RUAPEHU DISTRICT COUNCIL

RANGATAUA WASTEWATER TREATMENT PLANT

SUPPLEMENTARY INFORMATION

23 SEPTEMBER 2021

traverse ENVIRONMENTAL

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Report Information

Report Status	Draft for client review
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1 Executive Summary

This report provides supplementary information to the "Resource Consent Application for Rangataua Wastewater Treatment Plant" lodged by Ruapehu District Council ("RDC") on 30 June 2014 ("June 2014 application"). The June 2014 application sought to renew the existing resource consent for discharges from the Rangataua WWTP and to provide for its ongoing operation of the Rangataua WWTP for a period of 25 years.

The consents sought are:

- Discharge to land via seepage from the base of the treatment ponds;
- Discharge to air from the treatment ponds; and
- Discharge to land where it may enter water via the wetland systems with the ultimate receiving environment being the Mangaehuehu Stream.

In recognition that the June 2014 application does not account for the changes to the planning framework since it was lodged and the further effluent and instream monitoring RDC has undertaken, this report has been prepared to:

- Include updated analysis from recent in-stream and effluent quality monitoring and reported in the "Rangataua Wastewater Treatment Plant discharge to the Mangaehuehu Stream Assessment of current effects on freshwater quality and ecology" ("Aquanet 2120 Report" (Appendix 2));
- Include consideration of implications to the application from changes resulting from Treaty settlements;
- Consider the application in the context of Ngāti Rangi's Taiao Management Plan 2014;
- Incorporate information provided in the response to the Horizons further information request in June 2020;
- Provide a supplementary assessment of environmental effects based on recent data; and
- Provide analysis against the current planning framework introduced since the June 2014 application was lodged including the National Policy Statement for Freshwater 2020 and the National Environmental Standard for Freshwater Management 2020;

Recent water quality monitoring identifies that there are few detectable changes in concentrations of the key discharge constituents between upstream and downstream of the discharge point. There are small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream, however this is which is also influenced by unrestricted stock access to the discharge channel and the Mangaehuehu Stream.

Monthly periphyton monitoring is needed to address gaps in data and this is proposed by RDC as a condition of any granted resource consent.

Engagement is needed to understand and assess the cultural effects of the proposal, including the context of Ngāti Rangi’s Taiao Management Plant 2014 and the NPSFM 2020.

2 Introduction

2.1 Background

This report provides supplementary information to the "Resource Consent Application for Rangataua Wastewater Treatment Plant" lodged by Ruapehu District Council ("RDC") on 30 June 2014 ("June 2014 application").

The June 2014 application sought to renew the existing resource consent for the ongoing operation of the Rangataua WWTP for a period of 25 years.

The following resource consents were applied for:

- Discharge to land via seepage from the base of the treatment ponds;
- Discharge to air from the treatment ponds; and
- Discharge to land where it may enter water via the wetland systems with the ultimate receiving environment being the Mangaehuehu Stream.

The June 2014 application secured the ability for RDC to continue to operate the Rangataua Wastewater Treatment Plant ("WWTP") under Section 124 of the Resource Management Act ("RMA") while a decision on the new application is being made.

The June 2014 application was subject to a request for further information on 2 September 2014 which was responded to on 4 June 2020. The application was publicly notified in late 2020 with the period for submissions closing on November 25, 2020. During the submission period, three submissions were received:

- Ngā Waihua o Paerangi Trust (iwi authority for Ngāti Rangi) – Opposition submission
- Taranaki Fish and Game – Neutral submission
- MidCentral District Health Board – Supportive submission

In recognition that the June 2014 application does not account for the changes to the planning framework since it was lodged and the further effluent and instream monitoring RDC has undertaken, this report has been prepared to:

- Include updated analysis from recent in-stream and effluent quality monitoring and reported in the "Rangataua Wastewater Treatment Plant discharge to the Mangaehuehu Stream Assessment of current effects on freshwater quality and ecology" ("Aquanet 2120 Report" (Appendix 2));

- Include consideration of implications to the application from changes resulting from Treaty settlements;
- Consider the application in the context of Ngāti Rangi’s Taiao Management Plan 2014;
- Incorporate information provided in the response to the Horizons further information request in June 2020;
- Provide a supplementary assessment of environmental effects based on recent data; and
- Provide analysis against the current planning framework, introduced since the June 2014 application was lodged, including the National Policy Statement for Freshwater 2020 and the National Environmental Standard for Freshwater Management 2020;

3 Existing Environment

3.1 Mangaehuehu Stream

The Mangaehuehu Stream originates from the Mangaehuehu Glacier of the southwestern slopes of Mount Ruapehu. It flows through the Tongariro National Park and the Rangataua and Rangataua No.2 Conservation Areas before crossing under State Highway 49 near the WWTP. From the WWTP, it passes through pastoral farmland before entering the Whangaehu River.

The Mangaehuehu Stream the is located within the Upper Whangaehu (Whau_1) Water Management Zone and the Tokiahuru (Whau_1c) Water management sub-zone as identified in the Horizons One Plan.

3.1.1 River Values

Table 1 below provides a summary of the surface water values and their management objectives identified for the Tokiahuru (Whau_1c) Sub-zone.

Table 1 Summary of the management values& objectives applicable to the Tokiahuru (Whau_1c) Water Management Sub-zone, as per One Plan Schedule B.

Value Group	Management Values	Management Objective
Zone-wide Values	Life-Supporting Capacity (Upland Volcanic Acid)	The water body and its bed support healthy aquatic life/ecosystems.
	Aesthetics	The aesthetic values of the water body and its bed are maintained or enhanced.
	Contact Recreation	The water body and its bed are suitable for contact recreation.
	Mauri	The mauri of the water body and its bed is maintained or enhanced.
	Industrial Abstraction	The water is suitable as a water source for industrial abstraction or use, including for hydroelectricity generation.
	Irrigation	The water is suitable as a water source for irrigation.
	Stock water	The water is suitable as a supply of drinking water for livestock.
	Existing infrastructure	The integrity of existing infrastructure is not compromised.
	Capacity to Assimilate Pollution	The capacity of a water body and its bed to assimilate pollution is not exceeded.
	Natural State	The river and its bed are maintained in their natural state.
	Site of Significance - Aquatic	Sites of significance for indigenous aquatic biodiversity are maintained or enhanced.

	Site of Significance - Riparian	Sites of significance for indigenous riparian biodiversity are maintained or enhanced.
Site/Reach – specific values	Trout Fishery (Other trout fishery)	The water body^ and its bed^ sustain healthy rainbow or brown trout fisheries.
	Trout Spawning	The water body^ and its bed^ meet the requirements of rainbow and brown trout spawning and larval and fry development.
	Domestic Food Supply	The water^ is suitable for domestic food production.

3.2 Existing Rangataua Wastewater Treatment Plant

The Rangataua Wastewater Treatment Plant ("WWTP") is owned and operated by Ruapehu District Council. It is situated approximately 5 kilometres south from the centre of the Rangataua township, off the extension of Nei Street and is legally described as Pt Sec 33 Closed Road BLK V KARIOI SD-Mangaehuehu Scenic Reserve.

Wastewater is collected from the Rangataua township via a reticulated network (Figure 1) consisting of approximately 3.5km of 150mm diameter PVC pipes and flows under gravity to a pump station located on the north-eastern corner of the intersection of Marino and Kaha Streets from where it is pumped approximately 800 metres through a rising main to the treatment plant (Figure 2).

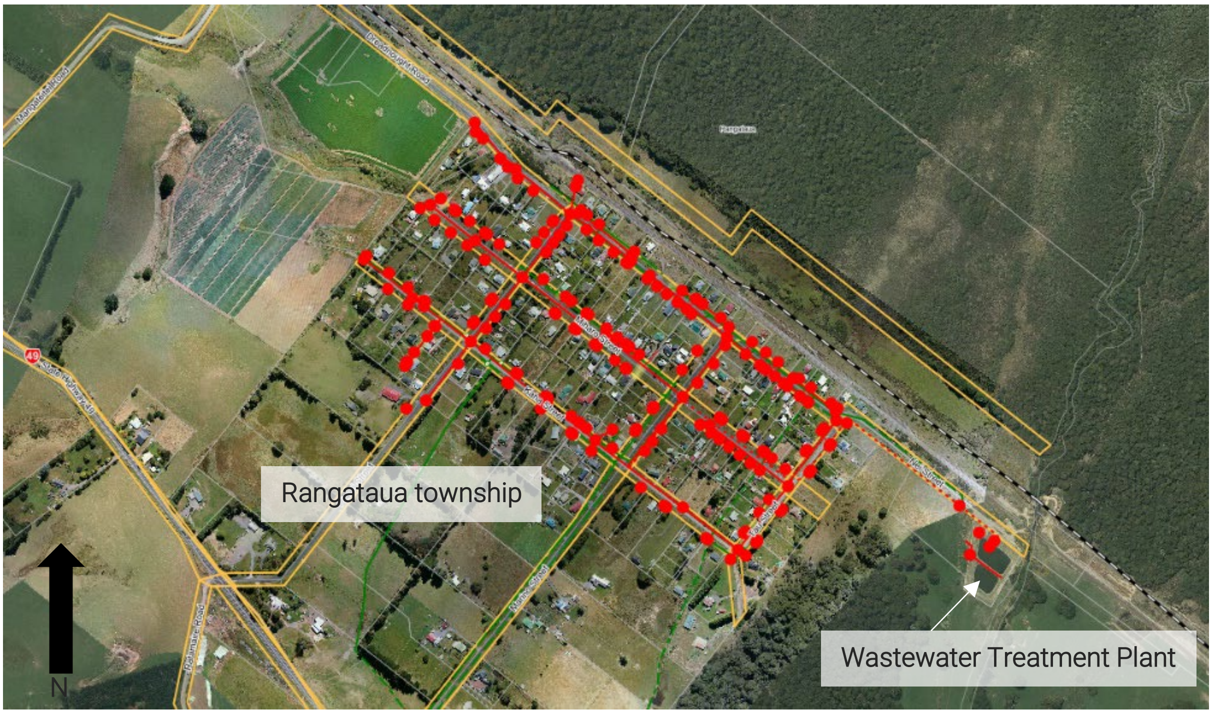


Figure 1 Rangataua Wastewater Reticulation Network(shown in red)

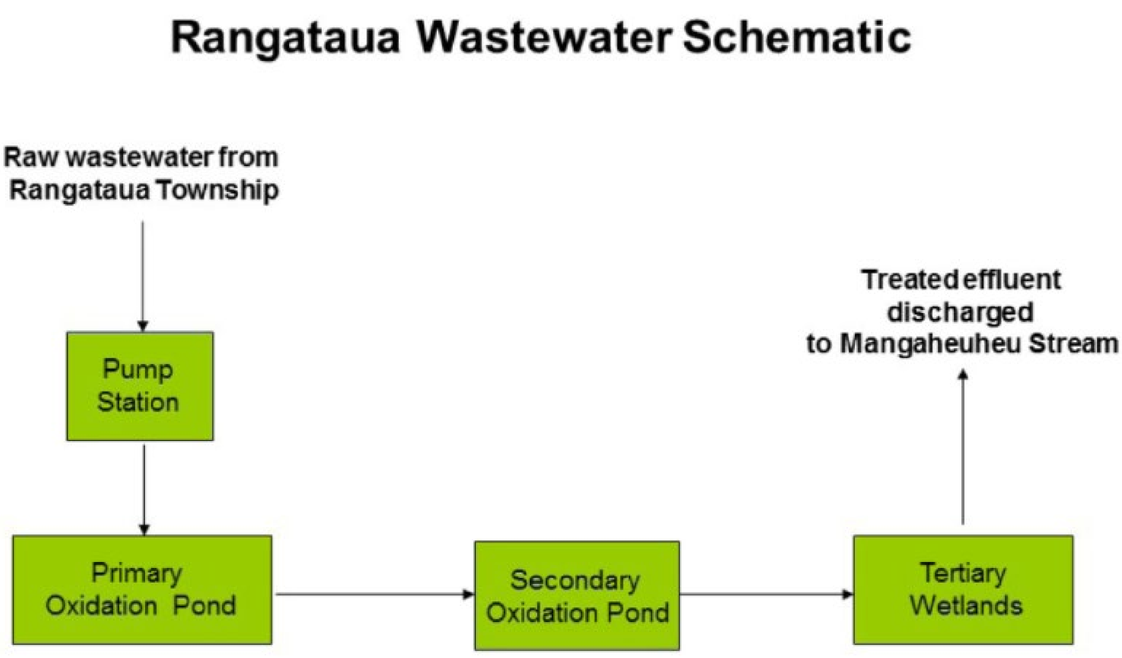


Figure 2 Rangataua Wastewater Treatment Schematic Diagram

The treatment ponds at the WWTP are constructed on relatively flat land on the western bank (true right) of the Mangaehuehu Stream with the top of the embankment around the treatment ponds raised some three metres or more above the normal stream level. The details of the treatment pond construction were lost in a fire and as a result, subsurface materials and construction are unknown. Plans found and provided as part of the s92 further information response (and attached as Appendix 1) show the ponds each having concrete wave bands at their edges.

The treatment ponds discharge into a constructed wetland area, formed in an existing drainage channel as described in Section 3.5 below.

The plant has a magflow unit (installed 2009) to provide instantaneous volume monitoring data of the discharge from the treatment ponds to the wetland area.

3.3 Effluent quality

Section 4.2 of the Aquanet 2021 Report (Appendix 2) summarises the existing effluent quality of the WWTP as follows:

> *Ammoniacal nitrogen, Nitrate nitrogen and SIN appear to follow seasonal patterns, with higher concentrations measured over late winter/early spring months and lower concentrations during*

summer (Figure 3). DRP concentrations were generally highest over summer months but have remained below 4.4 g/m3 year-round.

While seasonal patterns are not as clear, E.coli concentrations also tend to be higher during winter months (Figure 4).

TSS concentrations show no consistent patterns and CarbonaceousBOD5 concentrations are highest over summer months (Figure 4).

3.4 Effluent quantity

The Aquanet 2021 Report summarises the current quantity of effluent being discharge from the WWTP as follows:

The current consent allows for discharges of treated effluent of up to 29 m^3/day.

Discharge volumes from the Rangataua WWTP averaged 38.3 m^3/day between 2012 and 2021 but have ranged from 0 to 600 m^3/day (Table 7, Figure 2).

Discharges are typically higher over winter months and into spring, exceeding the currently consented volume (Range: 0 to 600 m^3/day, Average: 58.1 m^3/day), but then decrease over summer months falling below the discharge volume currently allowed by consent and sometimes not discharging at all for extended periods of time (Range: 0 to 168 m^3/day, Average: 20.3 m^3/day).

Table 7: Summary of daily discharge volumes of treated effluent from the Rangataua WWTP, over all years and during summer and winter months, 2012-2021.

	Overall (m^3/day)	Summer (m^3/day)	Winter (m^3/day)
Mean	38.3	20.3	58.1
Median	22.2	10.6	41.5
Minimum	0.0	0.0	0.0
Maximum	600.0	167.8	600.0

3.5 Existing wetland

Tonkin + Taylor Environmental Consultant Roger MacGibbon inspected the current wetland in August 2018 and describes the wetland in his report “Rangataua WWTP Wetland Assessment” (“T+T Report” Appendix 3) as:

The existing Rangataua wetland sits beside the oxidation ponds and is, in effect, a widened drainage channel (Figure 1). The lower half of the wetland area is flat bottomed with very gentle *fall to the south and is fully covered with exotic wetland grass species (Figure 2). Some self-regenerating willows are growing along the edges. The existing Rangataua WWTP wetland is likely to be 500mm deep or deeper in some places and shallower in others, with the deepest portions created by small cross-flow bunds that were built in the past to hold water back [from personnel communications with Anne-Marie Westcott, RDC]. The bunds are currently buried beneath a heavy cover of exotic grasses. Although covered with exotic grasses, rather than native sedges and rushes, this section of wetland is likely to be effective at removing nitrogen and filtering out any suspended solids.*

Currently the discharge pipe from the ponds enters the wetland about half way down its length.

The upper portion of the wetland area, above the inlet pipe, is more V-shaped than the lower half of the wetland (Figure 3) and as a consequence is less well suited, in its current state, to remove nitrate.

Downstream of the wetland area that lies on RDC land the wetland water flows into an unfenced drainage channel that passes through at least 500m of farmland before joining a stream. This channel appears to remain dry for a large part of the summer with the wetland water (i.e. wastewater discharge) filtering down into the ground soon after it leaves the RDC wetland block of land. The fact that the discharge water passes through earth, especially in summer, is likely to significantly improve nitrate extraction effectiveness (because denitrifying bacteria live in the organic soil zone) and increase faecal bacteria mortality.

Mr MacGibbon further states that the current wetland surface area of ~550m^2 in size (roughly 110m long x 5m wide) with approximately 260m^2 of the wetland downstream of the current pipe inlet from the treatment ponds.

The full extent of the wetland area is currently fenced.

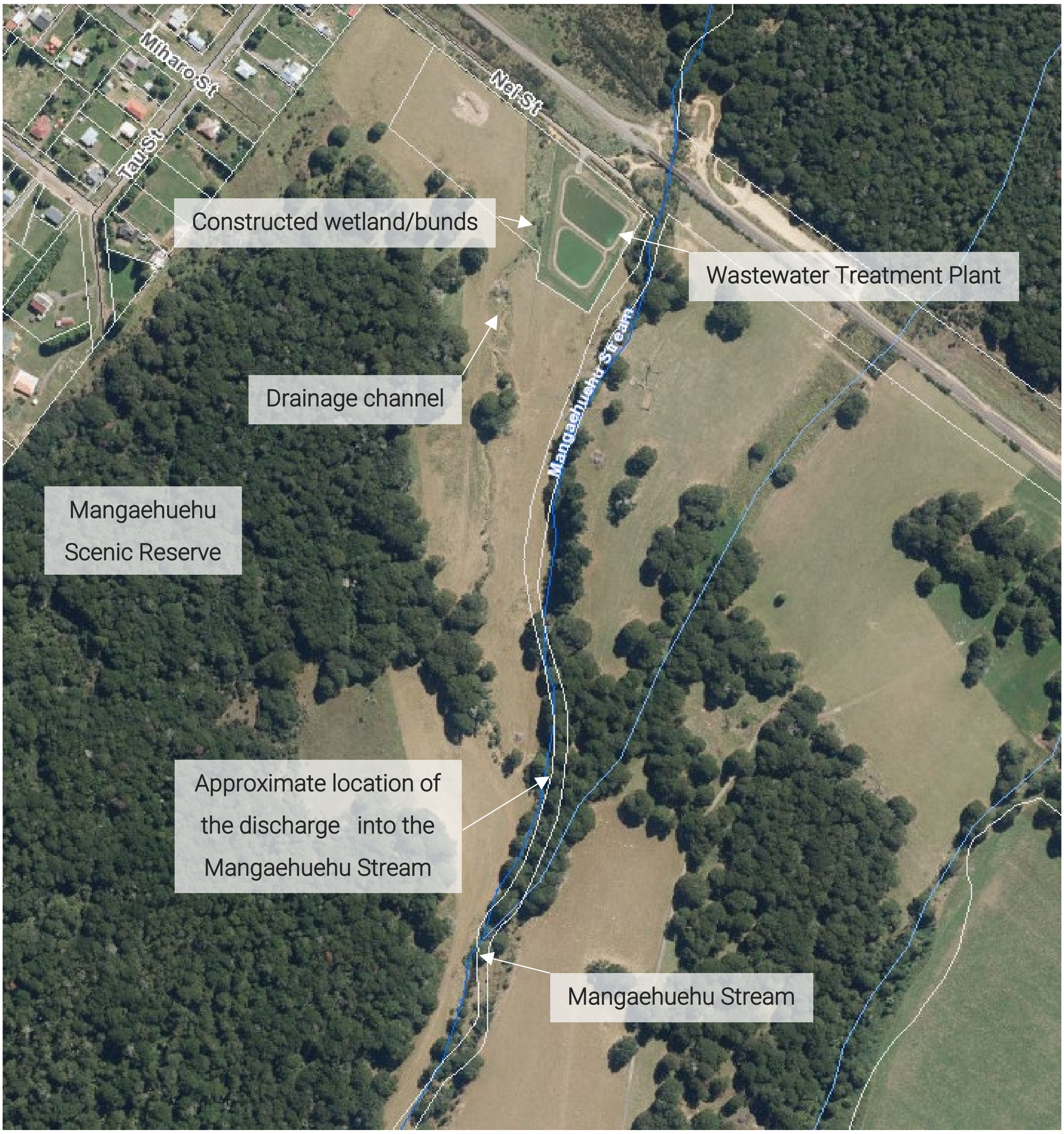


Figure 3 Discharge from the Rangataua WWTP into the Mangaehuehu Stream via a constructed wetland and drain

3.6 Drainage channel

On leaving the wetland area, the discharge runs through a drainage channel, through an area of pasture jointly owned by Ngāti Rangi and the Department of Conservation ("DOC"), known as the Mangaehuehu Scenic Reserve. A distance of approximately 570 metres separates the bunded wetland area and the discharge point of the channel into the Mangaehuehu Stream (Figure 3).

There is currently unrestricted stock access to the drainage channel and to the Mangaehuehu Stream which will need to be rectified to ensure compliance with the Resource Management (Stock Exclusion)

Regulations 2020. These regulations require that stock, including beef cattle, dairy cattle, deer and pigs, be excluded from any river that is wider than 1m, with a 3m setback from the edge of the bed of the waterways (where no fencing already exists) by 1 July 2023. Both the drainage channel and the Mangaehuehu Stream are wider than 1m. The regulations are required to be met by *"a person who owns or controls stock"*.

3.7 Population and network connections

The 2014 application states that 189 properties are serviced by the Rangataua WWTP. Data from RDC in 2021 indicates there are now 198 rating units that are or are able to connect to the Rangataua WWTP network.

Rangataua is not a standalone SA2 under StatsNZ population measurement units. It is part of the "Tangiwai" SA2 unit which spans some 2696km^2 of rural Ruapehu District but excludes the townships of Waiouru, Ohakune and Raetihi. As such, it is difficult to get accurate population data for Rangataua through census data.

RDC have advised that their population and population growth projections for Rangataua are based on considering Usually Resident Population ("URP"), Holiday Homes, Commercial Accommodation and Day Visitors. Details of this are contained in Appendix 4.

Commercial accommodation statistics are not available for Rangataua as RDC understand that there are no commercial accommodation providers in Rangataua. For all population projections, RDC have linked to commercial accommodation to the number of day visitors which poses a challenge for Rangataua as it assumes there are no day visitors which is considered unlikely and as a result, population projections for Rangataua are likely to be conservatively low.

Appendix 4 provides growth projections for Rangataua to 2031. These projections assume URP growth per year at 1.122% (low), 1.35% (medium) and 1.89=69% (high). RDC have projected low population growth in Rangataua which estimates the maximum population 811by 2031, combining URP and Holiday Homes.

Therefore, it is considered appropriate to use 811 as the population figure as a guide for future proofing the Rangataua WWTP.

4 Overview of existing consents

The Rangataua WWTP is currently operating under the following resource consent.

Table 2 Summary of existing consents relevant to the Rangataua WWTP

Consent reference	Description	Status
4962	Discharge Secondary Treated Municipal Blackwater from the Rangataua Wastewater Treatment Plant Wetland to a Mangaehuehu Stream Tributary	Expired on 20/12/2005 but continues to operate under s.124 provisions.

Discharge Permit 4962 was amended in December 2000 to extend the timeframe for a wetland to be constructed, from 31 October 1996 to May 2001. An additional requirement was added that a plan of the final wetland design and outline of the operation and maintenance of the wetland be submitted to Horizons by 16 February 2001.

4.1 Compliance with consent conditions

Discharge Permit 4962 required actions through consent conditions as follows:

Table 3 Summary of known compliance with existing consent conditions relevant to the Rangataua WWTP

Consent Condition	Requirement	Status
2	A wetland shall be constructed by 30 April 1996 in accordance with Plan RC4926 attached to and forming part of this consent.	Rangataua WWTP continues to discharge into an informal wetland. The current state of the wetland is described in Section 4.1 of the Tonkin and Taylor Report (Appendix 3) and in Section 3.5 above. Compliance with this condition is confirmed in the most recent compliance report from Horizons Regional Council for the 2017-2018 compliance period.
3	From the date of granting this consent and until the commissioning of the wetland the following conditions shall apply: (a) The organic matter in the discharge, as measured by the five day carbonaceous biochemical oxygen demand (CBODS), shall not exceed 70 g/m^3 (b) The suspended solids as measured by the W7hatman GF/C filter paper or equivalent levels in the effluent discharged shall not exceed 100 g/m^3	This condition was historically complied with but is no longer relevant due to the installation of the bunds to create the wetland area and Condition 4 containing the discharge quality standards relevant post-wetland.

	(c) The waste discharge shall have a dissolved oxygen content of at least 2g/m^3	
4	Six months after the date of commissioning of the wetland conditions 3(a), (b) and (c) shall be replaced by: (a) The organic matter in the waste discharge from the wetland, as measured by the five day carbonaceous biochemical oxygen demand (CBOD5), shall not exceed 30g/m^3. (b) The suspended solids in the waste discharge from the wetland, as measured by the Whatman GF/C filter paper or equivalent, shall not exceed 30g/m^3. (c) Effluent discharged to the wetland shall have a Dissolved Oxygen of >2g/m^3.	Monitoring of the treated effluent quality is undertaken where the treated effluent enters the wetland. There is currently no monitoring of effluent quality at the point that the treated wastewater leaves the wetland and therefore compliance with this condition cannot be determined.
5	Notwithstanding Conditions 3 and 4 above, when a water quality measurement is carried out at a site immediately upstream of the treated sewage outfall and this is compared to another measurement taken 50 metres downstream of the outfall then: a) the downstream dissolved oxygen shall not be reduced by more than 1 g/m^3. b) the downstream CBOD (as measured by the five day carbonaceous biochemical oxygen demand (CBOD5 test) shall not be increased by more than 1g /m^3. c) the downstream turbidity (NTU) shall not be increased by more than 2 NTU. d) the downstream total ammoniacal nitrogen (NH4-N) shall not be increased by more than 0.05 g/m^3.	(a) Section 5.1.8 of the Aquanet 2021 Report (Appendix 2) identifies that compliance with this condition was met 99% of the time. (b) Section 5.1.7 of the Aquanet 2021 Report identifies that there were no significant differences between sites. (c) Section 5.1.6 of the Aquanet 2021 Report (Appendix 2) identifies that compliance with this condition was met 98% of the time, with the last non-compliance in 2018. (d) Section 5.1.1 of the Aquanet 2021 Report (Appendix 2) identifies that compliance with this condition was generally met, with some exceptions 10 out of 113 sampling occasions showing non-compliance (91% compliance).
6	The Consent Holder shall install a suitable flow measuring device in the discharge line prior to the discharge to the wetland. This flow shall be logged over a twelve month period within the first three years of the granting of this consent.	The most recent compliance report from Horizons Regional Council for the 2017-2018 compliance period confirms that a flow measuring device is installed on the site and that full compliance with this condition.
7	Under the provisions of Section 128 of the Act the Manawatu-Wanganui Regional Council may review the conditions of this consent in July 1998 and July 2003 to deal with any adverse effects on the environment which may arise from the exercise of this consent and which it is appropriate to deal with at a later stage.	N/A

5 Description of proposal

This report provides supplementary information to the June 2014 application lodged by RDC.

Given the significant time since this original application was lodged, RDC recognise the need to provide updated information using the most up-to-date data available including effluent monitoring data and instream sampling and to reflect the changes in the planning framework relevant to the discharge of contaminants from the WWTP.

The description of the proposal from the June 2014 application sought the following:

1. *To deepen and enhance the drain on Nei Street upstream of the Rangataua Wastewater Treatment Plant*
2. *A permit to discharge into ground from the base of the Rangataua Treatment Lagoons*
3. *A discharge to air permit for odour and contaminants*
4. *To renew its existing resource consent (discharge permit 4926) for the Rangataua Wastewater to discharge to land and/or into the Mangaehuehu Stream via a wetland system*
5. *To ensure that the volume should account for population changes and set out in step changes to reflect growth calculated using Average Dry Weather Flow (ADWF) * 2 as a guide to expected discharge values under normal flow.*
6. *A term of 25 years with reviews at 10 year intervals reflective of the common catchment expiry date. The review will include discussions with Department of Conservation, Ngati Rangi and Horizons and cover:*
    - *Current technology available to treat wastewater*
    - *The quality of treatment achieved by the Rangataua system*
    - *The environmental analysis of effects on the receiving water*
    - *Sustainability of the community*
    - *A Matrix of values*
        - *The cost and benefits of implementing new technology at Rangataua*
        - *Weight will be placed on environmental achievements*
        - *Alignment with Cultural desires*

The following reflects an updated description of the proposal (additions underlined, deletions strikethrough):

1. *~~To deepen and enhance the drain on Nei Street upstream of the Rangataua Wastewater Treatment Plant~~ Earthworks to enhance/alter the profile of the existing wetland area including extension of the inlet pipeline, installation of an additional low bunded area and associated wetland planting;*

2. *A permit to discharge into ground from the base of the Rangataua Treatment Lagoons;*

3. *A discharge to air permit for odour and contaminants from the Rangataua WWTP;*

4. *To renew its existing resource consent (discharge permit 4926) for the Rangataua Wastewater to discharge to land and/or into the Mangaehuehu Stream via a wetland system;*

5. *~~To ensure that the volume should account for population changes and set out in step changes to reflect growth calculated using Average Dry Weather Flow (ADWF) * 2 as a guide to expected discharge values under normal flow.~~ Load-based controls on effluent rather than volume-based controls to provide for flexibility in response to growth while providing long-term certainty with regard to in-stream effects;*

6. *A term of ~~25~~ 18 years with reviews at 10 year intervals reflective of the common catchment expiry date. ~~The review will include discussions with Department of Conservation, Ngati Rangi and Horizons and cover:~~*

   - *~~Current technology available to treat wastewater~~*
   - *~~The quality of treatment achieved by the Rangataua system~~*
   - *~~The environmental analysis of effects on the receiving water~~*
   - *~~Sustainability of the community~~*
   - *~~A Matrix of values~~*
     - *~~The cost and benefits of implementing new technology at Rangataua~~*
     - *~~Weight will be placed on environmental achievements~~*
     - *~~Alignment with Cultural desires~~*

These changes are intended to clarify the matters for which consent is sought, and do not change the intent of the June 2014 application.

5.1 Wetland improvements

During the preparation of the T+T Report (Appendix 3) as part of the further information response, consideration of the suitability of the current wetland as a polishing device for WWTP discharge was undertaken. The report identifies recommended improvements in the functionality of the current wetland as well as planting recommendations. Details of these recommendations have been included below.

5.1.1 Functionality

The T+T Report identifies that to achieve *"more than 3 days' retention of the average daily flow and close to one day's retention of the 95th percentile of peak flow, the inlet pipe needs to be extended to the upstream end of the wetland to make full use of the 550m² wetland area potentially available.*

The upper portions of the wetland area (i.e. those sections above the current inlet pipe) will also require some earthworks to create a more flat bottomed, 5m wide profile to the existing channel [Figure 4 below]. *The amount of earthworks required to improve the form of this section is minor."*

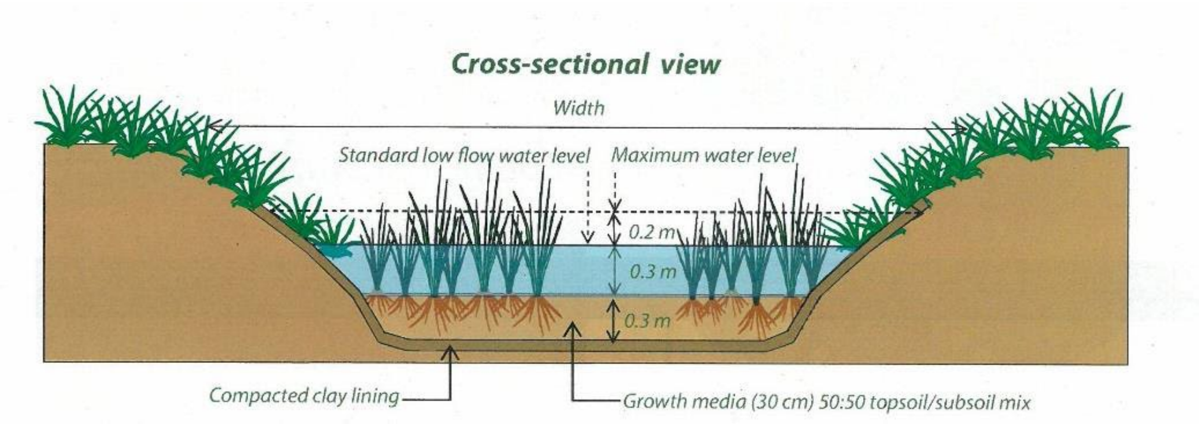


Figure 4: Cross-sectional view of surface flow wetland design (Sourced from T+T Report)

The T+T Report also identifies that *"Construction of an additional bund across the wetland channel midway down its length* [Figure 5 below], *and possibly another further upstream, will improve retention time. These bunds will complement those already in place in the lower half of the wetland. The bund(s), which could be built with earth generated from the excavation work that creates the flat bottomed upper portion, should not be any higher than 500mm on the upstream side so that water depths can never exceed 500m. It is recommended that any bunds that are constructed should be covered in coconut fibre and sown with grass to reduce erosion potential."*

It is anticipated that the earthworks required to create new bunds will be within the permitted activity threshold of 2500m² per property provided by Rule 13-1 of the One Plan.

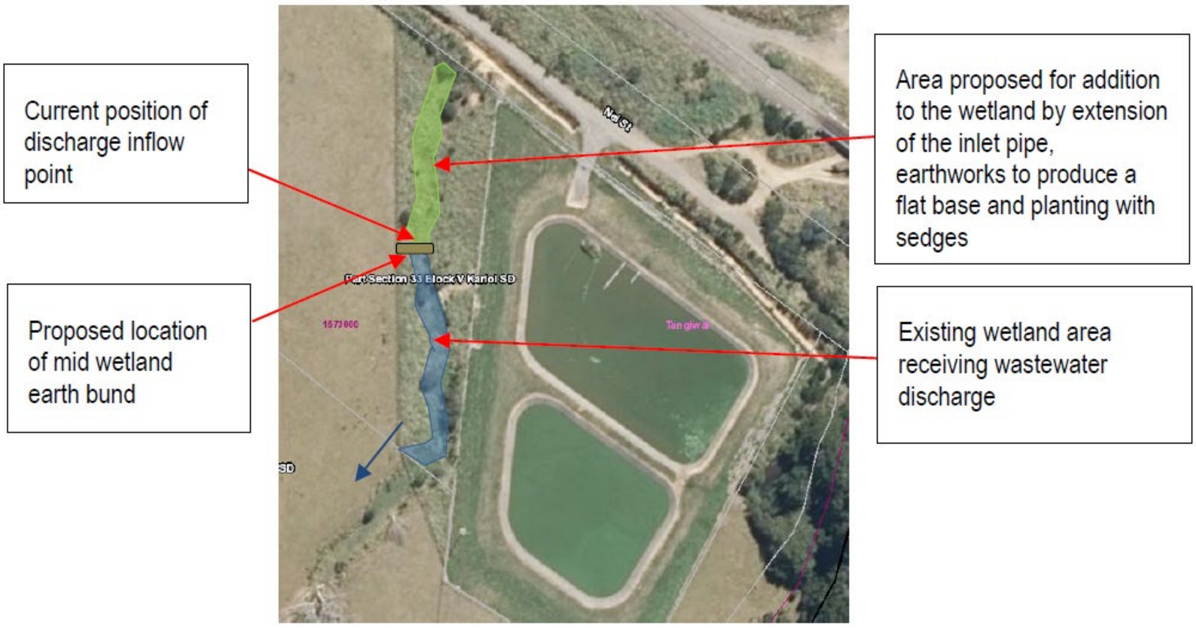


Figure 5: Rangataua WWTP showing location of the wetland (Sourced from T+T report)

RDC propose to undertake the recommended works in consultation with Ngāti Rangi to ensure that the wetland size, shape and functionality is improved as recommended in the T+T Report.

5.1.2 Planting

The T+T Report identifies that the existing exotic grass vegetation currently growing in the lower section of the wetland is *"as effective at promoting denitrification and filtering out solids as native sedges would be"* and that there is no need to replace this vegetation unless it is desirable to have a native plant vegetated wetland.

Due to the earthworks needed to improve the shape of the upper section of the wetland, planting of this area is required. The T+T Report recommends *"locally sourced native sedges (especially Carex secta) and rushes (Juncus spp)"* for these areas. Removal of Willow trees at the site is also recommended and RDC plans to poison these trees to prevent shading of the wetland area. Planting is recommended in the T+T report at a density of *"2 plants per square metre (i.e. 0.7m centres)"*.

RDC propose to work alongside Ngāti Rangi to determine, source and undertake suitable planting and ongoing maintenance of the wetland area to ensure its role as a polishing device for wastewater is optimised.

5.2 Proposed conditions

While RDC has not prepared a full suite of proposed conditions, the following conditions have been proposed to assist Horizons in the development of conditions with RDC.

5.2.1 Load-based effluent controls

Existing resource consent 4962 for the discharge from the WWTP has conditions relating to the concentration of treated wastewater leaving the wetland and in-stream concentrations downstream of the discharge.

As outlined in RDC's response to the s.92 request for further information on the 2014 Application, RDC seek to include conditions on the consent that are focussed on controlling actual effects on water quality/ecology and the risk of effects of the discharge. It acknowledged that the risks of effects, from a point-source discharge on water quality/ecology are primarily associated with the contaminant loads in the discharge as opposed to the discharge volume or concentrations in the discharge.

The s.92 response proposed the following load-based conditions:

Condition 1 – Effluent contaminant load triggers

The Permit Holder shall take monthly grab samples of the treated effluent to assess compliance with the load targets in Table 1 below.

Table 1 – Treated Effluent Contaminant Load Triggers

	TSS (kg/day)	***Ammoniacal-N (kg/day)***	***ScBOD$_5$ (kg/day)***	***DRP (kg/day)***
24 month rolling Median	*1.5*	*0.5*	*0.4*	*0.1*
24 month rolling 95th %ile	*6.5*	*2.5*	*0.8*	*0.3*

NB Numbers are based on combined Horizons and RDC data, for the period January 2012 to October 2019

Advice Note: This condition requires the Consent Holder to monitor effluent quality against triggers for contaminant loads in the discharge. An exceedance of any of the triggers will require additional assessment under Condition 2A.

Condition 2A – Supplementary Monitoring in response to any effluent load trigger being exceeded

In the event of exceedance of any of the Treated Effluent Contaminant Load Triggers specified in Condition 1, the Permit Holder shall undertake an assessment to consider:

a. *Whether the trigger exceedance and/or the trends in effluent contaminant load over time indicate a risk to meeting the load triggers over the following 12-month period; and*
b. *Any contributing factors such as expectations of growth in visitor numbers, industry, residents etc; and*

If a significant risk of exceeding any of the Treated Effluent Contaminant Load Triggers on an ongoing basis is identified, the Permit Holder shall initiate Supplementary Monitoring [Standard in-stream water quality monitoring].

Condition 2B – Supplementary Monitoring Outcomes

Where Supplementary Monitoring is required by Condition 2A, the Permit Holder shall assess the outcome of this monitoring to determine whether WWTP treatment improvements are necessary to ensure that the load triggers are met on an ongoing basis.

Condition 2C – Best Practicable Option Assessment

If WWTP treatment improvements are considered necessary under Condition 2B, the Permit Holder shall undertake a Best Practicable Option Assessment to:

a. *Evaluate the range of options available to avoid an on-going exceedance of the Treated Effluent Contaminant Load Trigger(s) for the relevant parameter(s); and*
b. *Identify the best practicable option to avoid on-going exceedance of the Treated Effluent Contaminant Load Trigger(s) for the relevant parameter(s), having regard to the following:*
    i. *the financial implications and the effects on the environment, of that option when compared with other options;*
    ii. *the current state of technical knowledge and the likelihood that the option can be successfully applied.*

Condition 2D – Load Trigger Reporting

Any assessments undertaken under Conditions 2A-2C shall be provided to the Regulatory Manager within 20 working days of each assessment being completed.

Condition 3 – Load limits

The Permit Holder shall manage effluent quality to ensure that monthly grab samples taken of the treated wastewater meet the standards in Table 2 below.

Table 2 – Treated Effluent Quality Limits

	TSS (kg/day)	***Ammoniacal-N (kg/day)***	***ScBOD$_5$ (kg/day)***	***DRP (kg/day)***

24 month rolling Median	*1.8*	*0.6*	*0.48*	*0.12*
24 month rolling 95^{th} %ile	*7.8*	*3*	*0.96*	*0.36*

As outlined in the Aquanet 2021 Report, *"The risks of effects posed by a point-source discharge on water quality/ecology are primarily associated with the contaminant loads in the discharge and the increase in in-stream concentrations these may cause".*

To model the potential effects of the Rangataua WWTP discharge, estimates of daily loads of key contaminants in the discharge were undertaken based on the following two, environmentally conservative scenarios:

1. *Median contaminant load from the discharge when the Mangaehuehu Stream is at Mean Annual Low Flow (MALF); and*
2. *95th percentile load from the discharge when the Mangaehuehu Stream is at Median flow.*

The Aquanet 2021 Report States "*These scenarios are considered worst case situations, on the basis that*:

- *During periods of extended dry weather (which would be prevailing conditions when the stream is at MALF), observations indicate that any discharge (noting there are extended periods over summer when there is no discharge at all) from the Rangataua WWTP infiltrates into the ground and does not reach the Mangaehuehu Stream by way of surface flow discharge.*
- *A high percentile (95th) of discharge loads was assumed when the stream is at median flow. In reality, high percentiles of discharge loads are highly likely to occur during or immediately following wet weather; stream flows are also likely to be high at these times.*
- *The mass balance calculations assume that all of the contaminant loads exiting the oxidation ponds enter directly into the Mangaehuehu Stream (i.e. assumes zero attenuation/removal by passage through the constructed wetland). This is a highly conservative assumption, particularly during periods of dry weather when there is little or no direct surface discharge to the stream.*

Results from the scenario modelling are included in Section 5.3 of the Aquanet 2021 Report, including Table 16 which provides the current daily load estimates for key contaminants discharge from the Rangataua WWTP (2012 – 2021).

The intent of these conditions is to ensure the triggers and limits reflect the existing discharge while managing effects on the receiving environment. When the conditions are confirmed, the exact detail of the triggers and upper limits will need to be determined to ensure that the triggers and limits are reflective of the characteristics of the discharge.

5.2.2 Odour reporting

While there are no known or recorded complaints about odour from the WWTP, it is recommended that conditions of consent be included to address the following:

a. Ensure no noxious, dangerous, offensive or objectionable odour are detected beyond the site boundary; and
b. A requirement for any complaints about odour from the plant to be recorded, investigated, action taken where appropriate and reported to the Regional Council.

5.2.3 Monthly monitoring of periphyton

As identified in the Aquanet 2021 Report, monthly monitoring of periphyton attributes is needed to determine ongoing compliance with One Plan and NPSFM 2020 targets. To achieve this, it is considered appropriate to include a condition on the consent which requires this ongoing monitoring to be undertaken.

5.2.4 Wetland maintenance

To ensure successful functioning of the wetland, it is recommended that a condition requiring a plant maintenance and weeding programme is included in the consent to ensure regular maintenance is undertaken.

6 Assessment of Alternatives

Section 105 of the RMA sets out additional matters that need to be considered in relation to applications for discharge permits. More specifically s 105(1) (c) states:

> *"If an application is for a discharge permit or coastal permit to do something that would contravene section 15 or section 15B, the consent authority must, in addition to the matters in section 104(1), have regard to-*
>
> *(c) any possible alternative methods of discharge, including discharge into any other receiving environment."*

Section 6 of the June 2014 application outlines the alternatives assessed during the preparation of the application. These alternatives included:

- Land discharge options
- Direct discharge to the Mangaehuehu Stream
- Optimised Chemical Treatment Systems
- NIWA Advanced Pond System
- Pond Aeration
- Floating Wetlands.

No additional alternatives have been explored in the preparation of this supplementary information. RDC did respond to a question in the further information request from 2014 which asked whether alternatives “such as piping the effluent to Ohakune” had been considered. In response, RDC outlined that piping effluent to an alternative plant would require significant capital expenditure and would likely have limited environmental benefit given the scale of effects from the WWTP on the existing receiving environment.

7 Planning Assessment

7.1 Resource consents sought

The following sections provide a supplementary assessment of the consent requirements for the continued operation of the WWTP under the Horizons One Plan to provide clarity from the June 2014 application. This section does not change what was applied for in 2014.

7.1.1 Discharge to land via seepage from treatment ponds

Rule 14-16 of the One Plan provides for Human effluent storage and treatment facilities as a Permitted Activity. A number of conditions apply to this activity status including the requirement that the facilities are sealed to restrict the seepage of effluent and that the sealing layer achieve a permeability of $1x10^{-9}$ m/s and are setback at least 30m from surface water bodies.

The existing Rangataua WWTP is within 30m of the Mangaehuehu Stream and therefore does not meet the requirements for a permitted activity. In addition, the permeability of the existing treatment ponds is unknown and as a result, compliance with this condition of the permitted activity also cannot be certain.

Therefore, resource consent for discharge to land from seepage from the treatment ponds is required under Rule 14-30 as a Discretionary Activity.

7.1.2 Discharge to land where it may enter water

Discharge from the WWTP treatment ponds is via a modified drainage channel to the Mangaehuehu Stream. The area immediately adjacent to the treatment pond discharge, and owned by RDC, is a constructed wetland area dominated by exotic wetland grass species and does not constitute a rare, threatened or at-risk habitat. The area acts as a polishing device for the treated wastewater discharged from the WWTP.

During winter months there is more water in the drainage channel as a result of natural land drainage. During this time treated wastewater from the WWTP moves down the drainage channel and into the Mangaehuehu Stream. In drier months, when the majority of the drainage channel has dried up, discharge from the WWTP is unlikely to reach the Mangaehuehu Stream, instead soaking into the ground either within the constructed wetland or further down the drainage channel.

The Horizons One Plan does not make specific provision for this discharge and therefore, it is considered to default to a Discretionary Activity under Rule 14-30.

7.1.3 Discharge to air

There are no specific provisions within Chapter 15 of the One Plan relating to the discharge of contaminants to air (odour). However, Rule 15-17 provides for 'other discharges' to air that are not otherwise provided for as a Discretionary Activity. RDC are applying for the consent for discharges to air from the WWTP on a precautionary basis.

7.2 Summary of Activity Status

In summary, the proposed new area of land-based discharge of treated wastewater associated with the Rangataua WWTP requires resource consent under the following rules:

Table 4 Summary of consents sought

Consent Type	Rule reference	Description	Activity status
Discharge to Land via seepage	Rule 14-30	A discharge permit for the discharge of contaminants from the Rangataua WWTP treatment ponds for a period of 18 years, ceasing on XX September 2039.	Discretionary
Discharge to Land where it may enter water	Rule 14-30	A discharge permit for the discharge of contaminants to land where it may enter the Mangaparare Stream as result of the discharge of treated wastewater to land/wetland for a period of 18 years, ceasing on XX September 2039.	Discretionary
Discharge to Air	Rule 15-17	A discharge permit for the discharge to air of odour and aerosols resulting from the application of treated wastewater to land for a period of 18 years, ceasing on XX September 2039.	Discretionary

As a result, the overall activity status of the proposed activity is a Discretionary Activity status.

7.2.1 Consent duration sought

To align with the common catchment expiry dates for the Upper Whangaehu Water Management Zone and the Tokiahuru Water Management Sub-zone of 2009 as set out in Table 12.1 of the One Plan, and in alignment with Policy 12-5(b) which provides for consent durations to be extended in 10 year increments, a consent duration of 18 years is sought, with an expiry date of 2039. This aligns with the original consent duration sought in the June 2014 application (25 years) but accounts for the time that has passed since that application was originally lodged.

The duration of consent sought is considered to provide sufficient certainty to RDC and the Rangataua community for the future operation of the plant while being consistent with the common catchment expiry dates outlined in the One Plan.

8 Assessment of Environmental Effects

S104(1) requires that, subject to Part 2, a consent authority must have regard to –

> *(a) any actual and potential effects on the environment of allowing the activity; and*
>
> *(ab) any measure proposed or agreed to by the applicant for the purpose of ensuring positive effects on the environment to offset or compensate for any adverse effects on the environment that will or may result from allowing the activity; and*

The continued operation of the WWTP has the potential to generate a range of effects on the surrounding environment.

The following sections provide a supplementary assessment, to the assessment contained in the June 2014 application, of the actual and potential effects on the environment of the discharge of treated wastewater from the Rangataua WWTP to land where it may enter water, discharge to land via seepage from the treatment ponds and discharges to air from the storage and treatment of wastewater.

In accordance with Section 88 of, and the Fourth Schedule to, the Resource Management Act 1991, this assessment corresponds with the scale and significance of the effects that the proposed activity may have on the environment.

In preparing this supplementary assessment, the actual or potential effects arising from the operation of the Rangataua WWTP have been identified as:

- Effects on River Values
- Effects on Freshwater Quality and Ecology
- Effects on Māori Cultural Values
- Effects on Groundwater
- Effects on Air Quality (Odour)
- Positive effects

These effects are assessed in detail below.

8.1 Effects on River Values

Table 5 provides analysis of the proposal against the River Values, identified in Schedule B, as applying to the Tokiahuru (Whau_1c) Sub-zone.

Table 5 Assessment of effects of proposal against River Values of the Tokiahuru Water Sub-zone (Whau_1c)

Value Group	Management Values	Management Objective	Commentary
Zone-wide Values	Life-Supporting Capacity (Upland Volcanic Acid)	The water body and its bed support healthy aquatic life/ecosystems.	Ecological monitoring results indicate that there are no more than minor effects on macroinvertebrate communities between upstream and downstream monitoring sites. Monitoring in 2008 & 2009 indicated that sites mostly fell in the A band under NPSFM 2020 upstream while in 2021, sites were mostly in B band. Band B is indicative of mild organic pollution or nutrient enrichment and mild loss of ecological integrity. The influence of surrounding farm land and direct stock access to the drainage channel and Mangaehuehu Stream mean that changes in macroinvertebrate communities cannot be attributed solely to the discharge from the WWTP.
	Aesthetics	The aesthetic values of the water body and its bed are maintained or enhanced.	Ecological monitoring indicates low cover by nuisance algal growth with stream substrates mostly clean or covered in thin diatom mats in all years that visual monitoring was completed. The ecological assessment notes that increases in periphyton biomass may be caused by either, or a combination of, differences in habitat and/or nutrient availability at the different sites. Monthly monitoring is required to assess whether periphyton is meeting NPSFM ecosystem health requirements and until there is more data, there is potential for effects from periphyton on the aesthetic values of the Mangaehuehu Stream.
	Contact Recreation	The water body and its bed are suitable for contact recreation.	As discussed above, monthly monitoring is required to understand effects on contact recreation values of the Mangaehuehu Stream. Until there is more data, there is the potential for effects from periphyton on the contact recreation values of the Mangaehuehu Stream
	Mauri	The mauri of the water body and its bed is maintained or enhanced.	The ongoing discharge of treated wastewater will continue to provide for the needs of the Rangataua community. RDC will continue to engage with Ngāti Rangi to understand the potential for the discharge to have adverse effects on the mauri of the Mangaehuehu Stream.
	Industrial Abstraction	The water is suitable as a water source for industrial abstraction or use, including for hydroelectricity generation.	There is no known industrial abstraction affected as a result of the Rangataua WWTP.

