138 Victoria Street, Level 3
Christchurch Central, Canterbury 8013
New Zealand
www.ghd.com

Your ref: APP-20232970
Our ref: 12553730

13 July 2023

Ryan Hodgson
Environment Southland
Cnr Price St & North Rd
Private Bag 90116
Invercargill
9840

Request for further information on resource consent application - APP-20232970

Dear Ryan,

In response to your email dated 12 June 2023, additional information has been provided in this letter to address your further questions regarding the Edendale – Wyndham Wastewater Treatment Plant.

Question 3

Please provide legal evidence/case law that supports the claim that the discretionary activity status of the RWP trumps the Non-Complying status of the pSWLP as requested. I also note that rule 33A (and Appendix E, Policy 15A and Policy 15B)) has been amended to include a discretionary activity rule and has since been made operative as at the sixth Interim decision on 23 March 2023. If you wish, you can consider utilising these updated provisions noting that you applied before the sixth interim decision was made.

The application for resource consent was lodged on 9 March 2023 and received as complete by Environment Southland for processing on 20 March 2023. At the time of lodgement, Rule 33A of the pSWLP was under appeal. As such, the application was considered under Rule 1 of the RWP as a discretionary activity, which relates to discharges to surface water bodies that meet water quality standards. Additional justification as to why Rule 1 of the RWP was considered relevant was provided in the Section 92 RFI dated 24 May 2023.

As noted above by Ryan Hodgson (ES Senior Consents Officer), *Rule 33A (and Appendix E, Policy 15A and Policy 15B)) has been amended to include a discretionary activity rule and has since been made operative as at the sixth Interim decision on 23 March 2023.* The application for resource consent was lodged with Environment Southland before the sixth interim decision on Rule 33A was made providing a pathway as a discretionary activity. Refer to Figure 1 outlining the provisional changes to the planning framework.

Considering the courts provisional approval and suggestion to make the above changes to the planning framework, SDC proposes a slight amendment to the application lodged on 9 March (in conjunction with the initial Section 92 RFI dated 24 May 2023) to align with the provisions of the *sixth Interim decision (Decision No. [2023] NZEnvC 051).* The change will allow the application to be processed pursuant to Rule 33A(a) of the pSWLP (Sixth Interim Decision) as a discretionary activity as the discharge meets *Appendix E Receiving Water Quality Standards.*

CV – Sixth Interim Decision

Rule 33A[76] – Community sewerage schemes (discharge to water) ~~(Consent Orders)~~

(a) The discharge of effluent or bio-solids from a community sewerage scheme into water in a river, lake, artificial watercourse, modified watercourse or natural wetland where the Appendix E – Receiving Water Quality Standards are met and the discharge does not reduce the water quality below those standards at the downstream edge of the reasonable mixing zone discretionary activity;

(b) The discharge of effluent or bio-solids from a community sewerage scheme into water in a river, lake, artificial watercourse, modified watercourse or natural wetland where Rule 33A(a) is not met the discharge is a non-complying activity.

Figure 1 Rule 33A pSWLP extract from Decision No. [2023] NZEnvC 051

Question 5

1. *NOF assessment provided does not account for the changes to national bottom line for ammonia and nitrate (lifted from C band to B Band) in the NPS-FM 2020. Please address this.*
2. *I'm not convinced Policy 15A (pSWLP) applies, I believe its 15B due to occasional E.Coli exceedances of the discharge that has occurred as part of the current consent and as explained in your response to question 6. Furthermore, there is no certainty that the new lower thresholds for E.Coli with a small mixing zone will help in this matter.*
3. *The Mataura River is a degraded water body as there are some attributes that do not meet the national bottom line/draft objective state. These would include suspended sediment, E. coli, MCI and potentially others. Therefore, with respect to these attributes (at the minimum), the activity should aim to improve and not just maintain water quality in accordance with Policy 5 and 13 of the NPS-FM. Please explain how this will occur (note this answer can be in conjunction with the assessment of Policy 15B above).*

National Objective Framework:

The receiving environment within the vicinity of the discharge is classified as Lowland Soft Bed in accordance with the relevant planning framework. The minimum attribute state (as defined by Environment Southland (2020)[1]and relevant maximum NPS-FM[2] values associated with these attribute states is outlined in Table 1.

Table 1 Receiving Environment Water Quality in Relation to Draft Freshwater Objectives and Southland Attributes

Parameter	Desired Attribute State[3]	Meeting attribute state	Units	Statistic	Number of Data Points used in Calculation	Maximum Limit to Achieve Attribute State [1/2]	Upstream Actual	Downstream Actual
Temperature ^	C		℃	5-day CRI	2	≤23	16.8	16.2
Clarity (m)	C	yes	C	Annual Maximum	5	<1.6	1.0	1.0
Ammoniacal ** N (eq. pH 8)	**B**	yes	g/m^3	Annual Median	5	<=0.24	0.04	0.03

[1] Environment Southland. Draft Murihiku Southland Freshwater Objectives. Technical Report November 2020
[2] National Policy Statement for Freshwater Management 2020

Parameter	Desired Attribute State[3]	Meeting attribute state	Units	Statistic	Number of Data Points used in Calculation	Maximum Limit to Achieve Attribute State [1/2]	Upstream Actual	Downstream Actual
Ammoniacal ** N (eq. pH 8)	B	yes	g/m^3	Annual Maximum	5	<=0.40	0.118	0.122
Nitrate N*	B	yes	g/m^3	Annual Median	5	<=2.4	1.0	1.0
Nitrate N*	B	yes	g/m^3	Annual 95%ile	5	<=3.5	1.5	1.5
E. Coli*	B	no	cfu/100 mL	Median (5 years)	24	<=130	510	540
E. Coli*	B	no	cfu/100 mL	95th Percentile (5 years)	24	<=1000	3300	2800
DO	A	yes	^0C	7 day mean minimum (1 Nov – 30th April)	NA	>=8	#	#
DO	A	yes	^0C	1 day mean minimum (1 Nov – 30th April)	3	>=7.5	7.6	8.1

^The statistic is to be measured over the summer period (1 December to 30 March) and is an average over the five hottest days during this period. Calculated values are based on the two data points during this latest period.
*Attribute state should be determined by using a minimum of 60 samples over a maximum of 5 years (the calculated value is based on only 24 distinct samples over the last five years)
**Calculated values not adjusted for pH equivalence
#Insufficent data to calculate
Shaded cells indicate non compliance with required attribute state
Calculated Actual data is based on previous 12 months of data (unless otherwise specified)

pSWLP Water quality standards:

Based on the sampling data available there has been periodic spikes in E. coli counts over the years in the past, with the most significant spikes occurring in February 2018 and September 2020. However, between December 2020 and September 2022, the E. coli counts have improved overall in comparison with previous years and ranged between 3.1 MPN\100ml and 85 MPN/100ml in the wastewater discharge.

The improvement was likely the result of SDC improving their management regime in 2020 by ensuring that the treatment plant is operating as intended and there are no gaps in the management required to run the plant. The changes in management included more regular site inspections and also replacement of the worm filter beds (wood shavings). These filter beds have a limited lifetime and are essentially the key driver of the treatment process as it contains the worms and microorganism that removes wastewater contaminants. When these filters are not well managed and maintained, the microorganisms are severely affected by the deterioration of the bed filters which subsequently reduces the treatment efficiency. The current sampling data demonstrates that the changes in the management of the WWTP has resulted in an improvement as E. coli counts in the wastewater discharge are lower and more consistent. This period (between December 2020 and September 2022) is more reflective of the expected E. coli counts in the wastewater discharge over the next five-year period.

