

monitoring point), **DS1** (fully mixed zone from the dye dilution study, 150 m downstream of the discharge point), **DS2** (~1.1 km downstream of the discharge point) and **DS3** (~2 km downstream of the discharge point). One sample also was collected from the discharge point in the un-named tributary (**DP**). The additional upstream monitoring location at US1 (at the bridge on the un-named road to the WWTP) was selected because the anaerobic ponds at the Kaikohe WWTP are located directly adjacent to the stream. The downstream locations (DS2 and DS3) were sampled as recommended by Cawthron Institute (July 2021) (Cawthron Institute, 2021). The water quality sampling locations are shown in Figure 5 above.

# 4 Assessment of the Water Quality Effects of the Existing Discharge

## 4.1 Assessment Criteria

An effects assessment of the Kaikohe WWTP discharge on the water quality of the Wairoro Stream was undertaken against a range of relevant guidelines: PRPN (December 2022), the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) and National Policy Statement for Freshwater Management (NPS-FM, 2020).

The PRPN, a combined regional air, land, water and coastal plan, was issued by Northland Regional Council (NRC) in accordance with the Resource Management Act 1991 (the RMA). The water quality standards in Table 22 (Water quality standards for ecosystem health in rivers) of PRPN apply to Northland's continually or intermittently flowing rivers, and they apply after allowing for reasonable mixing.

The new NPS:FM was brought into effect on 3 September 2020. The main objective (OBJ2.1(1)) of the new NPS:FM (2020) states:

*The objective of this National Policy Statement is to ensure that natural and physical resources are managed in a way that prioritises:*

*– First, the health and well-being of water bodies and freshwater ecosystems;*

*– Second, the health needs of people (such as drinking water);*

*– Third, the ability of people and communities to provide for their social, economic, and cultural wellbeing, now and in the future.*

ANZG (2018) present a preferred hierarchy of types of guideline values for water quality indicators. This hierarchy prioritises site-specific and/or local guidelines over regional and national guidelines. ANZWQ (2018) chemical and physical stressor and trigger values for the Wairoro Stream were identified using the River Environmental Classification (REC). The REC accounts for a range of natural factors that influence water quality (e.g., climate, topography and geology) and is widely used to study water quality patterns in New Zealand. The Wairoro Stream environment is classified as 'Warm Wet Low-elevation' by the REC database. Where applicable, REC (New Zealand) default guideline values (DGVs) for physical and chemical (PC) stressors are presented in Table 1 below, along with guidelines for different water quality parameters where relevant.

Table 1. Water quality assessment criteria.

| Parameter | PRPN | ANZG | NPS-FM | Ecological Value |
|---|---|---|---|---|
| Dissolved Oxygen (mg/L) | ≥ 4 / ≥ 5[1] | | ≥ 4 / ≥ 5[2] | |
| Temperature (°C) | ≤ 24 [3] | | | |
| pH | 6.0 < pH <9.0[4] | | | |
| Total suspended solids (TSS) (mg/L) | | 8.8 | | |
| *Escherichia coli* (*E. coli*) (cfu/100mL) | | | 130/1000[5] | |
| Total nitrogen (TN) (mg/L) | | 0.292 | | |
| Ammoniacal Nitrogen ($NH_4$-N) (mg/L) | 0.24/0.4[6] | 0.9[7] | 0.24/0.4[8] | |

| Parameter | PRPN | ANZG | NPS-FM | Ecological Value |
|---|---|---|---|---|
| Dissolved inorganic nitrogen (DIN) (mg/L) | | | | 0.295[9] |
| Dissolved reactive phosphorous (DRP) (mg/L) | | 0.014 | | |
| Total phosphorus (TP) (mg/L) | | 0.024 | | |

[1] 1-day minimum/7-day minimum.

[2] National bottom line (1-day minimum/7-day minimum) (summer period: 1 November to 30th April).

[3] Summer period measurement of the Cox-Rutherford Index (CRI), averaged over the five (5) hottest days (from inspection of a continuous temperature record).

[4] Annual median / annual maximum.

[5] Appendix 2A, Table 9 – *E. coli*, B (Green). For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 2% (median/95th percentile).

[6] annual median / annual maximum.

[7] Toxicity trigger value for protection of 95% species, based on pH 8 and temperature of 20°C.

[8] Appendix 2A, Table 5 – National bottom line (annual median / annual maximum). Numeric attribute state is based on pH 8 and temperature of 20°C.

[9] for a 20-day accrual period, Biggs, B.J.F. and Kilroy, C. (2000) Stream Periphyton Monitoring Manual. New Zealand Institute Water and Atmosphere for Ministry for the Environment (NIWA), Christchurch, New Zealand.

* The other parameters for ANZG (2018) are DGVs for PC stressor values for Warm Wet Low-elevation classification, except where otherwise stated.

## 4.2 Measured Effects on Wairoro Stream

### 4.2.1 Historical Data

FNDC carry out fortnightly monitoring 25 m upstream, and 80 m downstream of the Kaikohe WWTP discharge to the Wairoro Stream as part of consent conditions. The following section presents analysis from a five-year (from July 2017 to June 2022) record of measured water quality parameters collected at the two monitoring locations (25 m upstream and 80 m downstream of the Kaikohe WWTP discharge to the Wairoro Stream) using data collected for resource consent compliance purposes.

A comparison of sites upstream and downstream of the discharge point to the Wairoro Stream is provided in Table 2 showing the mean, median and range difference upstream and downstream sites from the discharge. Testing the significance of the difference in the upstream and downstream sample results used a paired equivalency test using NIWA's Time Trends software, with a significance level of 0.05, an upper bound of +10% and a lower bound of -10%. The paired equivalency test investigates any difference between upstream and downstream datasets with respect to samples taken on the same day. The results of the paired equivalence testing indicate if the downstream dataset is decreased, no change (none) or increased relative to the upstream dataset. The evidence of the result is given as inconclusive, trivial, moderate or strong. For additional comparison, five year upstream/downstream comparison box plots comparing the sites at upstream and downstream are presented of the measured parameters (see Appendix B).

Table 2. Summary of background water quality in the Wairoro Stream upstream and downstream of the discharge point (from July 2017 to June 2022).

| Parameter | Upstream | | | Downstream | | | Change | Evidence |
|---|---|---|---|---|---|---|---|---|
| | Mean | Median | Range | Mean | Median | Range | | |
| pH | 7.16 | 7.17 | 6.28-8.08 | 7.12 | 7.15 | 5.84-8.01 | None | Strong |
| Temperature (°C) | 17.34 | 17.65 | 9.6-22.9 | 17.18 | 17.5 | 9.5-23.9 | None | Strong |
| DO (mg/L) | 8.9 | 9.09 | 0.51-10.90 | 8.49 | 8.58 | 1.40-11.10 | Decrease | Moderate |
| $NH_4$-N (mg/L) | 0.23 | 0.01 | 0.0001-16 | 2.84 | **1.5** | 0.03-21 | Increase | Strong |
| DIN (mg/L) | 0.56 | 0.28 | 0.05-19.5 | 3.68 | 2.12 | 0.12-25.73 | Increase | Strong |
| DRP (mg/L) | 0.03 | 0.013 | 0.002-0.6 | 0.42 | 0.23 | 0.01-2.9 | Increase | Strong |
| *E. coli* (MPN/100 mL) | 1364 | 504 | 29-24,196 | 1325 | 600 | 59-24,196 | Increase | Moderate |

Note: Underline indicates the NPS-FM attribute state is not met, orange highlight indicates the ANZG chemical and physical stressor trigger is exceeded, **bold text** indicates the PRPN is exceeded, and red highlight indicates the DIN guideline value provided by NIWA (Biggs, 2000) is not met (See Table 1).

As shown in Table 2, $NH_4$-N, DIN and DRP showed a large variation in range between the difference in concentrations upstream and downstream.

From the analysis carried out above, the following conclusions are made:

- pH and temperature do not exhibit any change between upstream and downstream locations and meet the guideline values at both locations.
- The downstream dataset of DO shows a 'moderate' decrease. As the samples from the stream are collected fortnightly, DO data cannot be directly compared with '7-day mean minimum' guideline value. However, the concentrations of DO in almost all sampling collected during the period (July 2017-June 2022) are above the '1-day minimum/7-day minimum' limits, except few exceptions.
- $NH_4$-N exhibits a 'strong' increase downstream of the discharge location. $NH_4$-N concentrations are below the guideline values upstream the discharge point, however they are elevated above NPS-FM, PRPN and ANZG (toxicity trigger value) limits at the downstream monitoring location.
- DIN is elevated above the NIWA guideline and exhibits a 'strong' increase downstream of the discharge point to the stream.
- The DRP dataset also indicates a 'strong' increase and exceeds the ANZG guideline at the downstream monitoring location.
- There are not sufficient data for *E. coli* to show a trend downstream of the discharge location. The median concentrations of *E. coli* exceed its relevant water quality criteria (NPS-FM) at both upstream and downstream monitoring sites.

Based on the statistical analysis, there is strong evidence for a statistically significant increase in $NH_4$-N, DIN and DRP between the upstream and downstream sites. Given the increase in both DIN and DRP guideline values downstream as a result of the discharge, adverse effects on periphyton (slime on the stream bed) downstream would be anticipated.

### 4.2.2 Recent investigations and sampling on 18 April 2023

As mentioned in Section 3.2.2.2 above, water quality samples were collected from three upstream (US1, US2a, US2b) and three downstream (DS1, DS2 and DS3) sampling locations and also the discharge point in the un-named tributary (DP) on 18 April 2023. The samples were analysed for $NH_4$-N, *E. coli*, Total Coliforms, Faecal Coliform (FC), DIN, TN, chemical biological oxygen demand ($cBOD_5$), DRP, TP, turbidity and TSS. Field parameters (DO, pH, specific conductivity (SPC) and temperature) were measured using a YSI ProPlus water quality meter in the site. A summary of the water quality results is presented in Table 3. Graphs for some of the parameters are shown in Figure 6 to Figure 14 below.

Table 3. Water quality monitoring results (18 April 2023).

| Parameters | Unit | Sampling locations | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | US1 | US2a | US2b | DP | DS1 | DS2 | DS3 |
| $NH_4$-N | mg/L | 0.01 | 0.01 | 0.01 | 26 | 2.1 | 1 | 0.51 |
| *E. coli* | MPN/100mL | 583 | 677 | 763 | 1515 | 933 | 350 | 253 |
| Total Coliforms | MPN/100mL | 3873 | 5172 | 5794 | 24196 | 9208 | 2755 | 2909 |
| FC | cfu/100mL | 460 | 600 | 709 | 1036 | 1163 | 290 | 320 |
| DIN | mg/L | 0.37 | 0.38 | 0.38 | 26 | 2.6 | 2.3 | 2.2 |
| TN | mg/L | 0.56 | 0.56 | 0.54 | 29 | 2.8 | 2.6 | 2.6 |
| $cBOD_5$ | mg/L | <2 | <2 | <2 | 12 | <2 | <2 | <2 |
| DRP | mg/L | 0.004 | 0.004 | 0.004 | 4.8 | 0.41 | 0.33 | 0.28 |
| TP | mg/L | 0.017 | 0.018 | 0.016 | 6.1 | 0.46 | 0.38 | 0.32 |
| TSS | mg/L | 3 | 6 | 2 | 83 | 5 | 5 | 2 |
| Turbidity | NTU | 6 | 6.5 | 5.2 | 35 | 6.9 | 6.2 | 4.3 |
| Temperature | °C | 17.4 | 17.6 | - | 18.9 | 16.8 | 16.9 | 17.1 |
| DO | mg/L | 9.7 | 9.3 | - | 3.76 | 9.23 | 8.04 | 6.35 |
| SPC | µS/cm | 106.5 | 106.1 | - | 5.44 | 141 | 136.2 | 132.7 |
| pH | - | 7.26 | 7.66 | - | 7.17 | 6.88 | 6.99 | 6.94 |

From the measured data, historic data available background information and graphs below, the following conclusions can be drawn for each paramets:

#### 4.2.2.1 $NH_4$-N

From a toxicity viewpoint, the $NH_4$-N have been compared with ANZG (2018) toxicity trigger value for protection of 95% species. It should be noted that the toxicity trigger value is higher at higher temperatures and pH. Considering that pH and temperature during the sampling event (18 April 2023) were below 8 and 20°C, respectively (Table 3), a more conservative trigger value of 0.9 mg/L (based on pH 8 and temperature of 20°C) is adopted in this assessment.

At all three upstream monitoring locations, the concentrations of $NH_4$-N were below detection limit (< 0.010 mg/L) and below the respective guideline values. However, there was a substantial increase in $NH_4$-N concentrations 150 m downstream of the WWTP discharge point (2.1 mg/L at DS1) which resulted in exceedances of all three guideline values (Figure 6). The concentrations of the $NH_4$-N decreased in the monitoring locations further downstream, with the lowest concentrations at DS3 which was below the toxicity trigger value (ANZG, 2018). However, the $NH_4$-N levels at DS2 (~1.1 km downstream of the discharge point) and DS3 (~2 km downstream of the discharge point) were above the limits for PRPN (2022) and NPS-FM (2020).

Similar results had been obtained from the water quality investigations carried out by Cawthron in 2014 (on 15 April 2014) in the Wairoro Stream. In the 2014 Cawthron survey, the concentrations of $NH_4$-N were below the detection limit (< 0.010 mg/L) at all upstream monitoring locations and highly elevated downstream from the discharge (150 m and 330 m downstream sites) which exceeded the consent limit of 2.33 mg/L for measured pH of 6.8. However, the $NH_4$-N levels at 1100 m downstream site did not exceed the limit of 2.49 mg/L at measured pH of 6.4. In another Cawthron survey (July 2021) which was carried out on 14 October 2020, the concentrations of the $NH_4$-N did not exceed in any of the seven sampling locations, both upstream and downstream. This could be due to the sample collection after a fresh and the subsequent dilution of $NH_4$-N in the Wairoro Stream. In general, as the concentrations of $NH_4$-N is elevated in most of the sampling occasions (recently and historically) downstream of the discharge point, overall effect of the discharge on concentrations of $NH_4$-N is considered to be marked.

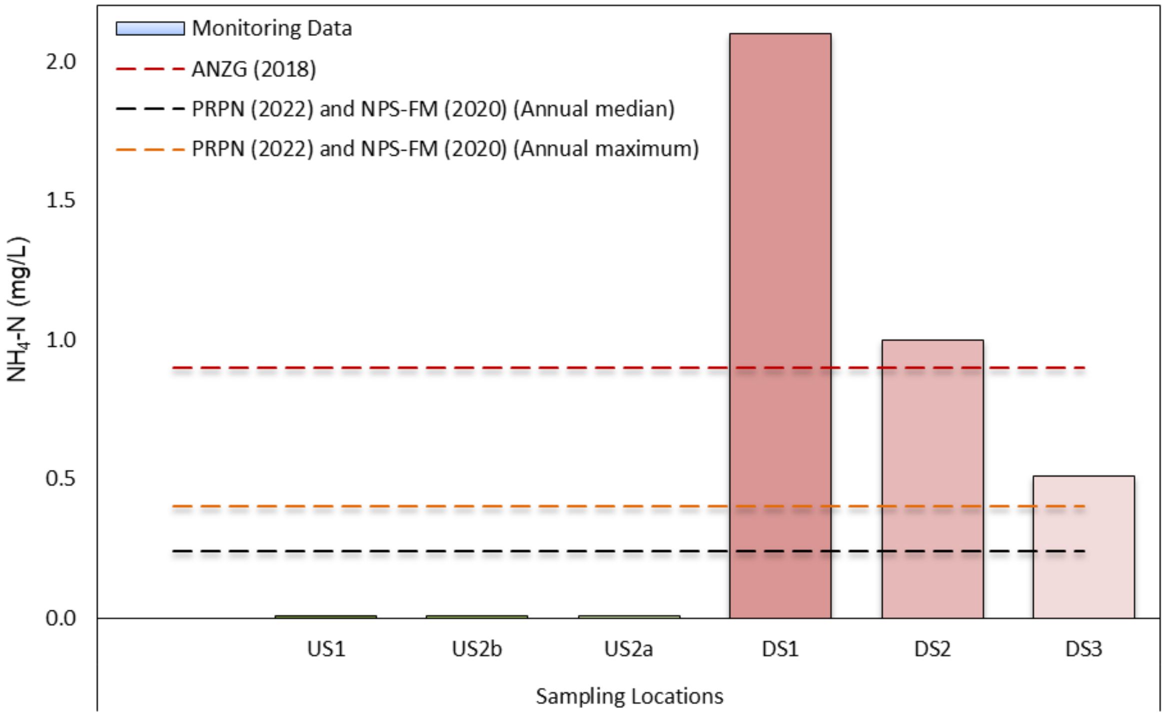



Figure 6. Concentrations of $NH_4$-N at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

#### 4.2.2.2 TN

The discharge of the treated wastewater from the Kaikohe WWTP resulted in increases in TN concentrations downstream of the discharge point, however the concentrations of TN exceeded the AZNG (2018) guideline value at both upstream and downstream sampling locations as it can be seen from the figure below. A similar trend in TN concentrations was observed in previous investigations Cawthron (2014 and 2020), showing lower concentrations of TN at the two upstream sites than downstream sites. Therefore, the increases in concentrations of TN in the downstream monitoring locations are considered moderate.

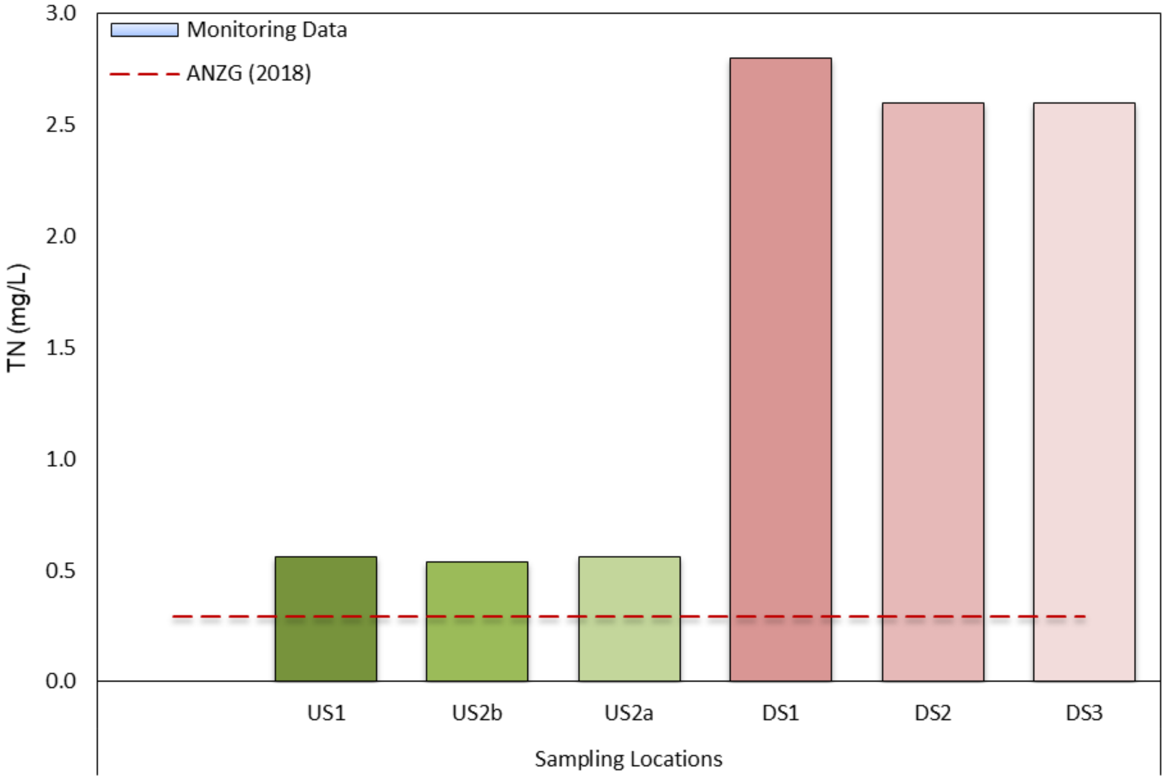



Figure 7. Concentrations of TN at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

#### 4.2.2.3 DIN

The DIN downstream dataset indicated significant increases compared with the upstream dataset. DIN concentrations were compared against the limit suggested by Biggs (2000). It is important to note that DIN concentrations were slightly elevated above the limit at the upstream monitoring location; however, the high concentrations of DIN at downstream monitoring locations resulted in significant exceedances of the limit.

Similarly, the investigation carried out by Cawthron in 2020 indicated that all upstream and downstream sites exceeded the proposed DIN limit (Biggs, 2000). The increase in the DIN levels downstream of the discharge point has been due to increases in ammonia levels as DIN comprises nitrate, nitrite and ammonium. A similar result was also observed from the Cawthron survey in 2014, showing high DIN values recorded at downstream sites. Considering the results obtained above about the DIN concentrations in Wairoro stream, overall effect of the discharge on concentrations of DIN is considered moderate.

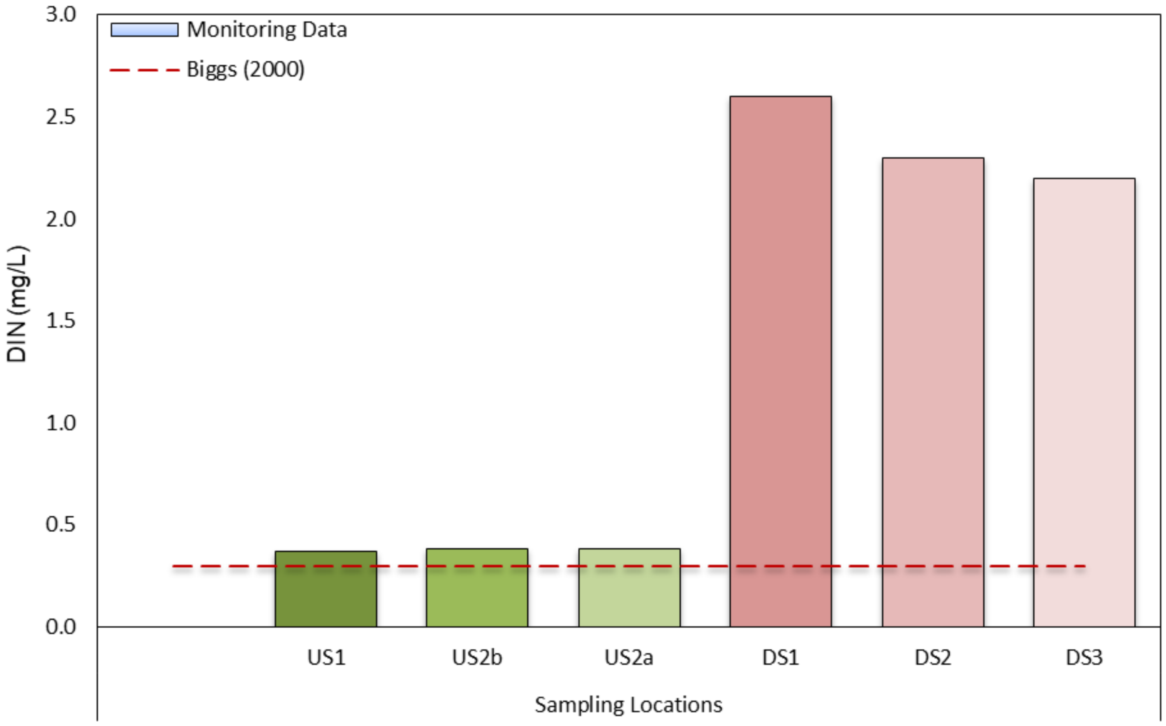



Figure 8. Concentrations of DIN at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

#### 4.2.2.4 DRP and TP

The dataset of DRP showed substantial increases downstream of the discharge point compared with the upstream dataset and there were minor decreases in DRP levels further downstream from DS1 to DS3 (Figure 9). Although the upstream concentrations of DRP (<0.004) were well below the ANZG guideline value for DRP (0.014 mg/L), the increases in concentrations of DRP downstream of the discharge point resulted in major exceedances of the guideline value (ranging from 0.28 to 0.41 mg/L). The same results were observed for TP concentrations, with TP concentrations below the ANZG guideline value (0.024 mg/L) at upstream monitoring locations and much higher TP concentrations than the guideline value at all downstream monitoring locations (Figure 10).