Value Group	Management Values	Management Objective	Commentary
	Irrigation	The water is suitable as a water source for irrigation.	The closest known abstraction of surface water for horticultural irrigation from the Mangaehuehu Stream is located approximately 1.2km downstream of the point where the discharge from the drainage channel enters the Mangaehuehu Stream (according to the Horizons mapping system). *E.coli* monitoring data suggests that increases are non-detectable and therefore effects on downstream users are considered to be no more than minor.
	Stock water	The water is suitable as a supply of drinking water for livestock.	The closest known abstraction of surface water from the Mangaehuehu Stream for stock water is located approximately 1.2km downstream of the point where the discharge from the drainage channel enters the Mangaehuehu Stream. (according to the Horizons mapping system). *E.coli* monitoring data suggests that increases are non-detectable and therefore effects on downstream users are considered to be no more than minor.
	Existing infrastructure	The integrity of existing infrastructure is not compromised.	This value provides for the proposed continued operation and associated discharge from the WWTP.
	Capacity to Assimilate Pollution	The capacity of a water body and its bed to assimilate pollution is not exceeded.	The ability of a waterbody to assimilate capacity can be determined by whether instream targets/limits are met or not. As outlined in the Aquanet report, targets for key contaminants are met, or in the case such as Phosphorus, are exceeded both upstream and downstream of the discharges due to natural conditions in the waterbody. Periphyton measurements downstream of the discharge are within the margin of error for monitoring and additional monthly monitoring is required to determine compliance with instream limits.
	Natural State	The river and its bed are maintained in their natural state.	While Natural State Values may apply upstream, elsewhere within the Whau_1c subzone, it does not apply to the section of the Mangaehuehu Stream where the discharge takes place. This is because the relevant section of the Mangaehuehu Stream is not "flowing within" Public Conservation Land as required by the Natural State Definition.
	Site of Significance - Aquatic	Sites of significance for indigenous aquatic biodiversity are maintained or enhanced.	This value applies to tributaries and streams elsewhere in the Whau_1 Water Management Zone but is not applicable to this application as detailed on Table B.3.
	Site of Significance - Riparian	Sites of significance for indigenous riparian biodiversity are maintained or enhanced.	This value applies to tributaries and streams elsewhere in the Whau_1 Water Management Zone but is not applicable to this application as detailed on Table B.3.

Value Group	Management Values	Management Objective	Commentary
Site/Reach – specific values	Trout Fishery (Other trout fishery)	The water body^ and its bed^ sustain healthy rainbow or brown trout fisheries.	It is noted that the no waterbodies in the Whau_1 Sub zone, including the Mangaehuehu Stream are identified in Table B.8 therefore this value is not considered further.
	Trout Spawning	The water body^ and its bed^ meet the requirements of rainbow and brown trout spawning and larval and fry development.	This value applies to tributaries and streams elsewhere in the Whau_1 Water Management Zone namely the Omarae, Waitaiki and Tokiahuru Streams, none of which are influenced by the Mangaehuehu Stream.
	Domestic Food Supply	The water^ is suitable for domestic food production.	The Whangaehu River and its tributaries, which includes the Mangaehuehu Stream, are identified as a source of water for Vegetable production in Table B.13. The closest known abstraction of surface water for horticultural irrigation from the Mangaehuehu Stream is located approximately 1.2km downstream of the point where the discharge from the drainage channel enters the Mangaehuehu Stream (according to the Horizons mapping system). *E.coli* monitoring data suggests that increases are non-detectable and therefore effects on downstream users are considered to be no more than minor.

8.2 Effects on Freshwater Quality and Ecology

Section 5.1 of the Aquanet 2021 Report (Appendix 2) provides a summary of the water quality monitoring completed in the Mangaehuehu Stream. The report describes the different locations where water quality and ecological monitoring have been undertaken and notes that the assessment includes the effects of the WWTP and associated discharge, as well as effects from surrounding farming activities and livestock access to the Mangaehuehu Stream and discharge channel.

Horizons monitoring data is captured upstream of the WWTP and downstream of the confluence of the drainage channel with the Mangaehuehu Stream. Veolia monitoring data is captured from a 'middle' site located downstream of the WWTP but upstream of the confluence of the drainage channel with the Mangaehuehu Stream and then downstream of this confluence as illustrated by Figure 1 in the Aquanet 2021 Report (Appendix 2).

The effects of the discharge from the WWTP on freshwater quality and ecology are summarised in the Aquanet 2021 Report as follows:

8.2.1 Freshwater quality

- *Total ammoniacal nitrogen concentrations were generally similar with no significant differences between sites upstream and downstream on the Mangaehuehu Stream and concentrations remained below relevant One Plan targets at both sites.*
- *Nitrate-nitrogen and SIN annual average concentrations showed small but statistically significant increases (3% increase from 0.180 g/m3 upstream to 0.186 g/m3 at D/S A, and 1% increase between the middle (0.193 g/m3) and D/S B (0.195 g/m3) sites).*
- *DRP concentrations were similar with no significant differences between sites but exceeded the One Plan target on all sampling occasions at all sites. Streams in the central plateau area generally display naturally elevated DRP concentrations, due to the volcanic geology in the area.*
- *Median E.coli concentrations remained within the One Plan targets both upstream and downstream of the Rangataua WWTP discharge in all flow 'bins'. When considering 95th percentile concentrations, the One Plan target of 550 E. coli /100mL at flows below the 20th FEP was also met at all sites. However, the One Plan target of 260 E. coli/100mL at flows below median flow in summer was exceeded at all sites. There were no significant differences between sites within each season but there were significant decreases from summer to winter months.*
- *Visual clarity was less than the One Plan target of 3 m at flows below median flow at all sites, and decreased significantly between the Upstream and Downstream sites. The One Plan target of no more than 20% reduction in visual clarity was regularly exceeded. TSS concentrations also increased significantly between Upstream and Downstream sites.*
- *ScBOD5 and POM did not differ significantly between the middle and D/S B sites and were generally compliant with relevant One Plan targets. No seasonal differences were observed.*
- *Water pH and temperature generally complied with relevant One Plan targets.*
- *DO saturation remained above the One Plan target of 80% on all monitoring occasions, with small but statistically significant increases observed between upstream and D/S A sites. It should be noted that the DO data available are day-time 'spot' measurements, which do not provide any indication of night-time minima or potential stress to the ecosystem.*

Assessment against the NPS-FM (2020) Attribute States for Ammonia, Nitrate, DRP, E.coli and suspended sediment:

- *Confirm a low risk of toxic effects from ammonia,*
- *Suggests a high conservation value system where any effects of nitrate toxicity are unlikely even on sensitive species,*

- *Suggests ecological communities could be impacted by moderate DRP elevation which may cause increased algal growth and loss of sensitive macroinvertebrate and fish taxa, noting however, that the elevated DRP concentrations in the Mangaehuehu Stream reflect natural conditions and are likely the result of natural sources of phosphorus associated with volcanic geology,*
- *Represents a low risk of effects from E.coli, with for at least half the time, the estimated risk of campylobacter infection at both upstream and downstream sites less than 1 in 1,000 (1-2% risk),*
- *Represents minimal impact of suspended sediment on instream biota,*
- *No assessment could be made for DO or periphyton as required data (DO: daily minima over seven consecutive days and Periphyton: monthly biomass over minimum of three years) are not available.*

Existing monitoring data collected in the Mangaehuehu Stream indicates that there are few detectable changes in concentrations of any of the key discharge constituents in the stream between upstream and downstream sites. The data does indicate however small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream.

8.2.2 Effects on aquatic ecology and ecosystems

Periphyton results indicate:

- *Periphyton biomass measured as Chlorophyll a, shows similar patterns in 2008 and 2009 with concentrations decreasing between upstream and middle sites and then increasing again further downstream. In 2021, increases were observed moving from upstream to downstream sites.*
- *The One Plan target for the Mangaehuehu Stream of 50 mg/m2 was met upstream and at the middle site in all three years and at the site downstream in 2009, but was marginally exceeded at downstream in both 2008 (56 mg/m2) and again in 2021 (56 mg/m2). Assessing whether the One Plan target is met overall at any of the sites would require regular (monthly) monitoring data.*
- *Periphyton communities visually assessed showed consistently low cover by "nuisance" algal growth. Visual cover showed substrates to be mostly clean or covered in thin diatom mats in all years. No long filamentous algae were observed at any of the sites in any year sampled, and cover by thick mats, when observed, remained low.*

- *Assessment against the NPS-FM (2020) periphyton Attributes requires monthly monitoring data, and could not be carried out on the basis of available data (3 individual sampling occasions).*

Macroinvertebrate results indicate:

- *Macroinvertebrate communities at sites both upstream and downstream of the Rangataua WWTP discharge are indicative of good to excellent water quality.*
- *No significant differences between sites were observed for any of the biotic indices apart from a decrease in % EPT Individuals and ASPM between the upstream and downstream sites.*
- *One Plan targets for MCI and QMCI were met in all years sampled.*
- *Assessment against the NPS-FM (2020) when considering all three indices MCI, QMCI and ASPM, shows sites upstream and downstream of the Rangataua WWTP fell mostly into Attribute State A in 2008 and 2009, while in 2021 all sites were mostly in Attribute State B. This reflects macroinvertebrate communities indicative of pristine conditions with almost no (Band A) or only mild (Band B) organic pollution or nutrient enrichment.*

Overall, results of ecological monitoring do not indicate more than minor effects on macroinvertebrate communities (indicative of ecological health) or periphyton cover (indicative of aesthetic and recreational values), but indicate an increase in periphyton biomass between upstream and downstream, at times exceeding the One Plan target.

The One Plan target and NPS-FM periphyton biomass attributes are not designed to be compared to single sample results, and regular (monthly) monitoring data would be required to confirm whether the One Plan target is met or exceeded and the NPS-FM Attribute state band each site falls into.

8.3 Effects on Māori cultural values

RDC are engaging with Ngāti Rangi on the application. It is recognised that the discharge of treated human effluent to waterways is offensive and contaminates mahinga kai food sources below the discharge point. Ngāti Rangi have indicated that their preference is for treated effluent to filter through land. In response to this, RDC propose to work alongside Ngāti Rangi and technical experts to improve the current wetland area and to design the extension to the wetland area in order to facilitate greater filtering of the treated wastewater once it leaves the WWTP treatment ponds.

Ngāti Rangi have indicated that the Mangaehuehu Stream has historically been a significant traditional fishery for the Ngāti Rangi people and that there has been adverse effects on this resource as a result of the Rangataua WWTP.

The proposed modifications to the existing wetland area proposed by RDC, including the extension of the outlet pipe to increase the functional wetland area, the modifications to the wetland area profile and creation of an additional bund and planting are considered to go some way to addressing Ngāti Rangi's concerns with the current plant operation and discharge. Further engagement and discussion is required to determine actual and potential cultural effects.

Consideration of the proposal against the relevant provisions of the Ngāti Rangi Taiao Management Plan is included in Section 9.7.1 below.

8.4 Effects on Groundwater

There is the potential for the discharge of treated wastewater to land to effect groundwater quality. The discharge to the wetland area/drainage channel from the WWTP is generally absorbed into the ground during the summer dry periods, while it is likely to flow down the channel to the Mangaehuehu Stream during the wetter, winter months.

Little is known about the groundwater flow in the area however it is considered reasonable to assume that groundwater from beneath the application site will flow into the Mangaehuehu Stream given its close proximity. As a result, effects on groundwater quality are reflected through the consideration of effects on freshwater quality and aquatic ecosystems in sections 8.2.1and 8.2.2 above.

Horizons Mapping shows the application site being within Drinking Water: Source Protection Zone 3. Based on the PDP Report entitled "Source Protection Management: Ruapehu District Council Drinking Water Supplies" provided by Horizons and on discussions with RDC, there are no municipal drinking water supplies downstream of the WWTP site and discharge location.

Based on Horizons mapping system, there are no bores or ground drinking water sources identified within 20km downstream of the WWTP site and disposal area.

Overall, the effects on groundwater from the discharge of treated wastewater are considered to be no more than minor.

8.5 Effects on Air quality (odour)

RDC and Horizons have both advised that there have been no odour complaints relating to the operation of the WWTP.

There is no active odour monitoring currently undertaken at the WWTP and based on the no complaints record, it is not considered that a formal Odour Management Plan or active odour monitoring programme is necessary. As a result, no odour issues are anticipated from the continued operation of the WWTP.

RDC note the concerns of the MidCentral Public Health Service in their submission regarding odour from the plant and would be comfortable with a consent condition being included which requires:

a. No noxious, dangerous, offensive or objectionable odour are detected beyond the site boundary
b. A requirement for any complaints about odour from the plant to be recorded, investigated, action taken where appropriate and reported to the Regional Council.

8.6 Positive Effects – maintenance of public health and safety

The continued operation of the Rangataua WWTP is an essential service necessary to protect public health. Without a reliable sanitary network, the Rangataua township would be unable to continue to provide adequate services for its residents.

The continued operation of the Rangataua WWTP continue to provide for the wellbeing of the people of the Rangataua township.

8.7 Summary of Assessment of Environmental Effects

The assessment of effects carried out above identifies:

- Few detectable changes in concentrations of any of the key discharge constituents in the stream between upstream and downstream sites. The data does indicate however small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream which is also influenced by the ability of stock to access the discharge channel and the Mangaehuehu Stream.
- The influence of surrounding farmland and direct stock access to the drainage channel and Mangaehuehu Stream mean that changes in macroinvertebrate communities cannot be attributed solely to the discharge from the WWTP.
- Additional monthly monitoring of periphyton is needed to better understand its effects instream
- The full extent of effects on cultural values remain unknown and engagement with Ngāti Rangi is needed.
- Effects on air quality are not anticipated, but consent conditions are proposed to ensure that there is a record of recording and investigating complaints about offensive or objectionable odour beyond the boundary of the WWTP site.
- Ongoing operation of the WWTP continues to provide for the wellbeing of people of the Rangataua township.

9 Statutory Consideration

S104(1) requires that, subject to Part 2, a consent authority must have regard to –

(b) any relevant provisions of—

(i) a national environmental standard:

(ii) other regulations:

(iii) a national policy statement:

(iv) a New Zealand coastal policy statement:

(v) a regional policy statement or proposed regional policy statement:

(vi) a plan or proposed plan; and

(c) any other matter the consent authority considers relevant and reasonably necessary to determine the application.

The following sections provide an assessment of the National, Regional and Local direction relevant to the application as well as other matters identified as relevant.

9.1 National Direction

Of the range of documents providing national direction under the RMA, those considered applicable to this application are:

- National Policy Statement for Freshwater Management (2020) (NPSFM)
- National Environmental Standard for Freshwater (2020) (NESF)
- National Environmental Standards for Sources of Human Drinking Water (2007) (NESDW)

Each of these is considered in detail below.

9.1.1 National Policy Statement for Freshwater Management

On 3 September 2020, the National Policy Statement for Freshwater Management 2020 ("NPSFM 2020") came into force, replacing and revoking the previous National Policy Statement for Freshwater

Management (2014[1], updated 2017) ("NPSFM 2017") both of which came into effect following the lodgement of the June 2014 application.

Consenting authorities are required to have regard to the relevant provisions of any operative national policy statement when considering resource consent applications under section 104 of the RMA. While Horizons Regional Council has not yet updated the One Plan to include the necessary provisions as directed by the NPSFM 2020, it is considered appropriate to provide an assessment under these provisions as if they did already form part of the Region's planning framework in relation to the management of freshwater.

Te Mana o te Wai is identified as the fundamental concept of the NPSFM 2020. It is a concept that refers to the "*fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai. The concept of Te Mana o te Wai is about restoring and preserving the balance between the water, the wider environment and the community*." Te Mana o te Wai applies to all aspects of freshwater management.

The 6 principles of Te Mana o te Wai inform the NPSFM 2020 and its implementation. These principles are:

a) Mana whakahaere: the power, authority, and obligations of tangata whenua to make decisions that maintain, protect, and sustain the health and well-being of, and their relationship with, freshwater

b) Kaitiakitanga: the obligation of tangata whenua to preserve, restore, enhance, and sustainably use freshwater for the benefit of present and future generations

c) Manaakitanga: the process by which tangata whenua show respect, generosity, and care for freshwater and for others

d) Governance: the responsibility of those with authority for making decisions about freshwater to do so in a way that prioritises the health and well-being of freshwater now and into the future

e) Stewardship: the obligation of all New Zealanders to manage freshwater in a way that ensures it sustains present and future generations

f) Care and respect: the responsibility of all New Zealanders to care for freshwater in providing for the health of the nation.

The NPSFM 2020 also specifies a hierarchy of obligations under the concept of Te Mana o te Wai through the objective which seeks to ensure that natural and physical resources are managed in a way that prioritises:

a) first, the health and well-being of water bodies and freshwater ecosystems

b) second, the health needs of people (such as drinking water)

c) third, the ability of people and communities to provide for their social, economic and cultural well-being, now and in the future.

[1] The NPSFM 2014 came into effect on 1 August 2014.

The NPSFM 2020 specifies a single objective and a series of 15 policies that are designed to achieve the objective. The objective of the NPSFM 2020 is to ensure natural and physical resources are managed in a way that achieves the above priorities.

The policies in the NPSFM 2020 considered relevant to this application are:

Policy 1: *Freshwater is managed in a way that gives effect to Te Mana o te Wai.*

Policy 2: *Tangata whenua are actively involved in freshwater management (including decision-making processes), and Māori freshwater values are identified and provided for.*

Policy 3: *Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.*

Policy 4: *Freshwater is managed as part of New Zealand's integrated response to climate change.*

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

Policy 7: *The loss of river extent and values is avoided to the extent practicable.*

Policy 9: *The habitats of indigenous freshwater species are protected.*

Policy 10: *The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.*

Policy 15: *Communities are enabled to provide for their social, economic, and cultural well-being in a way that is consistent with this National Policy Statement.*

In addition to the objective and policies, Part 3 of the NPSFM 2020 specifies a non-exhaustive list of the matters that local authorities must do to give effect to the objective and policies of the NPSFM. These implementation requirements are split into three subparts:

1. How local authorities must implement this NPS
2. The National Objectives Framework
3. Additional requirements on regional councils relating to freshwater management.

Local authorities are required to give effect to the NPSFM 2020 as soon as reasonably practicable.

Implementation clauses 3.22(1) (Natural inland wetlands), 3.24(1) (Rivers) and 3.26(1) (Fish passage) of the NPSFM 2020 require a regional council to include a policy in its Regional Plan to address a specific requirement. Wording is provided in the NPSFM 2020 or can be amended by the local authority using words to similar effect. Clause 1.7 specifies that the change is required to be undertaken without using a Schedule 1 plan change process specified in the RMA. For the purpose of this assessment, it is considered that the policy wording from within the NPSFM 2020 at Clause 3.24 relating to rivers is relevant for the consideration of this application.

There are also implementation clauses in the NPSFM 2020 which require a compulsory change to an RPS or Regional Plan but which need to be undertaken through a public plan change process. The intent of these compulsory changes are also considered to be relevant to this application, despite the changes not having been made to the One Plan yet, as it is merely a matter of time before they are included.

The following provides an assessment of the proposal against the objective, each of the relevant policies in the NPSFM 2020 and the relevant implementation clauses.

9.1.1.1 Objective

The objective of the NPSFM 2020 requires that the management of natural and physical resources in a way that prioritises the health and well-being of waterbodies and freshwater ecosystems is first, followed by the health needs of people and finally the ability of people and communities to provide for their social, economic and culture well-being, now and in the future.

The proposal includes the expansion of the existing constructed wetland area which is adjacent to the treatment ponds. This expansion will enable a greater area of treatment of the treated wastewater before it is discharged into the receiving environmental via the drainage channel. Improved discharge quality is anticipated as a result of the wetland expansion which will reduce the adverse effects of the discharge on the health and wellbeing of the Mangaehuehu Stream and wider receiving environment. Alternative treatment methods such as discharge to land were considered during the preparation of the June 2014 application and discounted.

As outlined in Section 8.6, the ability of people and communities to provide for their social, economic and culture well-being, now and in the future relies on the continued operation of the Rangataua WWTP. The proposed ongoing operation of the upgraded WWTP will continue to provide for the well-being of the community on an ongoing basis.

Overall, it is considered that the continued operation of the Rangataua WWTP with the proposed improvements to the wetland area manages natural and physical resources in a way that is consistent with the prioritisation required by the objective of the NPSFM 2020.

9.1.1.2 Policy 1: Freshwater is managed in a way that gives effect to Te Mana o te Wai.

The Horizons One Plan does not yet include objectives and policies that implement the requirements of the NPSFM 2020 in relation to giving effect to Te Mana o te Wai. However, the concept of the fundamental importance of water and the relationship of freshwater to all aspects of the wider environment has been central to the development of this updated application.

The hierarchy of priorities implied through Te Mana o te Wai have been addressed under Objective 1 above and are informed by the six principles relating to the roles of tangata whenua and all New Zealanders in the management of freshwater which inform the implementation of the NPSFM 2020.

RDC acknowledge that the treatment and disposal of treated wastewater from the Rangataua WWTP is a matter that is of significant importance to Ngāti Rangi and ongoing engagement between RDC and Ngāti Rangi is needed for the successful progression of this application.

Further engagement with Ngāti Rangi is desired by RDC and is needed to address whether the application is consistent with Policy 1.

9.1.1.3 Policy 2: Tangata whenua are actively involved in freshwater management (including decision-making processes), and Māori freshwater values are identified and provided for.

Further engagement with Ngāti Rangi is desired by RDC and needed to ensure that the application is consistent with Policy 2.

9.1.1.4 Policy 3: Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

The discharge from the WWTP to contribute to cumulative effects in the catchment. Monitoring results in the Aquanet 2021 Report indicate that *"there are few detectable changes in concentrations of any of the key discharge constituents in the stream between upstream and downstream sites. The data does indicate however small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream"*.

"Overall, results of ecological monitoring do not indicate more than minor effects on macroinvertebrate communities (indicative of ecological health) or periphyton cover (indicative of aesthetic and recreational values), but indicate an increase in periphyton biomass between upstream and downstream, at times exceeding the One Plan target".

Additional monitoring is required to better understand the effects of the discharge on periphyton in the Mangaehuehu Stream and confirm which NPSFM band the site falls within.

Based on the available monitoring results, effects on downstream users of the Mangaehuehu Stream for horticultural irrigation and stock water are unlikely to be affected in a more than minor way. It is acknowledged that the ability of stock to access both the drainage channel and the Mangaehuehu Stream will have impacts on the water quality downstream and that better management of this farming land use is needed.

Ultimately, it is considered that the proposal is consistent with the requirements of Policy 3.

9.1.1.5 Policy 7: The loss of river extent and values is avoided to the extent practicable.

The proposal will not result in a loss of the extent of any freshwater bodies including the Mangaehuehu Stream, or the Whangaehu River downstream.

The values of the surface waterbodies are outlined in the One Plan in Schedule B and are summarised as they relate to the proposal in Section 3.1.1 above. The NPSFM Policy requires that a loss of river values is avoided, however there is no guidance available on whether this means a total loss of a value or whether it also includes a reduction in a particular value. This is further complicated by the avoidance only being required "to the extent practicable".

We have considered the values for the Tokiahuru (Whau_1c) water management sub zone as identified in the One Plan (Section 8.1) and have taken into account the essential nature of the discharge to continue to meet the needs and wellbeing of the Rangataua community. On balance, the proposal is consistent with avoiding effects on river values to the extent practicable, and therefore is consistent with the direction of Policy 7.

9.1.1.6 Policy 9: The habitats of indigenous freshwater species are protected.

The Aquanet 2021 Report considers the impact of the existing discharge on freshwater ecology as identified in Section 8.2 above. The report identifies the following:

> *Overall, results of ecological monitoring do not indicate more than minor effects on macroinvertebrate communities (indicative of ecological health) or periphyton cover (indicative of aesthetic and recreational values), but indicate an increase in periphyton biomass between upstream and downstream, at times exceeding the One Plan target.*
>
> *The One Plan target and NPS-FM periphyton biomass attributes are not designed to be compared to single sample results, and regular (monthly) monitoring data would be required to confirm whether the One Plan target is met or exceeded and the NPS-FM Attribute state band each site falls into.*

In response to these findings, it is recommended that monthly periphyton monitoring be required as a condition of consent on the application to provide certainty that the proposal meets both the One Plan and NPSFM 2020 targets and to ensure habitats of indigenous freshwater species are protected.

9.1.1.7 Policy 10: The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

As identified in the Aquanet 2021 Report, *"the NZ Freshwater Fish database identified three fish species as being present in the Mangaehuehu Stream…"* which are Brown Trout, Koura and Longfin Eel. The Aquanet Report does not include any comment on any actual or potential effects of the discharge on fish species.

9.1.1.8 Policy 15: Communities are enabled to provide for their social, economic, and cultural well-being in a way that is consistent with this National Policy Statement.

The hierarchy of needs identified as the central concept of Te Mana o te Wai in the NPSFM 2020 places the health and well-being of water bodies and freshwater ecosystems as the first priority, with the health needs of people, and then the ability of people to provide for their social, economic and cultural well-being, now and in the future following.

As identified in Section 8.6, the ongoing treatment and disposal of wastewater from the Rangataua township is essential for the ongoing functioning of the community. Overall, this proposal provides for the well-being of communities is a manner consistent with Policy 15.

9.1.1.9 Clause 3.24 Rivers

Clause 3.24(1) requires a regional plan be amended to include a policy which states (or words to similar effect):

> *"The loss of river extent and values is avoided, unless the council is satisfied:*
>
> *(a) that there is a functional need for the activity in that location; and*
>
> *(b) the effects of the activity are managed by applying the effects management hierarchy."*

It is not anticipated that the proposal will result in a loss of river extent or values. However, due to uncertainty that currently remains, it is appropriate to consider the tests posed through the NPSFM 2020 policy as described below.

Functional Need

That there is a functional need for the treatment and disposal of wastewater generated from Rangataua township, in a location in relatively close proximity to the township.

Effects management

The NPSFM 2020 defines the effects management hierarchy as:

> ***effects management hierarchy****, in relation to natural inland wetlands and rivers, means an approach to managing the adverse effects of an activity on the extent or values of a wetland or river (including cumulative effects and loss of potential value) that requires that:*
>
> *(a) adverse effects are avoided where practicable; and*
> *(b) where adverse effects cannot be avoided, they are minimised where practicable; and*
> *(c) where adverse effects cannot be minimised, they are remedied where practicable; and*
> *(d) where more than minor residual adverse effects cannot be avoided, minimised, or remedied, aquatic offsetting is provided where possible; and*
> *(e) if aquatic offsetting of more than minor residual adverse effects is not possible, aquatic compensation is provided; and*
> *(f) if aquatic compensation is not appropriate, the activity itself is avoided*

While the One Plan contains policies which seek to manage effects on Surface Water Management Values in Schedule B, there is currently no policy that seeks to directly address the loss of river extent.

In granting an application, a regional council is required to ensure that the application meets the following two criteria (in accordance with 3.24(3):

> *(g) the council is satisfied that the applicant has demonstrated how each step in the effects management hierarchy will be applied to any loss of extent or values of the river (including cumulative effects and loss of potential value), particularly (without limitation) in relation to the values of: ecosystem health, indigenous biodiversity, hydrological functioning, Māori freshwater values, and amenity; and*
> *(h) any consent granted is subject to conditions that apply the effects management hierarchy.*

The effects management hierarchy in the NPSFM 2020 uses different terminology for the management of effects from that used in the RMA. Instead of avoid, remedy or mitigate adverse effects, the NPSFM 2020 requires that adverse effects are avoided where practicable and where this cannot be achieved, effects need to be minimised where practicable or remedied. The hierarchy goes further to outline how offsetting and compensation are to be used for more than minor residual adverse effects.

The proposal includes conditions which seek to manage the effects of the discharge based on effluent loads rather than volume to provide some flexibility for potential future growth while also providing appropriate controls on actual and potential instream effects. The proposal also includes improvements to the existing constructed wetland to provide greater treatment of wastewater.

Overall, it is considered that the proposal is consistent with Clause 3.24(1) of the NPSFM by providing for the essential treatment and disposal of wastewater from the township of Rangataua while managing effects on the environment in a manner which avoids the loss of river extent and value and appropriately manages the effects of the discharge that cannot be avoided.

9.1.2 National Environmental Standard for Freshwater (2020)

The National Environmental Standard for Freshwater ("NESF") came into force on 3 September 2020 and includes, standards designed to:

- Manage effects from farming activities
- Manage effects on natural wetlands
- Manage the effects on the passage of fish that can be caused by structures.

As the proposal does not relate to farming activities, natural wetlands or require structures in-stream that have the potential to affect fish passage, no further analysis against the requirements of the NESF is necessary.

For clarity, the definition of the natural wetland is provided in the NPSFM 2020, as *"a wetland (as defined in the Act*[2]*), that is not:*

> *(a) A wetland constructed by artificial means (unless it was constructed to offset impacts on, or restore, an existing or former natural wetland)…"*

As the wetland area has been formed via the modification to an existing drainage channel, it is not considered to be a natural wetland under the RMA, NPSFM 2020 or NESF.

9.1.3 National Environmental Standard for Sources of Human Drinking Water (2007)

The National Environmental Standard for Sources of Human Drinking Water 2007 ("NESDW") directs regional councils (under Regulation 7) to decline discharge permits that are likely to result in community drinking water no longer meeting health quality criteria, or no longer meeting aesthetic determinants, after existing treatment. This Regulation applies where the activity / discharge has the potential to affect registered drinking water supplies[3].

Under Regulation 12, when considering a resource consent application, a consent authority must consider whether the activity to which the application relates may lead to an event which may have a significant adverse effect on the quality of the water at any abstraction point or as a consequence of an

[2] RMA defines "wetland includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions"

[3] Only applies to drinking water supplies that provide >500 people with drinking water for not less than 60 days per calendar year

event (for example, an unusually heavy rainfall). If either of these applies, a condition of consent must be imposed that specifies certain notification requirements.

Horizons Mapping shows the application site being within Drinking Water: Source Protection Zone 3. Based on the PDP Report entitled "Source Protection Management: Ruapehu District Council Drinking Water Supplies" provided by Horizons and on discussions with RDC, there are no municipal drinking water supplies downstream of the WWTP site and discharge location.

Based on Horizons mapping system, there are no drinking water sources identified within 20km downstream of the WWTP site and disposal area.

9.1.4 National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health (2011) (NESCS)

Resource Management (National Environmental Standards for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011("NESCS") applies to any piece of land where an activity or industry described in the Hazardous Activities and Industries List ("HAIL list") is being, has been or is more likely than not to have been carried out.

The NESCS is implemented by each territorial and unitary authority in accordance with their functions under the RMA relating to contaminated land, specifically section 31(b)(iia) "the prevention or mitigation of any adverse effects of the development, subdivision, or use of contaminated land".

The NESCS achieves its policy objective through a mix of allowing (permitting) and controlling (through resource consents) certain activities on land affected or potentially affected by soil contaminants. The NES applies to proposals for the activities of subdivision, land-use change, earthworks (soil disturbance), soil sampling or removing fuel storage systems, after 1 January 2012.

The NESCS prevails over any district or regional rule that applies to assessing and managing contaminants in soil to protect human health (RMA s.43B(1)). Any district rules can, therefore, only have effect in so far as they apply to controlling effects other than assessing and managing contaminants in soil to protect human health.

NESCS regulations apply when a person wants to undertake certain "activities" on a site described as a "piece of land". Under section 5(7) of the NESCS, an area is described as a "piece of land" where "an activity or industry described in the HAIL is being undertaken on it". Regulation 5(7), which reads:

> *(7) The piece of land is a piece of land that is described by 1 of the following:*
>
> > *(a) an activity or industry described in the HAIL is being undertaken on it:*
> >
> > *(b) an activity or industry described in the HAIL has been undertaken on it:*

(c) *it is more likely than not that an activity or industry described in the HAIL is being or has been undertaken on it.*

9.1.5 Piece of land

The Hazardous Activities and Industries List (HAIL) identifies under section G6 "Waste recycling or wastewater treatment" as a HAIL activity. It is therefore considered that the wetland area, where the treated wastewater from the Rangataua WWTP is discharged, is also a HAIL activity.

Regulation 6 of the NESCS identifies there are two methods that a person may use to establish whether or not a piece of land is covered by the NESCS (regulation 5(7)). The two methods are:

1. *A search of the most up-to-date information held by the District and Regional Council's; or*

2. *Undertake a preliminary site investigation (PSI)*

Given the information held by both Horizons Regional Council, through the granting of resource consent for the use of the site for discharge of treated wastewater, and RDC being the WTP operators, it is confirmed that the existing disposal site is a piece of land for the purposes of the NESCS and further analysis against the provisions of the NESCS is required for this site.

9.1.6 Activities

The NESCS defines five specified activities that may require resource consent when undertaken on pieces of land identified under the HAIL. The five activities are identified as:

1. Removing or replacing all, or part of, a fuel storage system

2. Sampling the soil

3. Disturbing the soil

4. Subdividing the land

5. Changing the land use

The earthworks needed to improve the functionality of the wetland area would be considered 'disturbing the soil' of the existing disposal site.

9.1.7 Disturbing Soil - Regulation 8: Permitted Activities

To be classed as a permitted activity, soil disturbance must meet the provisions of regulation 8 (3) (a) to (g). Regulation 8(3) of the NES reads:

Disturbing soil

(3) Disturbing the soil of the piece of land is a permitted activity while the following requirements are met:

(a) controls to minimise the exposure of humans to mobilised contaminants must—

(i) be in place when the activity begins:

(ii) be effective while the activity is done:

(iii) be effective until the soil is reinstated to an erosion-resistant state:

(b) the soil must be reinstated to an erosion-resistant state within 1 month after the serving of the purpose for which the activity was done:

(c) the volume of the disturbance of the soil of the piece of land must be no more than 25 m^3 per 500 m^2:

(d) soil must not be taken away in the course of the activity, except that,—

(i) for the purpose of laboratory analysis, any amount of soil may be taken away as samples:

(ii) for all other purposes combined, a maximum of 5 m3 per 500 m2 of soil may be taken away per year:

(e) soil taken away in the course of the activity must be disposed of at a facility authorised to receive soil of that kind:

(f) the duration of the activity must be no longer than 2 months:

(g) the integrity of a structure designed to contain contaminated soil or other contaminated materials must not be compromised."

While construction details are yet to be determined for the work to enhance/alter the profile of the existing wetland area (including extension of the inlet pipeline and installation of an additional low bunded area), it is anticipated that the works can be designed to align with the requirements of the permitted activity under Regulation 8 as outlined above. In particular, volume requirements are anticipated to be within the requirements for (d)(ii) and the duration of works are not anticipated to be longer than 2 months.

RDC acknowledge that in the event that earthworks are required that do not meet the permitted activity requirements of Regulation 8, the relevant assessment will be completed, and the necessary resource consent application prepared and lodged with the consenting team at RDC.

9.2 Regional Direction – Horizons One Plan

The One Plan is a combined Regional Policy Statement and Regional Plan that has been operative since 19 December 2014.

9.2.1 Regional Policy Statement

Part I of the One Plan is the Regional Policy Statement. It sets out the regionally significant resource management issues, and outlines the objectives, policies and methods that will be used to address them.

The following section is an assessment of the application against Part I of the One Plan. It is intended that this analysis be read alongside the One Plan and as a result, the provisions are not reproduced here unless this is necessary for the analysis.

9.2.1.1 Chapter 2: Te Ao Māori

Chapter 2 of the RPS recognises the importance of the relationship of hapū and iwi with natural resources and identifies the resource management issues of significance to hapū and iwi in the Manawatū-Whanganui Region together with objectives and policies to address those issues.

Objective 2-1 specifies two key requirements to be considered when considering activities:

a. *"To have regard to the mauri of natural and physical resources to enable hapū and iwi to provide for their social, economic and cultural wellbeing.*
b. *Kaitiakitanga must be given particular regard and the relationship of hapū and iwi with their ancestral lands, water, sites, wāhi tapu and other taonga (including wāhi tūpuna) must be recognised and provided for through resource management processes."*

Of particular relevance to this application are policies which seek to achieve this objective through ensuring that hapū and iwi are involved in resource management processes and that regard is had to the mauri of water.

Assessment

Further engagement with Ngāti Rangi is needed to ensure that the application is consistent with the requirements of Chapter 2.

9.2.1.2 Chapter 3: Infrastructure

Chapter 3 outlines the objectives and policies that relate to infrastructure activities in the Region. Objective 3-1 recognises the benefits of infrastructure and recognises and provides for their establishment, operation, maintenance and upgrading.

Policy 3-1 requires regional council and territorial authorities to recognise *"public or community sewage treatment plants and associated reticulation and disposal systems"* as physical resources of regional or national significance. The policy further requires that:

> *(c) The Regional Council and Territorial Authorities must, in relation to the establishment, operation, maintenance, or upgrading of infrastructure and other physical resources of regional or national importance, listed in (a) and (b), have regard to the benefits derived from those activities.*

Policy 3-3 requires that the adverse effects from the establishment, operation, maintenance and upgrading of infrastructure must be managed to avoid, remedy or mitigate more than minor adverse effects arising from the establishment of new infrastructure while taking account of:

(i) *the need for the infrastructure^ or other physical resources of regional or national importance,*

(ii) *any functional, operational or technical constraints that require infrastructure^ or other physical resources of regional or national importance to be located or designed in the manner proposed,*

(iii) *whether there are any reasonably practicable alternative locations or designs, and*

(iv) *whether any more than minor adverse effects^ that cannot be adequately avoided, remedied or mitigated by services or works can be appropriately offset, including through the use of financial contributions.*

Assessment

Policy 3-1 identifies wastewater treatment plants and disposal systems as being of regional or national importance. The ongoing, feasible and affordable operation of the WWTP must therefore be considered in this context together with the benefits it provides to the Rangataua community and the wider Ruapehu District.

The proposal seeks to continue the treatment and disposal of wastewater at the Rangataua WWTP while improving the functionality and useable area of the constructed wetland for polishing the treated wastewater before it is discharged via the drainage channel to the Mangaehuehu Stream.

Overall, it is considered that the proposal is consistent with the direction in the RPS for wastewater infrastructure.

9.2.1.3 Chapter 5: Water

Chapter 5 outlines the objectives and policies for freshwater management in the region, including water quality.

The One Plan identifies the *"quality of many rivers and lakes in the Region has declined to the point that ecological values are compromised and contact recreation such as swimming is considered unsafe. The principal causes of this degradation are:*

a. nutrient enrichment caused by run-off and leaching from agricultural land, discharges of treated wastewater, and septic tanks

b. high turbidity and sediment loads caused by land erosion, river channel erosion, runoff from agricultural land and discharges of storm water

c. pathogens from agricultural run-off, urban run-off, discharge of sewage, direct stock access to water bodies and their beds and discharges of agricultural and industrial waste"[4].

To improve water quality, the objectives of Chapter 5 require that Schedule B values are recognised and provided for. Schedule B identifies the Surface Water Management Values that apply to each water management sub-zone.

Objective 5.1 of the RPS provides for surface water bodies and their beds to be managed:

> *"... in a manner which safeguards their life supporting capacity and recognises and provides for the Values in Schedule B."*

Objective 5.2 requires that surface water quality is managed to ensure that:

> *"... water quality is maintained in those rivers ... where the existing water quality is at a level sufficient to support the Values in Schedule B [and] ... enhanced in those rivers ... where the existing water quality is not at a level to support the Values in Schedule B."*

And, Objective 5-4 requires that the beds of rivers be managed in a manner which:

a. sustains their life supporting capacity

b. provides for the in stream morphological components of natural character

c. recognises and provides for the Schedule B Values

d. provides for infrastructure and flood mitigation purposes.

[4] Horizons One Plan; Section 5 Water; Issue 5-1 Water quality; page 5-6

The policies of Chapter 5 have specific requirements to ensure the objectives are achieved.

In particular Policy 5-1 outlines that *"…rivers and lakes and their beds must be managed in a manner which safeguards their life supporting capacity and recognises and provides for the Schedule B Values when decisions are made on avoiding, remedying and mitigated the adverse effects of activities…"*

Policy 5-4 requires that rivers will be managed as follows:

> *"Where the existing water quality does not meet the relevant Schedule E water quality targets within a Water Management Sub-zone, water quality within that sub-zone must be managed in a manner that enhances existing water quality in order to meet:*
>
> *i) the water quality target for the Water Management Zone in Schedule E, and/or*
>
> *ii) the relevant Schedule B Values and management objectives that the water quality target is designed to safeguard.*
>
> *For the avoidance of doubt:*
>
> *i) in circumstances where the existing water quality of a Water Management Sub-zone does not meet all of the water quality targets for the Sub-zone, (a) applies to every water quality target for the Sub-zone*
>
> *ii) in circumstances where the existing water quality of a Water Management Sub-zone does not meet some of the water quality targets for the Sub-zone, (a) applies only to those water quality targets not met."*

Assessment

The One Plan identifies that the WWTP site is within the Whau_1 Upper Whangaehu Surface Water Management Zone, and Tokiahuru (Whau_1c) Sub-zone which is described as "Tokiahuru Stream from Whangaehu River confluence at approx. NZMS 260 S21:219-865 to source".

Schedule B of the One Plan identifies the range of values that apply zone-wide to the Upper Whangaehu Water Management Zone. Table 1 above summarises the management values and objectives applicable to the Tokiahuru (Whau_1c) Water Management subzone.

As identified in the Aquanet 2021 Report, additional monitoring is required to better understand the potential effects of the discharge on periphyton within the Mangaehuehu Stream. For the remaining key contaminants, the Mangaehuehu Stream is compliant with One Plan limits except in the instances where these limits are already exceeded upstream of the discharge.

9.2.1.4 Chapter 7: Air

Chapter 7 outlines the objectives and policies for air quality management in the region. The following policies objectives are considered relevant.

Objective 7-1 seeks to ensure that ambient air quality is maintained at a level that is not detrimental to amenity values, human health, property of the life-supporting activity of air while meeting ambient air quality standards. Policy 7-2 contains the regional standards for ambient air quality while Policy 7-3 outlines the regulation of discharges to air by ensuring that discharges are consistent with the National Environmental Standard for ambient air quality and regional standards outlined in Policy 7-2.

Assessment

The Rangataua WWTP is located approximately 200m from the nearest residential dwelling in the Rangataua township. Neither Horizons nor RDC have any records indicating there have been complaints of odour issues from the operation of the WWTP. It is therefore considered that the WWTP activity is not known to be having adverse effects the ambient air quality in the surrounding environment and its continued operation will not be detrimental to amenity values, human health, property or the life-supporting capacity of air.

A condition of consent is recommended to manage any potential future effects from the continued operation of the Rangataua WWTP. The conditions require that no noxious, dangerous, offensive or objectionable odour are experienced beyond the site boundary and that any complaints about odour from the plant to be recorded, investigated, action taken where appropriate and reported to the Regional Council.

Overall, the proposal is considered consistent with requirements in the Regional Policy Statement for managing air quality.

9.2.2 Regional Plan

Part II of the Horizons One Plan is the Regional Plan which specifies the objectives, policies and regional rules on natural and physical resource use.

The following section contains an assessment of the application against Part II of the One Plan, in terms of the relevant objectives and policies. It is intended that this analysis be read alongside the One Plan and as a result, the provisions are not reproduced here unless this is necessary for the analysis.

9.2.2.1 Chapter 14: Discharges to Land and Water

Chapter 14 of the Regional Plan directs the management of discharges to land and water through objectives, policies and rules.

Objective 14-1 outlines the requirements for managing discharges as follows:

> *The management of discharges onto or into land (including those that enter water) or directly into water and land use activities affecting groundwater and surface water quality in a manner that:*
>
> *(a) safeguards the life supporting capacity of water and recognises and provides for the Values and management objectives in Schedule B,*
> *(b) provides for the objectives and policies of Chapter 5 as they relate to surface water and groundwater quality, and*
> *(c) where a discharge is onto or into land, avoids, remedies or mitigates adverse effects on surface water or groundwater.*

Policy 14-2 outlines the factors that the Regional Council must have regard to when making decisions on consents for discharges onto or into land. Of relevance to this application are the following considerations:

- objectives and policies of Chapter 5 regarding groundwater quality and surface water quality
- avoiding as far as reasonably practicable, any adverse effects on surface water bodies
- the appropriateness of adopting a BPO process to prevent or minimise adverse effects
- avoiding discharges of persistent contaminants
- objectives and policies of chapters 2, 3, & 6

Policy 14-4 specifies the requirement to consider and use alternative options for discharges to mitigate adverse effects and applying the BPO including discharging to land rather than water which is of particular relevance to this application.

Assessment

Chapter 14 requires consideration of the relevant Policies 5-1 to 5-5 and this is provided under Section 9.2.1 above (Regional Policy Statement) as well as relevant objectives and policies of Chapter 2.

Consideration of alternative options for the WWTP treatment and discharge are outlined in Section 6 above. Through these considerations, RDC determined that the proposal was the best option for the ongoing operation of the WWTP.

The consideration of adverse effects on surface water bodies, as required by Policy 14-2, is considered in Section 8.2. In addition, the relevant objectives and policies of Chapters 2, 3, 5 and 7, and to the extent that are relevant to the application, are discussed in Section 9.2.1 above.

Proposed conditions of consent include a requirement for additional monthly monitoring of periphyton to understand better any actual effects of the discharge on periphyton in the Mangaehuehu Stream.

9.2.2.2 Chapter 15: Air

Chapter 15 outlines the objectives, policies and rules for discharges to air from the Rangataua WWTP. Objective 15-1 requires that air quality be managed to ensure that ambient air quality is maintained in a way that safeguards the health of the community and that amenity values are not affected.

Policy 15-2 specifies the matters the Regional Council must have regard to when making decisions on resource consent applications regarding discharges to air. Of particular relevance to this application are the requirements to consider the following:

- Objectives and policies of Chapter 7
- The location of discharges
- Effects of scenic, landscape, heritage and recreational values
- *the appropriateness of adopting a BPO process to prevent or minimise adverse effects*

Assessment

The Rangataua WWTP has not previously held resource consent for discharges to air and Horizons or RDC have no records of complaints being received regarding odour. The consent for discharges to air is being sought on a precautionary basis to manage any potential effects including proposed conditions to require records of complaints and any actions taken in response to these complaints to be kept.

9.3 Overall Summary of the policy direction from the Horizons One Plan

The proposal seeks to continue the operation of the WWTP including improvements to the existing treatment wetland through expanding the useable area and undertaking additional planting. The proposal is considered to be consistent with the relevant objectives and policies of the One Plan as it recognises the importance of regionally/ nationally significant infrastructure while managing the actual and potential effects of the ongoing operation of the WWTP on the quality of water in the Mangaehuehu Stream and ensures that freshwater ecosystems and values are safeguarded.

However, future monthly monitoring of periphyton is recommended to better understand any actual effects of the discharge on periphyton in the Mangaehuehu Stream and a condition of consent is proposed as a result.

9.4 Section 124 of the RMA

On 2 September 2021, Horizons confirmed receipt of the June 2014 application by RDC and sought further information on the application under s.92. Acceptance of the application is considered to have secured the ability of RDC to continue to operate the WWTP while the new application is considered.

9.5 Section 104 of the RMA

Section 104(2A) of the RMA states:

> *"When considering an application affected by section 124, the consent authority must have regard to the value of the investment of the existing consent holder."*

RDC have advised that the Depreciated Value of the wastewater network, pump stations, treatment and disposal is in the order of $2.1millon with the treatment and disposal component being some $1.2 million (based on July 2020 valuation report).

9.6 Statutory Acknowledgements

The Rangataua township falls within the Ngāti Rangi Area of Interest as specified in the Deed of Settlement signed by the Crown and Ngāti Rangi on 7 December 2018. There are no specific statutory acknowledgements that apply to the area of land where the WWTP is located. It is acknowledged however that the catchment of the Whangaehu River "Te Waiū-o-Te-Ika" has a Deed of Recognition in the Ngāti Rangi settlement documents.

The Rangataua township also falls within the Area of Interest of Te Korowai o Wainuiārua as specified in Attachment 1 of the Agreement in Principle to Settle Historical Claims dated 23 November 2018. It is noted that the settlement of treaty claims is currently ongoing for Te Korowai o Wainuiārua. While both the Rangataua and Rangataua No.2 Conservation Areas are identified on Attachment 5 of the Agreement in Principle as Cultural Redress Maps, the site of the Rangataua WWTP is not identified as being a statutory acknowledgement area.

9.7 Other relevant considerations

9.7.1 Ngāti Rangi Taiao Management Plan 2014

The Taiao Management Plan was prepared to provide clarity and structure to the Ngāti Rangi approach to environmental management and provides a framework by which Ngāti Rangi can fulfil their role as tāngata tiaki.

The Vision Statement from the Taiao Management Plan is:

> *We as Ngāti Rangi iwi, hapū, whānau and individuals will live in a way that we and the world around us vibrantly exists in a thousand years. In order for Ngāti Rangi to be a flourishing tribal nation throughout and beyond the next millennium, the connections that exist with the natural world need to be strengthened. We can do this by: reconnecting with our whānau, hapū and wider iwi groupings; revitalising our connections with our natural world through talking with and listening to our waterways, ngahere, whenua and maunga; and playing an active role in the protection of the taiao.*

To realise the vision statement Ngāti Rangi outline their "*wish to ensure that the environment is cared for in a way that ensures our descendants can enjoy the fruits of the atua as our tūpuna did*" and to ensure that the main objective of active involvement and protection of the natural world is undertaken.

From the Taiao Management Plan, Ngāti Rangi seek that "*some of the Ngāti Rangi whakaaro about and approaches to caring for our environment, so that these can then be properly taken into account during decision making processes such as resource consent*."

Section 4 of the Taiao Management is entitled "Te Pou Tuawha: Tangaroa-i-te-wai-māori" with Tangaroa-i-te-wai-māori representing the embodiment of freshwater in the region. The section identifies a number of issues, the following of which are considered to be particularly relevant to the discharge of treated wastewater:

- *Water quality impacted by point source discharges and leaching and run off from urban and rural sources*
- *Point and non-point source discharges which can impact on the ability of the waterway to undertake its role in supporting the life contained within and around it.*

From this, Ngā Whainga – Objectives are identified that include the following objectives considered relevant to the consideration of a discharge of wastewater:

- *Water flowing out of our region will be clean and healthy, to ensure Ngāti Rangi's obligations to our downstream whānau are met.*
- *There are no discharges (either point source or nonpoint source) that impact on water quality.*
- *Land is utilised throughout the region as an added measure of purification for wastewater prior to any discharge into waterways.*
- *All waterbodies and wetlands in the Ngāti Rangi region have planted riparian margins.*

To achieve these objectives, Taiao Management Plan identifies the following relevant policies:

4.1.1 Water quality in the Ngāti Rangi rohe must be swimmable and fishable at all sites, at all times, unless it is naturally unswimmable.

4.2.1 Ngāti Rangi does not support discharges to water.

4.2.2 However, some discharges may be considered in exceptional circumstances. Any discharges agreed to by Ngāti Rangi will:

a. pass through land or a wetland prior to release to water; and

b. be high quality, free from contaminants, not contribute to cumulative impacts nor have any effect on the waterbody and its mouri.

4.2.3 There should be no impact on the mouri and ecology resulting from point or non-point discharges to water. Neither should there be any stress to aquatic species through algal blooms, temperature increases, or contaminants contributed by discharges.

4.2.5 Ngāti Rangi supports the full exclusion of stock from all water bodies in our region. Ngāti Rangi will seek opportunities to support landowners in practical ways as they work to exclude stock from their water bodies. Ngāti Rangi will support moves by local and national authorities to exclude stock access to waterbodies.

The Taiao Management Plan also includes Ngā Ture – Rules. The rules considered relevant to a discharge of treated wastewater from the Rangataua WWTP include the following:

4.1.1.1 No resource consent shall be granted that renders a water body unswimmable or unfishable, including resource consents that contribute to cumulative effects on swimming quality or fishability, or takes that impact on water quality and habitat.