The upstream and downstream E.Coli counts in the Mataura River regularly (approximately 33% of the time between September 2017 and September 2022 based on the available sampling data) exceed the water quality standards of 1,000MPN/100ml. The mass balance calculation provided in the Section 92 RFI dated

23 May 2023, demonstrated that the effect of the proposed discharge on the downstream water quality (assuming average flows since September 2017), is not noticeable within the mass balance calculation with the calculated downstream concentrations matching the up-stream concentrations. This is because the wastewater discharge contributes a very small proportion relative to the flow in the Mataura River.

It should be noted that the water quality downstream of the discharge point is heavily influenced by the upstream fluctuations as the river is impacted by various other sources of contamination, including the Fonterra discharge. The upstream and downstream concentrations are shown to be similar and follow the same water quality trends. The assessment demonstrated that the effects of the wastewater discharge will not impact the water quality (in terms of E.Coli) within the receiving environment given the low Ecoli counts in the wastewater discharge. The low counts of E. coli discharged into the Mataura River would also not likely be responsible for tipping over the water quality standards, when considered independent from other contamination sources.

Based on the above assessment, it has been demonstrated that the wastewater discharge contributes very low counts of E. coli (range 3.1 MPN\100ml to 85 MPN/100ml) to the Mataura River and the mass balance calculation shows that the downstream concentrations matches the up-stream concentrations and the effects are unnoticeable. The discharge will furthermore be limited to a mean[4] E. coli limit of 1,000MPN/100ml, which furthermore reduces the risk of exceeding water quality standards beyond the zone of reasonable mixing. As such, the proposal is considered pursuant to Rule 5.33A(a) and Policy 15A (Refer to Figure 2) of the pSWLP as the effects of the discharge following reasonable mixing with the receiving waters (in terms of E.coli) meets the Appendix E – Water Quality Standards.

The application was previously assessed against an earlier version of Policy 15A of the pSWLP. However, to give effect to the provisions of the sixth Interim decision (Decision No. [2023] NZEnvC 051) the following assessment should be adopted when considering the application. The intention of the five-year consent is to maintain water quality while further investigation is underway by SDC. There have been some improvements to the management regime of the WWTP in recent years and further options are currently being considered which would remove phosphorus, suspended solids and improve UV disinfection efficacy. The future operation of the wastewater scheme and compliance with the proposed consent conditions, will ensure that the water quality standards will continue to be met (beyond the zone of reasonable mixing). The application is therefore consistent with Policy 15A of the pSWLP.

CV – Sixth Interim Decision

Policy 15A – Approach where Appendix E or Appendix C ~~Maintain water quality where~~ standards are met

Where existing water quality meets the Appendix E Water Quality Standards or bed sediments meet the Appendix C ANZECC sediment guidelines, maintain water quality, ~~including~~ by:

~~1.~~ avoiding~~,~~ where reasonably practicable or otherwise minimising any ~~remedying or mitigating the~~ adverse effects, including residual adverse effects, of ~~new~~ discharges~~,~~ so that ~~beyond the zone of reasonable mixing,~~ those standards or sediment guidelines will continue to be met (beyond the zone of reasonable mixing for point source discharges)~~; and~~

Figure 2 Policy 15A pSWLP extract from Decision No. [2023] NZEnvC 051

Reasonable Mixing Zone:

There appears to be some uncertainty around the new lower thresholds for E.Coli (proposed mean 1,000 MPN/100ml vs 6,000MPN/100ml as per the existing consent) within a smaller mixing zone below the discharge point. As stated above, between December 2020 and September 2022, the E.coli counts have improved significantly in comparison with previous years and ranged between 3.1 MPN\100ml and 85 MPN/100ml in the wastewater discharge. There will however be fluctuations in respect of the E.coli counts in the wastewater discharge that may be caused by unforeseen circumstances. This is clear within the samples taken as there is a range of factors that may impact the sampling. The intention is to ensure the wastewater scheme is well managed and maintained to achieve optimal performance. As previously

[4] the mean shall be from any four consecutive samples

mentioned, the wastewater discharge contributes a very small proportion relative to the flow in the Mataura River and its unlikely that the smaller mixing zone will result in an exceedance of the water quality standards in terms of E.coli. Water quality in the Mataura River fluctuates and occasionally results in E.coli counts exceeding 1,000MPN/100ml upstream and downstream of the discharge point. Although the wastewater discharge contributes E.coli into the river, it is only a minor source of impact to the river water quality in terms of the E.Coli standards being exceeded below the zone of reasonable mixing.

National bottom line/draft objective state:

The Mataura River is a degraded water body as there are some attributes that do not meet the national bottom line/draft objective state. Based on the resource consent application it has been noted that E.Coli and suspended sediment have been identified as the main water quality issues within the Mataura River at the current discharge location. Other key contaminants of concern potentially associated with the treated wastewater discharge (ie. nitrate, ammoniacal N, dissolved reactive phosphorus) are other key indicators of degraded surface water bodies. However current available data for the area does not indicate any significant issues with these contaminants within the Mataura River at the location of interest. Although the current discharge contributes to the deterioration in water quality within the receiving environment, there are similarities in water quality trends upstream and downstream of the discharge point, indicating that the discharge is not having a significant impact on the water quality in the Mataura River. The intention of the five year proposal is to maintain water quality in the interim period. The focus is obviously to improve and not just maintain water quality in accordance with Policy 5 and 13 of the NPS-FM, however significant work is required to determine the future performance and operation of the Edendale Wyndham WWTP.

The application was previously discussed with Environment Southland and it was agreed that the most pragmatic approach would be to apply for a short term consent while further investigation is underway to determine the future operation of the Edendale Wyndham WWTP. The purpose of the short term consent is to enable the existing consent to maintain water quality, while ensuring the operational management of the WWTP is improved to maintain the existing performance and condition. GHD is currently investigating the existing WWTP operations and constraints and will advise SDC on the best approach to improve and upgrade the wastewater system to accommodate current and future wastewater demand generated by Edendale and Wyndham. The investigation will furthermore consider alternative discharge methods which are not covered in this application for resource consent. Until such time, there will be no further upgrades made to the Edendale Wyndham WWTP which will significantly improve the performance of the wastewater scheme or improve water quality in the Mataura River. Regular maintenance and repairs will continue over the next five-year period, or until the WWTP is upgraded, to ensure the system is performing as intended.

Question 6

Please explain, and provide evidence, for how E.Coli levels will be reduced three fold as I do not believe this has been fully demonstrated. How are we to know that E. Coli contaminant loads will not increase? Please recalculate the figures including the actual average, not just the consented average to ensure expected reductions to E.coli. are not overstated.

Based on the sampling data available, there have been periodic spikes in E.coli counts in the past, with the most significant spikes occurring in February 2018 and September 2020.

Since December 2020 and September 2022, the eight effluent E.coli results have shown improved overall in comparison with the previous years and generally less than 200 MPN/100mL. The improvement, albeit from a small data set, was likely the result of SDC improving their management regime since 2020 by ensuring that the treatment plant is operating as intended. The changes in management included more regular site inspections and also replacement of the worm filter beds (wood shavings). These filter beds have a limited lifetime and are essentially the “work-horse” of the treatment process as it contains the worms and microorganism that removes wastewater contaminants. When these filters are not well managed and maintained, the microorganisms are severely affected which subsequently reduces the treatment efficiency.

The recent sampling data demonstrate that the changes in the management of the WWTP has shown an improvements as E.coli counts in the wastewater discharge is lower and more consistent. This period (between December 2020 and September 2022) is more reflective of the expected E.coli counts in the wastewater discharge over the next five year period.