A similar pattern in DRP and TP concentrations was obeserved in Cawthron surveys in 2014 and 2020, indicating much lower concentrations at the two upstream sites and much higher values at the downstream sites. From the data available for upstream and downstream of the discharge point, the overall effect on these parameters is considered to be significant.

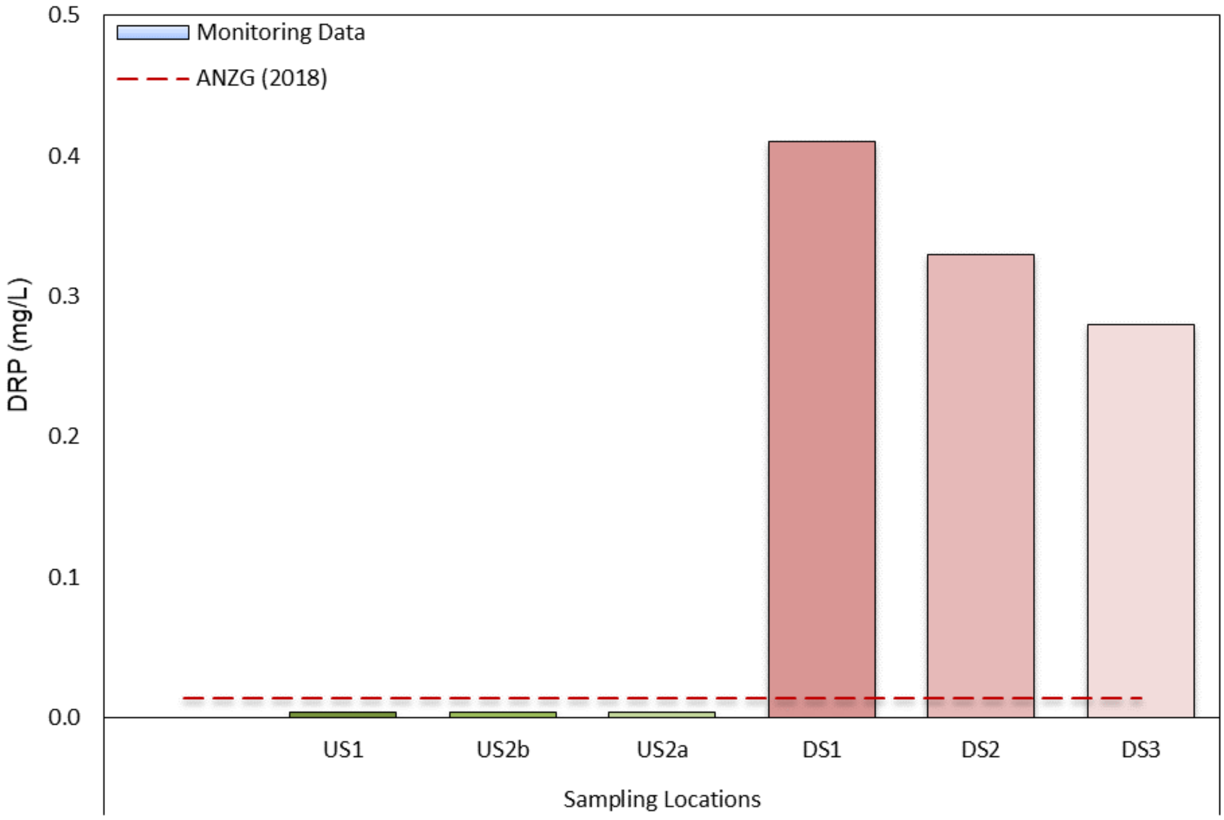



Figure 9. Concentrations of DRP at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

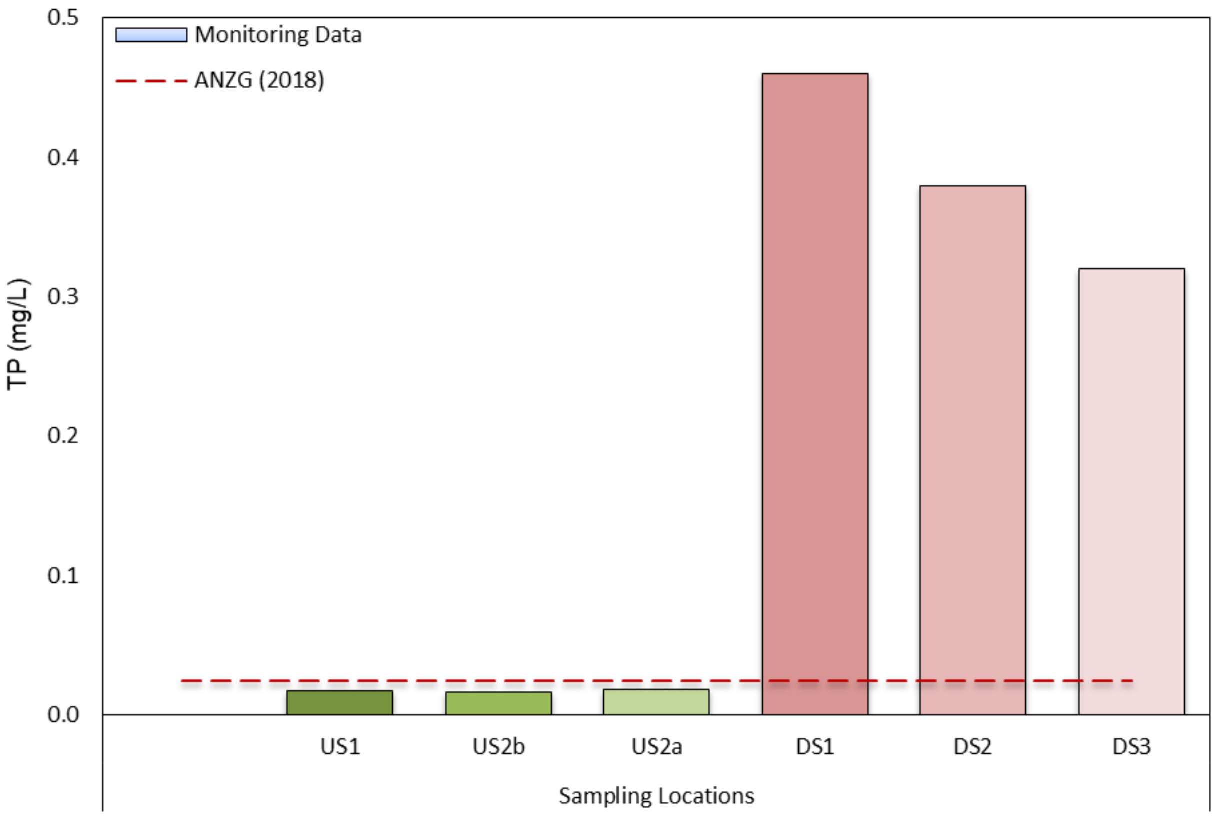



Figure 10. Concentrations of TP at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

#### 4.2.2.5 E. coli

According to Figure 11 below, *E. coli* level at DS1, 150 m downstream of the discharge point, was higher than the levels of *E. coli* at upstream monitoring locations. However, *E. coli* levels further downstream (at DS2 and DS3) were much lower than the levels at upstream monitoring locations and DS1. The results showed that the discharge of the treated wastewater resulted a minor increase in *E. coli* levels, however the levels of *E. coli* decreased further downstream due to dilution. *E. coli* levels at all monitoring locations were above the median value of the NPS-FM (2020), but below the 95$^{th}$ percentile value of the guideline. It should be noted that as there were only 'one-off' spot samples, the values should not be compared against the guideline limit directly.

The Cawthron survey in 2020 showed lower levels of *E. coli* at upstream monitoring locations compared to all downstream sampling locations. Also, the *E. coli* levels did not follow a decreasing trend in downstream sampling locations which is different from results shown in Figure 11. The *E. coli* level at the 1100 m downstream site was higher than that in the tributary discharge from the WWTP and also higher than the 150 m site. In general, the *E. coli* levels reported in the survey (ranged between 4000 and 14000 cfu/100 mL) were higher that the levels shown in Figure 11. Also, it should be noted that the *E. coli* level of the treated wastewater reported in 2020 (15,000 cfu/100 mL) was much higher than the *E. coli* level of treated wastewater in the recent investigation (1515 cfu/100 mL) (Table 3). Considering the information above, the overall effect of the discharge on levels of *E. coli* is considered low.

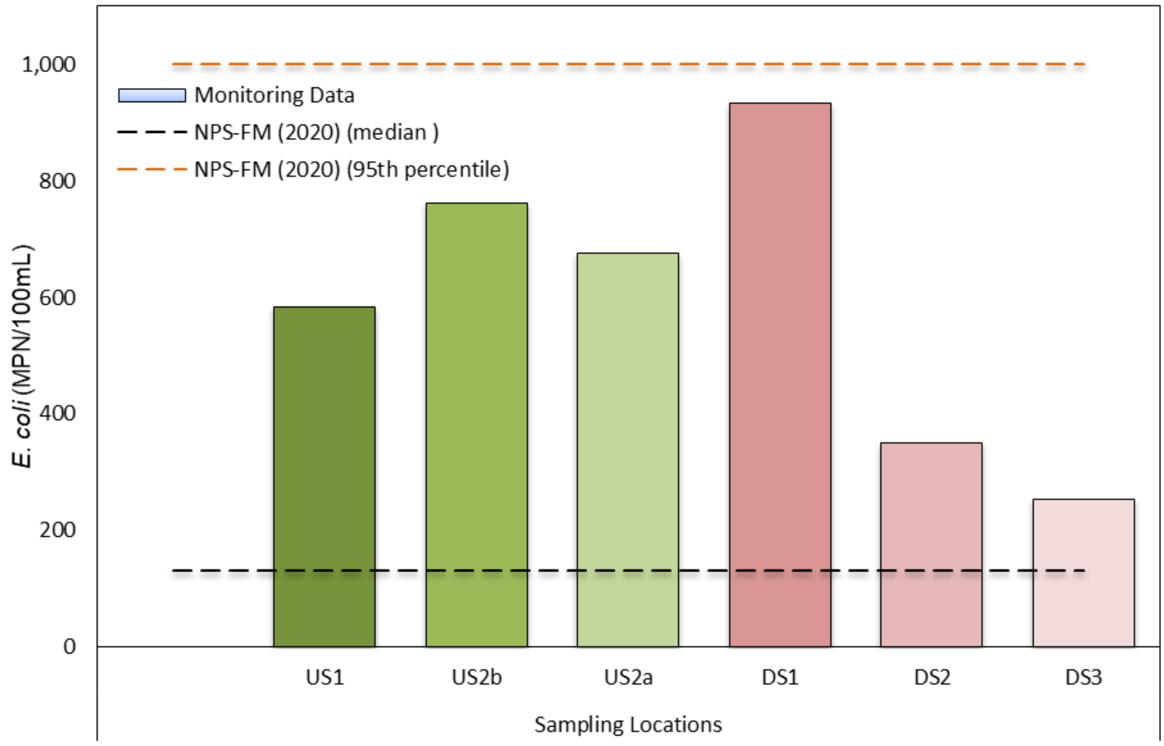



Figure 11. Levels of *E. coli* at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

#### 4.2.2.6 TSS

The concentrations of TSS were well below the guideline value at both upstream and downstream sampling locations. Also, there was not a clear trend in sampling results as shown in Figure 12. Therefore, the overall effect is deemed to be negligible.

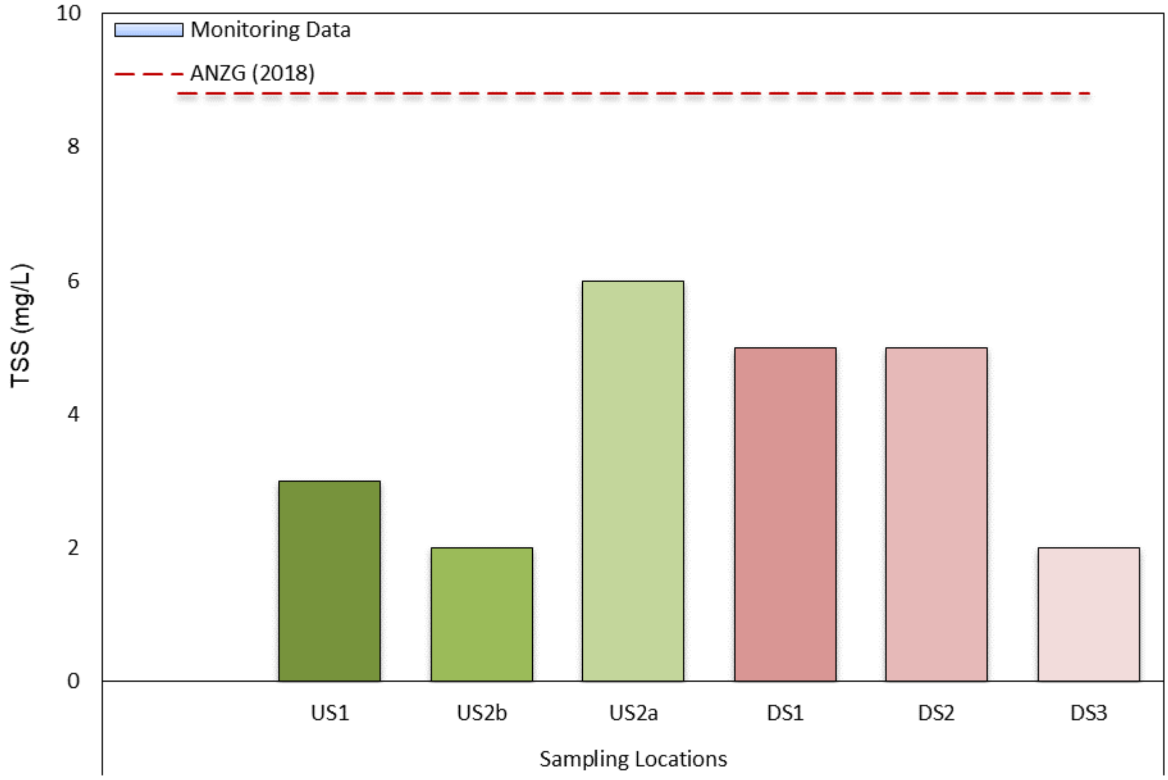



Figure 12. Concentrations of TSS at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023.

#### 4.2.2.7 DO

The downstream dataset of DO indicated decreases compared with the upstream monitoring locations. The concentration of DO at US1 was 9.7 mg/L and it decreased to 6.35 mg/L at DS3. As the samples from the stream were collected at one day ('one-off' spot samples), DO data cannot be directly compared with '7-day mean minimum' guideline value. The concentrations of DO in all samples at both upstream and downstream were above the '1-day minimum and '7-day minimum' limits.

According to the Cawthron survey in 2020, there was a 10% decrease in DO concentration between the 50 m downstream site and the upstream monitoring site. Considering all available data, the overall effect on this parameter is considered to be negligible.

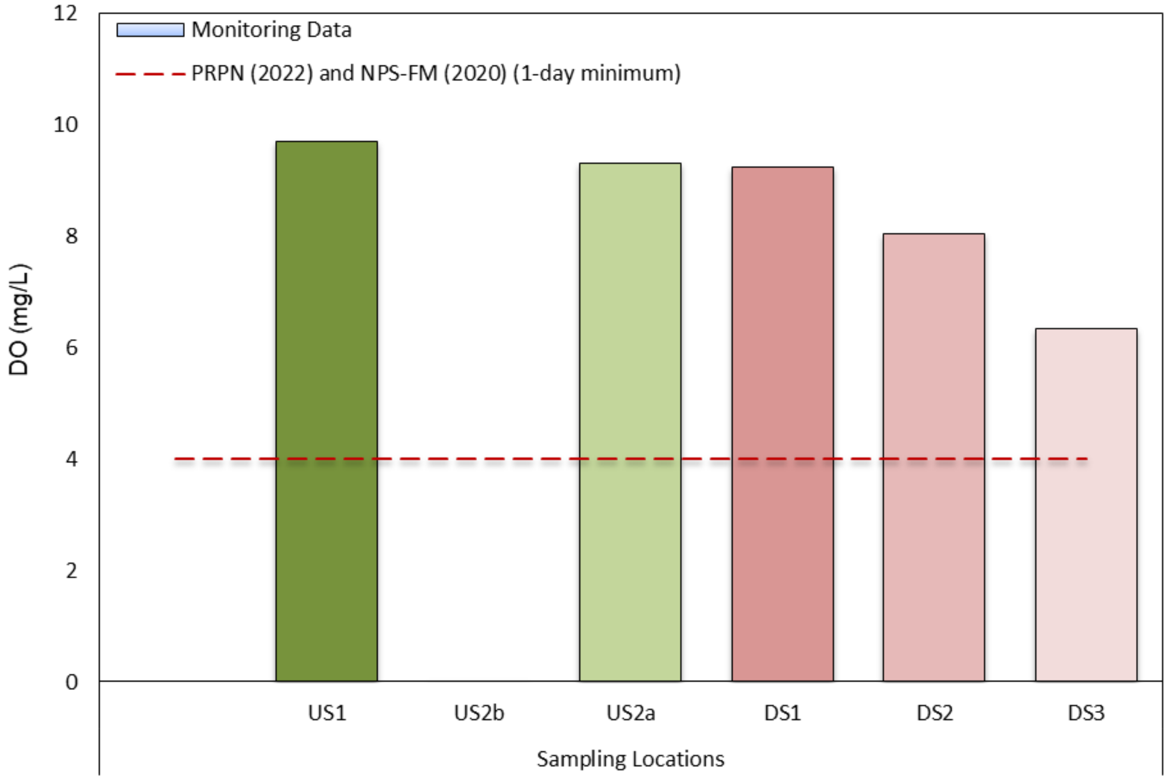



Figure 13. Concentrations of DO at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023 (concentrations of DO at US2b was not measured).

#### 4.2.2.8 pH and Temperature

pH and temperature levels did not show any change between upstream and downstream locations and meet the guideline values at both locations. Also, the pH and temperature of treated wastewater were only slightly different from pH and temperature levels in the stream. Therefore, the overall effect of the discharge on levels of pH and temperature is considered negligible.

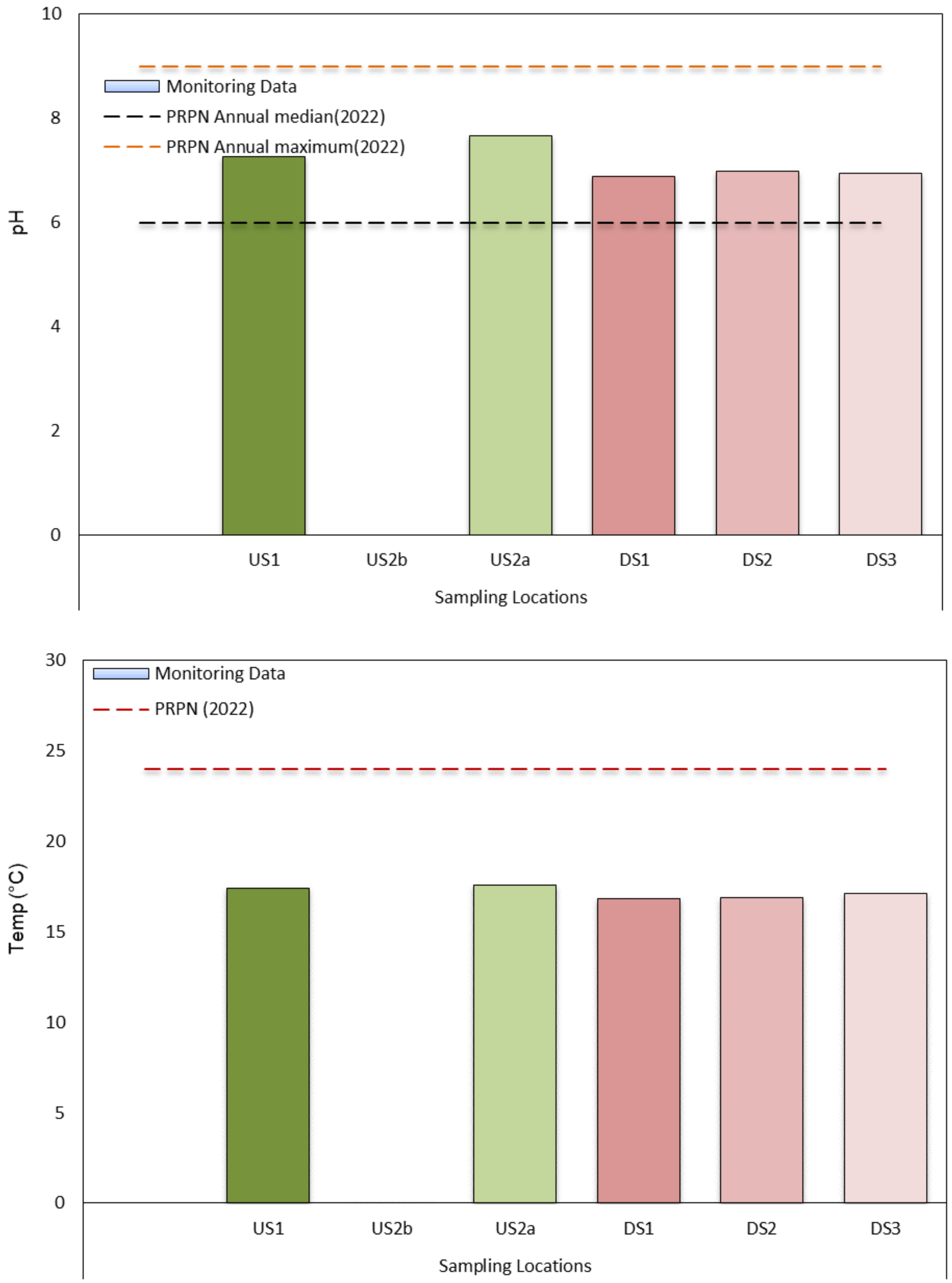



Figure 14. Levels of pH and temperature at six sampling locations (upstream and downstream of the Kaikohe WWTP discharge point (DP)) in Wairoro Stream on 18 April 2023 (Temperature at US2b was not measured).