4.2.1.1 In general, discharge consents to water should not be granted.

4.2.2.1 Any discharge consents that are granted must:

a) Not impact upon the mauri of the waterbody;

b) Have no impact on the receiving waterbody (as opposed to less than minor effects);

c) Not contribute to cumulative effects; and *d) Pass through Papa-tū-ā-nuku.*

Engagement with representatives of Ngāti Rangi is necessary to ensure that the view and values of Ngāti Rangi are accurately represented, including discussion on how the application can be considered against the provisions of Ngāti Rangi's Taiao Management Plan.

10 Part 2 of the Resource Management Act

Overall, the application is considered to be consistent with Part 2 of the RMA. The continued operation of the WWTP is an essential service for the people and communities of the Ruapehu District. The proposal seeks to continue the activity while improving the treatment of wastewater discharged from the plant by increasing the functional area of the constructed wetland area.

Further analysis of the proposal against each section of Part 2 is provided below.

10.1 Section 5 – Purpose

The matters to be considered under section 104 are subject to Part 2 of the RMA. The cornerstone of Part 2 is the Purpose of the Act as set out in section 5(1), which is:

> *"To promote the sustainable management of natural and physical resources".*

Section 5(2) of the RMA defines sustainable management as:

> *"Managing the use, development and protection of natural and physical resources in a way or at a rate which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while-*
>
> a. *Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and*
>
> b. *Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and*
>
> c. *Avoiding, remedying or mitigating any adverse effects of activities on the environment."*

The ongoing operation of the Rangataua WWTP will enable the people and communities of Rangataua to continue to provide for their social, and economic well-being and for their health and safety and is an essential service that is specifically provided for by the Horizons One Plan.

Sustainable management enables the use and development of resources while ensuring that the circumstances in section 5(2)(a)-(c) are able to be satisfied.

10.2 Sections 6, 7 and 8 Assessment

Section 6 of the RMA sets out the matters of national importance that must be recognised and provided for in managing the use, development and protection of natural and physical resources as follows:

> *"a. The preservation of the natural character of the coastal environment (including coastal marine area) wetlands and lakes and rivers and their margins and the protection of them from inappropriate subdivision, use and development:*
>
> *b. The protection of outstanding natural features and landscapes from inappropriate subdivision, use and development:*
>
> *c. The protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna:*
>
> *d. The maintenance and enhancement of public access to and along the coastal marine area, lakes and rivers:*
>
> *e. The relationship of Māori and their culture and traditions with their ancestral lands, water, waahi tapu, and other taonga;*
>
> *f. The protection of historic heritage from inappropriate subdivision, use and development;*
>
> *g. The protection of recognised customary activities*
>
> *h. The management of significant risks from natural hazards."*

In general, the matter of national importance considered relevant to this application are sections 6(c) and 6(e). Further engagement with Ngāti Rangi is necessary to ensure that the direction and requirements of s(6)(e) are appropriately addressed in terms of this consent application.

The proposed continued discharge of treated wastewater via the constructed wetland to the Mangaehuehu Stream is not considered to be contrary to any of the matters of national importance set out in section 6 of the RMA.

Analysis of instream monitoring data completed in the Aquanet 2021 Report indicates that "*Overall, results of ecological monitoring do not indicate more than minor effects on macroinvertebrate communities (indicative of ecological health) or periphyton cover (indicative of aesthetic and recreational values), but indicate an increase in periphyton biomass between upstream and downstream, at times exceeding the One Plan target.*"

Overall, the proposal is considered to be consistent with recognising and providing for matters of national importance.

Section 7 of the RMA sets out the matters that particular regard must be had to in managing the use, development and protection of natural and physical resources as follows:

- a. *kaitiakitanga:*
- aa. *the ethic of stewardship:*
- b. *the efficient use and development of natural and physical resources:*
- ba. *the efficiency of the end use of energy:*
- c. *the maintenance and enhancement of amenity values:*
- d. *intrinsic values of ecosystems:*
- e. *[Repealed]*
- f. *maintenance and enhancement of the quality of the environment:*
- g. *any finite characteristics of natural and physical resources:*
- h. *the protection of the habitat of trout and salmon:*
- i. *the effects of climate change:*
- j. *the benefits to be derived from the use and development of renewable energy.*

To ensure the appropriate regard is had to Sections 7(a) and (aa), RDC will continue to engage with Ngāti Rangi to give effect to these matters.

The proposed continued operation of the Rangataua WWTP and expansion of the constructed wetland area, is considered consistent with the direction provided in Sections 7(b), (c) (d), (f), (g) and (h).

Section 7(ba), (i) and (j) are not considered relevant to the renewal of this consent.

The ongoing operation of the Rangataua WWTP is not considered to be contrary to any of the matters of other matters out in section 7 of the RMA.

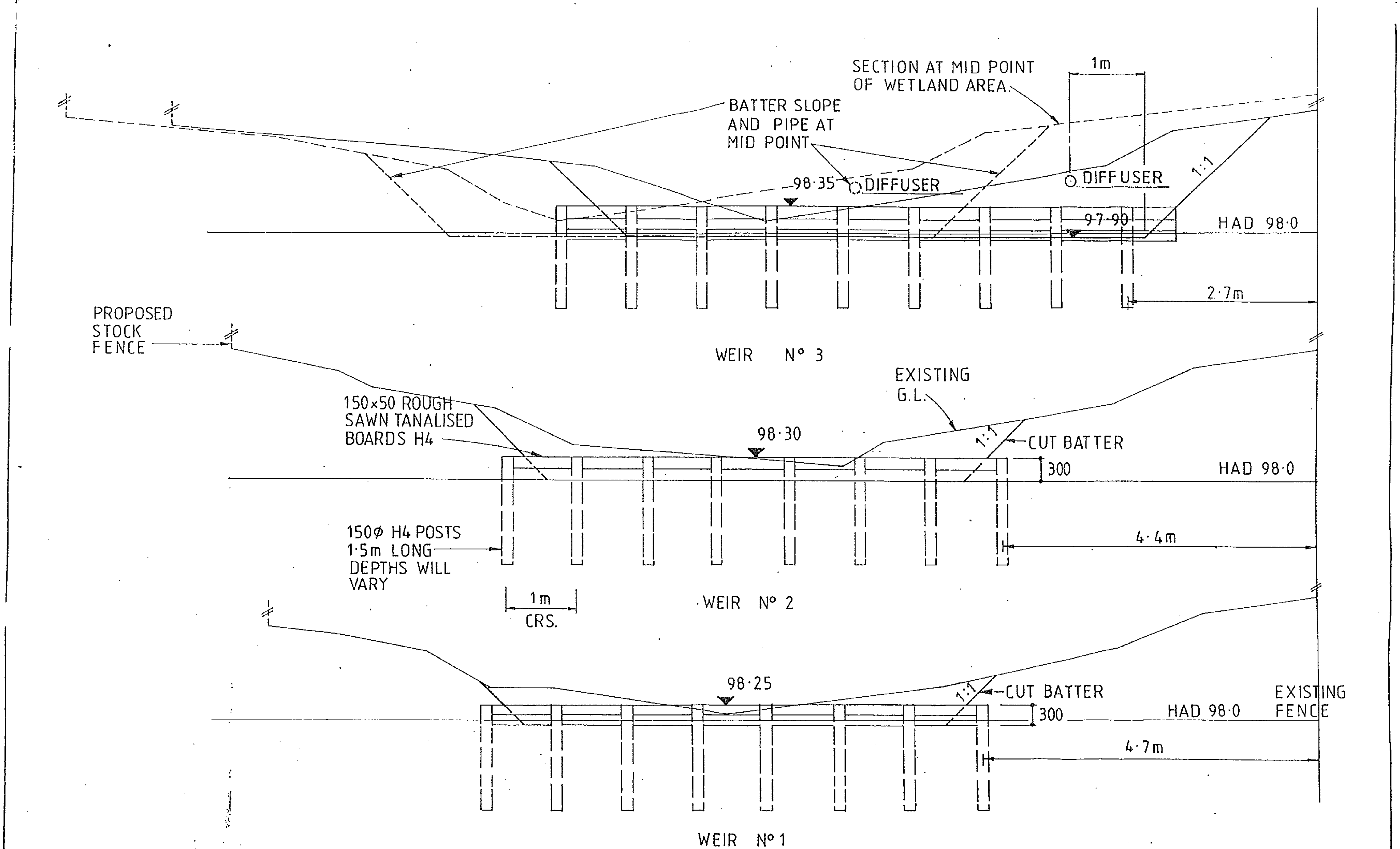
Section 8 of the Act requires that all persons exercising functions and powers must take into account the principles of the Te Tiriti o Waitangi and the proposal is not inconsistent with these principles.

11 Conclusions

The information in this supplementary report provides updated information on the Rangataua WWTP application which:

- Includes updated analysis from recent in-stream and effluent quality monitoring. This updated analysis identifies that there are few detectable changes in concentrations of the key discharge constituents between upstream and downstream of the discharge point. There are small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream, however this is influenced by unrestricted stock access to the discharge channel and the Mangaehuehu Stream.
- Identifies that additional monitoring of periphyton is needed to better understand effects instream.
- Incorporates information provided in the response to the Horizons further information request in June 2020 including upgrades to the current wetland including increasing the useable wetland area, works to ensure the profile and contour of the wetland is appropriate and undertake wetland planting to any earth worked areas. In addition, effluent load rather than volume conditions of consent are proposed. This approach facilitates a focus on controlling actual effects on stream water quality/ecology and the risk of effects from the discharge and enables flexibility in response to growth.
- Provides a supplementary assessment of environmental effects based on recent data, which indicates that effects from the discharge on cultural values are not fully understood, in-stream effects are no more than minor;
- Provides analysis against the current planning framework, introduced since the June 2014 application was lodged including the National Policy Statement for Freshwater 2020 and the National Environmental Standard for Freshwater Management 2020. This analysis requires further and ongoing engagement with Ngāti Rangi to ensure that the direction in these national-level documents are achieved;
- Includes consideration of implications to the application from changes resulting from Treaty settlements. Through the settlements currently finalised, there are no statutory acknowledgements directly relevant to the site of the WWTP; and
- Considers the application in the context of Ngāti Rangi's Taiao Management Plan 2014 which requires further and ongoing engagement with Ngāti Rangi to fully understand the implications of the proposal.

Appendix 1 – Treatment Pond Plans



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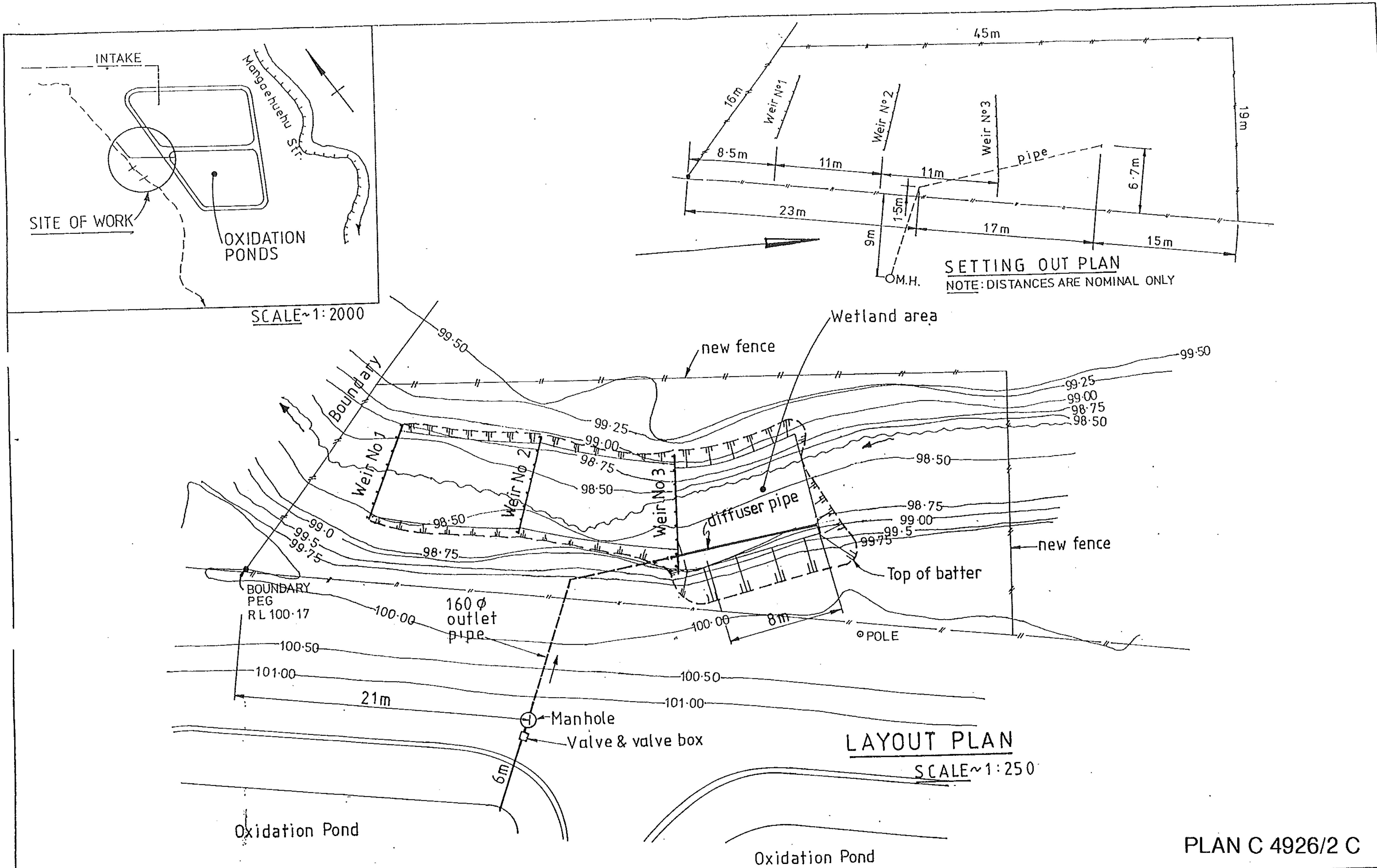

PLAN C 4926/2 C

DATE	AMENDMENT	INITIALS

RUAPEHU DISTRICT COUNCIL

APPROVED ________
DATE ________

NEW OUTLET WORKS FOR RANGATAUA OXIDATION PONDS

LAYOUT PLAN OF OUTLET

	NAME	DATE
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DRAWN	[signature]	3.99
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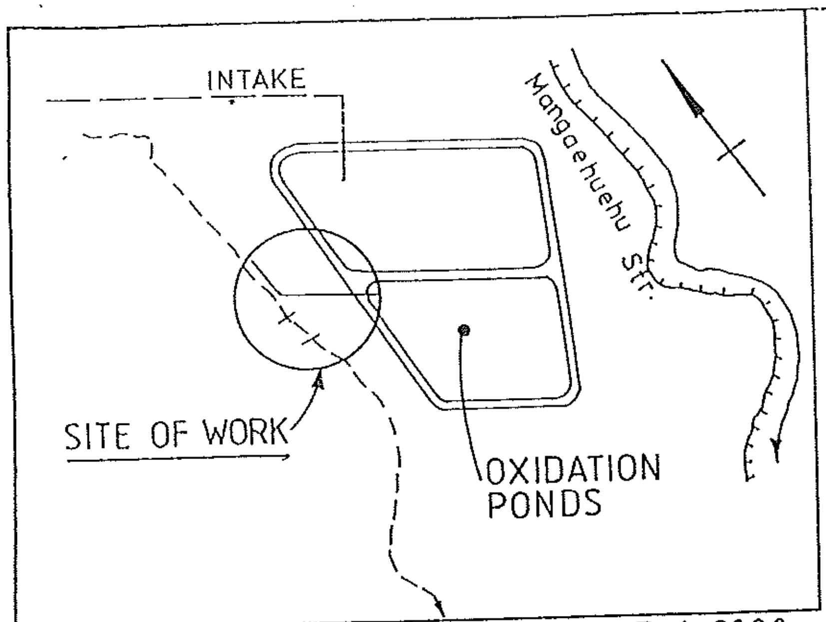
SCALE: HORIZ. VERT.

SHEET Nº1 OF 4 SHEETS

PLAN Nº 272



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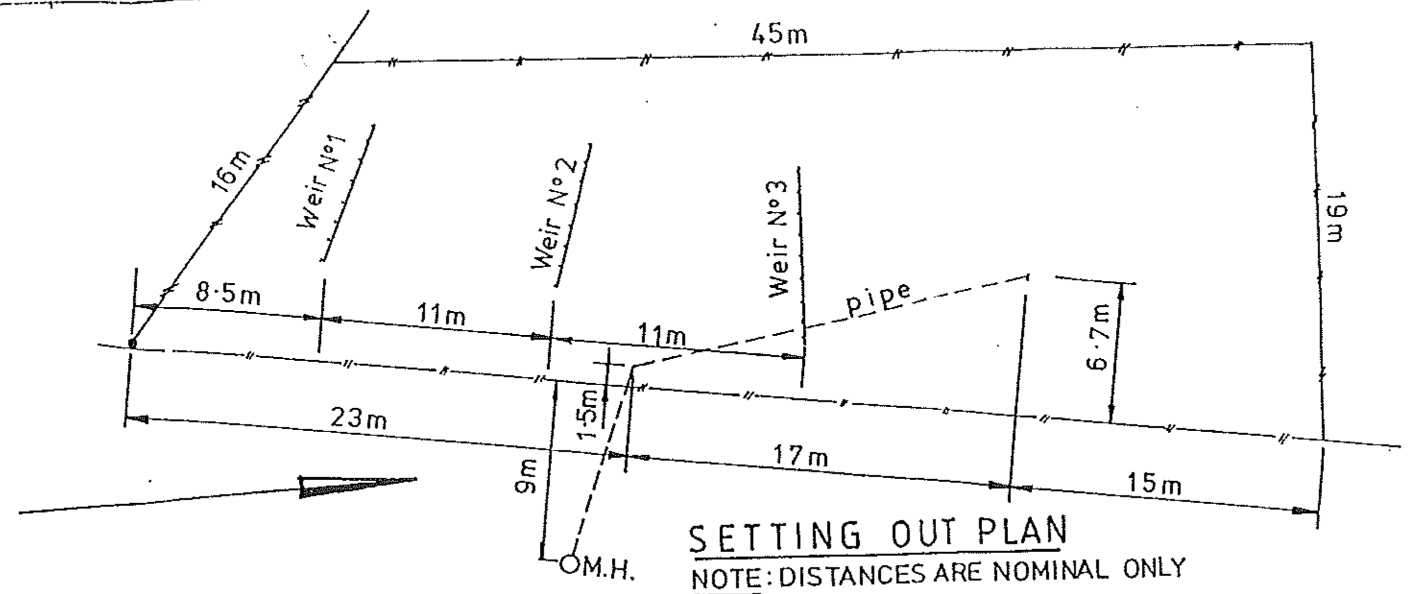
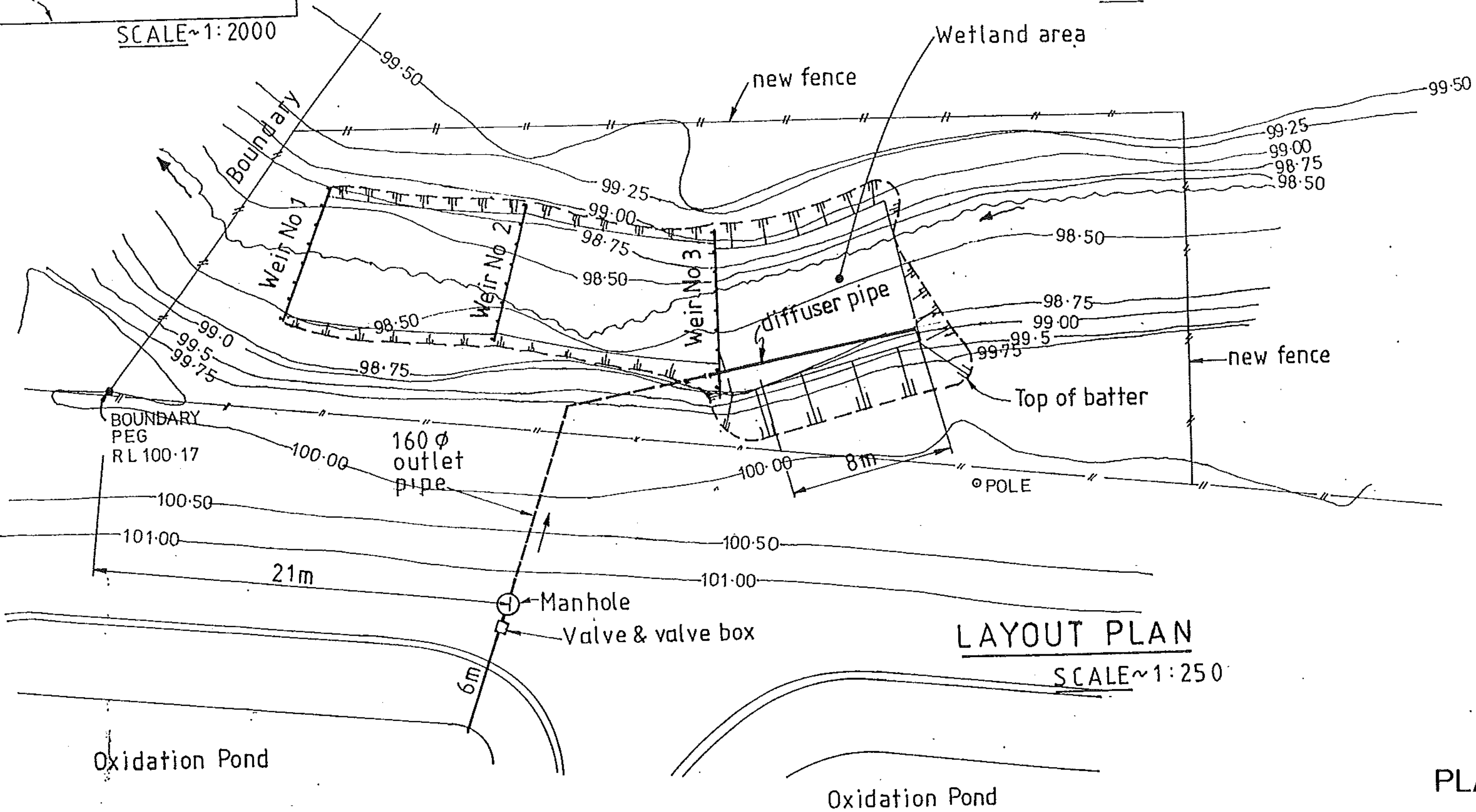


SETTING OUT PLAN

NOTE: DISTANCES ARE NOMINAL ONLY



LAYOUT PLAN

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PLAN C 4926/2 C

DATE	AMENDMENT	INITIALS

RUAPEHU DISTRICT COUNCIL

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NEW OUTLET WORKS FOR RANGATAUA OXIDATION PONDS

LAYOUT PLAN OF OUTLET

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SHEET N°1 OF 4 SHEETS

PLAN N° 272

Appendix 2 – Rangataua Wastewater Treatment Plant discharge to the Mangaehuehu Stream Assessment of current effects on freshwater quality and ecology – Aquanet 2021

Rangataua Wastewater Treatment Plant discharge to the Mangaehuehu Stream: Assessment of current effects on freshwater quality and ecology.

September 2021

Report Prepared for Ruapehu District Council

Aquanet Consulting Ltd
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Rangataua Wastewater Treatment Plant discharge to the Mangaehuehu Stream: Assessment of current effects on freshwater quality and ecology

10th September 2021

Report prepared for Ruapehu District Council by:

Fiona Death

Dimitrios Rados

Aquanet Consulting Limited

Quality Assurance			
Role	**Responsibility**	**Date**	**Signature**
Prepared by	Fiona Death Dimitrios Rados	15/07/2021	
Reviewed by	Ruapehu District Council	03/09/2021	
Approved for issue by:	Olivier Ausseil	10/09/2021	
Status	Final	10/09/2021	

EXECUTIVE SUMMARY

Context

The Rangataua Wastewater Treatment Plant (WWTP) is located just to the east of Ohakune and provides services for the township of Rangataua. It is owned by the Ruapehu District Council and operated by Veolia. Resource Consent N. 4926 currently allows for the discharge of up to 29 m^3/day treated wastewater from the Rangataua WWTP into the Mangaehuehu Stream and expired in December 2005.

A renewal application to enable the continuation of the discharge of treated wastewater from the Rangataua WWTP at or near the existing discharge location was lodged in June 2014 (Application Number 107258). This report is intended to provide an updated assessment of the nature and scale of effects of the current discharge of treated effluent from the Rangataua WWTP on the water quality of the Mangaehuehu Stream. This update has been prepared due to the significant amount of time that has lapsed since the application was lodged.

Assessment undertaken

This report provides:

- A summary of treated effluent quantity and quality data and daily load contributions to instream concentrations for key contaminants currently discharged from the Rangataua WWTP.
- An assessment of the effects of the current discharge of treated effluent from the Rangataua WWTP on the water quality and ecology of the Mangaehuehu Stream.

This assessment is based on monitoring data collected during the period 2012-2021 (water quality) and 2008, 2009 and 2021 (ecology).

The analysis of water quality and ecological data presented in this report also includes an assessment against the provisions of:

- Horizons One Plan Schedule E water quality targets for the Upper Whangaehu Tokiahuru (Whau_1c) water management sub-zone,
- The National Policy Statement for Freshwater Management (2020)'s relevant numeric Attribute States, and
- Current Resource Consent conditions.

Results

Effluent treatment and quality

The Rangataua WWTP treatment process involves passage through primary and secondary ponds, and a small, constructed wetland area before being discharged into the Mangaehuehu Stream via an old drainage channel, approximately 570 m long. This channel dries up during summer periods and the effluent discharged during dry summer periods does not appear to reach the Mangaehuehu Stream via surface flow.

Discharge volumes from the Rangataua WWTP are typically higher over winter months and into spring exceeding the currently consented daily volume of 29 m^3/day, but then decrease over summer months falling below the discharge volume currently allowed by consent, and sometimes not discharging at all for extended periods of time.

Effluent quality after the oxidation pond process appears consistent with other similar wastewater plants, with Ammoniacal-nitrogen, Nitrate-nitrogen and SIN appearing following seasonal patterns (higher concentrations observed over winter and lower concentrations during summer months).

Receiving Environment – Current effects:

Monitoring Sites

Water quality and ecology of the Mangaehuehu Stream were at three locations:

- Upstream of the WWTP, near the railway bridge (Upstream Site)
- Approximately 240m upstream of the point where the drainage channel meets the Mangaehuehu Stream but downgradient of the WWTP (Middle Site)
- Approximately 120m downstream of the point where the drainage channel meets the Mangaehuehu Stream (Downstream Site)

The reach of the Mangaehuehu Stream between the upstream and downstream sites flows through farm land, and, as of April 2021, livestock appear to have relatively unrestricted access to the drainage channel carrying the discharge and most of the Mangaehuehu Stream channel along this reach. Whilst there was no evidence of livestock access at the Upstream site, there were clear signs of recent stock presence, particularly on both sides of the Mangaehuehu Stream at the Downstream site. As a result, water quality and ecology at the middle and downstream sites will include any effects of contaminants from the WWTP but will also include contaminants from the surrounding farmed land and direct effects of stock access to the drainage channel and stream. This must be considered when using in-stream monitoring results to assess the effects of the WWTP discharge.

I. *Water quality:*

Results from monitoring of current sites on the Mangaehuehu Stream between 2012 and 2021 indicate:

- Total ammoniacal nitrogen concentrations were generally similar with no significant differences between sites upstream and downstream on the Mangaehuehu Stream and concentrations remained below relevant One Plan targets at both sites.
- Nitrate-nitrogen and SIN annual average concentrations showed small but statistically significant increases (3% increase from 0.180 g/m^3 upstream to 0.186 g/m^3 at D/S A, and 1% increase between the middle (0.193 g/m^3) and D/S B (0.195 g/m^3) sites).
- DRP concentrations were similar with no significant differences between sites but exceeded the One Plan target on all sampling occasions at all sites. Streams in the central plateau area generally display naturally elevated DRP concentrations, due to the volcanic geology in the area.
- Median *E.coli* concentrations remained within the One Plan targets both upstream and downstream of the Rangataua WWTP discharge in all flow 'bins'. When considering 95th percentile concentrations, the One Plan target of 550 *E. coli* /100mL at flows below the 20th FEP was also met at all sites. However, the One Plan target of 260 *E. coli*/100mL at flows below median flow in summer was exceeded at all sites. There were no significant differences between sites within each season but there were significant decreases from summer to winter months.
- Visual clarity was less than the One Plan target of 3 m at flows below median flow at all sites and decreased significantly between the Upstream and Downstream sites. The One Plan target of no more than 20% reduction in visual clarity was regularly exceeded. TSS concentrations also increased significantly between Upstream and Downstream sites.
- $ScBOD_5$ and POM did not differ significantly between the middle and D/S B sites and were generally compliant with relevant One Plan targets. No seasonal differences were observed.
- Water pH and temperature generally complied with relevant One Plan targets.
- DO saturation remained above the One Plan target of 80% on all monitoring occasions, with small but statistically significant increases observed between upstream and D/S A sites. It should be noted that the DO data available are day-time 'spot' measurements, which do not provide any indication of night-time minima or potential stress to the ecosystem.

Assessment against the NPS-FM (2020) Attribute states for Ammonia, Nitrate, DRP, *E.coli* and suspended sediment*:*

- Confirm a low risk of toxic effects from ammonia,
- Suggests a high conservation value system in which any effects of nitrate toxicity are unlikely even on sensitive species,
- Suggests ecological communities could be impacted by moderate DRP elevation which may cause increased algal growth and loss of sensitive macroinvertebrate and fish taxa, noting however, that

the elevated DRP concentrations in the Mangaehuehu Stream reflect natural conditions and are likely the result of natural sources of phosphorus associated with volcanic geology,

- Represents a low risk of effects from *E. coli*, with the estimated risk of campylobacter infection at both upstream and downstream sites less than 1 in 1,000 (1-2% risk) for at least half the time,
- Represents minimal impact of suspended sediment on instream biota,
- No assessment could be made for DO or periphyton as required data (DO: daily minima over seven consecutive days and Periphyton: monthly biomass over minimum of three years) are not available.

Existing monitoring data collected in the Mangaehuehu Stream indicates that there are few detectable changes in concentrations of any of the key discharge constituents in the stream between upstream and downstream sites. The data does indicate however small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream. These are discussed further in the interpretation section below.

II. Ecology:

Periphyton results indicate:

- Periphyton biomass measured as Chlorophyll *a,* shows similar patterns in 2008 and 2009 with concentrations decreasing between upstream and middle sites and then increasing again further downstream. In 2021, increases were observed moving from upstream to downstream sites.
- The One Plan target for the Mangaehuehu Stream of 50 mg/m^2 was met upstream and at the middle site in all three years and at the site downstream in 2009, but was marginally exceeded at downstream in 2008 and 2021 (56 mg/m^2). Assessing whether the One Plan target is met overall at any of the sites would require regular (monthly) monitoring data.
- Periphyton communities visually assessed showed consistently low cover by "nuisance" algal growth. Visual cover showed substrates to be mostly clean or covered in thin diatom mats in all years. No long filamentous algae were observed at any of the sites in any year sampled, and cover by thick mats, when observed, remained low.
- Assessment against the NPS-FM (2020) periphyton Attributes requires monthly monitoring data, and could not be carried out on the basis of available data (3 individual sampling occasions).

Macroinvertebrate results indicate:

- Macroinvertebrate communities at sites both upstream and downstream of the Rangataua WWTP discharge are indicative of good to excellent water quality.
- No significant differences between sites were observed for any of the biotic indices apart from a decrease in % EPT Individuals and ASPM between the upstream and downstream sites.
- One Plan targets for MCI (>120) and QMCI (no more than a 20% reduction) were met in all years sampled.
- Assessment against the NPS-FM (2020) when considering all three indices MCI, QMCI and ASPM, show sites upstream and downstream of the Rangataua WWTP fell mostly into Attribute State A

in 2008 and 2009, while in 2021 all sites were mostly in Attribute State B. This reflects macroinvertebrate communities indicative of pristine conditions with almost no (Band A) or only mild (Band B) organic pollution or nutrient enrichment.

Overall, results of ecological monitoring do not indicate more than minor effects on macroinvertebrate communities (indicative of ecological health) or periphyton cover (indicative of aesthetic and recreational values), but indicate an increase in periphyton biomass between upstream and downstream, at times exceeding the One Plan target.

The One Plan target and NPS-FM periphyton biomass attributes are not designed to be compared to single sample results, and regular (monthly) monitoring data would be required to confirm whether the One Plan target is met or exceeded and the NPS-FM Attribute state band each site falls into.

Receiving Environment – Load contributions to predicted instream concentrations

The risks of effects posed by a point-source discharge on water quality/ecology are primarily associated with the contaminant loads in the discharge and the increases in in-stream concentrations these may cause. To estimate the potential effects of the Rangataua WWTP discharge on in-stream concentrations of key contaminants, daily loads of key contaminants in the discharge were estimated, and potential increases in downstream concentrations were calculated on the basis of two scenarios:

1. Median contaminant load from the discharge when the Mangaehuehu Stream is at Mean Annual Low Flow (MALF); and
2. 95^{th} percentile load from the discharge when the Mangaehuehu Stream is at Median flow.

These scenarios are considered highly environmentally conservative, for two reasons:

(1) they assume combinations of discharge loads and stream flows that are likely to be at the “higher” end of conditions realistically encountered. For example, data indicates that the discharge from the oxidation ponds decreases and often stops during dry periods in summer. Assuming median contaminant discharge load values enter the stream when it is under very low flow conditions is therefore likely to overestimate the actual effects of the discharge.

(2) the mass balance calculations assume that all of the contaminant loads exiting the oxidation ponds enter directly the Mangaehuehu Stream (i.e. zero attenuation/removal by passage through the constructed wetland, drainage channel and/or groundwater is assumed).

Predicted increases in downstream concentrations of Nitrate-N, TSS and $ScBOD_5$ were very small, well below normal laboratory detection limits and would be highly unlikely to be detected against the background concentrations currently observed.

Although these findings are consistent with monitoring results for $ScBOD_5$ (no significant increases identified), they are in contradiction of monitoring results for Nitrate-N and TSS (for which increases were detected). This indicates that the concentration increases measured in-stream are unlikely to have been caused (or even significantly contributed to) by the WWTP discharge.

Moderate potential concentration increases in DRP and ammoniacal-N were predicted, which could at times, be detectable; however significant increases were not detected for either of these parameters.

Interpretation and recommendations

Overall, monitoring results do not point to more than minor detrimental changes in water quality and ecological health of the Mangaehuehu Stream between upstream and downstream of the Rangataua WWTP, with the notable exceptions of the significant reductions in water clarity (and increases in TSS) and increases in periphyton biomass measured between upstream and downstream.

Mass-balance calculations based on environmentally conservative scenarios indicate that the discharge from the WWTP does not have the potential to cause more than very minor increases in TSS concentrations in the stream. This indicates that causes other than the Rangataua WWTP discharge are likely responsible for the measured changes in TSS concentrations and water clarity. Given the unrestricted stock access to the drainage channel and stream banks along this reach of the stream, it seems likely that bank pugging and erosion and stream bed disturbance by livestock are the main cause of the water clarity change. This may need to be investigated further or addressed, although possibly separately from the WWTP re-consenting process.

Increases in periphyton biomass were measured on each the three monitoring occasions. On two of these occasions, the downstream site marginally exceeded the One Plan target. These data are too limited to draw firm conclusions on whether the One Plan target is exceeded or met, or what NPS-FM Attribute State each site falls within. It is recommended that additional, regular monitoring be undertaken to enable a robust assessment.

The increases in periphyton biomass may be caused by either, or a combination of, differences in habitat and/ or nutrient availability at the different sites. Whilst habitat differences were noted between sites, it is unclear whether, or how, these contribute to the measured changes. Given the relatively high natural background DRP concentrations, the growth of periphyton in the Mangaehuehu Stream is likely to be nitrogen limited. The DRP from the discharge is unlikely to be materially increasing the growth of periphyton in the stream. The increases in SIN concentrations measured downstream of the discharge, although very small (1-3% over background concentrations) may, however, contribute to the increase in periphyton growth. The contribution of the Rangataua WWTP to the in-stream vs. that of the adjacent land use may also need to be investigated further.

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1. Introduction

1.1. Background

The Rangataua Wastewater Treatment Plant (WWTP) is located just to the east of Ohakune and provides services for the township of Rangataua. It is operated under contract by Veolia through the Ruapehu District Council.

Wastewater from the Rangataua township is collected via a gravity-fed, piped network and treated at the WWTP via a combination of passage through primary and secondary ponds and a small, constructed wetland area before being discharged into the Mangaehuehu Stream via a drainage channel, approximately 570 m long. The Department of Conservation owns the land immediately adjacent to the WWTP and the land through which the discharge drain passes. This Mangaehuehu Scenic Reserve is co-governed by the Department of Conservation and Ngati Rangi.

Resource Consent N. 4926 currently allows for the discharge of treated wastewater from the Rangataua WWTP into the Mangaehuehu Stream and expired in December 2005.

1.2. Aim and scope

A renewal application to enable the continuation of the discharge of treated wastewater from the Rangataua WWTP at or near the existing discharge location was lodged in June 2014.

This report is intended to provide an updated assessment of the nature and scale of effects of the current discharge of treated effluent from the Rangataua WWTP on the water quality of the Mangaehuehu Stream to support that application. This update has been prepared due to the significant amount of time that has lapsed since the application was lodged.

It provides an assessment of the nature and scale of the current effects of the discharge of treated effluent from the Rangataua WWTP on the water quality and ecology of the Mangaehuehu Stream.

This assessment is made purely on technical grounds and is limited to water quality and aquatic ecology considerations. Planning provisions are taken into consideration, but only insofar as they inform the technical issues. Other aspects, such as effects on air, groundwater or cultural values, community aspirations or affordability/costs are not taken into consideration in this report.

The assessment presented in this report is based on data and information available at the time of writing and is primarily based on monitoring data collected during the period January 2012 to May 2021 (water quality) and 2008, 2009 and 2021 (ecology).

Where data are considered insufficient to fully inform a robust assessment, the conclusions of this report should be considered preliminary. Additional data/information may be required if specific parts of the assessment need to be refined in the future.

1.3. Structure of report

This report is comprised of six sections. The sections following this introductory section include:

- Section 2 which describes the current receiving environment and monitoring,
- Section 3 which outlines the data available and explains the approaches used for analysis. It also sets out the water quality and ecological targets or thresholds against which the monitoring data were assessed,
- Section 4 which provides a summary of the current effluent quantity and quality discharged from the Rangataua WWTP,
- Section 5 which presents an assessment of the current state of water quality and ecology in the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP discharge and considers daily load contributions to instream concentrations for key parameters.
- Section 6 which presents conclusions from the main findings of Sections 2 to 5.

2. Current Receiving Environment and Monitoring Sites

Treated effluent from the Rangataua WWTP discharges into a natural open drainage channel which flows approximately 570 m to the south of the treatment ponds before joining the Mangaehuehu Stream. The drainage channel tends to dry up over summer, and at the time of sampling in April 2021, while water was present in patches in the part of the channel near the ponds, the channel was dry further down nearer its confluence with the Mangaehuehu Stream. The effluent discharged during dry summer periods does not appear to reach the Mangaehuehu Stream via surface flow (although indirect discharges may occur via sub-surface/groundwater flow).

Water quality is regularly monitored by both Veolia (on behalf of Ruapehu District Council) and Horizons in the effluent before it is discharged, and in the Mangaehuehu Stream upstream and downstream of the WWTP. Monitoring site locations for upstream and downstream of the WWTP differ between the two collections.

Horizons samples are collected:

- upstream of the WWTP ponds (Upstream - Horizons WQ, Figure 1) and
- downstream of the confluence with the drainage channel (Downstream A - Horizons WQ, Figure 1).

Veolia samples are collected:

- downstream of the WWTP ponds but upstream of the confluence with the drainage channel (Middle - Veolia WQ, Figure 1) and
- downstream of the confluence with the drainage channel (Downstream - Veolia WQ, Figure 1).

Ecological monitoring (macroinvertebrates and periphyton) has also been undertaken in 2008, 2009 and 2021 at approximately the same three sites, called, for the purpose of this assessment, Upstream, Middle and Downstream sites.

Locations of all monitoring sites are shown in Figure 1 and examples of the sites in Plates 1 to 4. For ease of reference, site names used in this report are shown in Table 1.

The reach of the Mangaehuehu Stream between the upstream and downstream sites flows through farmland, and, as of April 2021, livestock appear to have relatively unrestricted access to the drainage channel carrying the discharge and most of the Mangaehuehu Stream channel along this reach. Whilst there was no evidence of livestock access at the Upstream site, there were clear signs of recent stock presence, particularly on both sides of the Mangaehuehu Stream at the Downstream site. As a result, water quality and ecology at the middle and downstream sites will include any effects of contaminants from the WWTP but will also include contaminants from the surrounding farmed land and direct effects of stock access to the drainage channel and stream. This must be considered when using in-stream monitoring results to assess the effects of the WWTP discharge.

Table 1: Site names used in this report for sampling locations of ecology and water quality, 2012 – 2021.

Site Name	Sampling location	Monitored for
Upstream	Upstream of Rangataua WWTP	Ecology and Horizons Water quality
Middle	Downstream of Rangataua WWTP BUT upstream of confluence with open drainage discharge channel	Ecology and Veolia Water quality
Downstream (D/S, D/S A & D/S B)	Downstream of Rangataua WWTP AND downstream of confluence with open drainage discharge channel	D/S: Ecology, D/S A: Horizons Water quality D/S B: Veolia Water quality

Figure 1: Location of sites monitored for water quality (2012-2021: Horizons [blue dots] and Veolia [green dots]), and ecology (periphyton and macroinvertebrates: 2008, 2009, 2021 -orange dots) in relation to the Rangataua WWTP.

Plate 1: Mangaehuehu Stream upstream of the Rangataua WWTP, April 2021 (Upstream – Ecology and Horizons WQ).

Plate 2: Natural drainage channel through which discharge travels from treatment ponds to Mangaehuehu Stream, April 2021. Note that at the time of sampling in April 2021, water was present in patches in the part of the channel nearer the ponds, but the channel was dry further down nearer the confluence with the Mangaehuehu Stream.

Plate 3: Middle site on the Mangaehuehu Stream - downstream of the Rangataua WWTP ponds but upstream of confluence with the discharge channel, April 2021 (Middle – Ecology and Veolia WQ).

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3. Methods

3.1. Available data

Water quality and ecology data used for this assessment are summarised in Table 2. River flow statistics used are summarised in Table 3.

Table 2: Summary of data used in this assessment.

Site	Type	Parameters	Frequency	Period	Source
Rangataua WWTP effluent - Current	Effluent water quality	Ammon-N, Nitrate-N, SIN, DRP, *E. coli,* $cBOD_5$, TSS, pH, Temp., DO	Monthly	January 2012 - January 2021 January 2012 - May 2021	Horizons Veolia
Rangataua WWTP effluent - Current	Effluent flows	Discharge volumes (recorded via Magflow meter)	Daily	January 2012 to April 2021	Veolia
• Upstream = Mangaehuehu Stream U/S of Rangataua WWTP ponds • Downstream A = Mangaehuehu Stream D/S of Rangataua WWTP ponds and D/S of discharge channel	River water quality	Ammon-N, Nitrate-N, Nitrite-N, SIN, TN, TP, DRP, *E. coli,* black disc, TSS, Turbidity, POM, pH, Temp., DO	Monthly	January 2012 - January 2021	Horizons
• Middle = Mangaehuehu Stream D/S of Rangataua WWTP ponds but U/S of discharge channel • Downstream B = Mangaehuehu Stream D/S of Rangataua WWTP ponds and D/S of discharge channel	River water quality	Ammon-N, Nitrate-N, Nitrite-N, SIN, TN, TP, DRP, *E. coli,* black disc, TSS, Turbidity, POM, $ScBOD_5$, $cBOD_5$, pH, Temp., DO	Monthly	January 2012 - May 2021	Veolia
• Upstream = Mangaehuehu Stream U/S of Rangataua WWTP ponds • Middle = Mangaehuehu Stream D/S of Rangataua WWTP ponds but U/S of discharge channel • Downstream = Mangaehuehu Stream D/S of Rangataua WWTP ponds and D/S of discharge channel	Biological indicators	Macroinvertebrate indices: MCI QMCI %EPT Taxa %EPT Individuals No. of Taxa No. of Individuals Periphyton: Biomass (Chlorophyll a) % Cover	Annually	2008, 2009 2021	PEC Ltd Aquanet

Table 3: Summary of flow statistics used in this assessment, based on data provided by Horizons, May 2021 (Tokiahuru River) and data modelled from NIWA "Shiny Rivers" website (Mangaehuehu Stream). All flows in L/s.

Site	Source	Mean flow (L/s)	Median flow (50th exceedance percentile) (L/s)	Half Median flow (L/s)	20th Exceedance percentile flow (L/s)	MALF (L/s)
Tokiahuru River @ Whangaehu Junction	Horizons	7,641	6,740	3,370	9,205	4,15?
Mangaehuehu Stream @ Rangataua	NIWA	1,120	808	404		406

3.2. Data analysis

3.2.1. Effluent quality data

Effluent quality data prior to discharge, collected monthly between January 2012 and May 2021, are presented in Section 4. Effluent quality datasets from Horizons and Veolia have been combined for this assessment. Descriptive statistics, such as mean, median, distribution percentiles, standard error and confidence intervals, are presented in Appendix A.

3.2.2. River flow data

There are no flow recording sites on the Mangaehuehu Stream. Flow data for the Tokiahuru at Whangaehu Junction (the closest flow gauging site) have therefore been used instead to classify water quality results according to river flow.

Modelled flow statistics for the Mangaehuehu Stream sourced from the NIWA "Shiny Rivers" website (Booker *et al.*, 2017) have been used to estimate the potential effects of effluent load contributions on in-stream concentrations in the Mangaehuehu Stream.

3.2.3. Instream water quality data

Instream water quality data collected monthly from sites upstream and downstream of the Rangataua WWTP on the Mangaehuehu Stream, between January 2012 and May 2021, are presented in Section 5.1.

To provide direct, pair-wise comparison between upstream and downstream datasets, water quality datasets from Horizons and Veolia were analysed separately:

- Horizons data provides an indication of changes between upstream of the WWTP ponds (Upstream Site) and downstream of both the ponds and discharge channel in the Mangaehuehu Stream (Downstream A site), and
- Veolia data provides an indication of changes between upstream (Middle Site) and downstream (Downstream B site) of the discharge channel in the Mangaehuehu Stream.

Descriptive statistics, such as mean, median, distribution percentiles, standard error and confidence intervals, as well as the proportion of samples complying with the relevant guidelines or targets are presented in Appendix B and Appendix C.

Water quality datasets contained a small proportion of "censored data, e.g. "less than detection limit" results. To conduct statistical analysis, such censored data were replaced by numerical values. The "less than" values were replaced by half of the detection limit which is consistent with the recommendations of Scarsbrook and McBride (2007). Where values were greater than the detection limit the actual value was used.

Water quality results were classified according to river flow (using Tokiahuru at Whangaehu Junction data) and upstream/downstream comparisons were undertaken using all the results available ("All flows"), and within four distinct flow "bins" (i.e. data collected above the 20th Flow Exceedence Percentile (FEP), below the 20th FEP, between the 20th FEP and median flow, and below median flow). No flows below half median were recorded, therefore no upstream/downstream comparisons within this flow bin could be made.

Comparisons of upstream/downstream results were carried out using a Wilcoxon Signed Rank Test in Statistix 9, as recommended in Scarsbrook and MacBride (2007). Comparisons were run for each flow 'bin'. It is noted that some flow 'bins' contained limited amounts of data and statistical comparisons within these flow "bins" should be considered with caution.

3.2.4. Assessment against relevant targets

To consider the risk of effects, and to help describe the effects of contaminant concentrations on ecosystem health and human health, water quality data were assessed against the following numerical targets and thresholds:

- Water quality targets set out in Horizons One Plan Schedule E for the Upper Whangaehu Tokiahuru (Whau_1c) water management sub-zone (Table 4). All references to the One Plan in this report are to the web-based Operative Version available on Horizons Regional Council's (Horizons) website.
- Instream water quality standards set by current Resource Consent Condition 5.
- Assessment against the NPS-FM (2020) – refer below.

3.2.5. Assessment against the NPS-FM (2020)

Assessments against the Attribute State tables in Appendix 2 of the National Policy Statement for Freshwater Management 2020 (Relevant tables copied in Appendix C) were undertaken for Total ammoniacal nitrogen, Nitrate-nitrogen, DRP, *E.coli*, suspended fine sediment and macroinvertebrate communities.

No assessment against other parameters, such as DO, periphyton, etc., recently added to the NPS-FM (2020) have been undertaken in this assessment as data required were not available (DO requires daily minima over seven consecutive days and Periphyton requires monthly biomass over minimum of three years).

The NPS-FM (2020) specifies that the numeric attribute states for ammoniacal nitrogen are based on pH 8 and temperature of 20^{o}C and that compliance with the numeric attribute states should be undertaken after pH adjustment. This was achieved by firstly calculating the proportion of unionised ammonia nitrogen at pH of 8 and 20°C, then calculating the unionised ammonia-nitrogen concentrations corresponding to the NPS-FM thresholds. The unionised ammonia concentration in each in-river sample was calculated on the basis of water pH and temperature measured on-site on each day of sampling, then compared with the unionised ammonia nitrogen NPS-FM thresholds.

3.2.6. Effluent Load Contributions to instream concentrations

Daily loads of key contaminants in the discharge were estimated on the basis of available discharge quality (Horizons and Veolia data combined) and quantity data (Veolia data) for the period January 2012 to May 2021. Results are presented in Section 5.3.

Predicted instream concentration for key parameters increases were then calculated on the basis of two scenarios:

1. Maximum 12-month Median contaminant load from the discharge when the Mangaehuehu Stream is at Mean Annual Low Flow (MALF); and
2. Maximum 12-month 95th percentile load from the discharge when the Mangaehuehu Stream is at median flow.

These scenarios are considered worst case situations, on the basis that:

- During periods of extended dry weather (which would be prevailing conditions when the stream is at MALF), observations indicate that any discharge (noting there are extended periods over summer when there is no discharge at all) from the Rangataua WWTP infiltrates into the ground and does not reach the Mangaehuehu Stream by way of surface flow discharge.
- A high percentile (95th) of discharge loads was assumed when the stream is at median flow. In reality, high percentiles of discharge loads are highly likely to occur during or immediately following wet weather; stream flows are also likely to be high at these times.
- The mass balance calculations assume that all of the contaminant loads exiting the oxidation ponds enter directly into the Mangaehuehu Stream (i.e. assumes zero attenuation/removal by passage through the constructed wetland). This is a highly conservative assumption, particularly during periods of dry weather when there is little or no direct surface discharge to the stream.

Table 4: Summary of One Plan water quality targets used for the Upper Whangaehu (Whau_1c) Water Management Sub-Zone in this assessment.