As such, we consider that the expected reductions to E.coli are not overstated and that its unlikely that the E.Coli contaminants will increase based on the data available (already accounting for higher effluent volumes). The discharge is therefore considered to meet the proposed consented E.coli limits of 1,000 MPN/100mL provided the site maintains good management practices in accordance with the O & M Plan.

Table 2 Calculated E.Coli Loading

	Average E.Coli limit	Average Discharge Volume	Maximum average total E.Coli Daily Load
	MPN/100 mL	m^3/day	n/day
Consented Average[5]	6,000	264 (actual: 422)	1,584,000
Actual Average long term*	1,700	422	716,000
Actual Average short term**	33	422	13,962
Proposed in Consent Application	1,000	450	450,000

**Based on average of all discharge data over 5 year period (Sept 2017 to Sept 2022)*
*** Based on average of discharge data over 4 consecutive Samples (Dec2020 to Sept 2022)*

Question 8

The further info response indicated that a new filtration step is proposed. Explain what filtration is being proposed, what the proposed consent condition will be for the new filtration system, and how E.Coli and DRP will remain within new consented limits with the updated O&M Plan.

Our previous letter (dated 23 May 2023) noted that one of the plant improvement options that GHD is investigating on behalf of the SDC, includes a filtration step. The options assessment is currently in progress and well underway, however the preferred filtration methods have not been confirmed or designed. This is because SDC seeks that any short-term improvement will be integrated as part of the long term Edendale-Wyndham WWTP, including assessing alternative effluent disposal methods. This means that the preferred short-term option must also be suitable to accommodate the long term operation of the plant to prevent unnecessary capital expenditure.

It is anticipated that the long term options assessment will be completed by GHD mid 2024. Once completed, SDC will communicate and engage with stakeholders and Iwi to determine the preferred long term option. Following stakeholder and Iwi engagement and subsequent engineering design, the installation of the preferred long term upgrades could commence in 2026. Depending on the long-term plant improvement option selected by SDC, part of the plant improvement could be brought forward as required. Meaning if the existing plant is not a complete rebuild, then parts of the system upgrades can start earlier.

In the interim prior to the installation of the plant improvement, improved plant operation and monitoring will be relied on to maintain compliance in E.coli and DRP, as evidenced in the improvement of E.coli results since December 2020. As such, the Operation and Management Plan (O & M Plan) will be updated to capture the recent operational practice and further improve the operation and monitoring tasks undertaken by the operators, such as routine review of the coagulant dose rate following receiving effluent monitoring results.

As such, we propose the inclusion of the following consent conditions to provide transparency about the short-term improvements to the Edendale-Wyndham WWTP.

Condition 1:

The Consent Holder shall undertake a comprehensive evaluation of available short term options for improving the condition and performance of the Edendale – Wyndham WWTP.

[5] Average over 4 consecutive Samples

Condition 2:

The Consent Holder shall provide Environment Southland with 6 monthly updates in writing detailing progress made towards the short term options.

Condition 3:

The consent holder shall document these options in a report. The report shall be provided to Environment Southland within 18 months of the consent being granted. The report shall include an implementation timeline setting out key milestones for the construction of the preferred option.

Condition 4:

The Consent Holder shall complete the installation of the preferred option within 36 months after the consent has been granted and notify Environment Southland once completed.

Operation and Management Plan:

The Operation and Management Plan will set out specific actions to be undertaken by SDC to ensure the wastewater scheme will operation within the proposed discharge limits. The expectation is that the implementation of good management practices will minimise the risk of exceeding the discharge limits due to poor system maintenance and management of the wastewater scheme.

The following condition is proposed to ensure the O & M Plan is adequate to manage the WWTP.

Condition 1:

The Consent Holder shall prepare an Operations Management Plan (OMP) for the WWTP. All future scheme operations and maintenance activities will be included in the OMP and adhere to the OMP. The purpose of the OMP is to outline the operation and maintenance of the Edendale - Wyndham WWTP and wastewater discharge systems. The OMP will clearly outline the operation and maintenance of the Edendale - Wyndham WWTP and wastewater treatment and disposal systems, including:

a. A description of the system's operating procedures (including manufacturer's specifications);
b. Roles and responsibilities for on-site activities and on-site staff training procedures.
c. Condition inspection and maintenance schedules (including manufacturer's specifications) for all plant infrastructure, including but not limited to; pumps, flow meters, valves.
d. Operational and compliance monitoring procedures.
e. A description of 'normal operating conditions'.
f. A protocol for odour management including:
    i. A description of the treatment and disposal system components and their operation relevant to the management of odours.
    ii. Routine odour monitoring.
    iii. Complaints receipt, investigation and reporting procedures.
    iv. Contingency measures to manage adverse odours.
g. Procedures for dealing with emergency discharge events, treatment failures or exceedance of trigger values.

Question 9

Please provide the 2021 ecological survey.

Ryder Environmental Limited undertook the Periphyton and Macroinvertebrate survey in April 2021 and the report is attached as Appendix A.

Question 10

There still has been no invert/periphyton data provided.
It is also noteworthy that there are times of low pH in the discharge. Please propose how this matter will be addressed (eg a consent condition around the pH of the receiving water being maintained within an acceptable range)

The invert/periphyton data is the report prepared by Ryder Environmental Limited attached in Appendix A.

Section 3.2 of the resource consent application (dated 8 March 2023) proposed conditions of consent to manage the effects associated with the discharge of treated wastewater to the Mataura River. Please refer to Condition 13, which relates to water quality standards applying beyond the zone of reasonable mixing. The requirement is that the pH of the water must be within the range 6 to 9, except when due to natural causes, when measured outside of the zone of reasonable mixing. The expectation is to sample pH conditions upstream and downstream of the discharge point in the river to compare any changes Its very unlikely that the pH in the Mataura River will be effected given the high flow rate compared to what the WWTP contributes.

We trust that the above information is sufficient to address the matters raised and that the processing of this application can now proceed.

Regards

Jan Steenkamp
Senior Environmental Planner

03 378 1028
jan.steenkamp@ghd.com

Amy Callaghan
Planning – Technical Director

03 378 0924
Amy.callaghan@ghd.com

Copy to: paul.reid@southlanddc.govt.nz

Appendix A

Biological Survey

Southland District Council

Wyndham and Edendale Wastewater Treatment System Discharge

Periphyton and Macroinvertebrate Survey: Mataura River

April 2021

ryder

Southland District Council

Wyndham and Edendale Wastewater Treatment System Discharge

Periphyton and Macroinvertebrate Survey: Mataura River

April 2021

Prepared for Southland District Council

by

Megha Sethi, MSc
Ben Ludgate, MSc.

Ryder Environmental Limited
195 Rattray Street
PO Box 1023
DUNEDIN, 9054
New Zealand
Phone: 03 477 2119
www.ryderenv.nz

Document version: 29 May 2021

Cover page: Looking upstream at the Mataura River towards the Edendale-Wyndham Road bridge, 8 April 2021.

Table of Contents

1. Introduction

Southland District Council has consent (Environment Southland Resource Consent 204630-V1) to discharge treated wastewater to the Mataura River from the Wyndham and Edendale townships via a series of 'droppers' at the Edendale-Wyndham Road bridge.