#### 4.2.2.9 Other Water Quality Parameters

As it can be seen from Table 3, concentrations of $BOD_5$ at all sampling locations were lower than 2 mg/L. Specific conductivity in the Wairoro Stream at the sites downstream of the discharge point were higher than at the upstream sampling locations. However, there are no guideline values for conductivity in a stream to assess the level of the effects of the discharge. Turbidity level slightly increased at the first downstream monitoring location (DS1), but it decreased to 4.3 NTU which was lower than Turbidity at all upstream sampling locations (ranging from 5.2 to 6.5).

# 5 Ecological Values and Features

### 5.1.1 Wairoro Stream

The characteristics of the Wairoro Stream reach across the five survey sites are relatively similar. The stream is a hard-bottom based stream with a mix of gravel, cobbles, silt/sand, and large boulders. Some sections of the stream channel had a lower gradient, however steep and incised channel sections were evident, with some erosion observed on the banks (**Error! Reference source not found.**).

Riparian vegetation (10 m on each bank) comprised of mixed native and exotic species and was generally dominated by tōtara (*Podocarpus totara*), flax, rand karamū (*Coprosma robusta*). However, kauri (*Agathis australis*) was observed at DS1 and large rimu (*Dacrydium cupressinum*) were observed at US1. Exotic species comprised of primarily *Cupressus macrocarpa*, Chinese privet, patches of gorse, pines (*Pinus* sp.), and weedy grassy growth including mercer grass (*Paspalum distichum*), creeping buttercup (*Ranunculus repens*), and dock. Vegetation coverage across the stream reaches was moderate to high, offering very good levels of stream shading.

Instream habitat was diverse within all stream reaches and included a range of run, riffle, and pool sections, with some small cascades. Additionally, there were some areas of extensive undercut banks that would offer habitat for freshwater fish (Figure 15).

Aside from the discharge inputs into the stream from the outlet via the unnamed tributary, there were no other artificial/man-made structures observed within the stream reaches surveyed. The DS2 and DS3 sections are located adjacent to farmland with stock, however, the streams appeared to be generally fenced to exclude stock.

Therefore, the ecological value of the Wairoro Stream is **High**, due to high ratings for representativeness and rarity/distinctiveness, and moderate ratings for diversity and pattern and ecological context (Table 4).

Table 4. Scoring and justification for the assigned ecological value for the Wairoro Stream.

| Matter | Rating | Justification |
|---|---|---|
| Representativeness | High | Permanent stream system.<br>Stream displayed natural meandering characteristics with run, riffle, cascade, and pool habitat.<br>Riparian vegetation was predominantly native species, offering very good levels of stream shading and is expected to stabilise water temperatures. |
| Rarity/Distinctiveness | High | Fauna surveys identify two At Risk freshwater fish species and sensitive macroinvertebrate species.<br>Moderate level of diversity of freshwater fauna identified across the upstream and downstream sampling locations of the Wairoro Stream channel. |
| Diversity and Pattern | Moderate | Moderate level of diversity of riparian vegetation species and freshwater fauna within this system. |
| Ecological context | Moderate | High availability of instream habitat for freshwater fauna,<br>Fourth-order stream connected to multiple tributaries.<br>Catchment is dominated by residential and commercial use.<br>Channel is expected to provide a suitable migratory pathway for diadromous freshwater fish.<br>Robust riparian vegetation. |

| Matter | Rating | Justification |
|---|---|---|
| | | Lower stream channel flows through farmland with stock, however fencing from stock is evident. |
| Overall value: **High** | | |

### 5.1.2 Unnamed tributary

Following the treatment of the wastewater through the WWTP, the wastewater is discharged into an unnamed tributary of the Wairoro Stream. The tributary is short in length, being less than 25 m and is a hard-bottom system comprising of silt/sand, gravels, and small cobbles. There is high riparian coverage of the tributary with very good (but not complete) shading observed. Vegetation comprised of primarily native species, with limited groundcover vegetation. The water was noted to have a dark-green discoloration, which is likely attributed to higher algal growth from nutrient inputs from the treated wastewater (Figure 16). Additionally, a high input of water relative to the size of the watercourse was observed coming in from the discharge outlet at the time of the site visit.

Therefore, given the low to moderate availability of habitat within the unnamed tributary, the robust riparian coverage and high shading of the channel, as well as high nutrient inputs expected from the treated wastewater discharge, the ecological value of the unnamed tributary is assessed as **Moderate** (Table 5).

Table 5. Scoring and justification for the assigned ecological value for the unnamed tributary.

| Matter | Rating | Justification |
|---|---|---|
| Representativeness | Moderate | Permanent stream system.<br>Stream displayed natural meandering characteristics with run, riffle, cascade, and pool habitat.<br>Riparian vegetation was mixed native and exotic species, with natives dominating.<br>Riparian vegetation provided high levels of stream shading and is expected to stabilise water temperatures. |
| Rarity/Distinctiveness | Moderate | Fauna surveys identify only shortfin eel within the tributary.<br>Low level of diversity of freshwater fauna expected within the tributary channel. |
| Diversity and Pattern | Low | Overall low level of diversity of riparian vegetation species and freshwater fauna within this system. |
| Ecological context | Low | Low to moderate availability of instream habitat for freshwater fauna.<br>The tributary direct receives the treated wastewater discharge from the WWTP.<br>Robust riparian vegetation. |
| Overall value: **Moderate** | | |

Figure 15. Wairoro Stream across the various sampling points including DS2 (top left), DS1 (top right), US2 (bottom left) and US1 (bottom right).

Figure 16. Unnamed tributary of the Wairoro Stream receiving the final discharge of the treated wastewater from the Kaikohe WWTP.

### 5.1.3 Macroinvertebrate Community

The MCI scores returned an MCI value of between 93 – 98.75 for US1, US2, DS2, and DS3, which is within attribute band C (Ministry for the Environment, 2022). This is indicative of a macroinvertebrate community with a mix of taxa sensitive and insensitive to organic pollution and nutrient enrichment. Macroinvertebrate diversity was low to moderate for these sites with % EPT taxa ranging from 41 – 55%. The DS1 site had an MCI score of 86.32 which is representative of attribute band D and is indicative of a macroinvertebrate community of severe organic pollution and nutrient enrichment. All five samples recorded > 200 number of individuals. Within the data, macroinvertebrate species identified across all five sites includes several At Risk species including mayfly (*Deleatidium* sp., *Mauiulus* sp., *Zephlebia* sp.,) and dragonfly (*Antipodochlora* sp.), as well as numerous species of caddisfly.

A full account of the MCI results can be found in Appendix D. It is acknowledged that the sample was collected following a period of high rainfall and the volumetric flow rate during this time was relatively higher compared to baseflows. This has potentially resulted in the disturbance and flushing out of the system, and it can often take several weeks for populations to re-establish.

As such, the Wairoro Stream is considered to have **Moderate** macroinvertebrate values based on the presence of numerous At-Risk species.

### 5.1.4 Freshwater Fish

The eDNA samples collected across the 6 sampling locations (including the discharge point) identifies the presence of several freshwater fish within the Wairoro Stream channel and only shortfin eel (*Anguilla* *australis*) within the unnamed tributary, with two At Risk species identified (Table 6). In addition to the native species identified, numerous pest fish were recorded including mosquitofish (*Gambusia affinis*) at all sampling locations and goldfish (*Carassius auratus*) at the DS1 location.

Table 6. Freshwater fish identified through eDNA surveying across the six sites sampled at the Wairoro Stream.

| Scientific Name | Common Name | Conservation Status | Location identified |
|---|---|---|---|
| *Gobiomorphus basalis* | Crans bully | Not Threatened | US1, US2, DS1, DS2,DS3 |
| *Anguilla australis* | Shortfin eel | Not Threatened | All locations |
| *Galaxias fasciatus* | Banded kōkopu | Not Threatened | US1 |
| *Anguilla dieffenbachii* | Longfin eel | At Risk – Declining | US1, US2, DS1, DS2, DS3 |
| *Galaxias maculatus* | Īnanga | At Risk – Declining | DS1 |

Therefore, due to the confirmed presence of At-Risk freshwater fauna within the receiving environment of the wastewater discharge the freshwater fish values are **High**.

# 6 Assessment of the Ecological Effects of the Existing Discharge

The ecological effects assessed here are associated with the long-term and permanent effects arising from the continuous existing discharge of treated wastewater into the natural receiving environment of the Wairoro Stream.

The assessment of ecological effects was undertaken in accordance with the EIANZ guidelines (2018). Level of effects are assessed as the product of the **magnitude** (determined according to the duration of effects, the degree of change that will be caused and the extent of potential impact), and the ecological values impacted. The effects assessed are described in detail below.

## 6.1 Overview of Nutrient Concentrations

The treatment process currently operating at the Kaikohe WWTP, including the sludge lagoon and storage systems, are expected to efficiently remove a significant amount of pollutants, nutrients, and chemicals from the wastewater prior to its discharge into the receiving environment. However, results obtained from the water quality monitoring both in 2023 and past years indicates that there are elevated nutrient concentrations within the receiving Wairoro Stream, some of which are likely due to the WWTP discharges.

A fulsome description of the water quality results is provided in Section 4. This section will outline the nutrient concentrations as they pertain to the ecological effects. With regard to this, the main water quality parameters of concern are ammoniacal nitrogen, DIN and DRP. Of the different forms of nitrogen, DIN is bioavailable and assimilated by primary producers. Additionally, ammonia, which can have acute and chronic effects on freshwater fauna, is a constituent of DIN.

A review of the data collected by FNDC over a five-year period (see Section 4.2.1) indicates that concentrations of DIN and DRP are overall higher at downstream locations, compared to the upstream locations. This was also identified in the 2014 and 2020 by Cawthron (Cawthron Institute, 2014, 2021) and 2023 monitoring by Beca. Additionally, data from the 2023 monitoring indicates that DIN concentrations were also elevated within both the upstream and downstream sampling locations, but concentrations were higher downstream compared to upstream.

It is important to note that due to the time constraints for the renewal resource consent both the water quality and ecological sampling were undertaken following several significantly high rainfall events. The flow gauge (see Figure 4) indicates that the sampling was taken just as the river flow levels were declining but have not yet reached base flow conditions. Therefore, the ecological effects assessed here are assessed based on the data collected during these higher flow conditions. However, the monitoring undertaken by Cawthron in 2014 was undertaken during base flow conditions and a comparison to their ecological findings will be made in the following sections.

## 6.2 Magnitude of Effect

### 6.2.1 Potential effects of nutrient enrichment on periphyton growth

The increase in concentration of DRP at the downstream sites, which exceeds ANZG thresholds, compared with the upstream sites, where it is well-below threshold, has the potential to affect aquatic ecosystem health through enabling the growth of problematic periphyton and algae (Ministry for the Environment, n.d.). Additionally, ammonia is also known to contribute to excessive periphyton and macrophyte growth within freshwater systems (Cawthron Institute, 2014). Periphyton is a primary producer and plays a significant role in freshwater ecosystems, providing resources for freshwater invertebrates and vertebrates in benthic food webs. The abundance of periphyton is influenced by a variety of physical, chemical, and biological factors including nutrient concentrations and light availability (Ren et al., 2021).

At the time of the site visit, periphyton coverage within the downstream sites mainly comprised of a mix of mats and filamentous species, however, no excessive or nuisance algal growths were observed. The higher nutrient availability (nitrogen and phosphorous) within the downstream section of the Wairoro Stream is expected to have some impacts on the periphyton percentage coverage, and this was noted in the survey results which indicated that coverage was lower at US1 (average 6%) and much higher at the downstream sampling sites. Although, the surveying did indicate that the highest periphyton coverage was DS1 (average 85%), after which there was a notable decline at DS2 (average 65%) and DS3 (57%).

The survey results indicates that periphyton coverage between US1 (average 50%) and the downstream sites did not significantly differ, indicating that the WWTP discharges may not be primarily influencing the periphyton community. As the Wairoro Stream catchment is dominated by rural and agricultural use, it is highly likely that there is nutrient input occurring from upstream locations, which may be influencing periphyton growth in the upper reach of the stream and potentially flowing downstream. Shading across the five sites remained similar, although the stream width at US2 was narrower, therefore, was slightly more shaded compared to US1 and the downstream sites. The lower percentage of periphyton coverage within US1 compared with the other four sampling sites is predicted to be attributed primarily due to the difference in the benthic substrate. US1, DS1, DS2, and DS3 were observed to have a higher presence of large cobbles and boulders in the streambed, whilst US2 had smaller cobbles, as well as a higher dominance of small gravels and sands/silt.

Periphyton surveys conducted in 2020 indicates that, at that time, there was a higher percentage of green algae at the two furthermost downstream sites, however, this was not observed during the 2023 sampling (Cawthron Institute, 2021). It is also important to note that this system has experienced recent periods of significant flooding due to the unexpected rain events from early 2023. Communications with the local farmer during the site survey indicated that, in early 2023, the stream level was substantially higher during this rainfall period, reaching and flooding the nearby paddock. This has potentially disturbed the system, flushing out macrophytes and periphyton and it is expected to take several months of populations to re-establish.

Based on the observations of the 2023 sampling event, the ongoing discharge of treated wastewater into the Wairoro Stream does not appear to be having an impact on the periphyton coverage between the upstream and downstream sampling sites. Additionally, there is expected to be reasonable mixing (which is seen in the water quality results) and inputs from tributary systems and groundwater within the downstream section that will further dilute nutrient concentrations. As such, the magnitude of effect is assessed as **Low** with an overall **Low** level of effect.

#### 6.2.2 Potential ecotoxic effects of nutrient inputs from the treated wastewater discharge on freshwater fauna

Increasing nutrient inputs into freshwater systems can significantly impact the survival of freshwater fish and macroinvertebrates. Total ammoniacal-N, an inorganic compound of nitrogen, in high concentrations within aquatic environments can be lethal to freshwater fauna and can also have impacts on the reproduction and growth performance of fish. Additionally, the concentration that ammonia is toxic to organisms can be affected by several abiotic environmental parameters, including temperature, pH, and oxygen. An increase in temperature is known to significantly elevate ammonia toxicity (Shin et al., 2016; Xu et al., 2021).

The concentrations of DIN across the sampling sites indicate exceedances of the guideline value provided by NIWA (Biggs, 2000) within both the upstream and downstream samples, however, the downstream samples were further elevated again when compared with the upstream samples. This was also evident in water quality sampling collected by Cawthron in both 2014 and 2020 (Cawthron Institute, 2014, 2021). It has been surmised that the downstream DIN exceedances may be due to increases in total ammoniacal-N levels as DIN comprises nitrate, nitrite and total ammoniacal-N (see Section 4.2.2.3). These exceedances have the potential to result in long-term chronic effects on freshwater fauna.

New Zealand's freshwater macroinvertebrates are generally more sensitive to ammonia than fish, and shortfin eels appear to be more highly tolerant to ammonia toxicity, which may explain their detected presence in the unnamed tributary. As such, the elevated DIN (as a proxy for ammoniacal nitrogen) levels within the downstream sites are not expected to result in a chemical barrier to migration (Cawthron Institute, 2014). Therefore, any impacts from the wastewater discharge on the water quality of the stream are more likely to be first noted and present at the macroinvertebrate level, which are expected to respond first to any nutrient impacts.

Currently, there is limited recent literature on the full environmental effects of treated wastewater as receiving freshwater bodies are often subject to multiple anthropogenic stressors. However, there is a high likelihood that systems receiving tertiary treated wastewater discharge would see a decline in EPT taxa abundance and potentially an increase in more tolerant species (González et al., 2023), such as *Oligochaetes* and *Potamopyrgus,* both of which are noted to be present in higher numbers within the MCI data collected.

With regard to the EPT taxa identified at Wairoro Stream, mayfly (*Ephemeroptera*) and caddisfly (*Trichoptera*) were identified across all five sites, however, no stonefly (*Plecoptera*) was identified. In fact, of the five mayfly species identified, one was identified across the upstream and downstream sites, two were identified just at the upstream sites, and two were identified just at the downstream sites. These two species have MCI scores of 8-9 indicating they are highly sensitive to environmental changes. One of the mayfly species identified just at the upstream sites has an MCI score of 5, indicating it is more tolerant to environmental changes. Additionally, across all five sites tolerant species including oligochaete worms and true flies were also identified.

Overall, the MCI scores across the sampling sites were low to moderate and indicated that the stream system is receiving organic pollution and/or nutrient input. However, when comparing the findings from this survey to the 2014 and 2020 sampling events, the 2023 surveying indicate that % of EPT taxa records for the downstream reaches (DS1, DS2, DS3), which ranged from 36 – 42, is much higher than the 2020 results, which ranged from 30 – 35 and the 2014 results, which ranged from 8 - 37. In addition, the MCI scores for the downstream reaches from 2023 are marginally higher (between 86 - 96) when compared to 2020 (between 70 – 93), and much higher when compared to 2014 (< 85) (Cawthron Institute, 2014, 2021).

Based on the current literature available and the water quality data collected both in 2023 and past years, there appears to be continuous exceedances in nutrient parameters within the downstream receiving environment of the Kaikohe WWTP. However, as the Wairoro Stream flows through an agriculturally dominant catchment, there is a high likelihood that there are multiple sources of organic and nutrient inputs into this freshwater system. The fauna surveying conducted upstream and downstream of the Kaikohe WWTP over the past decade has indicated there are EPT taxa present, and this appears to remain relatively consistent. This indicates that these species are able to successfully survive and reproduce within this system.

As such, the data collected here suggests that there are no acute toxic effects and no obvious chronic effects of the nutrient pollution on fish and macroinvertebrate populations within the vicinity of the WWTP discharge. As both the 2023 and 2020 sampling was undertaken during higher flow periods and the 2014 samples were collected during base flow conditions, it is surmised that low flow/ base flow stream conditions may result in a higher level of impact on the macroinvertebrate communities.

However, an assessment of the ecological effects made here are based on the results of the 2023 sampling, which indicates that the treated wastewater discharge is not having an impact on the structure and species composition within this stream system when comparing the upstream and downstream sampling results, and therefore, is assessed as a **Low** magnitude of effect, with an overall **Low** level of adverse effect. It is important to note that the magnitude and overall level of effect may be different during base flow/low flow conditions.

# 7 Summary of Water Quality and Ecological Effects of the Existing Discharge

In summary, the assessment of the effects of the current discharge on the receiving environment has been undertaken based on background information, historical data, measured data and the observations and surveying undertaken on 18 April 2023.

It is noted that there are currently two upgrade options being considered for the Kaikohe WWTP. These options are expected to reduce nutrient discharges significantly compared to the existing operation of the WWTP, therefore reducing the nutrient concentrations within the downstream receiving environment of the WWTP, which may subsequently improve the ecology of the system. As such, this report does not provide any further recommendations for management, as the upgrade is considered to adequately address the issue of nutrient exceedances.

The assessment results indicate that:

Water Quality:

- According to the dye dilution and dispersion study, the dye was fully mixed in the stream at 150 m downstream of the discharge point and that location was considered as the mixing zone. As confirmed by FNDC, the proposed mixing zone (150 m downstream of the discharge point) is the same as the downstream consent monitoring location (approximately 80 m downstream of the discharge point from the unnamed tributary).
- Based upon water quality monitoring results (recent and historical), there is evidence for increases in $NH_4$-N concentrations between the upstream and downstream sites. The increases of $NH_4$-N concentrations at downstream monitoring locations resulted in exceedances of guideline values of $NH_4$-N.
- DIN and TN concentrations downstream of the discharge point indicated increases compared with the upstream dataset. Although DIN and TN concentrations are already elevated above the guideline values at the upstream monitoring locations, the overall effect on these parameters is considered moderate because of resulting higher concentrations at downstream monitoring locations.
- Due to substantial increases in concentrations of TP and DRP downstream of the discharge point compared with the upstream dataset which resulted in major exceedances of the guideline values, the overall effect on DRP and TP is considered to be significant.
- Concentrations of *E. coli* at downstream monitoring locations indicated minor increases in *E. coli* levels. Therefore, the discharge effect on this contaminant is considered to be low.
- There have been minor changes in levels of TSS, DO, pH and Temperature between the upstream and downstream sites. As the changes are minor, the overall effect of the discharge on these parameters is negligible.

Ecology:

- Fauna surveying indicates the presence of sensitive macroinvertebrate species both within the upstream and downstream reaches of the WWTP discharge in the Wairoro Stream.
- Surveying undertaken between 2014, 2020 and 2023 indicate that % of EPT taxa records for the downstream reaches has increased over this time.

- For the above reasoning and as stated further in Section 6.2.2, the results from the 2023 sampling indicate that the treated wastewater discharge does not appear to be having an impact on the structure and species composition within this stream system when comparing the upstream and downstream sampling results, and therefore, is assessed as a **Low** magnitude of effect, with an overall **Low** level of adverse effect. It is important to note that the magnitude and overall level of effect may be different during base flow/low flow conditions.
- The results from the 2023 sampling indicates that periphyton coverage did not significantly differ between the upstream and downstream sites and no excessive periphyton growths were identified. As such, this was assessed as a **Low** magnitude of effect with an overall **Low** level of adverse effect. It is important to note that the magnitude and overall level of effect may be different during base flow/low flow conditions.

# 8 Applicability Statement

This report has been prepared by Beca Ltd (Beca) on the specific instructions of Far North District Council (FNDC) (Client). It is solely for our Client's use for the purpose for which it is intended in accordance with the agreed scope of work. Any use or reliance by any person contrary to the above, to which Beca has not given its prior written consent, is at that person's own risk.

Should you be in any doubt as to the applicability of this report and/or its recommendations for the proposed development as described herein, and/or encounter materials on site that differ from those described herein, it is essential that you discuss these issues with the authors before proceeding with any work based on this document.

In preparing this report Beca has relied on key information as stated and referenced in text.

Unless specifically stated otherwise in this report, Beca has relied on the accuracy, completeness, currency and sufficiency of all information provided to it by, or on behalf of, the Client, including the information referenced in text, and has not sought independently to verify the information provided.

This report should be read in full, having regard to all stated assumptions, limitations and disclaimers. No part of this report shall be taken out of context and, to the maximum extent permitted by law, no responsibility is accepted by Beca for the use of any part of this report in any context, or for any purpose, other than that stated herein.

# 9 References


Cawthron Institute. (2014). *Assessment of ammonia effects on the wairoro stream fauna near the kaikohe wastewater treatment plant* (Issue 2517).