Parameter	Target as per Horizons One Plan (Full Wording of the Target)
pH	The pH of the water must be within the range **7 to 8.2** unless natural levels are already outside this range.
	The pH of the water must not be changed by more than 0.5.
Temp (°C)	The temperature of the water must not exceed **19°C**
	The temperature of the water must not be changed by more than **2°C**
DO (% SAT)	The concentration of dissolved oxygen (DO) must exceed **80 %** of saturation.
$scBOD_5$	The monthly average five-days filtered soluble carbonaceous biochemical oxygen demand ($scBOD_5$) when the *river*^ flow is at or below the 20th *flow exceedance percentile** must not exceed **1.5 g/m^3**.
POM	The average concentration of particulate organic matter (POM) when the *river*^ flow is at or below the 50th *flow exceedance percentile** must not exceed **5 g/m^3**.
DRP	The annual average concentration of dissolved reactive phosphorus (DRP) when the *river* flow is at or below the 20th *flow exceedance percentile** must not exceed **0.006 g/m^3** unless natural levels already exceed this target.
SIN	The annual average concentration of soluble inorganic nitrogen (SIN) when the *river* flow is at or below the 20th *flow exceedance percentile* must not exceed **0.070 g/m^3** unless natural levels already exceed this target.
Total Ammoniacal Nitrogen	The average concentration of ammoniacal nitrogen must not exceed **0.320 g/m^3**.
	The maximum concentration of ammoniacal nitrogen must not exceed **1.7 g/m^3**
Deposited Sediment	The maximum cover of visible river bed by deposited sediment less than 2 millimetres in diameter must be less than **15 %** , unless natural physical conditions are beyond the scope of the application of the deposited sediment protocol of Capott *et al.* (2010)
Visual Clarity	The visual clarity of the *water* measured as the horizontal sighting range of a black disc must not be reduced by more than **20 %**.
	The visual clarity of the *water* measured as the horizontal sighting range of a black disc must equal or exceed **3 metres** when the *river* is at or below the 50th *flow exceedance percentile*
E. coli /100 mL (rivers)	The concentration of *Escherichia coli* must not exceed **260 per 100 millilitres 1 November - 30 April** (inclusive) when the *river* flow is at or below the 50th *flow exceedance percentile*.
	The concentration of *Escherichia coli* must not exceed **550 per 100 millilitres year-round** when the *river* flow is at or below the 20th *flow exceedance percentile**.
Periphyton (*rivers*^)	The algal biomass on the *river bed* must not exceed **50 mg** of chlorophyll *a* per square metre.
	The maximum cover of visible *river bed* by periphyton as filamentous algae more than 2 cm long must not exceed **30 %**.
	The maximum cover of visible river bed by periphyton as diatoms or cyanobacteria more than 0.3 cm thick must not exceed **60 %**.
QMCI	There must be no more than a **20 %** reduction in Quantitative Macroinvertebrate Community Index (QMCI) score between appropriately matched habitats upstream and downstream of discharges to *water*.
MCI	The Macroinvertebrate Community Index (MCI) must exceed **120**, unless natural physical conditions are beyond the scope of application of the MCI. In cases where the river^ habitat is suitable for the application of the soft-bottomed variant of the MCI (sb-MCI) the Water Quality Target* (or standard where specified under conditions/standards/terms in a rule) also apply.

3.2.7. Ecological data

Periphyton and macroinvertebrate data collected from sites upstream and downstream of the Rangataua WWTP on the Mangaehuehu Stream are presented in Section 5.2.1.

Periphyton Communities:

Periphyton is the brown or green slime coating stones, wood or any other stable surfaces in streams and rivers. In some situations, it can proliferate to form thick masses of green or brown filaments on the river bed degrading the aesthetic and recreational qualities of the river. Periphyton growth is generally controlled by a number of physical (e.g. river flow, sunlight, temperature) chemical (e.g. bioavailable nutrient concentration – DRP and SIN) and biological (e.g. grazing by invertebrates) phenomena.

The Ministry for the Environment guidelines for periphyton biomass and cover are presented in Table 5. The One Plan also defines targets for periphyton biomass (50 mg chlorophyll *a* /m^2) and cover (30% filamentous algae over 2cm long; 60% cyanobacteria or diatom mats over 3mm thick) for the Upper Whangaehu (Whau_1c) water management sub-zone.

Assessment against the NPS-FM (2020) for periphyton is based on monthly monitoring at a site with the minimum record length for grading a site based on chlorophyll *a* data over 3 years. Monthly periphyton monitoring data are not available for the Mangaehuehu Stream, therefore no assessment can be made against the NPS-FM (2020).

Table 5: Provisional biomass and cover guidelines for periphyton growing in gravel/cobble bed streams for three main instream values. Reproduced from Table 14 Ministry for the Environment guidelines (Biggs and Kilroy 2000).

Instream value / variable	Diatoms / Cyanobacteria	Filamentous algae
Aesthetics/recreation (1 November – 30 April)		
Maximum cover of visible stream bed	60 % > 0.3 cm thick	30% > 2 cm long
Maximum chlorophyll a (mg/m^2)	N/A	120
Benthic biodiversity		
Mean monthly chlorophyll a (mg/m^2)	15	15
Maximum chlorophyll a (mg/m^2)	50	50
Trout habitat and angling		
Maximum cover of whole stream bed	N/A	30% > 2 cm long
Maximum chlorophyll a (mg/m^2)	200	120

Macroinvertebrate Communities:

Macroinvertebrates are good indicators of water quality as they show a wide range of responses depending on their degree of sensitivity to pollution. For example, some taxa such as Gastropoda and Chironomidae are generally considered to be tolerant of poor-quality water, while others such as Ephemeroptera and Plecoptera prefer good water quality. The macroinvertebrate community at a given site may be considered a result of the prevailing water quality at that site. Consequently, macroinvertebrates are used widely both in New Zealand (Stark 1985, Winterbourn 1999) and overseas (Rosenberg and Resh 1993, Hynes 1994) as indicators of water quality.

Biological indices can be calculated to assess relationships between macroinvertebrate communities and water quality at a study site.

The Macroinvertebrate Community Index (**MCI**) (Stark 1985) considers the presence of macroinvertebrates based on an assigned score which is dependent on their tolerance to pollution (1= highly tolerant, 10 = highly sensitive).

The Quantitative Macroinvertebrate Community Index (**QMCI**) is similar to the MCI, but also takes into account the number of individuals of each species collected.

Ephemeroptera, Plecoptera and Trichoptera (mayflies, stoneflies and caddisflies) (EPT) consist of insects which are generally sensitive to pollution. The percentage of **EPT taxa** is the proportion of all taxa collected that belong to one of these groups.

The percentage of **EPT individuals** measures the proportion of the individual macroinvertebrates collected that are mayflies, stoneflies and caddisflies.

The **Average Score Per Metric (ASPM)** is a metric aggregation method. ASPM is derived by averaging the normalized values of MCI, EPT Taxa and percentage of EPT individuals (Collier, 2008), and indicates the status of the macroinvertebrate communities' ecological integrity in comparison to reference conditions.

Values for the biotic indices discussed above indicative of various water quality categories are given in Table 6.

Differences in biotic indices between sites were assessed using Analysis of Variance (ANOVA) in Statistix 9. Values at $P < 0.05$ indicate a statistically significant change.

Assessments against the Attribute State tables in Appendix 2A of the National Policy Statement for Freshwater Management 2020 were also undertaken for macroinvertebrates (MCI, QMCI and ASPM).

Table 6: Interpretation of MCI, QMCI and ASPM values after the National Policy Statement for Freshwater Management (2020) for stony streams.

Interpretation	MCI	QMCI
Excellent / Clean water	≥ 130	≥ 6.5
Good / Possible Mild pollution	110 -129	5.5 – 6.49
Fair / Probable Moderate pollution	90 - 109	4.5 – 5.49
Poor / Probable Severe pollution	<90	< 4.5
	ASPM	
High ecological integrity	≥ 0.6	
Mild-to-moderate loss of ecological integrity	0.4 – 0.59	
Moderate-to-severe loss of ecological integrity	0.3 – 0.39	
Severe loss of ecological integrity	< 0.3	

4. Discharge characteristics

Effluent treatment at the Rangataua WWTP currently includes passage through a two-pond system, before being discharged into a natural open drainage channel which flows approximately 570 m to the south of the treatment ponds where it joins the Mangaehuehu Stream. This channel tends to dry up over summer months. It is therefore unlikely that effluent discharged during summer ever reaches the Mangaehuehu Stream via surface flow but is more likely to filter down into shallow groundwater.

4.1. Effluent Quantity

The current consent allows for discharges of treated effluent of up to 29 m^3/day.

Discharge volumes from the Rangataua WWTP averaged 38.3 m^3/day between 2012 and 2021 but have ranged from 0 to 600 m^3/day (Table 7, Figure 2).

Discharges are typically higher over winter months and into spring, exceeding the currently consented volume (Range: 0 to 600 m^3/day, Average: 58.1 m^3/day), but then decrease over summer months falling below the discharge volume currently allowed by consent and sometimes not discharging at all for extended periods of time (Range: 0 to 168 m^3/day, Average: 20.3 m^3/day).

Table 7: Summary of daily discharge volumes of treated effluent from the Rangataua WWTP, over all years and during summer and winter months, 2012-2021.

	Overall (m^3/day)	Summer (m^3/day)	Winter (m^3/day)
Mean	38.3	20.3	58.1
Median	22.2	10.6	41.5
Minimum	0.0	0.0	0.0
Maximum	600.0	167.8	600.0

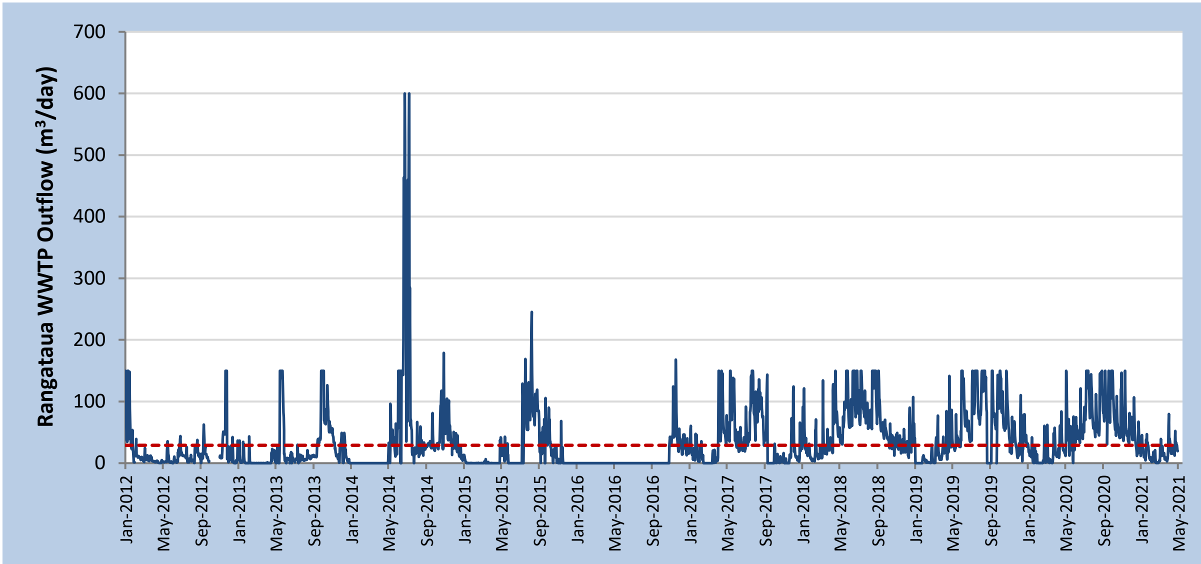

Figure 2: Daily Effluent discharge volumes recorded via a Magflow meter from the Rangataua WWTP ponds into the wetland drainage channel, January 2012 – May 2021. The red dashed line represents the currently consented daily discharge volume. Note the gap in data during 2016 was due to loss in communications with the Magflow meter.

4.2. Effluent Quality

A summary of the existing effluent quality (Horizons and Veolia combined, January 2012 – May 2021) is presented below. For full descriptive statistics, such as mean, median, distribution percentiles, standard error and confidence intervals, refer Appendix A.

Ammoniacal nitrogen, Nitrate nitrogen and SIN appear to follow seasonal patterns, with higher concentrations measured over late winter/early spring months and lower concentrations during summer (Figure 3). DRP concentrations were generally highest over summer months but have remained below 4.4 g/m^3 year-round.

While seasonal patterns are not as clear, *E.coli* concentrations also tend to be higher during winter months (Figure 4).

TSS concentrations show no consistent patterns and CarbonaceousBOD$_5$ concentrations are highest over summer months (Figure 4).

Table 8: Summary of effluent quality data from the Rangataua WWTP prior to discharge, January 2012 – May 2021.

Rangataua effluent	Ammoniacal-N (g/m^3)	Nitrate-N (g/m^3)	SIN (g/m^3)	TN (g/m^3)	DRP (g/m^3)	TP (g/m^3)	DRP (g/m^3)
Average	11.7	0.300	11.9	18.5	2.4	3.6	2.4
50%ile (Median)	11.7	0.204	12.0	17.9	2.3	3.6	2.3
95%ile	24.0	1.010	24.3	31.0	4.0	5.6	4.0
N. of Samples	141	141	141	141	141	141	141

Rangataua effluent	*E. coli* (MPN/100mL)		TSS (g/m^3)	$cBOD_5$ (g/m^3)	$ScBOD_5$ (g/m^3)	pH	Temperature (°C)	DO (g/m^3)
	Year Round	Summer only (Nov-April incl)						
Average	2,397	607	52.0	19.8	4.3	7.7	14.0	6.9
50%ile (Median)	330	185	42.0	18.0	4.0	7.6	13.8	6.9
95%ile	9,700	2,050	139.6	46.9	8.0	9.3	22.6	11.8
N. of Samples	140	71	210	108	139	104	107	107

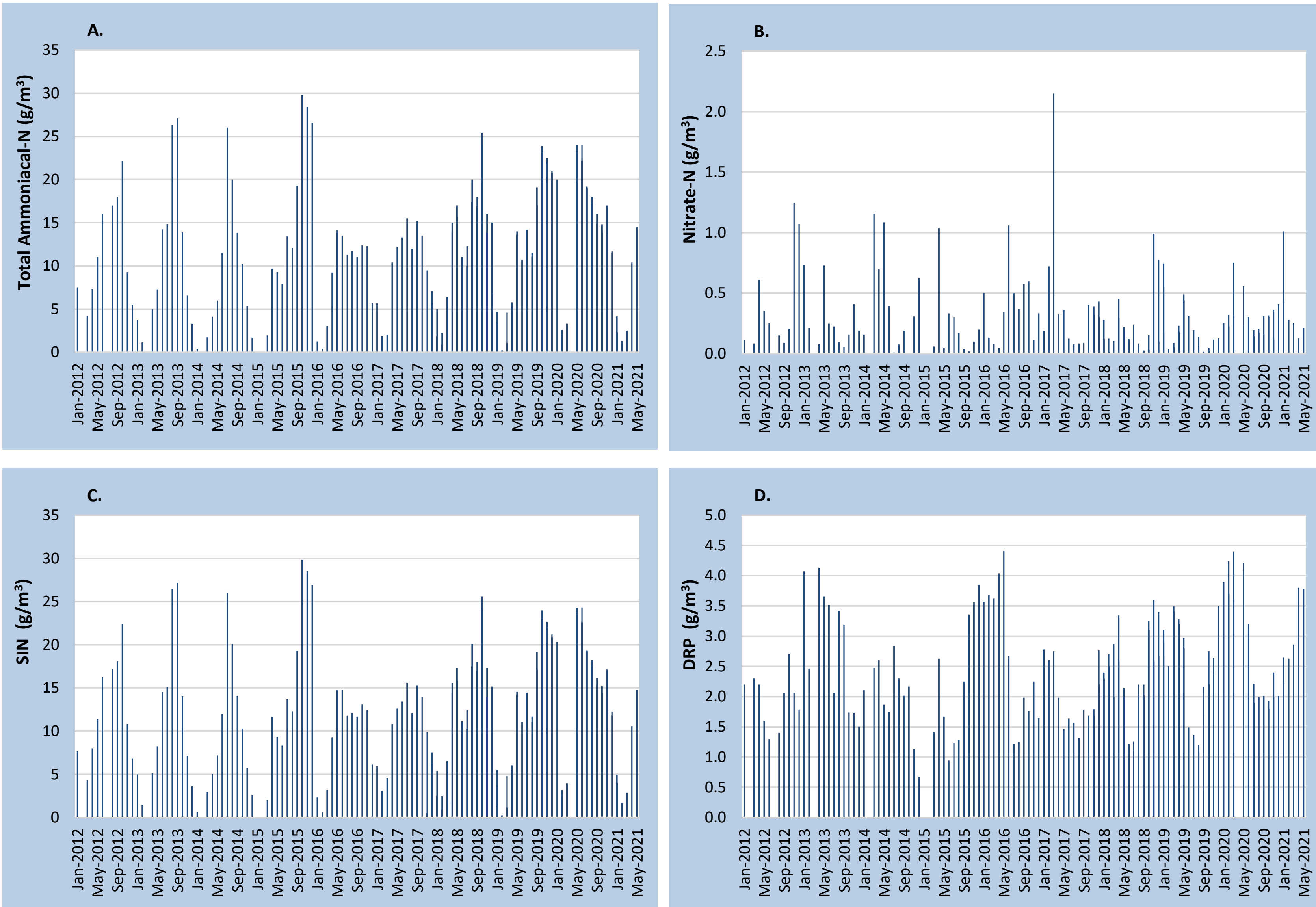

Figure 3: A. Total Ammoniacal Nitrogen, B. Nitrate nitrogen, C. Soluble Inorganic Nitrogen (SIN), and D. Dissolved Reactive Phosphorus (DRP) concentrations in the effluent from the Rangataua WWTP, January 2012 to May 2021.

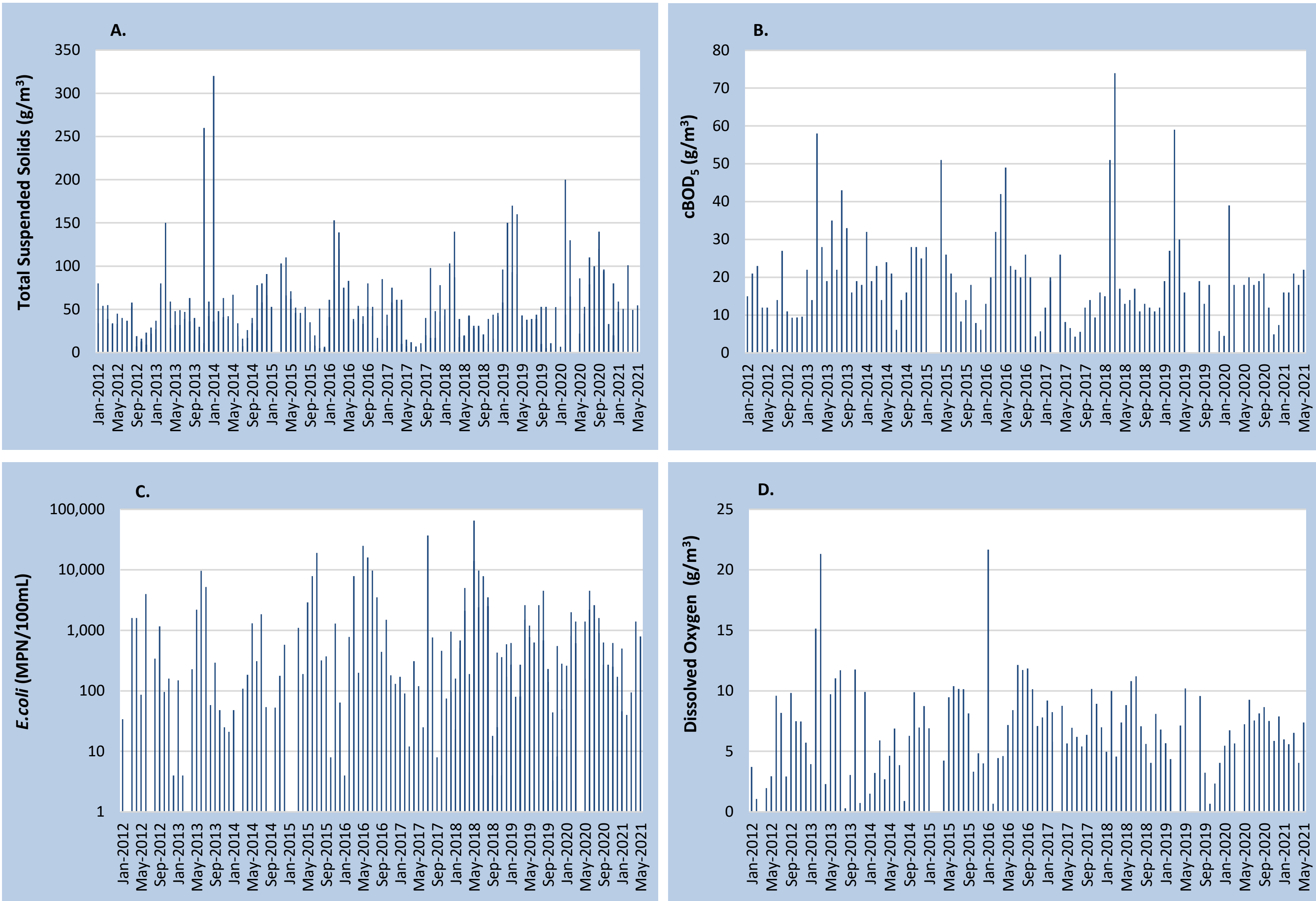

Figure 4: A. Total Suspended Solids, B. cBOD$_5$, C. *E.coli* (log scale) and D. Dissolved Oxygen concentrations in the effluent from the Rangataua WWTP, January 2012 to May 2021.

5. Assessment of Current Effects

5.1. Instream Water Quality

Water quality data collected upstream and downstream of the Rangataua WWTP between January 2012 and May 2021 have been analysed and assessed against the relevant One Plan targets and Consent conditions. Results are summarised in Table 9 and 10 and discussed in more detail below. One Plan targets applicable at various flows are shown along with an indication of whether or not the One Plan target has been met. Detailed descriptive statistics, such as mean, median, distribution percentiles, standard error and confidence intervals are presented in Appendix B (Horizons data) and Appendix C (Veolia data).

Due to the inconsistency of water quality monitoring sites Assessments have been made to consider:

- Any changes between upstream of the WWTP ponds and downstream of both the ponds and discharge channel in the Mangaehuehu Stream (Horizons data), and
- Any changes between upstream and downstream of the discharge channel in the Mangaehuehu Stream (Veolia data).

It should be remembered when considering this assessment that the monitoring sites on the Mangaehuehu will not only pick up any effects from the treatment plant and associated discharge but will also include any effects from farming activities undertaken on surrounding land between the upstream and downstream sites, including unrestricted livestock access to the stream and discharge channel.

Table 9: Summary of main statistics for key water quality determinands measured at sites on the Mangaehuehu Stream upstream of the Rangataua WWTP ponds and downstream of the both the ponds and the discharge channel (Horizons data). Cells shaded in grey indicate the relevant statistic for appropriate flow bin for comparison with One Plan water quality targets. Significant changes relate to statistical testing (Wilcoxon signed ranked test, P<0.05) of data within the flow "bin" applicable to the One Plan target for each determinand (e.g. stream flow below the 20th FEP for SIN and DRP).

	Ammoniacal-N		SIN		DRP		*E. coli*				Visual Clarity		POM		pH		Temp		DO	
	(g/m³)		(g/m³)		(g/m³)		(/100mL)				(m)		(g/m³)		(g/m³)		(ºC)		(% sat.)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Mean	0.005	0.005	0.180	0.186	0.021	0.021	95	80	174	128	2.6	2.2	1.4	1.4	7.4	7.4	8.8	8.9	98.3	99.7
Median	0.005	0.005	0.174	0.192	0.019	0.019	21	30	56	57	2.5	2.1	1.5	1.5	7.4	7.5	8.4	8.3	99.0	100.3
20th percentile	0.001	0.002	0.122	0.123	0.015	0.015	6	11	16	31	2.2	1.7	1.0	1.0	7.2	7.3	6.2	6.3	97.3	99.3
95th percentile	0.010	0.013	0.317	0.318	0.039	0.037	263	374	280	523	4.1	3.4	1.9	2.8	7.9	7.7	13.4	13.5	101.6	102.5
N. samples	108	108	93	93	108	108	93	93	42	42	51	49	64	64	108	108	108	108	108	108
OP Target	Average 0.32 Max 1.7		0.07		0.006		550 (Year round)		260 (Main bathing season)		> 3		< 5		7.0 - 8.2		< 19ºC / < 2ºΔ		> 80%	
Applicable Flow	All flows		Below 20th FEP		Below 20th FEP		Below 20th FEP		Below 50th FEP		Below 50th FEP		Below 50th FEP		All flows		All flows		All flows	
Significant change?	No		Yes		No		Yes		No		Yes		No		Yes		Yes		Yes	
OP Target met?	√	√	x	x	x	x	√	√	x	x	x	x	√	√	√	√	√	√	√	√

Table 10: Summary of main statistics for key water quality determinands measured at sites on the Mangaehuehu Stream upstream and downstream of the confluence with the discharge channel from the Rangataua WWTP (Veolia data). Cells shaded in grey indicate the relevant statistic for appropriate flow bin for comparison with One Plan water quality targets. Significant changes relate to statistical testing (Wilcoxon signed ranked test, P<0.05) of data within the flow "bin" applicable to the One Plan target for each determinand (e.g. stream flow below the 20th FEP for SIN and DRP).

	Ammoniacal-N		SIN		DRP		*E. coli*				Visual Clarity		POM		pH		Temp		DO	
	(g/m^3)		(g/m^3)		(g/m^3)		(/100mL)				(m)		(g/m^3)		(g/m^3)		(ºC)		(% sat.)	
	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B	Mid	D/S B
Mean	0.006	0.007	0.193	0.195	0.021	0.021	231	111	407	180			2.2	2.4	7.4	7.5	10.6	10.6		
Median	0.003	0.003	0.195	0.200	0.022	0.021	46	48	140	100			2.2	1.6	7.4	7.5	10.1	10.2		
20th percentile	0.003	0.003	0.135	0.142	0.015	0.013	13	17	54	42			0.5	0.6	6.9	6.9	6.9	7.2		
95th percentile	0.021	0.017	0.288	0.279	0.032	0.033	499	480	1190	718			5.0	5.6	9.0	8.7	16.0	16.9		
N. samples	57	57	34	34	42	42	35	35	19	19	0	0	27	27	108	106	109	109	0	0
OP Target	Average 0.32 Max 1.7		0.07		0.006		550 (Year round)		260 (Main bathing season)		> 3		< 5		7.0 - 8.2		< 19ºC / < 2ºΔ		> 80%	
Applicable Flow	All flows		Below 20th FEP		Below 20th FEP		Below 20th FEP		Below 50th FEP		Below 50th FEP		Below 50th FEP		All flows		All flows		All flows	
Significant change?	No		No		No		No		No				No		Yes		No			
OP Target met?	√	√	x	x	x	x	√	√	x	x	No data		√	√	√	√	√	√	No data	

5.1.1. Ammoniacal Nitrogen

The One Plan defines two total ammoniacal nitrogen concentration targets for the Whau_1c Water Management Sub-Zone: an average concentration of 0.320 mg/L (chronic exposure) and a maximum concentration of 1.7 mg/L (acute exposure).

Total ammoniacal nitrogen concentrations were similar between sites upstream and downstream of the Rangataua WWTP discharge and always well below both One Plan targets (**Figure** 5). Small differences were apparent in total ammoniacal nitrogen concentrations between the upstream and D/S A sites in most flow bins, but these were not statistically significant. Similarly, differences were observed between the Middle site and D/S B (upstream and downstream of the discharge channel), but again these were not statistically significant.

Consent condition 5(d) requires that *"the downstream total ammoniacal nitrogen (NH_4-N) shall not be increased by more than 0.05 g/m^3"*. Between 2012 and 2021 ammoniacal nitrogen concentrations did not increase by more than 0.05 g/m^3 downstream of the discharge (D/S A) compared with upstream (Upstream) on any sampling occasion. However, increases of more than 0.05 g/m^3 between upstream and downstream of the confluence with the discharge channel (Middle vs D/S B) occurred on 10 out of 113 sampling occasions (9% of the time). Most of these exceedances occurred in 2012, with the latest including one in September 2020 and one in March 2021 (0.053 g/m^3 and 0.052 g/m^3 increases, respectively). Figure 5 A shows that at times, ammoniacal nitrogen concentrations were actually higher upstream of the discharge compared to downstream between 2012 and 2021 (14% of the time between Upstream and D/S A and 12% of the time between Middle and D/S B).

Seasonal patterns

Total ammoniacal nitrogen concentrations were similar between upstream and D/S A sites and between the Middle and D/S B sites within each season (Figure 5, lower).

Assessment against NPS-FM 2020 Attribute State

Assessment of data, corrected for pH and temperature, against the NPS-FM 2020 for ammoniacal nitrogen (refer Appendix C, Table 1), assigns all sites upstream, middle and downstream on the Mangaehuehu Stream to Attribute State A (based on the overall average of rolling annual median and maximum unionized ammonia concentrations) (Table 11, Figure 6). Unionised Ammonia concentrations downstream did move into Band B for a short period in 2020 due to higher pH values recorded towards the end of 2019 and into the beginning of 2020. However, rolling annual maximum concentrations were higher upstream compared with downstream during this period.

These results confirm a low risk of toxic effects from ammonia in the Mangaehuehu Stream.

The NPS-FM (2020) places the National bottom line for ammonia toxicity at the threshold between Attribute States B and C. Annual median concentrations of more than 9.2 ppb and annual maximum concentrations above 15.3 ppb are considered to be below the National Bottom Line.

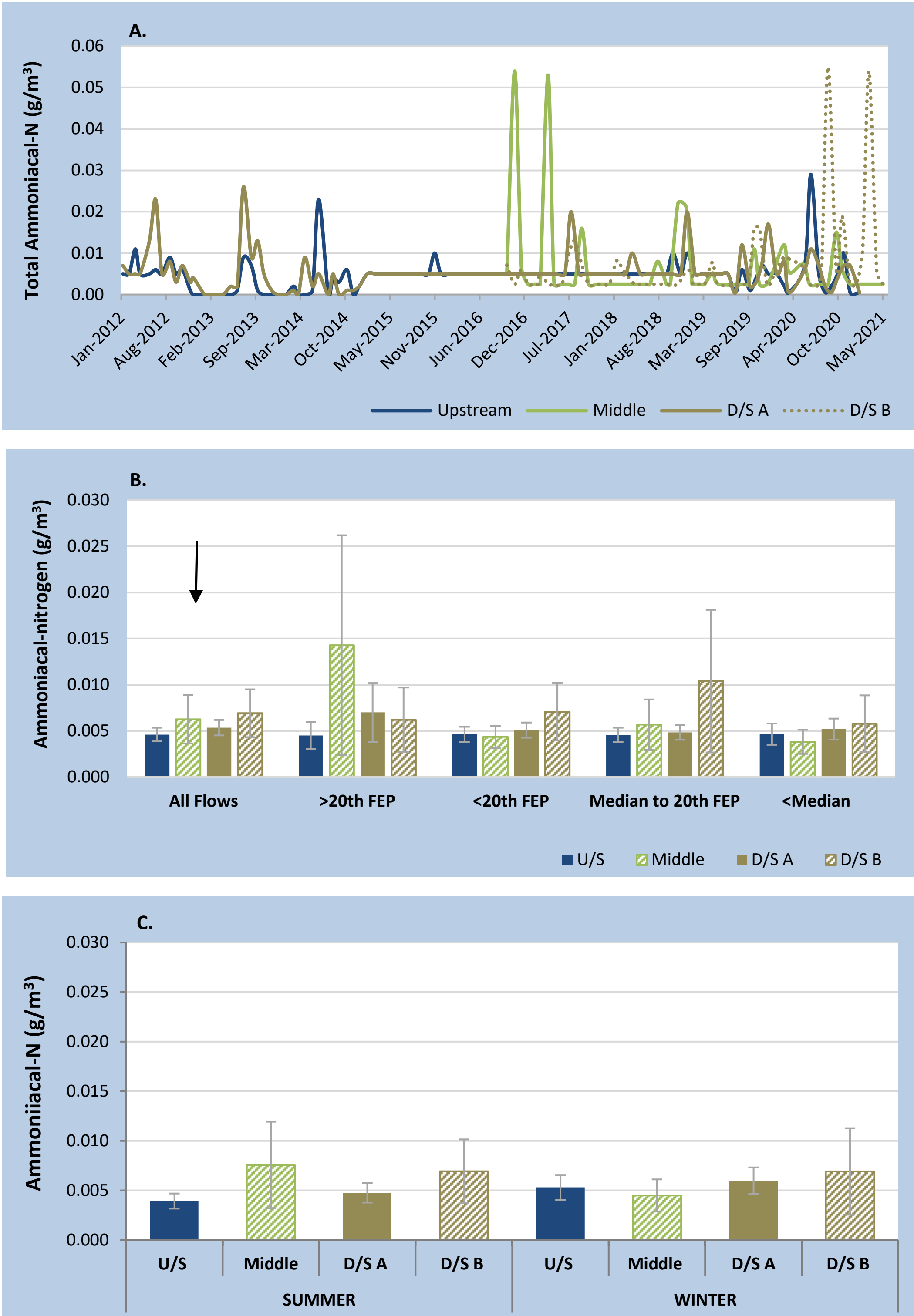

Figure 5: Total ammoniacal nitrogen concentrations as A. Time series, B. Mean concentrations at various flows and C. Mean concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP (Refer Table 1 and Figure 1 for site locations). The One Plan target for total ammoniacal nitrogen (chronic exposure) is 0.32 g/m³ has been omitted from the graphs for ease of interpretation. The arrow represents flows at which the One Plan target applies.

Table 11: NPS-FM (2020) Attribute State calculations for Ammonia (toxicity), for sites sampled on the Mangaehuehu Stream, January 2012 – May 2021).

	Upstream	D/S A	Middle	D/S B
Av. Median	0.018	0.023	0.0330	0.0850
Av. Maximum	0.085	0.077	1.1360	0.9885
Av. Median state	A	A	A	A
Av. Maximum state	A	A	A	A
Overall state	A	A	A	A
No. times graded as A	104	104	39	39
No. times graded as B	0	0	13	13
No. times graded as C	0	0	0	0
No. times graded as D	0	0	0	0

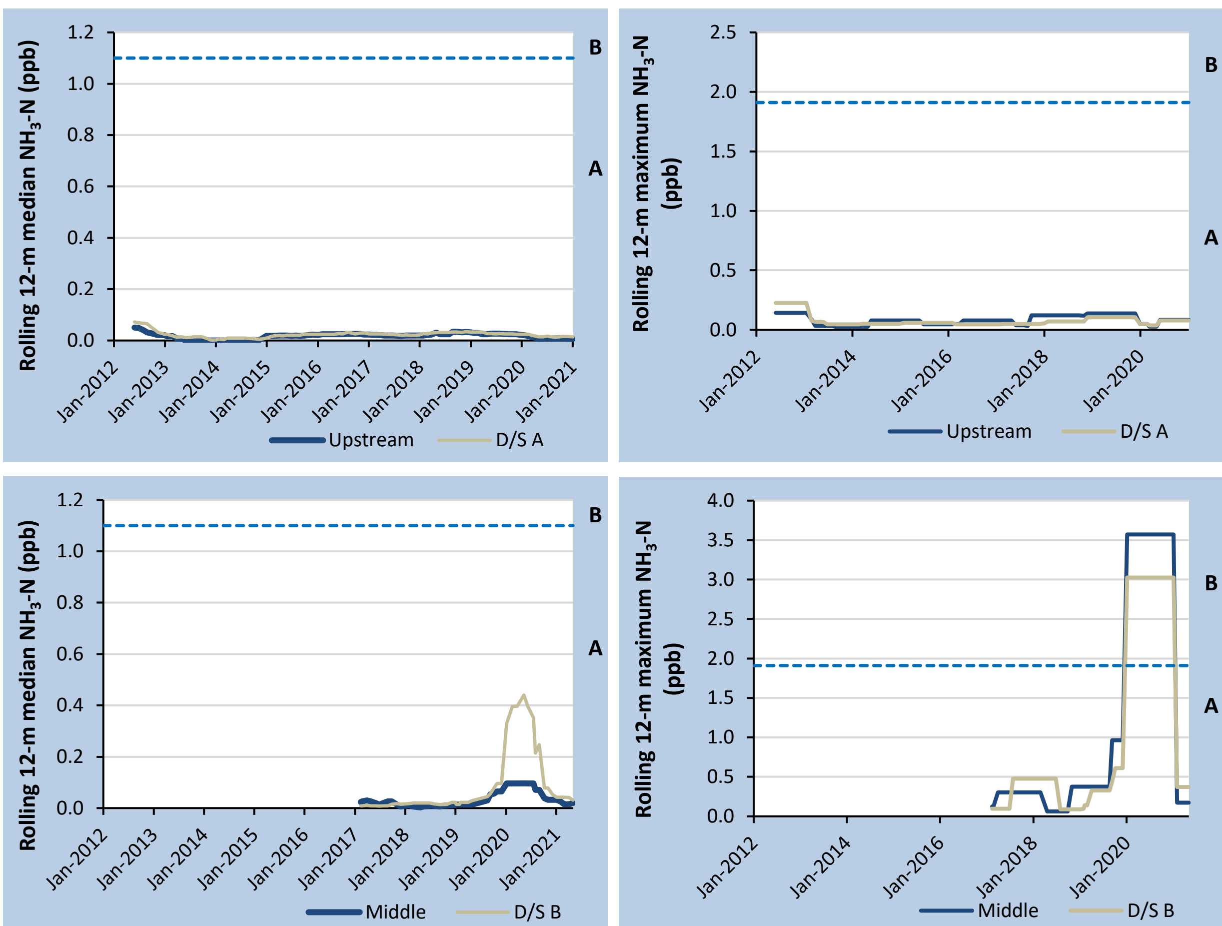

Figure 6: Rolling annual Median (upper) and Maximum (lower) unionised ammoniacal nitrogen concentrations in the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP (January 2012 – May 2021 data). NPS-FM 2020 Attribute States (A and B) are indicated by dashed lines.

5.1.2. Nitrate-nitrogen

Comparisons of Nitrate-nitrogen concentrations showed statistically significant differences between the upstream and D/S A sites on the Mangaehuehu Stream in all flow "bins" except at flows below median flow and no significant differences between the middle and D/S B sites in any flow 'bins' (Figure 7). In our experience, it is relatively unusual to measure increases in nitrate-nitrogen concentrations downstream of a WWTP discharge. Generally speaking, ammoniacal-nitrogen is the dominant inorganic nitrogen form in the treated effluent. Nitrate is more typically associated with effects of farming, which may be the cause of, or a contributor to, the increases measured here.

The One Plan does not specify targets for Nitrate concentrations.

Nitrite-nitrogen concentrations remained low, averaging 0.003 g/m^3 both upstream and at D/S A (maximum 0.02 g/m^3) and averaging 0.001 g/m^3 at the middle and D/S B sites (maximum 0.003 g/m^3 at the middle site and 0.01 g/m^3 at D/S B) between 2012 and 2021.

Seasonal patterns

No seasonal patterns were observed in Nitrate-N concentrations with no significant differences between seasons or between sites within each season (Figure 7, C).

Assessment against NPS-FM 2020 Attribute State

Assessment against the NPS-FM 2020 for nitrate-nitrogen concentrations (refer Appendix C, Table 2), assigns all sites on Mangaehuehu Stream both upstream and downstream of the Rangataua WWTP ponds and discharge channel according to Attribute State A (based on the overall average of rolling annual median and 95th Percentile Nitrate-nitrogen concentrations between January 2012 and May 2021) (Table 12, Figure 8).

This suggests a high conservation value system where any effects of nitrate toxicity are unlikely even on sensitive species.

The NPS-FM (2020) places the National bottom line for nitrate toxicity at the threshold between Attribute States B and C. Annual median concentrations of more than 2.4 mg/L and annual 95th Percentile concentrations above 3.5 mg/L are considered to be below the National Bottom Line.

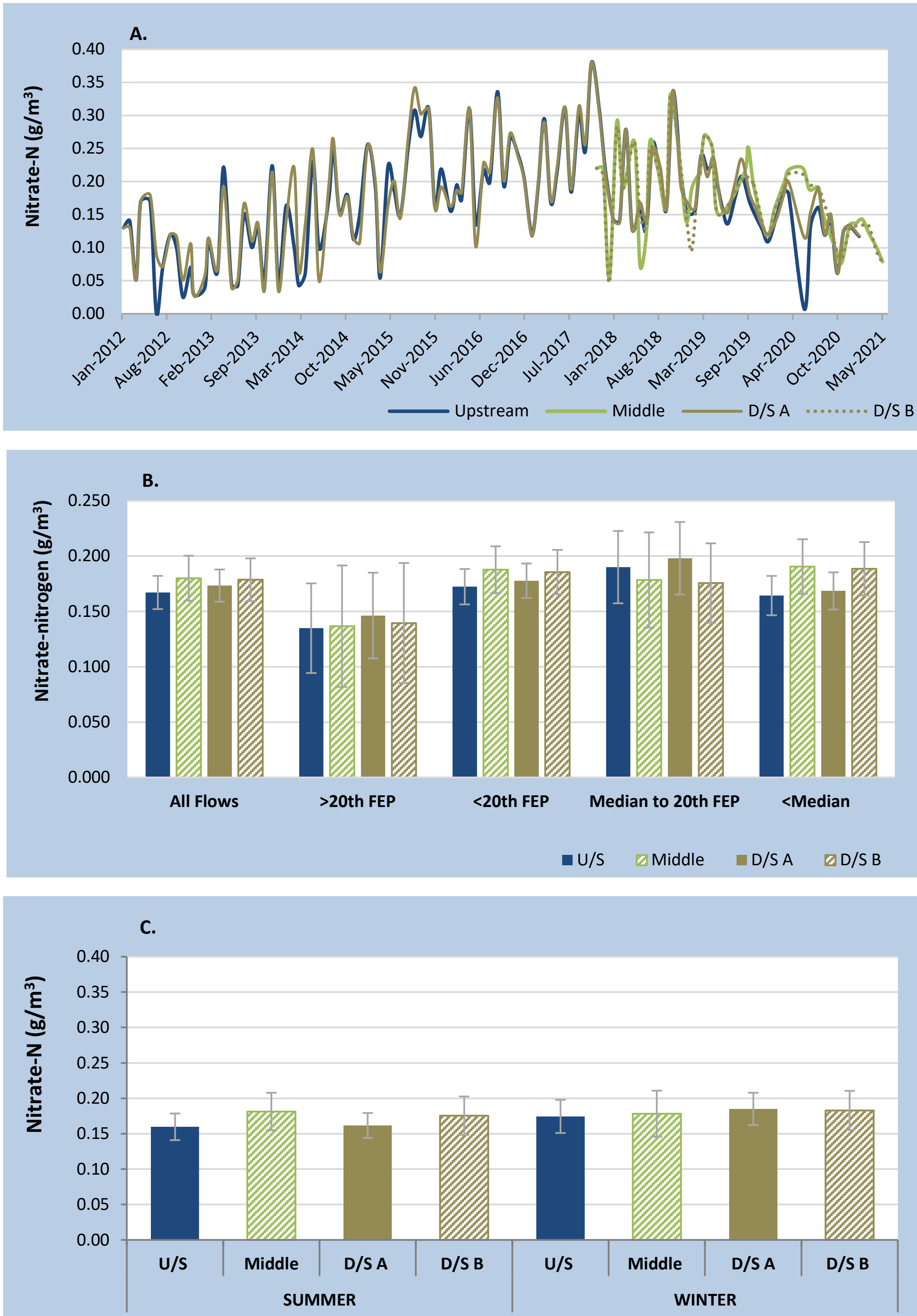

Figure 7: Total Nitrate-nitrogen concentrations as A. Time series, B. Mean concentrations at various flows and C. Mean concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP (Refer Table 1 and Figure 1 for site locations).

Table 12: NPS-FM (2020) Attribute State calculations for Nitrate (toxicity), for sites sampled on the Mangaehuehu Stream, January 2012 – May 2021).

	Upstream	D/S A	Middle	D/S B
Av. Median	0.16	0.17	0.20	0.20
Av. Maximum	0.26	0.26	0.26	0.26
Av. Median state	A	A	A	A
Av. Maximum state	A	A	A	A
Overall state	A	A	A	A
No. times graded as A	104	104	38	38
No. times graded as B	0	0	0	0
No. times graded as C	0	0	0	0
No. times graded as D	0	0	0	0

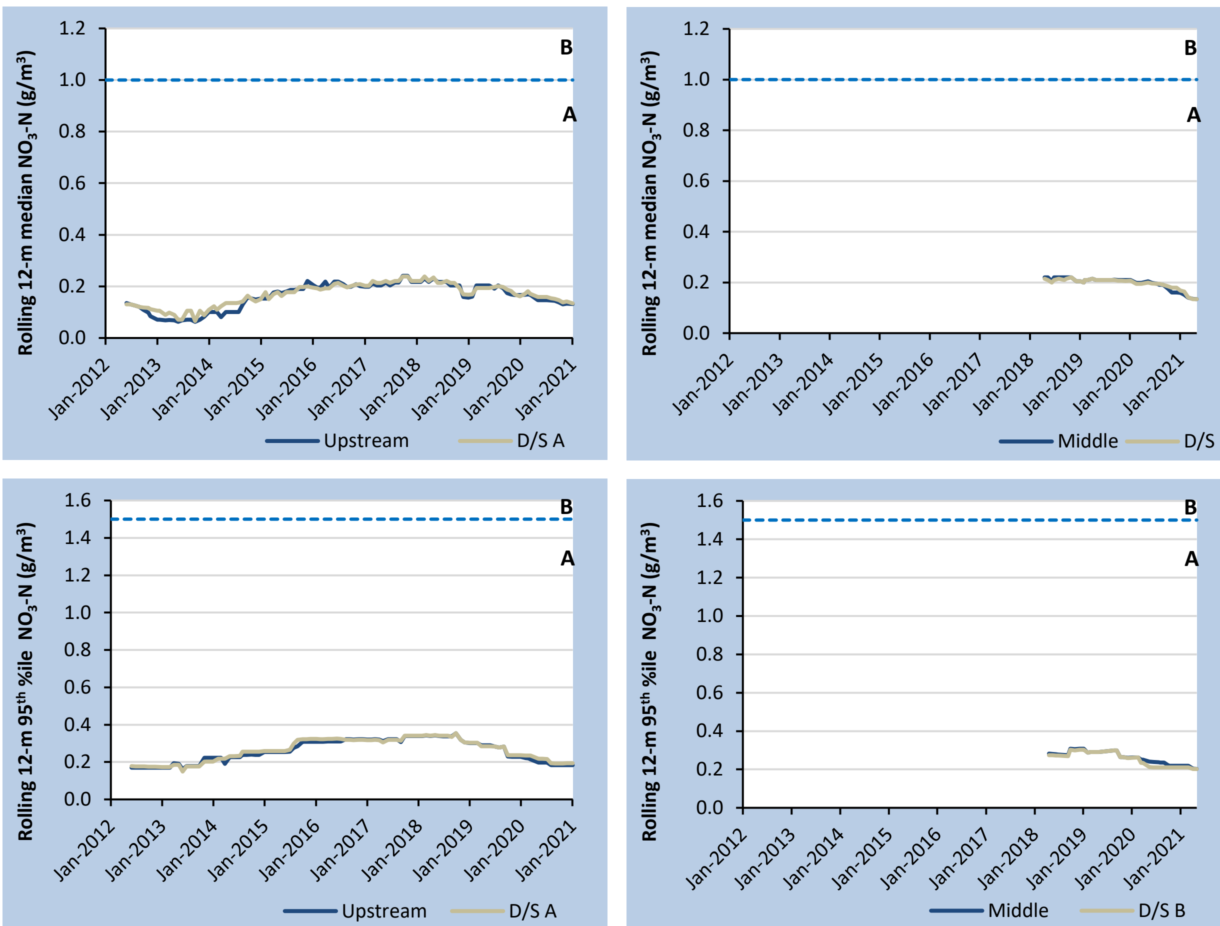

Figure 8: Rolling annual Median (upper) and 95th Percentile (lower) Nitrate-nitrogen concentrations in the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP (January 2012 – May 2021 data). NPS-FM 2020 Attribute States (A and B) are indicated by dashed lines.

5.1.3. Soluble Inorganic Nitrogen (SIN)

Soluble Inorganic Nitrogen (SIN) concentrations monitored between 2012 and 2021 were above the One Plan target (i.e. an annual average concentration of 0.070 g/m^3 at flows below the 20th FEP) at the upstream, middle and downstream sites on the Mangaehuehu Stream on most sampling occasions (Figure 9). There was a 3% increase in annual average SIN concentrations at flows below 20th FEP from 0.180 g/m^3 upstream to 0.186 g/m^3 at D/S B and only 1% increase between the middle (0.193 g/m^3) and D/S B (0.195 g/m^3) sites.

Small but statistically significant increases were observed between the upstream and D/S A sites in all flow bins except at flows below median and no differences between the middle and D/S B sites.

SIN in the Mangaehuehu Stream is mostly comprised of Nitrate-nitrogen with ammonia-nitrogen and nitrite-nitrogen contributions comparatively small.

Ecologically, these small increases represent a correspondingly small risk of causing increases in periphyton growth downstream of the discharge.

Seasonal patterns

No significant differences were observed in SIN concentrations at sites upstream or downstream of the Rangataua WWTP between summer and winter months.

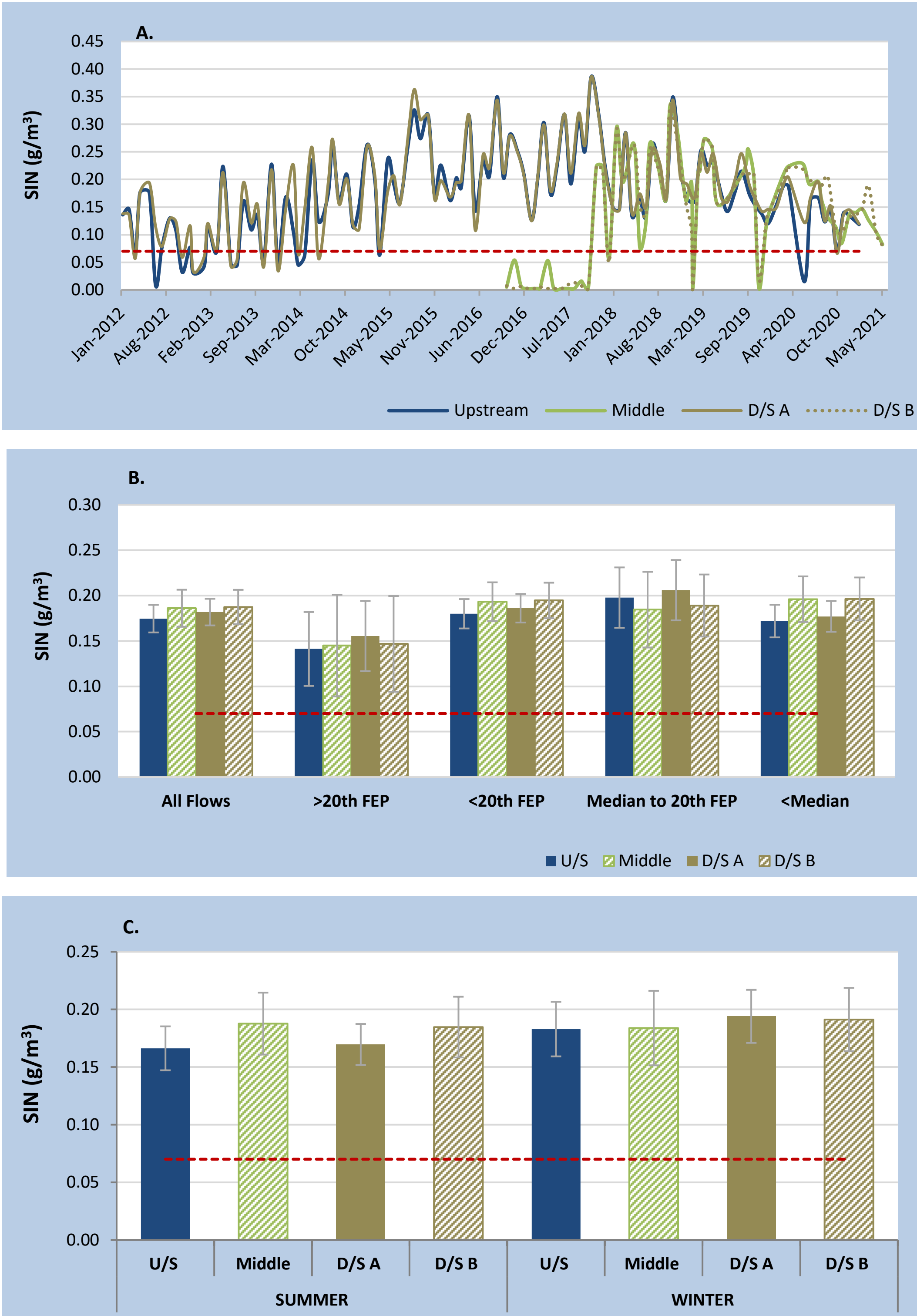

Figure 9: Soluble Inorganic Nitrogen (SIN) concentrations as A. Time series, B. Mean concentrations at various flows and C. Mean concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan target for SIN. The arrow represents flows at which the One Plan target applies.