Condition 10 of this consent states:

10. The consent holder or its agent shall survey macroinvertebrate fauna and periphyton in the receiving waters at two sites, one above and one at least 100 metres below the discharge point but within the mixing zone specified in condition 14. The survey shall be as follows:

(a) the survey shall be undertaken once every three calendar years, at a time when the Mataura River, as measured at the Southland Regional Council's monitoring site at Gore, has had a flow of less than 22.3 cumecs for a period of at least twenty consecutive days. The monitoring sites and methodology shall be to the satisfaction of the Council's Compliance Manager;

(b) the macroinvertebrate fauna monitoring results shall be presented as a species inventory together with mean relative abundances, and shall be summarised as a total number of species and total number of organisms per square metre. The mean total invertebrate densities at each site shall be compared statistically using the Mann-Whitney U test to assess the significance ($p<0.05$) of any difference that may occur;

(c) the result of the survey and statistical analysis shall be reported to the Southland Regional Council within 20 working days of the completion of the requisite field work; and

(d) visual and photographic assessment of the periphyton coverage on the river bed at both above sites to assess compliance with Ministry for the Environment New Zealand Periphyton Guidelines June 2000.

Condition 14 of this consent states:

14. The standard for surface waterbodies classified as Mataura 3 (Appendix 1), in accordance with Rule 2 of the Proposed Regional Water Plan for Southland, shall apply and be maintained outside of the zone of reasonable mixing.

For the purpose of this condition, the zone of reasonable mixing in the Mataura River shall extend from 5 metres upstream of the discharge point to 425 metres downstream.

Southland District Council engaged Ryder Environmental to undertake a periphyton and macroinvertebrate survey of the Mataura River in the vicinity of the Wyndham and Edendale discharge in 2021, in accordance with conditions 10 and 14. This report summarises the April 2021 survey.

2. Survey sites

The discharge is located at the Edendale-Wyndham Road bridge (Figure 1) and is comprised of a series of 'droppers' discharging into the centre of the Mataura River (Figure 2).

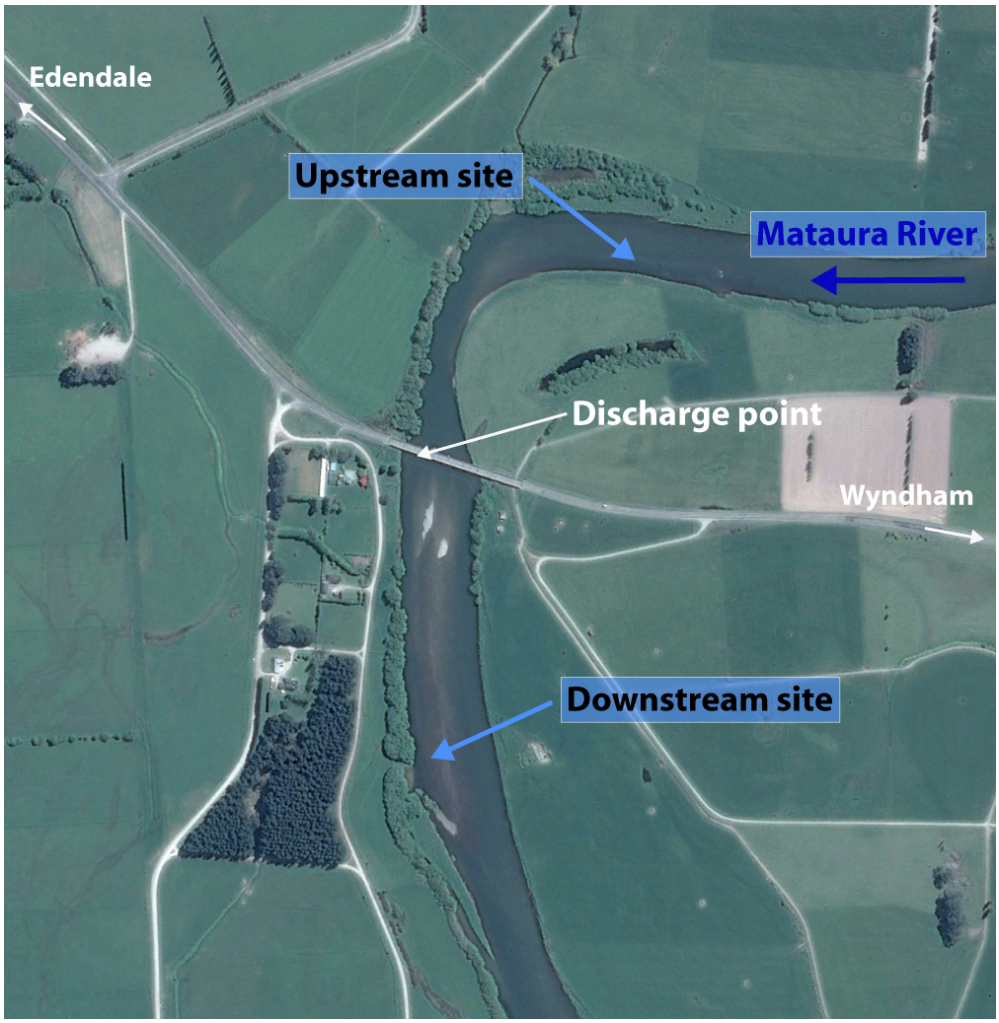

Figure 1. Aerial photo showing location of Wyndham and Edendale wastewater treatment system discharge and sampling sites. Photo: Google Earth.

Figure 2. Wyndham and Edendale wastewater treatment system discharge 'droppers' on the southern side of the Edendale-Wyndham Road bridge, April 2021.

The Mataura River in the vicinity of the discharge point is a run with deep sluggish water. The substrate character is comprised of fine gravels and cobbles.

The Downstream sampling site was located approximately 375 m downstream of the Edendale-Wyndham Road bridge along the true right edge of the Mataura River (Figures 1 and 3). The Upstream sampling site was located approximately 400 m upstream of the bridge along the true left edge of the river (Figures 1 and 3). It would have been preferable to locate the Upstream site in the reach between the Wyndham and Edendale wastewater treatment system discharge point and the Fonterra Edendale discharge point, which is located approximately 300 m upstream of the bridge. However, the river between the two discharge points is a deep run with low velocity water, and is not comparable with the Downstream site. It also exceeded the maximum depth for periphyton monitoring of 0.6 m recommended in the Ministry for the Environment's New Zealand periphyton guidelines (Biggs 2000). The Upstream site was therefore located in the first area of suitable habitat upstream of the Edendale-Wyndham Road bridge. Sampling was undertaken along transect lines across the river up to a distance of 20 m out from the bank.

Figure 3. Upstream (top) and Downstream (bottom) sampling sites for the Wyndham and Edendale wastewater treatment system discharge, April 2021.

3. Methodology

3.1 Periphyton

Field assessment

Periphyton sampling was undertaken using a quadrat method for percentage cover of a site by different categories of periphyton. This method allows comparisons with the Ministry for the Environment's New Zealand periphyton guidelines (Biggs 2000). The method is summarised below:

A 25 m measuring tape was laid out along the river bank and four equally spaced intervals were calculated along its length. The width of the river able to be sampled (i.e., <0.6 m depth) was divided into five equally spaced points. A sampling quadrat (0.25 m^2) was placed on the substrate centred on the first point and the percentage of the substrate covered by each periphyton colour and thickness category was estimated using an underwater viewer. This estimation was continued across the river width and repeated moving upstream.

Photographs were taken of the substrate within five representative quadrats at each site. Samples of representative algal cover were collected from each site.

Laboratory assessment

Samples of representative algal cover were taken back to the laboratory and inspected microscopically under 200-400x magnification. Algal taxa were identified using the keys of Biggs and Kilroy (2000), Entwisle *et al.* (1988) and Moore (2000).