Cawthron Institute. (2021). *Ecological surveying of the Wairoro Stream near the Kaikohe Wastewater Treatment Plant*.

González, J. M., de Guzmán, I., Elosegi, A., & Larrañaga, A. (2023). Tertiary wastewater treatment combined with high dilution rates fails to eliminate impacts on receiving stream invertebrate assemblages. *Science of the Total Environment*, *859*(November 2022). https://doi.org/10.1016/j.scitotenv.2022.160425

*iNaturalist*. (n.d.). https://www.inaturalist.org/home

Land Information New Zealand. (n.d.). *NZ River Name Lines*. https://data.linz.govt.nz/layer/103632-nz-river-name-lines-pilot/

Lowe, M., Ingley, R., & Young, D. (2016). *Watercourse assessment methodology: infrastructure and ecology version 2.0.* Prepared by Morphum for Auckland Council. Auckland Council technical report, TR2016/002.

McDowall, R. M., & Richardson, J. (1983). *The New Zealand freshwater fish survey: a guide to input and output.* https://niwa.co.nz/freshwater-and-estuaries/nzffd/catchment-number-dictionary

Ministry for the Environment. (n.d.). *Dissolved Reactive Phosphorous Factsheet*. https://environment.govt.nz/assets/Publications/Files/FS30B-Dissolved-reactive-phosphorus-factsheet-final.pdf

Ministry for the Environment. (2022). National Policy Statement for Freshwater Management 2022 (NPS-FM). In *Publication reference ME 1155 34p*.

National Institute of Water & Atmospheric Research Ltd. (2020). *User Manual Stream Health Monitoring and Assessment Kit*.

Ren, W., Yao, Y., Zhang, Z., Cao, Y., Yuan, C., Wang, H., Chou, Q. C., Ni, L., Zhang, X., & Cao, T. (2021). Changes of Periphyton Abundance and Biomass Driven by Factors Specific to Flooding Inflow in a River Inlet Area in Erhai Lake, China. *Frontiers in Environmental Science*, *9*(May), 1–10. https://doi.org/10.3389/fenvs.2021.680718

Shin, K. W., Kim, S. H., Kim, J. H., Hwang, S. D., & Kang, J. C. (2016). Toxic effects of ammonia exposure on growth performance, hematological parameters, and plasma components in rockfish, Sebastes schlegelii, during thermal stress. *Fisheries and Aquatic Sciences*, *19*(1), 1–8. https://doi.org/10.1186/s41240-016-0044-6

Stark, J. ., Boothroyd, I. K. ., Harding, J. ., Maxted, J. ., & Scarsbrook, M. . (2001). *Protocols for sampling macroinvertebrate s in wadeable streams*. *1*, 57.

Xu, Z., Cao, J., Qin, X., Qiu, W., Mei, J., & Xie, J. (2021). Oxidative Stress , Immune Responses and Tissue Structure in Fish Exposed to Ammonia Nitrogen : A Review. *Animals Review*, *11*, 1–19.

# A

## Appendix A – A Copy of the Resource Consent

CON20100241701
REPLACEMENT DOCUMENT

# *Resource Consent*

*Pursuant to the Resource Management Act 1991, the Northland Regional Council (hereinafter called "the Council") does hereby grant a Resource Consent to:*

**FAR NORTH DISTRICT COUNCIL, PRIVATE BAG 752, KAIKOHE 0440**

To undertake the following activities associated with the operation of the Kaikohe wastewater treatment system on Lot 2, DP 45233, Blk XV, Omapere SD; Sec 27, SO 40585 Blk IV Punakitere SD; Sec 2, SO 12295 Blk IV Punakitere SD; Sec 30 Blk IV Punakitere SD.

*(Note: all location co-ordinates in this document refer to Geodetic Datum 2000, New Zealand Transverse Mercator Projection):*

(01) To discharge treated wastewater to an unnamed tributary of Wairoro Stream, at or about location co-ordinates 1674845E 6079488N.

(02) To discharge contaminants to ground via seepage from the base of an anaerobic pond, oxidation pond and a constructed wetland, at or about location co-ordinates 1674525E 6079466N.

(03) To discharge contaminants (primarily odour) to air from the Kaikohe wastewater treatment system, at or about location co-ordinates 1674525E 6079466N.

Subject to the following conditions:

**(01) and (02) Discharge to Water and to Ground**

1 The volume of treated wastewater discharged to the unnamed tributary of the Wairoro Stream shall not, based on a 30 day rolling average of dry weather discharges, exceed 1,710 cubic metres per day. Compliance with this condition shall be based on the average daily discharge volume of the 30 most recent "dry weather discharge days". For the purposes of this consent, a "dry weather discharge day" is any day on which there is less than 1 millimetre of rainfall, and that day occurs after three consecutive days either without rainfall or with rainfall of less than 1 millimetre on each day.

***Advice Note:*** *The rainfall measurements used to determine a dry weather discharge shall be based on the nearest appropriate rainfall recorder site. The recorder site shall be selected in consultation with the Northland Regional Council.*

2 The Consent Holder shall maintain in good working order a flow meter on the outlet of the constructed treatment wetland that has an accuracy of ±5% to measure the volume of wastewater discharged to the unnamed tributary of the Wairoro Stream.

3 The Consent Holder shall keep records of the daily volume of treated wastewater discharged to the unnamed tributary of the Wairoro stream, as measured by the meter required by Condition 2, the local daily rainfall measurement, and the 30 day rolling average dry weather discharge volume, as defined in Condition 1. These records shall be recorded in a format agreed to by the Northland Regional Council and shall be forwarded to the Northland Regional Council by 15 May of each year for the preceding six months of November to April, and by 15 November of each year for the preceding months of May to October

4 The Consent Holder shall monitor the exercise of these consents in accordance with the Monitoring Programme in Schedule 1 (**attached**).

5 The Consent Holder shall prepare monthly reports on the monitoring undertaken in accordance with Conditions 3 and 4. These reports shall include, but not be limited to, all the raw data, the averages and/or medians calculated for compliance purposes, and a summary showing the level of compliance with any consent conditions for which limits have been defined. The monthly reports shall be in a format agreed to by the Northland Regional Council and shall be forwarded to the Northland Regional Council prior to the tenth working day of the following month. Where the monitoring is required to be undertaken over a period greater than a month, then the results of that monitoring event shall be included in the next scheduled monitoring report. If the monitoring results indicate a non-compliance with any consent condition, then the Consent Holder shall report the results to the Northland Regional Council within 24 hours of receiving the analysis results.

6 The Consent Holder shall provide and maintain easy and safe access to each of the following sampling points (all shown on NRC Plan 3514, **attached**):

(a) Northland Regional Council Sampling Site Number 100562, discharge point from the wastewater treatment system into natural wetland, at or about location co-ordinates 1674845E 6079488N.

(b) Northland Regional Council Sampling Site Number 100560, unnamed tributary of the Wairoro Stream at the point where the unnamed tributary discharges into the Wairoro Stream, at or about location co-ordinates 1674854E 6079181N.

(c) Northland Regional Council Sampling Site Number 103316, Wairoro Stream approximately 25 metres upstream of the discharge point from the unnamed tributary into Wairoro Stream, at or about location co-ordinates 1674725E 6079148N.

(d) Northland Regional Council Sampling Site Number 100807, Wairoro Stream approximately 80 metres downstream of the discharge point from the unnamed tributary into Wairoro Stream, at or about location co-ordinates 1674866E 6079142N.

7 Notwithstanding any other conditions of these consents, the exercise of these consents shall not give rise to any of the following effects on the water quality of the Wairoro Stream, as measured at Northland Regional Council Monitoring Site 100807, Wairoro Stream approximately 80 metres downstream of the discharge point from the unnamed tributary into Wairoro Stream, when compared with the water quality at Northland Regional Council Monitoring Site 103316, Wairoro Stream approximately 25 metres upstream of the discharge point from the unnamed tributary into Wairoro Stream:

(a) The natural temperature of the water shall not change by more than 3 degrees Celsius;

(b) The natural pH of the water shall be within the range 6.5 to 9.0;

(c) The concentration of dissolved oxygen (daily minimum) shall not be reduced by more than 20%;

(d) The production of conspicuous oil or grease films, scums or foams, floatable or suspended materials, or emissions of objectionable odour;

(e) Acute toxicity, or significant adverse effects of chronic toxicity, to natural aquatic life by reason of a concentration of toxic substances.

(f) The hue of the waters shall not be changed by more than 10 Munsell units.

(g) The waters shall not be tainted so as to make them unpalatable to farm animals, nor contain toxic substances to the extent that they are unsuitable for consumption by farm animals. The microcystin concentration expressed as microcystin-LR shall not exceed 2.3 micrograms per litre and/or the concentration of potentially toxic blue green algae species shall not exceed 11,500 cells per millilitre, for samples taken in accordance with Section 4.2.3 of the Monitoring Programme in Schedule 1 (**attached**).

(h) The increase in the median *Escherichia coli* concentration shall not exceed 50 per 100 millilitres, for samples taken in accordance with Section 4.2.2 of the Monitoring Programme in Schedule 1 (**attached**).

(i) The concentration of total ammoniacal nitrogen shall not exceed the following:

| pH of Water at the Time of Sampling | Total Ammoniacal Nitrogen ($[NH_3 + NH_4]$-N) (grams per cubic metre) |
|---|---|
| 6.0 | 2.57 |
| 6.1 | 2.56 |
| 6.2 | 2.54 |
| 6.3 | 2.52 |
| 6.4 | 2.49 |
| 6.5 | 2.46 |
| 6.6 | 2.43 |
| 6.7 | 2.38 |
| 6.8 | 2.33 |
| 6.9 | 2.26 |
| 7.0 | 2.18 |
| 7.1 | 2.09 |
| 7.2 | 1.99 |
| 7.3 | 1.88 |
| 7.4 | 1.75 |
| 7.5 | 1.61 |
| 7.6 | 1.47 |
| 7.7 | 1.32 |
| 7.8 | 1.18 |
| 7.9 | 1.03 |
| 8.0 | 0.90 |
| 8.1 | 0.78 |
| 8.2 | 0.66 |
| 8.3 | 0.56 |
| 8.4 | 0.48 |
| 8.5 | 0.40 |
| 8.6 | 0.34 |
| 8.7 | 0.29 |
| 8.8 | 0.24 |
| 8.9 | 0.21 |
| 9.0 | 0.18 |

In the event that the background concentration of total ammoniacal nitrogen, as measured at Northland Regional Council Site Number 103316, Wairoro Stream approximately 25 metres upstream of the discharge point from the unnamed tributary into Wairoro Stream, exceeds the above concentrations, then the exercise of these consents shall not result in an increase of the total ammoniacal nitrogen concentration of more than 0.10 grams per cubic metre.

8 The Consent Holder shall compare actual influent suspended solids and five day biochemical oxygen demand loadings, as required to be monitored in accordance with Section 1 of the Monitoring Programme in Schedule 1 (**attached**), with the design loadings for the wastewater treatment system. The results of this comparison shall be reported in the Annual Review Report required to be prepared in accordance with Condition 15.

9 The Consent Holder shall undertake an assessment of the degree of stormwater/groundwater inflow and infiltration into the Kaikohe sewage reticulation system. If there is unacceptable inflow and infiltration occurring, then a programme for inflow and infiltration reduction shall be provided to the Northland Regional Council. In the event that an inflow and infiltration reduction programme is required to reduce inflow to the sewer, the results of investigations, work undertaken, progress made and priorities for further work, shall be included in the Annual Review Report, required to be prepared in accordance with Condition 15.

### (03) Discharge to Air

10 The Consent Holder's operations shall not give rise to any discharge of contaminants at or beyond the legal boundary of the area occupied by the Kaikohe wastewater treatment system, which is deemed by a suitably trained and experienced Enforcement Officer of the Northland Regional Council to be noxious, dangerous, offensive or objectionable to such an extent that it has, or is likely to have, an adverse effect on the environment.

### General Conditions

11 The Consent Holder shall, within two years of the date of commencement of these consents, install an appropriately designed influent screen prior to the inlet to the anaerobic pond. For the purpose of this condition, an "appropriately designed influent screen" is one that includes a practical system for removing large solids that would not degrade within the treatment system; is self cleaning and is sized to allow wastewater to pass through the screen under all influent flow regimes. Residues caught by the screen shall be disposed of to a facility for which the necessary resource consents are held.

12 The Consent Holder shall, within six months of the date of commencement of these consents, submit a Management Plan covering all aspects of the operation and maintenance of the wastewater treatment system, including the discharge structure, to the Northland Regional Council for certification of its adequacy. The Management Plan shall include, but not be limited to, the following:

(a) Specification of the design wastewater volume, dimensions, design loading and expected treatment performance of each component of the treatment system in which wastewater treatment occurs.

(b) A schedule of inspection, servicing, and maintenance actions to be carried out on the wastewater treatment system. This will include identification of the timing of desludging of the anaerobic lagoon and oxidation pond, and any required maintenance of the treatment wetland cells.

(c) Where it is not practical to schedule low frequency maintenance activities, such as the desludging of the anaerobic lagoon, oxidation pond, and treatment wetlands, a monitoring programme shall be provided to demonstrate that the design treatment capacity is maintained, and criteria shall be provided to trigger required maintenance. Particular attention shall be given to the method used for measuring the depth of wastewater and sludge in the treatment system components.

When desludging of a treatment system component is required, a detailed plan of the proposed desludging shall be provided to the Northland Regional Council at least one month prior to commencement of any desludging works.

(d) Contingency measures for unauthorised discharges.

(e) Methods to be used to combat nuisances that might arise in the treatment system including midges and other insects, and blue-green algae (cyanobacteria).

***Advice Note:*** *Algicides, including copper sulphate, and insecticides shall not be used within the Wastewater Treatment System without the prior written approval of the Northland Regional Council.*

13 The operation and maintenance of the wastewater treatment system shall be undertaken in accordance with the certified Management Plan required to be prepared in accordance with Condition 12, but also always subject to the conditions of these consents. Any changes to the Management Plan shall be made with the prior written agreement of the Northland Regional Council.

14 The Consent Holder shall, in consultation with the Northland Regional Council, review the Management Plan two years after the date of commencement of these consents, and thereafter at no greater than five yearly intervals. Any changes to the Management Plan, as a result of a review, shall be subject to the prior written agreement of the Northland Regional Council. The Consent Holder shall meet all reasonable costs of each review.

15 The Consent Holder shall forward to the Northland Regional Council by 1 August each year an Annual Review Report covering the previous year (1 July to 30 June) that shall include, but not be limited to, the following:

(a) A summary of all activities required by the Management Plan; and

(b) A summary of the results of all monitoring required to be undertaken in accordance with Schedule 1 (**attached**).

**Advice Note:** *The Monitoring Programme in Schedule 1 (**attached**) includes a requirement to measure concentrations of total nitrogen and phosphorus being discharged under this consent to the Wairoro Stream. The Annual Review Report required by Condition 16 should identify trends in concentrations and mass loadings of total nitrogen and total phosphorus being discharged from the treatment plant. One of the goals of the district-wide nutrient management programme that the Consent Holder is developing, including management of nutrients discharged from the Kaikohe wastewater treatment system, should be the prevention of any further increase in the mass discharges of total nitrogen and total phosphorus over a specified period of time.*

16 The Consent Holder shall, in consultation with the Northland Regional Council, review the Monitoring Programme in Schedule 1 (**attached**) by 1 August each year. The review shall consider compliance with the consent conditions, and shall also include review of sampling methods, sites, determinands and frequencies. No changes may be made to the monitoring programme without the prior written agreement of the Northland Regional Council. The Consent Holder shall meet the reasonable costs of each review.

**Advice Note:** *In the past there has been limited monitoring of the discharge and the receiving environment. This consent imposes a more extensive and intensive monitoring programme and the Consent Holder has requested a review of that programme after 18 months of the date of commencement of the consent with a view to reduction of the monitoring if there is ongoing compliance with the standards set in this consent.*

17 Notwithstanding Condition 13, the wastewater treatment system shall be correctly operated and maintained in an effective and workmanlike manner.

18 The Consent Holder shall, for the purposes of adequately monitoring these consents as required under Section 35 of the Act, on becoming aware of any discharge of contaminants associated with the Consent Holder's operations otherwise than in conformity with these consents, immediately notify the Northland Regional Council of the discharge. In addition, if the discharge of contaminants, excluding those to air, is outside of the area legally occupied by the wastewater treatment plant, the Consent Holder shall also immediately notify the Medical Officer of Health, Northland Health Ltd. The Consent Holder shall then supply a written report to the Northland Regional Council within one week detailing:

(a) The nature of the non-compliance;

(b) The location of the discharge and receiving environment;

(c) The time of discharge;

(d) The duration of discharge;

(e) The quantity of contaminant discharged;

(f) The nature of contaminant discharged (eg. raw sewage, primary, secondary treated sewage);

(g) The measures taken to mitigate the effects on the environment and public health; and

(h) The proposed measures to prevent similar discharges in future.

19 The Consent Holder shall, for the purposes of adequately monitoring these consents as required under Section 35 of the Act, maintain records of any complaints relating to the operation of these consents received by the Consent Holder, as detailed below:

(a) The name and address of the complainant (where provided);

(b) The date and time the complaint is received;

(c) The duration of the event that gave rise to the complaint;

(d) The location from which the complaint arose;

(e) The weather conditions prevailing at that time;

(f) Any events in the management and operation of any processes that may have given rise to the complaint; and

(g) Any actions taken by the Consent Holder, where possible, to minimise contaminant emissions.

The Consent Holder shall notify the Northland Regional Council as soon as is practicable of any complaint received. Records of the above shall also be sent to the Northland Regional Council immediately upon request.

20 The Northland Regional Council may, in accordance with Section 128 of the Resource Management Act 1991, serve notice on the Consent Holder of its intention to review the conditions of these consents. Such notice may be served annually during the month of May. The review may be initiated for any one or more of the following purposes:

(a) To deal with any adverse effects on the environment that may arise from the exercise of these consents and which it is appropriate to deal with at a later stage, or to deal with any such effects following assessment of the results of the monitoring of these consents and/or as a result of the Northland Regional Council's monitoring in the area.

(b) To require the adoption of the best practicable option to remove or reduce any adverse effect on the environment.

(c) To provide for compliance with rules in any regional plan that has been made operative since the commencement of these consents.

(d) To deal with any inadequacies or inconsistencies the Northland Regional Council considers there to be in the conditions of these consents, following the establishment of the activities the subject of these consents.

(e) To deal with any material inaccuracies that may in future be found in the information made available with the application. Notice may be served at any time for this reason.

(f) To change existing conditions relating to, or impose new limits on, the quality of the discharges and/or the receiving waters.

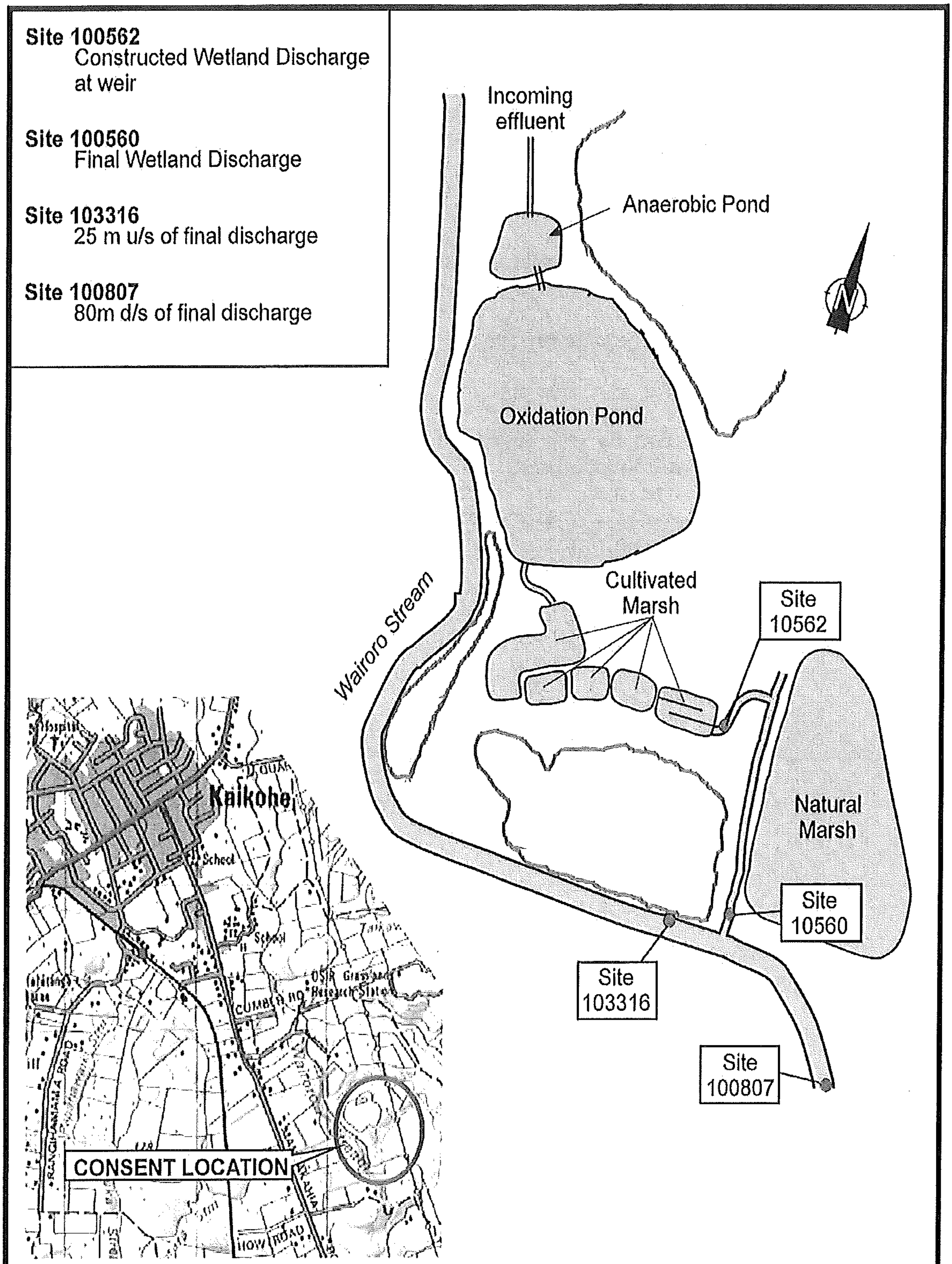
The Consent Holder shall meet all reasonable costs of any such review.