5.1.4. Dissolved Reactive Phosphorus (DRP)

Dissolved Reactive Phosphorus (DRP) concentrations exceeded the One Plan target (i.e. an annual average concentration of 0.006 g/m^3 at flows below the 20th FEP) on all sampling occasions at all sites both upstream and downstream of the Rangataua WWTP (Figure 10).

There were however no significant differences between upstream and D/S A or middle and D/S B sites on the Mangaehuehu Stream in any of the flow 'bins'.

Elevated DRP concentrations reflect natural conditions and are likely the result of natural sources of phosphorus associated with volcanic geology in the area.

Seasonal patterns

Average DRP concentrations were similar between sites with no significant differences between summer and winter months.

Assessment against NPS-FM 2020 Attribute State

Assessment against the NPS-FM 2020 for DRP concentrations (refer Appendix C, Table 3) which requires an action plan rather than limits, assigns upstream, middle and downstream sites on the Mangaehuehu Stream into Attribute State C with respect to both 5-year median and 95th percentiles (Figure 11). Grading in Band C suggests ecological communities are impacted by moderate DRP elevation which may cause increased algal growth and loss of sensitive macroinvertebrate and fish taxa.

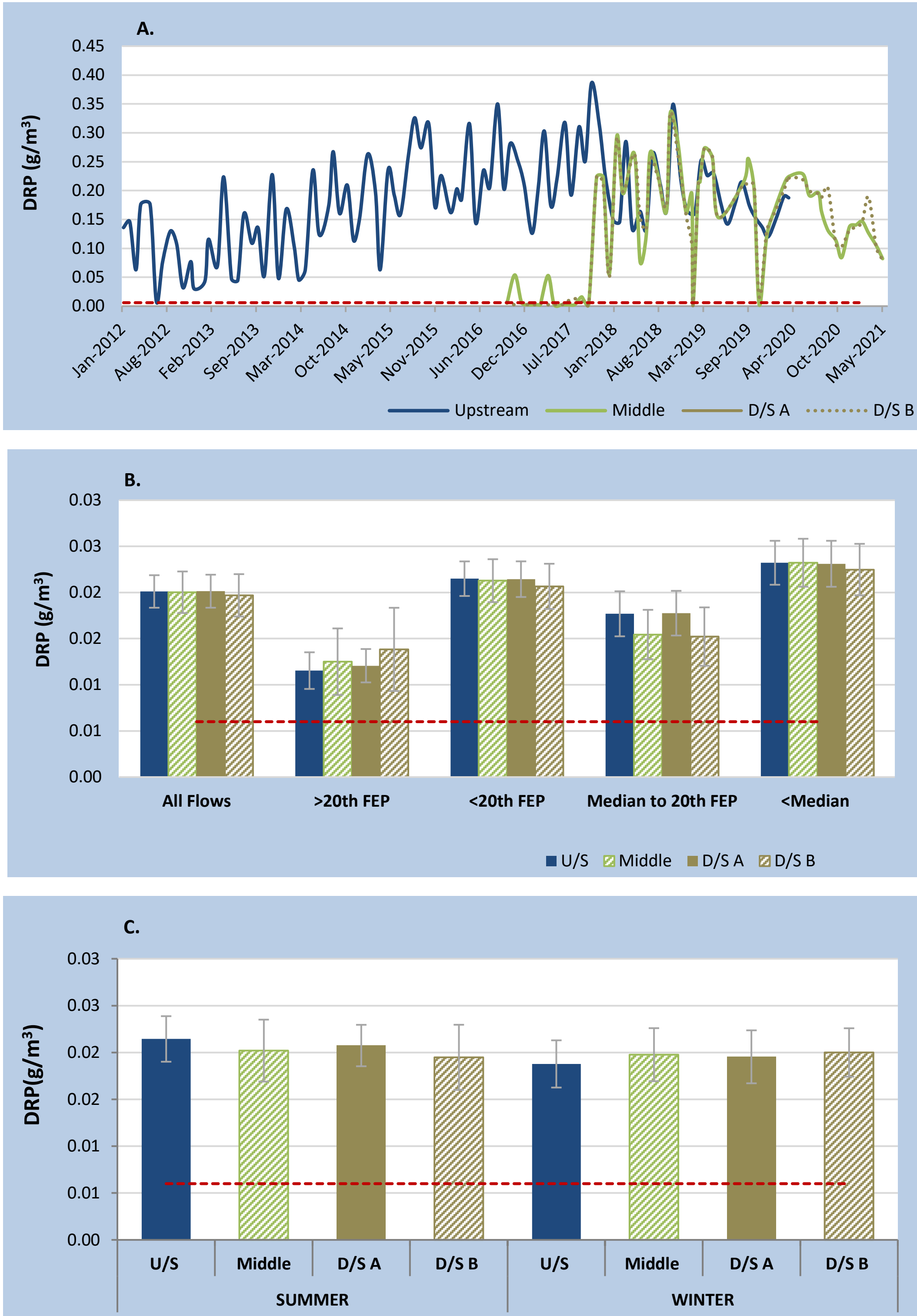

Figure 10: Dissolved Reactive Phosphorus (DRP) concentrations as A. Time series, B. Mean concentrations at various flows and C. Mean concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan target for DRP. The arrow represents flows at which the One Plan target applies.

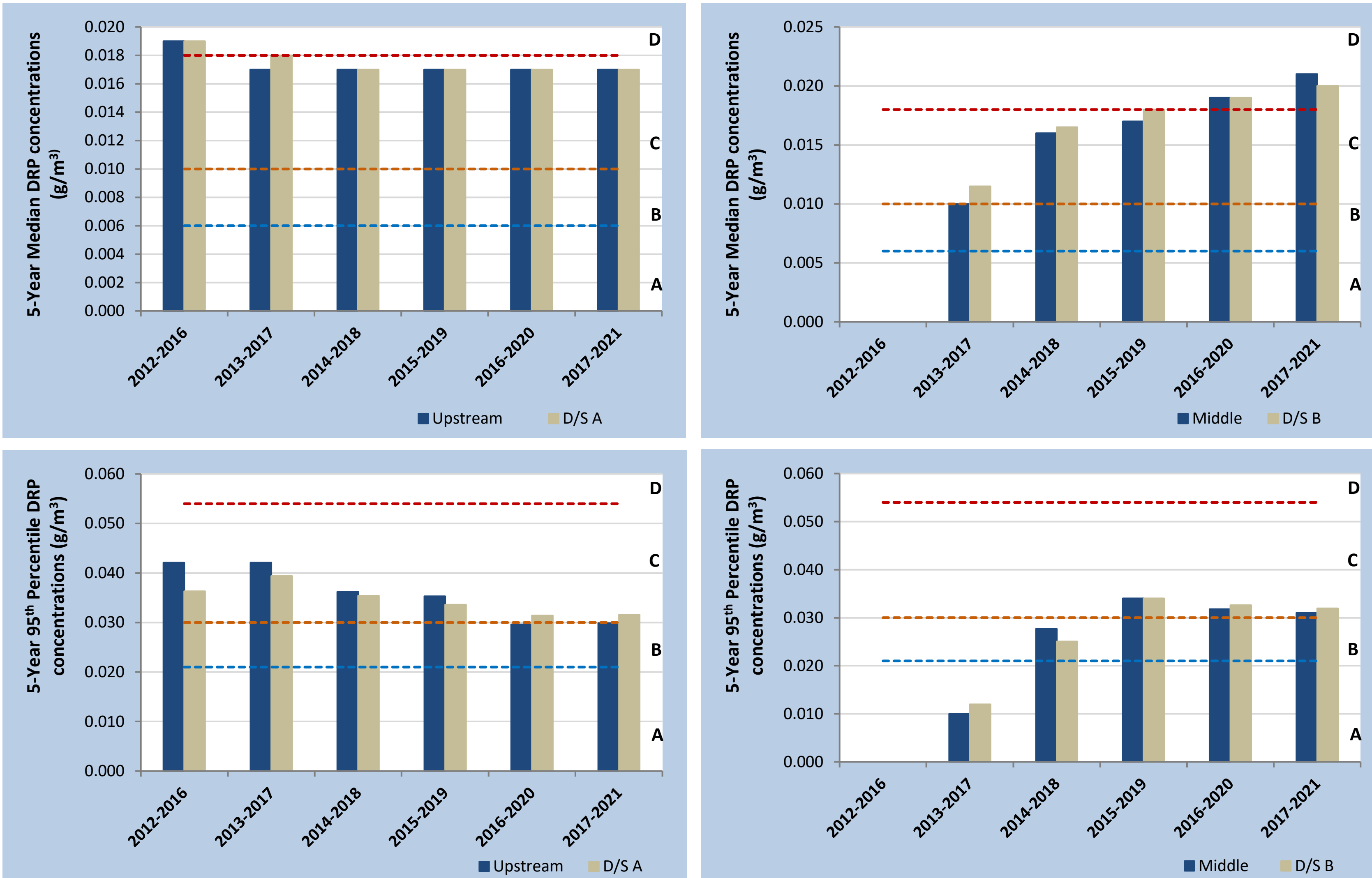

Figure 11: Annual 5-Year Median (upper) and 95th Percentile (lower) DRP concentrations in the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP (January 2 012 – May 2021 data). NPS-FM 2020 Attribute States (A to D) are indicated by dashed lines.

5.1.5. *E. coli*

The One Plan defines two *E. coli* concentration targets: 260 *E.coli* /100mL at flows below median flow during the main bathing season (November to April inclusive) and 550 *E.coli* /100mL at flows below the 20th FEP year-round. Ausseil and Clark (2007) recommended that compliance with these targets be assessed at the 95% compliance level.

Individual *E.coli* concentrations in the Mangaehuehu Stream measured between 2012 and 2021 (Figure 12) remained mostly below both One Plan targets at all sites, that is:

- Below 550 *E. coli* /100mL at flows below 20th FEP 97% of the time upstream and 98% of the time at D/S A between 2012 and 2021;
- Below 260 *E. coli* /100mL at flows below median flow 93% of the time upstream and 89% of the time at D/S A between 2012 and 2021;
- Below 550 *E. coli* /100mL at flows below 20th FEP 93% of the time at both the middle and D/S B sites between 2012 and 2021;
- Below 260 *E. coli* /100mL at flows below median flow 75% of the time at the middle site and 83% of the time at D/S A between 2012 and 2021.

Median *E.coli* concentrations remained within the One Plan targets both upstream and downstream of the Rangataua WWTP discharge in all flow 'bins' (Figure 12, B).

When considering 95th percentile concentrations, the One Plan target of 550 *E. coli* /100mL at flows below the 20th FEP was also met at all sites upstream and downstream of the discharge. However, the One Plan target of 260 *E. coli*/100mL at flows below median flow was exceeded at all sites.

Seasonal patterns

E.coli concentrations did decrease significantly at all sites in winter months compared with summer, however there were no significant differences between sites (from upstream to D/S A and from middle to D/S B) within each season.

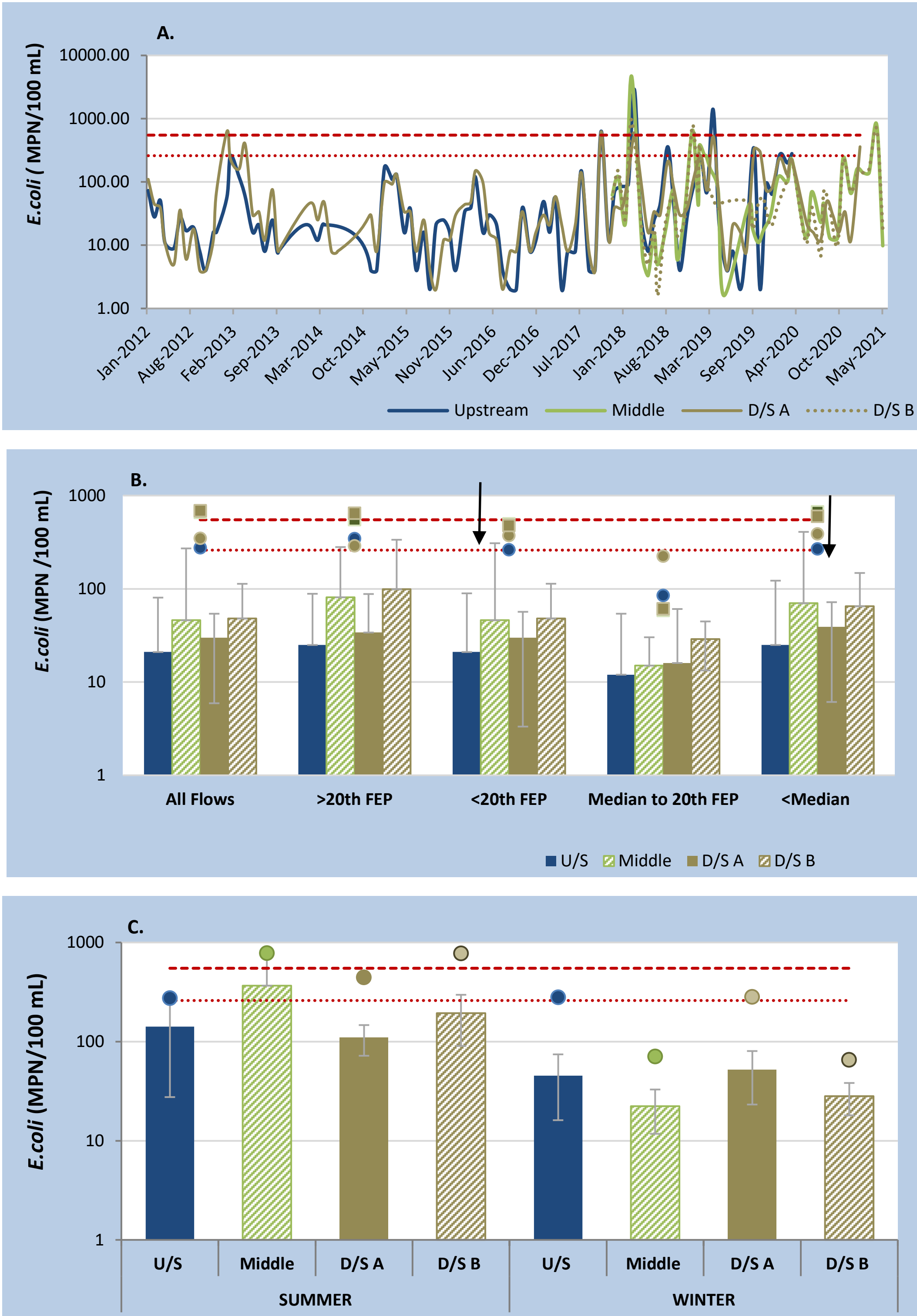

Figure 12: ***E.coli*** **concentrations (log scale) as A. Time series, B. Median (bars) and 95th Percentile (dots) concentrations at various flows and C. Median (bars) and 95th Percentile (dots) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate One Plan targets for** ***E.coli.*** **The arrows represent flows at which the One Plan targets apply.**

Assessment against NPS-FM 2020 Attribute State

The NPS-FM 2020 describes five "Attribute States" (A-E) defined by the percentage of exceedances over 540 cfu/100ml, the percentage of exceedances over 260 cfu/100ml, the median concentration and the 95^{th} percentile of *E. coli*/100ml based on a minimum of 60 samples over a maximum of 5 years (although this time period can increase if there are not 60 samples). The Attribute State is determined by satisfying all numeric attribute states. Band A represents the lowest risk of effects (or the highest quality) whilst Band E represents the highest risk of effects (or the lowest quality).

An assessment against the NPS-FM for *E.coli* concentrations (refer Appendix C, Table 4) in the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP between January 2012 and May 2021 assigns Attribute state gradings as per Table 13.

The site upstream of the ponds falls into Attribute State A between 2012 and 2017, then moves into Attribute State B from 2018 to 2021. The site downstream of the ponds and the discharge (D/S A) falls into Attribute State A from 2013 to 2020, and Attribute State B in 2012 and 2021.

There is less data available for the sites upstream and downstream of the confluence with the discharge channel. However, assessment of the data available assigns both sites into Attribute State B . The middle site has improved since 2019 moving from Attribute State D in 2018 to Attribute State B in more recent years. The D/S B site has remained in Attribute State B since 2018.

The difference in gradings between the D/S A and D/S B sites is difficult to explain given they are sampled in similar locations, but may be due to the differences in the amount of data collected for each.

These results however, mean that for at least half the time, the estimated risk of campylobacter infection at all sites is less than 1 in 1,000 (1-2% risk). The Mangaehuehu Stream is considered swimmable based on this assessment.

Table 13: NPS-FM (2020) Attribute State calculations for *E.coli*, for sites sampled on the Mangaehuehu Stream, January 2012 – May 2021). Attribute States are coloured as follows: A (blue), B (green), C (yellow), D (orange), E (red).

Site name	Year	% above 540 cfu/100mL	% above 260 cfu/100mL	Median (cfu/100mL)	95th (cfu/100mL)	Attribute state	Swimmable	N.
Upstream	2012	0	0	20	203	A	Yes	18
Upstream	2013	0	0	18	247	A	Yes	28
Upstream	2014	0	0	17	212	A	Yes	39
Upstream	2015	0	0	19	168	A	Yes	51
Upstream	2016	0	0	16	156	A	Yes	57
Upstream	2017	4	4	16	219	A	Yes	57
Upstream	2018	5	7	21	508	B	Yes	59
Upstream	2019	5	12	25	508	B	Yes	59
Upstream	2020	6	13	30	576	B	Yes	54
Upstream	2021	7	17	34	938	B	Yes	42
Downstream A	2012	6	11	35	536	B	Yes	18
Downstream A	2013	3	10	34	408	A	Yes	29
Downstream A	2014	3	8	34	335	A	Yes	40
Downstream A	2015	2	6	30	269	A	Yes	52
Downstream A	2016	2	5	25	256	A	Yes	58
Downstream A	2017	3	6	26	337	A	Yes	65
Downstream A	2018	4	8	34	530	A	Yes	79
Downstream A	2019	3	9	39	530	A	Yes	89
Downstream A	2020	4	11	39	530	A	Yes	95
Downstream A	2021	5	12	48	562	B	Yes	83

Site name	Year	% above 540 cfu/100mL	% above 260 cfu/100mL	Median (cfu/100mL)	95th (cfu/100mL)	Attribute state	Swimmable	N.
Middle	2017	14	14	23	Not enough data	C	Yes	7
Middle	2018	10	15	53	2680	D	No	20
Middle	2019	7	10	43	660	B	Yes	30
Middle	2020	7	10	46	723	B	Yes	41
Middle	2021	7	10	46	723	B	Yes	41
Downstream B	2017	14	14	26	Not enough data	C	Yes	7
Downstream B	2018	10	15	51	880	B	Yes	20
Downstream B	2019	7	10	47	790	B	Yes	30
Downstream B	2020	7	10	48	735	B	Yes	41
Downstream B	2021	7	10	48	735	B	Yes	41

5.1.6. Visual clarity (Black disc), Total Suspended Solids (TSS) and Turbidity

Visual clarity (measured with a black disc) data are only available for the sites upstream of the ponds (Upstream) and downstream of the ponds and confluence with the discharge channel (D/S A), with no black disc readings recorded since September 2019. Visual clarity decreased significantly between these sites on most sampling occasions between 2012 and 2019.

The One Plan target of 3 m visual clarity at flows below median flow was not met at either upstream nor downstream sites (Figure 13, B) and significant decreases in visual clarity were recorded from upstream to downstream in all flow 'bins' except at flows above the 20th FEP.

Comparisons of upstream and downstream visual clarity readings on individual days indicates that there was a reduction in visual clarity of more than 20% on 33 out of 83 paired upstream/downstream measurements. Readings were compliant with the One Plan target on all other sampling occasions (Figure 16).

Total Suspended Solids (TSS) and water turbidity (an index of light scattering by suspended particles and often used as surrogates for visual water clarity) data were also collected between 2012 and 2021.

TSS concentrations were highest at the site downstream of the discharge channel confluence (D/S B) (averaging 5 g/m^3 upstream, 29.1 g/m^3 at the middle site, 3.6 g/m^3 at D/S A and 124 g/m^3 at D/S B) supporting the decrease in visual clarity observed (Figure 14). Statistically significant increases were observed between the middle site and D/S B at flows below 20th FEP and at flows between median and 20th FEP. There are no One Plan targets for TSS.

Turbidity was generally higher at the middle site in most flow 'bins' and highest at the D/S A site at flows above the 20th FEP, as would be expected. There were no statistically significant differences between sites in any of the flow 'bins'.

There are no One Plan targets for turbidity. However, Condition 5 of the current consent requires that the downstream turbidity shall not be increased but more than 2 NTU. Compliance with this condition has been met 98% of the time between 2012 and 2021 with the last non-compliance back in 2018.

Seasonal patterns

Visual clarity decreased at sites downstream of the Rangataua WWTP discharge in both summer and winter months (D/S A), while TSS increased (D/S B).

Visual clarity and TSS concentrations were not significantly different when compared between summer and winter months.

Assessment against NPS-FM 2020 Attribute State

Assessment against the NPS-FM 2020 for visual clarity (refer Appendix C, Table 5) assigns both sites into Attribute State A, indicating minimal impact of suspended sediment on instream biota (Figure 17).

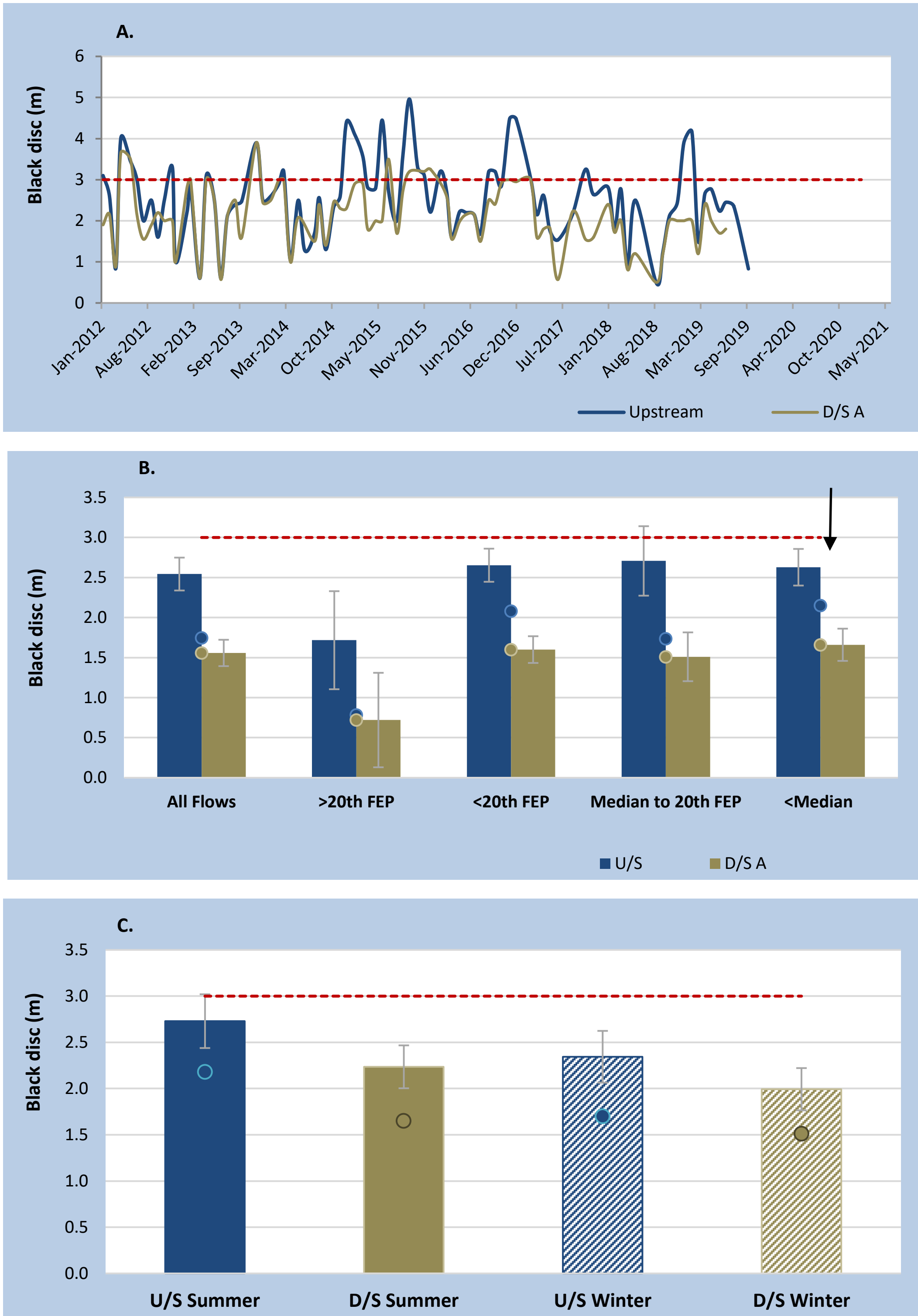

Figure 13: Black disc readings as A. Time series, B. Mean (bars) and 20th Percentile (dots) concentrations at various flows and C. Mean (bars) and 20th Percentile (dots) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate One Plan targets. The arrow represents flows at which the One Plan target applies.

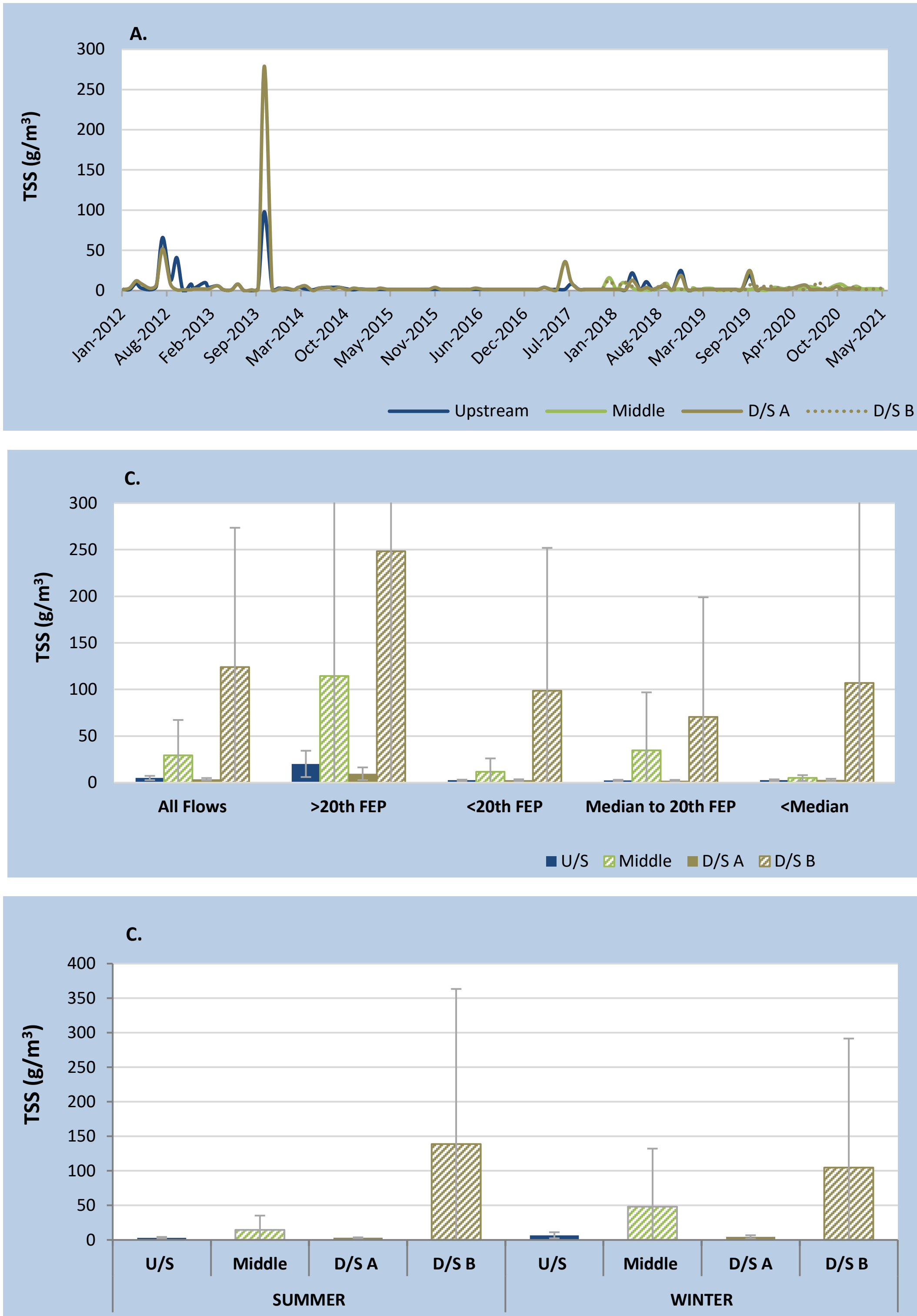

Figure 14: Total Suspended Solid (TSS) concentrations as A. Time series, B. Mean concentrations at various flows and C. Mean concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP.

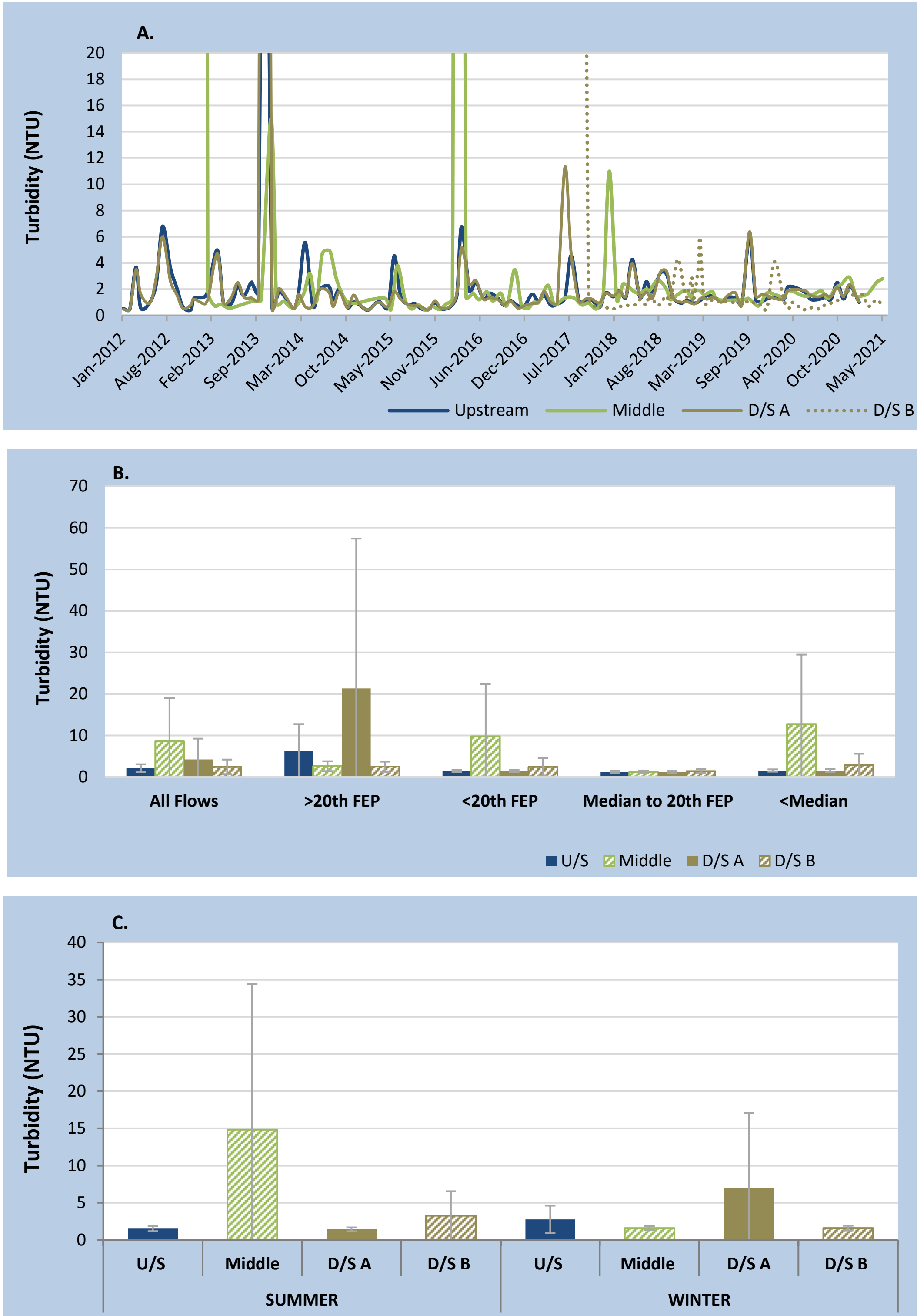

Figure 15: Turbidity as A. Time series, B. Mean concentrations at various flows and C. Mean concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP.

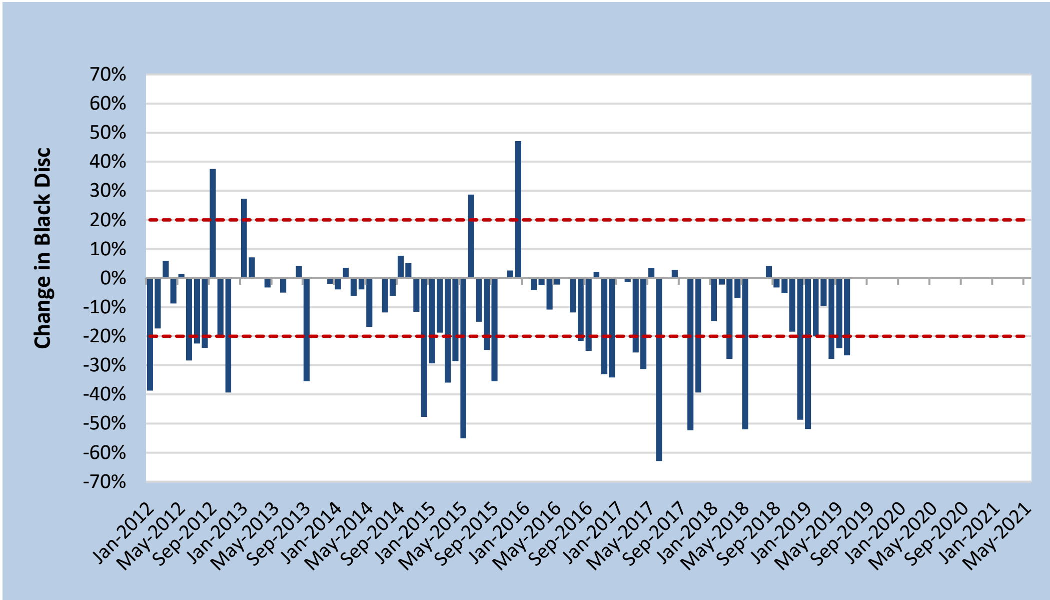

Figure 16: Percent change in black disc between sites sampled on the Mangaehuehu Stream (January 2012 – May 2019), upstream and downstream (D/S A) of the Rangataua WWTP. The One plan target for black disc of no more than a 20% change is represented by red dashed lines.

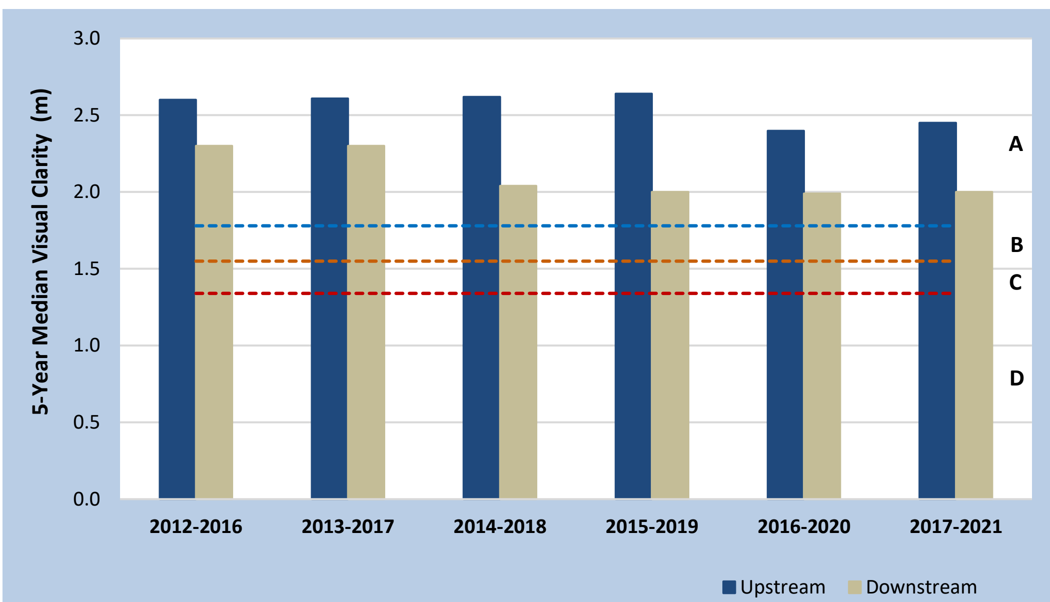

Figure 17: Annual 5-Year Median visual clarity (measured using black disc) in the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP (January 2012 – May 2021 data). NPS-FM 2020 Attribute States (A to D) are indicated by dashed lines.

5.1.7. Biochemical Oxygen Demand ($ScBOD_5$) and Particulate Organic Matter (POM)

$ScBOD_5$ is the amount of dissolved oxygen needed by biological organisms to break down organic material. $ScBOD_5$ data, only available for the middle and D/S B sites, was generally similar between the two sites on the Mangaehuehu Stream from 2012 and 2021 and compliant with the One Plan target of less than 1.5 g/m^3 (Figure 18).

There were no significant differences between sites within each flow bin.

POM concentrations, although higher at the middle and D/S B sites were not statistically different between sites monitored on the Mangaehuehu Stream and generally compliant (89-98%) with the One Plan target (Figure 19).

Seasonal patterns

Small changes in $ScBOD_5$ concentrations between sites was observed in summer (increased) and winter (decreased) months, although none were significant.

POM concentrations did not differ between upstream and D/S A sites or between middle and D/S B sites over summer months but increased in winter months. There were, however, no differences between seasons.

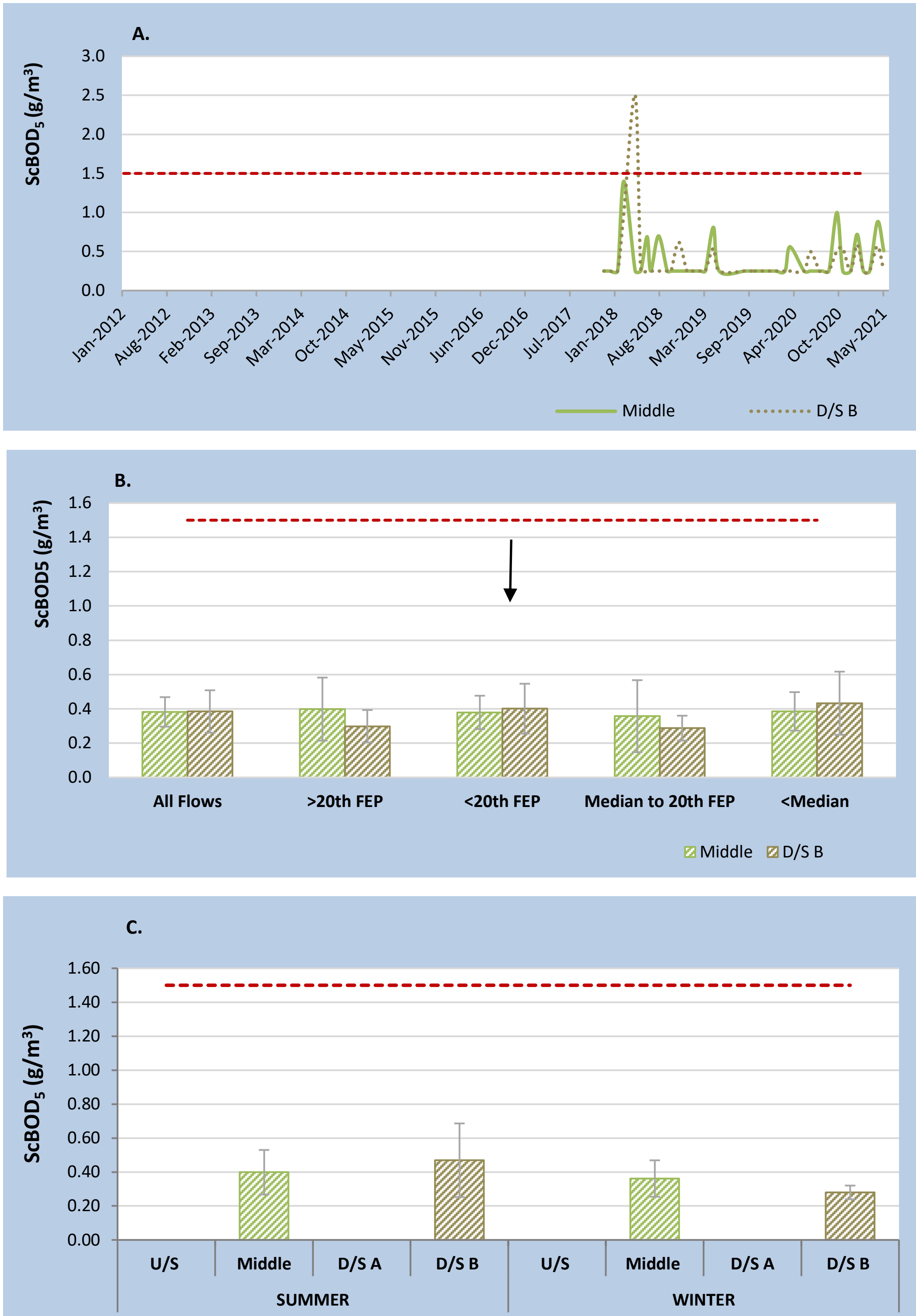

Figure 18: Biochemical oxygen demand ($ScBOD_5$) as A. Time series, B. Mean (± 95% CI) concentrations at various flows and C. Mean (± 95% CI) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan targets. The arrow represents flows at which the One Plan target applies.

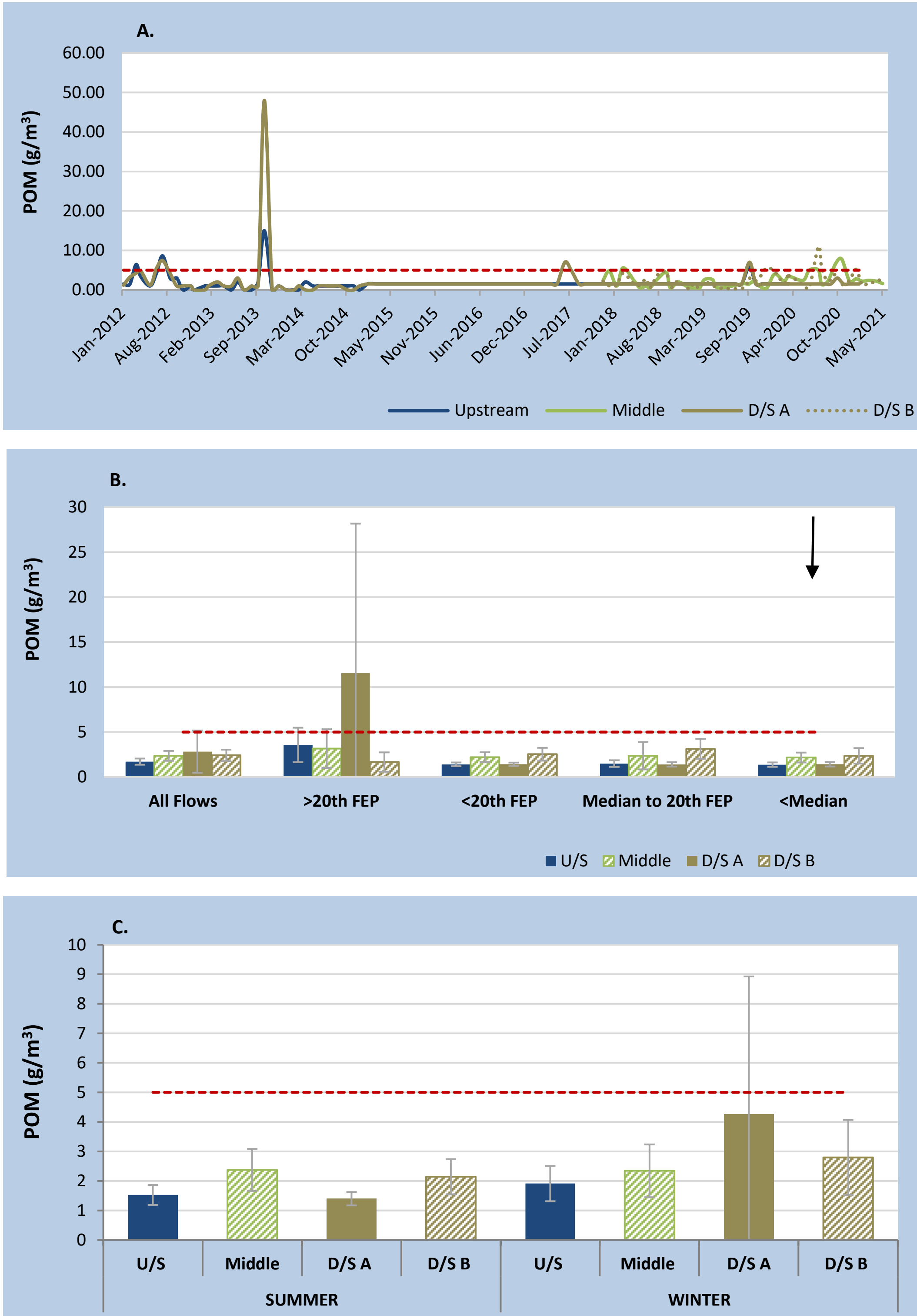

Figure 19: Particulate Organic Matter (POM) as A. Time series, B. Mean (± 95% CI) concentrations at various flows and C. Mean (± 95% CI) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan targets. The arrow represents flows at which the One Plan target applies.

5.1.8. pH , Temperature and Dissolved Oxygen

Water pH did not differ significantly between upstream and D/S A or between the middle and D/S B sites and was within the One Plan target range (7.0 – 8.2) 87% of the time at the upstream site, 90% at D/S A, 58% of the time at the middle site and 62% at D/S B (Figure 20). There were also small but significant increases downstream (D/S A and D/S B) in all flow bins except at all flows.

The One Plan target of no more than a 0.5 unit change in pH was complied with on all monitoring occasions between upstream and D/S A sites and on all but 25 monitoring occasions (88% of the time) between the middle and D/S B sites from 2012 to 2021 (Figure 20 and Figure 23).

Water Temperature in the Mangaehuehu Stream remained below the One Plan target of 19 °C, 100% of the time upstream and at D/S A between 2012 and 2021, and at the middle and D/S B sites since 2014 (Figure 21). Average temperatures were similar between upstream and D/S A within each of the flow bins and between the middle and D/S B sites (although slightly higher at these sites) and always well below the One Plan target.

The One Plan target of no more than a 2°C change was met on all but one monitoring occasion between upstream and D/S A sites (April 2012) and on all but three occasions between the middle and D/S B sites from 2012 to 2021 (Nov 2013, Dec 2018 and Feb 2019) (Figure 24).

Dissolved Oxygen (DO) saturation remained above the One Plan target of 80% on all monitoring occasions, although there have been small but statistically significant increases observed between upstream and downstream sites in all flow bins. It should be noted that the DO data available are day-time 'spot' measurements, which do not provide any indication of night-time minima.

Condition 5 of the current consent requires that the downstream DO concentration shall not be reduced by more than 1 g/m^3. Compliance with this condition has been met 99% of the time at the upstream and D/S A sites and 93% of the time at the middle and D/S B sites between 2012 and 2021 with only 9 out of 222 observations non-compliant.

Seasonal patterns

No differences in pH were detected between seasons, but as would be expected temperature differences did occur with lower temperatures at all sites in winter months. DO saturation increased downstream (D/S A and D/S B) in both seasons, but no significant differences were observed between sites in different seasons (i.e. upstream DO remained similar between summer and winter months, as did downstream DO saturation).

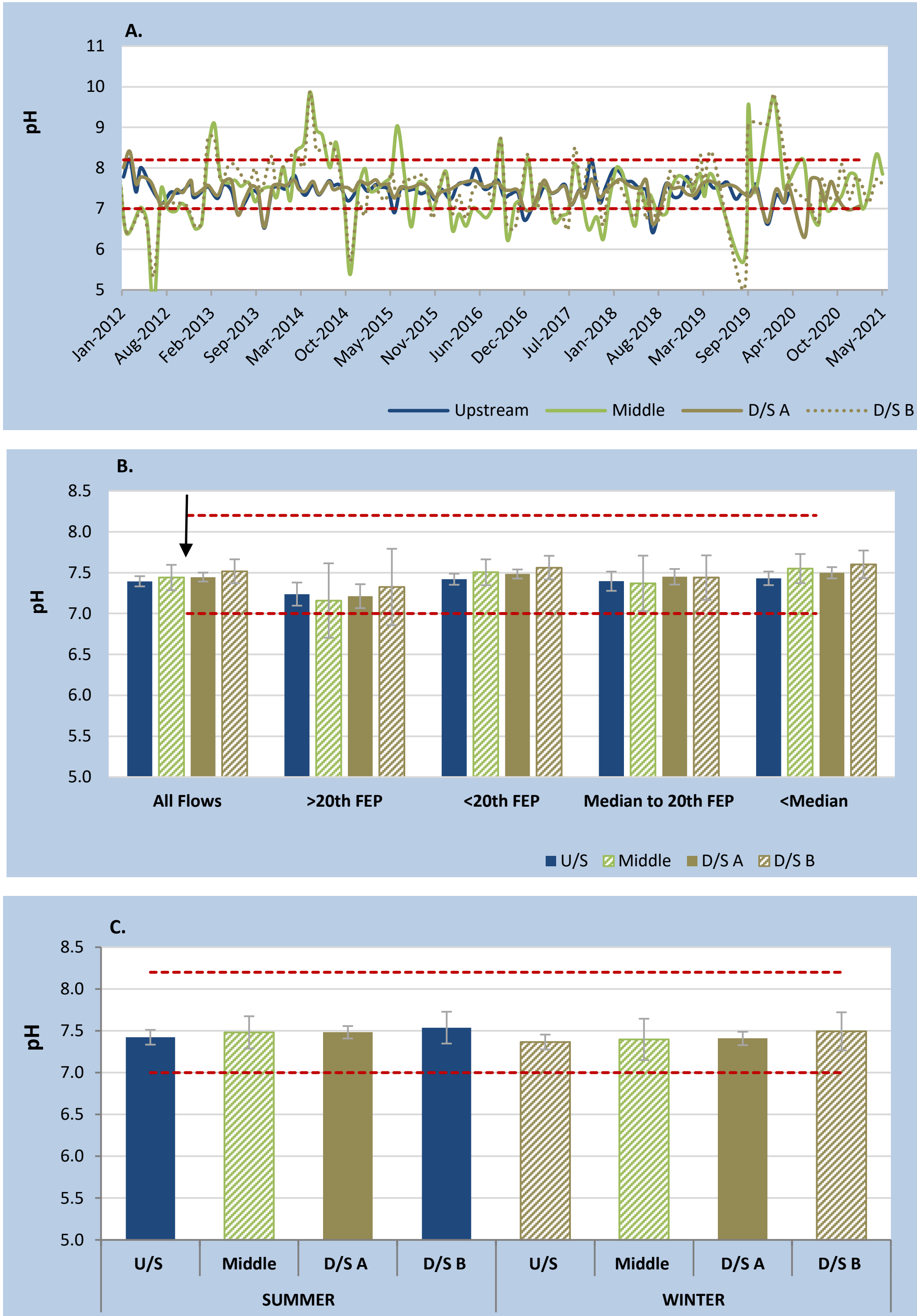

Figure 20: Water pH as A. Time series, B. Mean (± 95% CI) concentrations at various flows and C. Mean (± 95% CI) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan targets. The arrow represents flows at which the One Plan target applies.