Data presentation and analyses

The Mataura River at Wyndham is classified in Environment Southland's Regional Water Plan for Southland (2014) and in Environment Southland's Proposed Southland Water and Land Plan (decision version, 4 April 2018) as a 'Mataura 3' waterbody. However, the Plans do not include any periphyton (cover or biomass) standards for 'Mataura 3' water bodies. Therefore, periphyton data was tabulated and assessed in accordance with the Ministry for the Environment's New Zealand periphyton guidelines (Biggs 2000) for gravel/cobble streams to protect aesthetics/recreation waters and trout habitat and angling (Table 1).

Table 1. Ministry for the Environment periphyton guidelines for gravel/cobble streams (Biggs 2000). Maximum guideline values are averaged across the full width of the stream or river.

Instream value/variable	Diatoms/Cyanobacteria	Filamentous algae
Aesthetics/recreation (1 November – 30 April):		
Maximum cover of visible streambed	60% > 0.3 cm thick	30% > 2 cm long
Trout habitat and angling:		
Maximum cover of visible streambed	N/A	30% > 2 cm long

3.2 Macroinvertebrates

Field assessment

Benthic macroinvertebrates were sampled using a 0.04 m^2 Surber sampler with a 500 µm diameter mesh net. Five replicate samples were collected from each site. Sampling was undertaken within stony substrate habitats beneath moderate current. Samples were preserved in 70% ethanol for later identification.

Laboratory assessment

In the laboratory, samples were sieved through a 500 µm sieve to remove fine material and residual ethanol. Contents of the sieve were then placed in a white tray and macroinvertebrates were identified under a dissecting microscope (10-40X) using criteria from Winterbourn *et al.* (2006).

Data presentation and analyses

Environment Southland's standards for 'Mataura 3' waterbodies do not include any macroinvertebrate standards. Therefore, macroinvertebrate data was tabulated and benthic macroinvertebrate community health was assessed by determining the following characteristics:

Number of invertebrates per m^2: The total number of individuals from all taxa groups per m^2 of riverbed.

Number of taxa: A measurement of the number of taxa present.

Number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, percentage of the total number of taxa comprising EPT taxa (% EPT taxa), and percentage of the total abundance comprising EPT taxa (% EPT individuals): These insect groups are generally dominated by invertebrates that are indicative of higher quality conditions. In stony bed rivers, these indexes usually increase with improved water quality and increased habitat diversity.

Quantitative Macroinvertebrate Community Index (QMCI) (Stark 1985): This index was developed largely for the purpose of determining the tolerance of stony stream benthic invertebrate communities to organic enrichment. Each invertebrate taxon is assigned a score between 1 and 10, 1 representing a species highly tolerant to organic pollution (e.g., worms and some dipteran species) and 10 representing species highly sensitive to organic pollution (e.g., most mayflies and stoneflies). Site scores range between 0 and 10. A score of 1 represents 'poor' conditions and 10 represents 'excellent' conditions (Table 2). For interpreting results from this monitoring, the Quality Class B classification system has been adopted.

$$QMCI = \sum_{i=1}^{i=S} \frac{(n_i \times a_i)}{N}$$

Table 2. Interpretation of macroinvertebrate community index values from Boothroyd and Stark (2000) (Quality class A) and Stark and Maxted (2007) (Quality class B).

Quality Class A	Quality Class B	QMCI
Clean water	Excellent	≥ 6.00
Doubtful quality	Good	5.00 – 5.99
Probable moderate pollution	Fair	4.00 – 4.99
Probable severe pollution	Poor	< 4.00

Data has been presented graphically as means +/- one standard error. Analysis of Variance (ANOVA) was used to test for differences between sampling sites using the statistical package R version 3.3.3. Abundance data was first transformed (log x + 1) to meet the assumptions of normal distribution of data required for ANOVA.

The resource consents require a comparison of mean total invertebrate densities using a Mann-Whitney U test. This analysis was also undertaken but is considered to provide little meaningful value with respect to assessing the effects of the discharges on downstream invertebrate communities.

4. Results

4.1 Survey conditions

Sampling was undertaken on the 8th of April 2021. River flows at the time of sampling were low at the Gore flow monitoring site (Figure 4). River flows had been less than 22.3 m^3/s for 20 consecutive days, and therefore met the requirements of condition 10(a) of the resource consent.

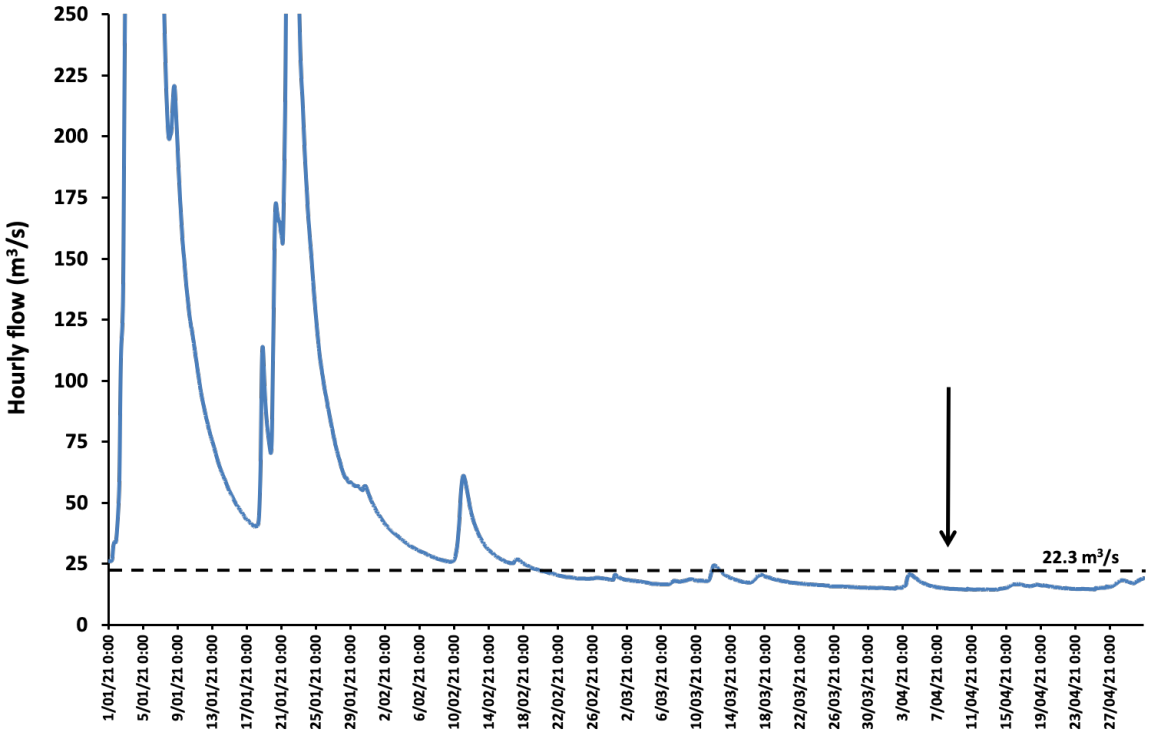

Figure 4. Hourly flow (m^3/s) of the Mataura River at Gore from the 1st of January to the 30th of April 2021. Sampling was undertaken on the 8th of April (indicated by arrow). Data from Environment Southland.

4.2 Periphyton

Periphyton cover data can be found in Appendix One, with photographs of the substrate within representative quadrats in Appendix Two.

Periphyton cover at both sites was dominated by thin light brown films/mats, with lower cover of medium mats (Figure 5, Appendix One). The films/mats were comprised of several types of diatoms, including *Melosira*, *Cymbella*, and *Gomphoneis* (Table 3). Cover of long filamentous algae (more than 2 cm long) and thick algal mats (greater than 3 mm

thick) were both well below Ministry for the Environment (Biggs 2000) guidelines levels at both sites (Table 1, Figure 5, Appendix One).