**EXPIRY DATE: 30 NOVEMBER 2021**

**This consent was issued by D L Roke on Fourth day of August 2005 under delegated authority from the Council.**

**This change to consent is granted this Nineteenth day of April 2011 under delegated authority from the Council by:**

**Robert Lieffering**
**Consents Senior Programme Manager**




NORTHLAND REGIONAL COUNCIL

**RESOURCE CONSENT CON19990241701**
**for**
**Far North District Council**
**Kaikohe Waste Water Treatment Plant**
**Sampling Sites**

| | | |
|---|---|---|
| Scale: | N.T.S. | |
| Drawn: | CNA | 05/05 |
| App'd: | | |
| Plan No. | **3514** | |

## SCHEDULE 1

## MONITORING PROGRAMME

The Consent Holder (or its authorised agent) shall monitor Resource Consent 2417 in accordance with the following monitoring programme.

### 1. TREATMENT SYSTEM MASS LOADINGS

#### 1.1 Wastewater Discharge Volume

The discharge volume from the treatment plant and the local daily rainfall over the same 24-hour period shall be recorded. The Consent Holder shall then use this data to calculate the 30 day rolling average dry weather discharge volume, as defined in Condition 1.

#### 1.2 Biochemical Oxygen Demand and Total Suspended Solids

The influent 5-day biochemical oxygen demand[(See Note 1)] and total suspended solids daily mass loadings shall be determined annually during February-March, on a minimum of four consecutive days under dry weather discharge conditions. A dry weather discharge day is defined in Condition 1.

24 hour flow proportional influent samples shall be taken for determination of the mass loadings.

#### 1.3 Significant Intermittent Loadings

An assessment of the effects on final effluent quality of any significant intermittent loadings to the Kaikohe wastewater treatment system from activities such as discharges by septic tank cleaning contractors and discharges from sources of potentially high organic loading such as stock truck washing facilities shall be provided in the Annual Review Report.

### 2. FACULTATIVE (OXIDATION) POND AND TREATMENT WETLAND DISSOLVED OXYGEN MONITORING

The concentration and percentage saturation of dissolved oxygen shall be measured every three months at three points at approximately equal intervals around the edge of the oxidation pond, and at the outlet from each of the five treatment wetland cells.

Dissolved oxygen measurements in the facultative pond shall be taken at least 60 centimetres from the water's edge and at a constant depth of 5 centimetres below the water surface.

Dissolved oxygen monitoring of the facultative pond and treatment wetlands shall be carried out on one of the days on which final effluent and receiving water monitoring is undertaken, and shall be carried out prior to the sampling of the final effluent and receiving water. The time shall be recorded for all samples.

During each visit for monitoring purposes, any significant odours at or beyond the property boundary shall be noted and reported to the Northland Regional Council within 24 hours of the visit. "Property boundary" is defined in Condition 10 of these consents.

# 3. DISCHARGE AND RECEIVING WATER MONITORING

## 3.1 Sites

The following sites (shown on NRC Plan 3514, **attached**) shall be monitored.

| NRC Monitoring Site Number | Location Description |
|---|---|
| 100562 | Discharge from treatment plant (outlet from final treatment wetland at flow monitoring point). |
| 100560 | Unnamed tributary, at point where it joins the Wairoro Stream. |
| 103316 | Wairoro Stream 25 metres upstream of the discharge point of the unnamed tributary into which the treated wastewater is discharged. |
| 100807 | Wairoro Stream approximately 80 metres downstream of the discharge point of the unnamed tributary into which the treated wastewater is discharged. |

## 3.2 Sampling Procedures, Determinands and Frequency

### 3.2.1 Discharge Monitoring

Two triplicate(See Note 2) samples of the discharged wastewater (NRC Sampling Site 100562) shall be taken at least two weeks apart, during each month between November and April (inclusive), and monthly triplicate samples shall be collected for the rest of the year. The time shall be recorded for each sample and all samples shall be taken between 1000 and 1200 hours and analysed for the following determinands:

- Temperature(See Note 3)
- pH

- Dissolved oxygen concentration(See Note 3) and percentage saturation
- 5 day biochemical oxygen demand
- Total suspended solids
- Total ammoniacal nitrogen
- Dissolved inorganic nitrogen
- Total nitrogen
- Dissolved reactive phosphorus
- Total phosphorus

During the following three two-month periods each year, October-November; February-March; and July-August, 20 triplicate(See Note 2) samples of treated wastewater from NRC Sampling Site 100562 shall be taken during each period, with a minimum of one day between samples. These samples shall be analysed for *Escherichia coli* (See Note 4) concentration.

Discharge sampling shall be co-ordinated with receiving water sampling and the discharge samples shall be taken prior to the receiving water samples.

### 3.2.2 Receiving Water Monitoring

The flow of the Wairoro Stream, and the flow of the unnamed tributary into which the WTS discharge occurs shall be recorded for each sampling occasion.

***Advice Note:*** *The Wairoro Stream flow should be determined from the most suitable existing flow monitoring site, and pro-rated to the area adjacent to the Kaikohe WTS. The Far North District Council is to install a weir near NRC Monitoring Site 100560 for measuring the flow of the unnamed tributary including the WTS discharge. The weir shall allow the passage of fish.*

The unnamed tributary of the Wairoro Stream into which the wastewater is discharged shall be monitored at a point approximately 30 metres upstream of the point of where the wastewater discharge enters the main stream of the unnamed tributary (Northland Regional Council Site 100560).

The Wairoro Stream shall be monitored 25 metres upstream of the point of discharge of the unnamed tributary (Northland Regional Council Site 103316), and at the downstream boundary of the mixing zone, this being approximately 80 metres downstream of the point of discharge from the unnamed tributary (Northland Regional Council Site 100807).

Two triplicate(See Note 2) samples per month, taken at least two weeks apart, shall be collected each month between November and April (inclusive) and monthly triplicate samples shall be collected for the rest of the year. Samples shall be analysed for the following determinands:

- Temperature(See Note 3)
- pH
- Dissolved oxygen concentration(See Note 3) and percentage saturation
- Total ammoniacal nitrogen
- Dissolved inorganic nitrogen
- Dissolved reactive phosphorus
- Hue (Munsell units)

The time shall be recorded for each receiving water sample and all receiving water samples shall be taken between 1000 and 1200 hours.

Compliance shall be determined for each sampling occasion.

During the following three two-month periods each year, (October-November; February-March; and July-August) 20 triplicate(See Note 2) samples shall be taken, with a minimum of one day between samples, from the NRC Sampling Sites 100560, 103316 and 100807. Paired samples (See Note 5) shall be taken from Sites 103316, and 100807 and the difference between *Escherichia coli* concentrations shall be determined for each of the 20 paired samples.

The median difference for the set of 20 paired samples shall not exceed an increase of 50 *Escherichia coli* per 100 millilitres.

To assist data interpretation, the monitoring of determinands with different sampling frequencies shall be integrated so that the maximum number of determinands is sampled at one time.

The water quality data from Northland Regional Council Site 100560 shall be considered if non-compliance is recorded, and there is an inconsistency between the wastewater quality data and the Wairoro Stream upstream and downstream data.

### 3.2.3 Blue-green Algal Toxicity

During periods when blue-green algae are prominent in the oxidation pond discharge, one triplicate sample shall be taken each week from Northland Regional Council Sampling Site 100807 and analysed for microcystins, expressed as microcystin-LR, and for cell counts of potentially toxic blue green algae species.

**Notes:**

(1) The "total" 5-day biochemical oxygen demand shall be measured and nitrogenous inhibitors shall not be added to the samples prior to analysis.

(2) Triplicate sampling shall involve collection of three separate samples taken at least five minutes apart during the same sampling event. Analysis shall be conducted on a composite sample made up of equal volumes of each triplicate sample.

(3) Temperature and dissolved oxygen concentration shall be measured in the field using a meter in accordance with standard procedures and triplicate measurements are not required for these parameters, apart from the measurement of dissolved oxygen in the facultative pond which is to be measured in accordance with Section 2.0.

(4) *Escherichia coli* shall, unless otherwise agreed to by the Northland Regional Council, be measured using the Colilert™ method.

(5) Paired samples are samples taken from the same body of water prior to and after the addition of the wastewater discharge. Paired samples shall be obtained by marking the upstream water with dye (or small drogues such as oranges) at the same time as the upriver sample is taken, and then sampling the marked body of water when it reaches the downstream boundary of the mixing zone.

## 4. RECORD OF SIGNIFICANT ODOURS

A record shall be kept of any significant odour at or beyond legal boundary of the area occupied by the Kaikohe wastewater treatment system. The record shall identify the source and cause of any significant odour, duration of the odour, wind strength and direction, remedial action undertaken, and the degree of success of the remedial action.

# 5. SAMPLE COLLECTION, SAMPLE TRANSPORT, AND LABORATORY REQUIREMENTS

All samples shall be collected using standard procedures and in appropriate laboratory supplied containers.

All samples shall be transported in accordance with standard procedures and under chain of custody to the laboratory.

All samples shall be analysed at a laboratory with registered quality assurance procedures#, and all analyses shall be undertaken using standard methods, where applicable.

# Registered Quality Assurance Procedures are procedures which ensure that the laboratory meets recognised management practices as would include registrations such as ISO 9000, ISO Guide 25, Ministry of Health Accreditation, IANZ.

## APPLICATION NUMBER: CON20100241701

**Application Type:** Non Notified Change

**Applicant Name:** FAR NORTH DISTRICT COUNCIL

## REASONS FOR THE DECISION

This consent is granted pursuant to Section 104B of the Resource Management Act 1991 (the Act). In reaching this decision, the Council has considered the matters outlined in Part 2 and Section 104 of the Act. It has been determined that the adverse effects of the proposed change on the environment will be no more than minor, and that the granting of this change achieves the purposes of the Act.

### Summary of Activity

The applicant has applied to delete Condition 6 of the consent which required the upgrade of the treatment system so that it could achieve a 4 log reduction in F-specific bacteriophage (a viral indicator organism), and all other references to this upgrade within the conditions of the consent. The deletion of the reference to the upgrade requires the modification of Condition 8(j) and changes to the monitoring programme for the consent. There are also consequential changes to consent conditions and cross references as a result of changes.

The requested changes to condition are shown below:

6 ~~The Consent Holder shall, within two years of the date of commencement of this consent, upgrade the wastewater treatment system to include an appropriate disinfection system. All wastewater shall then receive treatment within this disinfection system prior to being discharged to the unnamed tributary of the Wairoro Stream. For the purpose of this condition, disinfection is defined as the use of a process designed specifically to reduce the number of viable, potentially infectious micro-organisms in the discharge. The upgraded wastewater treatment system shall achieve at least a four order of magnitude (ie. four logarithm) reduction in the concentration of F-specific bacteriophage within the wastewater as a result of the treatment process. An alternative viral indicator may be used with the prior written approval of the Northland Regional Council. Compliance with the required F-specific bacteriophage reduction shall be determined by the results of monitoring undertaken in accordance with Section 2.0 of the Monitoring Programme in Schedule 1 **(attached)**.~~

*(Consequential change to Condition 7(h) in consent document)*

8(h) The increase in the median *Escherichia coli* concentration shall not exceed 50 per 100 millilitres, for samples taken in accordance with Section 4.2.2 of the Monitoring Programme in Schedule 1 (**attached**). ~~This condition 8(h) shall cease to have effect once the disinfection system required by condition 6 has been commissioned.~~

## SCHEDULE 1

## MONITORING PROGRAMME

## ~~2 INFLUENT AND DISCHARGE MONITORING FOR VIRAL INDICATORS~~

~~The concentrations of F-specific bacteriophage virus shall be determined both for a sample of untreated influent taken within the treatment plant at the inlet to the anaerobic pond, and for a sample of the final discharge from a point immediately after the disinfection system each month. An alternative viral indicator may be used as provided for in Condition 6. The Consent Holder shall, at least two weeks prior to the beginning of this sampling, provide the proposed sampling procedure for F-specific bacteriophage to Northland Regional Council for written approval.~~

*(Consequential change to Section 3.2 in consent document)*

## 4.2 Sampling Procedures, Determinands and Frequency

### 4.2.1 Discharge Monitoring

Two triplicate(See Note 2) samples of the discharged wastewater (NRC Sampling Site 100562) shall be taken at least two weeks apart, during each month between November and April (inclusive), and monthly triplicate samples shall be collected for the rest of the year. The time shall be recorded for each sample and all samples shall be taken between 1000 and 1200 hours and analysed for the following determinands:

- Temperature(See Note 3)
- pH
- Dissolved oxygen concentration(See Note 3) and percentage saturation
- 5 day biochemical oxygen demand
- Total suspended solids
- Total ammoniacal nitrogen
- Dissolved inorganic nitrogen
- Total nitrogen
- Dissolved reactive phosphorus
- Total phosphorus

During the following three two-month periods each year, October-November; February-March; and July-August, 20 triplicate(See Note 2) samples of treated wastewater from NRC Sampling Site 100562 shall be taken during each period, with a minimum of one day between samples. These samples shall be analysed for *Escherichia coli* (See Note 4) concentration.

~~The *Escherichia coli* sampling may be discontinued following commissioning of a disinfection system which meets the requirements of Condition 6.~~

Discharge sampling shall be co-ordinated with receiving water sampling and the discharge samples shall be taken prior to the receiving water samples.

### 4.2.2 Receiving Water Monitoring

The flow of the Wairoro Stream, and the flow of the unnamed tributary into which the WTS discharge occurs shall be recorded for each sampling occasion.

***Advice Note:*** *The Wairoro Stream flow should be determined from the most suitable existing flow monitoring site, and pro-rated to the area adjacent to the Kaikohe WTS. The Far North District Council is to install a weir near NRC Monitoring Site 100560 for measuring the flow of the unnamed tributary including the WTS discharge. The weir shall allow the passage of fish.*

The unnamed tributary of the Wairoro Stream into which the wastewater is discharged shall be monitored at a point approximately 30 metres upstream of the point of where the wastewater discharge enters the main stream of the unnamed tributary (Northland Regional Council Site 100560).

The Wairoro Stream shall be monitored 25 metres upstream of the point of discharge of the unnamed tributary (Northland Regional Council Site 103316), and at the downstream boundary of the mixing zone, this being approximately 80 metres downstream of the point of discharge from the unnamed tributary (Northland Regional Council Site 100807).

Two triplicate(See Note 2) samples per month, taken at least two weeks apart, shall be collected each month between November and April (inclusive) and monthly triplicate samples shall be collected for the rest of the year. Samples shall be analysed for the following determinands:

- Temperature(See Note 3)
- pH
- Dissolved oxygen concentration(See Note 3) and percentage saturation
- Total ammoniacal nitrogen
- Dissolved inorganic nitrogen
- Dissolved reactive phosphorus
- Hue (Munsell units)

The time shall be recorded for each receiving water sample and all receiving water samples shall be taken between 1000 and 1200 hours.

Compliance shall be determined for each sampling occasion.

During the following three two-month periods each year, (October-November; February-March; and July-August) 20 triplicate(See Note 2) samples shall be taken, with a minimum of one day between samples, from the NRC Sampling Sites 100560, 103316 and 100807. Paired samples (See Note 5) shall be taken from Sites 103316, and 100807 and the difference between *Escherichia coli* concentrations shall be determined for each of the 20 paired samples.

The median difference for the set of 20 paired samples shall not exceed an increase of 50 *Escherichia coli* per 100 millilitres. ~~Monitoring for *Escherichia coli* shall no longer be undertaken once the disinfection system required by Condition 6 has been commissioned.~~

To assist data interpretation, the monitoring of determinands with different sampling frequencies shall be integrated so that the maximum number of determinands is sampled at one time.

The water quality data from Northland Regional Council Site 100560 shall be considered if non-compliance is recorded, and there is an inconsistency between the wastewater quality data and the Wairoro Stream upstream and downstream data.

## Regional Plan Rule(s) Affected

The change is discretionary under section 127 of the RMA.

## Actual and Potential Effects (Section 104(1)(a) of the Act)

The adverse effects on the environment of the change have been determined to be no more than minor for the following reasons:

(a) The application for the current consent was publicly notified in 1999 and there were 4 submission received, all in opposition. These submissions raised issues regarding the recreational use of the Wairoro Stream and the effect of the discharge on the Hokianga Harbour. In 2005, the reporting officer drafted conditions of consent which included the requirement for an upgrade to achieve a 4 log reduction in F-specific bacteriophage. This requirement was based on the best information available at the time to minimise adverse effects from pathogens, and was included because the applicant had not presented any upgrade details to date nor any evidence to counter claims of adverse effects on recreational use. The draft conditions were discussed at a pre-hearing meeting, which was the third one to be held, where the applicant agreed to the upgrade requirements. From the staff report, there was no agreement by the submitters to all the conditions and therefore a hearing was held. No submitters attended the hearing and consent was granted in August 2005.

(b) The applicant has stated that the current treatment system is capable of achieving a 3 log reduction in F-specific bacteriophage during summer "when most water sports and shell fish gathering is carried out". This statement has been based on an average of 1 log reduction in the anaerobic ponds, 1 to 1.5 log reduction in the oxidation pond, and 1 log reduction in the constructed wetland.

(c) The applicant is still proposing to upgrade the WWTP to deal specifically with ongoing issues relating to high ammonia concentrations in the discharge. There is likely to be some consequential additional pathogen treatment provided as a result of this upgrade.

(d) The current consent has a very stringent effects based standard after reasonable mixing which only allows a median increase of 50 Escherichia coli (E-coli), calculated on 20 samples taken during a two month period. This sampling is required three times a year – October - November, February – March and July - August. It is considered that if the treatment system can meet the receiving water standards for E-coli on the current consent, then the potential adverse effects on the receiving water quality as a result of not upgrading the WWTP to achieve a 4 log removal efficiency will be very minor, and most likely un-measurable.

## Relevant Statutory Provisions (Section 104(1)(b) of the Act)

The Council has determined that granting the change is consistent with the objectives and policies contained in Chapters 7 and 8 of the Regional Water and Soil Plan for Northland.

The activity contravenes Section 15 of the Act, and therefore the Council has also had regard to the matters outlined in Section 105 of the Act. The Council is satisfied that the activity will not give rise to the effects outlined in Section 107 of the Act after reasonable mixing.

**I confirm that these are the true and correct reasons for the decision to grant a change to resource consent CON19990241701**

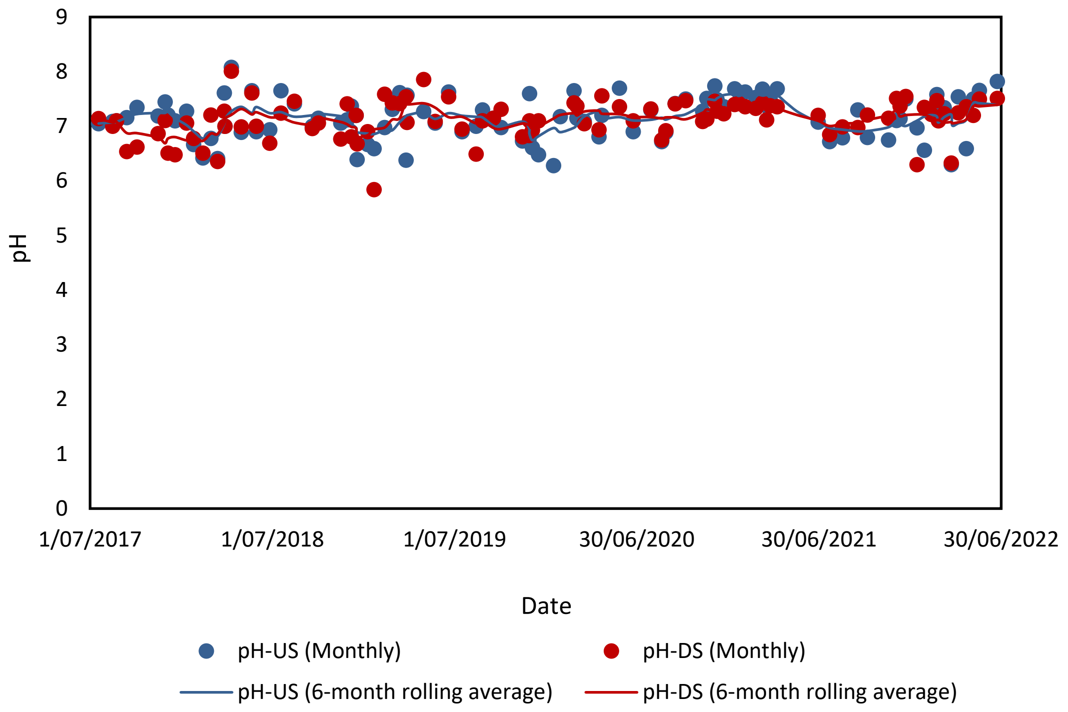
**Name and Signature of Authorised Person:** ...................................................
R Lieffering
Consents Senior Programme Manager