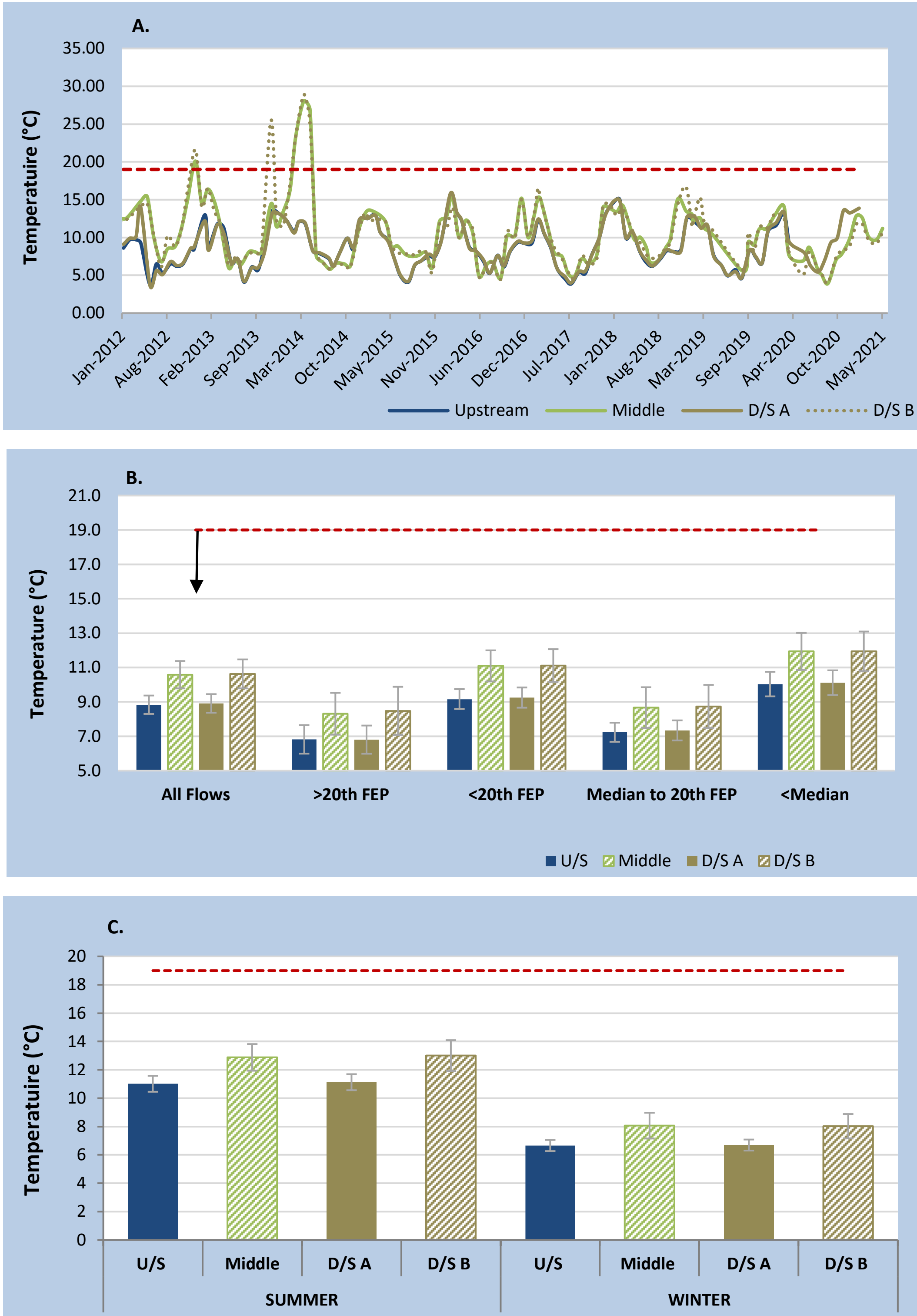

Figure 21: Water Temperature as A. Time series, B. Mean (± 95% CI) concentrations at various flows and C. Mean (± 95% CI) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan targets. The arrow represents flows at which the One Plan target applies.

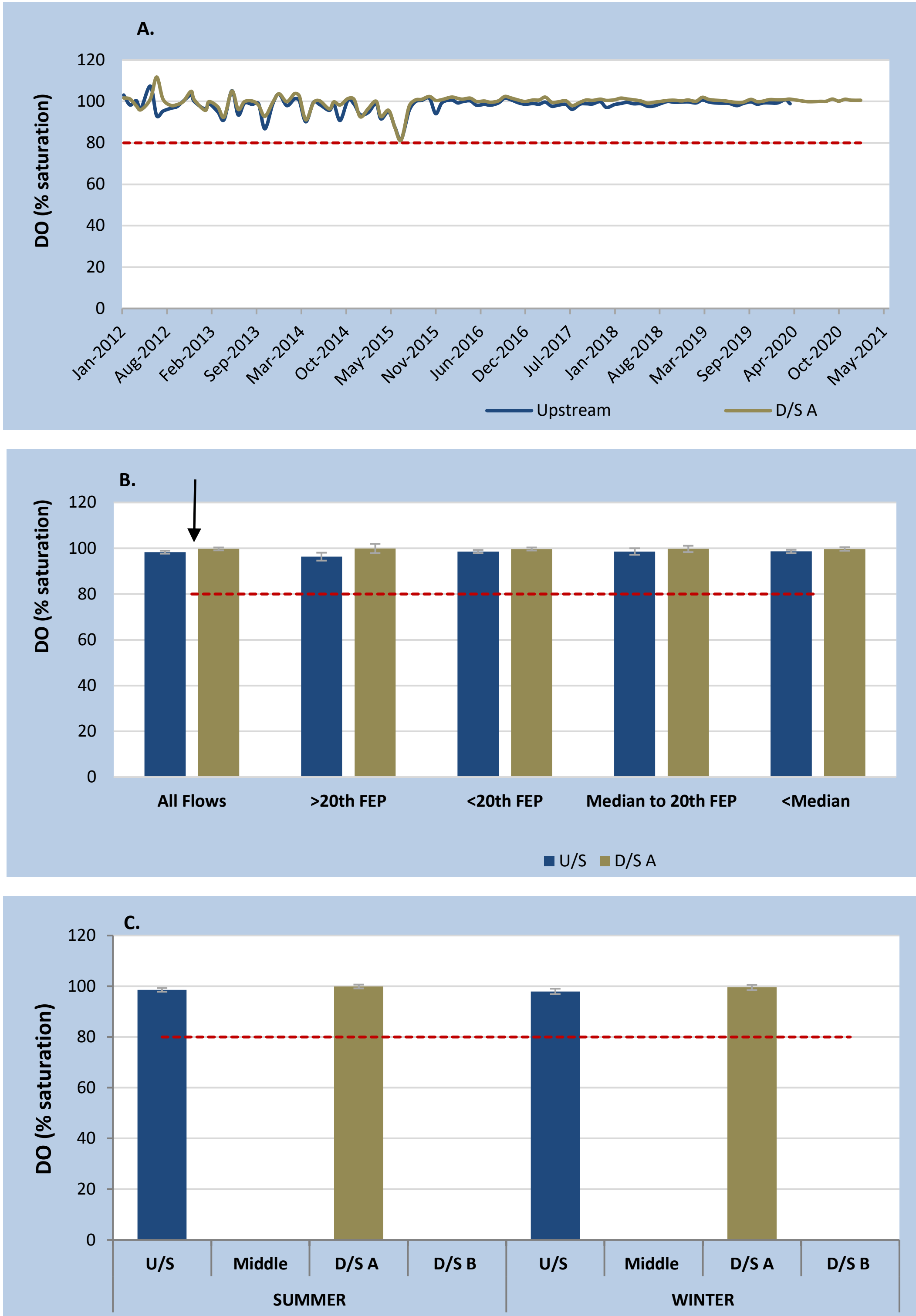

Figure 22: Dissolved oxygen (DO) saturation as A. Time series, B. Mean (± 95% CI) concentrations at various flows and C. Mean (± 95% CI) concentrations by season (Summer: December to April inclusive, Winter: May to November inclusive) for sites sampled on the Mangaehuehu Stream (January 2012 – May 2021), upstream and downstream of the Rangataua WWTP. Dashed red lines indicate the One Plan targets. The arrow represents flows at which the One Plan target applies.

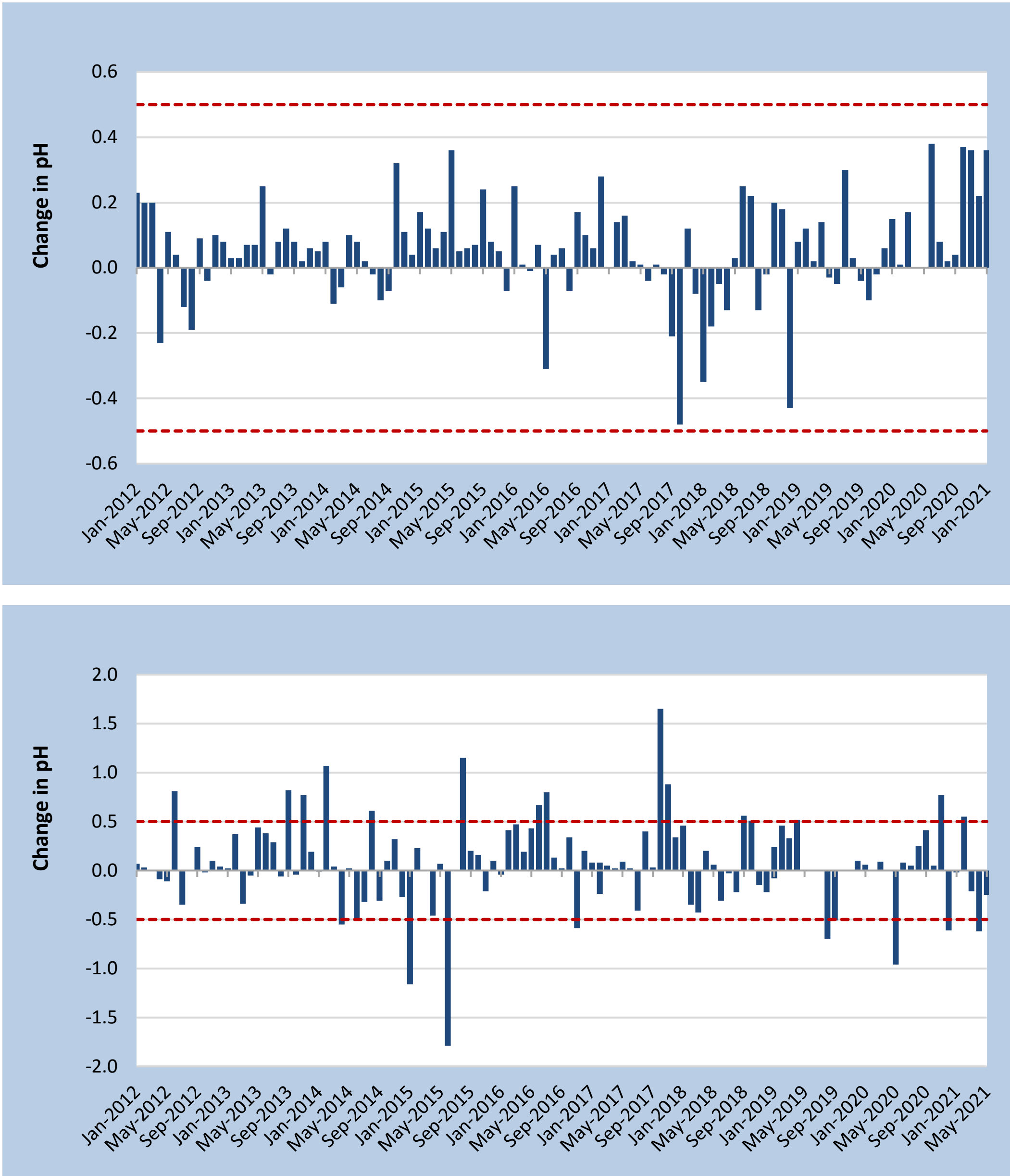

Figure 23: Change in pH between sites sampled on the Mangaehuehu Stream (January 2012 – May 2019), upstream and downstream of the Rangataua WWTP (Upstream vs D/S A – upper and Middle vs D/S B - lower). The One plan target for pH of no more than a 0.5 unit change is represented by red dashed lines.

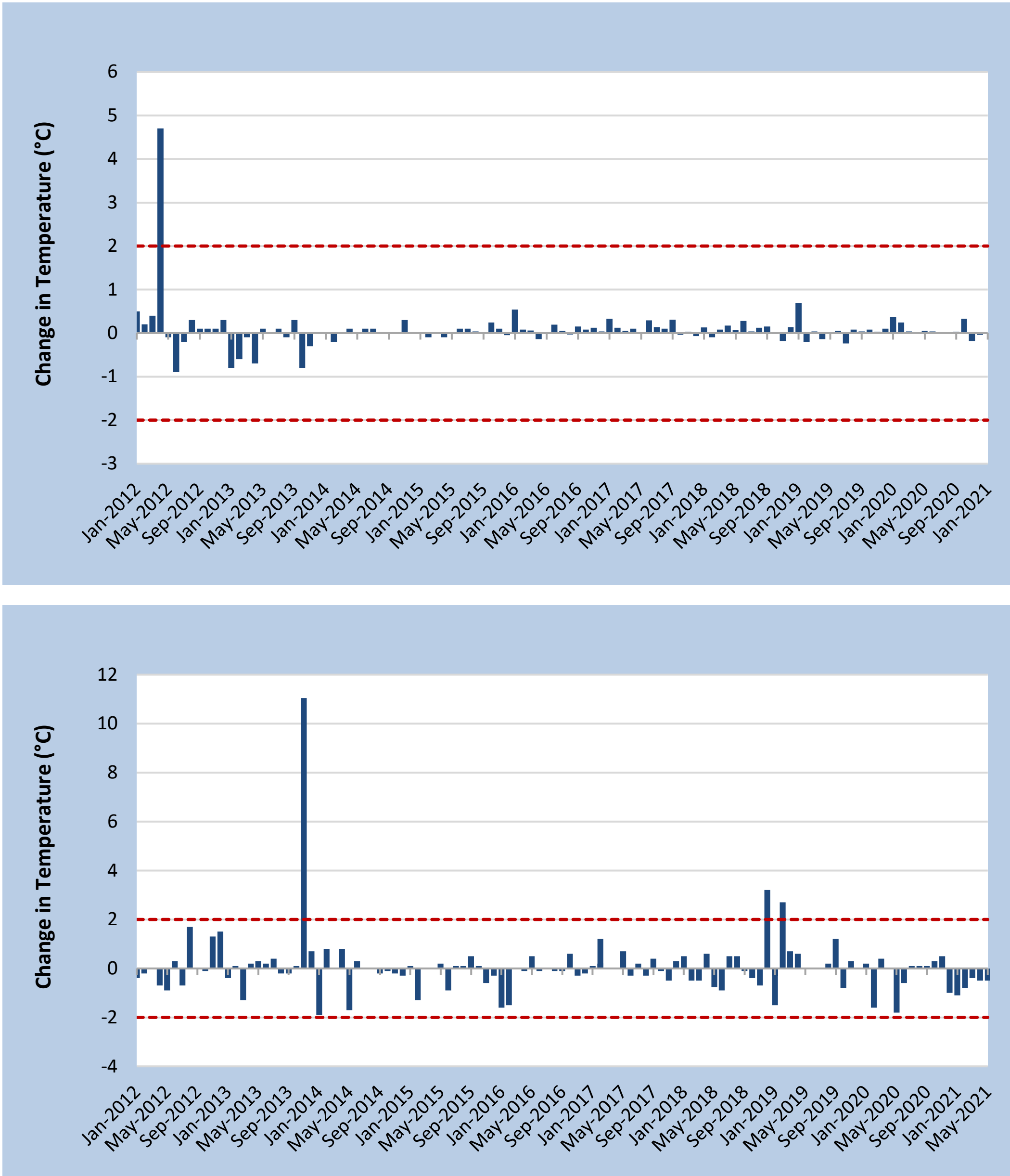

Figure 24: Change in Temperature between sites sampled on the Mangaehuehu Stream (January 2012 – May 2019), upstream and downstream of the Rangataua WWTP (Upstream vs D/S A – upper and Middle vs D/S B - lower). The One plan target for temperature of no more than a 2 °C change is represented by red dashed lines.

5.2. Stream Ecology

5.2.1. Periphyton communities

Periphyton communities have been sampled in the Mangaehuehu Stream in 2018, 2019 and 2021. Results are summarised below.

Periphyton biomass

Periphyton biomass, measured as Chlorophyll *a,* shows similar patterns in 2008 and 2009 with concentrations decreasing between upstream and the middle site and then increasing significantly again further downstream. In 2021, successively large increases were observed moving from upstream to middle to downstream sites (Figure 25).

The One Plan target for the Mangaehuehu Stream of 50 mg/m^2 was met upstream and at the middle site in all three years sampled and at the downstream site in 2009. The One Plan target was marginally exceeded at the downstream site in both 2008 (56 mg/m^2) and again in 2021 (56 mg/m^2).

Sites upstream and downstream of the discharge did differ slightly in that upstream is more open with smaller substrates compared to the two downstream sites. However, while this may partly explain the decrease in algal biomass observed at the first downstream site in 2008 and 2009, the pattern was not repeated in 2021, and it does not explain the increase seen further downstream in all years. Furthermore, thin diatom mats or clean substrates dominated sites in all years. Nutrient inputs from the discharge are a possible cause although the SIN concentration increases downstream were very small (3%) and DRP concentrations did not differ much between upstream and downstream sites. Most of the SIN in the stream is under the form of nitrate-nitrogen, which is not typically associated with direct WWTP discharges. The sources of nitrate into the stream are not well understood or quantified, but it is possible that there are inputs via groundwater from the ponds, the drainage channel and surrounding farmland.

Periphyton cover (Thick diatom mats and Long Filamentous algae)

- Periphyton communities visually assessed showed consistently low cover by "nuisance" growth algal types, with substrates at all sites predominantly clean or covered in a thin diatom mat (Figure 26).
- Cover by thick mats was only visible at the downstream sites in 2021, albeit at very low levels (6 % cover).
- No long filamentous algae were observed at any of the sites on any of the three sampling occasions.

Assessment against NPS-FM 2020 Attribute State

Assessment against the NPS-FM (2020) for periphyton requires grading to be based on a minimum of three years' worth of monthly sampling data (refer Appendix C, Table 6). Insufficient data were available to allow this assessment.

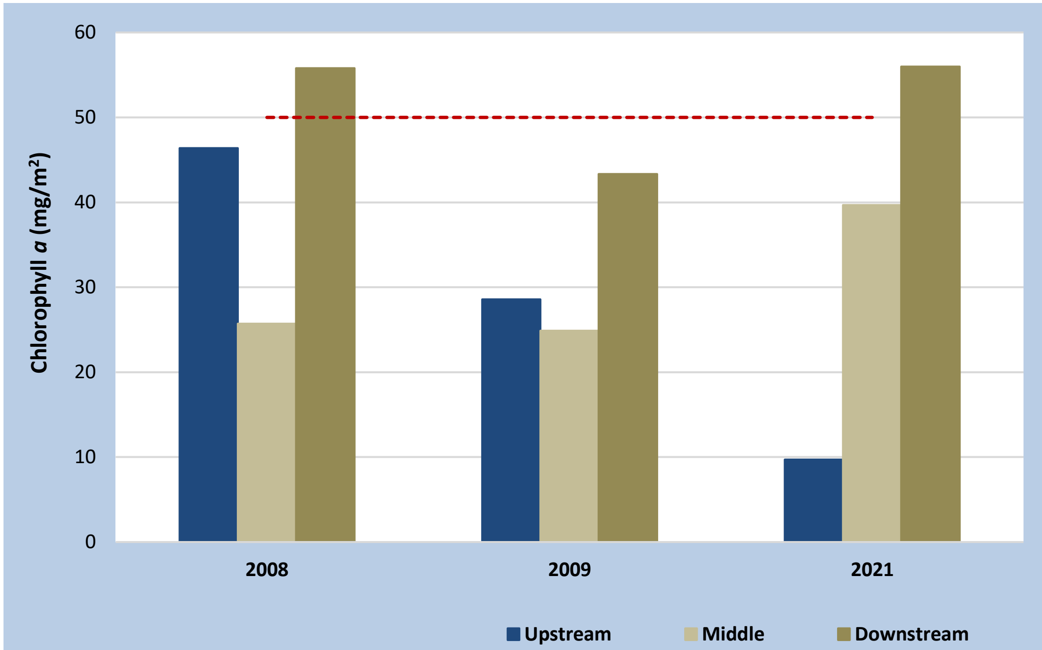

Figure 25: Mean periphyton biomass, measured as Chlorophyll *a* (mg/m²) for sites sampled on the Mangaehuehu Stream (2008, 2009 and 2021), upstream and downstream of the Rangataua WWTP. Red lines indicate the MfE guidelines and One Plan target.

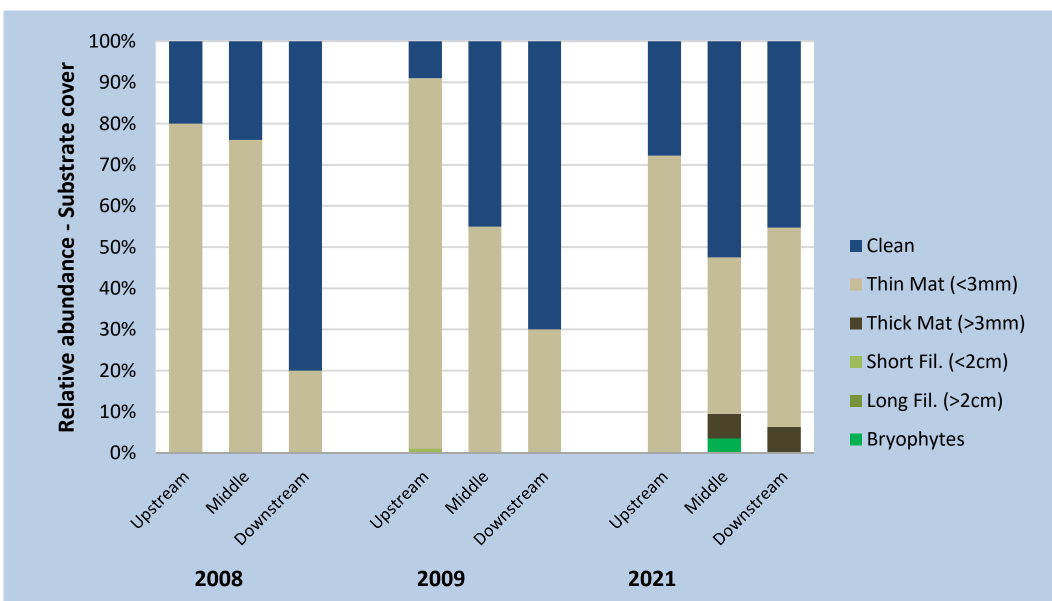

Figure 26: Periphyton communities visually assessed at sites sampled on the Mangaehuehu Stream in 2008, 2009 and 2021, upstream and downstream of the Rangataua WWTP.

5.2.2. Macroinvertebrate communities

Macroinvertebrate community composition in the Mangaehuehu Stream was generally similar at sites upstream and downstream of the Rangataua WWTP in the three years sampled (Figure 27), although numbers of mayflies decreased at all sites in 2009 while numbers of stoneflies increased. Communities were dominated by EPT taxa: mayflies (mostly *Deleatidium* sp.), stoneflies (mostly *Zelandobius* sp. and *Zelandoperla* sp.) and caddisflies (mostly *Aoteapsyche* sp. and *Pycnocentria* sp.). Elmid beetles and chironomids (Orthocladiinae) were also present at all sites in reasonable numbers.

Biotic indices for sites sampled on the Mangaehuehu Stream in 2008, 2009 and 2021 are shown in Figure 28 and Figure 29 and summarised in Appendix D. Sites upstream and downstream of the Rangataua WWTP ponds had instream communities indicative of good to excellent water quality in all years sampled.

Biotic indices differed from year to year, as would be expected, however there were no significant differences in the indices between sites, except for a decrease in % EPT (Individuals) and ASPM between the upstream and 800 m downstream sites.

The One Plan “State of the Environment monitoring” target for MCI (a score of 120) was met at all sites on the Mangaehuehu Stream in each year sampled.

The One Plan target of no more than a 20% reduction between upstream and downstream of a point source discharge was also met between sites in all years.

Assessment against NPS-FM 2020 Attribute States

The NPS-FM 2020 describes four “Attribute States” for macroinvertebrates defined by the median value of annual MCI and QMCI scores over five years (refer Appendix C, Table 7) and by the 5-year median score of the Average Score by Metric (ASPM) (refer Appendix C, Table 8).

Assessment for macroinvertebrate communities in the Mangaehuehu Stream assign Attribute state gradings as per Table 14.

If we consider all three indices (MCI, QMCI and ASPM) sites upstream and downstream of the Rangataua WWTP fell mostly into Attribute State A in 2008 and 2009, while in 2021 all sites were mostly in Attribute State B. This reflects macroinvertebrate communities indicative of pristine conditions with almost no (Band A) or mild (Band B) organic pollution or nutrient enrichment.

Note that macroinvertebrate data for the Mangaehuehu Stream is limited to only three years, therefore this NPS-FM assessment should be considered preliminary.

Overall results indicate that the discharge from the Rangataua WWTP may be having some effect on periphyton communities but does not appear to be affecting macroinvertebrate communities in this stretch of the Mangaehuehu Stream.

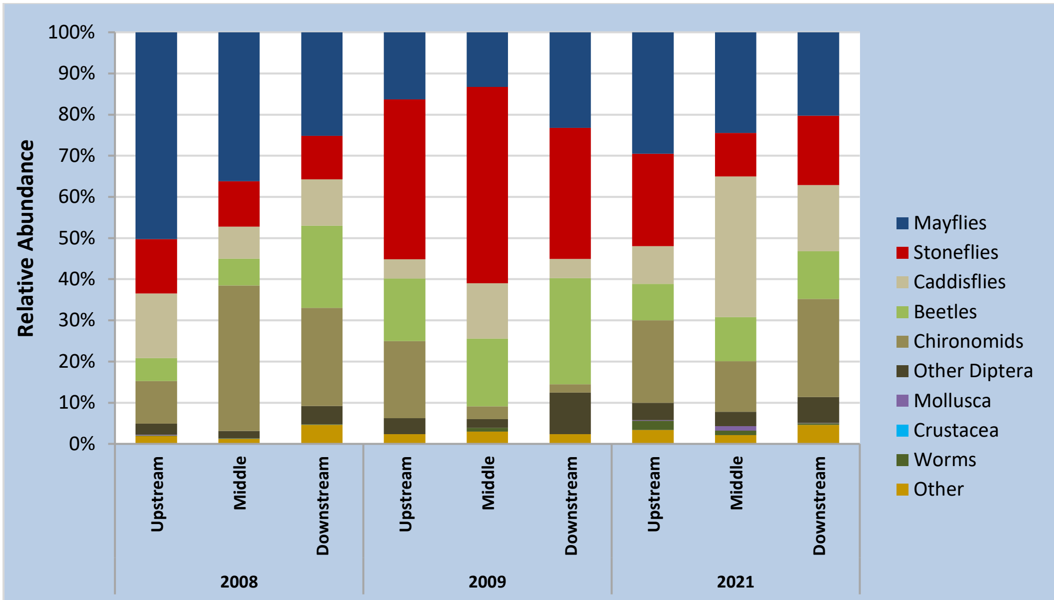

Figure 27: Relative abundance of the main taxonomic groups for the sites sampled on the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP discharge in 2008, 2008 and 2021.

Table 14: Assessment against NPS-FM (2020) for macroinvertebrate communities sampled on the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP discharge in 2008, 2009 and 2021.

	MCI			QMCI			ASPM		
	Upstream	Middle	Downstream	Upstream	Middle	Downstream	Upstream	Middle	Downstream
2008	A	A	A	A	B	B	A	B	B
2009	A	B	A	A	A	A	B	B	B
2021	A	B	B	B	B	B	B	B	B

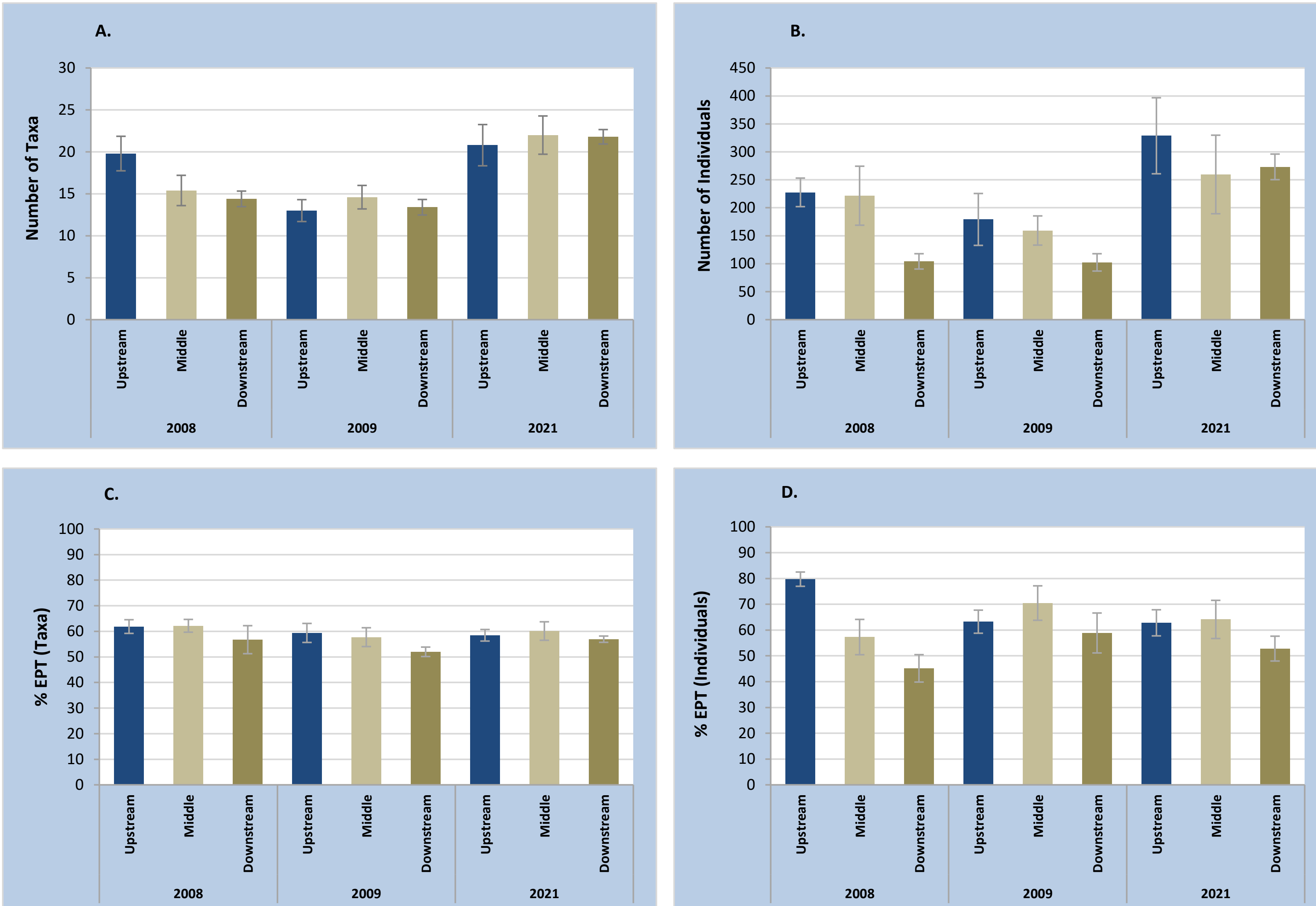

Figure 28: Mean (± 1 SE) A. Number of Taxa, B. Number of Individuals, C.% EPT Taxa and D. % EPT Individuals for the sites sampled on the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP discharge in 2008, 2009 and 2021 (U/S: Upstream, D/S 1: 400 m Downstream and D/S 2: 800 m Downstream).

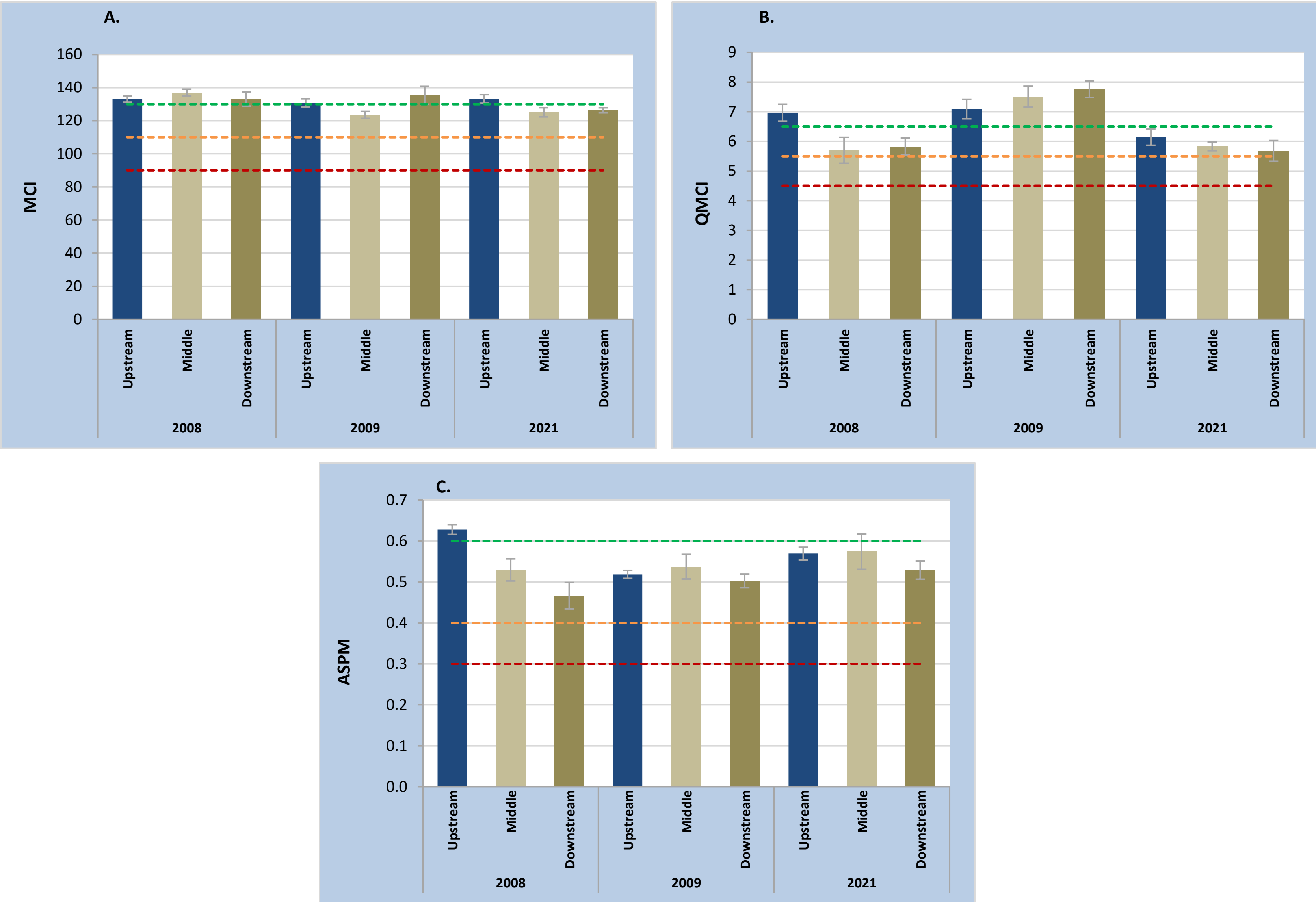

Figure 29: Mean (± 1 SE) A. MCI, B. QMCI and C. ASPM for sites sampled on the Mangaehuehu Stream upstream and downstream of the Rangataua WWTP discharge in 2008, 2009 and 2021 (U/S: Upstream, D/S 1: 400 m Downstream and D/S 2: 800 m Downstream). Dashed lines indicate NPS-FM (2020) Attribute State bands.

5.2.3. Fish communities

A search of the NZ Freshwater Fish database identified three fish species as being present in the Mangaehuehu Stream, these are listed in Table 15. Existing fish records show brown trout to dominate the Mangaehuehu and nearby streams. The most recent records date back to a spotlighting survey in 2012.

Table 15: Fish species observed in the Mangaehuehu Stream, from a search of the New Zealand Freshwater Fish Database.

Scientific name	Common name
Salmo trutta	Brown trout
Paranephrops spp.	Koura
Anguilla dieffenbachii	Longfin eel

5.3. Potential effluent load contributions to instream concentrations

The risks of effects posed by a point-source discharge on water quality/ecology are primarily associated with the contaminant loads in the discharge. Daily loads for key contaminants currently discharged from the Rangataua WWTP were estimated for the period 2012-2021 (Table 16). Load estimates were based on the maximum of 12- and 24-month rolling median and 95th percentile values calculated using historical effluent data (quantity and quality).

Table 16: Current daily load estimates for key contaminants discharged from the Rangataua WWTP, 2012-2021.

		Overall		Maximum of rolling 12-month		Maximum of rolling 24-month	
Parameter	**Unit**	**Median**	**95th Percentile**	**Median**	**95th Percentile**	**Median**	**95th Percentile**
Ammoniacal-N	kg/d	0.27	1.76	1.04	2.08	0.70	1.72
Nitrate-N	kg/d	0.003	0.03	0.01	0.16	0.01	0.12
SIN	kg/d	0.28	1.80	1.05	2.08	0.72	1.99
DRP	kg/d	0.06	0.25	0.12	0.46	0.10	0.35
TSS	kg/d	0.47	6.02	2.26	9.24	1.48	8.51
$ScBOD_5$	kg/d	0.07	0.65	0.38	0.90	0.23	0.87

Increases in downstream concentrations expected in the Mangaehuehu Stream as a result of predicted effluent loads for key water quality parameters were calculated on the basis of two scenarios:

3. Maximum 12-month median contaminant load from the discharge when the Mangaehuehu Stream is at Mean Annual Low Flow (MALF); and
4. Maximum 12-month 95th percentile load from the discharge when the Mangaehuehu Stream is at Median flow.

Results based on 12-month rolling median and 95th percentile values are shown in Table 17.

Table 17: Predicted instream concentration increases (based on maximum 12-month rolling median and 95th percentile load values) caused by the Rangataua WWTP discharge to the Mangaehuehu Stream after full mixing, at Mean Annual Low Flow (MALF) and at Median flows.

Parameter	Unit	In stream concentration increases Stream at MALF (0.406 m^3/s), Median discharge load	In stream concentration increases Stream at Median flow (0.808 m^3/s) 95th Percentile discharge load
Ammoniacal-N	g/m^3	0.030	0.030
Nitrate-N	g/m^3	0.0004	0.002
SIN	g/m^3	0.030	0.030
DRP	g/m^3	0.003	0.007
TSS	g/m^3	0.065	0.132
$ScBOD_5$	g/m^3	0.011	0.013
POM	g/m^3	0.057	0.131

The Mangaehuehu Stream upstream of the Rangataua WWTP currently presents low concentrations of ammoniacal-N and nitrate-N (refer Section 5.1) and is in Band A for both the ammonia and nitrate NPS-FM Attributes. Predicted increases in instream concentrations of ammoniacal- and nitrate- nitrogen are also low and well below the One Plan targets and the NPS-FM thresholds for Band A (indicative of no observed effect on any species tested). However, we cannot discount the fact that the small SIN concentration increases currently observed downstream are possibly, at least in part, associated with the Rangataua WWTP discharge.

Water quality data for the Mangaehuehu Stream indicate that DRP concentrations are elevated both upstream and downstream of the WWTP and exceed the One Plan target. This is a natural feature of streams and rivers in the area, where the phosphorus rich geology provides natural sources of dissolved phosphorus into waterbodies. Maximum increases in DRP concentrations predicted are in the order of 0.003 g/m^3. While these concentration increases might be detectable at times if they were to occur against very low background concentrations, it is doubtful whether they would be detectable against the naturally elevated DRP concentrations currently observed.

TSS concentrations were much higher downstream of the discharge between 2012 and 2021, while $ScBOD_5$ and POM concentrations were generally similar between upstream and downstream sites.

Predicted concentration increases in TSS and $ScBOD_5$ are very small and would not be expected to be detected against the natural background levels observed. Any associated effects on visual water clarity or heterotrophic growth are expected to be immaterial. This indicates that the decreases in visual clarity and increases in TSS observed between upstream and downstream sites are unlikely to be caused by the discharge.

In-stream data shows that effects of the discharge on water quality and ecology in the Mangaehuehu Stream have for the most part been less than minor, and within the One Plan targets since 2012, although we cannot discount the possibility that nutrients from the discharge may be having some effect on periphyton growth downstream of the ponds and discharge channel confluence, albeit via groundwater pathways.

In principle, as long as the contaminant loads in the discharge do not increase, the effects on water quality/ecology should remain similar to what they currently are. However, it would be worth undertaking additional monitoring if /when any material increase in contaminant loads were to occur, to assess actual effects on the basis of monitoring data.

6. Conclusions

From monitoring data collected between January 2012 and June 2021 within, upstream and downstream of the Rangataua WWTP ponds and discharge, the following conclusions have been made about the effects of the discharge on water quality and ecology of the Mangaehuehu Stream.

Effluent treatment and quality

The Rangataua WWTP treatment process involves passage through primary and secondary ponds, and a small, constructed wetland area before being discharged into the Mangaehuehu Stream via an old drainage channel, approximately 570 m long. This channel dries up during summer periods and the effluent discharged during dry summer periods does not appear to reach the Mangaehuehu Stream via surface flow.

Discharge volumes from the Rangataua WWTP are typically higher over winter months and into spring exceeding the currently consented daily volume of 29 m^3/day, but then decrease over summer months falling below the discharge volume currently allowed by consent.

Effluent quality after the oxidation pond process appears consistent with other similar wastewater plants, with Ammoniacal-nitrogen, Nitrate-nitrogen and SIN appearing to follow seasonal patterns (higher concentrations observed over winter and lower concentrations during summer months).

Receiving Environment – Current effects:

Monitoring Sites

Water quality and ecology of the Mangaehuehu Stream were at three locations:

- Upstream of the WWTP, near the railway bridge (Upstream Site)
- Approximately 240m upstream of the point where the drainage channel meets the Mangaehuehu Stream but downgradient of the WWTP (Middle Site)
- Approximately 120m downstream of the point where the drainage channel meets the Mangaehuehu Stream (Downstream Site)

The reach of the Mangaehuehu Stream between the upstream and downstream sites flows through farm land, and, as of April 2021, livestock appear to have relatively unrestricted access to the drainage channel carrying the discharge and most of the Mangaehuehu Stream channel along this reach. Whilst there was no evidence of livestock access at the Upstream site, there were clear signs of recent stock presence, particularly on both sides of the Mangaehuehu Stream at the Downstream site. As a result, water quality and ecology at the middle and downstream sites will include any effects of contaminants from the WWTP but will also include contaminants from the surrounding farmed land and direct effects of stock access to the drainage channel and stream. This must be considered when using in-stream monitoring results to assess the effects of the WWTP discharge.

I. Water quality:

Results from monitoring of current sites on the Mangaehuehu Stream between 2012 and 2021 indicate that for:

- Total ammoniacal nitrogen concentrations were generally similar with no significant differences between sites upstream and downstream on the Mangaehuehu Stream and concentrations remained below relevant One Plan targets at both sites.
- Nitrate-nitrogen and SIN annual average concentrations showed small but statistically significant increases (3% increase from 0.180 g/m^3 upstream to 0.186 g/m^3 at D/S A, and 1% increase between the middle (0.193 g/m^3) and D/S B (0.195 g/m^3) sites).
- DRP concentrations were similar with no significant differences between sites but exceeded the One Plan target on all sampling occasions at all sites. Streams in the central plateau area generally display naturally elevated DRP concentrations, due to the volcanic geology in the area.
- Median *E.coli* concentrations remained within the One Plan targets both upstream and downstream of the Rangataua WWTP discharge in all flow 'bins'. When considering 95th percentile concentrations, the One Plan target of 550 *E. coli* /100mL at flows below the 20th FEP was also met at all sites. However, the One Plan target of 260 *E. coli*/100mL at flows below median flow in summer was exceeded at all sites. There were no significant differences between sites within each season but there were significant decreases from summer to winter months.
- Visual clarity was less than the One Plan target of 3 m at flows below median flow at all sites, and decreased significantly between the Upstream and Downstream sites. The One Plan target of no more than 20% reduction in visual clarity was regularly exceeded. TSS concentrations also increased significantly between Upstream and Downstream sites.

- $ScBOD_5$ and POM did not differ significantly between the middle and D/S B sites and were generally compliant with relevant One Plan targets. No seasonal differences were observed.
- Water pH and temperature generally complied with relevant One Plan targets.
- DO saturation remained above the One Plan target of 80% on all monitoring occasions, with small but statistically significant increases observed between upstream and D/S A sites. It should be noted that the DO data available are day-time 'spot' measurements, which do not provide any indication of night-time minima or potential stress to the ecosystem.

Assessment against the NPS-FM (2020) Attribute States for Ammonia, Nitrate, DRP, *E.coli* and suspended sediment:

- Confirm a low risk of toxic effects from ammonia,
- Suggests a high conservation value system where any effects of nitrate toxicity are unlikely even on sensitive species,
- Suggests ecological communities could be impacted by moderate DRP elevation which may cause increased algal growth and loss of sensitive macroinvertebrate and fish taxa, noting however, that the elevated DRP concentrations in the Mangaehuehu Stream reflect natural conditions and are likely the result of natural sources of phosphorus associated with volcanic geology,
- Represents a low risk of effects from *E.coli,* with for at least half the time, the estimated risk of campylobacter infection at both upstream and downstream sites less than 1 in 1,000 (1-2% risk),
- Represents minimal impact of suspended sediment on instream biota,
- No assessment could be made for DO or periphyton as required data (DO: daily minima over seven consecutive days and Periphyton: monthly biomass over minimum of three years) are not available.

Existing monitoring data collected in the Mangaehuehu Stream indicates that there are few detectable changes in concentrations of any of the key discharge constituents in the stream between upstream and downstream sites. The data does indicate however small increases in nitrate and SIN concentrations and a material decrease in visual clarity between upstream and downstream. These are discussed further in the interpretation section below.

II. Ecology:

Periphyton results indicate:

- Periphyton biomass measured as Chlorophyll *a,* shows similar patterns in 2008 and 2009 with concentrations decreasing between upstream and middle sites and then increasing again further downstream. In 2021, increases were observed moving from upstream to downstream sites.
- The One Plan target for the Mangaehuehu Stream of 50 mg/m^2 was met upstream and at the middle site in all three years and at the site downstream in 2009, but was marginally exceeded at downstream in both 2008 (56 mg/m^2) and again in 2021 (56 mg/m^2). Assessing whether the One Plan target is met overall at any of the sites would require regular (monthly) monitoring data.

- Periphyton communities visually assessed showed consistently low cover by "nuisance" algal growth. Visual cover showed substrates to be mostly clean or covered in thin diatom mats in all years. No long filamentous algae were observed at any of the sites in any year sampled, and cover by thick mats, when observed, remained low.
- Assessment against the NPS-FM (2020) periphyton Attributes requires monthly monitoring data, and could not be carried out on the basis of available data (3 individual sampling occasions).

Macroinvertebrate results indicate:

- Macroinvertebrate communities at sites both upstream and downstream of the Rangataua WWTP discharge are indicative of good to excellent water quality.
- No significant differences between sites were observed for any of the biotic indices apart from a decrease in % EPT Individuals and ASPM between the upstream and downstream sites.
- One Plan targets for MCI and QMCI were met in all years sampled.
- Assessment against the NPS-FM (2020) when considering all three indices MCI, QMCI and ASPM, shows sites upstream and downstream of the Rangataua WWTP fell mostly into Attribute State A in 2008 and 2009, while in 2021 all sites were mostly in Attribute State B. This reflects macroinvertebrate communities indicative of pristine conditions with almost no (Band A) or only mild (Band B) organic pollution or nutrient enrichment.

Overall, results of ecological monitoring do not indicate more than minor effects on macroinvertebrate communities (indicative of ecological health) or periphyton cover (indicative of aesthetic and recreational values), but indicate an increase in periphyton biomass between upstream and downstream, at times exceeding the One Plan target.

The One Plan target and NPS-FM periphyton biomass attributes are not designed to be compared to single sample results, and regular (monthly) monitoring data would be required to confirm whether the One Plan target is met or exceeded and the NPS-FM Attribute state band each site falls into.

Receiving Environment – Load contributions to predicted instream concentrations

The risks of effects posed by a point-source discharge on water quality/ecology are primarily associated with the contaminant loads in the discharge and the increases in in-stream concentrations these may cause. To estimate the potential effects of the Rangataua WWTP discharge on in-stream concentrations of key contaminants, daily loads of key contaminants in the discharge were estimated, and potential increases in downstream concentrations were calculated on the basis of two scenarios:

5. Median contaminant load from the discharge when the Mangaehuehu Stream is at Mean Annual Low Flow (MALF); and
6. 95th percentile load from the discharge when the Mangaehuehu Stream is at Median flow.

These scenarios are considered highly environmentally conservative, for two reasons:

(3) they assume combinations of discharge loads and stream flows that are likely to be at the "higher" end of conditions realistically encountered. For example, data indicates that the discharge from the oxidation ponds decreases and often stops during dry periods in summer. Assuming median contaminant discharge load values enter the stream when it is under very low flow conditions is therefore likely to overestimate the actual effects of the discharge.