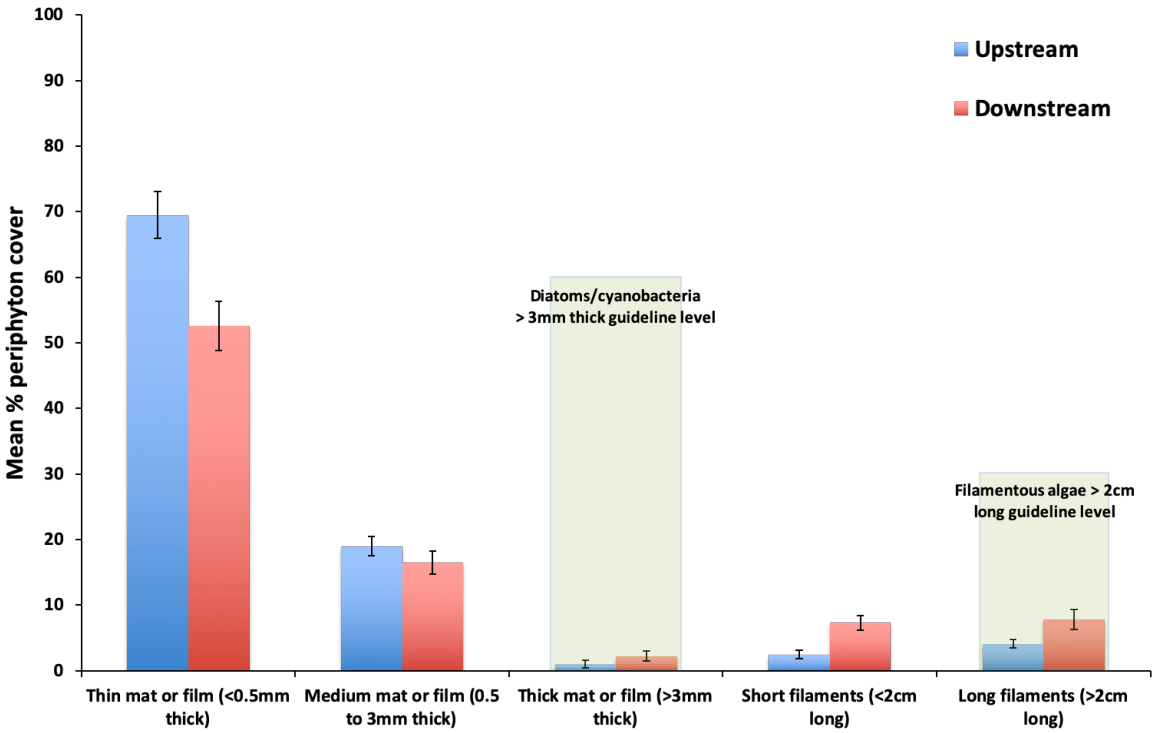

Figure 5. Average cover of the bed substrate by different types of periphyton in the vicinity of the Wyndham and Edendale wastewater treatment system discharge to the Mataura River, April 2021. Error bars are +/- one standard error.

Table 3. Periphyton taxa found upstream and downstream of the Wyndham and Edendale wastewater treatment system discharge, April 2021. '✓' indicates presence at a site.

	Upstream	Downstream
Filamentous red algae		
Audouinella	✓	✓
Filamentous green algae		
Stigeoclonium	✓	
Cyanobacteria		
Oscillatoria/Phormidium	✓	✓
Filamentous diatoms		
Melosira	✓	✓
Diatoms		
Cocconeis		✓
Cymbella	✓	✓
Gomphoneis	✓	✓
Naviculoid diatom	✓	✓
Synedra	✓	✓
Single celled green algae		
Cosmarium	✓	

4.3 Macroinvertebrates

In total, 23 invertebrate taxa were identified from the samples collected from the two sites in April 2021 (Table 4). The number of taxa per sample ranged between 7 and 11 at the Upstream site and 10 and 15 at the Downstream site, with a total of 16 different taxa identified Upstream and 20 different taxa Downstream. Overall taxonomic diversity was therefore lower than (Upstream) or higher than (Downstream) the national median of 18 taxa per site, as determined by Scarsbrook *et al.* (2000) from samples collected from 66 sites throughout New Zealand. Taxonomic diversity at the Upstream site was significantly lower than Downstream ($p<0.05$, Table 5, Figure 6).

A total of seven EPT taxa (invertebrates typically indicative of higher water quality, mayflies, stoneflies and caddisflies) were identified from the Upstream site and eight from the Downstream site (Table 4). The total number of EPT taxa at both sites was therefore similar to the median of eight taxa per site determined by Scarsbrook *et al.* (2000) from their national assessment. *Deleatidium* mayflies and *Aoteapsyche* caddisflies were the dominant EPT taxa at both sites. There were no statistically significant differences in the number of EPT taxa, the percentage of the total number of taxa

comprising EPT taxa (% EPT taxa), or the percentage of the total abundance comprising EPT taxa (% EPT) between sites (*p>0.05*, Table 5, Figure 6).

Invertebrate abundance was similar at both sampling sites, as determined by the ANOVA (*p>0.05*, Table 5) and the Mann-Whitney U test (*p=0.35*). *Deleatidium* mayflies were the most abundant taxa at both sites (Table 4).

Macroinvertebrate community health index (QMCI) scores were high, with average scores at both sites indicative of 'excellent' quality conditions, using the narrative terminology of Stark and Maxted (2007) (Tables 2 and 4, Figure 6). There was no statistically significant difference in QMCI scores between sites (*p>0.05*, Table 5, Figure 6).

Table 4. Invertebrate taxa found upstream and downstream of the Wyndham and Edendale wastewater treatment system discharge to the Mataura River, April 2021. Results are shown as number of individuals per sample (0.04 m^2).

		Upstream					Downstream				
TAXON	**MCI score**	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
COLEOPTERA											
Elmidae	6	1	1				1		1		2
CRUSTACEA											
Ostracoda	3		1	1							
Paraleptamphopus species	5							1			
DIPTERA											
Aphrophila species	5								1		
Orthocladiinae	2	4	12	5	2	3	1	1	10	7	16
Tanytarsini	3		27				2	1	4	2	5
EPHEMEROPTERA											
Austroclima species	9		2								
Deleatidium species	8	135	86	81	97	112	50	90	102	164	195
MOLLUSCA											
Physa / Physella species	3						1	1			
Potamopyrgus antipodarum	4		2	6	5		4	16	12	3	2
Sphaeriidae	3							1			
NEMATODA	3	1						1			
NEMERTEA	3	3					1	1	3		2
OLIGOCHAETA	1	18	5	10	34		2	7	5	4	2
PLATYHELMINTHES	3	1				1	1		1	2	1
TRICHOPTERA											
Costachorema species	7					1					
Hudsonema amabile	6								1		
Hydrobiosis umbripennis group	5	4	3	1	1	3		1	1	1	3
Hydropsyche - Aoteapsyche group	4	2	4	1	3	5	17	18	8	6	13
Olinga species	9								1		
Oxyethira albiceps	2						1	1	1	1	
Pycnocentria species	7	1			1	1		2	3	3	1
Pycnocentrodes species	5	1	1	1		1	4	2			
Number of invertebrates (per m^2)		4275	3600	2650	3575	3175	2125	3600	3850	4825	6050
Number of taxa		11	11	8	7	8	12	15	15	10	11
Number of EPT taxa		5	5	4	4	6	4	6	7	5	4
% EPT taxa		45	45	50	57	75	33	40	47	50	36
% EPT		84	67	79	71	97	85	79	76	91	88
QMCI score		6.8	6.0	6.7	6.0	7.6	6.2	6.4	6.5	7.3	7.1
Average QMCI score				6.6					6.7		

Table 5. Results of analysis of variance (ANOVA) testing for differences between sites for each of the main invertebrate metrics measured. Statistically significant results are shown in bold.