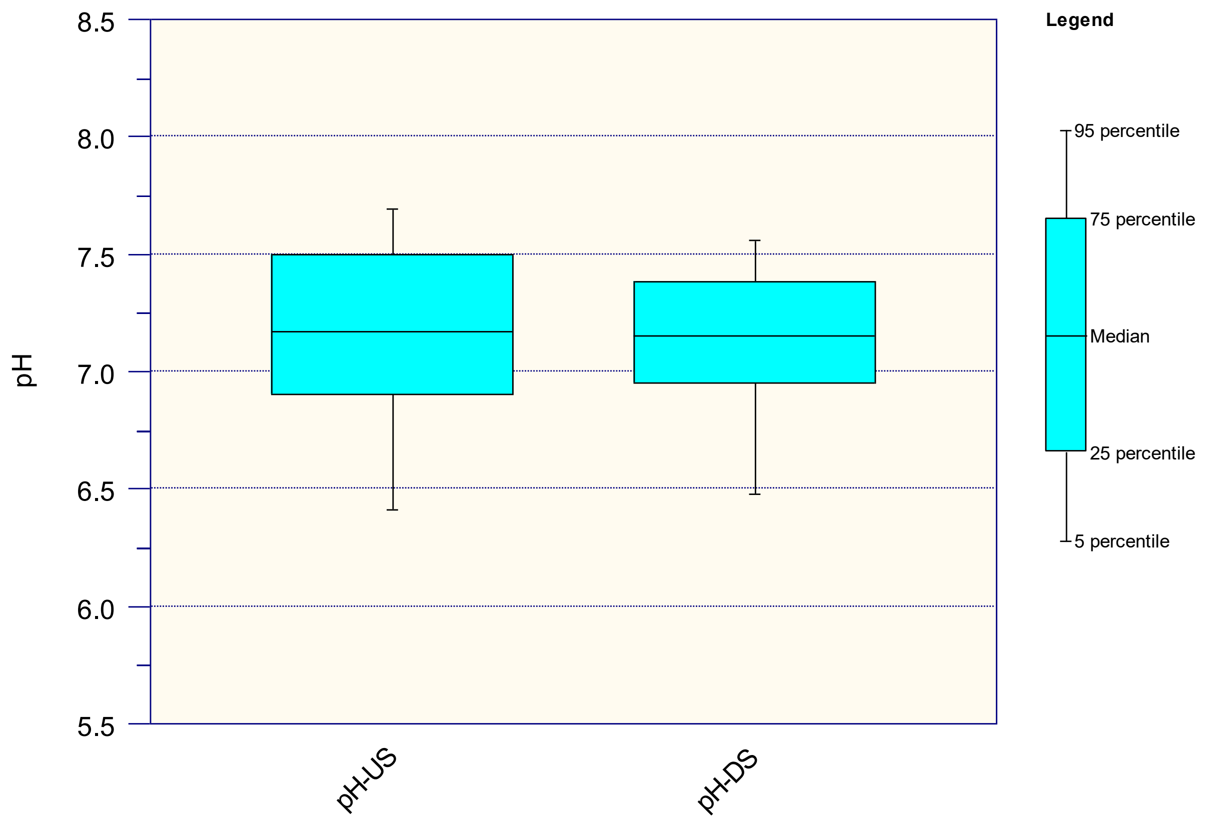
**Date:** **19 April 2011**

# B

# Appendix B – Five year comparison graph and box plots comparing the upstream and downstream sites in Wairoro Stream

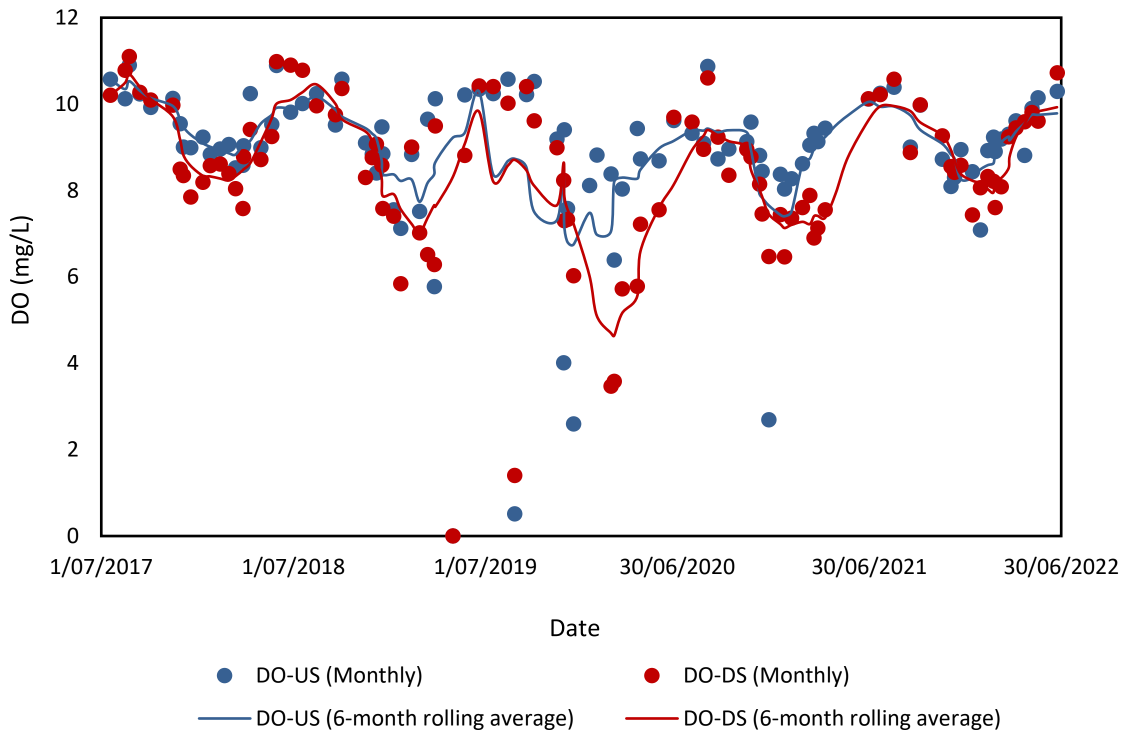
**pH:**

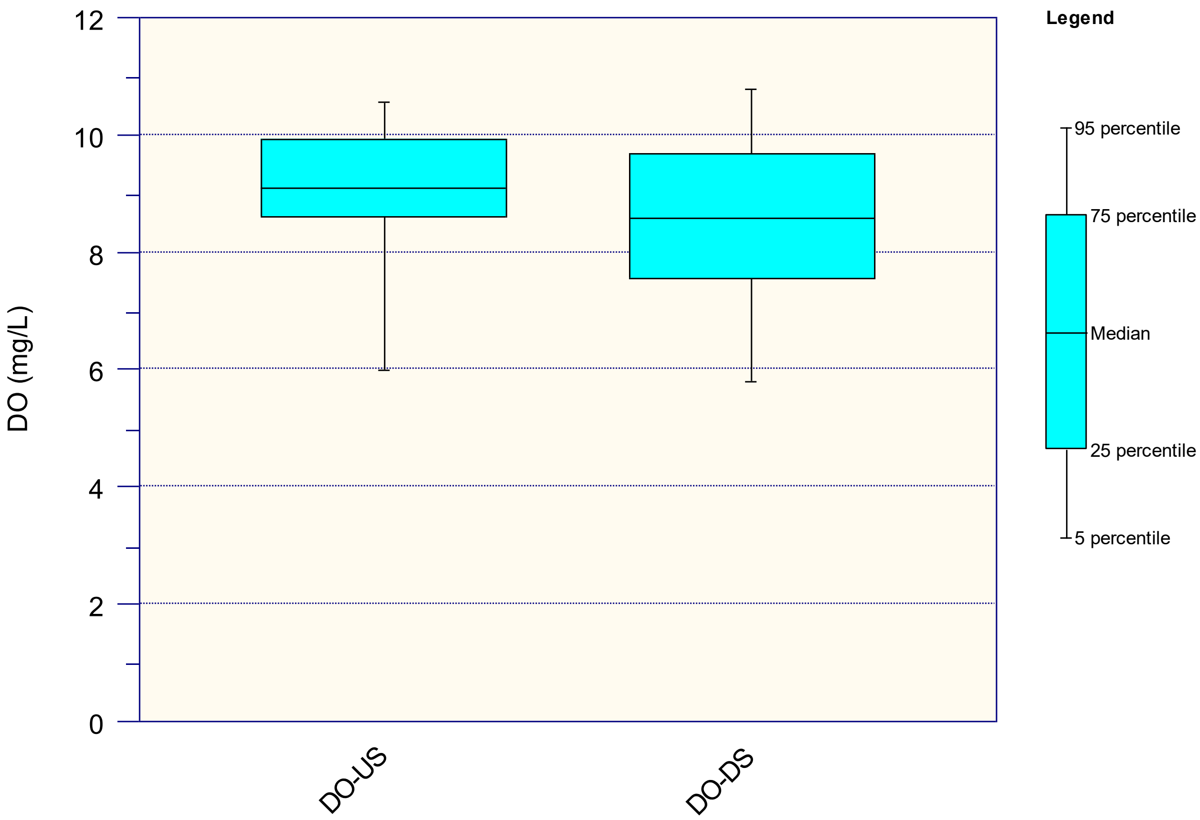



Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for pH.

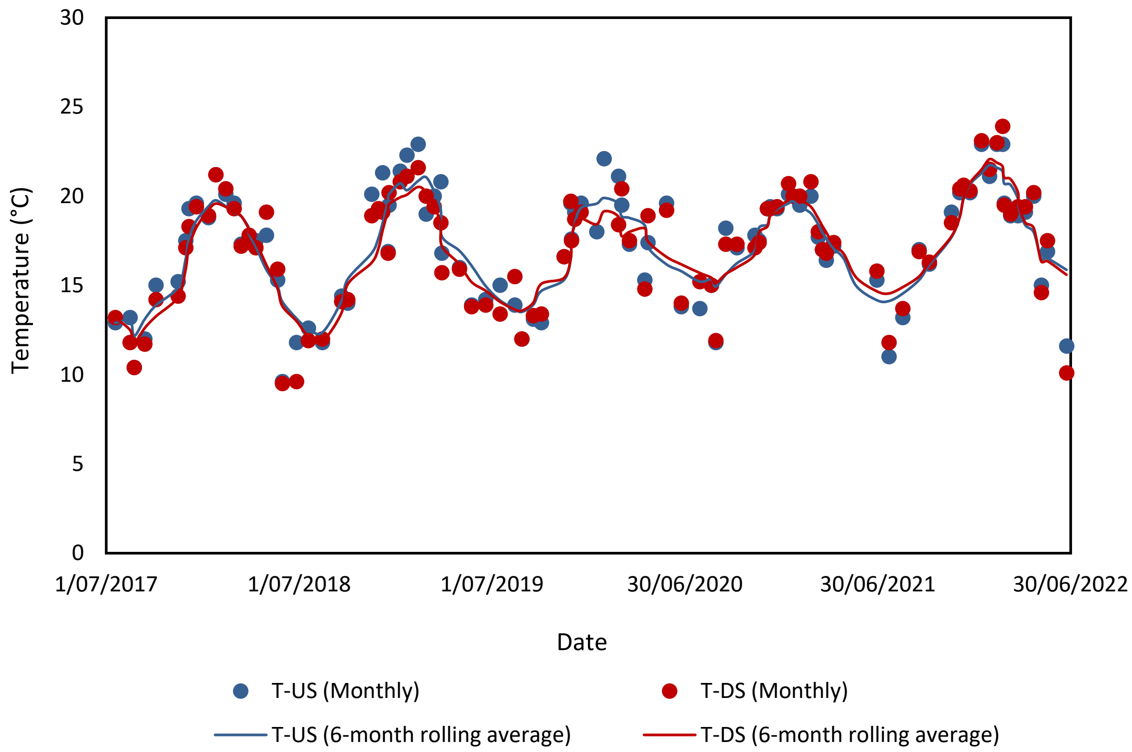
**DO:**

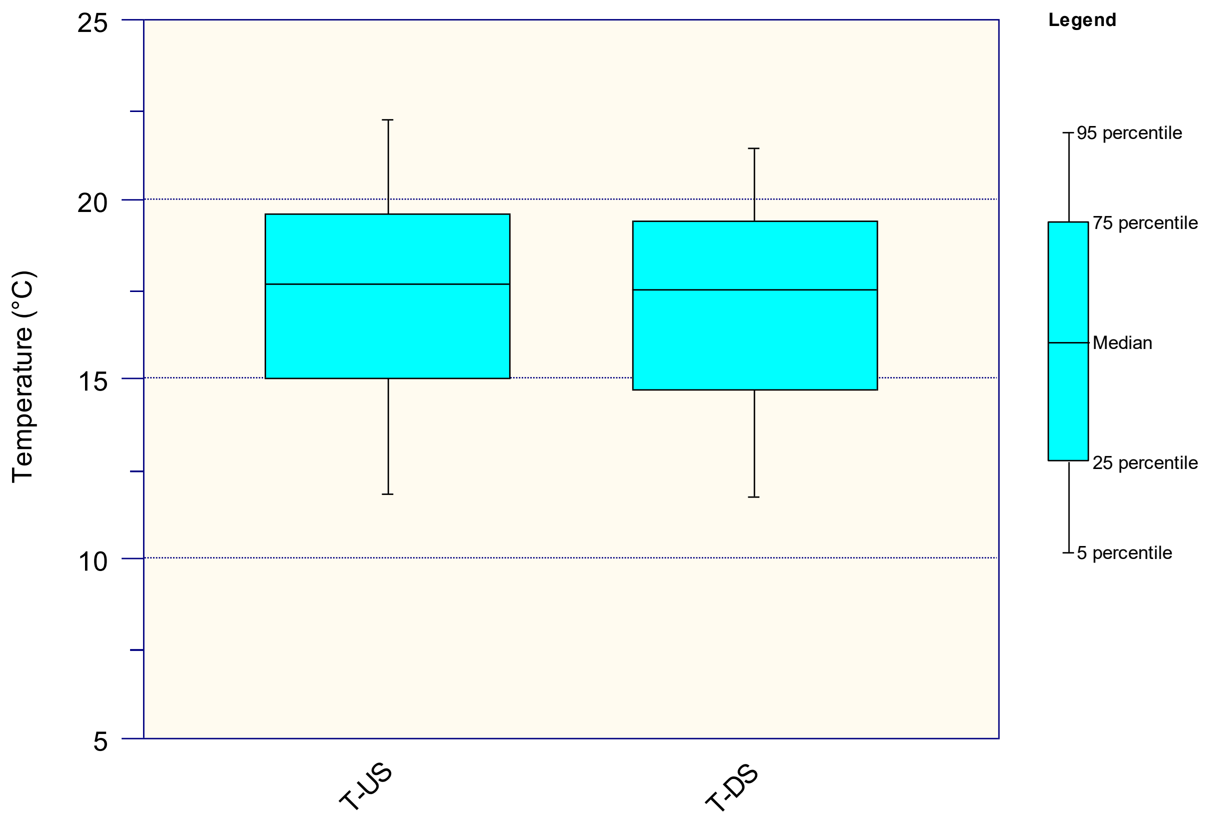



Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for DO.

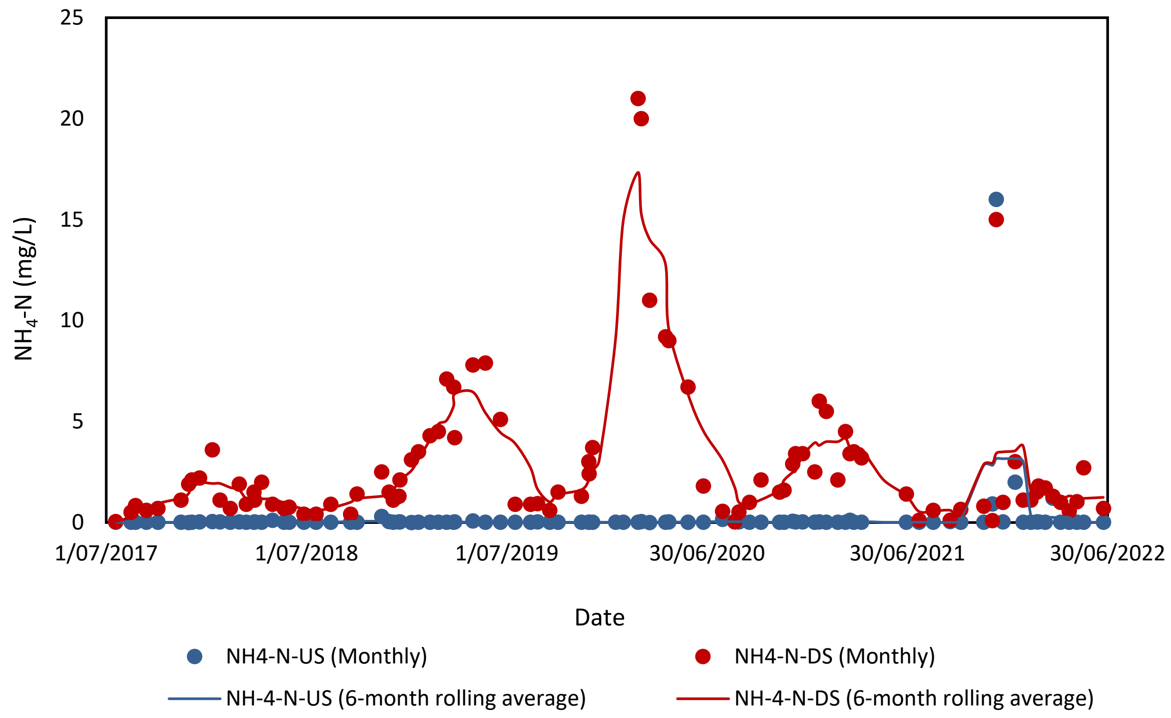
**Temperature:**

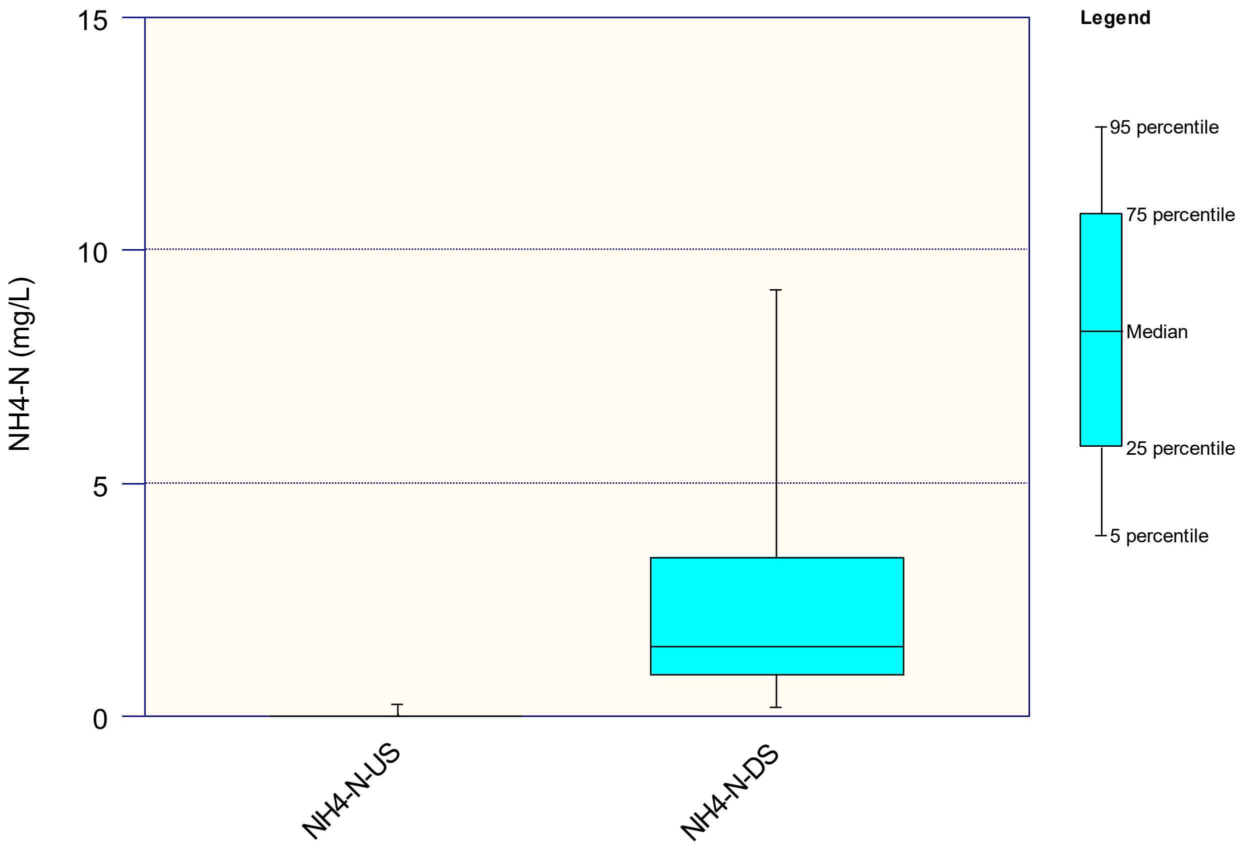



Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for Temperature.

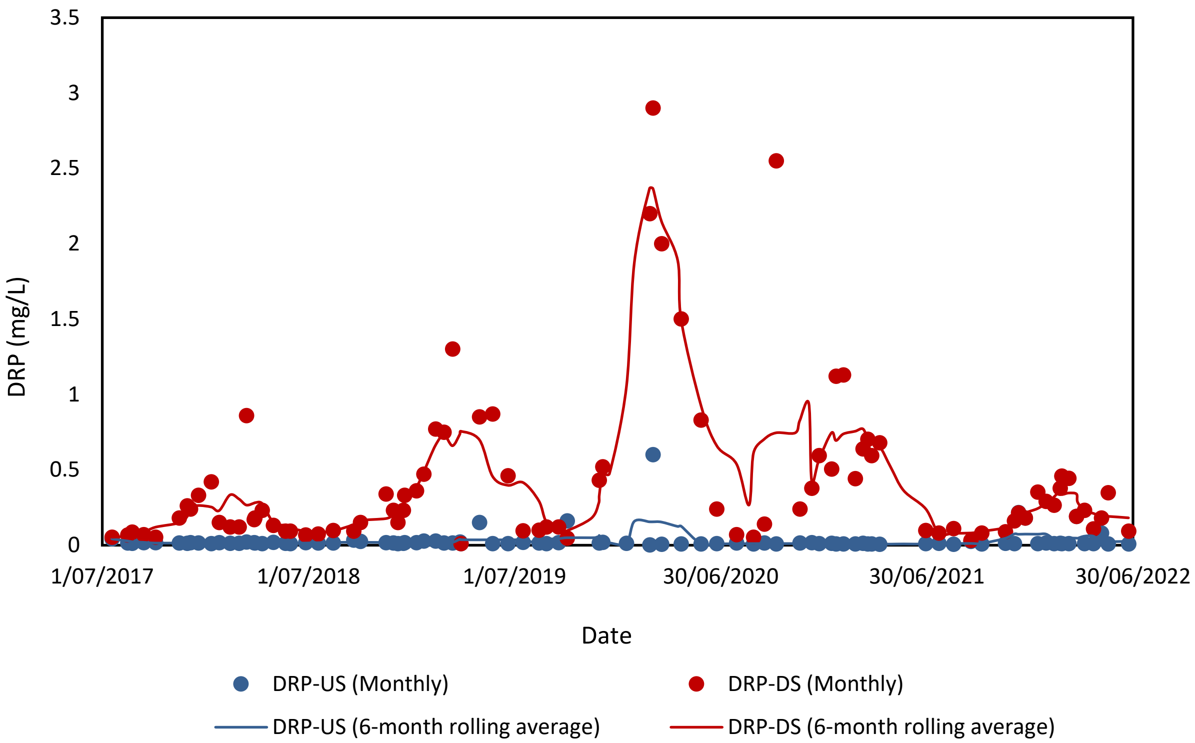
**$NH_4$-N:**

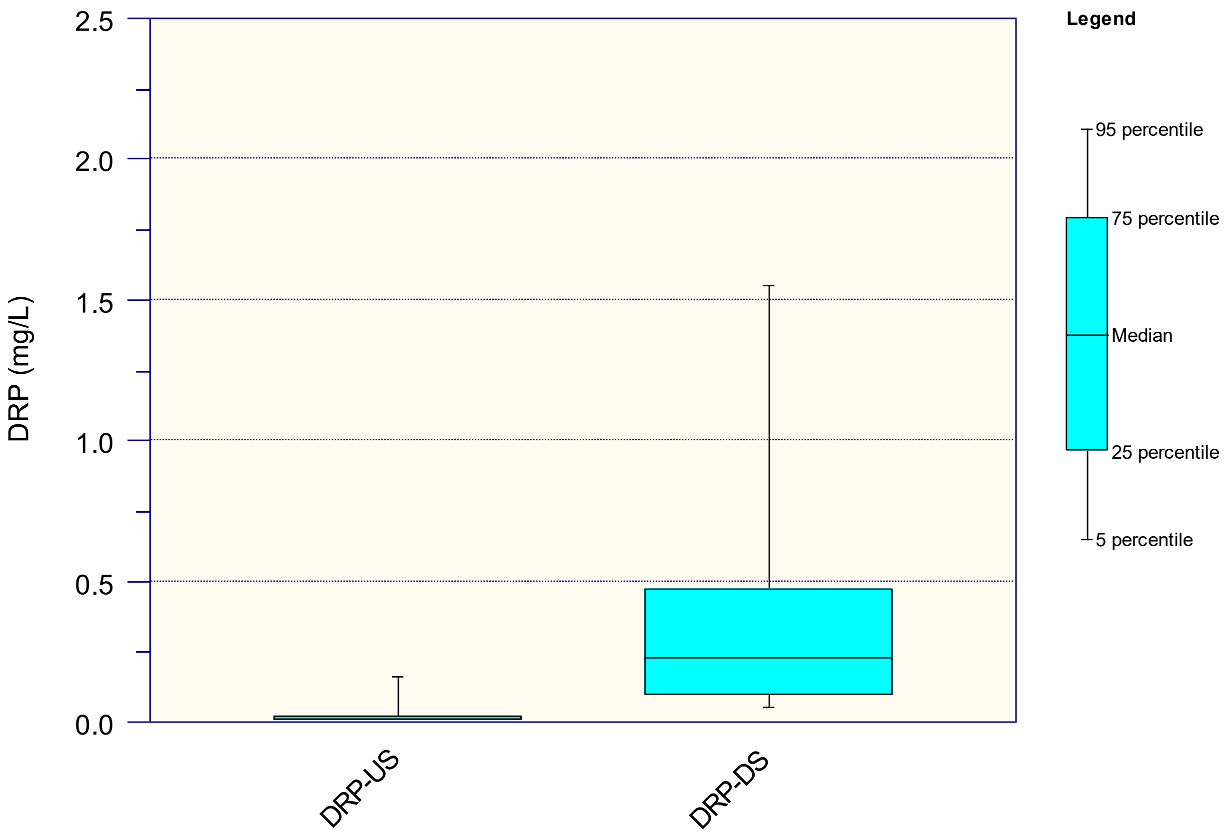



Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for Ammonia.