(4) the mass balance calculations assume that all of the contaminant loads exiting the oxidation ponds enter directly the Mangaehuehu Stream (i.e. zero attenuation/removal by passage through the constructed wetland, drainage channel and/or groundwater is assumed).

Predicted increases in downstream concentrations of Nitrate-N, TSS and $ScBOD_5$ were very small, well below normal laboratory detection limits and would be highly unlikely to be detected against the background concentrations currently observed.

Although these findings are consistent with monitoring results for $ScBOD_5$ (no significant increases identified), they are in contradiction of monitoring results for Nitrate-N and TSS (for which increases were detected). This indicates that the concentration increases measured in-stream are unlikely to have been caused (or even significantly contributed to) by the WWTP discharge.

Moderate potential concentration increases in DRP and ammoniacal-N were predicted, which could at times, be detectable; however significant increases were not detected for either of these parameters.

Interpretation and recommendations

Overall, monitoring results do not point to more than minor detrimental changes in water quality and ecological health of the Mangaehuehu Stream between upstream and downstream of the Rangataua WWTP, with the notable exceptions of the significant reductions in water clarity (and increases in TSS) and increases in periphyton biomass measured between upstream and downstream.

Mass-balance calculations based on environmentally conservative scenarios indicate that the discharge from the WWTP does not have the potential to cause more than very minor increases in TSS concentrations in the stream. This indicates that causes other than the Rangataua WWTP discharge are likely responsible for the measured changes in TSS concentrations and water clarity. Given the unrestricted stock access to the drainage channel and stream banks along this reach of the stream, it seems likely that bank pugging and erosion and stream bed disturbance by livestock are the main cause of the water clarity change. This may need to be investigated further or addressed, although possibly separately from the WWTP re-consenting process.

Increases in periphyton biomass were measured on each the three monitoring occasions. On two of these occasions, the downstream site marginally exceeded the One Plan target. These data are too limited to draw firm conclusions on whether the One Plan target is exceeded or met, or what NPS-FM Attribute State each site falls within. It is recommended that additional, regular monitoring be undertaken to enable a robust assessment.

The increases in periphyton biomass may be caused by either, or a combination of, differences in habitat and/ or nutrient availability at the different sites. Whilst habitat differences were noted between sites, it is unclear whether, or how, these contribute to the measured changes. Given the relatively high natural background DRP concentrations, the growth of periphyton in the Mangaehuehu Stream is likely to be nitrogen limited. The DRP from the discharge is unlikely to be materially increasing the growth of periphyton in the stream. The increases in SIN concentrations measured downstream of the discharge, although very small (1-3% over background concentrations) may, however, contribute to the increase in periphyton growth. The contribution of the Rangataua WWTP to the in-stream vs. that of the adjacent land use may also need to be investigated further.

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APPENDICES

Appendix A:

Summary of effluent data discharged from Rangataua WWTP, January 2012 to May 2021.

Rangataua WWTP Effluent	Ammon-N (g/m^3)	Nitrate-N (g/m^3)	Nitrite-N (g/m^3)	SIN (g/m^3)	TN (g/m^3)	DRP (g/m^3)	TP (g/m^3)	E.coli (/100mL)	TSS (g/m^3)	$cBOD_5$ (g/m^3)	$ScBOD_5$ (g/m^3)	pH	Temperature (°C)	DO conc. (g/m^3)
Average	11.7	0.300	0.107	11.9	18.5	2.4	3.6	2,397	52.0	19.8	4.3	7.7	14.0	6.9
Min	0.2	0.005	0.001	0.3	2.0	0.7	1.8	0	1.5	1.0	0.5	5.0	4.6	0.3
5%ile	1.1	0.018	0.006	1.4	10.2	1.2	2.2	8	6.8	5.6	1.5	6.7	7.2	1.2
10%ile	1.9	0.035	0.012	2.5	11.1	1.3	2.3	25	10.9	7.2	1.8	6.7	8.1	2.8
20%ile	3.4	0.081	0.021	4.0	13.4	1.7	2.7	63	20.0	12.0	2.1	7.1	9.0	4.2
25%ile	5.2	0.100	0.029	5.5	14.0	1.8	2.8	90	26.3	12.0	3.0	7.1	9.7	4.5
50%ile (median)	11.7	0.204	0.061	12.0	17.9	2.3	3.6	330	42.0	18.0	4.0	7.6	13.8	6.9
75%ile	16.9	0.364	0.115	16.9	22.0	3.1	4.2	1,500	61.8	23.0	5.2	8.0	17.8	9.1
90%ile	22.2	0.720	0.250	22.6	28.0	3.7	5.1	5,020	100.0	32.3	7.1	8.7	20.6	10.6
95%ile	24.0	1.010	0.390	24.3	31.0	4.0	5.6	9,700	139.6	46.9	8.0	9.3	22.6	11.8
Max	29.8	2.150	0.968	29.8	36.0	4.4	7.5	65,000	320.0	74.0	22.0	10.8	28.9	21.7
StdDev	7.4	0.312	0.145	7.3	6.4	0.9	1.1	7,092	42.9	12.3	2.6	0.9	5.1	3.6
95% C.I.	1.2	0.051	0.024	1.2	1.1	0.1	0.2	1,175	5.8	2.3	0.4	0.2	1.0	0.7
N. of Samples	141	141	141	141	141	141	141	140	210	1	139	104	107	107

Appendix B:

Summary of data from the for sites sampled on the Mangaehuehu Stream upstream of the WWTP ponds (Upstream) and downstream of the ponds and discharge channel (D/S A) at different flows, January 2012 to May 2021 (Horizons data). Assessment against Horizons One Plan targets is shown along with results from Wilcoxon Tests, where significant differences (P < 0.005) are indicated in red.

Table 1: -Mangaehuehu Stream Upstream and Downstream A of Rangataua WWTP, at ALL FLOWS.

All Flows	Ammon-N (g/m³)		Nitrate-N (g/m³)		Nitrite-N (g/m³)		SIN (g/m³)		TN (g/m³)		DRP (g/m³)		TP (g/m³)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	0.005	0.005	0.167	0.173	0.003	0.003	0.175	0.182	0.230	0.236	0.020	0.020	0.027	0.027
Min	0.000	0.000	0.001	0.027	0.001	0.000	0.008	0.033	0.090	0.084	0.005	0.004	0.012	0.013
5%ile	0.000	0.000	0.042	0.051	0.001	0.001	0.045	0.057	0.133	0.124	0.007	0.009	0.016	0.016
10%ile	0.000	0.001	0.053	0.063	0.001	0.001	0.063	0.071	0.140	0.141	0.010	0.011	0.017	0.017
20%ile	0.001	0.002	0.110	0.116	0.001	0.001	0.117	0.122	0.164	0.170	0.013	0.013	0.019	0.019
25%ile	0.002	0.004	0.120	0.121	0.001	0.001	0.129	0.134	0.178	0.180	0.014	0.014	0.020	0.019
50%ile (median)	0.005	0.005	0.161	0.167	0.002	0.002	0.167	0.176	0.220	0.230	0.018	0.018	0.025	0.024
75%ile	0.005	0.005	0.218	0.216	0.003	0.004	0.225	0.222	0.280	0.279	0.024	0.024	0.032	0.032
90%ile	0.007	0.009	0.271	0.282	0.006	0.006	0.282	0.289	0.350	0.343	0.035	0.035	0.039	0.038
95%ile	0.010	0.013	0.309	0.312	0.009	0.009	0.316	0.318	0.377	0.400	0.039	0.036	0.044	0.046
Max	0.029	0.026	0.380	0.380	0.023	0.023	0.386	0.386	0.410	0.470	0.048	0.062	0.068	0.062
StdDev	0.004	0.004	0.080	0.077	0.003	0.004	0.081	0.078	0.075	0.081	0.009	0.009	0.010	0.010
95% C.I.	0.001	0.001	0.015	0.015	0.001	0.001	0.015	0.015	0.014	0.015	0.002	0.002	0.002	0.002
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					14%	10%			1%	1%		
N. of Samples	108	108	108	108	108	108	108	108	108	108	108	108	108	107
Wilcoxon		*1.974*		*3.296*		*1.585*		*3.474*		*3.309*		*0.797*		*0.287*
P value		*0.048*		*0.001*		*0.113*		*0.001*		*0.001*		*0.425*		*0.774*

Table 1: continued

All Flows	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		cBOD$_5$ (g/m^3)		ScBOD$_5$ (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	94	81	142	109	2.5	2.1	5.0	3.6	2.1	4.2	1.7	2.8				
Min	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.4	0.4	0.0	0.0				
5%ile	2.0	4.0	4.0	10.0	0.9	0.8	1.0	1.0	0.5	0.5	0.0	0.0				
10%ile	4.0	7.4	8.9	12.0	1.3	1.2	1.5	1.0	0.6	0.7	1.0	1.0				
20%ile	8.0	9.2	12.0	23.4	1.7	1.6	1.5	1.5	0.8	0.8	1.0	1.0				
25%ile	8.0	12.0	16.0	30.0	2.1	1.7	1.5	1.5	0.9	1.0	1.5	1.4				
50%ile (median)	21.0	30.0	36.5	48.0	2.5	2.0	1.5	1.5	1.3	1.3	1.5	1.5				
75%ile	58.3	80.0	92.8	127.5	3.1	2.5	3.1	3.0	1.9	1.8	1.5	1.5				
90%ile	179	233	221	254	3.9	3.0	8.2	7.1	3.3	3.1	2.0	3.0				
95%ile	277	350	274	443	4.4	3.3	17.6	11.7	4.8	4.7	3.9	4.9				
Max	2,900	630	2,900	630	5.0	3.9	98.0	52.0	52.0	279.0	15.0	130.0				
StdDev	316	128	429	140	1.0	0.8	12.2	6.7	5.0	26.7	1.8	12.4				
95% C.I.	60	24	114	37	0.2	0.2	2.3	1.3	0.9	5.0	0.3	2.3				
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	97%	98%	93%	89%	71%	84%					95%	94%				
N. of Samples	108	108	54	54	85	80	108	108	108	108	108	108	0	0	0	0
Wilcoxon		*2.447*		*1.711*		*5.379*		*0.661*		*0.101*		*0.968*				
P value		*0.014*		*0.087*		*0.000*		*0.509*		*0.919*		*0.333*				

Table 1: continued

All Flows	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	7.4	7.4	8.8	8.9	98.3	99.7	10.6	10.8
Min	6.3	6.3	3.7	3.6	81.8	81.4	9.1	9.2
5%ile	6.7	7.0	4.7	4.9	91.3	92.7	9.4	9.6
10%ile	7.0	7.0	5.4	5.5	94.5	96.3	9.6	9.7
20%ile	7.2	7.3	6.2	6.3	97.3	99.3	9.9	9.9
25%ile	7.3	7.3	6.6	6.7	98.0	99.6	10.0	10.1
50%ile (median)	7.4	7.5	8.4	8.3	99.0	100.3	10.7	10.8
75%ile	7.6	7.6	10.9	11.0	99.8	101.0	11.2	11.3
90%ile	7.7	7.7	13.0	13.0	100.7	101.8	11.5	11.7
95%ile	7.9	7.7	13.4	13.5	101.6	102.5	11.8	11.9
Max	8.2	8.4	15.3	15.9	107.4	111.8	13.2	13.0
StdDev	0.3	0.3	2.8	2.9	3.4	3.4	0.8	0.8
95% C.I.	0.1	0.1	0.5	0.5	0.6	0.6	0.1	0.1
One Plan target	7 - 8.2		< 19		>80			
% Compliance	87%	90%	100%	100%	100%	100%		
N. of Samples	108	108	108	108	108	108	108	108
Wilcoxon		*4.022*		*3.024*		*6.922*		*7.870*
P value		*0.000*		*0.003*		*0.000*		*0.000*

Table 2: -Mangaehuehu Stream Upstream and Downstream A of Rangataua WWTP, at FLOWS ABOVE 20TH FEP (> 9,205 L/s).

Above 20th FEP	Ammon-N (g/m³)		Nitrate-N (g/m³)		Nitrite-N (g/m³)		SIN (g/m³)		TN (g/m³)		DRP (g/m³)		TP (g/m³)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	0.005	0.007	0.135	0.146	0.002	0.002	0.141	0.155	0.233	0.235	0.012	0.012	0.026	0.023
Min	0.000	0.002	0.001	0.034	0.001	0.001	0.008	0.042	0.108	0.119	0.006	0.006	0.015	0.013
5%ile	0.000	0.002	0.030	0.046	0.001	0.001	0.034	0.051	0.130	0.135	0.007	0.007	0.016	0.015
10%ile	0.001	0.002	0.046	0.059	0.001	0.001	0.048	0.065	0.144	0.149	0.007	0.008	0.016	0.016
20%ile	0.001	0.003	0.065	0.086	0.001	0.001	0.072	0.107	0.158	0.168	0.009	0.010	0.018	0.018
25%ile	0.003	0.004	0.084	0.103	0.001	0.001	0.092	0.119	0.160	0.170	0.009	0.010	0.018	0.019
50%ile (median)	0.005	0.005	0.127	0.128	0.001	0.002	0.133	0.139	0.237	0.180	0.010	0.012	0.021	0.021
75%ile	0.005	0.007	0.177	0.185	0.003	0.003	0.183	0.201	0.300	0.311	0.015	0.014	0.031	0.023
90%ile	0.008	0.016	0.229	0.242	0.003	0.004	0.235	0.248	0.352	0.346	0.016	0.016	0.035	0.029
95%ile	0.009	0.021	0.263	0.273	0.004	0.005	0.269	0.279	0.363	0.365	0.017	0.017	0.044	0.037
Max	0.010	0.023	0.304	0.314	0.004	0.006	0.310	0.320	0.370	0.400	0.020	0.020	0.061	0.053
StdDev	0.003	0.006	0.080	0.077	0.001	0.001	0.080	0.076	0.087	0.089	0.004	0.004	0.012	0.010
95% C.I.	0.001	0.003	0.040	0.039	0.001	0.001	0.041	0.039	0.044	0.045	0.002	0.002	0.006	0.005
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					20%	13%			0%	0%		
N. of Samples	15	15	15	15	15	15	15	15	15	15	15	15	15	14
Wilcoxon		*1.274*		*2.271*		*1.153*		*2.527*		*1.067*		*0.612*		*0.471*
P value		*0.203*		*0.023*		*0.249*		*0.012*		*0.286*		*0.541*		*0.638*

Table 2: continued

<u>Above 20th FEP</u>	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	87	85	25	66	1.7	1.7	20.1	9.5	6.3	21.3	3.6	11.6				
Min	4.0	4.0	16.0	12.0	0.5	0.5	1.5	0.1	1.0	1.1	1.5	1.0				
5%ile	4.0	4.0	16.9	17.4	0.5	0.5	1.5	0.7	1.1	1.1	1.5	1.4				
10%ile	5.6	4.8	17.8	22.8	0.6	0.6	1.5	1.2	1.1	1.2	1.5	1.5				
20%ile	14.4	7.6	19.6	33.6	0.8	0.7	1.5	1.5	1.3	1.5	1.5	1.5				
25%ile	16.5	10.0	20.5	39.0	0.8	0.8	2.8	1.5	1.7	1.6	1.5	1.5				
50%ile (median)	25.0	34.0	25.0	66.0	1.8	1.9	8.0	5.0	2.6	2.6	1.5	1.5				
75%ile	92.0	130.0	29.5	93.0	2.4	2.2	20.5	9.6	4.4	4.3	3.6	5.2				
90%ile	302	248	32	109	3.0	2.4	56.0	20.2	6.5	6.2	7.6	7.2				
95%ile	346	290	33	115	3.1	2.8	75.6	33.1	20.4	88.2	10.5	44.2				
Max	360	330	34	120	3.1	3.2	98.0	52.0	52.0	279.0	15.0	130.0				
StdDev	125	107	13	76	1.0	0.9	27.9	13.4	12.8	71.3	3.8	32.8				
95% C.I.	63	54	18	106	0.6	0.6	14.1	6.8	6.5	36.1	1.9	16.6				
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	100%	100%	100%	100%	80%	89%					80%	67%				
N. of Samples	15	15	2	2	10	9	15	15	15	15	15	15	0	0	0	0
Wilcoxon		*0.439*		*Too few untied*		*0.592*		*1.467*		*-0.028*		*1.050*				
P value		*0.660*				*0.554*		*0.142*		*0.977*		*0.294*				

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Table 2: continued

Above 20th FEP	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	7.2	7.2	6.8	6.8	96.3	99.9	10.9	11.2
Min	6.5	6.5	3.9	4.0	86.8	92.8	9.2	10.0
5%ile	6.8	6.8	4.8	4.8	91.2	95.2	9.8	10.2
10%ile	7.0	6.9	5.3	5.3	93.3	96.9	10.2	10.4
20%ile	7.1	7.0	5.4	5.5	94.0	98.1	10.6	10.8
25%ile	7.1	7.1	5.8	5.6	94.7	98.3	10.7	10.9
50%ile (median)	7.3	7.3	6.7	7.0	97.5	100.1	10.9	11.1
75%ile	7.4	7.4	7.3	7.4	98.9	100.8	11.2	11.7
90%ile	7.5	7.5	8.6	8.2	99.0	101.1	11.6	11.9
95%ile	7.5	7.6	9.4	9.1	99.3	104.4	11.6	12.2
Max	7.7	7.7	10.7	10.8	99.8	111.8	11.8	12.8
StdDev	0.3	0.3	1.6	1.6	3.4	4.0	0.7	0.7
95% C.I.	0.1	0.1	0.8	0.8	1.7	2.0	0.3	0.4
One Plan target	7 - 8.2		< 19		>80			
% Compliance	87%	80%	100%	100%	100%	100%		
N. of Samples	15	15	15	15	15	15	15	15
Wilcoxon		*0.738*		*0.839*		*3.379*		*3.379*
P value		*0.460*		*0.402*		*0.001*		*0.001*

Table 3: -Mangaehuehu Stream upstream and downstream of Rangataua WWTP, at FLOWS BELOW 20th FEP (< 9,205 L/s).

Below 20th FEP	Ammon-N (g/m³)		Nitrate-N (g/m³)		Nitrite-N (g/m³)		SIN (g/m³)		TN (g/m³)		DRP (g/m³)		TP (g/m³)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	0.005	0.005	0.172	0.178	0.003	0.003	0.180	0.186	0.229	0.236	0.021	0.021	0.028	0.027
Min	0.000	0.000	0.007	0.027	0.001	0.000	0.015	0.033	0.090	0.084	0.005	0.004	0.012	0.013
5%ile	0.000	0.000	0.044	0.051	0.001	0.001	0.047	0.058	0.135	0.126	0.009	0.010	0.016	0.016
10%ile	0.000	0.001	0.061	0.064	0.001	0.001	0.064	0.073	0.141	0.140	0.013	0.012	0.017	0.017
20%ile	0.001	0.002	0.114	0.117	0.001	0.001	0.122	0.123	0.170	0.180	0.015	0.015	0.020	0.019
25%ile	0.002	0.004	0.130	0.130	0.001	0.001	0.136	0.142	0.180	0.187	0.016	0.016	0.021	0.020
50%ile (median)	0.005	0.005	0.166	0.170	0.002	0.002	0.174	0.192	0.220	0.230	0.019	0.019	0.025	0.026
75%ile	0.005	0.005	0.219	0.221	0.004	0.004	0.226	0.226	0.262	0.270	0.026	0.025	0.032	0.033
90%ile	0.007	0.008	0.277	0.288	0.007	0.007	0.284	0.296	0.348	0.339	0.036	0.036	0.040	0.039
95%ile	0.010	0.012	0.310	0.312	0.009	0.010	0.317	0.318	0.380	0.400	0.039	0.037	0.043	0.046
Max	0.029	0.026	0.380	0.380	0.023	0.023	0.386	0.386	0.410	0.470	0.048	0.062	0.068	0.062
StdDev	0.004	0.004	0.079	0.077	0.003	0.004	0.080	0.078	0.073	0.080	0.009	0.010	0.010	0.010
95% C.I.	0.001	0.001	0.016	0.016	0.001	0.001	0.016	0.016	0.015	0.016	0.002	0.002	0.002	0.002
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					13%	10%			1%	1%		
N. of Samples	93	93	93	93	93	93	93	93	93	93	93	93	93	93
Wilcoxon		*1.528*		*2.614*		*1.344*		*2.700*		*3.117*		*1.130*		*0.084*
P value		*0.127*		*0.009*		*0.179*		*0.007*		*0.002*		*0.259*		*0.934*

Table 3: continued

Below 20th FEP	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	95	80	147	111	2.7	2.2	2.5	2.7	1.5	1.5	1.4	1.4				
Min	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.4	0.4	0.0	0.0				
5%ile	2.0	4.0	4.0	9.7	1.2	1.0	1.0	1.0	0.5	0.5	0.0	0.0				
10%ile	4.0	8.0	8.3	12.0	1.5	1.2	1.4	1.0	0.6	0.6	0.2	0.2				
20%ile	5.6	11.4	12.0	26.0	2.1	1.6	1.5	1.5	0.8	0.8	1.0	1.0				
25%ile	8.0	12.0	16.0	30.0	2.2	1.7	1.5	1.5	0.9	0.9	1.0	1.0				
50%ile (median)	21.0	30.0	44.0	48.0	2.6	2.1	1.5	1.5	1.2	1.3	1.5	1.5				
75%ile	58.0	76.0	97.3	130.0	3.2	2.7	2.0	2.0	1.7	1.6	1.5	1.5				
90%ile	128	228	227	258	4.0	3.0	4.0	4.0	2.3	2.0	1.5	1.5				
95%ile	263	374	275	456	4.4	3.4	8.0	6.4	3.4	3.0	1.7	2.4				
Max	2,900	630	2,900	630	5.0	3.9	25.0	36.0	6.8	11.3	8.0	7.0				
StdDev	337	131	437	142	0.9	0.7	3.2	4.3	1.1	1.3	1.0	0.9				
95% C.I.	68	27	119	39	0.2	0.2	0.7	0.9	0.2	0.3	0.2	0.2				
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	97%	100%	92%	88%	69%	83%					98%	99%				
N. of Samples	93	93	52	52	75	71	93	93	93	93	93	93	0	0	0	0
Wilcoxon		*2.365*		*1.513*		*5.346*		*0.144*		*0.268*		*0.280*				
P value		*0.018*		*0.130*		*0.000*		*0.886*		*0.789*		*0.780*				

Table 3: continued

Below 20th FEP	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	7.4	7.5	9.2	9.3	98.6	99.7	10.6	10.7
Min	6.3	6.3	3.7	3.6	81.8	81.4	9.1	9.2
5%ile	6.7	7.0	4.8	4.9	91.4	92.7	9.4	9.5
10%ile	7.0	7.2	5.7	5.6	95.1	96.4	9.6	9.7
20%ile	7.3	7.4	6.4	6.4	98.1	99.5	9.8	9.9
25%ile	7.3	7.4	6.9	7.0	98.5	99.8	9.9	10.0
50%ile (median)	7.5	7.5	8.7	8.7	99.1	100.3	10.6	10.7
75%ile	7.6	7.6	11.6	11.9	100.0	101.1	11.2	11.3
90%ile	7.7	7.7	13.1	13.2	100.8	101.9	11.5	11.6
95%ile	7.9	7.7	13.6	13.7	102.2	102.5	11.8	11.9
Max	8.2	8.4	15.3	15.9	107.4	105.0	13.2	13.0
StdDev	0.3	0.3	2.9	2.9	3.3	3.3	0.8	0.8
95% C.I.	0.1	0.1	0.6	0.6	0.7	0.7	0.2	0.2
One Plan target	7 - 8.2		< 19		>80			
%compliance	87%	91%	100%	100%	100%	100%		
N. of Samples	93	93	93	93	93	93	93	93
Wilcoxon	*4.560*		*2.812*		*6.048*		*7.052*	*4.560*
P value	*0.000*		*0.005*		*0.000*		*0.000*	*0.000*

Table 4: -Mangaehuehu Stream upstream and downstream of Rangataua WWTP, at FLOWS between Median (6,740 L/s) and 20th FEP (9,205 L/s).

Median to 20th FEP	Ammon-N (g/m^3)		Nitrate-N (g/m^3)		Nitrite-N (g/m^3)		SIN (g/m^3)		TN (g/m^3)		DRP (g/m^3)		TP (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	0.005	0.005	0.190	0.198	0.003	0.003	0.198	0.206	0.246	0.256	0.018	0.018	0.023	0.022
Min	0.000	0.000	0.025	0.027	0.001	0.001	0.030	0.033	0.100	0.084	0.008	0.008	0.014	0.014
5%ile	0.000	0.001	0.037	0.051	0.001	0.001	0.044	0.058	0.139	0.128	0.009	0.010	0.015	0.014
10%ile	0.001	0.003	0.067	0.095	0.001	0.001	0.074	0.105	0.148	0.148	0.011	0.011	0.016	0.016
20%ile	0.004	0.005	0.125	0.125	0.001	0.001	0.132	0.133	0.184	0.183	0.014	0.013	0.017	0.017
25%ile	0.005	0.005	0.130	0.133	0.001	0.001	0.137	0.142	0.190	0.190	0.014	0.014	0.017	0.018
50%ile (median)	0.005	0.005	0.193	0.201	0.001	0.001	0.203	0.208	0.230	0.240	0.016	0.016	0.020	0.019
75%ile	0.005	0.005	0.254	0.265	0.005	0.004	0.264	0.273	0.290	0.330	0.019	0.020	0.025	0.024
90%ile	0.006	0.007	0.308	0.313	0.009	0.006	0.318	0.322	0.382	0.400	0.027	0.027	0.030	0.029
95%ile	0.007	0.008	0.326	0.336	0.011	0.010	0.340	0.355	0.396	0.406	0.033	0.032	0.036	0.033
Max	0.011	0.012	0.380	0.380	0.013	0.016	0.386	0.386	0.400	0.430	0.036	0.036	0.042	0.041
StdDev	0.002	0.002	0.090	0.090	0.004	0.004	0.091	0.091	0.084	0.093	0.007	0.007	0.007	0.006
95% C.I.	0.001	0.001	0.033	0.033	0.001	0.001	0.033	0.033	0.031	0.034	0.002	0.002	0.003	0.002
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					10%	10%			0%	0%		
N. of Samples	29	29	29	29	29	29	29	29	29	29	29	29	29	29
Wilcoxon		*1.334*		*2.879*		*1.193*		*2.787*		*2.547*		*0.348*		*0.829*
P value		*0.182*		*0.004*		*0.233*		*0.005*		*0.011*		*0.728*		*0.407*

Table 4: continued

Median to 20th FEP	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	41	55	32	41	2.7	2.1	2.3	2.2	1.2	1.2	1.5	1.4				
Min	0.0	0.0	2.0	8.0	0.9	0.9	0.0	1.0	0.4	0.4	0.0	0.0				
5%ile	2.0	2.0	2.9	9.8	1.0	1.0	1.2	1.1	0.5	0.5	0.4	0.4				
10%ile	2.0	3.6	3.8	11.6	1.3	1.2	1.5	1.4	0.5	0.6	1.0	1.0				
20%ile	2.0	8.0	7.2	15.2	1.7	1.5	1.5	1.5	0.7	0.7	1.3	1.1				
25%ile	4.0	8.0	9.0	17.3	1.9	1.6	1.5	1.5	0.8	0.8	1.5	1.5				
50%ile (median)	12.0	16.0	16.0	30.0	2.7	2.0	1.5	1.5	1.1	1.0	1.5	1.5				
75%ile	39.0	34.0	50.5	60.8	3.3	2.7	1.5	1.5	1.3	1.4	1.5	1.5				
90%ile	55	86	75	78	4.2	3.0	4.4	3.2	1.8	1.7	1.5	1.5				
95%ile	85	224	84	94	4.5	3.2	7.2	4.6	2.7	2.7	1.5	1.5				
Max	630	620	93	110	5.0	3.5	8.8	12.0	3.7	3.5	6.4	4.2				
StdDev	116	123	32	33	1.1	0.7	2.0	2.1	0.7	0.7	1.0	0.7				
95% C.I.	42	45	20	20	0.4	0.3	0.7	0.8	0.3	0.3	0.4	0.2				
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	97%	97%	100%	100%	58%	86%					97%	100%	97%	97%	100%	100%
N. of Samples	29	29	10	10	24	22	29	29	29	29	29	29	29	29	10	10
Wilcoxon		*1.029*		*0.889*		*3.247*		*0.255*		*0.021*		*0.135*				
P value		*0.304*		*0.374*		*0.001*		*0.799*		*0.984*		*0.893*				

Table 4: continued

<u>Median to 20th FEP</u>	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	7.4	7.4	7.2	7.3	98.6	99.7	11.0	11.1
Min	6.4	6.6	4.1	4.2	81.8	81.4	9.8	9.7
5%ile	6.8	7.0	4.7	4.8	92.7	97.7	10.5	10.2
10%ile	7.0	7.0	5.2	5.2	97.3	98.2	10.5	10.6
20%ile	7.3	7.4	6.0	6.1	98.1	99.6	10.6	10.7
25%ile	7.3	7.4	6.2	6.3	98.2	99.6	10.6	10.7
50%ile (median)	7.4	7.5	7.5	7.6	99.0	100.2	11.2	11.2
75%ile	7.6	7.6	8.4	8.7	100.2	100.8	11.4	11.5
90%ile	7.6	7.7	9.2	9.3	101.5	101.8	11.5	11.6
95%ile	7.8	7.7	9.3	9.6	102.5	102.4	11.7	11.8
Max	8.2	8.0	9.7	10.1	103.1	104.9	11.8	11.9
StdDev	0.3	0.3	1.5	1.6	3.9	3.8	0.4	0.5
95% C.I.	0.1	0.1	0.6	0.6	1.4	1.4	0.2	0.2
One Plan target	7 - 8.2		< 19		>80			
% Compliance	86%	86%	100%	100%	100%	100%		
N. of Samples	29	29	29	29	29	29	29	29
Wilcoxon		*2.433*		*3.137*		*3.414*		*3.774*
P value		*0.015*		*0.002*		*0.001*		*0.000*

Table 5: -Mangaehuehu Stream upstream and downstream of Rangataua WWTP, at FLOWS BELOW MEDIAN (< 6,740 l/S).

Note no flows below half median were recorded in the Tokiahuru Stream.

Below Median	Ammon-N (g/m^3)		Nitrate-N (g/m^3)		Nitrite-N (g/m^3)		SIN (g/m^3)		TN (g/m^3)		DRP (g/m^3)		TP (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	0.005	0.005	0.164	0.169	0.003	0.003	0.172	0.177	0.221	0.228	0.023	0.023	0.030	0.030
Min	0.000	0.000	0.007	0.000	0.001	0.000	0.015	0.000	0.090	0.000	0.005	0.000	0.012	0.000
5%ile	0.000	0.000	0.045	0.058	0.001	0.001	0.048	0.061	0.132	0.131	0.011	0.011	0.019	0.018
10%ile	0.000	0.000	0.061	0.064	0.001	0.001	0.065	0.073	0.142	0.140	0.013	0.013	0.020	0.019
20%ile	0.001	0.001	0.110	0.117	0.001	0.001	0.119	0.122	0.166	0.180	0.016	0.016	0.022	0.022
25%ile	0.002	0.002	0.129	0.129	0.001	0.001	0.135	0.143	0.175	0.183	0.017	0.016	0.023	0.023
50%ile (median)	0.005	0.005	0.159	0.167	0.002	0.002	0.167	0.176	0.210	0.221	0.021	0.021	0.028	0.029
75%ile	0.005	0.005	0.217	0.200	0.003	0.004	0.224	0.210	0.253	0.270	0.028	0.029	0.034	0.034
90%ile	0.007	0.009	0.251	0.252	0.006	0.007	0.260	0.259	0.300	0.317	0.038	0.036	0.042	0.043
95%ile	0.010	0.013	0.306	0.303	0.007	0.009	0.312	0.309	0.350	0.349	0.042	0.039	0.047	0.048
Max	0.029	0.026	0.337	0.338	0.023	0.023	0.349	0.344	0.410	0.470	0.048	0.062	0.068	0.062
StdDev	0.005	0.005	0.073	0.069	0.003	0.004	0.073	0.069	0.067	0.073	0.010	0.010	0.010	0.010
95% C.I.	0.001	0.001	0.018	0.017	0.001	0.001	0.018	0.017	0.016	0.018	0.002	0.002	0.002	0.002
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					14%	9%			2%	2%		
N. of Samples	64	64	64	64	64	64	64	64	64	64	64	64	64	64
Wilcoxon		*1.169*		*1.361*		*0.741*		*1.592*		*1.979*		*1.262*		*0.446*
P value		*0.243*		*0.174*		*0.459*		*0.112*		*0.048*		*0.207*		*0.656*

Table 5: continued

<u>Below Median</u>	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	119	91	174	128	2.6	2.2	2.6	2.9	1.6	1.6	1.4	1.4				
Min	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0				
5%ile	4.0	8.0	4.4	11.1	1.4	1.1	1.0	1.0	0.5	0.5	0.0	0.0				
10%ile	4.0	8.9	12.0	12.9	1.6	1.4	1.1	1.0	0.6	0.7	0.0	0.0				
20%ile	8.0	14.4	16.0	30.8	2.2	1.7	1.5	1.5	0.9	0.9	1.0	1.0				
25%ile	11.8	16.0	16.0	35.3	2.2	1.8	1.5	1.5	0.9	1.0	1.0	1.0				
50%ile (median)	25.0	39.0	56.0	56.5	2.5	2.1	1.5	1.5	1.3	1.4	1.5	1.5				
75%ile	73.8	98.0	117.5	145.0	3.0	2.6	2.0	2.9	1.8	1.7	1.5	1.5				
90%ile	191	237	255	350	3.9	3.0	4.0	4.7	2.4	2.1	1.5	1.5				
95%ile	268	391	280	523	4.1	3.4	7.7	6.8	4.2	2.6	1.9	2.8				
Max	2,900	630	2,900	630	4.5	3.9	25.0	36.0	6.8	11.3	8.0	7.0				
StdDev	397	134	483	153	0.8	0.7	3.6	5.0	1.2	1.5	1.0	1.0				
95% C.I.	97	33	146	46	0.2	0.2	0.9	1.2	0.3	0.4	0.3	0.3				
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	97%	98%	90%	86%	75%	82%					98%	98%				
N. of Samples	64	64	42	42	51	49	64	64	64	64	64	64	0	0	0	0
Wilcoxon		*1.967*		*1.160*		*4.365*		*0.156*		*0.043*		*0.698*				
P value		*0.049*		*0.246*		*0.000*		*0.876*		*0.965*		*0.485*				

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Table 5: continued

Below Median	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	U/S	D/S A	U/S	D/S A	U/S	D/S A	U/S	D/S A
Average	7.4	7.5	10.0	10.1	98.6	99.7	10.4	10.5
Min	6.3	0.0	3.7	0.0	87.5	0.0	9.1	0.0
5%ile	6.7	7.0	5.0	5.1	91.9	92.6	9.3	9.4
10%ile	7.0	7.2	6.1	6.1	95.0	95.8	9.4	9.6
20%ile	7.2	7.4	7.5	7.5	98.1	99.5	9.7	9.8
25%ile	7.3	7.4	8.0	8.1	98.5	99.9	9.8	9.8
50%ile (median)	7.5	7.6	9.9	10.3	99.2	100.5	10.3	10.3
75%ile	7.6	7.7	12.3	12.5	99.8	101.1	10.9	11.0
90%ile	7.8	7.7	13.3	13.4	100.7	101.9	11.5	11.6
95%ile	8.0	7.7	13.9	14.0	101.2	102.5	11.8	11.9
Max	8.2	8.4	15.3	15.9	107.4	105.0	13.2	13.0
StdDev	0.3	0.3	2.9	2.9	3.1	3.1	0.8	0.8
95% C.I.	0.1	0.1	0.7	0.7	0.7	0.7	0.2	0.2
One Plan target	7 - 8.2		< 19		>80			
% Compliance	88%	94%	100%	100%	100%	100%		
N. of Samples	64	64	64	64	64	64	64	64
Wilcoxon		*3.875*		*0.974*		*5.136*		*6.069*
P value		*0.000*		*0.330*		*0.000*		*0.000*

Appendix C:

Summary of data from the for sites sampled on the Mangaehuehu Stream downstream of the ponds but upstream of the discharge channel (Middle) and downstream of the ponds and discharge channel (D/S B) at different flows, January 2012 to May 2021 (Veolia data). Assessment against Horizons One Plan targets is shown along with results from Wilcoxon Tests, where significant differences (P < 0.005) are indicated in red.

Table 1: -Mangaehuehu Stream At the Middle site and Downstream B of Rangataua WWTP, at ALL FLOWS.

All Flows	Ammon-N (g/m^3)		Nitrate-N (g/m^3)		Nitrite-N (g/m^3)		SIN (g/m^3)		TN (g/m^3)		DRP (g/m^3)		TP (g/m^3)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	0.006	0.007	0.180	0.179	0.001	0.001	0.186	0.187	0.181	0.179	0.020	0.020		
Min	0.003	0.003	0.052	0.047	0.001	0.001	0.056	0.051	0.052	0.047	0.005	0.004		
5%ile	0.003	0.003	0.077	0.083	0.001	0.001	0.082	0.101	0.077	0.083	0.010	0.010		
10%ile	0.003	0.003	0.096	0.097	0.001	0.001	0.102	0.105	0.096	0.100	0.011	0.011		
20%ile	0.003	0.003	0.122	0.130	0.001	0.001	0.126	0.133	0.120	0.130	0.013	0.012		
25%ile	0.003	0.003	0.133	0.134	0.001	0.001	0.136	0.144	0.130	0.130	0.015	0.014		
50%ile (median)	0.003	0.003	0.190	0.190	0.001	0.001	0.194	0.199	0.190	0.190	0.021	0.020		
75%ile	0.005	0.007	0.220	0.211	0.001	0.001	0.225	0.219	0.220	0.212	0.024	0.023		
90%ile	0.013	0.013	0.260	0.260	0.002	0.002	0.265	0.264	0.260	0.260	0.030	0.031		
95%ile	0.021	0.017	0.271	0.271	0.002	0.002	0.285	0.274	0.271	0.271	0.031	0.032		
Max	0.054	0.055	0.330	0.330	0.003	0.011	0.334	0.334	0.330	0.330	0.036	0.036		
StdDev	0.010	0.010	0.066	0.062	0.000	0.002	0.066	0.061	0.066	0.062	0.007	0.008		
95% C.I.	0.003	0.003	0.020	0.019	0.000	0.001	0.020	0.019	0.020	0.019	0.002	0.002		
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					3%	3%			2%	2%		
N. of Samples	57	57	40	40	40	40	40	40	40	40	42	42	0	0
Wilcoxon		*0.449*		*0.346*		*0.204*		*0.948*		*0.467*		*0.566*		Too few untied
P value		*0.6535*		*0.7294*		*0.8385*		*0.3433*		*0.6406*		*0.5716*		

Table 1: continued

All Flows	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	224	125	367	194			29.1	124.0	8.6	2.5	2.4	2.4	1.9	3.6	0.4	0.4
Min	1.6	1.6	6.6	13.0			0.5	0.5	0.4	0.3	0.5	0.5	0.3	0.3	0.3	0.3
5%ile	4.9	6.7	17.9	20.8			0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3
10%ile	6.6	11.0	25.1	25.3			0.5	0.5	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3
20%ile	13.0	18.0	39.0	42.2			1.0	1.2	0.9	0.8	0.5	0.5	0.3	0.3	0.3	0.3
25%ile	15.0	20.0	57.3	51.8			1.0	1.4	1.0	0.9	1.0	1.2	0.3	0.3	0.3	0.3
50%ile (median)	46.0	48.0	130.0	100.0			2.4	3.2	1.3	1.3	2.2	2.0	0.5	0.4	0.3	0.3
75%ile	140.0	110.0	245.0	175.0			5.0	6.6	1.9	1.7	2.8	3.2	0.8	0.9	0.3	0.3
90%ile	260	220	573	600			13.2	13.0	2.8	2.7	5.0	4.6	1.5	2.3	0.7	0.6
95%ile	660	690	779	775			35.0	309.6	4.7	4.1	5.6	5.6	2.5	16.0	0.9	0.7
Max	4,700	970	4,700	970			990.0	3400.0	500.0	90.0	7.8	11.0	79.0	160.0	1.4	2.5
StdDev	736	213	943	258			141.5	555.2	53.1	8.9	1.8	2.1	8.3	16.4	0.3	0.4
95% C.I.	225	65	377	103			38.1	149.5	10.4	1.8	0.6	0.6	1.6	3.1	0.1	0.1
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	93%	93%	75%	83%							88%	90%			100%	97%
N. of Samples	41	41	24	24	0	0	53	53	100	100	41	41	110	110	38	38
Wilcoxon		0.348		1.234		Too few untied		2.862		1.928		0.134		0.913		1.188
P value		0.7278		0.2173				0.0042		0.0539		0.893		0.3610		0.2348

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Table 1: continued

All Flows	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	7.4	7.5	10.6	10.6			9.3	9.5
Min	4.5	5.0	3.9	4.0			0.3	0.3
5%ile	6.4	6.5	5.3	5.3			3.1	4.5
10%ile	6.6	6.7	6.2	6.0			5.7	6.8
20%ile	6.9	6.9	6.9	7.2			9.0	9.0
25%ile	7.0	7.1	7.5	7.6			9.1	9.3
50%ile (median)	7.4	7.5	10.1	10.2			10.0	10.1
75%ile	7.8	7.9	12.9	12.4			10.8	10.9
90%ile	8.4	8.4	15.2	15.2			11.4	11.5
95%ile	9.0	8.7	16.0	16.9			11.7	11.7
Max	9.9	9.9	28.1	28.9			12.4	12.1
StdDev	0.8	0.8	4.2	4.5			2.5	2.3
95% C.I.	0.2	0.1	0.8	0.8			0.5	0.4
One Plan target	7 - 8.2		< 19		>80			
% Compliance	58%	62%	96%	95%				
N. of Samples	108	106	109	109	0	0	109	108
Wilcoxon		*2.166*		*0.773*		Too few untied		*2.958*
P value		*0.0303*		*0.4395*				*0.0031*

Table 2: -Mangaehuehu Stream Upstream and Downstream A of Rangataua WWTP, at FLOWS ABOVE 20TH FEP (> 9,205 L/s).

Above 20th FEP	Ammon-N (g/m³)		Nitrate-N (g/m³)		Nitrite-N (g/m³)		SIN (g/m³)		TN (g/m³)		DRP (g/m³)		TP (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	0.014	0.006	0.137	0.139	0.001	0.002	0.145	0.147	0.137	0.140	0.013	0.014		
Min	0.003	0.003	0.052	0.047	0.001	0.001	0.056	0.051	0.052	0.047	0.005	0.004		
5%ile	0.003	0.003	0.058	0.056	0.001	0.001	0.063	0.064	0.058	0.056	0.006	0.006		
10%ile	0.003	0.003	0.064	0.065	0.001	0.001	0.070	0.077	0.065	0.065	0.007	0.008		
20%ile	0.003	0.003	0.077	0.083	0.001	0.001	0.084	0.103	0.077	0.083	0.009	0.011		
25%ile	0.003	0.003	0.088	0.095	0.001	0.001	0.094	0.111	0.088	0.095	0.010	0.012		
50%ile (median)	0.003	0.003	0.130	0.140	0.001	0.002	0.143	0.146	0.130	0.140	0.015	0.016		
75%ile	0.015	0.009	0.193	0.193	0.001	0.002	0.202	0.198	0.193	0.195	0.016	0.017		
90%ile	0.053	0.013	0.216	0.214	0.002	0.002	0.222	0.218	0.215	0.215	0.016	0.019		
95%ile	0.054	0.016	0.218	0.217	0.002	0.002	0.226	0.221	0.218	0.218	0.016	0.019		
Max	0.054	0.019	0.220	0.220	0.002	0.002	0.229	0.225	0.220	0.220	0.016	0.020		
StdDev	0.020	0.006	0.069	0.068	0.000	0.001	0.070	0.066	0.068	0.068	0.005	0.006		
95% C.I.	0.012	0.004	0.055	0.054	0.000	0.000	0.056	0.053	0.055	0.055	0.004	0.005		
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					17%	17%			17%	17%		
N. of Samples	11	11	6	6	6	6	6	6	6	6	6	6	0	0
Wilcoxon		*1.022*		*1.079*		Too few untied		*0*		*1.278*		*1.079*		Too few untied
P value		*0.3066*		*0.2807*				*1.0000*		*0.2012*		*0.2807*		

Table 2: continued

Above 20th FEP	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	Middle	**D/S B**	**Middle**	**D/S B**	**Middle**	**D/S B**	**Middle**	**D/S B**	**Middle**	**D/S B**	**Middle**	**D/S B**	**Middle**	**D/S B**	**Middle**	**D/S B**
Average	182	208	340	387			114.3	248.3	2.6	2.5	3.2	1.7	2.4	2.8	0.4	0.3
Min	15.0	20.0	120.0	150.0			1.0	0.5	0.8	0.7	1.0	0.5	0.3	0.3	0.3	0.3
5%ile	15.3	20.3	132.0	157.0			1.0	0.5	0.9	0.7	1.0	0.5	0.3	0.3	0.3	0.3
10%ile	15.5	20.5	144.0	164.0			1.0	0.5	1.0	0.8	1.0	0.5	0.3	0.3	0.3	0.3
20%ile	16.0	21.0	168.0	178.0			1.4	1.0	1.1	1.0	1.0	0.5	0.3	0.3	0.3	0.3
25%ile	22.5	27.8	180.0	185.0			1.6	1.4	1.2	1.1	1.2	0.6	0.3	0.3	0.3	0.3
50%ile (median)	81.0	99.0	240.0	220.0			2.8	4.4	1.9	1.7	2.2	1.2	0.7	0.7	0.3	0.3
75%ile	210.0	202.5	450.0	505.0			7.8	6.6	2.7	2.4	4.3	2.5	0.9	0.9	0.6	0.3
90%ile	450	505	576	676			210.8	450.4	4.8	4.6	6.3	3.3	1.5	4.0	0.7	0.4
95%ile	555	648	618	733			600.4	1325.2	6.1	6.9	7.1	3.6	3.8	6.7	0.7	0.5
Max	660	790	660	790			990.0	2200.0	11.0	11.0	7.8	3.8	34.0	37.0	0.7	0.5
StdDev	249	296	284	351			328.4	731.9	2.5	2.6	2.7	1.3	7.5	8.2	0.2	0.1
95% C.I.	199	237	321	397			214.6	478.2	1.2	1.2	2.2	1.1	3.3	3.6	0.2	0.1
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	83%	83%	67%	67%							83%	100%			100%	100%
N. of Samples	6	6	3	3	0	0	9	9	17	17	6	6	20	20	6	6
Wilcoxon		*1.258*		*0.802*				0.355		1.784		0.839		0.465		0.802
P value		*0.2084*		*0.4227*				0.7223		0.0744		0.402		0.6417		0.4227

Table 2: continued

Above 20th FEP	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	7.2	7.3	8.3	8.5			10.1	10.1
Min	4.5	5.0	4.6	4.5			6.9	5.0
5%ile	5.3	5.3	4.9	4.6			7.0	6.9
10%ile	5.7	5.7	5.4	5.6			8.0	7.2
20%ile	6.8	6.7	6.1	6.0			9.1	9.3
25%ile	6.9	6.7	6.4	6.3			9.7	9.8
50%ile (median)	7.3	7.5	7.7	8.0			10.4	10.6
75%ile	7.6	8.1	10.1	10.0			11.0	11.0
90%ile	8.2	8.5	12.6	12.3			11.3	11.5
95%ile	8.7	8.6	13.5	14.5			11.8	11.7
Max	8.8	8.7	13.9	16.7			11.9	12.1
StdDev	1.0	1.1	2.8	3.2			1.4	1.8
95% C.I.	0.5	0.5	1.2	1.4			0.6	0.8
One Plan target	7 - 8.2		< 19		>80			
% Compliance	60%	50%	100%	100%				
N. of Samples	20	20	20	20	0	0	20	20
Wilcoxon		*1.232*		*0.698*		*Too few untied*		*1.717*
P value		*0.2180*		*0.4851*				*0.0859*

Table 3: -Mangaehuehu Stream upstream and downstream of Rangataua WWTP, at FLOWS BELOW 20th FEP (< 9,205 L/s).

Below 20th FEP	Ammon-N (g/m^3)		Nitrate-N (g/m^3)		Nitrite-N (g/m^3)		SIN (g/m^3)		TN (g/m^3)		DRP (g/m^3)		TP (g/m^3)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	0.004	0.007	0.188	0.186	0.001	0.001	0.193	0.195	0.188	0.186	0.021	0.021		
Min	0.003	0.003	0.073	0.077	0.001	0.001	0.078	0.080	0.076	0.077	0.010	0.008		
5%ile	0.003	0.003	0.091	0.096	0.001	0.001	0.097	0.104	0.091	0.098	0.011	0.011		
10%ile	0.003	0.003	0.106	0.105	0.001	0.001	0.116	0.114	0.106	0.108	0.012	0.012		
20%ile	0.003	0.003	0.132	0.134	0.001	0.001	0.135	0.142	0.130	0.130	0.015	0.013		
25%ile	0.003	0.003	0.139	0.138	0.001	0.001	0.142	0.154	0.138	0.135	0.015	0.014		
50%ile (median)	0.003	0.003	0.191	0.191	0.001	0.001	0.195	0.200	0.190	0.191	0.022	0.021		
75%ile	0.003	0.007	0.220	0.212	0.001	0.001	0.227	0.221	0.221	0.213	0.027	0.025		
90%ile	0.009	0.010	0.260	0.260	0.002	0.002	0.271	0.264	0.260	0.260	0.031	0.031		
95%ile	0.014	0.016	0.277	0.274	0.002	0.002	0.288	0.279	0.277	0.274	0.032	0.033		
Max	0.022	0.055	0.330	0.330	0.003	0.011	0.334	0.334	0.330	0.330	0.036	0.036		
StdDev	0.004	0.011	0.063	0.060	0.001	0.002	0.063	0.058	0.063	0.060	0.007	0.007		
95% C.I.	0.001	0.003	0.021	0.020	0.000	0.001	0.021	0.020	0.021	0.020	0.002	0.002		
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					0%	0%			0%	0%		
N. of Samples	46	46	34	34	34	34	34	34	34	34	36	36	0	0
Wilcoxon		*0.027*		*0.814*		*0.35*		*1.026*		*0.971*		*1.211*		*Too few untied*
P value		*0.9782*		*0.4155*		*0.7263*		*0.3050*		*0.3313*		*0.2260*		

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Table 3: continued

<u>Below 20th FEP</u>	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m³)		Turbidity (NTU)		POM (g/m³)		cBOD₅ (g/m³)		ScBOD₅ (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	231	111	371	166			11.7	98.6	9.8	2.5	2.2	2.5	1.8	3.8	0.4	0.4
Min	1.6	1.6	6.6	13.0			0.5	0.5	0.4	0.3	0.5	0.5	0.3	0.3	0.3	0.3
5%ile	4.4	6.2	17.0	20.0			0.5	0.5	0.5	0.5	0.5	0.5	0.3	0.3	0.3	0.3
10%ile	6.2	10.3	23.0	25.0			0.5	0.5	0.7	0.6	0.5	0.5	0.3	0.3	0.3	0.3
20%ile	12.6	17.2	33.0	38.0			1.0	1.2	0.8	0.8	0.5	1.1	0.3	0.3	0.3	0.3
25%ile	13.0	19.0	43.0	45.0			1.0	1.5	0.9	0.9	0.8	1.2	0.3	0.3	0.3	0.3
50%ile (median)	46.0	48.0	120.0	70.0			2.2	3.2	1.3	1.2	2.2	2.0	0.4	0.3	0.3	0.3
75%ile	140.0	100.0	220.0	140.0			3.7	6.5	1.8	1.6	2.6	3.4	0.8	0.9	0.3	0.3
90%ile	260	196	370	390			9.7	12.4	2.5	2.5	4.8	5.0	1.5	2.0	0.8	0.6
95%ile	499	480	800	690			23.4	72.4	3.2	2.9	5.2	5.7	2.3	16.0	0.9	0.8
Max	4,700	970	4,700	970			320.0	3400.0	500.0	90.0	6.8	11.0	79.0	160.0	1.4	2.5
StdDev	792	197	1,007	241			48.3	518.9	58.3	9.8	1.6	2.1	8.5	17.8	0.3	0.4
95% C.I.	262	65	431	103			14.3	153.3	12.5	2.1	0.5	0.7	1.8	3.7	0.1	0.1
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	94%	100%	76%	86%							89%	89%			100%	97%
N. of Samples	35	35	21	21	0	0	44	44	83	83	35	35	90	90	32	32
Wilcoxon		0.907		1.69		*Too few*		2.949		1.341		0.625		0.71		0.815
P value		0.3645		0.0910		*untied*		0.0032		0.1800		0.532		0.4775		0.4148

Table 3: continued

Below 20th FEP	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	7.5	7.6	11.1	11.1			9.2	9.4
Min	6.2	6.4	3.9	4.0			0.3	0.3
5%ile	6.5	6.6	5.7	5.4			2.7	3.5
10%ile	6.6	6.8	6.5	6.4			5.2	6.3
20%ile	6.9	7.0	7.5	7.5			8.9	9.0
25%ile	7.0	7.1	7.8	7.9			9.1	9.3
50%ile (median)	7.4	7.6	10.6	10.8			9.9	10.1
75%ile	7.8	7.8	13.4	12.9			10.8	10.8
90%ile	8.4	8.3	15.2	15.5			11.4	11.3
95%ile	9.0	8.8	16.4	19.8			11.6	11.7
Max	9.9	9.9	28.1	28.9			12.4	11.9
StdDev	0.8	0.7	4.3	4.6			2.6	2.5
95% C.I.	0.2	0.1	0.9	1.0			0.5	0.5
One Plan target	7 - 8.2		< 19		>80			
% Compliance	58%	65%	96%	94%	58%	65%		
N. of Samples	88	86	89	89	0	0	89	88
Wilcoxon		*1.837*		*1.087*		*Too few untied*		2.453
P value		*0.0661*		*0.2769*				0.0142

Table 4: -Mangaehuehu Stream upstream and downstream of Rangataua WWTP, at FLOWS between Median (6,740 L/s) and 20th FEP (9,205 L/s).

Median to 20th FEP	Ammon-N (g/m³)		Nitrate-N (g/m³)		Nitrite-N (g/m³)		SIN (g/m³)		TN (g/m³)		DRP (g/m³)		TP (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	0.006	0.010	0.178	0.176	0.001	0.002	0.184	0.189	0.178	0.177	0.015	0.015	0.006	0.010
Min	0.003	0.003	0.098	0.100	0.001	0.001	0.114	0.107	0.098	0.100	0.010	0.008	0.003	0.003
5%ile	0.003	0.003	0.105	0.106	0.001	0.001	0.116	0.115	0.106	0.109	0.011	0.009	0.003	0.003
10%ile	0.003	0.003	0.112	0.111	0.001	0.001	0.119	0.123	0.113	0.119	0.012	0.010	0.003	0.003
20%ile	0.003	0.003	0.122	0.129	0.001	0.001	0.126	0.147	0.124	0.136	0.013	0.011	0.003	0.003
25%ile	0.003	0.003	0.126	0.141	0.001	0.001	0.129	0.163	0.127	0.144	0.013	0.011	0.003	0.003
50%ile (median)	0.003	0.006	0.176	0.182	0.001	0.001	0.183	0.207	0.175	0.180	0.015	0.016	0.003	0.006
75%ile	0.007	0.009	0.228	0.210	0.001	0.001	0.232	0.214	0.228	0.213	0.018	0.019	0.007	0.009
90%ile	0.014	0.016	0.254	0.229	0.001	0.004	0.258	0.233	0.253	0.229	0.021	0.021	0.014	0.016
95%ile	0.015	0.032	0.257	0.240	0.001	0.007	0.261	0.243	0.257	0.240	0.022	0.022	0.015	0.032
Max	0.016	0.055	0.260	0.250	0.001	0.011	0.264	0.254	0.260	0.250	0.022	0.022	0.016	0.055
StdDev	0.005	0.014	0.062	0.052	0.000	0.004	0.060	0.049	0.061	0.050	0.004	0.005	0.005	0.014
95% C.I.	0.003	0.008	0.043	0.036	#NUM!	0.002	0.042	0.034	0.042	0.035	0.003	0.003	0.003	0.008
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					0%	0%			0%	0%		
N. of Samples	13	13	8	8	8	8	8	8	8	8	9	9	13	13
Wilcoxon		*0.21*		*0.169*		*Too few untied*		*0.21*		*0.105*		*0*		*Too few untied*
P value		*0.8339*		*0.8658*				*0.8336*		*0.9165*		*1.0000*		

Table 4: continued

<u>Median to 20th FEP</u>	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	23	32	24	38	#DIV/0!	#DIV/0!	34.7	70.6	1.3	1.4	2.4	3.1	1.3	3.2	0.4	0.3
Min	4.9	1.6	17.0	20.0	0.0	0.0	0.5	0.5	0.4	0.5	0.5	0.5	0.3	0.3	0.3	0.3
5%ile	7.0	4.5	17.7	21.8	#NUM!	#NUM!	0.5	1.3	0.5	0.5	0.5	1.1	0.3	0.3	0.3	0.3
10%ile	9.2	7.3	18.3	23.6	#NUM!	#NUM!	0.5	2.0	0.5	0.6	0.5	1.7	0.3	0.3	0.3	0.3
20%ile	11.8	13.1	19.6	27.2	#NUM!	#NUM!	0.9	3.6	0.8	0.8	0.7	2.2	0.3	0.3	0.3	0.3
25%ile	12.5	16.0	20.3	29.0	#NUM!	#NUM!	1.1	4.1	0.8	0.8	0.9	2.2	0.3	0.3	0.3	0.3
50%ile (median)	15.0	29.0	23.5	38.0	#NUM!	#NUM!	2.2	6.0	1.2	1.2	1.8	3.0	0.5	0.4	0.3	0.3
75%ile	21.0	48.5	26.8	47.0	#NUM!	#NUM!	6.0	7.0	1.4	1.5	2.8	4.2	0.8	1.1	0.3	0.3
90%ile	43	58	29	52	#NUM!	#NUM!	40.1	74.1	2.0	2.5	5.1	4.9	1.1	4.1	0.6	0.4
95%ile	59	61	29	54	#NUM!	#NUM!	180.1	367.0	2.1	4.1	6.0	5.3	1.6	23.0	0.8	0.4
Max	74	64	30	56	0.0	0.0	320.0	660.0	3.8	4.3	6.8	5.6	18.0	32.0	1.0	0.5
StdDev	22	23	9	25	#DIV/0!	#DIV/0!	100.3	207.1	0.8	1.1	2.2	1.6	3.7	8.2	0.3	0.1
95% C.I.	15	16	13	35	#DIV/0!	#DIV/0!	62.2	128.4	0.3	0.5	1.5	1.1	1.6	3.4	0.2	0.1
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	100%	100%	100%	100%	#DIV/0!	#DIV/0!					88%	88%			100%	100%
N. of Samples	8	8	2	2	0	0	10	10	21	21	8	8	22	22	7	7
Wilcoxon		*0.592*		*Too few untied*		*Too few untied*		*2.113*		*0.653*		*0.809*		*1.224*		*Too few untied*
P value		*0.5541*						*0.0346*		*0.5136*		*0.419*		*0.2209*		

Table 4: continued

Median to 20th FEP	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	7.4	7.4	8.7	8.7			10.7	10.5
Min	6.3	6.5	3.9	4.0			9.1	6.2
5%ile	6.6	6.6	4.9	4.9			9.4	7.6
10%ile	6.8	6.8	5.4	5.4			9.9	9.3
20%ile	6.9	7.1	6.6	6.7			10.2	10.2
25%ile	6.9	7.1	6.9	7.2			10.3	10.4
50%ile (median)	7.2	7.3	8.0	8.0			10.8	10.6
75%ile	7.4	7.7	10.5	10.7			11.2	11.2
90%ile	8.8	7.7	11.3	11.4			11.6	11.7
95%ile	9.0	9.0	14.8	14.6			11.7	11.8
Max	9.6	9.1	15.2	16.5			12.0	11.8
StdDev	0.8	0.6	2.9	3.1			0.7	1.3
95% C.I.	0.3	0.3	1.2	1.3			0.3	0.5
One Plan target	7 - 8.2		< 19		>80			
% Compliance	45%	76%	100%	100%				
N. of Samples	22	21	23	23	0	0	23	23
Wilcoxon		*1.176*		*0.471*		*Too few untied*		*0.243*
P value		*0.2396*		*0.6378*				*0.8078*

Table 5: -Mangaehuehu Stream upstream and downstream of Rangataua WWTP, at FLOWS BELOW MEDIAN (< 6,740 l/S).

Note no flows below half median were recorded in the Tokiahuru Stream.

Below Median	Ammon-N (g/m³)		Nitrate-N (g/m³)		Nitrite-N (g/m³)		SIN (g/m³)		TN (g/m³)		DRP (g/m³)		TP (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	0.004	0.006	0.191	0.189	0.001	0.001	0.196	0.196	0.191	0.189	0.023	0.022		
Min	0.003	0.001	0.073	0.001	0.001	0.001	0.078	0.017	0.076	0.017	0.010	0.001		
5%ile	0.003	0.003	0.084	0.096	0.001	0.001	0.088	0.102	0.084	0.096	0.011	0.012		
10%ile	0.003	0.003	0.112	0.113	0.001	0.001	0.116	0.118	0.110	0.115	0.014	0.012		
20%ile	0.003	0.003	0.137	0.134	0.001	0.001	0.141	0.146	0.137	0.130	0.017	0.015		
25%ile	0.003	0.003	0.145	0.138	0.001	0.001	0.148	0.154	0.143	0.135	0.020	0.018		
50%ile (median)	0.003	0.003	0.191	0.191	0.001	0.001	0.195	0.199	0.192	0.192	0.023	0.022		
75%ile	0.003	0.006	0.220	0.212	0.001	0.001	0.227	0.221	0.221	0.213	0.029	0.028		
90%ile	0.006	0.009	0.265	0.265	0.002	0.002	0.279	0.269	0.265	0.265	0.031	0.031		
95%ile	0.009	0.010	0.285	0.278	0.003	0.002	0.291	0.285	0.285	0.278	0.034	0.034		
Max	0.022	0.054	0.330	0.330	0.003	0.003	0.334	0.334	0.330	0.330	0.036	0.036		
StdDev	0.004	0.009	0.064	0.063	0.001	0.000	0.065	0.062	0.065	0.063	0.007	0.007		
95% C.I.	0.001	0.003	0.025	0.024	0.000	0.000	0.025	0.024	0.025	0.024	0.003	0.003		
One Plan target	< 0.32 / ≤ 1.7						< 0.070				< 0.006			
% Compliance	100% / 100%	100% / 100%					0%	0%			0%	0%		
N. of Samples	33	33	26	26	26	26	26	26	26	26	27	27	0	0
Wilcoxon		*0.134*		*1.041*		*1.099*		*1.575*		*1.372*		*1.183*		*Too few untied*
P value		*0.8934*		*0.2977*		*0.2719*		*0.1153*		*0.1701*		*0.2366*		

Table 5: continued

Below Median	E.coli (/100mL)		*E.coli* (Summer) (/100mL)		Black Disc (m)		TSS (g/m^3)		Turbidity (NTU)		POM (g/m^3)		$cBOD_5$ (g/m^3)		$ScBOD_5$ (g/m^3)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	293	134	407	180			4.9	106.8	12.7	2.8	2.2	2.4	1.9	4.0	0.4	0.4
Min	1.6	0.0	6.6	0.0			0.5	0.3	0.5	0.3	0.5	0.3	0.3	0.3	0.3	0.3
5%ile	4.1	8.0	21.4	23.8			0.5	0.5	0.6	0.5	0.5	0.5	0.3	0.3	0.3	0.3
10%ile	6.3	12.2	31.0	25.8			0.5	0.5	0.7	0.7	0.5	0.5	0.3	0.3	0.3	0.3
20%ile	15.0	19.4	54.4	42.2			1.0	1.2	0.9	0.9	0.5	0.6	0.3	0.3	0.3	0.3
25%ile	23.0	25.5	64.0	49.5			1.1	1.2	1.0	1.0	0.8	1.2	0.3	0.3	0.3	0.3
50%ile (median)	70.0	65.0	140.0	100.0			2.3	2.3	1.5	1.3	2.2	1.6	0.3	0.3	0.3	0.3
75%ile	160.0	120.0	240.0	150.0			3.6	5.2	1.8	1.6	2.6	2.8	0.8	0.9	0.3	0.5
90%ile	304	288	456	450			8.9	12.4	2.8	2.5	4.4	4.8	1.6	1.6	0.8	0.6
95%ile	671	600	1,190	718			17.8	60.4	3.2	2.8	5.0	5.6	2.4	12.0	0.9	0.9
Max	4,700	970	4,700	970			50.0	3400.0	500.0	90.0	5.6	11.0	79.0	160.0	1.4	2.5
StdDev	896	220	1,055	249			9.2	582.1	67.3	11.3	1.5	2.3	9.6	20.0	0.3	0.5
95% C.I.	338	83	474	112			3.1	195.7	16.8	2.8	0.6	0.9	2.3	4.7	0.1	0.2
One Plan target	< 550		< 260		> 3						< 5				< 1.5	
% Compliance	93%	93%	74%	84%	#DIV/0!	#DIV/0!					89%	89%			100%	96%
N. of Samples	27	27	19	19	0	0	34	34	62	62	27	27	68	68	25	25
Wilcoxon		*1.318*		*1.894*		*Too few*		*2.129*		*1.833*		*-0.016*		*0.015*		*0.474*
P value		*0.1874*		*0.0583*		*untied*		*0.0333*		*0.0669*		*0.987*		*0.9884*		*0.6356*

Table 5: continued

<u>Below Median</u>	pH		Temperature (°C)		DO Sat. (% sat)		DO Conc. (g/m³)	
	Middle	D/S B	Middle	D/S B	Middle	D/S B	Middle	D/S B
Average	7.6	7.6	11.9	11.9			8.6	9.0
Min	6.2	0.0	5.1	0.0			0.3	0.0
5%ile	6.5	6.6	6.4	6.2			2.5	3.0
10%ile	6.6	6.8	6.9	6.6			3.7	5.5
20%ile	7.0	7.0	8.1	8.1			6.0	8.4
25%ile	7.0	7.1	8.7	8.9			8.7	9.0
50%ile (median)	7.5	7.6	12.2	11.7			9.5	9.8
75%ile	7.9	8.0	14.1	13.7			10.3	10.4
90%ile	8.4	8.3	15.5	16.5			11.1	11.1
95%ile	8.9	8.7	19.2	22.9			11.5	11.3
Max	9.9	9.9	28.1	28.9			12.4	11.9
StdDev	0.7	0.7	4.5	4.8			2.8	2.7
95% C.I.	0.2	0.2	1.1	1.2			0.7	0.6
One Plan target	7 - 8.2		< 19		>80			
% Compliance	62%	62%	94%	92%				
N. of Samples	66	65	66	66	0	0	66	65
Wilcoxon		*1.398*		*1.422*		*Too few untied*		*2.934*
P value		*0.1622*		*0.1550*				*0.0033*

Appendix D:

Summary of Attribute States for Total Ammoniacal Nitrogen, Nitrate, *E.coli* and periphyton copied from Appendix 2 of the National Policy Statement for Freshwater Management (2020).

Table 1: Attribute states for Ammonia (Toxicity) taken from Appendix 2A, Table 5 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Water quality)	
Freshwater Body Type	Lakes and Rivers	
Attribute Unit	mg NH_4-N/L (milligrams ammoniacal-nitrogen per litre)	
Attribute band and description	Numeric Attribute State	
	Annual Median	Annual Maximum
A 99% species protection level: No observed effect on any species tested.	≤ 0.03	≤ 0.05
B 95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	>0.03 and ≤ 0.24	>0.05 and ≤ 0.40
National Bottom Line	0.24	0.4
C 80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	>0.24 and ≤ 1.30	>0.40 and ≤ 2.020
D Starts approaching acute impact level (i.e. risk of death) for sensitive species.	>1.30	>2.20

Numeric attribute state is based on pH 8 and temperature of 20^{o}C.

Compliance with then numeric attribute states should be undertaken after pH adjustment.

Table 2: Attribute states for Nitrate (Toxicity) taken from Appendix 2A, Table 6 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Water quality)	
Freshwater Body Type	Rivers	
Attribute Unit	mg NO_3-N/L (milligrams nitrate-nitrogen per litre)	
Attribute band and description	Numeric Attribute State	
	Annual Median	Annual 95th Percentile
A High conservation value system. Unlikely to be effects even on sensitive species.	≤ 1.0	≤ 1.5
B Some growth effect on up to 5% of species.	>1.0 and ≤ 2.4	>1.5 and ≤ 3.5
National Bottom Line	2.4	3.5
C Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.	>2.4 and ≤ 6.9	>3.5 and ≤ 9.8
D Impacts on growth of multiple species, and starts approaching acute impact level (i.e. risk of death) for sensitive species at higher concentrations (> 20 mg/l).	>6.9	>9.8

This attribute measures the toxic effects of nitrate, not the trophic state. Where other attributes measure trophic state, for example periphyton, freshwater objectives, limits and/or methods for those attributes will be more stringent.

Table 3: Attribute states for Dissolved Reactive Phosphorus taken from Appendix 2B, Table 20 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Water quality)	
Freshwater Body Type	Rivers	
Attribute Unit	DRP mg/L (milligrams per litre)	
Attribute band and description	Numeric Attribute State	
	Median	95th Percentile
A Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to dissolved reactive phosphorus (DRP) enrichment are expected.	≤ 0.006	≤ 0.021
B Ecological communities are slightly impacted by minor DRP elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa and higher respiration and decay rates.	>0.006 and ≤ 0.010	>0.021 and ≤ 0.030
C Ecological communities are slightly impacted by moderate DRP elevation above natural reference conditions. If other conditions also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macroinvertebrate and fish taxa and higher respiration and decay rates.	>0.010 and ≤ 0.018	>0.030 and ≤ 0.054
D Ecological communities are slightly impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, , DRP enrichment may drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost.	> 0.018	>0.054

Numeric attribute state must be derived from the median of monthly monitoring over 5 years.

Table 4: Water Quality limits for *E. coli* as set out in Appendix 2A, Table 9 of the National Policy Statement for Freshwater Management 2020.

Value	Human contact			
Freshwater Body Type	Lakes and rivers			
Attribute Unit	E.coli / 100ml (number of E.coli per hundred millilitres)			
Attribute band and description	Numeric Attribute State			
Description of risk of *Campylobacter* infection (based on *E.coli* indicator)	% exceedances over 540 /100ml	% exceedances over 260 /100ml	Median concentration (/100ml)	95th percentile of *E.coli* /100ml
A (Blue) For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 1%.	<5%	<20%	≤130	≤540
B (green) For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 2% *.	5-10%	20-30%	≤130	≤1000
C (yellow) For at least half the time, the estimated risk is <1 in 1000 (0.1% risk). The predicted average infection risk is 3% *.	10-20%	20-34%	≤130	≤1200
D (orange) 20-30% of the time the estimated risk is >50 in 1000 (>5% risk). The predicted average infection risk is >3% *.	20-30%	>34%	>130	>1200
E (red) For more than 30% of the time the estimated risk is >50 in 1000 (>5% risk). The predicted average infection risk is >7% *.	>30%	>50%	>260	>1200

Attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years, collected on a regular basis regardless of weather and flow conditions. However, where a sample has been missed due to adverse weather or error, attribute state may be determined using samples over a longer timeframe.

Attribute state must be determined by satisfying all numeric attribute states.

The predicted average infection risk is the overall average infection to swimmers based on a random exposure on a random day, ignoring any possibility of not swimming during high flows or when surveillance advisory is in place (assuming that the *E.coli* concentration follows a lognormal distribution). Actual risk will generally be less if a person does not swim during high flows.

Table 5: Water Quality limits for Suspended Fine Sediment as set out in Appendix 2A, Table 8 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Aquatic Life)			
Freshwater Body Type	Rivers			
Attribute Unit	Visual Clarity (m)			
Attribute band and description	Numeric Attribute State by suspended sediment class			
	1	2	3	4
A Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	≥ 1.78	≥ 0.93	≥ 2.95	≥ 1.38
B Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced.	< 1.78 and ≥ 1.55	< 0.93 and ≥ 0.76	< 2.95 and ≥ 2.57	< 1.38 and ≥ 1.17
C Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost.	< 1.55 and ≥ 1.34	< 0.76 and ≥ 0.61	< 2.57 and ≥ 2.22	< 1.17 and ≥ 0.98
National Bottom Line	1.34	0.61	2.22	0.98
D High impact of suspended sediment on instream biota. . Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	< 1.34	< 0.61	< 2.22	< 0.98

The minimum record length for grading a site is the median of 5 years of at least monthly samples (at least 60 samples).

Councils may monitor turbidity and convert the measures to visual clarity.

See Appendix 2C Tables 23 and 26 for the definition of suspended sediment classes and their composition.

The following are examples of **naturally occurring processes** relevant for suspended sediment:

- Naturally highly coloured brown-water streams
- Glacial flour affected streams and rivers
- Selected lake-fed REC classes (particularly warm climate classes) where low visual clarity may reflect autochthonous phytoplankton production.

Table 6: Attribute states for Periphyton (trophic state) taken from Appendix 2A, Table 2 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Aquatic Life)	
Freshwater Body Type	Rivers	
Attribute Unit	mg chl-*a* / m^2 (milligrams chlorophyll-*a* per square metre)	
Attribute band and description	Numeric Attribute State (default class)	Numeric Attribute State (productive class)
	Exceeded no more than 8% of samples	Exceeded no more than 17% of samples
A Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.	≤ 50	≤ 50
B Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat.	>50 and ≤ 120	>50 and ≤ 120
C Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat.	>120 and ≤ 200	>120 and ≤ 200
National Bottom Line	200	200
D Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.	>200	>200

At low risk sites monitoring may be conducted using visual estimates of periphyton cover. Should monitoring based on visual cover estimates indicate that a site is approaching the relevant periphyton abundance threshold, monitoring should then be upgraded to include measurement of chlorophyll-*a*.

Classes are streams and rivers defined according to types in the River Environment Classification (REC). The Productive periphyton class is defined by the combination of REC “Dry” Climate categories (that is, Warm-Dry (WD) and Cool-Dry (CD)) and REC Geology categories that have naturally high levels of nutrient enrichment due to their catchment geology (that is, Soft-Sedimentary (SS), Volcanic Acidic (VA) and Volcanic Basic (VB)). Therefore the productive category is defined by the following REC defined types: WD/SS, WD/VB, WD/VA, CD/SS, CD/VB, CD/VA. The Default class includes all REC types not in the Productive class.

Based on a monthly monitoring regime. The minimum record length for grading a site based on periphyton (chlorophyll-*a*) is 3 years.

Table 7: Attribute states for Macroinvertebrates taken from Appendix 2B, Table 15 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Aquatic Life)	
Freshwater Body Type	Wadeable Rivers	
Attribute Unit	Macroinvertebrate Community Index (MCI) score; Quantitative Macroinvertebrate Community Index (QMCI) score	
Attribute band and description	Numeric Attribute States	
	QMCI	MCI
A Macroinvertebrate community, indicative of pristine conditions with almost no organic pollution or nutrient enrichment.	≥ 6.5	≥ 130
B Macroinvertebrate community indicative of mild organic pollution or nutrient enrichment. Largely composed of taxa sensitive to organic pollution/nutrient enrichment.	≥ 5.5 and ≤ 6.5	≥ 110 and ≤ 130
C Macroinvertebrate community indicative of moderate organic pollution or nutrient enrichment. There is a mix of taxa sensitive and insensitive to organic pollution/nutrient enrichment.	≥ 4.5 and ≤ 6.5	≥ 90 and ≤ 110
National Bottom Line	4.5	90
D Macroinvertebrate community indicative of severe organic pollution or nutrient enrichment. Communities are largely composed of taxa insensitive to organic pollution/nutrient enrichment.	< 4.5	< 90

MCI and QMCI scores to be determined using annual samples taken between December and March (inclusive) with either fixed counts with at least 200 individuals, or full counts, and with current state calculated as the five-year median score. All sites for which the deposited sediment attribute does not apply, whether because they are in river environment classes shown in Table 25 in Appendix 2C or because they require alternate habitat monitoring under clause 3.25 are to use soft sediment sensitivity scores and taxonomic resolution as defined in table A1.1 in Clapcott et al. 2017 *Macroinvertebrate metrics for the National Policy Statement for Freshwater Management.* Cawthron Institute: Nelson, New Zealand. (see clause 1.8).

MCI and QMCI to be assessed using the method defined in Stark JD, and Maxted, JR. 2007 *A user guide for the Macroinvertebrate Community Index.* Cawthron Institute: Nelson, New Zealand (see clause 1.8), except for sites for which the deposited sediment attribute does not apply, which require use of the soft-sediment sensitivity scores and taxonomic resolution defined in table A1.1 in Clapcott et al. 2017 *Macroinvertebrate metrics for the National Policy Statement for Freshwater Management.* Cawthron Institute: Nelson, New Zealand. (see clause 1.8).

Table 8: Attribute states for Macroinvertebrates taken from Appendix 2B, Table 14 of the National Policy Statement for Freshwater Management 2020.

Value (and component)	Ecosystem health (Aquatic Life)
Freshwater Body Type	Wadeable Rivers
Attribute Unit	Macroinvertebrate Average Score per Metric (ASPM)
Attribute band and description	Numeric Attribute States ASPM Score
A Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions	≥ 0.6
B Macroinvertebrate communities have mild-to-moderate loss of ecological integrity	< 0.6 and ≥ 0.4
C Macroinvertebrate communities have moderate-to-severe loss of ecological integrity	< 0.4 and ≥ 0.3
National Bottom Line	0.3
D Macroinvertebrate communities have severe loss of ecological integrity	< 0.3

ASPM scores to be determined using annual samples taken between December and March (inclusive) with either fixed counts with at least 200 individuals, or full counts, and with current state calculated as the five-year median score. All sites for which the deposited sediment attribute does not apply, whether because they are in river environment classes shown I table 25 in Appendix 2C or because they require alternate habitat monitoring under clause 3.25, are or use soft-bottom sediment sensitivity scores and taxonomic resolution as defined in Table A1.1 in Clapcott et al 2017*. Macroinvertebrate metrics for the National Policy Statement for Freshwater Management.* Cawthron institute: Nelson, New Zealand. (see clause 1.8).

When normalising scores for the ASPM, use the following minimums and maximums: %EPT-abundance (1-100), EPT-richness (0-29), MCI (0-200) using the method of Kevin J. Collier (2008). Average score per metric: An alternative metric aggregation method for assessing wadeable stream health. *New Zealand Journal of marine and Freshwater Research, 42:4, 367-378, DOI: 10.1080/00288330809509965. (see clause 1.8).*

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Appendix E:

Summary of annual biotic indices for sites sampled upstream and downstream of the Rangataua WWTP, 2008, 2009 and 2021.

Percent change in QMCI is also shown with a more than 20% change shown in red.

Taxa	MCI score	2008			2009			2021		
		Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2
Mayflies										
Austroclima sp.	9	0	0	0	0.4	0	0	0	0	0
Coloburiscus sp.	9	1.6	1	0.2	0.6	0.4	0.2	1.4	14.4	2.6
Deleatidium sp.	8	104.6	73.2	23.2	27.4	20.6	23.4	90.4	31.8	51
Mauiulus sp.	5	0	0	0	0	0	0	0	0	0
Neozeplebia sp.	7	0	0	0	0	0	0	0.2	0	0
Nesameletus sp.	9	5.4	4.2	2.4	0.8	0.2	0.2	4.2	3.8	0.6
Zephlebia sp.	7	2.8	1.8	0.4	0	0	0	0.8	13.6	1.8
Stoneflies										
Acroperla sp.	5	0	0	0	0.4	0	1	0	0	0
Austroperla sp.	9	4.4	0.6	0.6	0	2	0	5	1	1
Megaleptoperla sp.	9	2	2.2	0.8	0.6	0.4	0.4	1	0.6	0.4
Stenoperla sp.	10	0.6	0	0	0.4	0	0.2	1.8	0.2	1.8
Taraperla sp.	7	0	0	0	0	0	0	0	0	0
Zelandobius sp.	5	11.2	11.8	8.4	11.8	4.8	3	46.6	21.8	23
Zelandoperla sp.	10	11.8	9.8	1.2	56.4	68.8	28	19.4	3.8	20.4
Caddisflies										
Alloecentrella sp.	9	0	0	0	0	0	0	0	7	0
Aoteapsyche sp.	4	11.8	10.2	6	2.8	15.6	1.6	0.4	39.4	15
Beraeoptera sp.	8	4.8	0.8	0.4	0	0	0	8	2.6	4.6
Confluens sp.	5	0	0	0	0	0.6	0	0	3.6	3.4
Costachorema sp.	7	0.2	0	0	0	0	0	0	0.2	0

Taxa	MCI score	2008			2009			2021		
		Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2
Cryptobiosella sp.	9	0	0	0	0	0	0	0	0	0
Hudsonema sp.	6	0	0	0	0	0	0	0.2	0.2	0
Hydrobiosella sp.	9	0	0	0	0	0	0	0	0	0
Hydrobiosidae Early Instar	5	4	3.6	2.2	1.6	1.4	1.4	9	5.2	9
Hydrobiosis clavigera	5	0	0	0	0	0	0	0.2	0	0
Hydrobiosis frater	5	0	0	0	0	0	0	0	0	0
Hydrobiosis parumbripennis	5	0.8	0.2	0	0	0	0	2.2	0.6	3.2
Hydrobiosis spatulata	5	0	0	0	0	0	0	0	0	0.2
Hydrobiosis sp.	5	0.2	0	0	0	0	0	0	0	0
Hydrochorema sp.	9	0	0	0	0	0	0	0	0	0.2
Neurochorema sp.	6	0.2	0	0	0	0.2	0	0	0.6	0.2
Oecetis sp.	6	0	0	0	0	0	0	0	0	0
Oeconesidae sp.	9	0	0	0	0	0	0	0	0	0
Olinga feryadi	9	2	0.8	0.4	0.6	0.4	0.4	1.2	0.8	0.4
Orthopsyche	9	0	0	0	0	0	0	0	0	0
Periwinkla	7	0	0	0	3	2.2	0.6	0	0	0
Philorheithrus	8	0	0	0	0	0	0	0	0	0
Plectrocnemia sp.	8	0	0	0	0	0	0	0	0	0
Polycentropodidae	8	0	0	0	0	0	0	0	0	0
Polyplectropus sp.	8	0	0	0	0	0	0	0	0	0
Psilochorema sp.	8	0	0.4	0.2	0	0.6	0	0.2	0	0
Pycnocentria sp.	7	7.8	1	2.4	0.4	0.4	0.8	7.8	26.8	7.6
Pycnocentrodes sp.	5	3.4	0	0	0	0	0	1	1.6	0.6
Triplectides sp.	5	0	0	0	0	0	0	0	0	0
Zelolessica sp.	10	0	0	0	0	0	0	0	0	0
Oxyethira albiceps	2	0.6	0.2	0.2	0	0	0	0	0	0
Paroxyethira sp.	2	0	0	0	0	0	0	0	0	0
Beetles										

Taxa	MCI score	2008			2009			2021		
		Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2
Liodesus	5	0	0	0	0	0	0	0	0	0.2
Elmidae	6	12.4	14	20	26.8	26	24.6	24.8	25.8	30.6
Hydraenidae	8	0	0	0	0.2	0.2	0.4	0	0	0
Hydrophilidae	5	0	0	0	0	0	0	0	0	0
Ptilodactylidae	8	0	0	0.2	0	0	0	1.4	1.4	1.2
Sciritidae	8	0.2	0.6	0.6	0.2	0	1.4	3	0.6	0
Staphylinidae	5	0	0	0	0	0	0	0	0	0
Chironomidae										
Chironomous	1	0	0	0	0	0	0	0	0	0
Maoridiamesa sp.	3	0	0.4	0	0	0	0	0.2	1.2	0.6
Orthocladiinae	2	23.2	77.8	24.4	33.6	5	1.4	65.2	30.6	65
Podonominae	8	0	0	0	0	0	0	0	0	0
Polypedilum	3	0	0	0	0	0	0.6	0	0	0
Tanypodinae	5	0.4	0	0.4	0	0	0	0.4	0	0
Tanytarsini	3	0	0	0	0	0	0	0	0.2	0.2
Other Diptera										
Aphrophila sp.	5	0.4	0.6	0.6	1.2	0.6	0.2	0.4	1.8	10
Austrosimulium sp.	3	2	1.4	0.4	2.2	0.2	0.6	1.2	0.4	1.6
Blephariceridae	7	0.6	0	0	0	0	0.2	0	0	0.6
Ceratopogonidae	3	0	0	0	0	0	0	0.2	0	0
Empididae	3	0.2	0	0.2	0	0.4	0	0.2	0.6	1
Ephydridae scatella	4	0	0	0	0	0	0	0	0	0
Eriopterini	9	1.8	1.8	3.4	3.6	1.4	8.2	9	5.2	3.4
Hexatomini	5	0	0	0	0	0	0	0	0.6	0
Limonia	6	0.2	0	0	0	0	0	0	0	0
Mischoderus sp.	5	1	0.2	0	0	0.8	1.2	2.8	0.4	0.8
Molophilus	5	0	0	0	0	0	0	0	0	0
Muscidae	3	0	0	0	0	0	0	0	0	0
Paradixa sp.	4	0	0	0	0	0	0	0	0	0

Taxa	MCI score	2008			2009			2021		
		Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2
Paralimnophila sp.	6	0	0	0	0	0	0	0	0	0
Psychodidae sp.	1	0	0	0	0	0	0	0	0	0
Crustacea										
Amphipoda	5	0	0	0	0	0	0	0	0	0
Cladocera	5	0	0	0	0	0	0	0	0	0
Copepoda	5	0	0	0	0	0	0	0	0	0
Ostracoda	3	0	0	0	0	0	0	0	0	0
Mollusca										
Ferrissia sp.	3	0	0	0	0	0	0	0	0	0
Gyraulus sp.	3	0	0	0	0	0	0	0	0	0
Latia sp.	3	0	0	0	0	0	0	0	0	0
Lymnaeidae	3	0	0	0	0	0	0	0	0	0
Physa sp.	3	0	0	0	0	0	0	0	0	0
Potamopyrgus antipodarum	4	0.4	0	0	0	0	0	0.4	2.8	0.2
Sphaeriidae	3	0	0	0	0	0	0	0	0	0
Worms										
Flatworms	3	0	0	0	0	0	0	0	0	0
Hirudinea	3	0	0	0	0	0	0	0	0	0
Nematophora	3	0	0	0	0	0	0	0	0	0
Oligochaetes	1	0.2	0.4	0.2	0	1.4	0	7.4	2.8	1
Proboscis worm	3	0	0	0	0	0	0	0	0	0
Other										
Acari	5	0	0	0	0	0	0	0	0	0
Archichauliodes	7	4.4	2.6	4.8	4.2	4.8	2.4	11	5.6	12.8
Collembola	6	0	0	0	0	0	0	0.2	0	0
Hydra	3	0	0	0	0	0	0	0	0	0
Hygraula (Aquatic caterpillar)	4	0	0	0	0	0	0	0	0	0
Kempynus	5	0	0	0	0	0	0	0	0	0

Taxa	MCI score	2008			2009			2021		
		Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2	Upstream	Downstream 1	Downstream 2
Microvelia	5	0	0	0	0	0	0	0	0	0
Sigara	5	0	0	0	0	0	0	0	0	0
Xanthocnemis sp.	5	0	0	0	0	0	0	0	0	0
Number of Taxa		21	16	14	13	15	13	22	22	23
Number of Individuals		228	222	104	179	159	102	329	260	273
% EPT (Taxa)		63	63	57	59	58	52	61	61	59
% EPT (Individuals)		80	57	45	63	70	59	63	64	53
MCI		128	131	129	131	124	135	131	125	125
QMCI		6.89	5.62	5.75	7.09	7.50	7.76	6.15	5.83	5.68
% Change in QMCI (U/S to D/S1 & U/S to D/S2)			-18%	-16%		6%	10%		-5%	-8%

Appendix 3 – Rangataua WWTP Wetland Assessment – Tonkin + Taylor 2019

Tonkin+Taylor

Job No: 1008249.1000
15 April 2019

Ruapehu District Council
Private Bag 1001
Taumarunui 3946

Attention: Anne-Marie Westcott, Environmental Manager

Rangataua WWTP Wetland Assessment

1 Introduction

Tonkin & Taylor Ltd (T+T) has been engaged by Ruapehu District Council to provide, based on a visual inspection, an assessment of the functionality of the wetland area that receives the discharge from the Rangataua wastewater treatment plant at Rangataua in the Ruapehu District. In particular, T+T has been asked to give consideration to the suitability of the wetland as a nutrient polishing device for the wastewater discharge before it flows down a drainage channel through farm land. This work has been undertaken as an extension to the T+T engagement for this project for Ruapehu District Council as set out in our letter of 26 November 2018.

Roger MacGibbon from T+T visited the Rangataua WWTP site on 29 August 2018 and viewed the receiving wetland. Subsequently we have been supplied with discharge flow data from the WWTP up to 27/9/17.

This brief report is our assessment of the suitability of the wetland as a polishing device based on visual observations during the single site visit by Roger MacGibbon and our experience of how wetland systems typically function. No water samples were taken or analysed and consequently we cannot provide any information of how the wetland is actually functioning. However, we comment on the shape, size and vegetation of the wetland and from this assessment we are able to provide an indication as to whether the wetland is likely to have any nutrient removal function.

2 Wetlands as nutrient polishing devices for wastewater discharges

Shallow surface flow wetlands that have a complete coverage of sedges, rushes and reeds can be effective at removing nitrates from receiving waters and as such can be useful nutrient polishing devices when positioned between wastewater treatment plant outlets and rivers or streams. Nitrate extraction occurs by a process called denitrification and requires the presence of denitrifying bacteria that "consume" nitrate molecules and break them down to atmospheric nitrogen (N_2) and water molecules. Nitrate removal is most effective when the water retention time is at least 2 to 3 days and the interaction of water (and nitrate molecules) with organic matter and denitrifying bacteria is maximised. Some well-constructed wetlands are achieving in excess of 95% nitrate

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extraction during summer months[1]. Well vegetated wetlands can also serve to filter out solids from a WWTP discharge and reduce faecal bacteria levels.

Wetlands also potentially address Maori cultural requirements for the management of wastewater discharge by achieving a high degree of water – organic matter interaction.

3 Rangataua WWTP discharge and minimum wetland requirements

The Rangataua WWTP is small compared to the plants at Ohakune and Raetihi. In the period 14 November 2016 to 27 September 2017 (the most recent period of consecutive discharge flow readings available) the Rangataua plant discharged an average of 46.45 m^3 per day. The peak daily flow was 168m^3 on 5 December 2016.

The average daily flow rate appears to be lower in years preceding 2016.

To achieve effective nitrate removal the objective should be to retain average flows within the wetland for at least 3 days and peak flows (or 95th percentile flows) for at least one day (24 hours). Surface flow wetlands should not be deeper than 500mm with 300mm the optimum depth for good plant growth. At an average depth of 300mm the Rangataua wetland would need to have a surface area of at least 465m^2 to retain average flows for at least 3 days and 560m^2 to retain the peak flow for at least one day.

4 Rangataua wetland

4.1 Current state

The existing Rangataua wetland sits beside the oxidation ponds and is, in effect, a widened drainage channel (Figure 1). The lower half of the wetland area is flat bottomed with very gentle fall to the south and is fully covered with exotic wetland grass species (Figure 2). Some self-regenerating willows are growing along the edges. The existing Rangataua WWTP wetland is likely to be 500mm deep or deeper in some places and shallower in others, with the deepest portions created by small cross-flow bunds that were built in the past to hold water back[2]. The bunds are currently buried beneath a heavy cover of exotic grasses. Although covered with exotic grasses, rather than native sedges and rushes, this section of wetland is likely to be effective at removing nitrogen and filtering out any suspended solids.

[1] The constructed wetland at Owl Farm near Cambridge (a Lincoln University sponsored demonstration farm) is an example of a constructed wetland that is achieving in excess of 95% nitrate extraction in summer months.
[2] Anne-Marie Westcott, Ruapehu DC, pers comm

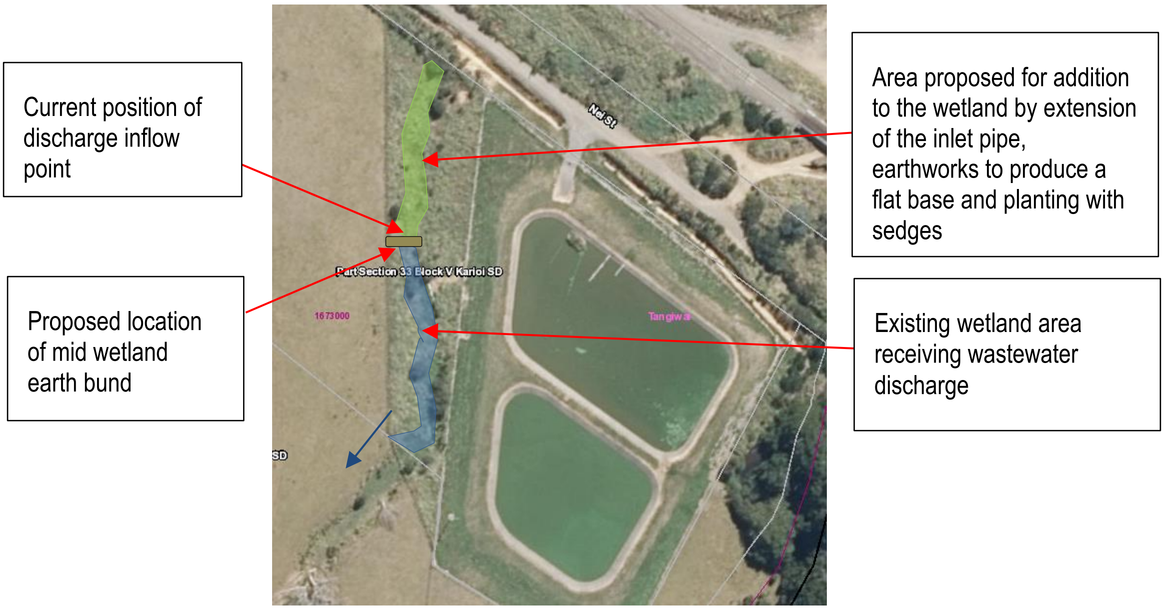

Figure 1: Rangataua WWTP showing location of the wetland

Currently the discharge pipe from the ponds enters the wetland about half way down its length.

The upper portion of the wetland area, above the inlet pipe, is more V-shaped than the lower half of the wetland (Figure 3) and as a consequence is less well suited, in its current state, to remove nitrate.

Figure 2: View of the wetland looking downstream from the discharge inlet pipe

Figure 3: View of the wetland are looking upstream of the discharge inlet pipe

Downstream of the wetland area that lies on RDC land the wetland water flows into an unfenced drainage channel that passes through at least 500m of farmland before joining a stream. This channel appears to remain dry for a large part of the summer with the wetland water (i.e. wastewater discharge) filtering down into the ground soon after it leaves the RDC wetland block of land. The fact that the discharge water passes through earth , especially in summer, is likely to significantly improve nitrate extraction effectiveness (because denitrifying bacteria live in the organic soil zone) and increase faecal bacteria mortality.

4.2 Suitability as a wastewater nutrient polishing wetland

4.2.1 Size

The wetland surface area (i.e. the area over which water flows) is about 550m^2 in size (110m long by 5m wide) with about 260m^2 of that downstream of the current pipe inlet. To achieve more than 3 days' retention of the average daily flow and close to one day's retention of the 95th percentile of peak flow the inlet pipe needs to be extended to the upstream end of the wetland to make full use of the 550m^2 wetland area potentially available.

The upper portions of the wetland area (i.e. those sections above the current inlet pipe) will also require some earthworks to create a more flat bottomed, 5m wide profile to the existing channel (as shown in Figure 4). The amount of earthworks required to improve the form of this section is minor.

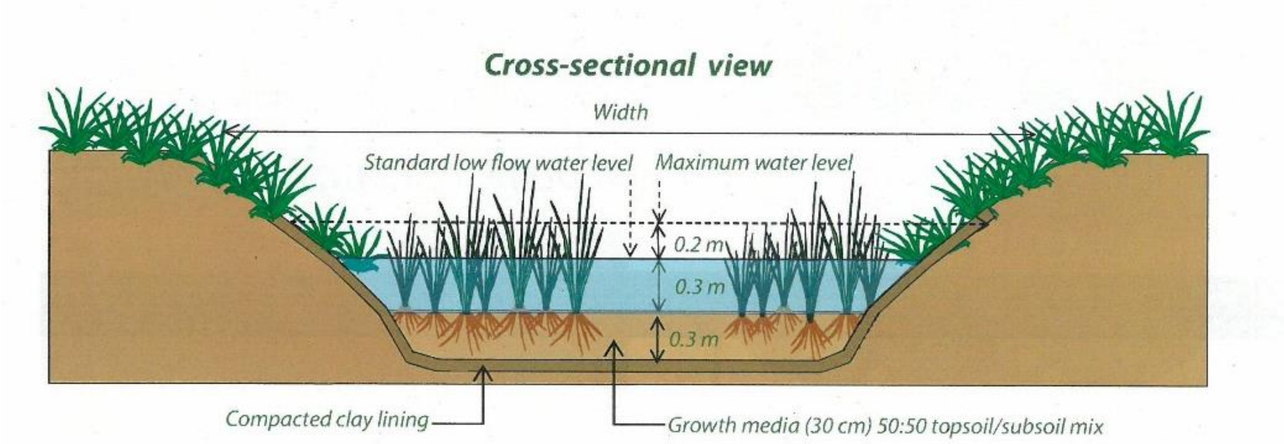

Figure 4: Cross-sectional view of surface flow wetland design (Sourced from Tanner et al 2010[3])

4.2.2 Shape

Normally surface flow wetlands are constructed so that their width to length ratio lies between 1:3 and 1:10. Proportionately wider wetlands tend not to have full and even dispersion of water across the surface whereas narrower wetlands tend to encourage water to flow through them too quickly. In the Rangataua case the low flow volume, the gentle gradient of the wetland and the existence of bunds to hold back water mean this is less likely to be a problem provided a thick sward of sedges, rushes and grasses is retained on the wetland floor at all times. Construction of an additional bund across the wetland channel midway down its length (see proposed bund position in Figure 1), and possibly another further upstream, will improve retention time. These bunds will complement those already in place in the lower half of the wetland.

The bund(s), which could be built with earth generated from the excavation work that creates the flat bottomed upper portion, should not be any higher than 500mm on the upstream side so that

[3] Tanner, C.C.; Sukias, J.P.S.; Yates, C.R. 2010. *New Zealand guidelines: Constructed wetland treatment of tile drainage*. NIWA Information Series No. 75. National Institute of Water & Atmospheric Research Ltd.

water depths can never exceed 500m (see Figures 5 and 6 below). It is recommended that any bunds that are constructed should be covered in coconut fibre and sown with grass to reduce erosion potential (see Figure 6).

Figure 5: Wetland under construction with earth bund mid wetland. The bund overflow sill has been installed at 500mm above the base of the upstream wetland bay so that water depth never exceeds 500mm.

Figure 6: Constructed wetland showing wetland bays with coconut fibre reinforced sills set 500mm above the base of the upstream bay.

4.2.3 Vegetation

As stated above, the existing exotic grass vegetation growing in the lower section of the wetland is as effective at promoting denitrification and filtering out solids as native sedges would be. Consequently, there is no need to replace this vegetation unless there is a wish to make the wetland site vegetation entirely indigenous.

Because the upper wetland area needs some earthworks to improve its shape it is recommended that locally sourced native sedges (especially *Carex secta*) and rushes (*Juncus* spp) are planted on the reformed areas. These plants should be planted at 2 plants per square metre (i.e. 0.7m centres). The planted native sedges will need to be regularly released from competing exotic grasses for the first two years following planting but after that period they should be resistant to competition.

The regenerating willows should be removed from the site and the wetland margin vegetation retained as low stature shrubs and flaxes. This is to ensure the wetland grasses and sedges are not shaded (shade reduces sedge and grass vigour and denitrification performance).

4.2.4 Supervision of earthworks and planting

While the earthworks and planting required to improve the performance of the wetland are relatively straight forward it is recommended that a person with recognised constructed wetland expertise should oversee the work.

5 Summary: assessment of suitability of the Rangataua wetland as a suitable polishing device for the WWTP discharge

The wetland area adjacent to the Rangataua WWTP is, with some minor alterations, of a size and shape suitable to provide effective polishing of the wastewater discharge from the plant. Once some excavation is undertaken to create a more flat-bottomed profile to the upper wetland area, one or more bunds are built between the upper and lower sections of the wetland, and the inlet pipe is extended upstream to carry discharge to the top end of the wetland the wetland area will be approximately 550m^2 in size which is sufficient to hold average flows for at least 3 days and 95th percentile peak flows for 24 hours. Once sedge/rush/grass vegetation is fully established across the base of the wetland nitrate extraction could be expected to exceed 70% in summer and 50% in winter when flows are close to average levels. Nitrate extraction will be further enhanced during summer months when the discharge soaks down through the soil surface rather than flowing along the channel surface.

As is the case for all wetlands that perform a nutrient polishing function for WWTP discharges, a plant maintenance programme should be developed and implemented annually with the objectives of excluding weed invasion and maintaining wetland plant vigour and cover.

6 Applicability

This report has been prepared for the exclusive use of our client Ruapehu District Council and the Wai Group who advise RDC, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by
....	....
Roger MacGibbon Principal Environmental Consultant	Tony Bryce Project Director

Roger MacGibbon
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Appendix A : Existing Rangataua WWTP wetland photos

Photo 1 (above): View of the Rangataua WWTP wetland looking downstream from the inlet point

Photo 2: View of the Rangataua WWTP wetland looking upstream from the inlet point

Appendix 4 – Population Data

Peak population and growth projections for Rangataua

	Rangataua Village													
URP		**2018/19**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
	High	132	134	137	140	142	145	148	150	153	156	159	162	165
	Medium	132	134	136	137	139	141	143	145	147	149	151	153	155
	Low	132	133	135	136	138	140	141	143	144	146	148	149	151
Holiday Homes		**2018/19**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
	Medium		578	586	593	600	608	615	623	630	638	645	652	660
CAM		**2018/19**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
	High		0	0	0	0	0	0	0	0	0	0	0	0
	Medium		0	0	0	0	0	0	0	0	0	0	0	0
	Low		0	0	0	0	0	0	0	0	0	0	0	0
Day Visitors		**2018/19**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
	High		0	0	0	0	0	0	0	0	0	0	0	0
	Medium		0	0	0	0	0	0	0	0	0	0	0	0
	Low		0	0	0	0	0	0	0	0	0	0	0	0
Total		**2018/19**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**
	High		713	723	732	743	753	763	773	783	794	804	814	825
	Medium		712	721	730	740	749	758	768	777	787	796	805	815
	Low		712	720	729	738	747	756	765	774	784	793	802	811

Source: RDC