Variable	$F_{1, 8}$	p-value	Interpretation
Number of invertebrates (per m²)	0.42	0.54	No significant difference
Number of taxa	**7.36**	**0.03**	**Higher downstream**
Number of EPT taxa	0.33	0.58	No significant difference
% EPT taxa	4.42	0.07	No significant difference
% EPT	0.48	0.51	No significant difference
QMCI score	0.04	0.85	No significant difference

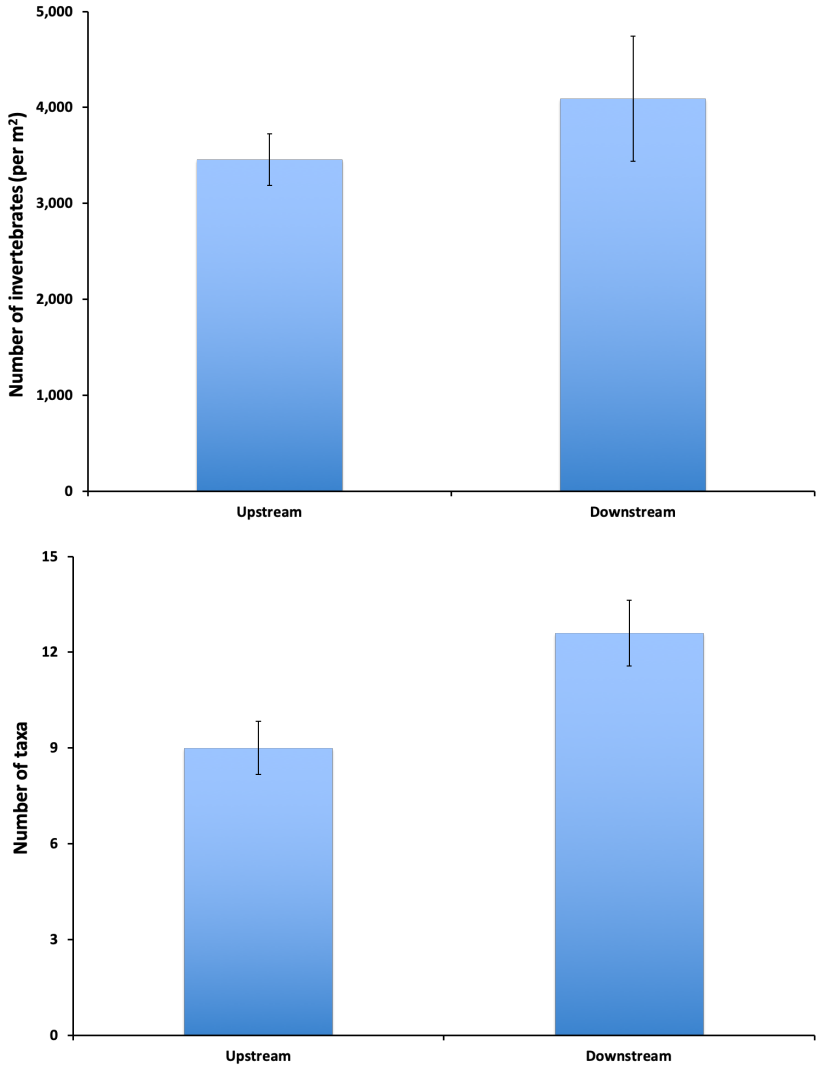

Figure 6. Values for invertebrate metrics for samples collected from the Mataura River, April 2021. Error bars are +/- one standard error.

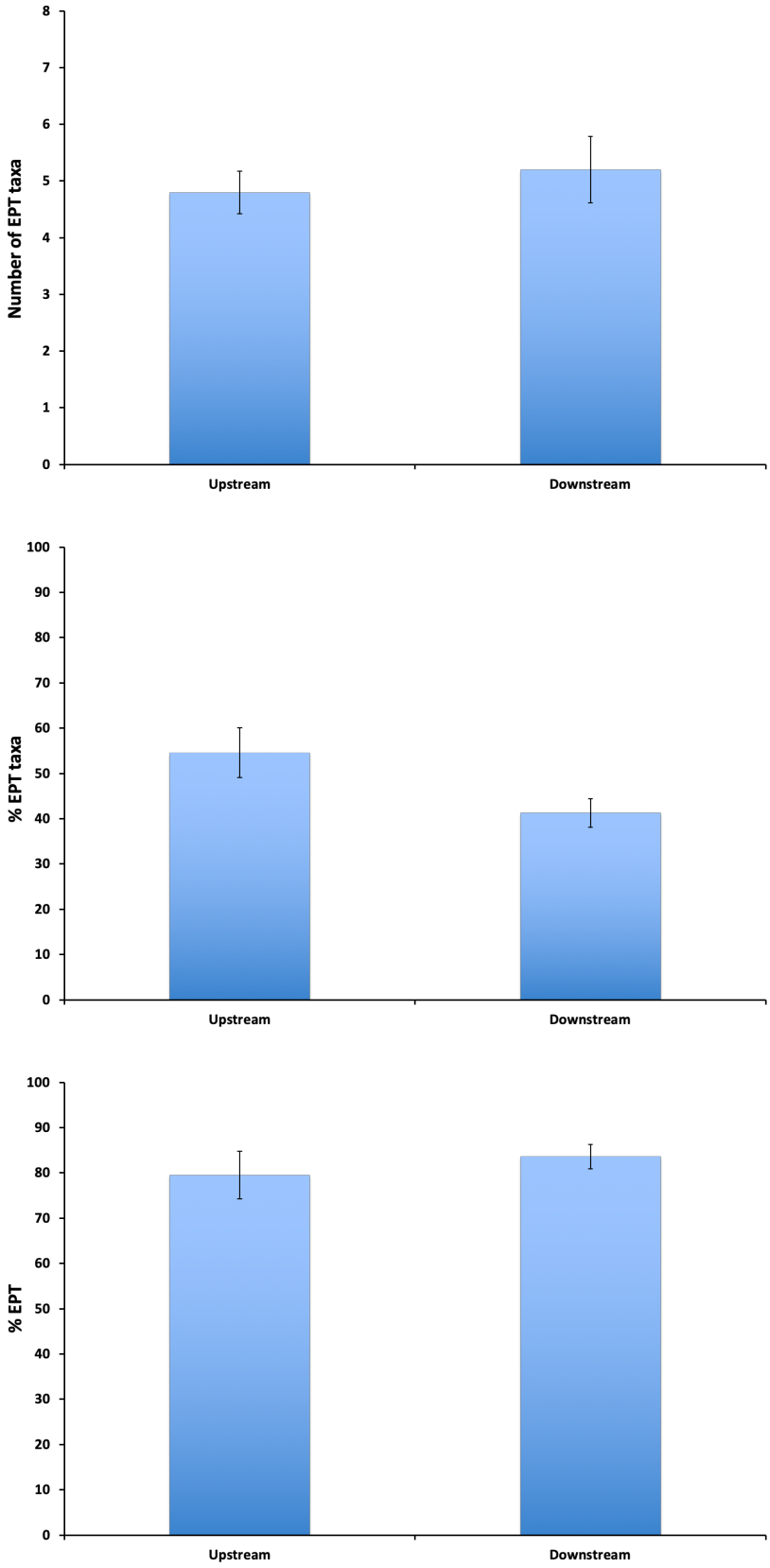

Figure 6 cont. Values for invertebrate metrics for samples collected from the Mataura River, April 2021. Error bars are +/- one standard error.