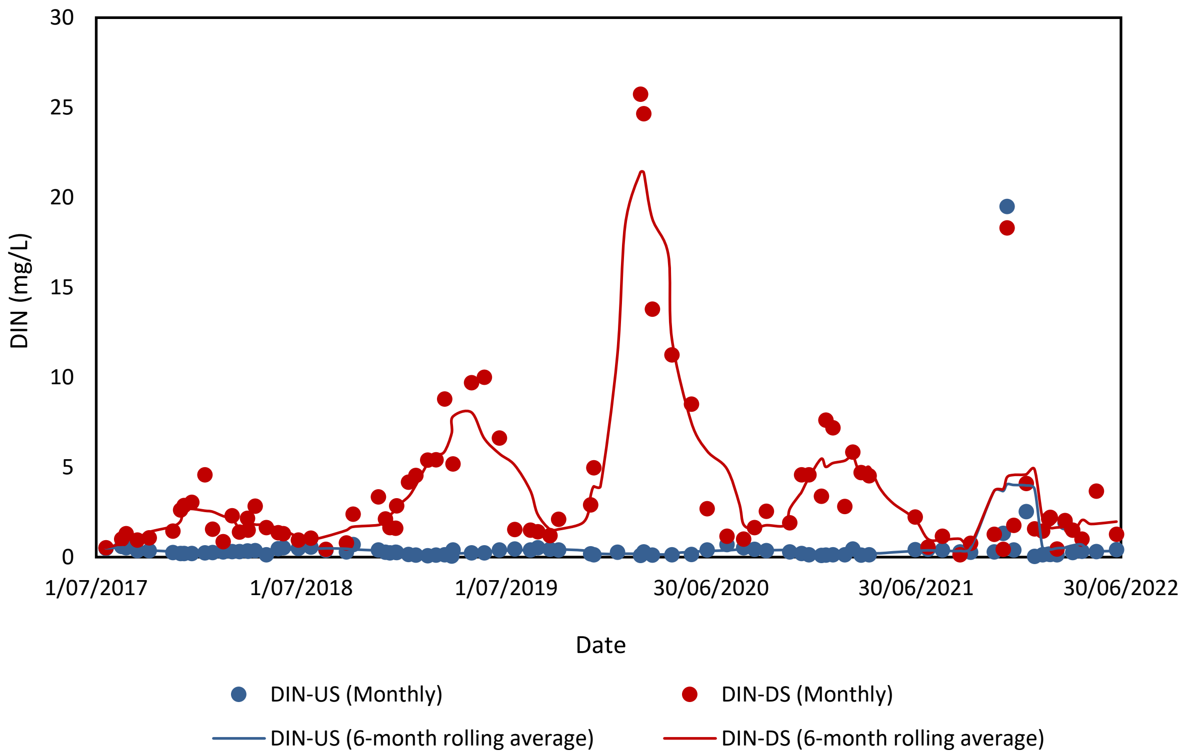
**DRP:**

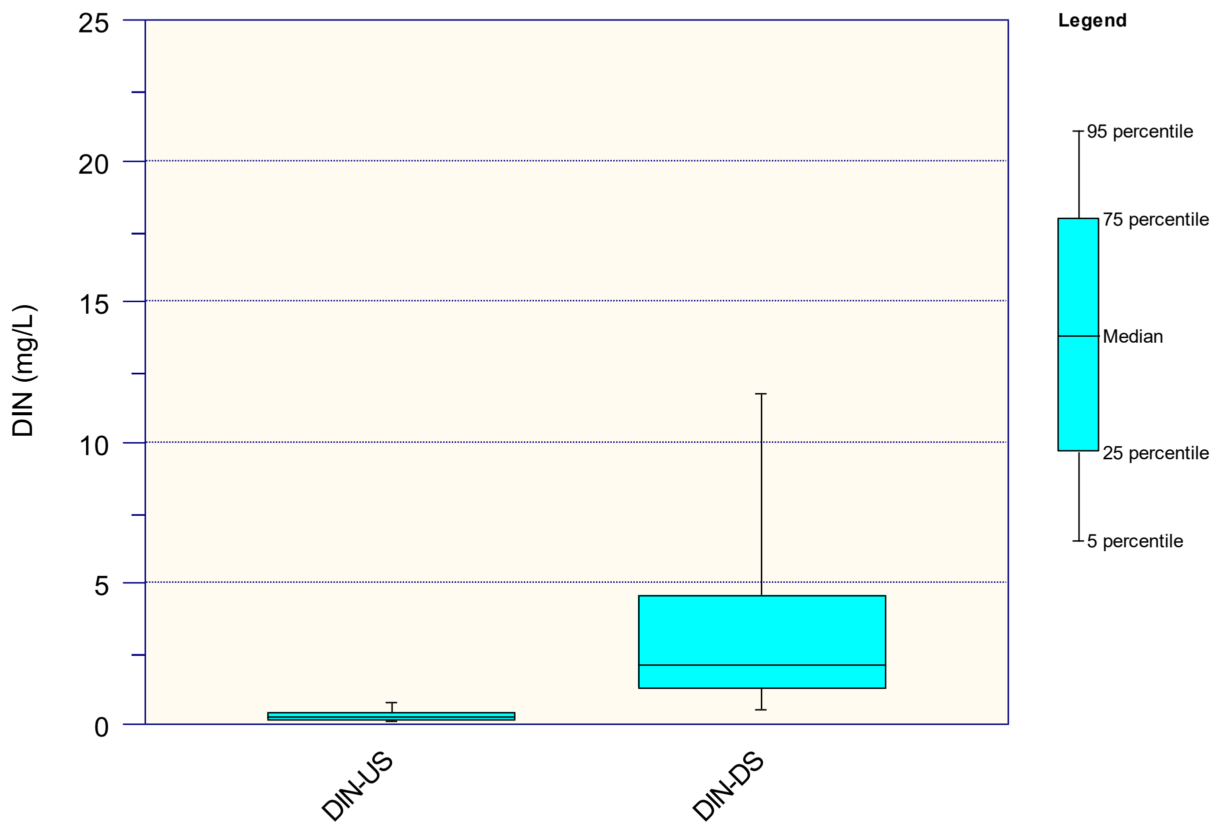



Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for DRP.

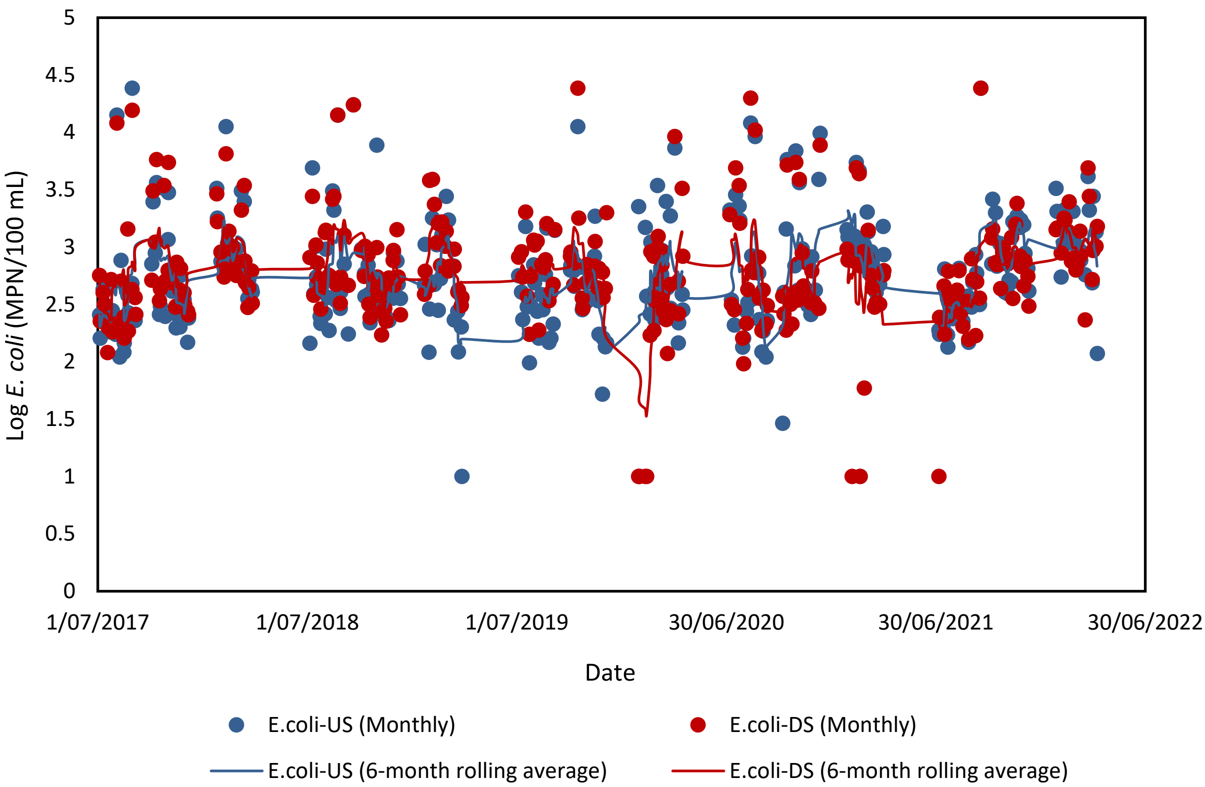
**DIN:**

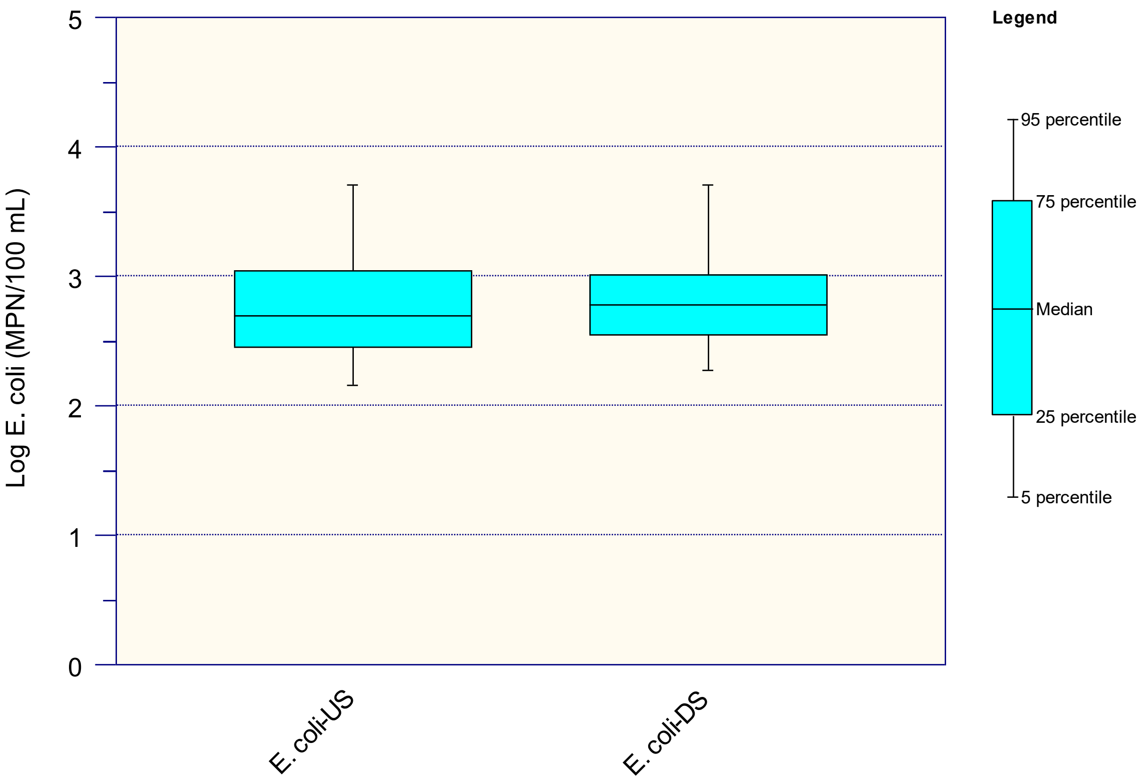



Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for DIN.

***E. coli:***




Five year upstream/downstream comparison plots comparing the sites at upstream and downstream for E. coli.

# C

## Appendix C – EIANZ Ecological Impact Assessment Guidelines

# Appendix C: Ecological Impact Assessment Guidelines

## Assigning Ecological Value

### Freshwater and terrestrial habitat

The ecological values of freshwater and terrestrial systems (riparian vegetation, habitats and species present) potentially impacted by the works were assessed against the following attributes:

- Representativeness;
- Rarity or distinctiveness;
- Diversity or pattern; and
- Ecological context.

These attributes are described in Table 1.1 and Table 1.2 below.

Table 1.1. Matters that may be considered when assigning ecological value to a freshwater site or area.

| Matters | Attributes to be assessed |
|---|---|
| Representativeness | Extent to which site/catchment is typical or characteristic<br>Stream order<br>Permanent, intermittent or ephemeral waterway<br>Catchment size<br>Standing water characteristics |
| Rarity/distinctiveness | Supporting nationally or locally threatened, at risk or uncommon species<br>National distribution limits<br>Endemism<br>Distinctive ecological features<br>Type of lake/pond/wetland/spring |
| Diversity and pattern | Level of natural diversity<br>Diversity metrics<br>Complexity of community<br>Biogeographical considerations - pattern, complexity, size, shape |
| Ecological context | Stream order<br>Instream habitat<br>Riparian habitat<br>Local environmental conditions and influences, site history and development<br>Intactness, health and resilience of populations and communities<br>Contribution to ecological networks, linkages, pathways<br>Role in ecosystem functioning – high level, proxies |

Table 1.2. Attributes to be considered when assigning ecological value or importance to a site or area of vegetation/ habitat/community.

| Matters | Attributes to be assessed |
|---|---|
| Representativeness | Criteria for representative vegetation and aquatic habitats:<br>Typical structure and composition<br>Indigenous species dominate<br>Expected species and tiers are present<br>Thresholds may need to be lowered where all examples of a type are strongly modified<br>Criteria for representative species and species assemblages:<br>Species assemblages that are typical of the habitat<br>Indigenous species that occur in most of the guilds expected of the habitat type |
| Rarity/distinctiveness | Criteria for rare/ distinctive vegetation and habitats:<br>Naturally uncommon, or induced scarcity<br>Amount of habitat or vegetation remaining<br>Distinctive ecological features<br>National priority for protection<br>Criteria for rare/ distinctive species or species assemblages:<br>Habitat supporting nationally Threatened or At Risk species, or locally uncommon species<br>Regional or national distribution limits of species or communities<br>Unusual species or assemblages<br>Endemism |
| Diversity and pattern | Level of natural diversity, abundance, and distribution<br>Biodiversity reflecting underlying diversity<br>Biogeographical considerations, considerations of lifecycles, daily or seasonal cycles of habitat availability and utilisation |
| Ecological context | Site history, and local environmental conditions which have influenced the development of habitats and communities<br>The essential characteristics that determine an ecosystem's integrity, form, functioning, and resilience (form "intrinsic value" as defined in RMA)<br>Size, shape and buffering<br>Condition and sensitivity to change<br>Contribution of the site to ecological networks, linkages, pathways and the protection and exchange of genetic material<br>Species role in ecosystem functioning – high level, key species identification, habitat as proxy |

The freshwater habitat features were assessed considering each of the attributes in Table 1.1, and terrestrial habitat features were assessed considering attributes in Table 1.2. Features of interest were subjectively given a rating on a scale of 'Very Low' to 'High' for each attribute and assigned a value in accordance with the description provided in Table 1.3.

Table 1.3. Rating system for assessing ecological value of terrestrial and freshwater systems (Roper-Lindsay et al. 2018)

| Value | Description |
|---|---|
| Negligible | Feature rates Very Low for at least three assessment attributes and Low to Moderate for the remaining attribute(s). |
| Low | Feature rates Very Low to Low for most assessment attributes and moderate for one.<br>Limited ecological value other than providing habitat for introduced or tolerant indigenous species. |
| Moderate | Feature rates High for one assessment attribute and Low to Moderate for the remainder, OR the project area rates Moderate for at least two attributes and Very Low to Low for the rest.<br>Likely to be important at the level of the Ecological District. |
| High | Feature rates High for at least two assessment attributes and Low to Moderate for the remainder, OR the project area rates High for one attribute and Moderate for the rest. Likely to be regionally important. |
| Very High | Feature rates High for at least three assessment attributes.<br>Likely to be nationally important. |

### Species

The EIANZ provides a method for assigning value (Table 1.4) to species for the purposes of assessing actual and potential effects of activities.

Table 1.4. Criteria for assigning ecological values to species

| Ecological Value | Species |
|---|---|
| Very High | Threatened (Nationally Critical, Nationally Endangered, Nationally Vulnerable) |
| High | At Risk (Declining) |
| Moderate | At Risk – Recovering and At Risk – Naturally Uncommon |
| Low | Nationally and locally common indigenous species |

## Assigning Magnitude of Impacts

The magnitude of impacts is determined by the scale (temporal and spatial) of potential impacts identified and the degree of ecological change that is expected to occur as a result of the proposed activity (Roper-Lindsay *et al*. 2018).

Based on the assessor's knowledge and experience, the magnitude of identified impacts on the ecological values within the project area and zone of influence were assessed and rated on a scale of 'Very High' to 'Negligible' based on the description provided in Table 1.5.

Table 1.5. Criteria for describing the magnitude of effects (Roper-Lindsay et al. 2018)

| Magnitude | Description |
|---|---|
| Very high | Total loss or very major alteration to key features of existing conditions, such that the post-development attributes will be fundamentally changed and may be lost altogether; and/or loss of a very high proportion of the known population or range of the feature. |
| High | Major loss or alteration of key features of existing conditions, such that post-development attributes will be fundamentally changed; and/or loss of a high proportion of the known population or range of the feature. |
| Moderate | Loss or alteration to one or more key features of the existing condition, such that post-development attributes will be partially changed; and/or loss of a moderate proportion of the known population or range of the feature. |
| Low | Minor shift away from existing conditions. Change arising from the loss/alteration will be discernible, but underlying attributes will be similar to pre-development circumstances; and/or having a minor effect on the known population or range of the feature. |
| Negligible | Very slight change from existing conditions. Change barely distinguishable, approximating "no change"; and/or having negligible effect on the known population or range of the feature. |

Assessment also considered the temporal scale at which potential impacts were likely to occur:

- Permanent (>25 years).
- Long-term (15-25 years).
- Medium-term (5-15 years).
- Short-term (0-5 years).
- Temporary (during construction)

## Assessing the Level of Effects

The overall level of effect on each ecological feature identified within the zone of influence were determined by considering the magnitude of impacts and the values of impacted ecological features (Roper-Lindsay *et al*. 2018).

Results from the assessment of ecological value and the magnitude of identified impacts were used to determine the level or extent of the overall impacts on identified ecological features within the project area and zone of influence using the matrix described in Table 1.6.

Table 1.6. Matrix combining magnitude and value for determining the level of ecological impacts (Roper-Lindsay et al. 2018).

| Effect Level | | Ecological and/or Conservation Value | | | | |
|---|---|---|---|---|---|---|
| | | **Very High** | **High** | **Moderate** | **Low** | **Negligible** |
| | **Very High** | Very High | Very High | High | Moderate | Low |
| **Magnitude** | **High** | Very High | Very High | Moderate | Low | Very Low |
| | **Moderate** | High | High | Moderate | Low | Very Low |
| | **Low** | Moderate | Low | Low | Very Low | Very Low |
| | **Negligible** | Low | Very Low | Very Low | Very Low | Very Low |
| | **Positive** | Net Gain | Net Gain | Net Gain | Net Gain | Net Gain |

Results from the matrix were used to determine the type of responses that may be required to mitigate potential direct and indirect impacts within the project area and within the zone of influence, considering the following guidelines (Roper-Lindsay *et al*. 2018):

- A 'Low' or 'Very Low' level of impact is not normally of concern, though design should take measures to minimise potential effects.
- A 'Moderate' to 'High' level of impact indicates a level of impact that qualifies careful assessment on a case-by-case basis. Such activities could be managed through avoidance (revised design) or appropriate mitigation. Where avoidance is not possible, no net loss of biodiversity values would be appropriate.

A 'Very High' level of impact is are unlikely to be acceptable on ecological grounds alone and should be avoided. Where avoidance is not possible, a net gain in biodiversity values would be appropriate.

# D

# Appendix D – Macroinvertebrate Community Index (MCI) Results

# Appendix D – MCI Results

| Bottle No. | | | US - 1 | US - 2 | DS - 1 | DS - 2 | DS - 3 |
|---|---|---|---|---|---|---|---|
| | | | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 | 18/04/2023 |
| Sample No. | | | | | | | |
| Site Name | | | | | | | |
| Taxa | MCI score | MCI-sb score | | | | | |
| Mayfly Coloburiscus | 9 | 8.1 | 9 | 1 | 9 | | 8 |
| Mayfly Deleatidium | 8 | 5.6 | | | | 7 | 16 |
| Mayfly Mauiulus | 5 | 4.1 | 8 | 3 | | | |
| Mayfly Nesameletus | 9 | 8.6 | | | | 10 | 25 |
| Mayfly Zephlebia | 7 | 8.8 | 1 | | | 3 | 9 |
| Caddisfly Aoteapsyche | 4 | 6 | 6 | | 8 | 1 | 14 |
| Caddisfly Hudsonema | 6 | 6.5 | | 1 | 2 | 7 | |
| Caddisfly Hydrobiosis | 5 | 6.7 | 10 | | 1 | 4 | 2 |
| Caddisfly Neurochorema | 6 | 6 | 2 | | | | |
| Caddisfly Oxyethira | 2 | 1.2 | 1 | | 1 | 13 | 65 |
| Caddisfly Philorheithrus | 8 | 5.3 | | | | 1 | |
| Caddisfly Polyplectropus | 8 | 8.1 | 1 | | | | |
| Caddisfly Psilochorema | 8 | 7.8 | | 1 | | | |
| Caddisfly Pycnocentria | 7 | 6.8 | 25 | 4 | 11 | 1 | 7 |
| Caddisfly Pycnocentrodes | 5 | 3.8 | 1 | 29 | 5 | 11 | 6 |
| Caddisfly Triplectides | 5 | 5.7 | 3 | 9 | 5 | 16 | 2 |
| Dragonfly Antipodochlora | 6 | 6.3 | | | | 3 | |
| Dobsonfly Archichauliodes | 7 | 7.3 | | 3 | 1 | 1 | 2 |
| Beetle Elmidae | 6 | 7.2 | 3 | 17 | 1 | 1 | |
| True Fly Austrosimulium | 3 | 3.9 | 2 | | 2 | 2 | 18 |
| True Fly Muscidae | 3 | 1.6 | | | | 1 | 1 |
| True Fly Orthocladiinae | 2 | 3.2 | 28 | 6 | | 8 | 6 |
| True Fly Polypedilum | 3 | 8 | | 1 | | 1 | 2 |
| True Fly Tanytarsini | 3 | 4.5 | 6 | | 35 | 13 | 25 |
| Collembola | 6 | 5.3 | | | | 1 | |
| Crustacea Ostracoda | 3 | 1.9 | | | 2 | | |
| MITES (Acari) | 5 | 5.2 | | 1 | | | |
| SPIDERS Dolomedes | 5 | 6.2 | | | | | 2 |
| Mollusc Ferrissia | 3 | 2.4 | | 2 | 2 | 2 | |
| Mollusc Gyraulus | 3 | 1.7 | | 1 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Mollusc Physella (Physa) | 3 | 0.1 | | | | | 2 |
| Mollusc Potamopyrgus | 4 | 2.1 | 90 | 120 | 123 | 100 | 53 |
| OLIGOCHAETES | 1 | 3.8 | 5 | 6 | 9 | 12 | 4 |
| HIRUDINEA (Leeches) | 3 | 1.2 | | | 1 | | |
| PLATYHELMINTHES (Flatworms) | 3 | 0.9 | 1 | | 1 | 6 | 2 |
| HYDROIDS | 3 | 1.6 | | | 5 | | |
| | | | | | | | |
| | | | | | | | |
| Number of Taxa | | | 18 | 16 | 19 | 24 | 21 |
| EPT Value | | | 10 | 7 | 7 | 10 | 9 |
| Number of Individuals | | | 202 | 205 | 224 | 225 | 271 |
| % EPT | | | 32.67 | 23.41 | 18.30 | 27.11 | 32.84 |
| % EPT Taxa | | | 55.56 | 43.75 | 36.84 | 41.67 | 42.86 |
| Sum of recorded scores | | | 85 | 79 | 82 | 116 | 98 |
| Count of recorded scores | | | 18 | 16 | 19 | 24 | 21 |
| Sum of individuals with scores | | | 202 | 205 | 224 | 225 | 271 |
| **MCI Value** | | | **94.44** | **98.75** | **86.32** | **96.67** | **93.33** |
| Sum of abundance load | | | 885 | 894 | 917 | 949 | 1175 |
| **QMCI Value** | | | **4.38** | **4.36** | **4.09** | **4.22** | **4.34** |
| | | | | | | | |
| Sum of recorded scores | | | 90.9 | 83.7 | 81.6 | 121.5 | 102.9 |
| Count of recorded scores | | | 18 | 16 | 19 | 24 | 21 |
| Sum of individuals with scores | | | 202 | 205 | 224 | 225 | 271 |
| SBMCI Value | | | 101 | 104.63 | 85.89 | 101.25 | 98 |
| Sum of abundance load | | | 784.6 | 681.4 | 755.1 | 796.6 | 1080.8 |
| QMCI-sb Value | | | 3.88 | 3.32 | 3.37 | 3.54 | 3.99 |

# E

## Appendix E – Periphyton Percentage Coverage Results

# Appendix E – Periphyton Coverage

| Site Name | Periphyton coverage (%) | | | | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
| DS2 | 80 | 60 | 55 | 30 | 80 | 15 | 90 | 90 | 90 | 60 | Combination of filaments and mats |
| DS3 | 90 | 90 | 35 | 25 | 40 | 10 | 80 | 75 | 85 | 40 | Combination of filaments and mats<br>Small amounts of algae |
| DS1 | 10 | 80 | 100 | 95 | 95 | 95 | 100 | 100 | 80 | 90 | High density of periphyton generally seen in the deeper pool sections compared to the riffle area. |
| US2 | 15 | 15 | 10 | 5 | 7 | 0 | 3 | 0 | 2 | 0 | No filaments only mats |
| US1 | 10 | 50 | 75 | 10 | 30 | 90 | 80 | 20 | 80 | 55 | Mostly mats, no filaments |

# F

## Appendix F – eDNA Results

| Scientific Name | Common Name | Group | DP | US1 | US2 | DS3 | DS1 | DS2 |
|---|---|---|---|---|---|---|---|---|
| Gobiomorphus basalis | Crans bully | Fish | 0 | 4052 | 3803 | 3113 | 4096 | 3300 |
| Mesocyclops leuckarti | Copepod | Crustaceans | 2958 | 0 | 0 | 144 | 4963 | 1347 |
| Lumbriculus variegatus | Blackworm | Worms | 5599 | 131 | 59 | 223 | 326 | 192 |
| Potamothrix bavaricus | Aquatic oligochaete worm | Worms | 5745 | 0 | 0 | 68 | 366 | 84 |
| Anguilla australis | Shortfin eel | Fish | 710 | 564 | 424 | 844 | 779 | 340 |
| Bos taurus | Cattle | Mammals | 379 | 266 | 551 | 529 | 338 | 157 |
| Gambusia affinis | Mosquitofish | Fish | 1594 | 145 | 111 | 35 | 287 | 41 |
| Tubifex tubifex | Sludge worm | Worms | 1677 | 7 | 0 | 44 | 172 | 83 |
| Porphyrio melanotus | Pukeko | Birds | 147 | 750 | 691 | 55 | 265 | 50 |
| Anas platyrhynchos | Mallard duck | Birds | 730 | 141 | 97 | 307 | 147 | 314 |
| Tuberolachnus salignus | Giant willow aphid | Insects | 0 | 49 | 720 | 55 | 110 | 449 |
| Chaetogaster diaphanus | Oligochaete worm | Worms | 0 | 61 | 0 | 291 | 161 | 465 |
| Limnodrilus hoffmeisteri | Redworm | Worms | 605 | 39 | 0 | 19 | 90 | 114 |
| Craspedacusta sowerbii | Freshwater jellyfish | Cnidarians | 0 | 0 | 11 | 662 | 24 | 0 |
| Trichosurus vulpecula | Common brushtail possum | Mammals | 63 | 25 | 320 | 45 | 115 | 85 |
| Anguilla dieffenbachii | Longfin eel | Fish | 0 | 75 | 31 | 59 | 179 | 250 |
| Hydra vulgaris | Hydra | Cnidarians | 23 | 26 | 12 | 68 | 229 | 147 |
| Chironomus cloacalis | Grey midge | Insects | 80 | 27 | 23 | 47 | 98 | 227 |
| Compsopogon caeruleus | Freshwater red alga | Red algae | 0 | 47 | 21 | 237 | 0 | 7 |
| Galaxias maculatus | Inanga | Fish | 0 | 0 | 0 | 0 | 276 | 0 |
| Potamopyrgus antipodarum | Mud Snail | Molluscs | 0 | 41 | 104 | 46 | 23 | 59 |
| Chaetogaster sp. 10 JM-2023 | Worm | Worms | 47 | 51 | 0 | 40 | 28 | 100 |
| Tadorna variegata | Paradise Shelduck | Birds | 0 | 0 | 17 | 103 | 0 | 109 |
| Sus scrofa | Pig | Mammals | 60 | 0 | 110 | 0 | 26 | 5 |
| Paratanytarsus grimmii | Chironomid | Insects | 24 | 103 | 44 | 5 | 7 | 16 |
| Prostoma eilhardi | Freshwater ribbon worm | Other | 0 | 0 | 0 | 82 | 35 | 77 |
| Triplectides obsoletus | NZ caddisfly | Insects | 0 | 0 | 118 | 48 | 9 | 0 |
| Austrosimulium australense | Sandfly | Insects | 0 | 155 | 0 | 0 | 11 | 0 |
| Bothrioneurum vejdovskyanum | Worm | Worms | 33 | 0 | 0 | 72 | 0 | 56 |
| Chaetogaster diastrophus | Oligochaete worm | Worms | 43 | 5 | 99 | 0 | 0 | 7 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Rattus norvegicus | Norway Rat | Mammals | 97 | 13 | 0 | 26 | 14 | 0 |
| Prostoma graecense | Freshwater nemertean | Other | 0 | 59 | 36 | 15 | 13 | 22 |
| Ectopsocus briggsi | Psocopteran fly | Insects | 0 | 29 | 24 | 0 | 83 | 5 |
| Nocturama antipodites | Freshwater red alga | Red algae | 0 | 0 | 86 | 13 | 13 | 21 |
| Tanytarsus sp. EJD-2015 | Non-biting midge | Insects | 0 | 0 | 0 | 33 | 0 | 77 |
| Oxyethira albiceps | Micro caddisfly | Insects | 0 | 30 | 10 | 39 | 6 | 15 |
| Acanthocyclops robustus | Copepod | Crustaceans | 0 | 29 | 22 | 39 | 0 | 5 |
| Aulodrilus pluriseta | Aquatic oligochaete worm | Worms | 0 | 70 | 0 | 13 | 6 | 0 |
| Ranoidea aurea | Green bell frog | Amphibians | 0 | 68 | 0 | 0 | 0 | 0 |
| Carassius auratus | Goldfish | Fish | 0 | 0 | 0 | 0 | 60 | 0 |
| Rattus rattus | Black Rat | Mammals | 0 | 0 | 0 | 36 | 13 | 0 |
| Hyalinella punctata | | Bryozoans | 0 | 0 | 0 | 0 | 17 | 31 |
| Dero digitata | Worm | Worms | 28 | 0 | 0 | 0 | 0 | 11 |
| Pycnocentria evecta | NZ caddisfly | Insects | 0 | 0 | 33 | 0 | 5 | 0 |
| Ablabesmyia sp. NZ08.Motel | | Insects | 0 | 0 | 37 | 0 | 0 | 0 |
| Physella acuta | Left handed sinistral snail | Molluscs | 0 | 6 | 0 | 23 | 0 | 5 |
| Todiramphus sanctus vagans | Sacred kingfisher | Birds | 0 | 0 | 0 | 0 | 32 | 0 |
| Orthonychiurus folsomi | Springtail | Springtails | 0 | 25 | 5 | 0 | 0 | 0 |
| Eiseniella tetraedra | Squaretail worm | Worms | 29 | 0 | 0 | 0 | 0 | 0 |
| Astrohydra japonica | Hydra | Cnidarians | 0 | 0 | 5 | 8 | 15 | 0 |
| Nais communis/variabilis complex sp. A1 | Sludgeworm | Worms | 25 | 0 | 0 | 0 | 0 | 0 |
| Octolasion lacteum | Worm | Worms | 0 | 6 | 10 | 0 | 8 | 0 |
| Pristina osborni | Worm | Worms | 0 | 0 | 9 | 0 | 0 | 11 |
| Cochliopodium kieliense | Amoeba | Amoebae | 0 | 20 | 0 | 0 | 0 | 0 |
| Paracyclops fimbriatus | Copepod | Crustaceans | 20 | 0 | 0 | 0 | 0 | 0 |
| Lumbricus rubellus | Red earthworm | Worms | 0 | 0 | 12 | 0 | 7 | 0 |
| Galaxias fasciatus | Banded kokopu | Fish | 0 | 18 | 0 | 0 | 0 | 0 |
| Austroclima sepia | Mayfly | Insects | 0 | 5 | 13 | 0 | 0 | 0 |
| Mauiulus aquilus | NZ mayfly | Insects | 0 | 0 | 0 | 0 | 8 | 10 |
| Rotaria rotatoria | Rotifer | Rotifers | 17 | 0 | 0 | 0 | 0 | 0 |
| Sheathia transpacifica | Red alga | Red algae | 0 | 0 | 17 | 0 | 0 | 0 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Hydrozetidae sp. | | Mites and ticks | 0 | 12 | 0 | 5 | 0 | 0 |
| Oxysarcodexia varia | | Insects | 0 | 15 | 0 | 0 | 0 | 0 |
| Archichauliodes diversus | NZ dobsonfly | Insects | 0 | 0 | 15 | 0 | 0 | 0 |
| Canis lupus familiaris | Dog | Mammals | 0 | 14 | 0 | 0 | 0 | 0 |
| Stylodrilus heringianus | Worm | Worms | 0 | 9 | 0 | 0 | 0 | 5 |
| Octolasion cyaneum | Worm | Worms | 0 | 12 | 0 | 0 | 0 | 0 |
| Anas chlorotis or gracilis | Brown or grey teal | Birds | 11 | 0 | 0 | 0 | 0 | 0 |
| Deroceras laeve | Marsh slug | Molluscs | 0 | 5 | 5 | 0 | 0 | 0 |
| Mythimna separata | Armyworm | Insects | 0 | 0 | 9 | 0 | 0 | 0 |
| Costachorema xanthopterum | Caddisfly | Insects | 0 | 0 | 9 | 0 | 0 | 0 |
| Ctenoplusia limbirena | Scar Bank gem; Silver U-tail | Insects | 0 | 0 | 9 | 0 | 0 | 0 |
| Insecta sp. NZAC 03010486 | | Insects | 0 | 0 | 9 | 0 | 0 | 0 |
| Nais communis | Sludgeworm | Worms | 8 | 0 | 0 | 0 | 0 | 0 |
| Culex quinquefasciatus | Southern house mosquito | Insects | 0 | 0 | 7 | 0 | 0 | 0 |
| Dero obtusa | Worm | Worms | 7 | 0 | 0 | 0 | 0 | 0 |
| Philodina megalotrocha | Rotifer | Rotifers | 7 | 0 | 0 | 0 | 0 | 0 |
| Pseudolycoriella cavatica | | Insects | 0 | 0 | 7 | 0 | 0 | 0 |
| Ovis aries | Sheep | Mammals | 6 | 0 | 0 | 0 | 0 | 0 |
| Corynoneura scutellata | Non-biting midge | Insects | 0 | 6 | 0 | 0 | 0 | 0 |
| Monomorium antarcticum | Southern ant | Insects | 0 | 0 | 6 | 0 | 0 | 0 |
| Amynthas corticis | Snake worm | Worms | 5 | 0 | 0 | 0 | 0 | 0 |
| Sheathia confusa | Freshwater red alga | Red algae | 0 | 0 | 5 | 0 | 0 | 0 |
| Mermessus fradeorum | | Spiders | 0 | 0 | 0 | 0 | 5 | 0 |
| Isotenes miserana | Moth | Insects | 0 | 5 | 0 | 0 | 0 | 0 |
| Gobiomorphus | Bullies | Fish | 0 | 2191 | 2099 | 2485 | 2964 | 1872 |
| Nais | Sludgeworm | Worms | 99 | 719 | 1705 | 1349 | 673 | 1508 |
| Dero | Worm | Worms | 3038 | 0 | 0 | 16 | 212 | 71 |
| Potamopyrgus | Mud snails | Molluscs | 0 | 65 | 293 | 488 | 182 | 200 |
| Phytophthora | Water mold | Oomycetes | 0 | 87 | 51 | 13 | 0 | 52 |
| Bothrioneurum | Worm | Worms | 123 | 21 | 0 | 0 | 6 | 0 |
| Plumatella | Plumatella | Bryozoans | 0 | 0 | 0 | 39 | 43 | 60 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Galaxias | Galaxiids | Fish | 0 | 0 | 0 | 0 | 108 | 0 |
| Prostoma | | Other | 0 | 34 | 14 | 19 | 0 | 38 |
| Limnodrilus | Worm | Worms | 54 | 0 | 0 | 16 | 0 | 9 |
| Anguilla | Eels | Fish | 44 | 0 | 0 | 0 | 28 | 0 |
| Chamaedrilus | Worm | Worms | 11 | 0 | 0 | 0 | 59 | 0 |
| Mauiulus | NZ mayfly | Insects | 0 | 0 | 62 | 0 | 0 | 0 |
| Rotaria | Rotifer | Rotifers | 59 | 0 | 0 | 0 | 0 | 0 |
| Culex | | Insects | 28 | 6 | 0 | 0 | 0 | 0 |
| Turdus | Thrush | Birds | 0 | 14 | 0 | 14 | 0 | 0 |
| Ablabesmyia | | Insects | 0 | 23 | 0 | 0 | 0 | 0 |
| Pycnocentrodes | Stony cased caddisfly | Insects | 0 | 0 | 22 | 0 | 0 | 0 |
| Tubifex | Worm | Worms | 16 | 0 | 0 | 0 | 0 | 5 |
| Hydra | Hydra | Cnidarians | 0 | 0 | 5 | 7 | 0 | 5 |
| Spodoptera | | Insects | 0 | 12 | 0 | 0 | 0 | 0 |
| Hyalinella | | Bryozoans | 0 | 0 | 0 | 0 | 0 | 11 |
| Girardia | | Flatworms | 0 | 0 | 0 | 0 | 0 | 6 |
| Ctenopseustis | Brownheaded leafroller moth | Insects | 0 | 0 | 0 | 0 | 0 | 6 |
| Limnophyes | Non-biting midge | Insects | 0 | 6 | 0 | 0 | 0 | 0 |
| Spumella | Golden-brown alga | Heterokont algae | 0 | 0 | 0 | 0 | 0 | 5 |
| Poecilopachys | Orb-weaver spider | Spiders | 0 | 0 | 5 | 0 | 0 | 0 |
| Tubificinae | | Worms | 148 | 0 | 0 | 8 | 21 | 20 |
| Chironomidae | Nonbiting midges | Insects | 0 | 0 | 0 | 0 | 0 | 89 |
| Batrachospermaceae | | Red algae | 0 | 43 | 24 | 19 | 0 | 0 |
| Anserinae | Swans and geese | Birds | 0 | 0 | 0 | 58 | 0 | 0 |
| Aphididae | Aphids | Insects | 0 | 18 | 17 | 0 | 0 | 18 |
| Caprinae | | Mammals | 28 | 0 | 0 | 0 | 0 | 0 |
| Naididae | Sludgeworms | Worms | 0 | 13 | 7 | 0 | 0 | 0 |
| Nesameletidae | Mayflies | Insects | 0 | 0 | 12 | 0 | 0 | 0 |
| Isotomidae | Smooth springtails | Springtails | 0 | 0 | 0 | 8 | 0 | 0 |
| Hyriidae | | Molluscs | 0 | 0 | 5 | 0 | 0 | 0 |
| root | Unidentified | Other | 9935 | 4772 | 5029 | 5763 | 5494 | 6919 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Metazoa | Metazoans | Other | 275 | 619 | 952 | 5219 | 231 | 831 |
| Insecta | Insects | Other | 0 | 241 | 794 | 155 | 151 | 407 |
| Arthropoda | Arthropods | Other | 0 | 569 | 594 | 79 | 104 | 191 |
| Trichoptera | Caddisflies | Insects | 0 | 172 | 70 | 33 | 31 | 118 |
| Annelida | Annelid worms | Other | 0 | 60 | 115 | 67 | 23 | 86 |
| Chordata | Chordates | Other | 123 | 31 | 10 | 37 | 30 | 0 |
| Cyclopoida | | Crustaceans | 40 | 0 | 0 | 0 | 127 | 0 |
| Eurotatoria | | Rotifers | 0 | 0 | 0 | 35 | 9 | 95 |
| unclassified Ceratophysella | | Springtails | 0 | 135 | 0 | 0 | 0 | 0 |
| Clitellata | | Worms | 0 | 0 | 0 | 0 | 29 | 72 |
| Mollusca | Molluscs | Other | 0 | 0 | 66 | 0 | 0 | 29 |
| unclassified Chaetogaster | | Worms | 0 | 39 | 20 | 8 | 6 | 7 |
| Florideophyceae | | Red algae | 0 | 0 | 70 | 0 | 0 | 0 |
| Rotifera | Rotifers | Other | 22 | 6 | 25 | 0 | 0 | 10 |
| Artiodactyla | Hoofed Animals | Mammals | 0 | 14 | 29 | 0 | 0 | 18 |
| Euteleostomi | Bony vertebrates | Other | 0 | 61 | 0 | 0 | 0 | 0 |
| Gobiiformes | Gobies and sleepers | Fish | 0 | 54 | 0 | 0 | 0 | 0 |
| Nemertea | Bootlace worms | Other | 0 | 11 | 22 | 12 | 0 | 0 |
| Neoptera | Winged insects | Insects | 0 | 39 | 6 | 0 | 0 | 0 |
| Diptera | Flies | Insects | 0 | 6 | 9 | 0 | 7 | 0 |
| unclassified Philodina | | Rotifers | 19 | 0 | 0 | 0 | 0 | 0 |
| Batrachospermales | Red alga | Red algae | 0 | 14 | 0 | 0 | 0 | 0 |
| unclassified Macrothrix | | Crustaceans | 0 | 0 | 0 | 0 | 0 | 13 |
| Arcellinida | | Amoebae | 0 | 0 | 0 | 0 | 12 | 0 |
| Oomycota | | Heterokont algae | 0 | 11 | 0 | 0 | 0 | 0 |
| Lepidoptera | Butterflies and moths | Insects | 0 | 0 | 0 | 0 | 11 | 0 |
| Aves | Birds | Other | 0 | 0 | 0 | 9 | 0 | 0 |
| Mammalia | Mammals | Other | 9 | 0 | 0 | 0 | 0 | 0 |
| unclassified Paraphysomonas | | Heterokont algae | 0 | 7 | 0 | 0 | 0 | 0 |
| unclassified Saccamoeba | | Amoebae | 0 | 0 | 0 | 0 | 5 | 0 |