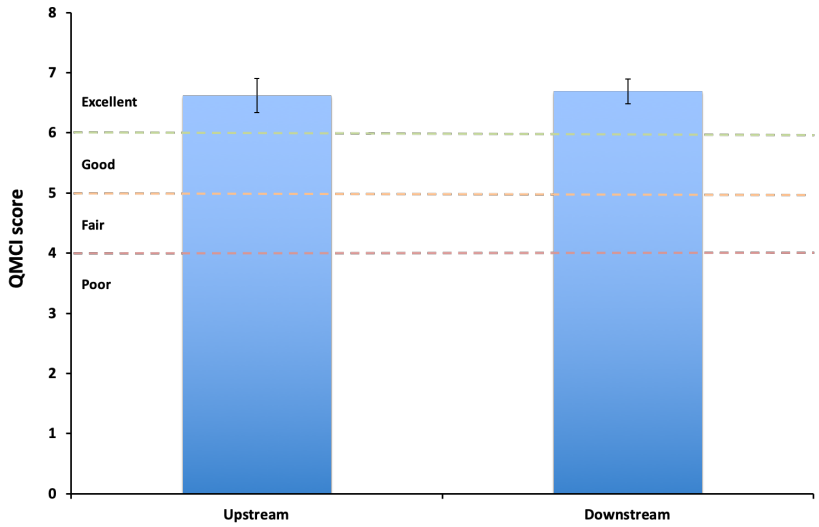

Figure 6 cont. Values for invertebrate metrics for samples collected from the Mataura River, April 2021. Error bars are +/- one standard error.

5. Summary and Conclusion

The April 2021 survey of the Mataura River in the vicinity of the Wyndham and Edendale wastewater treatment system discharge revealed similar benthic communities upstream and downstream of the discharge.

The periphyton community at both sites was dominated by thin light brown diatom films/mats, with similar cover levels and community composition at both sites. Cover of thick algal mats and long filamentous algae was well below Ministry for the Environment (Biggs 2000) guideline levels at both sites.

Deleatidium mayflies numerically dominated the macroinvertebrate communities at both sites. Taxonomic diversity was lower upstream of the discharge than downstream, but all other macroinvertebrate community metrics were similar at both sites. Community health index (QMCI) scores were similarly high at both sites and indicative of 'excellent' quality conditions. Average QMCI scores in recent surveys (e.g., Ludgate 2015, 2016) have also been similar at both sites.

In summary, monitoring in April 2021 indicates that the discharge from the Wyndham and Edendale wastewater treatment system discharge was not adversely affecting the local periphyton and benthic macroinvertebrate communities of the Mataura River.

6. References

Biggs, B.J.F. 2000. New Zealand periphyton guidelines: detecting, monitoring and managing enrichment of streams. Prepared for the Ministry for the Environment, Wellington.

Biggs, B.J.F. and Kilroy, K.C. 2000. Stream periphyton monitoring manual. Ministry for the Environment, Wellington.

Boothroyd, I.G. and Stark, J.D. 2000. Use of invertebrates in monitoring. Chapter 14 in Collier, K.J. and Winterbourn, M.J. eds. New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Christchurch. Pp. 344-373.

Entwisle, T.J., Sonneman, J.A. and Lewis, S.H. 1988. Freshwater algae of Australia: a guide to conspicuous genera. Sainty and Associates, Sydney.

Environment Southland. 2014. Regional Water Plan for Southland. August 2014. Publication No. 2014-09.

Environment Southland. 2018. Proposed Southland Water and Land Plan Part A. 4 April 2018 (Decisions Version).

Ludgate, B. 2015. Wyndham and Edendale wastewater treatment system discharge. Mataura River Benthic Macroinvertebrate and Periphyton Monitoring. January 2015. Report prepared by Ryder Consulting Limited for Southland District Council.

Ludgate, B. 2016. Wyndham and Edendale wastewater treatment system discharge. Mataura River Benthic Macroinvertebrate and Periphyton Monitoring. April 2016. Report prepared by Ryder Consulting Limited for Southland District Council.

Moore, S.C. 2000. Photographic guide to the freshwater algae of New Zealand. Otago Regional Council, Dunedin.

Scarsbrook, M., Boothroyd, I. and Quinn, J. 2000. New Zealand's National River Water Quality Network: long-term trends in macroinvertebrate communities. *New Zealand Journal of Marine and Freshwater Research*. **34**: 289–302.

Stark, J.D. 1985. A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication 87. National Water and Soil Conservation Authority, Wellington.

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

Winterbourn, M.J., Gregson, K.L.D. and Dolphin, C.H. 2006. Guide to the aquatic insects of New Zealand. *Bulletin of the Entomological Society of New Zealand*. **14**.

Appendix One: Periphyton cover data

Upstream:

Transect	Quadrat	Thin mat or film (less than 0.5mm thick)			Medium mat or film (0.5mm to 3mm thick)			Thick mat or film (more than 3mm thick)		Short filaments (less than about 2cm long)		Long filaments (more than about 2cm long)	
		Green	Light brown	Black/dark brown	Green	Light brown	Black/dark brown	Green/light brown	Black/dark brown	Green	Brown/ reddish	Green	Brown/ reddish
1	1	5	80				5			5		2	
	2	5	60			5	20			2		2	
	3	5	50	5		15	5			5		5	
	4	5	60	10		15	5					2	
	5	10	40	10		15	15			2		2	
2	1	5	70	50		10	5					2	
	2	5	50			10	5			5	5	5	
	3		50			10	10		10	2		10	
	4	5	60	5		10	10			2		5	
	5		60	5		20	5			2	5	2	
3	1	10	60			5	5					2	
	2	5	60			10	5		5	5		5	
	3	5	50	10		20	5					5	
	4		40	10		10	15		5	2		10	
	5	5	65	5		15	5					2	
4	1	20	60			5						2	
	2	5	60	5		20				5		2	
	3	5	50	10		15	10				2	5	
	4	5	50	10		15	5					10	
	5	5	60	10		15	5					2	

Downstream:

Transect	Quadrat	Thin mat or film (less than 0.5mm thick)			Medium mat or film (0.5mm to 3mm thick)			Thick mat or film (more than 3mm thick)		Short filaments (less than about 2cm long)		Long filaments (more than about 2cm long)	
		Green	Light brown	Black/dark brown	Green	Light brown	Black/dark brown	Green/light brown	Black/dark brown	Green	Brown/ reddish	Green	Brown/ reddish
1	1	10	50			10	10			5			
	2	10	50			10	5		5	2	5	2	
	3	15	60			20				2		2	
	4	20	50			20					2	2	
	5	10	20	5		15	15					5	5
2	1	15	50			15					10		2
	2	10	50	5		10				5	5	2	2
	3	5	40	15			10		5	5		5	5
	4	5	20	10		15	10		5		15	2	5
	5		20	5		15	20	5		2	10	5	5
3	1	5	70			10				2		2	2
	2	10	40	5		10	10		10		5	2	
	3	5	50	5		5	5				10	2	2
	4	5	30	5		10	10			2		2	20
	5	2	30	5		10	10		5	2		5	10
4	1		15								15		15
	2	10	40	10		10	5				10	2	
	3	5	50	5		10	5				5	5	15
	4	5	50	5		10					10	2	5
	5	5	30	5		5	5		10	2	15	2	15

Appendix Two: Periphyton cover photographs

Upstream:





Downstream: