I hereby give notice that a hearing by commissioners will be held on:

Date:	**Wednesday 2 & Thursday 3 April 2025** **(with Friday 4 April 2025 if required)**
Time:	**9:30am**
Meeting Room:	**Council Chambers**
Venue:	**Level 1, Manukau Civic Centre,** **33 Manukau Station Road, Manukau City Centre, Auckland**

APPLICATION MATERIAL AND SUBMISSIONS

VOLUME II

100 OKARORO DRIVE, BEACHLANDS

WATERCARE SERVICES LIMITED

COMMISSIONERS

Chairperson	**Karyn Sinclair**
Commissioners	**Martin Neale**
	Juliane Chetham

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Note: The reports contained within this document are for consideration and should not be construed as a decision of Council. Should commissioners require further information relating to any reports, please contact the hearings advisor.

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ATTACHMENT 12

WATER QUALITY & BIOLOGICAL ASSESSMENT, TE PURU STREAM TRIBUTARY 2 MAY 24

Bioresearches
A Babbage Company

Water Quality and Biological Assessment, Te Puru Stream Tributary, Beachlands
May 2024

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Water Quality and Biological Assessment, Te Puru Stream Tributary, Beachlands April 2024

DOCUMENT APPROVAL

Document title:	Water Quality and Biological Assessment, Te Puru Stream Tributary, Beachlands
Prepared for:	Watercare Services Limited
Version:	Final
Date:	2 May 2024
Document name:	67064 Te Puru Tributary Monitoring V3_Updated 260424

Authors:	Christel du Preez M.Sc. (Hons) Freshwater Ecologist
Reviewer	Treffery Barnett M.Sc. (Hons), MEIANZ Technical Director, Freshwater Senior Coastal & Freshwater Ecologist

Reference: Bioresearches (2024). Water Quality and Biological Assessment, Te Puru Stream Tributary, Beachlands. Report for Watercare Services Limited. pp 91

Cover Illustration: Site C, Farm Pond Tributary of the Te Puru Stream, Beachlands (31 January 2024)

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EXECUTIVE SUMMARY

A survey of the upper Te Puru Stream catchment was undertaken on behalf of Watercare Services Limited (Watercare), as a comparative study of water quality and biological condition upstream and downstream of the Beachlands wastewater treatment plant discharge point. This report presents the results of the water quality and biological survey undertaken at ten sites over the period 31st of January, and 1st and 2nd of February 2024, to determine the effects of the existing discharge of highly treated effluent from the treatment facility on the water quality and biology of the receiving waters.

Overall water quality and biological health of the Te Puru stream tributaries were relatively poor throughout both reference and impact sites, reflecting in part the pastoral catchment in which the Te Puru Stream tributaries are located.

In terms of water quality, conductivity was elevated below the discharge point and continued to be substantially elevated beyond the lowest site surveyed. pH and carbonaceous biochemical oxygen demand did not appear to be influenced by the discharge.

Bioavailable nutrients (nitrogen and phosphorus) increased below the discharge point. Nutrient concentrations tended to decrease with increasing distance downstream; however, some parameters such as total nitrogen, dissolved inorganic nitrogen, total phosphorus, and dissolved reactive phosphorus continued to be elevated until the furthest downstream site, approximately 1.5 km downstream of the discharge pond. Ammonia, which can be toxic to aquatic fauna at elevated concentrations, increased markedly downstream of the discharge pond, however returned to reference levels by the most downstream site. All of the sites surveyed recorded ammoniacal nitrogen below both these acute and chronic guidelines.

There was no evidence of bacterial contamination by the discharge, with some very high values for faecal coliforms and enterococci bacteria recorded at both reference and effects sites, which was attributed to the presence of livestock and birds within the catchment.

Macroinvertebrate communities were generally indicative of fair/good quality habitat at reference sites and poor/fair quality habitat across effects sites and sensitive macroinvertebrate taxa tended to be absent from effects sites. Macroinvertebrate indices at the most downstream sites did show some recovery, indicating localised adverse effects from the discharge on macroinvertebrate communities.

Fish communities appeared to be influenced by the discharge, with reductions in native species diversity and abundance observed downstream of the discharge pond. Juvenile eels and juvenile banded kōkopu were recorded in the upstream reference site, indicating that fish are able to migrate upstream of the discharge.

Macrophytes increased in cover and diversity downstream of the discharge, with a diverse range of both introduced and native species present, dominated by Nitella, followed by filamentous algae. Due to differences in shading, flow rate and bioavailable nutrient levels between reference and effects sites, the differences observed in macrophyte and periphyton growth were attributed to these range of factors.

Overall comparison with the results of the previous surveys since 2000 (Bioresearches 2002, 2010, 2016, 2019 and 2022), shows that water quality and ecological conditions in the upper Te Puru Stream tributaries surveyed were broadly similar in the present survey. Ammonia showed substantial decreases at effects sites compared to 2022 data; however, are still considered to be markedly higher than that at reference sites. Macrophytes and macroinvertebrate communities appeared to be negatively influenced at effects sites surveyed over 31 January – 2 February 2024, specifically noting a decline in sensitive macroinvertebrates species and an increase in macrophyte species at effects sites. Native fish were still able to migrate beyond the farm pond, as found previously. Conductivity levels below the discharge were very high and remained high throughout the Te Puru Tributary. The elevated levels of conductivity require further consideration, both in terms of whether these levels can be reduced in the discharge and the extent the elevated levels are present downstream of the survey sites.

While the overall quality of the Te Puru Stream tributaries is determined principally by the land use of the adjacent catchment, the results of the survey indicate that the wastewater treatment plant discharge influences the quality of the habitat of the Te Puru Stream Tributary for a distance of at least 200 m downstream of the farm pond, with some water quality parameters such as conductivity and bioavailable nutrients affected for a greater distance (observed at lowest monitoring site, Site C). Fish populations, sensitive macroinvertebrates and filamentous algae also appeared to be affected for some distance downstream of the discharge (observed up to the lowest monitoring site, Site C), although eels and banded kōkopu were able to migrate upstream past the discharge.

1. INTRODUCTION

Watercare operates the wastewater treatment plant (WWTP) at Beachlands, Auckland, and regular monitoring of the effects of the discharge on water quality and stream biology is required. The WTP discharges highly treated effluent through pipes and then through a trickle system through a vegetated area, then into a large farm pond, which discharges to a tributary of the Te Puru Stream in Beachlands.

This water quality and biological assessment of selected Te Puru Stream tributaries is a repeat of the water quality and biological surveys carried out for Manukau Water in 1997, 1999, 2002 and 2010, and for Watercare in 2016, 2019 and 2022 (Bioresearches 1997, 1999, 2002, 2010, 2016, 2019 and 2022). Monitoring is usually undertaken every three years; however, the most recent monitoring in January-February 2024 which is described in this report was carried out only two years after the previous (2022) monitoring to inform Watercare's understanding of the potential effects of an increased discharge of treated effluent into the tributary of the Te Puru Stream, as part of its application to Auckland Council to renew its current discharge consent.

The Te Puru Stream is located in the Beachlands area, near the east coast, south of Auckland. The stream is approximately four kilometres long and flows through moderately steep pastoral land before discharging into the ocean at Kelly's Beach. The highly treated effluent from the WTP is discharged into a farm pond on a tributary of the Te Puru Stream located approximately 4.5 km inland from the stream mouth.

Analysing water and sediment quality can give an indication of the presence and extent of nutrient enrichment/contaminants from influences such as wastewater discharges, urban areas and pastoral land use. Parameters such as nitrogen and phosphorous compounds and bacteria are often measured when analysing water and sediment quality. The biological characteristics of stream ecosystems can give indications of stream health and the effects that factors such as a wastewater discharge may have on freshwater communities.

Sampling was undertaken in two main tributaries adjacent to Okaroro Road, referred to as the Reference Tributary and Te Puru Stream Tributary. A side tributary of the main tributary, which included the farm pond into which the treated wastewater is held for final polishing, was referred to as the Farm Pond Tributary (Figure 1).

Water quality samples were taken at seven sites from the two tributaries, including three reference sites, and sediment quality samples were taken at four sites. Biological samples included fish and macroinvertebrates, taken from six sites, and macrophytes, which were evaluated at eight sites. Site names and locations correspond to those used in previous Te Puru Stream monitoring surveys (Bioresearches 1997, 1999, 2002, 2010, 2016, 2019 and 2022). This report presents the results of the water quality and biological assessments carried out on the 31st of January, and 1st and 2nd of February 2024.

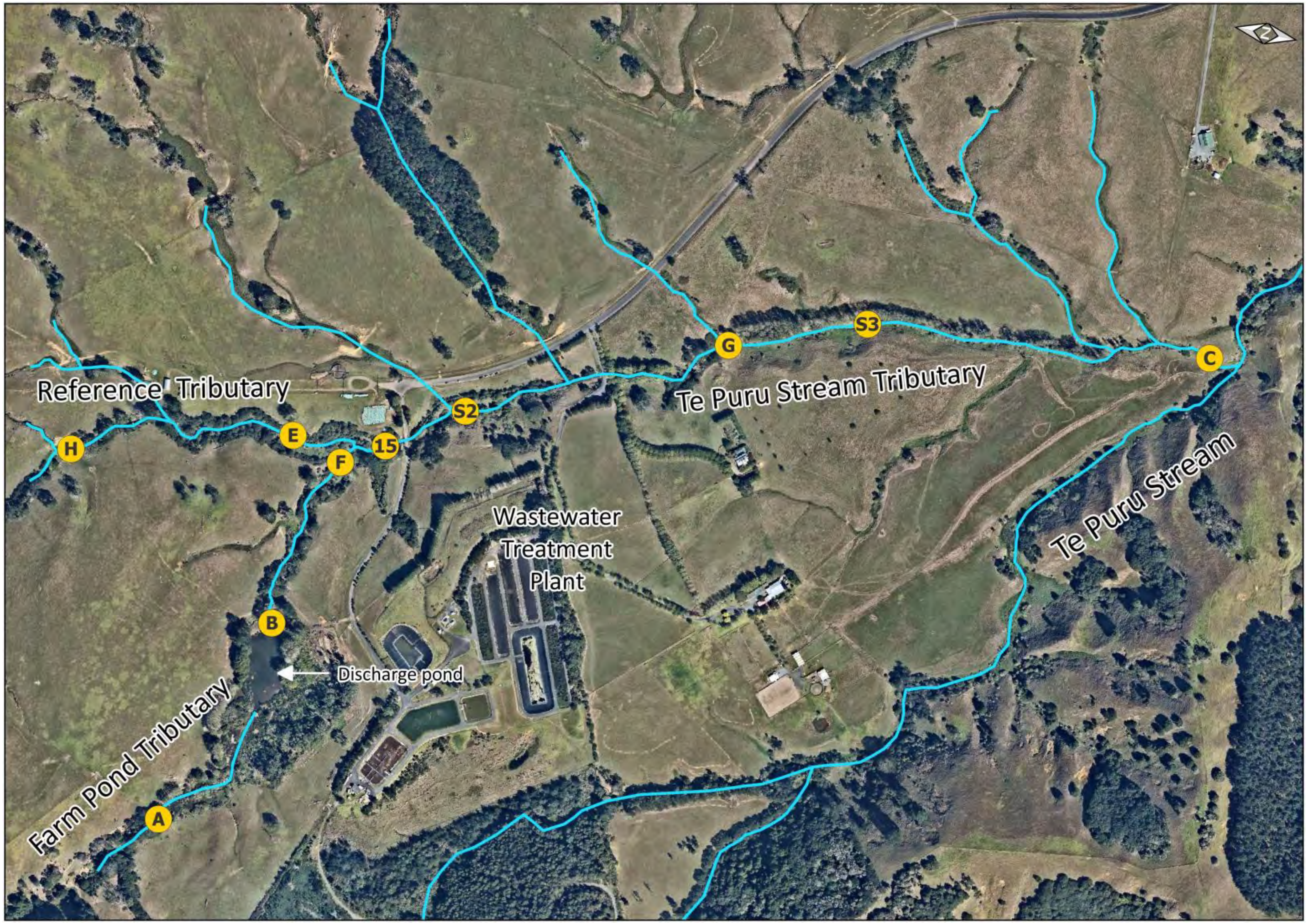

Figure 1. ***Sampling site locations in Te Puru Stream tributaries (blue lines – Reference Tributary, Farm Pond Tributary and Te Puru Stream Tributary), site locations (yellow circles) and the location of the wastewater treatment plant.***

2. METHODOLOGY

2.1 Site Locations

Locations of sampling sites for the water quality and biological surveys were the same as in the previous monitoring surveys (Table 1 and Table 2).

Table 1. Sampling site locations.

Site	Description	Tributary	Location (NZTM)
A	Reference site, upstream of the farm pond.	Farm Pond Tributary	E1781181.11 N5912504.77
B	Effect site, immediately downstream of the farm pond discharge.	Farm Pond Tributary	E1780823.81 N5912650.06
F	Effect site, approximately 200m downstream of the farm pond and immediately upstream of the Te Puru Stream Tributary confluence.	Farm Pond Tributary	E1780640.75 N5912676.69
H	Reference site, upstream of E in the headwaters of the Reference Tributary	Reference Tributary	E1780642.45 N5912324.68
E	Reference site, downstream of H and just upstream of the confluence with the Farm Pond Tributary, Te Puru Stream Tributary	Reference Tributary	E1780549.89 N5912604.50
15	Effect site, immediately downstream of the confluence of the of the Farm Pond Tributary and the Reference Tributary	Te Puru Stream Tributary	E1780548.57 N5912764.51
S2	Effect site, approximately 200m downstream of the Farm Pond Tributary and Reference Tributary confluence, within replanted area.	Te Puru Stream Tributary	E1780445.25 N5912920.30
G	Effect site, approximately 600m downstream of the Farm Pond Tributary and Reference Tributary confluence.	Te Puru Stream Tributary	E1780300.63 N5913226.02
S3	Effect site, approximately 800m downstream of the Farm Pond Tributary and Reference Tributary confluence.	Te Puru Stream Tributary	E1780236.26 N5913406.90
C	Effect site, approximately 100m upstream of the confluence with the mainstem Te Puru Stream	Te Puru Stream Tributary	E1780186.32 N5913871.81

Table 2. Sample types taken at each site.

Site	Sample Types
A	Water Quality, Macroinvertebrates and Fish, Macrophytes
B	Water Quality
F	Water Quality, Sediment, Quality, Macroinvertebrates and Fish, Macrophytes
H	Macroinvertebrates and Fish, Macrophytes
E	Water Quality, Sediment Quality, Macroinvertebrates and Fish Macrophytes
15	Water Quality
S2	Macrophytes
G	Water Quality, Sediment Quality, Macroinvertebrates and Fish, Macrophytes
S3	Macrophytes
C	Water Quality, Sediment Quality, Macroinvertebrates and Fish, Macrophytes

2.2 Water and Sediment Quality

Water quality sampling was undertaken on the 31st of January 2024, after a period of settled weather and under late summer low-flow conditions. Water samples were collected from Sites A, B, C, E, F, G & 15 (Figure 1). The water samples were chilled and delivered to the laboratory (Hills Laboratories, Hamilton) within 24-29 hours of collection. These samples were analysed for the following parameters:

- Conductivity – the total ionic strength of the water and an indication of nutrient enrichment;
- pH – the concentration of hydrogen ions in the water showing the strength of acid present;
- Total Suspended Solids – suspended particles that are not dissolved in the water;
- Carbonaceous Biochemical Oxygen Demand ($CBOD_5$) – the oxygen used by bacteria for the biochemical degradation of organic matter;
- Chlorophyll-α – a measure of the phytoplankton biomass;
- Total Ammoniacal Nitrogen (NH_4-N) – an indicator of nutrient enrichment, often from point source discharges such as sewage or dairy effluent;
- Total Nitrogen – the sum of all organic and inorganic forms of nitrogen, an indicator of nutrient enrichment;
- Nitrate Nitrogen (NO_3-N) – a common nutrient in urban and rural areas and an indicator of nutrient enrichment;
- Nitrite Nitrogen (NO_2-N) – a less common form of nitrogen and an indicator of nutrient enrichment;
- Total Kjeldahl Nitrogen (TKN) – a measure of nitrogen in the trivalent state (NH_4-N, protein N and non-protein-N), an indicator of nutrient enrichment;
- Dissolved Inorganic Nitrogen (DIN) – a measure of nitrite, nitrate and ammonium, an indicator of nutrient enrichment;
- Total Phosphorus – all phosphorus concentrations (dissolved, solid or bound to sediment), an indicator of nutrient enrichment;
- Dissolved Reactive Phosphorus (DRP) – a measure of the dissolved phosphorus compounds that are readily available for use by plants and algae, an indicator of a waterbody's ability to support algae/plant growth;
- Faecal Coliform Bacteria – predominantly found in the gut of humans and animals, an indicator of faecal contamination; and
- Enterococci – a faecal coliform bacteria species that naturally occurs in the gut of humans and animals (including birds, fish and reptiles), an indicator of faecal contamination.

Spot measurements of basic water quality parameters (temperature, dissolved oxygen and conductivity) were also taken using a Yellow Springs Instrument (YSI) Professional Series meter and water clarity was measured using a turbidity tube at each site.

Water quality results were compared to the Australia and New Zealand Guidelines for Freshwater and Marine Water Quality (ANZECC Guidelines – ANZG 2018, ANZECC and ARMCANZ 2000); the New Zealand National Policy Statement for Freshwater Management (NPS-FM) criteria for protecting aquatic ecosystems, (Ministry for the Environment (MfE) 2020); habitat indicators of stream health from the National Institute of Water and Atmosphere (NIWA) (Hickey 2001, 2014 and Biggs *et al*. 2002); and sewage fungus growth (Quinn 2009). The raw water quality data are presented in Appendix 1.

Composite sediment samples were collected at Sites C, E, F and G on the 31st of January 2024. Six sediment cores (80mm x 100mm) were collected from each site (two from true left bank, two from true right bank, two from centre of tributary) and combined. A representative sub-sample was taken from this composite sample and sent to Hills Laboratories, Hamilton for analyses of the following parameters:

- % Dry Weight – the amount of organic matter in a sample;
- Total Phosphorus – an indicator of nutrient enrichment;
- Total Nitrogen – an indicator of nutrient enrichment and of sources of organic matter input;
- Total Carbon – an indicator of sources of organic matter input;
- Carbon: Nitrogen Ratio – an indicator of the relative sources of organic matter; and
- Ammonium-Nitrogen – an indicator of nutrient enrichment.

Stream velocity measurements were undertaken on the 31st of January and the 1st of February 2024 at sites within all three tributaries. The width of the stream was measured, and depth and velocity readings were taken at proportional intervals across a transect – at 10%, 30% 50%, 70% and 90% of the stream width. This enabled flow to be calculated. While a pygmy flow meter was the preferred instrument to take the stream velocity measurements, the high electrical conductivity in the water meant the instrument was not able to perform as required. As such, stream velocity was recorded by measuring the amount of time it took for an object to travel a certain distance. Other limitations with once-off flow measurements include:

- A Lack of temporal variability: A single flow measurement may not capture the temporal variability in flow patterns, which can affect habitat conditions and the distribution of aquatic organisms over time;
- Inadequate representation: Flow measurements taken at a single point at the various sites in time may not adequately represent the range of flow conditions experienced by aquatic organisms throughout different seasons or hydrological events (high flows, low flows etc.);
- Inaccuracy in habitat assessment: Flow data collected at a single time point may not accurately reflect the range of habitats available to aquatic organisms, particularly if flow conditions vary significantly over the various seasons;
- Without multiple flow measurements over time, it is challenging to assess long-term trends in flow patterns and its effects on aquatic ecosystems;
- Without repeated flow measurements, it is difficult to develop a comprehensive understanding of the relationships between flow dynamics and ecological responses in the Te Puru stream and tributaries; and
- Limited ability to evaluate management interventions: Single flow measurements may not provide sufficient data to evaluate the effectiveness of management interventions aimed at mitigating the impacts of altered flow regimes on aquatic ecosystems.

2.3 Biological Surveys

Biological assessments were undertaken on the 31st of January, and 1st and 2nd of February 2024. Six sites were sampled for macroinvertebrates and fish, and macrophytes were sampled at eight sites (Figure 1 and Table 2).

Macroinvertebrates were sampled from instream habitats to obtain semi-quantitative data in accordance with the Ministry for the Environment's current "Protocols for Sampling Macroinvertebrates in Wadeable Streams" (Stark *et al*. 2001). Sampling was undertaken using protocol 'C1: hard-bottomed, semi-quantitative' where the majority of the substrate was hard bottomed (Sites H and E), and protocol 'C2: soft-bottomed, semi-quantitative' where the site was predominantly soft bottomed (Sites A, F, G and C). The macroinvertebrate sample was preserved in 70% ethyl alcohol (ethanol), returned to the laboratory and sorted (using protocol 'P3: full count with sub-sampling option' (Stark *et al*. 2001)). Macroinvertebrates were then identified to the lowest practicable level and counted to enable biotic indices to be calculated.

Several biotic indices were calculated, namely the number of taxa, the number and percentage of Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies) recorded in a sample (%EPT), the Macroinvertebrate Community Index (MCI) and the Semi-Quantitative Macroinvertebrate Community Index (SQMCI) (Stark & Maxted, 2007a). EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment but exclude *Oxyethira* and *Paroxyethira* as these taxa are not sensitive and can proliferate in degraded habitats. The MCI and SQMCI are based on the average sensitivity score for individual taxa recorded within a sample; although the SQMCI is calculated using coded abundances instead of actual scores. The raw macroinvertebrate data are presented in Appendix 2. For the MCI and SQMCI, respectively, scores of:

- ≥ 120 and ≥ 6.0 are indicative of excellent habitat quality,
- 100 – 119 and 5.0 – 5.9 are indicative of good habitat quality,
- 80 – 99 and 4.0 – 4.9 are indicative of fair habitat quality and
- < 80 and < 4.0 are indicative of poor habitat quality (Stark & Maxted, 2007b).

The Auckland Unitary Plan (AUP), Chapter E1.3, provides additional MCI values criteria, AUP Table E1.3.10, for freshwater ecosystem health associated with various land uses within catchments (Table 3). Policy E1.3(2) mandates the management of discharges that could potentially impact freshwater systems to maintain or improve water quality, flow rates, stream channels, margins, and other freshwater values. This policy applies when the current condition is either above (for maintenance) or below (for enhancement) the National Policy Statement for Freshwater Management (NPS-FM) National Bottom Lines and the relevant MCI guidelines.

Table 3. MCI guideline for Auckland rivers and streams as per AUP Policy E1.3(2)

Land use	MCI guideline
Native forest	123
Exotic forest	111
***Rural areas**	94
Urban areas	68

*MCI guideline applicable to the Te Puru catchment

Fish communities can be good indicators of stream ecosystem health. Freshwater fish were sampled using three baited Gee's minnow traps which were deployed overnight at each site. Electric fishing was also intended to be carried out at each site using an electric fishing machine (EFM) 300 backpack. Electric fishing was only effective at Sites A, H and E as the high conductivity at sites downstream of the pond prevented effective operation of the machine. The electric fishing machine temporarily stuns the fish, allowing them to be captured. All fish captured were identified and counted, and their size estimated before being returned to their habitats. A Fish Index of Biotic Integrity (IBI) for the Auckland Region was calculated for each site based on fish species present, altitude and distance inland (Joy and Henderson 2004). New Zealand Freshwater Fish Database (NZFFD, NIWA) forms were completed for each site. The raw freshwater fish data are presented in Appendix 3.

At each site the percentage cover (proportion of the total line width impinged) of algae and/or macrophytes was recorded along twelve random replicate transects which ran from bank to bank. Transect locations were determined using a random number table. From the centre of the site, six transects were completed in an upstream direction at random intervals in metres determined by the table, followed by six transects returning in a downstream direction. At each transect the stream width, and the length of the transect impinged by the plant taxa were recorded and converted to percentage plant cover. Incidental species present at the site but not recorded along the transects were also noted. The raw macrophyte survey results are present in Appendix 5.

2.4 Results Comparison

All results were compared to guideline values, where applicable. Guideline values for water quality can give an indication as to the relevant concentrations of nutrients and toxicants above or below which possible adverse effects are known to occur.

Results from 2024 were also compared to the most recent three-yearly survey (Bioresearches, 2022). Any large deviations in results from what was found in 2019 and 2022 was also reported.

3. RESULTS

3.1 Physical Characteristics

The physical characteristics of Te Puru Stream tributary sites are summarised in Table 4 and photographs of each site are shown in Photos 1 to 10.

The average width at each stream site varied between 1.74 m (Site H) to 2.69 m (Site S3) wide, and the average stream width across all sites was 2.11 m. Average depth at most sites was relatively shallow and ranged between 0.12 m (Site F and S2) and 0.51 m (Site S3).

Substrate was predominantly made up of silt, with the exception of Sites H and S2, where bedrock and cobbles were dominant. Cobble and gravels were also common at all sites. Fish habitat/cover types observed during the survey comprised macrophytes, instream debris (e.g. wood), undercut banks and bankside vegetation.

Stream flow varied substantially across the sites. Flow was highest at Site G (66.39 L/s) and lowest at Site E (10.24 L/s), and generally increased with distance downstream.

One thing to note, monitoring of reference Site A was shifted 10 m upstream due to the abundant growth of wetland plants within the previous monitoring site. This is further discussed in Section 4.1.1

Table 4. Summary of the physical characteristics and biological survey results of the Te Puru Stream sites, 31st of January to the 2nd of February 2024.

	Reference Tributary		Farm Pond Tributary			Te Puru Stream Tributary		
Site	**H**	**E**	**A**	**F**	**S2**	**G**	**S3**	**C**
Date	31 Jan 2024	31 Jan 2024	31 Jan 2024	31 Jan 2024	31 Jan 2024	31 Jan 2024	31 Jan 2024	31 Jan 2024
Habitat								
Average Width (m)	1.74	2.16	1.61	2.36	2.36	2.17	2.69	1.82
Average Depth (m)	0.24	0.23	0.19	0.12	0.12	0.25	0.51	0.27
Flow (L/s)	Not assessed	10.24	Not assessed	15.8	31.73	49.24	38.66	40.49
Dominant substrate	Bedrock with small cobble	Silt and cobble	Small gravel on top of soft sediments	Thick layer of fine organic material and silt	Bedrock, cobble	Silt, cobble and gravel	Silt, cobble and gravel	Silt, cobble and gravel
Fish Cover	Instream debris, Undercut banks	Macrophytes, instream debris, undercut banks, bank vegetation	Macrophytes, instream debris, undercut banks, bank vegetation	Macrophytes, instream debris, bank vegetation	Instream debris, bank vegetation	Macrophytes, instream debris, bank vegetation	Instream debris, bank vegetation, undercut banks	Macrophytes, instream debris, undercut banks, bank vegetation
Macrophytes and Algae								
No. of Taxa	1	8	3	7	4	9	7	7
Average Percent Cover	5	11	7	43	9	53	60	72
Species Recorded	Water celery	Willow weed, curly pondweed, water celery, buttercup, forget me knot, *Nitella*, green mat and filaments.	Willow weed, red ludwigia, and green filaments.	Willow weed, watercress, duck weed, Starwort, forget me knot, brown mat, green filaments.	Forget me not, Nitella, brown mat, brown filaments.	Willow weed, watercress, duck weed, curly pondweed, water celery, buttercup, forget me not, *Nitella*, green filaments	Willow weed, watercress, duck weed, curly pondweed, buttercup, *Nitella*, green mat	Willow weed, watercress, water celery, oxygen weed, *forget me not*, *Nitella*, green filaments

Site	H	E	A	F	S2	G	S3	C
Macroinvertebrates								
No. of Taxa	15	22	21	3	Not assessed	12	Not assessed	12
Dominant taxon	*Potymopyrgus*	*Potymopyrgus*	*Paracalliope fluviatilis*	*Potymopyrgus*		*Potymopyrgus*		*Paracalliope fluviatilis*
%EPT	20	30	22	0		0		0
MCI	101.3 - Good	98.2 - Good	104.7 - Fair	63.3 - Poor		81.7 - Fair		67.3 - Poor
SQMCI	4.78 - Fair	4.46 - Fair	6.01 - Excellent	2.13 - Poor		4.49 - Fair		4.83 - Fair
Large invertebrates	*Paratya* shrimp, kōura	*Paratya* shrimp, kōura	kōura			*Paratya* shrimp		*Paratya* shrimp, kōura
Fish								
No. of species	4	3	4	1	Not assessed	3	Not assessed	4
No. of fish	36	19	21	1		25		14
Fish IBI	34 - Fair	26 - Poor	34 - Fair	14 – Very Poor		26 - Poor		26 - Poor
Species recorded	Kōura, Cran's bully, Common bully, Banded kokopu	Common bully, unidentified eel, kōura	Banded kokopu, kōura, common bully, unidentified eel	Unidentified eel		Mosquito fish, common bully, longfin eel		Common bully, mosquito fish, longfin eel, unidentified eel

*HB = hard-bottomed, SB = soft-bottomed

Photo 1. Site A – reference site, Farm Pond Tributary.

Photo 2. Site H – reference site, Reference Tributary.

Photo 3. Site E – reference site, Reference Tributary.

Photo 4. Site B – effect site, Farm Pond Tributary.

Photo 5. Site F – effect site, Farm Pond Tributary.

Photo 6. Site 15 – effect site, Te Puru Stream Tributary

Photo 7. Site S2 – effect site, Te Puru Stream Tributary

Photo 8. Site S3 – effect site, Te Puru Stream Tributary

Photo 9. Site G – effect site, Te Puru Stream Tributary

Photo 10. Site C – effect site, Te Puru Stream Tributary

3.2 Water Quality

Water quality results are presented in Table 5 and Figures 2 to 6.

Small amounts of nutrients such as nitrogen and phosphorus in freshwater are important for plant growth, however excess concentrations can lead to nuisance aquatic plant growth, algal blooms, eutrophication of freshwater ecosystems and some compounds are toxic to aquatic life at high concentrations. Faecal bacteria associated with wastewater discharges can indicate a risk to human health.

Water quality results were compared to freshwater guideline values for the protection of aquatic ecosystems, where values for the water quality component were available and relevant. Guideline values used were all New Zealand based data (ANZG 2018; ANZECC and ARMCANZ 2000; Ministry for the Environment 2020; Quinn 2009; Biggs *et al.* 2002, Hickey 2014) and NIWA site specific data (Hickey 2001). These guidelines give the concentrations of nutrients and toxicants above or below which possible adverse effects are known to occur.

The ANZG (2018), which succeeded ANZECC (2000), provides generic default guideline values (DGVs) for toxicants and physical and chemical stressors in waterways. Physical and chemical DGVs are available for both high and low values:

- High indicates the stressor is harmful at high values (80th percentile); and
- Low indicates the stressor is harmful at low values (20th percentile).

DGVs for physical and chemical stressors were derived for a low elevation river in a warm-dry climate, based on the River Environmental Classification (REC) of Te Puru stream and tributaries (NIWA 2004)[1].

Guidelines from the National Policy Statement for Freshwater Management (NPS-FM – Ministry for the Environment 2020) include several attribute states, the lowest being Attribute State D (significant, persistent stress on aquatic organisms, high risk of local extinctions of keystone species and loss of ecological integrity) to the highest of Attribute State A (no stress caused by the indicator on 99% aquatic organisms at pristine (reference) sites). Attribute State B refers to lakes and rivers impacted by land use practices and/or provides for 95% species protection level (i.e. starting to impact occasionally on the 5% most sensitive species). As the surrounding catchment has been cleared and the dominant land use is farming this report mainly refers to the Attribute State B guideline values.

Habitat indicators of stream health from Biggs *et al*. (2002) do not provide specific guideline values, however, they do provide ranges of some water quality components that would indicate ‘poor’, ‘fair’, ‘good’ and ‘excellent’ stream health and these ranges were used where appropriate.

[1] Since 2019, the monitoring report used DGVs for a REC of low elevation river in a warm-wet climate. This change in classification does not impact on the outcome of this study, as the updated classification refers to specific guidelines to which the most recent water quality analysis is compared to.

Specific guideline values for carbonaceous biochemical oxygen demand ($cBOD_5$) were not available for New Zealand river systems. Evidence presented by Quinn (2009) at a hearing relating to water quality in the Horizons region presents professional opinion regarding the concentration of BOD to protect river systems from sewage fungus. This evidence has been cited and utilised as a guideline value when reporting on water quality previously (Mott MacDonald 2017). Chlorophyll α concentrations in lake ecosystems from the NPS-FM (MfE 2020) were used as guideline values in this report, however, should be reviewed with some caution due to the differing ecosystem types.

Table 5. Water quality results for the Te Puru Stream sites, sampled January/February 2024. Bold text corresponds to values not meeting the guideline.

	Reference Tributary	Farm Pond Tributary			Te Puru Stream Tributary			Guideline	
	E	A	B	F	15	G	C	Low/High*	Value
Time (hrs, NZDST)	15:00	10:40	11:25	12:05	13:10	15:40	9:10		
Temperature (°C)	19.9	18.2	24.5	24.2	22.4	22	20.6	H	20 [5]
Dissolved Oxygen (mg/L)	6.8	6	**7.7**	**4.6**	6.5	7.00	5.3	L	5.0 - 7.5 [4]
Oxygen Saturation (%)	**76**	**65**	**94**	**56.0**	**76**	**81**	**61**	L and H	82 - 100 [1]
Conductivity (µS/cm)	**158.9**	**149.8**	**1964**	**1944**	**1297**	**1166**	**1188**	H	86 [1]
Conductivity (mS/m)	15.89	14.98	196.4	194.4	129.7	116.6	118.8	H	
Salinity (ppt)	0.08	0.08	1.01	1	0.68	0.62	0.65		
Visual Clarity (m)	**0.7**	0.47	**0.76**	**0.75**	**0.72**	**0.8**	**0.78**	L	0.7 [1]
pH (pH unit)	7.4	**7.1**	7.7	7.8	7.5	7.7	7.5	L and H	7.27 - 7.8 [1]
Total Suspended Solids (g/m^3)	< 3	**6**	**7**	**6**	**10**	< 3	< 3	H	4.6 [1]
Carbonaceous Biochemical Oxygen Demand ($g\ O_2/m^3$)	< 2[#1]	< 2[#1]	< 2[#1]	< 2[#1]	< 2[#1]	< 2[#1]	< 2[#1]	H	2 [3]
Chlorophyll α (g/m^3)	< 0.003	< 0.003	0.006	< 0.003	< 0.003	< 0.003	< 0.003	H	0.05 - 0.12 [4]
Total Ammoniacal Nitrogen (g/m^3)	0.011	0.029	0.167	0.057	0.022	0.011	0.01	H	3 [6]
Total Nitrogen (g/m^3)	0.23	0.25	**3.5**	**3.5**	2.4	2	2.1	H	3 [6]
Nitrate-N (g/m^3)	0.115	0.099	**2.4**	**2.5**	**1.69**	**1.51**	**1.47**	H	0.195 [1]
Nitrite-N (g/m^3)	0.002	< 0.002	0.173	0.094	0.036	0.017	0.013	H	0.444 [2]
Nitrate-N + Nitrite-N (g/m^3)	0.117	0.101	2.6	2.6	1.73	1.52	1.49	-	
Total Kjeldahl Nitrogen (g/m^3)	0.11	0.15	0.95	0.87	0.63	0.52	0.57	-	
Dissolved Inorganic Nitrogen (g/m^3)	0.128	0.13	2.7	2.7	1.75	1.53	1.5	-	
Total Phosphorous (g/m^3)	**0.04**	**0.029**	**0.69**	**0.61**	**0.45**	**0.32**	**0.28**	H	0.023 [1]
Dissolved Reactive Phosphorous (g/m^3)	**0.015**	0.005	**0.51**	**0.48**	**0.29**	**0.24**	**0.2**	H	0.007 [1]
Faecal Coliforms (cfu / 100mL)	**460**	**560**	**540**	**410**	**340**	**1800[#2]**	**1300[#2]**	H	150 [2]
Enterococci (MPN / 100mL)	**1,986**	461	166	549	517	**1,203**	461	H	700 [2]

*L = harmful at low values; H = harmful at high values, [1] ANZG (2018), [2] ANZECC (2000), [3] Quinn (2009), [4]Ministry for the Environment (2020), [5] Biggs *et al.* (2002), [6]Hickey 2011, 2014) specific guideline for Te Puru derived from ANZECC (2000); Ammoniacal nitrogen guideline used as Total N is the sum of nitrate, nitrite, organic nitrogen and ammonia.

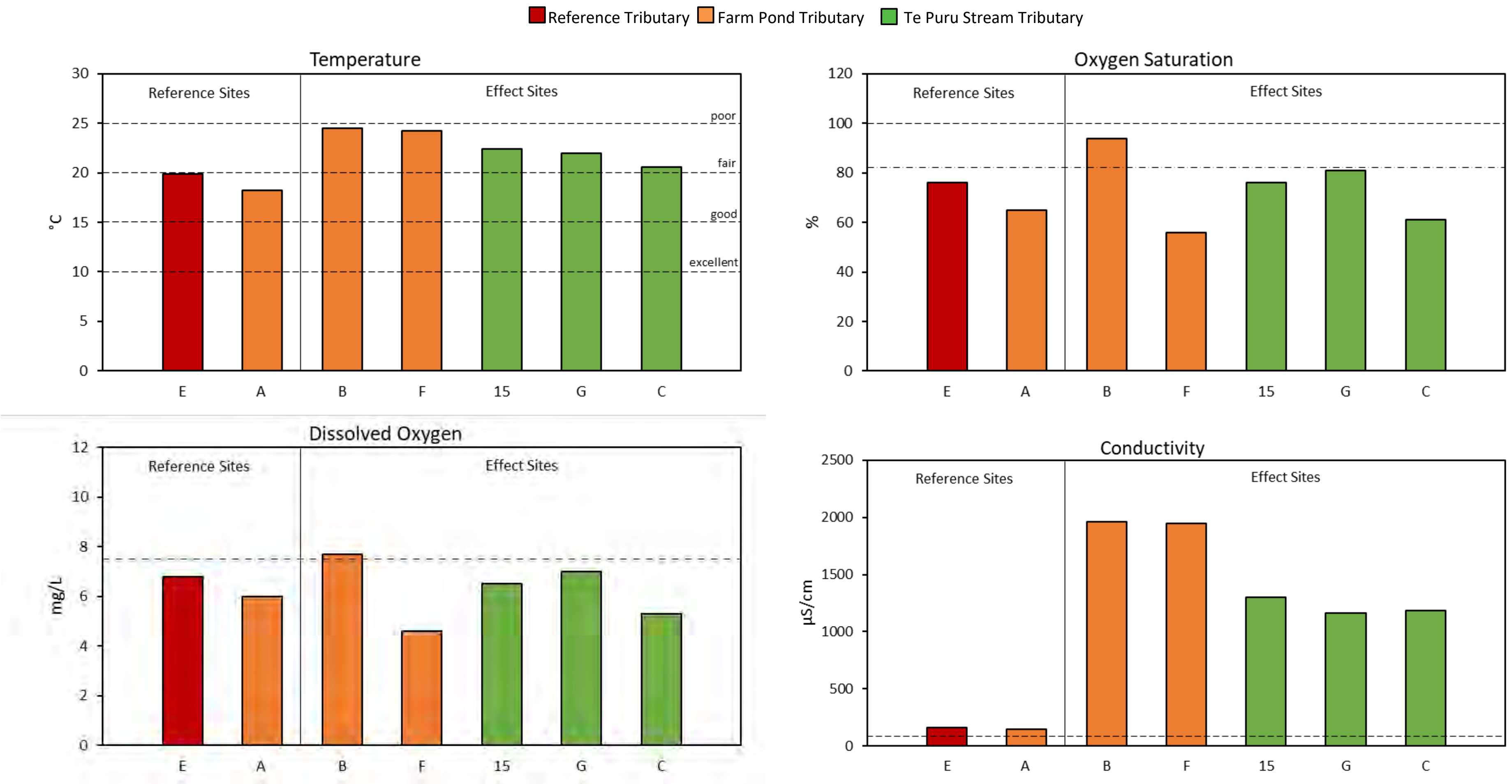

Figure 2. ***Water quality results for temperature, oxygen saturation, dissolved oxygen and conductivity for the Te Puru Stream tributaries. Dashed lines represent upper guideline values and dot-dashed lines represent lower guideline values.***

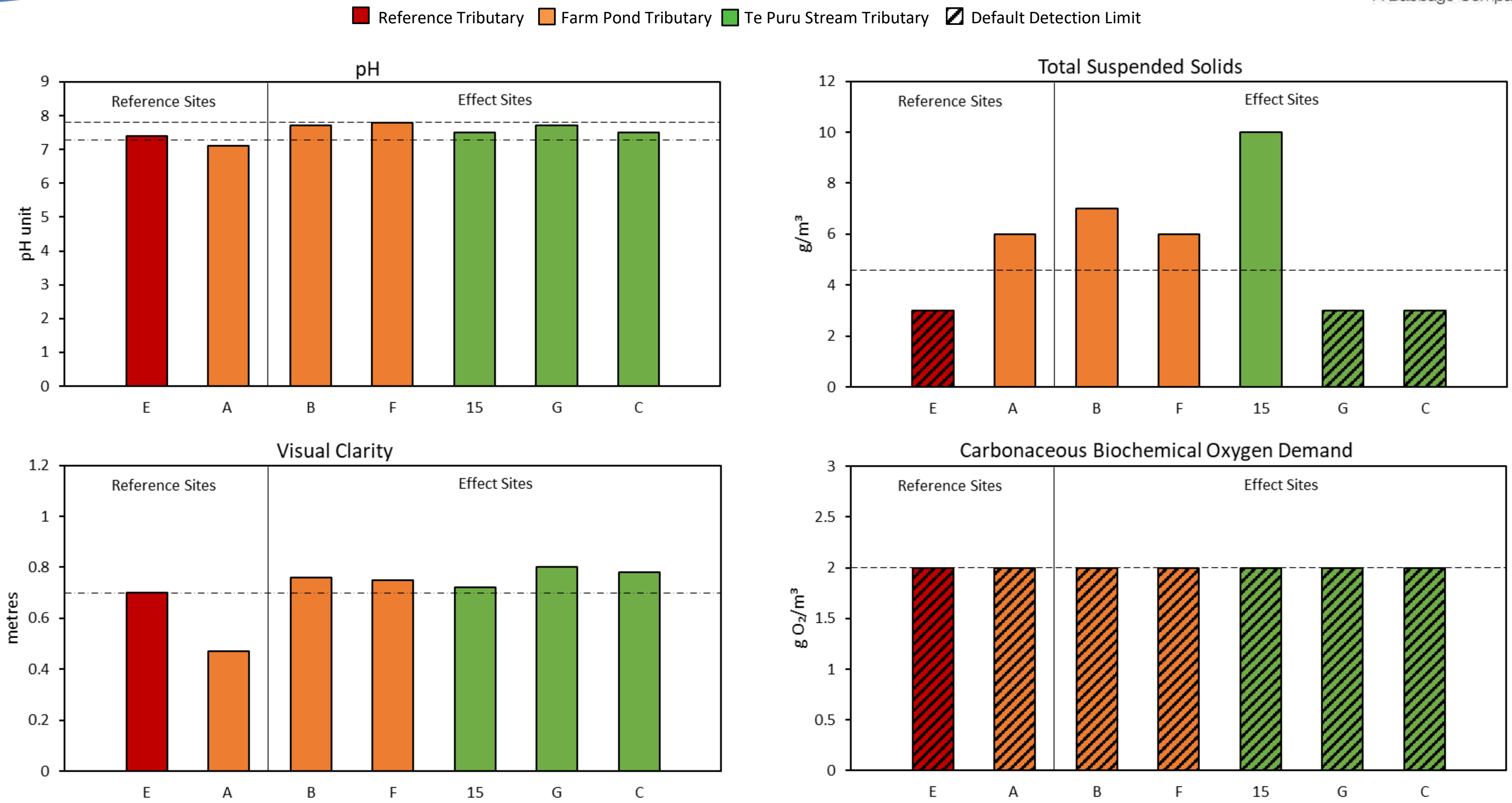

Figure 3. ***Water quality results for pH, total suspended solids, visual clarity and carbonaceous biochemical oxygen demand for the Te Puru Stream tributaries. Dashed lines represent upper guideline values and dot-dashed lines represent lower guideline values. Hashed fill represents values below the detection limit[2].***

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[2] A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes.

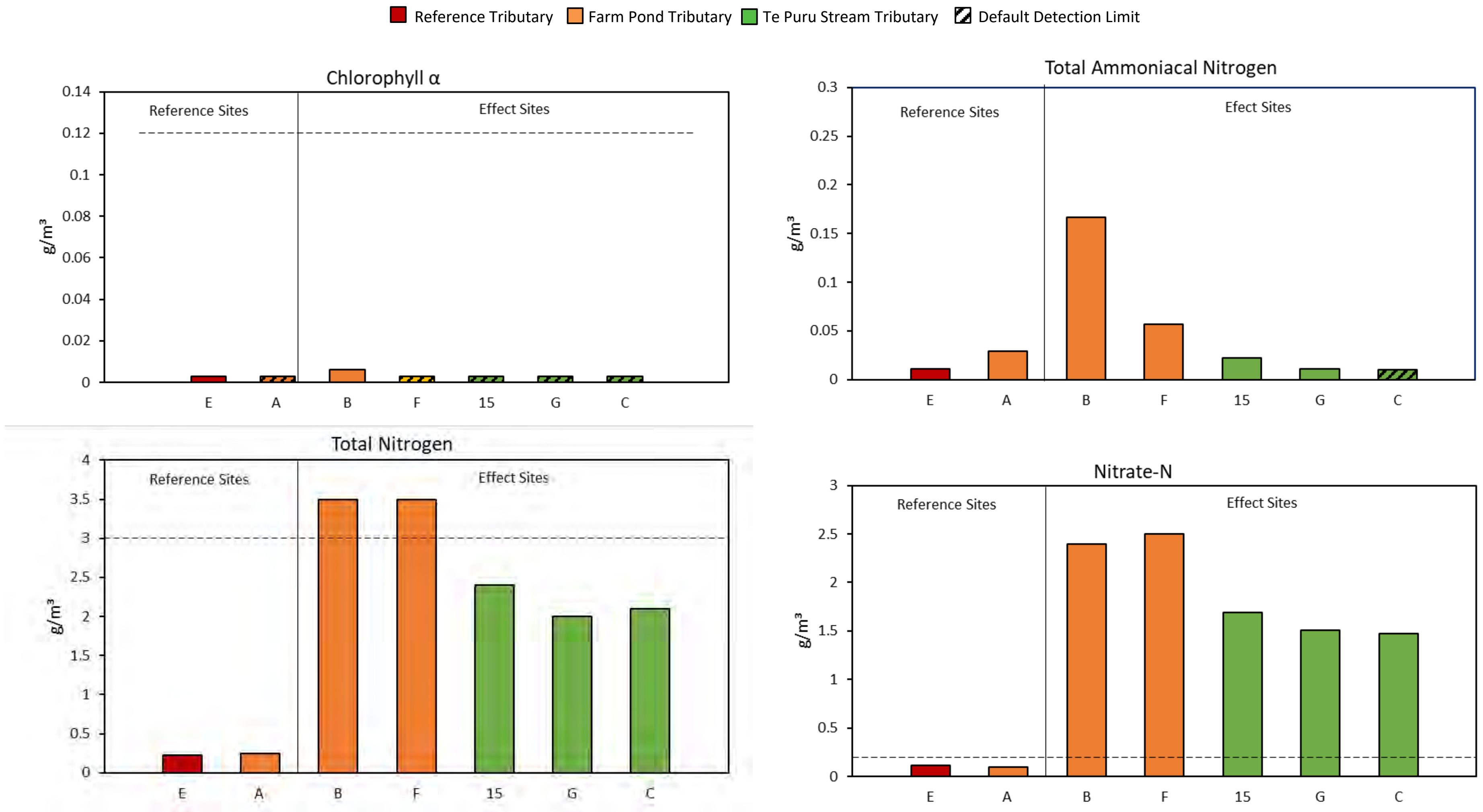

Figure 4. ***Water quality results for chlorophyll α, total ammoniacal nitrogen, total nitrogen and nitrate nitrogen for the Te Puru Stream tributaries. Dashed lines represent upper guideline values. Note that the guideline value of Total Ammoniacal Nitrogen is set at 3 g/m3, which far exceeds the measured concentrations, and thus also the scale of the graph.***

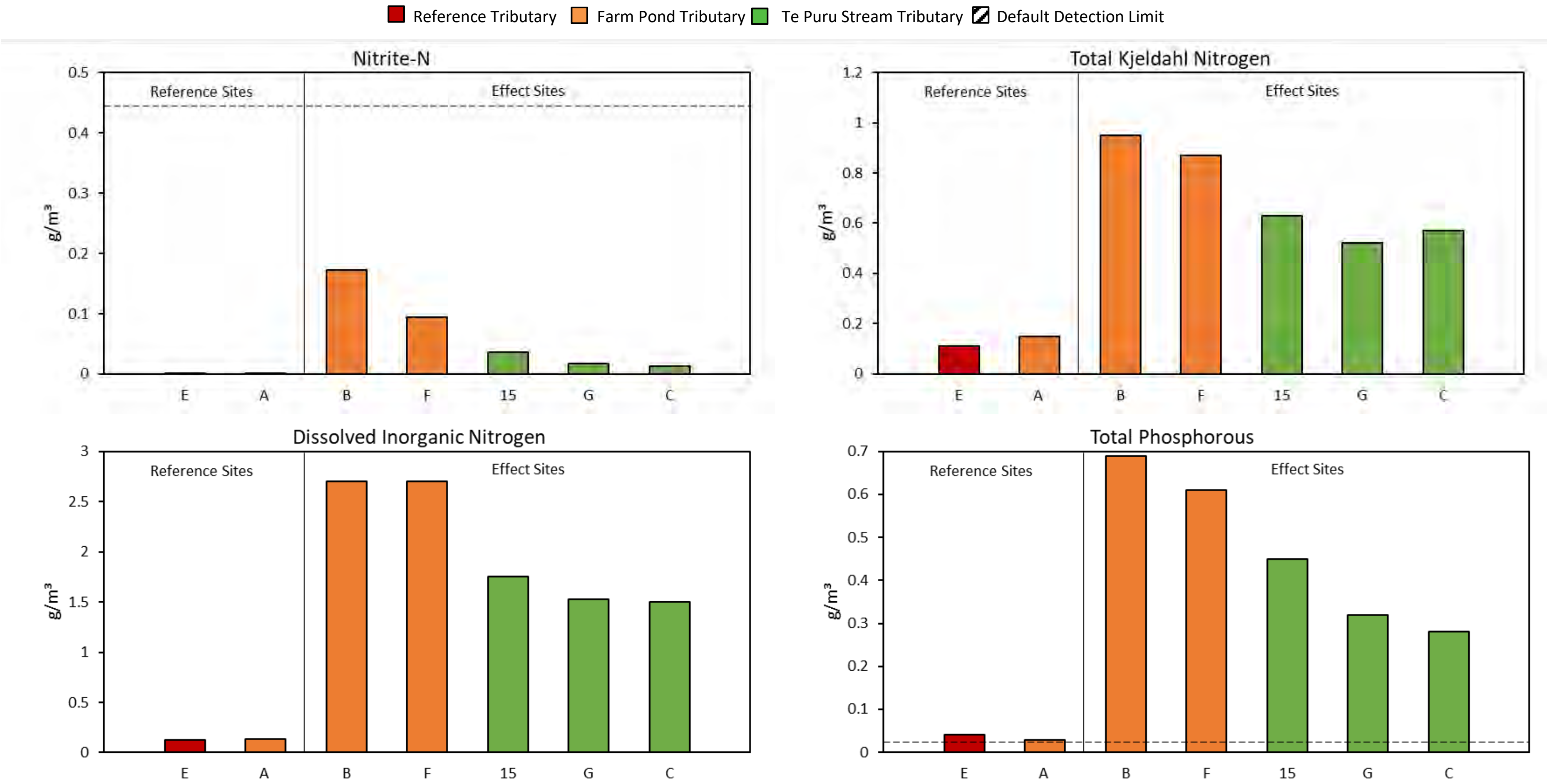

Figure 5. ***Water quality results for nitrite nitrogen, total Kjeldahl nitrogen, dissolved inorganic nitrogen and total phosphorus for the Te Puru Stream tributaries. Dashed lines represent upper guideline values. Note that Total Kjeldahl Nitrogen and Dissolved Inorganic Nitrogen does not have set guideline values.***

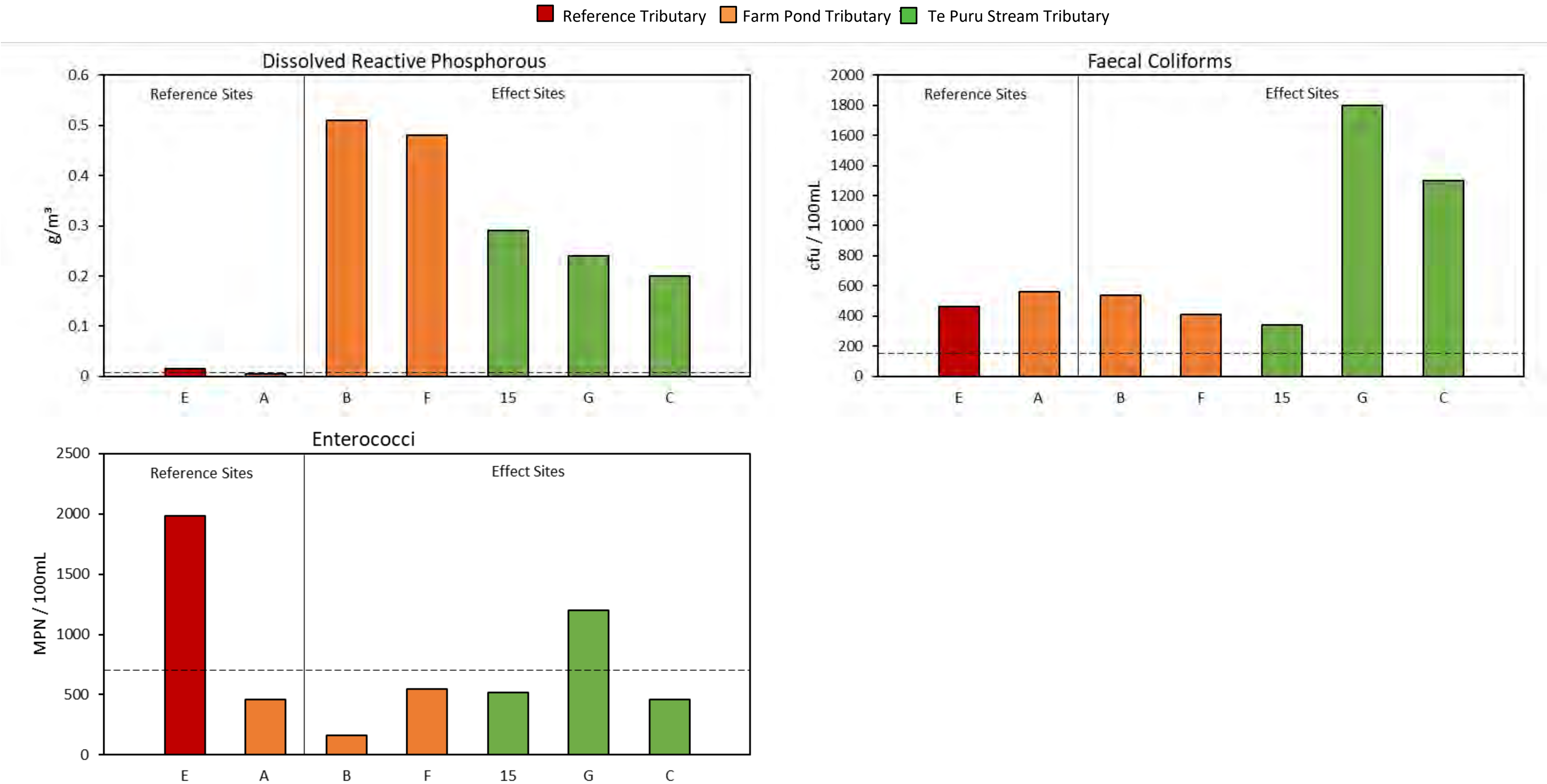

Figure 6. ***Water quality results for dissolved reactive phosphorus, faecal coliforms and enterococci for the Te Puru Stream tributaries. Dashed lines represent upper guideline values.***

3.2.1 Temperature

Elevated water temperatures can adversely affect the physiological processes of aquatic fauna, particularly more sensitive species. Water temperatures are heavily influenced by the shading provided by riparian vegetation both at the site and more importantly the catchment upstream of the site.

The temperature ranged between 18.2 °C (Site A) and 24.5 °C (Site B). The lowest temperatures were recorded at sites upstream of the farm pond, peaking immediately downstream of it, and gradually decreasing further downstream (Figure 2). The higher temperature recorded at Site B, the discharge point from the farm pond, was not unexpected during summer as the pond is very large and mostly unshaded, and ponds such as this develop thermoclines in summer with a layer of much warmer surface water overlying the deeper cooler water. This would have influenced the temperature of the impact sites, particularly the upper impact sites. Although all effect sites exhibited higher water temperatures compared to the reference sites, Site C, the downstream impact site was very similar to the upstream reference site, both near 20 °C

Temperature guideline ranges from Biggs *et al.* (2002) indicate that the reference sites (Sites E and A) registered temperatures indicative of 'good' stream health (ranging from 15 °C to 19.9 °C), although reaching a level where temperatures begin to stress some invertebrates (e.g., stoneflies). In contrast, all effect sites recorded temperatures above 20 °C, falling within the range indicative of 'fair' stream health (20°C to 24.9°C).

3.2.2 Dissolved Oxygen

Dissolved oxygen is required by aquatic fauna for respiration. Low dissolved oxygen can be a stressor, providing insufficient oxygen to maintain stream health, however high levels of dissolved oxygen can also indicate excess plant/algal growth, which can lead to super-saturation with associated lethal and sub-lethal effects on fish.

Both dissolved oxygen saturation (%) and concentration (mg/L) were measured at all water quality sites (Figure 2). No clear trend was observed in dissolved oxygen saturation, with the lowest and highest values recorded at effect sites, ranging between 56 % (Site F) and 94 % (Site B).

According to ANZG (2018) guidelines, most sites (A, C, E, F, G, and 15) had oxygen saturation levels below the DGV range (82%), with only Site B falling within this range. Site G, with an oxygen saturation of 81%, was just below the DGV range. Dissolved oxygen concentrations at Sites B and G were classified under Attribute State B (≥7 and <8 mg/L), while all other sites fell under prescribed Attribute State C (≥5 and <7 mg/L), yet all remained above the National bottom line (MfE, 2020).

Dissolved oxygen concentrations mirrored the general pattern observed in oxygen saturation, with the lowest concentration recorded at Site F, where the water was barely flowing (averaging 0.02 m/s i.e. 50 seconds to travel a metre), and the highest at Site B, where the water was flowing much faster (averaging 0.24 m/s i.e. 4 seconds to travel a metre) as it exited the pond.

3.2.3 Conductivity

Conductivity is a measure of the free ions in the water and indicates the amount of mineral salts in the water, which is often an indicator of the presence of dissolved nutrients, salt water or pollution. There was a very large difference in conductivity between reference and effect sites, with a notable increase immediately downstream of the discharge point, followed by a decline at sites further downstream (Figure 2). Even at the most downstream effect site (Site C), conductivity remained approximately eight times higher than that of any reference site. Site A exhibited the lowest conductivity at 149.8 µS/cm, while Site B recorded the highest at 1964 µS/cm.

All sites had conductivity measurements higher than the ANZG (2018) guideline value of 86 µS/cm, indicating the conductivity at all sites could have potential adverse effects. Reference site A's conductivity reading hovered at the borderline of the 'good' range (Biggs *et al.,* 2002), which extends from 50 to 149 µS/cm. Reference site E's conductivity fell within the 'fair' range (Biggs et al., 2002), indicating slightly enriched water. Conversely, all effect sites fell within the 'poor' range (Biggs *et al.,* 2002), suggesting either highly enriched waters or other contaminants (e.g. dissolved salts).

3.2.4 pH

pH is a measure of the acidity or alkalinity of water (and hence the strength of acid present), with neutral pH at 7. With increasingly acid waters, numbers of species and individuals of aquatic organisms decrease (Biggs *et al.,* 2002).

At the sampling sites, pH levels ranged from 7.1 (Site A) to 7.8 (Site F), with Sites A and E (reference sites) exhibiting the lowest pH readings, while all other effect sites ranged between 7.5 to 7.8. The majority of pH values fell within the guideline range (Figure 3), except for Site A, which marginally fell outside the lower guideline range. The pH level recorded at Site F (7.8) reached the upper limit of the guideline value. Deviations from the recommended pH range can result in negative consequences, affecting the health and functioning of the freshwater ecosystem, but the pH of all the Te Puru tributary sites were circum-neutral and well within the range of pH usual in New Zealand streams (6.5 -8.0, LAWA, 2024).

3.2.5 Total Suspended Solids

Total Suspended Solids (TSS) are particles less than 2 microns found in the water sample and includes anything drifting in the water from sediment/silt to planktonic algae. TSS was below the detectable limit at Site E, G and C (< 3g/m^3). TSS were highest at effect Site 15. In comparing the two reference sites, TSS levels were twice as high at Site A compared to Site E. TSS increased slightly at effect Site B (immediately after the farm pond), but subsequently decreased at the following site (Site F), reaching levels similar to those at Site A. Downstream of Effect Sites B and F, Site 15 showed an increase in TSS, which indicated a source of TSS downstream of Site F. Following the elevated TSS levels at Site 15, concentrations dropped to below detectable values at the most downstream effect sites (Sites G and C). High suspended solids can result in adverse effects on habitats through smothering and abrasion. With the exception of Sites E, G, and C (below the detectable level), all sites had TSS levels exceeding the ANZG (2018) guideline value of 4.6 g/m^3.

3.2.6 Visual Clarity

Water clarity refers to the degree of transparency or how clear the water appears, indicating how far light can penetrate through it. It is often inversely related to Total Suspended Solids (TSS), with low clarity typically associated with high TSS levels. Clarity can be indicative of potential adverse effects, particularly at low values.

Visual clarity was found to be lowest at the reference sites, particularly at Site A, whereas all effect sites exhibited higher clarity than the reference sites. At reference Site E, visual clarity was relatively high, attributed to relatively low TSS measures, in contrast to the high TSS measures at Site A, which corresponded to lower visual clarity. Interestingly, Site 15 displayed similar visual clarity to other effect sites despite having the highest measured TSS of all the sites.

The reference sites (Sites A and E) had clarity lower than the guideline value of 0.7 m (ANZG 2018), with all the effects sites having clarity above the guideline value.

3.2.7 Carbonaceous Biochemical Oxygen Demand

Carbonaceous biochemical oxygen demand ($cBOD_5$) measures the amount of oxygen consumed by microorganisms in decomposing organic matter in stream water. All values for $cBOD_5$ were below the detectable limit of 2 g O_2/m^3. This limit is also the guideline value (Quinn 2009), therefore no sites had $cBOD_5$ that would be indicative of adverse effects.

3.2.8 Chlorophyll α

Chlorophyll α serves as an indicator of the total algae present in water. The highest concentration of chlorophyll α was recorded at Site B, directly below the farm pond, at 0.006 g/m^3, with levels decreasing downstream of Site B to undetectable levels. Measurements of chlorophyll α at all other sites remained below the detectable limit. Importantly, all measurements, including those at Site B, were below the guideline value that could potentially harm freshwater ecosystems (MfE 2020).

3.2.9 Total Ammoniacal Nitrogen

In aqueous solutions, ammonia primarily exists in two forms, un-ionized ammonia (NH_3) and ammonium ion (NH_4^+), which are in equilibrium with each other. The un-ionized ammonia fraction is significantly more toxic than the ammonium ion, although under certain conditions, the ammonium ion can also contribute significantly to ammonia toxicity. The proportions of these fractions vary notably with temperature and pH.

When comparing the concentrations of ammoniacal nitrogen (total ammonia - NH_4-N) between the two reference sites, Site A exhibited a higher concentration (0.029 g/m^3) compared to Site E (0.011 g/m^3). Concentrations of ammoniacal nitrogen increased immediately downstream of the farm pond (Site B: 0.167 g/m^3), but subsequently, progressively decreased downstream, reaching a minimum of <0.010 g/m^3 at the most downstream site (Site C), falling below the detection limit (Figure 4).

As reported previously (Bioresearches 2010, 2016, 2019 and 2022), Hickey (2001) used the ANZECC (2000) and USEPA (1999) derivation procedures to derive ammonia toxicity guidelines specific to the Te Puru Stream Tributary. Acute values were based on USEPA (1999) and adjusted for New Zealand species present. An acute guideline of 3.0 g/m^3 NH_4-N or higher was derived for these sites based on the highest pH recorded during a previous study (pH 8.1 at Site B, Hickey 2001). A chronic guideline of 2.46 g/m^3 NH_4-N was derived by Hickey (2001) for banded kōkopu, the most sensitive fish species recorded in the Te Puru Stream. All of the sites surveyed recorded ammoniacal nitrogen below both these acute and chronic guidelines.

3.2.10 Total Nitrogen

The total nitrogen in water is composed of total Kjeldahl nitrogen, nitrate and nitrite. The concentration of Total Nitrogen (Total-N) was lowest at the two reference sites (Site E: 0.23 g/m^3 and Site A: 0.25 g/m^3). Concentrations substantially increased at the sites immediately below the farm pond, with the highest Total Nitrogen concentration observed at Site B and F (both at 3.5 g/m^3), before decreasing with distance from the discharge (Figure 4). The total nitrogen levels at Sites B and F exceeds the guideline value for the Te Puru Stream Tributary developed by NIWA (Hickey, 2001).

3.2.11 Nitrate-Nitrogen

Nitrate, primarily derived from nitrogen-fixing plants or through the complete oxidation of ammonium ions, represents the most common form of nitrogen in water. Nitrate nitrogen (Nitrate-N), a constituent of total nitrogen, exhibited a pattern similar to Total-N, with lowest concentrations observed at the reference sites (Site E: 0.12 g/m^3 and Site A: 0.1 g/m^3). Subsequently, concentrations increased substantially below the pond, reaching maximum values of 2.4 g/m^3 and 2.5 g/m^3 at Site B and F, respectively, before decreasing at sites further away from the farm pond (Figure 4). Notably, all effect sites (Sites B, F, 15, G, and C) exceeded the ANZG (2018) guideline of 0.195 g/m^3 for nitrate concentration.

3.2.12 Nitrite-Nitrogen

Nitrite, as the intermediate product of the nitrification process (the complete oxidation of ammonium ions to nitrate), constitutes Nitrite-N. Concentrations of Nitrite-N were consistently low across all sites, mirroring the patterns observed for Nitrate-N and Total-N. The lowest Nitrite-N concentrations were recorded at the reference sites, with increases noted at sites immediately below the farm pond. Concentrations decreased progressively as samples were taken further downstream from the discharge (Figure 5). Nitrite-N ranged between < 0.002 g/m^3 (Site A) to 0.173 g/m^3 (Site B). All Nitrite-N samples were below the ANZECC (2000) guideline value of 0.444 g/m^3.

3.2.13 Total Kjeldahl Nitrogen

Total Kjeldahl nitrogen (TKN) consists of both organic nitrogen and ammonia. The concentrations of TKN exhibited a similar overall pattern as total nitrogen and nitrate nitrogen, with typically low levels observed at both of the reference sites (Sites E and A). Concentrations increased immediately downstream of the farm pond (Site B) and subsequently decreased with increasing distance downstream (Figure 5). There are no specific guidelines for concentrations of TKN.

3.2.14 Dissolved Inorganic Nitrogen

Both nitrate and ammonia are considered biologically available to plants, comprising the dissolved inorganic nitrogen (DIN) content of freshwaters. Dissolved inorganic nitrogen (DIN), including ammonia and nitrate, is a crucial nutrient that fosters periphyton growth.

DIN concentrations ranged from 0.128 g/m^3 at Site E upstream of the farm pond to 2.7 g/m^3 downstream of the pond (both at Site B and F), subsequently decreasing with distance downstream to 1.5 g/m^3 at the lowest site, Site C. There are no specific guidelines for concentrations of DIN.

3.2.15 Total Phosphorus

Total phosphorus is a measure of all types of phosphorus present and includes the phosphate bound to sediment as well as dissolved reactive phosphorus. Phosphorus, being a key element necessary for plant growth, often acts as a growth-limiting nutrient. Excessive levels of phosphorus can stimulate excessive or nuisance growths of algae and other aquatic plants. Total phosphorus includes all forms of phosphorus likely to become available to support plant growth.

The general trend of Total-P concentrations followed a similar pattern to other stressors such as nitrogen, with both reference sites exhibiting lower concentrations (Site E: 0.04 g/m^3 and Site A: 0.029 g/m^3) compared to the effect sites. Total-P peaked at Site B (0.69 g/m^3) and decreased as sites moved further downstream from the discharge. However, Total-P at Site C, the effect site furthest from the discharge, remained seven to nine times higher than concentrations recorded at reference sites (Figure 5). Total-P at all sites exceed the guideline value (0.023 g/m^3), and all effects sites concentrations exceed the NPS-FM attribute D (i.e. > 0.05 g/m^3 as the national bottom line).

3.2.16 Dissolved Reactive Phosphorous

Dissolved reactive phosphorus (DRP) represents the form of phosphorus most readily available to plants. At the reference sites (Site E: 0.015 g/m^3 and Site A: 0.005 g/m^3), DRP concentrations were observed to be lowest. Concentrations exhibited a substantial increase at the Effect Sites, reaching 0.51 g/m^3 at Site B and 0.48 g/m^3 at Site F, before decreasing with increasing distance downstream. These higher values were more than 34 times higher than the DRP concentrations observed at the reference sites (Figure 6).

As sampling progressed downstream from Site F, DRP concentrations decreased, albeit remaining approximately 13 times higher than those recorded at the reference sites. The guideline value (0.007 g/m^3) from the ANZG (2018) was exceeded by all sites, with the exception of Site A, and all effects sites concentrations exceed the NPS-FM attribute D (i.e. > 0.018 as a median).

3.2.17 Faecal Coliforms

Faecal coliforms represent a defined bacterial group present in the faecal material of humans, livestock, and wildlife. Escherichia coli, the most common bacteria in this group, is consistently and exclusively associated with the faecal waste of warm-blooded animals.

Bacteria forming faecal coliforms were found to be abundant at all sites, without displaying a clear trend between either reference/effect sites or distance from the discharge (Figure 6). The concentration of faecal coliforms varied from 340 cfu/100mL at Site 15 to 1,800 cfu/100mL at Site G. Notably, Site A, a reference site, recorded the third-highest result with 560 cfu/100mL, only slightly higher than the immediately downstream effect site (Site B: 540 cfu/100mL). As the Te Puru Stream Tributary is actively farmed and stock were present, it is highly likely the suddenly elevated concentrations of faecal coliforms at the downstream sites resulted from livestock. The ANZECC (2000) guideline value for faecal coliforms of 150 cfu/100mL was exceeded at all sites that were sampled.

Note: These results should be interpreted with caution as samples were > 10 °C on receipt at the lab, which may result elevated levels of faecal coliforms.

3.2.18 Enterococci

Enterococci are also indicators of the presence of faecal material in water, and are used as an indicator of the possible presence of other bacteria and viruses that have the potential to cause disease or illness. Surveys at marine and freshwater bathing sites indicated that swimming related gastroenteritis is related directly to the quality of bathing water and that enterococci are the most efficient indicator of bathing water quality.

The number of enterococci varied between the two reference sites, with the highest count of 1986 MPN/100ml recorded at reference site E and reference site A recorded 461 MPN/100ml (Figure 6). The most upstream effect site, Site B, immediately downstream of the farm pond, recorded the lowest count of all the sites, 166 MPN/100mL. This then increased to 549 MPN/100mL and 517 MPN/100mL at the subsequent two downstream sites (Site F and G, respectively). Enterococci counts spiked at Site G (1203 MPN/100mL), followed by a decrease at Site C to 461 MPN/100mL.

The low concentrations of enterococci at the most upstream Effect Site, and the elevated concentrations at one of the Reference Sites and Effect Sites downstream in the catchment indicate that there are various sources of enterococci.

The ANZECC (2000) guideline values associated with enterococci are also related to primary and secondary contact recreation. These guideline values are based on a median value, but state that there should be a maximum of 60-100 organisms/100ml in any one sample for primary contact (i.e. full body immersion activities such as swimming) and 450-700 organisms/100ml in any one sample for secondary contact (i.e. activities where only limbs are in contact with water such as wading). All sites exceeded the upper primary guideline value of 100 MPN/100ml, with only reference site E and effect site G exceeding the secondary contact guideline value of 700 MPN/100mL. It's important to note that the Te Puru Stream tributaries are unlikely to be used for either primary or secondary contact recreation.

Note: these results should be interpreted with caution as samples were > 10 °C on receipt at the lab, which may result elevated levels of enterococci.

3.3 Sediment Quality

Sediment quality results are presented in Table 6 and Figure 7 and Figure 8. Components of sediment quality were tested at one reference site (Site E) and three effect sites (Sites F, G and C).

Sediment characteristics such as organic matter and relevant carbon/nutrient compositions can give an indication as to the sources of organic matter input the stream receives. Factors such as carbon and nitrogen can affect the primary production and eutrophication status of aquatic ecosystems.

Table 6. Sediment quality results summary for the Te Puru Stream tributaries. Site E is a reference site and sites F, G and C are effect sites.

	Reference Tributary	Farm Pond Tributary	Te Puru Stream Tributary	
	E	**F**	**G**	**C**
Dry Matter (% of sample)	46	37	43	54
Total Carbon (g/100g dry weight)	2.2	3.9	2.9	1.62
Total Nitrogen (g/100g dry weight)	0.12	0.26	0.2	0.12
C : N ratio	18	15	15	14
Ammonium-N (mg/kg dry weight)	24	148	11	18
Total Recoverable Phosphorous (mg/kg dry weight)	380	2,000	1,210	800

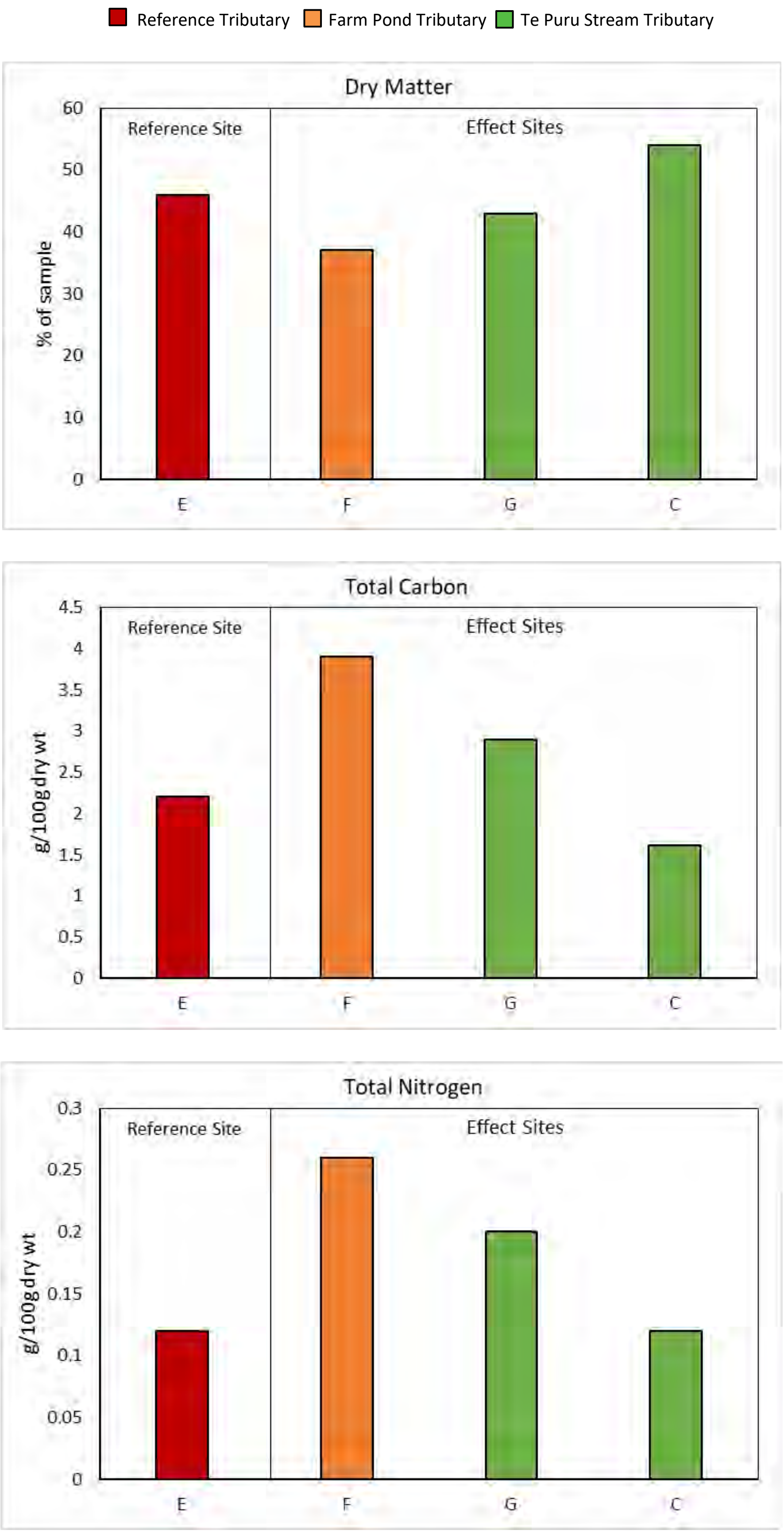

Figure 7. Sediment quality results for dry matter, total carbon and total nitrogen.

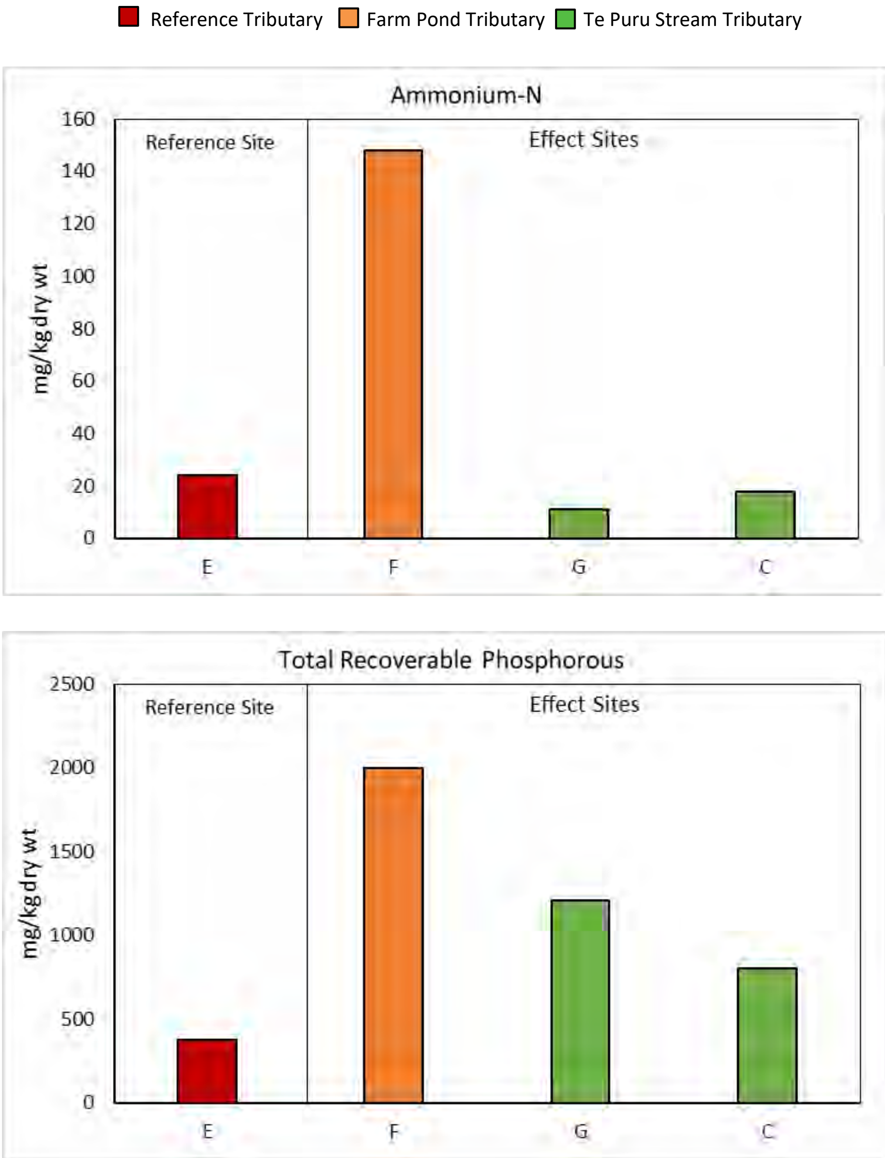

Figure 8. Sediment quality results for Ammonium – N and total recoverable phosphorous.

3.3.1 Dry Matter

The highest percentage of dry matter (organic matter) was found at the most downstream site (Site C: 54 %) and the most upstream site (Site E: 46 %). Site F, downstream of the discharge, had the lowest percentage of dry matter (37 %).

3.3.2 Total Carbon and Total Nitrogen

Both total carbon and total nitrogen showed very similar patterns, elevated downstream of the farm pond (Site F) compared to the reference site (Site E), decreasing at Site G, and even more so at the most downstream Site C. Both total carbon and total nitrogen decreased with distance downstream, within concentrations at the most downstream effects site (Site C), similar or lower than the reference site.

3.3.3 Carbon to Nitrogen Ratio

The carbon-to-nitrogen ratio was highest at reference Site E (18), followed by a ratio of 15 at both downstream effect Sites F and G. Downstream effect Site C had the lowest ratio (14).

3.3.4 Ammonium - Nitrogen

Ammonium nitrogen was highest at the most upstream effect site (Site F: 148 mg/kg dry weight), with substantially lower concentrations noted at all other sites. Reference Site E (24 mg/kg dry weight) measured higher concentrations of ammonium nitrogen than Sites G and C (11 mg/kg dry weight and 18 mg/kg dry weight, respectively) further downstream of the discharge.

3.3.5 Total Recoverable Phosphorous

Total Recoverable Phosphorus was lowest at the reference site (Site E: 380 mg/kg dry weight) and then increased substantially downstream of the discharge (Site F: 2000 mg/kg dry weight). Total Recoverable Phosphorus then showed decreasing concentrations with distance downstream.

3.4 Biological Survey

3.4.1 Macroinvertebrates

Macroinvertebrate results are presented in
Table 4 and Figure 9 and Figure 10.

Macroinvertebrate diversity, represented by the number of taxa present, showed considerable variability. The highest number of taxa was recorded at the headwaters of the tributaries above the WTP, with 21 taxa at Site A and 22 taxa at Site E. In contrast, the lowest number of taxa was observed at the site below the discharge pond (Site F), with only 3 taxa. Taxa numbers increased downstream in the Te Puru Stream tributary, reaching 12 taxa at both Site G and Site C.

With the exception of reference Site A and effect Site C, macroinvertebrates were dominated by the freshwater snail (*Potamopyrgus antipodarum*) This species constituted 28 % of individuals at Site H, 37 % at Site E, 98 % at Site F, and 59 % at Site G. Sites A and C were dominated by the freshwater amphipod (*Paracalliope fluviatilis*), comprising 63 % and 80 % of the individuals, respectively.

The lowest assessed site, Site C, had the most variability in abundance (1534 individuals), which was made of 80 % freshwater amphipod, followed by freshwater snail (17 %). The lowest abundance was noted at Site E.

The more sensitive EPT taxa were present in the headwaters of the tributaries, Sites A and E, comprising 21.9 % and 30.2 % of individuals respectively. No EPT taxa were noted at Site F (effect site downstream of the farm pond). The %EPT was negligible (0 or near 0) at effect Sites G and C further below the farm pond.

MCI scores ranged from 101 at Site H to 105 at Site A, indicating 'Good' quality habitat at both sites (Stark & Maxted, 2007b). Site E, on the reference tributary, had an MCI score of 98, reflecting 'Fair' quality habitat. The MCI score dropped to 63 at effect site F ('Poor' habitat quality), increased at Site

G (82, 'Fair' habitat quality), before dropping again to 67 ('Poor' habitat quality) at Site C. The low score on the reference tributary may have been influenced by low water levels and potentially a lack of aquatic habitat during the driest summer months. Only the MCI scores of the reference sites are above the AUP guideline value (94).

The Scores Quality Macroinvertebrate Community Index (SQMCI), which considers the relative abundance of taxa as well as the MCI score, was highest at the two headwater reference sites (Site A and Site H), recorded at 6.01 and 4.78, respectively. Site A fell within the 'Excellent' habitat quality band, while Site H fell within the 'Fair' habitat quality band. The SQMCI score at Reference Site E indicated 'Fair' habitat quality. Effect Site F, the first effect site below the farm pond, had the lowest SQMCI score, falling in the 'Poor' habitat quality band. However, SQMCI scores showed some improvement downstream, reaching 'Fair' habitat quality.

The presence of large macroinvertebrates, kōura (freshwater crayfish) and kākahi (freshwater mussels) were recorded. Kōura were recorded as present at reference Sites A, H and E, plus effect site C, and are therefore likely to be present in low numbers through the entire tributary. No live kākahi were recorded but shells were observed at Sites H and E (Photo 11 and Photo 12).

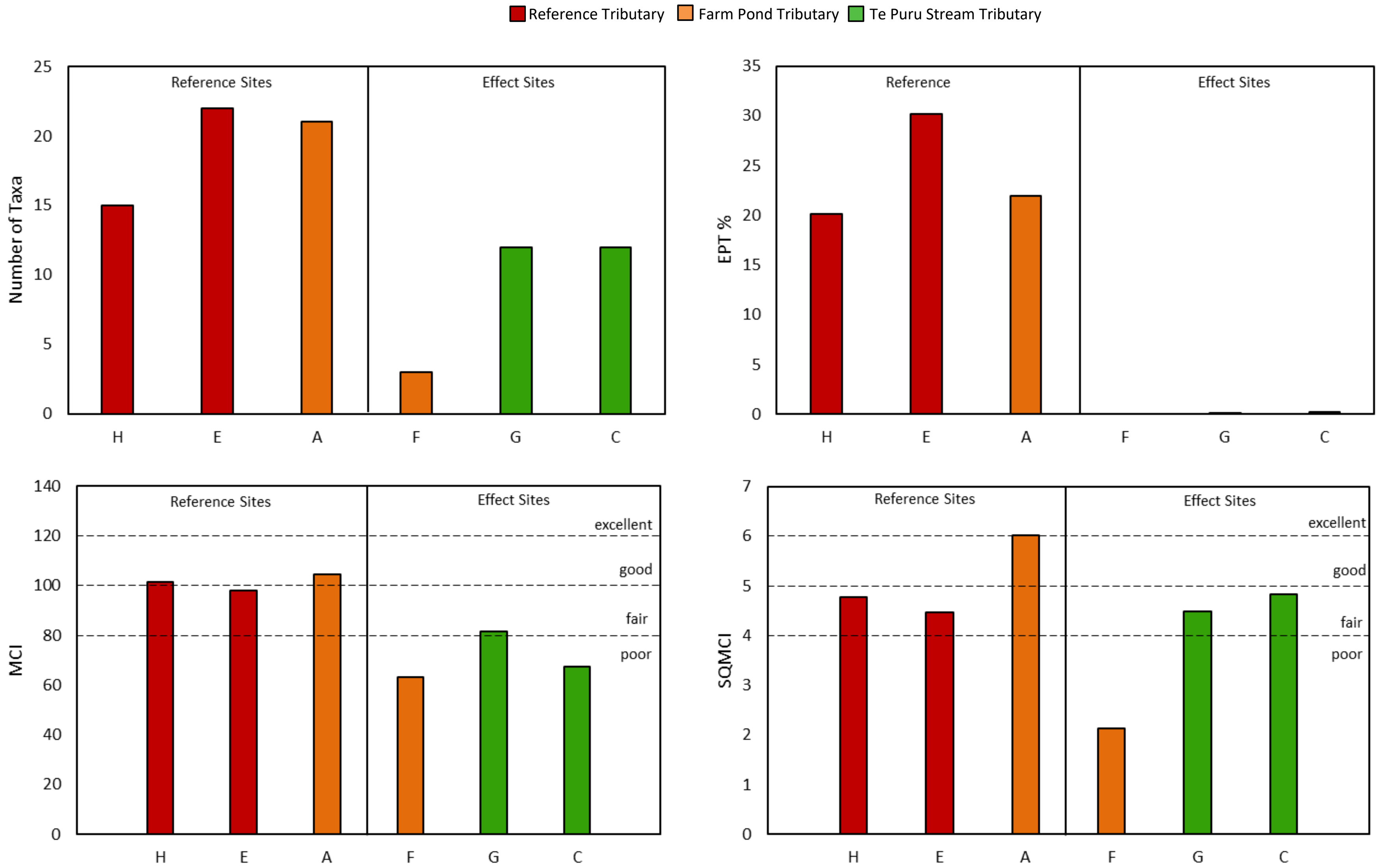

Figure 9. Macroinvertebrate community results – number of taxa, EPT%, MCI and SQMCI.

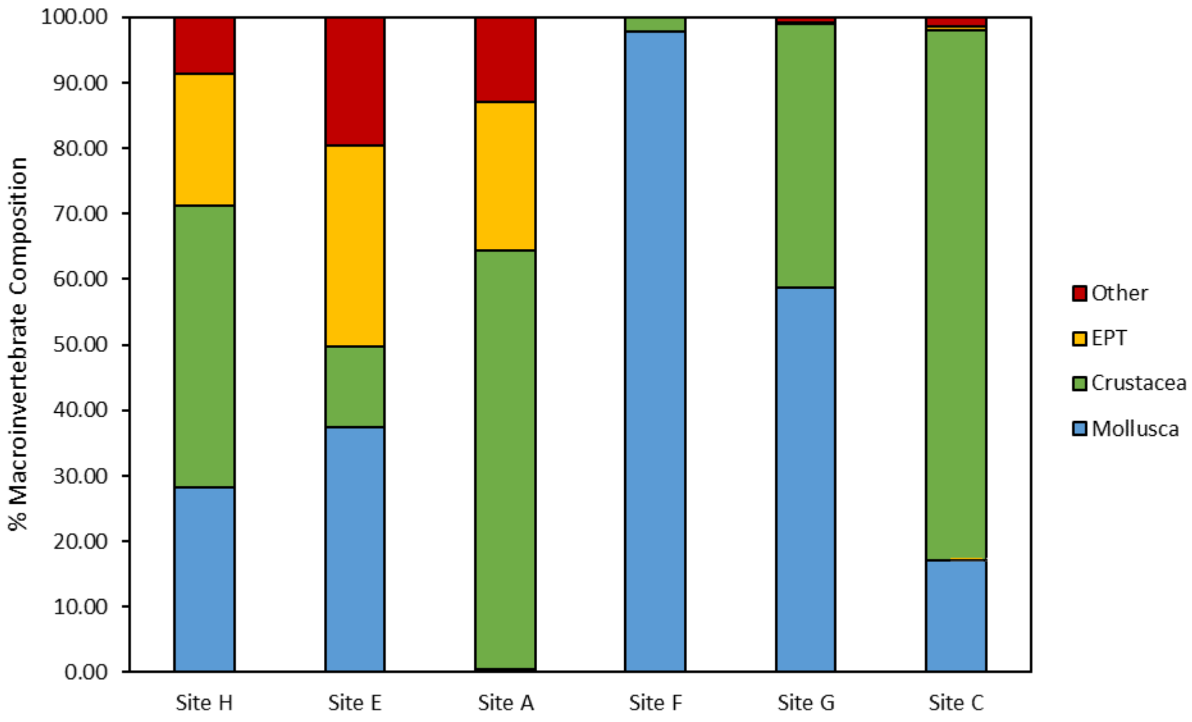

Figure 10. The percent composition of macroinvertebrate taxa at each Te Puru site.

3.4.2 Freshwater Fish

Fish species were sampled using electric fishing and gee minnow traps at the three reference sites (Sites H, E and A). Native fish species biodiversity and abundance was highest at Site H, with four species recorded and 36 individuals captured. At Sites E and A, three and four native species, respectively, were recorded. Reference site fish abundance was lowest at Site E, with 19 individuals caught. Native fish species recorded at the three reference sites included an unidentified eel species (*Anguilla spp.*), and three species listed as 'Not Threatened' - banded kōkopu (*Galaxias fasciatus*), common bully (*Gobiomorphus cotidianus*) and Cran's bully (*G. basalis*) (Dunn *et al*. 2017).

Electric fishing could not be undertaken downstream of the farm pond due to the very high electrical conductivity in the water, therefore only Gee's minnow traps and a hand net were used to sample native fish communities at Sites F, G and C. Both native fish species biodiversity and abundance decreased at the effect Sites C and F compared to the reference sites, with only common bully and eels (longfin eel and an unidentified eel at Site C; unidentified eel at Site F) caught. Site G, however, had a high abundance of common bully (21 individuals). Introduced 'mosquito fish' *Gambusia affinis* was also identified at Sites C and G.

The Fish IBI score for the upper Reference Tributary (Site H) was 34, indicative of 'Fair' species diversity in comparison to other Auckland streams, given the altitude and distance from the sea (Joy and Henderson 2004). Reference Sites IBI scores A and E were 34 and 26, respectively, indicative of 'Fair' and 'Poor' species diversity in comparison to other Auckland streams. The downstream sites are indicative of 'Poor' species diversity, and Site F specifically of 'Very Poor' species diversity.

To put the fish survey results into context of the wider catchment, a search of fish records from the New Zealand Freshwater Fish Database for the Te Puru Stream catchment was carried out, with the data collected between 1991 and 2022 (Table 7). Seven native and one introduced fish species (*Gambusia affinis*) have been recorded around the wider Te Puru Stream catchment, with the shortfin eel and common bully being the most commonly recorded species. Freshwater mussel and kōura were also recorded within the catchment. No additional species were recorded in the 2024 study. Based on these records, Cran's bully was last recorded in 1991, which was recorded at Site H in 2024.

Table 7. Fish previously recorded in the Te Puru Stream catchment, from the New Zealand Freshwater Fish Database (NIWA, sourced February 2024).

Genus	Scientific name	Common name	Number of Records	Year sampled*:
Galaxias	*fasciatus*	Banded kokopu	38	1997, 1998, 2001, 2002, 2005, 2010, 2016, 2022
Galaxias	*maculatus*	īnanga	4	2001, 2005
Gobiomorphus	*cotidianus*	Common bully	45	1991, 1997, 1998, 1999, 2001, 2002, 2005, 2010, 2016, 2019, 2022
Gobiomorphus	*basalis*	Crans bully	1	1991
Gobiomorphus	*huttoni*	Redfin bully	6	1998, 2005, 2016, 2019
Anguilla	*unidentified*	unidentified eel	17	19971999, 2002, 2005, 2010, 2022
Anguilla	*australis*	shortfin eel	43	1991, 1997, 1998, 1999, 2002, 2005, 2010, 2019, 2022
Anguilla	*dieffenbachii*	longfin eel	18	1991, 1997, 1998, 1999, 2002, 2005, 2010, 2016, 2022
Echydridella	*spp.*	freshwater mussel	5	2005, 2016
Paranephrops	*spp.*	kōura	30	1997, 1998, 1999, 2002, 2005, 2010, 2016, 2022
Paratya	*curvirostris*	Freshwater Shrimp	11	1991, 2002, 2005, 2016

*This column provides the listed years in which the corosponding species were sampled based on the recorded data available from NIWA. Those higlighted in red, have not since the listed date been recorded.

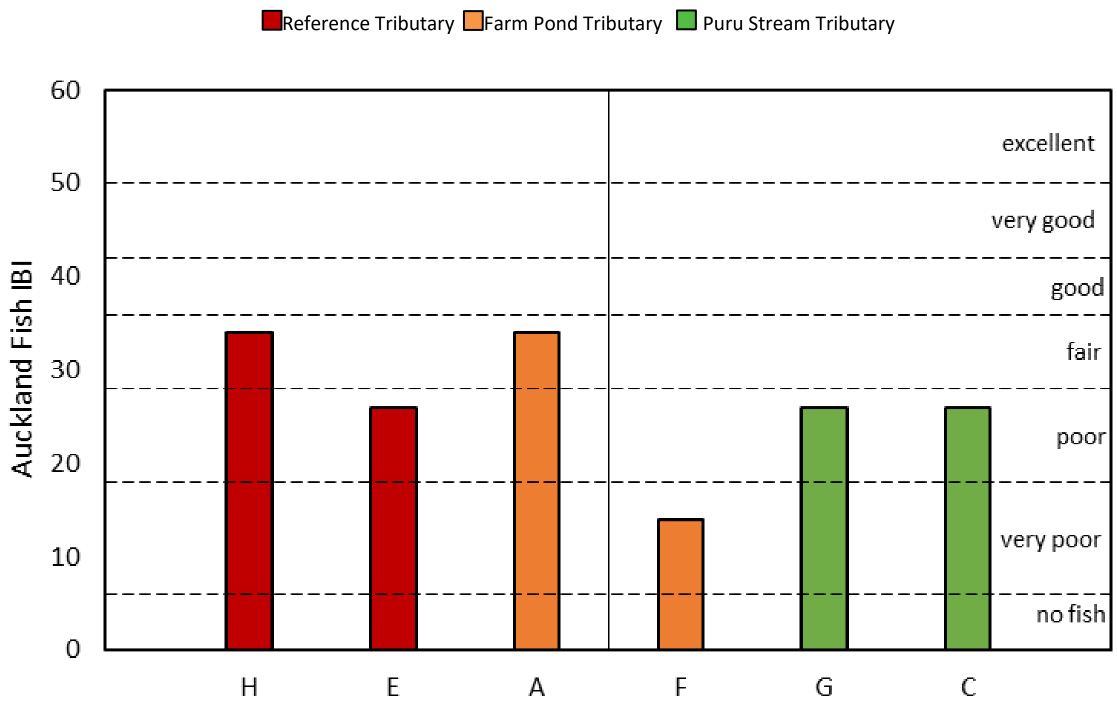

Figure 11. Auckland Fish IBI scores for sites on the Te Puru Stream Tributaries.

Photo 11. Freshwater mussel shells at Site E.

Photo 12. Kōura caught at Site A.

Photo 13. Banded kōkopu.

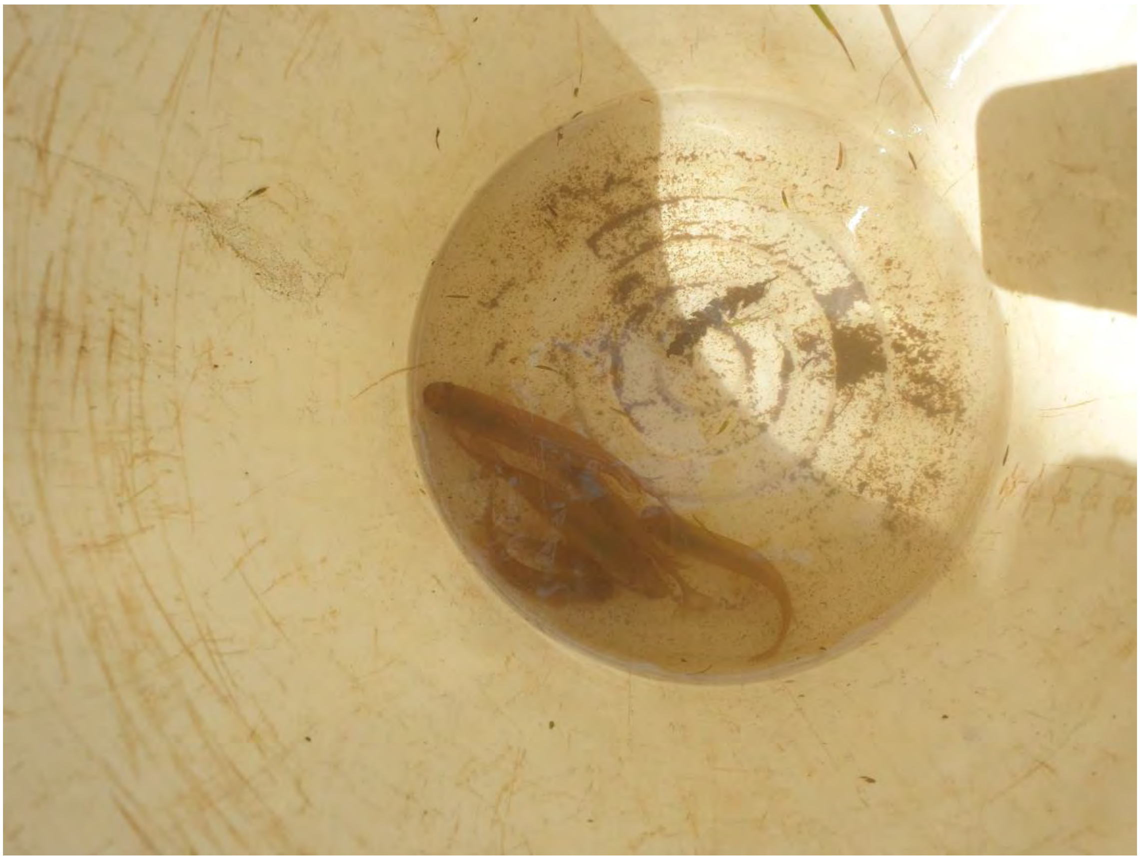

Photo 14. Native fish abundance and diversity was highest at Site A.

3.4.3 Macrophytes

Macrophyte diversity generally increased with distance downstream. Reference sites (Sites H and A) displayed the lowest diversity, ranging between zero and two species, while the highest diversity (seven species) was documented at Site G. Notably, Site F, situated downstream of the discharge point, also recorded seven species.

Among the macrophyte species surveyed, willow weed (*Persicaria* sp.) was the most prevalent, identified at six out of the eight sites, followed by water forget-me-not (*Myosotis laxa*) found at five sites, and watercress (*Nasturtium officinale*) and water celery (*Apium nodiflorum*), each present at four sites. Green and brown filamentous algae was observed at most sites (the exceptions being Site H and Site S3).

Differences in macrophyte/algae community composition were observed between reference and effect sites. For instance, Nitella was absent at Sites H and A (reference sites), whereas it constituted a significant proportion of total plant cover at Sites G, S3, and C (ranging from 12 % to 54 %). Filamentous algae were detected at only six sites, with Site F exhibiting the highest coverage at 23 % (Figure 12).

The percentage of macrophyte and algae cover generally increased downstream (Table 8), likely due to the effects sites having less shade. The highest percentage of bare substrate was recorded at Site H (94.9 %), followed by Site A (92.6 %). Notably, three out of the five sites downstream of the farm pond displayed macrophyte and algae cover exceeding 50 %, with Site C showcasing the highest coverage at 72 %. Nitella accounted for the highest percent cover among plant species, followed by filamentous algae (Figure 12).

Table 8. Average percent cover (n=12) and standard error (S.E.) at each site of macrophytes, algae and bare substrate.

Site	Total Macrophytes (%)		Total Algae / Iron Floc (%)		Bare Substrate (%)	
	Mean (n = 12)	S.E.	Mean (n = 12)	S.E.	Mean (n = 12)	S.E.
H	5.10	± 4.99	0.00	± 0.0	94.90	± 4.99
E	0.88	± 0.49	10.50	± 3.23	88.63	± 3.12
A	7.00	± 3.36	0.42	± 0.42	92.58	± 3.42
F	18.45	± 6.75	24.17	± 6.33	57.38	± 10.39
S2	5.00	± 2.38	3.67	± 1.83	91.33	± 2.66
G	23.68	± 6.73	29.08	± 6.8	47.24	± 8.88
S3	5.74	± 2.07	54.92	± 8.41	39.34	± 9.71
C	23.43	± 5.68	48.58	± 771	27.99	± 5.09

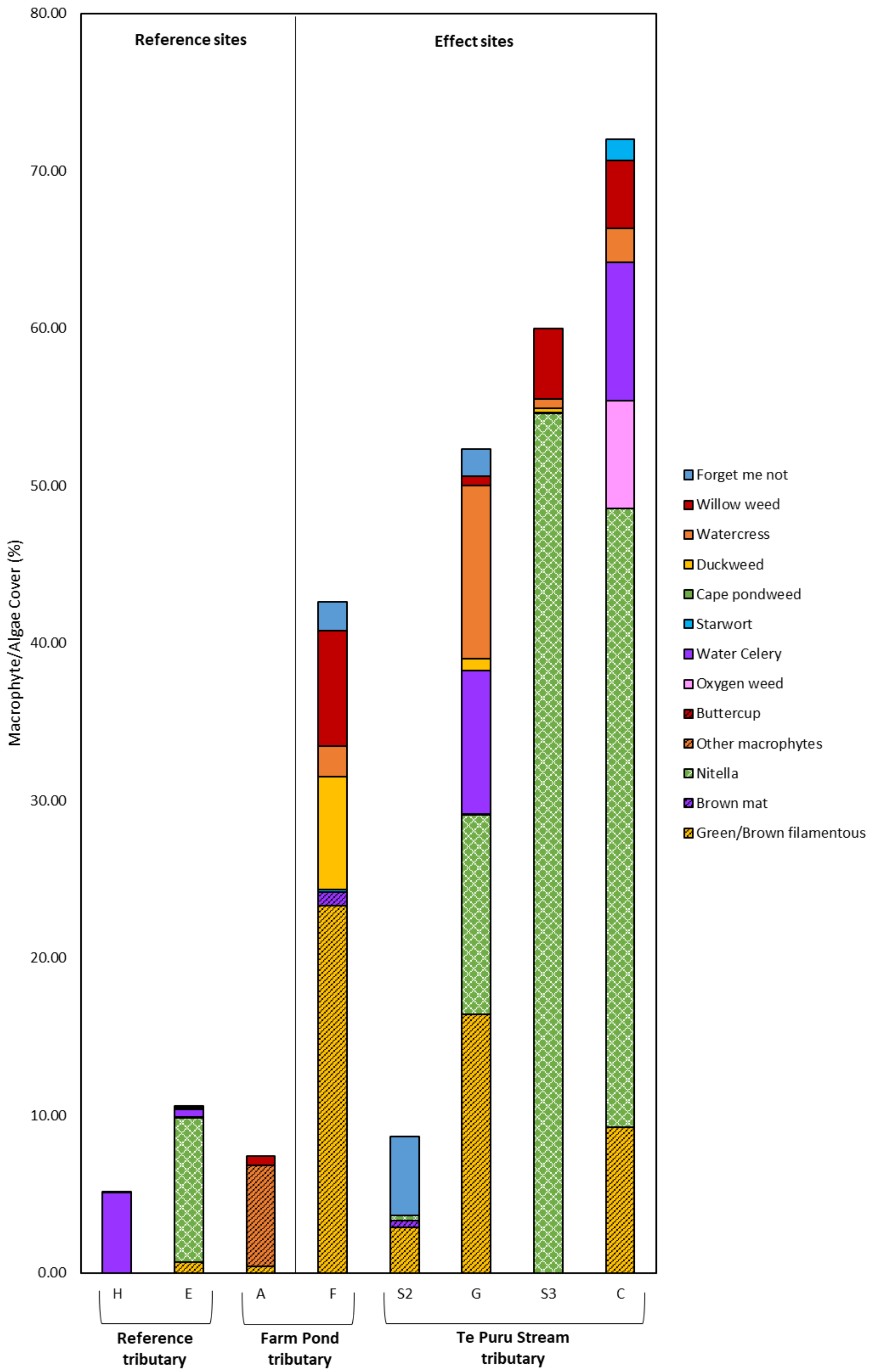

Figure 12. Macrophyte and algae % cover by species for the Te Puru Stream Tributaries

3.5 Comparison with 2022 Survey

The results of the 2024 study at Te Puru were compared to the same study carried out in 2022 (Bioresearches 2022). Results that appeared to deviate substantially from the 2022 survey or results that changed in regard to the current guideline value are summarised below. All 2022 data are visually compared to the 2024 data in Appendix 6.

3.5.1 Water Quality:

- Conductivity at all sites decreased from 2022 to 2024, with a minimum reduction of 17%. Notably, three effect sites (Site 15, G, and C) experienced a significant decrease of almost 50%.
- The TSS measurements in 2024 differed substantially from those in 2022. TSS reduced at both reference sites in 2024 (by 75 % at Site E and 33 % at Site A). Conversely, TSS doubled at effect Site F, increased by more than 60 % at effect Site 15, while decreasing by 13 % at effect Site B and by 40 % at the lowest effect Site C.
- Ammoniacal nitrogen concentrations decreased at all sites between 2022 and 2024, with the most notable reduction of 81 % at effect Site 15.
- Total phosphorus slightly decreased at the reference sites (Site E and A) from 2022 to 2024. However, total phosphorus increased at all effect sites, with a minimum increase of 14% at Site G and a maximum increase of 41 % at Site B.
- Dissolved reactive phosphorus substantially decreased at Site A between 2022 and 2024 (reduced by 62 %), while it reduced by 25 % at Site E. Conversely, dissolved reactive phosphorus increased at all effect sites in 2024 compared to 2022.
- Faecal coliform counts in 2024 were substantially lower compared to 2022 (with a minimum of 54 % reduction), except for Site A, which increased by 14 % in 2024.
- Enterococci counts increased substantially in 2024 (by a minimum of 75 % at Site A) compared to 2022. However, counts reduced at most effect sites in 2024, except for Site G, which experienced a 56 % increase.

3.5.2 Sediment Quality:

- Total carbon at the effect sites decreased, most substantially at the most downstream Site C, being more than two times lower in 2024 compared to 2022. However, total carbon increased at reference Site E in 2024 compared to 2022.
- Total nitrogen at all sites increased in 2024 compared to 2022, although with no substantial concentrations noted.
- The C:N ratio in 2024 differed from that noted in 2022. In 2024, the ratio was higher at the reference Site E but lower at the most upstream effect Site F. The C:N ratio was marginally lower at Site G in 2024 compared to 2022, but the most substantial change was noted at the most downstream effect Site C, where the ratio in 2024 was more than two times lower than that of 2022.
- An overall decrease in ammonium-N was noted in 2024 relative to 2022, except for Site C, which had higher ammonium-N in 2024.
- Total recoverable phosphorus varied at the sites between 2024 and 2022. Reference site E and the most upstream effect Site F had lower total recoverable phosphorus in 2024, but increases

were observed at the downstream effect Sites G and C (Site C had one and a half times more total recoverable phosphorus in 2024 than 2022).

3.5.3 Biological Surveys:

- Changes in macrophyte diversity varied between 2022 and 2024. Diversity at reference Site A decreased from 8 species in 2022 to 3 species in 2024, while it increased at Site H and E in 2024. Diversity also increased at two effect sites (Site G and C) and decreased at Site S2 in 2024 compared to 2022. However, diversity remained the same at Site F and S3 between 2024 and 2022.
- Macrophyte coverage only slightly increased at reference Sites H and E in 2024 but decreased substantially at Site A (by 82 %). Changes in % macrophyte cover at the effect sites were variable, with decreases noted at Sites S2 (70 %) and G (15 %), and increases at Sites F (81 %), S3 (22 %), and C (15 %) in 2024 compared to 2022.
- Fish diversity at reference sites in 2024 did not differ significantly from that noted in 2022 – With the exception of Site A, all other sites had the same diversity in 2024 to that of 2022. In 2024, Site A had 1 one more species in 2024, than that of 2022.
- There is an overall increase in the MCI and SQMCI measured in 2024 relative to that measured in 2022. Sites E and G were promoted to higher MCI quality classes. Sites A and C also moved up into higher SQMCI quality classes in 2024. Site A was reduced to a lower MCI quality class in 2024 but maintained the same SQMCI quality class as in 2022.

4. DISCUSSION

4.1 Summary

A survey of the upper Te Puru Stream catchment was undertaken on behalf of Watercare, as a comparative study of water quality and biological condition upstream and downstream of the Beachlands wastewater treatment plant discharge. This report presents the results of the water quality and biological surveys undertaken at ten sites over the period from the 31st of January to 2nd of February 2024, to determine the effects of the highly treated effluent discharged from the treatment facility on the water quality and biology of the receiving waters, a tributary of the Te Puru Stream.

The overall water quality and biological results indicated poor freshwater condition, partly due to the pastoral land use within the catchment. Appendix 6 provides a summary of historical water quality, sediment quality and macroinvertebrate data for comparison and trend analysis.

There were consistent trends where water quality and biological parameters were typically poorest at sites directly downstream of the discharge pond. However, variability was observed at sites further downstream, with a general trend of improving freshwater quality with distance downstream from the discharge pond across multiple parameters.

4.1.1 Physical characteristics

The diversity of substrate types was highest at reference Site H, with bedrock dominant and cobbles and gravels also common, with some silt loading present. Silt was recorded at effect sites downstream of the discharge pond, with an increase in gravel abundance evident as sites were further from the discharge. Observed at all sites were sediment plumes in the water whenever the stream bed was disturbed. The silt dominance at both reference and effect sites reflects the pastoral catchment. The increase in soft substrate downstream of the discharge is likely the result of fine material, algae, and sediment being retained in the farm pond and released during high flow to settle at nearby sites.

The width and depth of the stream varied between each site, with the stream generally flowing in incised, vertical banks with good access to the floodplain. Notably, no significant changes to the embankment structure/condition at the various sites were observed following the flood events of early 2023, and the incision that was noted is considered normal in comparison to previous monitoring occasions. The exception was Site A, where the site characteristics reflected a predominantly wetland habitat, with the stream transitioning into small and shallow braided channels over the floodplain at the sampling site.

Instream flow rates varied at the reference sites, with Site E having a very low flow rate and the highest flow rates recorded at effect Sites S2, G, and C, which are the most downstream sites. The volume of water being discharged from the discharge pond formed a significant proportion of the stream flow. Riparian vegetation extent and shading also varied between sites. The reference sites had riparian vegetation dominated by native trees and shrubs, resulting in high shading on the upper stream. Downstream, vegetation and shading decreased as the Te Puru Stream Tributary flowed through pasture.

4.1.2 Water quality

All reference sites had temperatures indicative of 'good' stream health (15°C to 19.9°C) (Biggs *et al.* 2002), with the effects sites all having temperatures indicative of 'fair' stream health (20 to 24.9°C). Although no marked temperature trend was noted between all the sites, a marginal increase in temperature was noted at the sites directly downstream of the discharge. It is probable that the low shading and summer heating of the water in the farm pond resulted in this temperature increase. The temperature of the most downstream site was similar to that of the reference tributary site (Site E). There is a lack of shading in the lower catchment, and the water temperature readings were undertaken during the peak of summer (within a week of very high ambient day temperatures- ranging from 25 to 29 °C), while previous monitoring has been undertaken in cooler autumn months. Water temperatures cool as the water flows through the Te Puru Stream tributary and is likely to eventually lower in temperature further downstream (beyond the monitoring sites) to transition into the 'good' temperature range (Biggs *et al.* 2002) again.

The conductivity at all effect sites was very high. Conductivity was elevated above ANZECC (ANZG, 2018) guideline values at all sites; however, conductivity at sites downstream of the discharge pond was up to 13 times higher than reference sites, indicative of very high concentrations of dissolved ions in the tributaries downstream of the WTP.

Although these findings show a similar trend to those from the previous surveys (Bioresearches, 2002, 2010, 2016, 2019, and 2022), which had elevated conductivity below the discharge, the conductivity levels in 2016, 2019, 2022, and 2024 at sites below the discharge were at least 1000 µS/cm higher than the highest conductivity recorded in 2002 or 2010. It should be noted that the conductivity recorded at the effect sites in 2024 was substantially lower (by at least 40 %) than that recorded at the effect sites in 2016, 2019, and 2022. Also, the conductivity at the reference sites is almost similar to the conductivity levels measured in 2002 (i.e., the lowest measured conductivity at the reference sites in 20 years). After the 2016 survey, it was recommended that these very high conductivity levels in the water downstream of the farm pond required investigation to determine the source and whether they are the result of a change in treatment or an input source to the treatment plant. Watercare subsequently carried out extensive investigations of the network, and the network was repaired close to the coastal management area, resulting in a decrease in conductivity (pers. com. Iris Tscharntke, Wastewater Operations Controller Southern Regional Wastewater Treatment Plants, 2019). The increases in conductivity in the stream recorded in 2019 and beyond indicate that there is likely infiltration through the network again. Following this, additional repairs to the wastewater network which removed saltwater intrusion, also resulted in a decrease of conductivity (pers. com. Emma Baker, Environmental Scientist at Watercare, 2024).

The slightly enriched waters above the farm pond are likely the result of increased nutrient runoff from the surrounding pastoral landscape and are similar to conductivity levels found in pastoral catchments (Biggs *et al*. 2002).

Dissolved oxygen concentration and saturation varied slightly between all sites. All sites, including reference Site E, failed to meet the stringent ANZECC 2018 oxygen saturation (%) guidelines. In comparison, the dissolved oxygen concentrations at Site B were just above the upper DGV set by the

NPS-FM (2020). All other sites met the NPS-FM (2020) lower guideline for oxygen concentration (mg/L) for maintaining stream health.

Chlorophyll α was measured below the lower detection limit (< 0.003 g/m^3) at most sites, except for the site directly downstream of the discharge pond (Site B). The concentration of chlorophyll α of all sites was below the lower guideline value (MfE, 2020). The higher levels of chlorophyll-α at Site B, in comparison to all other sites, were attributed to the influence of photosynthetic activity in the pond itself, with large amounts of algae observed. These findings were similar to those from the previous surveys (Bioresearches, 2002, 2010, 2016, 2019, and 2022).

Total suspended solids (TSS) were highest at the effect sites (B, F, and S15) and reference Site A. Despite this, visual clarity was relatively high at Sites B, F, and S15. An immediate reduction in TSS was noted at Site F, located below the discharge, but an increase in TSS was measured at Site 15. The farm pond appeared very turbid, and the high TSS at Site B can be attributed to this high level of suspended material.

Visual clarity at all sites had worsened since 2016, but almost all met the ANZECC DGV, the exception being reference Site A. As TSS effects visual clarity, the relatively high TSS at some sites relates to poor visual clarity. TSS in 2024 differed the most from that measured in 2022 at Site E (decreased by 75 %), F (increased by 100 %), and S15 (increased by almost 70 %). It's unclear why the TSS varied; however, it may potentially be prescribed to the ongoing land use changes (specifically noting the change at the upstream reference site), potentially due to erosion (increased stock rates) within the larger catchment.

Levels of pH fell within the ANZECC (ANZG, 2018) values at all sites and fell within the 'excellent' to 'fair' range for New Zealand stream health monitoring (Biggs *et al*. 2002) that would maintain stream life.

Carbonaceous biochemical oxygen demand ($cBOD_5$), a measure of the amount of oxygen needed by aerobic biological organisms to breakdown organic (carbonaceous) material, was below the default detection limit at all sites. $cBOD_5$ has remained consistently low since 2016.

High bacterial indicators were found both above and below the discharge pond, and all sites failed to meet ANZECC (2000) guidelines. These bacteria are found in the gut of warm-blooded animals and are indicators of faecal contamination. High bacteria levels both above and below the discharge pond likely reflect the pastoral catchment, where stock come in close proximity to water bodies, and the large population of water birds present in the discharge pond. The treatment plant discharge was not considered to be having any major effect on bacterial contamination of the Te Puru Stream (considering similarly high amounts upstream and downstream of the discharge).

Faecal coliforms measured in 2024 were substantially lower than that measured in 2022. In 2024, enterococci either increased or decreased at the individual sites compared to that of 2022, with the significant elevations noted at the reference sites (90 % increase in 2024). This may be attributed to farming practices, the number of livestock within the catchment. The bacterial contamination could be bovine (from the stock) and/or avian (from the significant number of birds on the pond).

All nitrogen components (total ammoniacal nitrogen, total nitrogen, nitrate, nitrite, total Kjeldahl nitrogen, and dissolved inorganic nitrogen) followed the same general pattern, where nitrogen levels were elevated at sites directly downstream of the farm pond, then decreased with distance downstream. Nitrogen levels recorded at the furthest downstream site (Site C) still tended to be higher than levels at reference sites.

Although total ammoniacal nitrogen and nitrate levels in the three sections of Te Puru Stream tributaries were above the ANZECC (ANZG, 2018) guideline values, they were within the site-specific acute specific ammonia toxicity guidelines for the Te Puru Stream Tributary developed by NIWA (Hickey, 2001), and below the upper DGV limit of the national MfE (2020) guidelines for 95 % species protection. As concluded in the previous monitoring surveys, the elevated nitrate levels were likely to have influenced the similarly elevated total nitrogen levels downstream of the discharge, as well as the high dissolved inorganic nitrogen, which is readily bioavailable. Elevated nitrogen values at both reference and effect sites indicate some influence from land use practices; however, the very high levels seen downstream of the farm pond indicate amplified nutrient enrichment caused by the wastewater discharge, albeit below the site-specific guideline values.

Total nitrogen, specifically at effect sites, was similar or less than that measured in 2022. The total nitrogen measured in 2022 and 2024 far exceeds the concentrations measured in 2016 and 2019 but is comparable to 2010 levels (Bioresearches, 2010). Ammoniacal nitrogen, a toxic pollutant often found in waste products such as sewage and dairy effluent, decreased in 2024 compared to that measured in 2022. Notably, the total ammoniacal nitrogen measured at Site E, F, and S15 is the lowest since 2002. The variability in ammonia levels, specifically at the reference sites, indicates the variable effect from the pastoral land use surrounding the catchment on the entire tributary, as opposed to effects of discharge from the wastewater treatment plant. Nonetheless, all levels were lower than the site-specific banded kōkopu protection guideline values (Hickey, 2001).

Dissolved inorganic nitrogen (DIN), considered to be one of the key nutrients promoting periphyton growth, was substantially higher at effect sites than at reference sites. By comparison with previous Bioresearches (2002, 2010, 2016, and 2019) results, the levels of DIN at effect sites (below the farm pond) were elevated, but marginally lower in the current survey compared with 2022.

Phosphorus (both total and dissolved reactive) showed a similar pattern of elevation below the discharge and reduced concentrations with distance downstream; however, phosphorus levels did not return to concentrations comparable to reference sites.

Approximately 73 % to 78 % of the total phosphorus recorded at effects sites comprised the bioavailable form – dissolved reactive phosphorus (DRP), compared to between 17 % and 35 % DRP at reference sites. Phosphorus results were slightly elevated in comparison to the 2019 and 2022 survey, but the 2024 levels are substantially less than that measured in 2002 and 2010. All previous surveys showed a similar pattern, with elevated levels of both total and dissolved reactive phosphorus immediately below the discharge. While phosphorus concentrations decreased with distance downstream, total phosphorus and DRP were still elevated above the reference levels in all surveys and exceeded ANZECC (ANZG, 2018) guidelines.

4.1.3 Sediment quality

Sediment quality results showed the concentration of carbon, nitrogen (total nitrogen and ammonium), and phosphorus were elevated below the farm pond when compared to reference sites, then decreased at downstream sites, a general trend throughout all surveys (2002 - 2024). Total carbon, total nitrogen, the C:N ratio of Site G decreased to similar or slightly higher concentrations to the reference site, and were comparable for the phosphorous parameters. These parameters are similar or slightly higher/lower at Site C (the most downstream site), indicating further nutrient input from the surrounding pasture near the most downstream site.

Carbon to nitrogen ratios (C : N) can give an indication of whether the source of organic matter input is from vascular land plants or non-vascular (e.g., algae) plant material. Algae typically have atomic C : N ratios between 4 and 10, whereas vascular land plants have C : N ratios of 20 or more (Premuzic *et al*. 1982; Jasper and Gagosian 1990). The C : N ratios were highest at Site E in 2024 and decrease with distance downstream, indicating more organic material came from algal sources than land sources downstream of the reference site. Apart from the markedly high C:N ratio at Site C in 2022, and the lowest ratio recorded in 2010 (at Site E – 7.7), all other ratios are within the measured range between 2002 and 2024.

4.1.4 Biological aspects

Macrophyte and algae cover differed between reference and effect sites, where macrophyte/algal percent cover increased downstream of the farm pond, along with aquatic plant diversity, a general trend observed from 2002. The increased macrophyte abundance and diversity are reflective of both the lower level of riparian vegetation and shading and of the increased bioavailable nutrient levels (dissolved inorganic nitrogen and dissolved reactive phosphorus) observed at effect sites. Macrophyte and algae composition differed between reference and effect sites, with Nitella algae present at most effect sites and comprising the largest percent cover. Also noted in 2024 is the presence of filamentous algae at effects sites, more so than what was recorded in 2022.

Compared to 2019, the reference sites had a higher diversity of macrophytes in 2024, with the effects sites having relatively the same diversity. Changes in diversity were more evident between 2024 and 2022, with less diversity at reference site A and but the same proportion of diversity higher at reference Site E, but overall, the macrophyte diversity and cover decreased approximately only by 4 % in 2024.

Macroinvertebrate results all showed similar trends, where biotic indices (number of taxa, %EPT, MCI, and SQMCI) were lower at effect sites compared to reference sites. Specifically, Site F, located closest to the discharge, had the lowest scores across all four indices in 2024, ranking as ‘poor’ in both MCI and SQMCI. Site G further downstream of the discharge increased in number of taxa, MCI, and SQMCI, but still lower than that of reference sites. Nonetheless, Site G had comparatively similar EPT taxa as that up reference site A.

Dominant taxa, which tended to be species characteristic of slow-flowing habitats or poor water quality, included the freshwater snail *Potamopyrgus antipodarum* (a trend which has been ongoing since 2022). However, in 2024, the reference sites were also dominated by similar species (snails or amphipods), with Site A having a high dominance (63%) of freshwater amphipod, Site H dominated by freshwater snail, followed by amphipods and shrimp, and Site E dominated by freshwater snail, caddisflies, and black flies.

Sites A and H had the highest MCI scores, falling in the 'Good' quality habitat category. Site E has an improved MCI category; similarly, Site E also promoted into the 'fair' SQMCI category. Site A also improved in SQMCI category. There appeared to be an overall increase in the habitat quality indicators in the 2024 survey macroinvertebrate results compared to 2022. The SQMCI scores of Site E and G is the highest that it has been recorded. This can be attributed to the slight increase in taxa at most sites (a decrease was only noted at Site F), and specifically an overall increase of EPT taxa. The poor macroinvertebrate scores downstream of the discharge are likely due to a combination of stressors, such as the decreased riparian vegetation and hard substrate at downstream sites (thus, a lack of good macroinvertebrate habitat), along with effects caused by the discharge itself such as increased temperature, nutrient input (including potentially toxic nutrients such as ammonium), and suspended sediment.

Native fish biodiversity tended to decrease with distance downstream, with only two native species recorded at Site G, C and F. Native biodiversity at reference sites was generally higher, with three to four species recorded at each site, including more sensitive taxa such as banded kōkopu and longfin eels. Native fish abundance was also higher at reference sites compared to effect sites. Fish IBI scores ranged between 'fair' and 'poor' at reference sites, with 'poor' to 'very poor' scores at the effect sites. Electric fishing of the Te Puru Tributary and lower Farm Pond Tributary could not be carried out as the conductivity of the water was too high to carry the charge from the electric fishing machine. As such, only trapping was carried out at these sites and the species diversity of these sites may have therefore been under-represented.

The presence of juvenile eels and juvenile banded kōkopu at the reference sites indicates that they have been able to migrate upstream past the discharge point over the past few years. This is similar to findings of the previous surveys (Bioresearches 2002, 2010, 2016, 2019 and 2022) in which both adult and juvenile banded kōkopu and eels were found at the upstream reference sites.

5. REFERENCES

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6. APPENDICES

Appendix 1. Laboratory Water and Sediment Quality Results

Hill Labs
R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand
0508 HILL LAB (44 555 22)
+64 7 858 2000
mail@hill-labs.co.nz
www.hill-labs.co.nz

Certificate of Analysis Page 1 of 3

Client:	Bioresearches	**Lab No:**	3456213 SPv1
Contact:	Treff Barnett C/- Bioresearches PO Box 2828 Auckland 1140	**Date Received:**	31-Jan-2024
		Date Reported:	09-Feb-2024
		Quote No:	74278
		Order No:	
		Client Reference:	1608
		Submitted By:	Treff Barnett

Sample Type: Sediment

Sample Name:		Site F (Sediment) 31-Jan-2024 12:20 pm	Site E (Sediment) 31-Jan-2024 3:20 pm	Site G (Sediment) 31-Jan-2024 4:00 pm	Site C (Sediment) 31-Jan-2024 9:12 am
Lab Number:		3456213.8	3456213.9	3456213.10	3456213.11
Individual Tests					
Dry Matter	g/100g as rcvd	37	46	43	54
Total Recoverable Phosphorus	mg/kg dry wt	2,000	380	1,210	800
Total Nitrogen*	g/100g dry wt	0.26	0.12	0.20	0.12
Ammonium-N*	mg/kg dry wt	148	24	11	18
Total Carbon*	g/100g dry wt	3.9	2.2	2.9	1.62

Sample Type: Aqueous

Sample Name:		Site A 31-Jan-2024 11:10 am	Site B 31-Jan-2024 11:40 am	Site 15 31-Jan-2024 1:00 pm	Site F 31-Jan-2024 12:30 pm	Site E 31-Jan-2024 3:20 pm
Lab Number:		3456213.1	3456213.2	3456213.3	3456213.4	3456213.5
Individual Tests						
pH	pH Units	7.1	7.7	7.5	7.8	7.4
Electrical Conductivity (EC)	mS/m	21.9	193.6	134.5	190.8	16.2
Total Suspended Solids	g/m^3	6	7	10	6	< 3
Dissolved Inorganic Nitrogen*	g/m^3	0.130	2.7	1.75	2.7	0.128
Total Nitrogen	g/m^3	0.25	3.5	2.4	3.5	0.23
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.15	0.95	0.63	0.87	0.11
Total Phosphorus	g/m^3	0.029	0.69	0.45	0.61	0.040
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	< 2 #1	< 2 #1	< 2 #1	< 2 #1	< 2 #1
Faecal Coliforms	cfu / 100mL	560	540	340	410	460
Enterococci	MPN / 100mL	461	166	517	549	1,986
Chlorophyll a	g/m^3	< 0.003	0.006	< 0.003	< 0.003	< 0.003
Nutrient Profile						
Total Ammoniacal-N	g/m^3	0.029	0.167	0.022	0.057	0.011
Nitrite-N	g/m^3	< 0.002	0.173	0.036	0.094	0.002
Nitrate-N	g/m^3	0.099	2.4	1.69	2.5	0.115
Nitrate-N + Nitrite-N	g/m^3	0.101	2.6	1.73	2.6	0.117
Dissolved Reactive Phosphorus	g/m^3	0.005	0.51	0.29	0.48	0.015

Sample Name:		Site G 31-Jan-2024 4:00 pm	Site C 31-Jan-2024 9:12 am
Lab Number:		3456213.6	3456213.7
Individual Tests			
pH	pH Units	7.7	7.5
Electrical Conductivity (EC)	mS/m	121.8	127.5
Total Suspended Solids	g/m^3	< 3	< 3
Dissolved Inorganic Nitrogen*	g/m^3	1.53	1.50
Total Nitrogen	g/m^3	2.0	2.1
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.52	0.57

Sample Type: Aqueous			
	Sample Name:	Site G 31-Jan-2024 4:00 pm	Site C 31-Jan-2024 9:12 am
	Lab Number:	3456213.6	3456213.7
Individual Tests			
Total Phosphorus	g/m^3	0.32	0.28
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2 #1	< 2 #1
Faecal Coliforms	cfu / 100mL	1,800 #2	1,300 #2
Enterococci	MPN / 100mL	1,203	461
Chlorophyll a	g/m^3	< 0.003	< 0.003
Nutrient Profile			
Total Ammoniacal-N	g/m^3	0.011	0.010
Nitrite-N	g/m^3	0.017	0.013
Nitrate-N	g/m^3	1.51	1.47
Nitrate-N + Nitrite-N	g/m^3	1.52	1.49
Dissolved Reactive Phosphorus	g/m^3	0.24	0.20

Analyst's Comments

#1 Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand(cBOD5) analyses on the day that they arrived at the laboratory. The analysis was performed, as soon as possible on the unpreserved sample which had been kept in refrigerated storage at approximately 4°C.

#2 Statistically estimated count based on the theoretical countable range for the stated method.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	8-11
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	8-11
Soil Prep Dry & Sieve for Agriculture	Air dried at 35°C and sieved, <2mm fraction.	-	8-11
Dry Matter	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	8-11
2M KCl Extraction*	2M potassium chloride extraction of as received fraction for analysis of NH4N, NO2N and NO3N. Analyst, 109, 549, (1984).	-	8-11
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	8-11
Total Recoverable Phosphorus	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	40 mg/kg dry wt	8-11
Total Nitrogen*	Catalytic Combustion (900°C, O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	8-11
Ammonium-N*	2M potassium chloride extraction on as received fraction. Phenol/hypochlorite colorimetry. Flow Injection Analyser. APHA 4500-NH_3 H (modified) : Online Edition.	5 mg/kg dry wt	8-11
Total Carbon*	Catalytic Combustion (900°C, O_2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	8-11

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Nutrient Profile		0.0010 - 0.010 g/m^3	1-7
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-7
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-7

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-7
Total Suspended Solids	Filtration using Whatman 934 AH, Advantec GC-50 or equivalent filters (nominal pore size 1.2 - 1.5µm), gravimetric determination. APHA 2540 D (modified) : Online Edition.	3 g/m^3	1-7
Dissolved Inorganic Nitrogen*	Calculation: NH_4-N + NO_3-N + NO_2-N. In-house calculation.	0.005 g/m^3	1-7
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-7
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-7
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-7
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-7
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-7
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-7
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-7
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-7
Enterococci	MPN count using Enterolert, Incubated at 41°C for 24 hours. MIMM 12.4, APHA 9230 D : Online Edition.	1 MPN / 100mL	1-7
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-7

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 01-Feb-2024 and 09-Feb-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

Appendix 2. Raw Macroinvertebrate Data

PHYLUM	CLASS: Order	Family	Taxa	Taxa MCI hb	Taxa MCI sb	Site A	Site H	Site E	Site F	Site G	Site C
						SB	HB	HB	SB	HB	SB
ANNELIDA	**OLIGOCHAETA**		Oligochaeta	1	3.8	1		2			2
	HIRUDINEA		*Glossiphonia* sp.	3	1.2	1				1	
MOLLUSCA	**GASTROPODA**	Hydrobiidae	*Potamopyrgus antipodarum*	4	2.1	1	41	83	179	1121	263
		Lymneaidae	*Lymnaea columella*	3	1.2		1				
		Latiidae	*Latia neritoides*	3	6.1			1			
	BIVALVIA	Sphaeriidae	*Pisidium hodgkini*	3	2.9	1					
ARTHROPODA	**Ostracoda**		Ostracoda	3	1.9	4			3		1
	Amphipoda		*Paracalliope fluviatilis*	5	5.5	331	34	25	1	766	1222
	Decapoda		*Paranephrops planifrons*	5	8.4	1	2	1			1
			Paratya curvirostris	5	3.6		28	2		4	18
	INSECTA:										
	Megaloptera	Corydalidae	*Archichauliodes diversus*	7	7.3		1	1			
	Odonata	Zygoptera	*Xanthocnemis zealandica*	5	1.2	4				6	12
		Anisoptera	*Hemicordulia australiae*	5	0.4						1
	Ephemeroptera	Leptophlebiidae	*Deleatidium 'lilli'* group	8	5.6		1	7			
			Arachnocolus phillipsi	8	8.1	2					
			Zephlebia spp	7	8.8	16	7	3			
			Neozephlebia scita	7	7.6	10		4			
	Trichoptera	Hydropsychidae	*Orthopsyche fimbriata*	9	7.5					1	
		Hydroptilidae	*Oxyethira albiceps*	2	1.2	4		1		1	4
		Hydrobiosidae	*Hydrobiosis parumbripennis*	7	7.4		2				
			Psilochorema sp.	8	7.8			2			
			Neurochorema confusum	6	6			1			
			Costachorema sp.	7	7.2			2			
		Polycentropodidae	*Polyplectropus puerilis*	8	8.1	86					
		Leptoceridae	*Triplectides obsoleta*	5	5.7	1	20	7		1	4
		Conoesucidae	*Pycnocentrodes* sp.	5	3.8			42			
	Coleoptera	Ptilodactylidae	Ptilodactylidae	8	7.1		1	1			
		Scirtidae	Scirtidae	8	6.4	1					
		Hydrophilidae	Hydrophilidae	5	8	2					
			Enochrus tritus	5	2.6		1				
	Lepidoptera		*Hygraula nitens*	4	1.3						3
	Diptera	Hexatomini	*Paralimnophila skusei*	6	7.4	1					
		Simuliidae	*Austrosimulium australense* gp	3	3.9			26		2	
		Chironomidae	*Chironomus*	1	3.4	1	1	1		2	
			Orthcladiinae	2	3.2	4	7	11		5	
			Tanypodinae	5	6.5	51		1		1	
		Tanyderidae	*Mischoderus* sp.	4	5.9			1			
		Dixidae	*Paradixa* sp.	4	8.5	2	2				
	Collembola	Collembola .	Collembola	6	5.3						3
		TOTALS:	**NO. TAXA**			21	15	22	3	12	12
			NO. EPT TAXA			6	4	9	0	3	2
			NO. INDIVIDUALS			525	149	225	183	1911	1534
CHORDATA	**VERTEBRATA**	Poeciliidae	*Gambusia affinis*				3		19	1	1
		Gobiidae	*Gobiomorphus* sp.					1			1
		Galaxiidae	*Galaxias* sp.								

Appendix 3. New Zealand Freshwater Fish Database Forms

FRESHWATER FISH DATABASE FORM			1
Date **01/02/2024**	River/Lake system **Tributary to Te Puru Stream**		Catchment number **084.00**
Time	Sampling locality **C: Lower**		
Observer **ld**	Access		Altitude (m) **15**
Organisation **bior**	NZMS 260 Map no.	Coord.	Distance inland (km) **3.6**
Fishing method **gmt**	Area fished (m2) or no. nets used	Number of electric fishing passes	Tidal water **n**

HABITAT DATA

Water	Colour			Clarity		Temp.	pH
	Average width (m)		Average depth (m)	Maximum depth (m)		Conductivity	
Habitat type (%)	Still	Back-water	Pool	Run	Riffle	Rapid	Casc.
Substrate type (%)	Mud	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bed-rock
Fish cover (y/n)	Macrophyte	Instream debris	Undercut bank	Bank veg.			
Catchment vegetation(%)	Native forest	Exotic forest	Farm	Urban zone	Scrub	Swamp land	Other
Riparian vegetation(%)	Native forest	Exotic forest	Grass tussock	Exposed bed	Scrub willow	Raupo flax	Other
Type of river/stream/lake							
Water level			Downstream barrier			Pollution	
Large invertebrate fauna		Koura		Paratya		Freshwater mussel	
Bottom fauna abundance			Predominant species group			Permanent water	

FISH DATA

Species		Abundance	Length	Habitat/Comments
Anguilla	**Unidentified eel**	**1**		
Gobiomorphus cotidianus	**Common bully**	**10**		
Gambusia affinis	**Gambusia**	**2**		
Anguilla dieffenbachii	**Longfin eel**	**1**		

Comments

FRESHWATER FISH DATABASE FORM							2
Date **01/02/2024**	River/Lake system **Tributary to Te Puru Stream**					Catchment number **084.00**	
Time	Sampling locality **H: Farmstop**						
Observer **ld**	Access					Altitude (m) **31**	
Organisation **bior**	NZMS 260 Map no. **s11**		Coord.			Distance inland (km) **5.5**	
Fishing method **gmt**	Area fished (m2) or no. nets used		Number of electric fishing passes			Tidal water **n**	

HABITAT DATA

Water	Colour			Clarity		Temp.	pH
	Average width (m)		Average depth (m)	Maximum depth (m)		Conductivity	
Habitat type (%)	Still	Back-water	Pool	Run	Riffle	Rapid	Casc.
Substrate type (%)	Mud	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bed-rock
Fish cover (y/n)	Macrophyte	Instream debris	Undercut bank	Bank veg.			
Catchment vegetation(%)	Native forest	Exotic forest	Farm	Urban zone	Scrub	Swamp land	Other
Riparian vegetation(%)	Native forest	Exotic forest	Grass tussock	Exposed bed	Scrub willow	Raupo flax	Other
Type of river/stream/lake							
Water level			Downstream barrier			Pollution	
Large invertebrate fauna		Koura		Paratya		Freshwater mussel	
Bottom fauna abundance			Predominant species group			Permanent water	

FISH DATA

Species		Abundance	Length	Habitat/Comments
Paranephrops	**Koura**	**4**		
Gobiomorphus basalis	**Crans bully**	**5**		
Gobiomorphus cotidianus	**Common bully**	**24**		
Galaxias fasciatus	**Banded kokopu**	**3**		

Comments

FRESHWATER FISH DATABASE FORM							3
Date **01/02/2024**	River/Lake system **Tributary to Te Puru Stream**						Catchment number **084.00**
Time	Sampling locality **E: farm access**						
Observer **ld**	Access						Altitude (m) **24**
Organisation **bior**	NZMS 260 Map no. **s11**		Coord.				Distance inland (km) **5.1**
Fishing method **gmt**	Area fished (m2) or no. nets used		Number of electric fishing passes				Tidal water **n**

HABITAT DATA

Water	Colour			Clarity		Temp.	pH
	Average width (m)		Average depth (m)	Maximum depth (m)		Conductivity	
Habitat type (%)	Still	Back-water	Pool	Run	Riffle	Rapid	Casc.
Substrate type (%)	Mud	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bed-rock
Fish cover (y/n)	Macrophyte	Instream debris	Undercut bank	Bank veg.			
Catchment vegetation(%)	Native forest	Exotic forest	Farm	Urban zone	Scrub	Swamp land	Other
Riparian vegetation(%)	Native forest	Exotic forest	Grass tussock	Exposed bed	Scrub willow	Raupo flax	Other
Type of river/stream/lake							
Water level			Downstream barrier			Pollution	
Large invertebrate fauna		Koura		Paratya		Freshwater mussel	
Bottom fauna abundance			Predominant species group			Permanent water	

FISH DATA

Species		Abundance	Length	Habitat/Comments
Gobiomorphus cotidianus	**Common bully**	**14**		
Anguilla	**Unidentified eel**	**4**		
Paranephrops	**Koura**	**1**		

Comments

FRESHWATER FISH DATABASE FORM							4
Date **01/02/2024**		River/Lake system **Tributary to Te Puru Stream**				Catchment number **084.00**	
Time		Sampling locality **A: Upper pond trib**					
Observer **ld**		Access				Altitude (m) **40**	
Organisation **bior**		NZMS 260 Map no. **s11**		Coord.		Distance inland (km) **5.8**	
Fishing method **gmt**		Area fished (m2) or no. nets used		Number of electric fishing passes		Tidal water **n**	
HABITAT DATA							
Water	Colour			Clarity		Temp.	pH
	Average width (m)		Average depth (m)	Maximum depth (m)		Conductivity	
Habitat type (%)	Still	Back-water	Pool	Run	Riffle	Rapid	Casc.
Substrate type (%)	Mud	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bed-rock
Fish cover (y/n)	Macrophyte	Instream debris	Undercut bank	Bank veg.			
Catchment vegetation(%)	Native forest	Exotic forest	Farm	Urban zone	Scrub	Swamp land	Other
Riparian vegetation(%)	Native forest	Exotic forest	Grass tussock	Exposed bed	Scrub willow	Raupo flax	Other
Type of river/stream/lake							
Water level			Downstream barrier			Pollution	
Large invertebrate fauna		Koura		Paratya		Freshwater mussel	
Bottom fauna abundance			Predominant species group			Permanent water	
FISH DATA							

Species		Abundance	Length	Habitat/Comments
Anguilla	**Unidentified eel**	**1**		
Galaxias fasciatus	**Banded kokopu**	**9**		
Paranephrops	**Koura**			
Gobiomorphus cotidianus	**Common bully**			

Comments

FRESHWATER FISH DATABASE FORM							5
Date 01/02/2024	River/Lake system **Tributary to Te Puru Stream**					Catchment number **084.00**	
Time	Sampling locality **G: Mid down trib**						
Observer **ld**	Access					Altitude (m) **18**	
Organisation **bior**	NZMS 260 Map no. **s11**		Coord.			Distance inland (km) **4.4**	
Fishing method **gmt**	Area fished (m2) or no. nets used		Number of electric fishing passes			Tidal water **n**	

HABITAT DATA

Water	Colour			Clarity		Temp.	pH
	Average width (m)		Average depth (m)	Maximum depth (m)		Conductivity	
Habitat type (%)	Still	Back-water	Pool	Run	Riffle	Rapid	Casc.
Substrate type (%)	Mud	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bed-rock
Fish cover (y/n)	Macrophyte	Instream debris	Undercut bank	Bank veg.			
Catchment vegetation(%)	Native forest	Exotic forest	Farm	Urban zone	Scrub	Swamp land	Other
Riparian vegetation(%)	Native forest	Exotic forest	Grass tussock	Exposed bed	Scrub willow	Raupo flax	Other
Type of river/stream/lake							
Water level			Downstream barrier			Pollution	
Large invertebrate fauna		Koura		Paratya		Freshwater mussel	
Bottom fauna abundance			Predominant species group			Permanent water	

FISH DATA

Species		Abundance	Length	Habitat/Comments
Gambusia affinis	**Gambusia**	**3**		**gen**
Gobiomorphus cotidianus	**Common bully**	**21**		
Anguilla dieffenbachii	**Longfin eel**	**1**		

Comments

FRESHWATER FISH DATABASE FORM							6
Date 01/02/2024		River/Lake system Tributary to Te Puru Stream				Catchment number 084.00	
Time		Sampling locality F: Below pond					
Observer ld		Access				Altitude (m) 25	
Organisation bior		NZMS 260 Map no. s11		Coord.		Distance inland (km) 5	
Fishing method gmt		Area fished (m2) or no. nets used		Number of electric fishing passes		Tidal water n	
HABITAT DATA							
Water	Colour			Clarity		Temp.	pH
	Average width (m)		Average depth (m)	Maximum depth (m)		Conductivity	
Habitat type (%)	Still	Back-water	Pool	Run	Riffle	Rapid	Casc.
Substrate type (%)	Mud	Sand	Fine gravel	Coarse gravel	Cobble	Boulder	Bed-rock
Fish cover (y/n)	Macrophyte	Instream debris	Undercut bank	Bank veg.			
Catchment vegetation(%)	Native forest	Exotic forest	Farm	Urban zone	Scrub	Swamp land	Other
Riparian vegetation(%)	Native forest	Exotic forest	Grass tussock	Exposed bed	Scrub willow	Raupo flax	Other
Type of river/stream/lake							
Water level			Downstream barrier			Pollution	
Large invertebrate fauna		Koura		Paratya		Freshwater mussel	
Bottom fauna abundance			Predominant species group			Permanent water	
FISH DATA							
Species				Abundance	Length	Habitat/Comments	
Anguilla			**Unidentified eel**	**1**			
Comments							

Appendix 4. Auckland Fish Index of Biotic Integrity (IBI)

Index of Biological Integrity - Auckland Region : Fish

Centre for Freshwater Ecosystem Modelling and Management, Massey University

Site	IBI score	Rating
H	34	Fair
E	26	Poor
A	34	Fair
F	14	Very Poor
G	26	Poor
C	26	Poor

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Appendix 5. Macrophyte Survey Results

Site A															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		1.43	1.76	3.22	2.15	1.48	1.56	1.25	0.99	1.58	1.5	1.56	0.86		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0.05	3	0	0	2	0	1	0	0	0	0	1	0.5875	0.28684
Watercress	*Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Duckweed	*Lemna minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Celery	*Apium nodiflorum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	
Buttercup	*Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other macrophytes	*Forget-me-knot*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red ludwigia	0	1	5	10	3	15	40	3	0	0	0	0	6.41667	3.3427
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green filamentous		0	0	0	5	0	0	0	0	0	0	0	0	0.41667	0.41667
Brown mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Macrophytes (%)		0.05	4	5	10	5	15	41	3	0	0	0	1	7.00	3.36
Total Algae (%)		0	0	0	5	0	0	0	0	0	0	0	0	0.42	0.42
Bare Substrate (%)		99.95	96	95	85	95	85	59	97	100	100	100	99	92.58	3.42

Site H															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		1.05	1.11	1.23	1.42	1.07	2.31	2.76	2.52	2.38	1.64	2.27	1.08		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watercress	*Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Duckweed	*Lemna minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0.01	0	0	0	0	0	0	0.00	0.00
Water Celery	*Apium nodiflorum*	0	60	0	0	0	0.05	0.1	0	0	0	0.01	1	5.10	4.99
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buttercup	*Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other macrophytes	*Forget-me-knot*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Macrophytes (%)		0	60	0	0	0	0.06	0.1	0	0	0	0.01	1	5.10	4.99
Total Algae (%)		0	0	0	0	0	0	0	0	0	0	0	0	0.00	0.00
Bare Substrate (%)		100	40	100	100	100	99.94	99.9	100	100	100	99.99	99	94.90	4.99

Site E															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		1.77	1.73	2.86	2.77	2.56	2.41	2.12	1.71	2.12	1.94	2.07	1.89		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0	0	0	0	0	0	0	0	1	0	0	0	0.083333	0.083333
Watercress	*Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Duckweed	*Lemna minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Celery	*Apium nodiflorum*	0	0	0	0	0	0	0	1	3	0	1	1	0.5	0.261116
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	0	1	0	0	0	0	0	0	0	0	0	0.083333	
Buttercup	*Ranunculus repens*	0	0	0	0	0	0	0	0	1	0	0	0	0.083333	0.083333
Other macrophytes	*Forget-me-knot*	0	0	0	0	0	0	0	0.5	1	0	0	0	0.125	0.089718
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	5	10	15	5	25	30	0	0	0	0	20	0	9.166667	3.128155
Green mat		0	3	0	0	0	0	0	0	0	0	0	5	0.666667	0.466017
Green filamentous		0	0	5	1	0	2	0	0	0	0	0	0	0.666667	0.432283
Brown mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Macrophytes (%)		0	0	1	0	0	0	0	1.5	6	0	1	1	0.88	0.49
Total Algae (%)		5	13	20	6	25	32	0	0	0	0	20	5	10.50	3.23
Bare Substrate (%)		95	87	79	94	75	68	100	98.5	94	100	79	94	88.63	3.12

Site F															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		2.2	2.28	2.27	1.8	1.88	2.7	1.84	1.34	1.45	1.37	1.36	1.65		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	1	10	50	10	10	2	0	0	0	0	5	0	7.333333	4.068231
Watercress	*Nasturtium officinale*	1	5	10	5	2	0.1	0	0	0	0	0	0	1.925	0.915119
Duckweed	*Lemna minor*	10	20	5	40	1	0.1	0.01	0	0	0.1	5	5	7.184167	3.434091
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0.1	0	2	0	0	0	0	0	0	0	0	0.175	0.166117
Water Celery	*Apium nodiflorum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	
Buttercup	*Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other macrophytes	*Forget-me-knot*	0	2	0	0	0	0	0	0	0	0	20	0	1.833333	1.659834
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown mat		10	0	0	0	0	0	0	0	0	0	0	0	0.833333	0.833333
Brown filamentous		20	20	30	40	10	30	10	0	0	10	30	80	23.33333	6.316565
Total Macrophytes (%)		12	37.1	65	57	13	2.2	0.01	0	0	0.1	30	5	18.45	6.75
Total Algae (%)		30	20	30	40	10	30	10	0	0	10	30	80	24.17	6.33
Bare Substrate (%)		58	42.9	5	3	77	67.8	89.99	100	100	89.9	40	15	57.38	10.39

Site S2															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		1.98	1.52	2.24	2.69	2.4	2.18	1.91	1.77	1.74	1.51	1.78	1.77		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Watercress	*Nasturtium officinale*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Duckweed	*Lemna minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Celery	*Apium nodiflorum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	
Buttercup	*Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other macrophytes	*Forget-me-knot*	25	0	15	0	0	10	10	0	0	0	0	0	5	2.383656
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	2	0	0	0	0	0	2	0	0	0	0	0	0.333333	0.224733
Green mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green filamentous		0	0	0	1	0	0	0	0	0	0	0	0	0.083333	0.083333
Brown mat		0	0	0	0	5	0	0	0	0	0	0	0	0.416667	0.416667
Brown filamentous		0	10	0	20	2	2	0	0	0	0	0	0	2.833333	1.76598
Total Macrophytes (%)		25	0	15	0	0	10	10	0	0	0	0	0	5.00	2.38
Total Algae (%)		2	10	0	21	7	2	2	0	0	0	0	0	3.67	1.83
Bare Substrate (%)		73	90	85	79	93	88	88	100	100	100	100	100	91.33	2.66

Site G															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		3.1	2.39	2.1	2.35	3.25	1.46	1.5	1.47	1.35	1.8	2.9	2.4		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0	0	0	0	0	0	0	2	0	0	5	0	0.583333	0.434468
Watercress	*Nasturtium officinale*	0	25	40	30	0	0	1	10	10	1	10	5	11	3.892495
Duckweed	*Lemna minor*	0	0	0	2	1	1	1	0	0	1	1	2	0.75	0.217597
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Celery	*Apium nodiflorum*	15	25	40	1	1	0	1	10	10	0	1	5	9.083333	3.576985
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	5	0	0	0	0	0	0	0	0	0	0	0.416667	
Buttercup	*Ranunculus repens*	0	0	0	0.1	0	0	0	0	0	0	0	1	0.091667	0.082992
Other macrophytes	*Forget-me-knot*	0	0	1	0	0	5	10	5	0	0	0	0	1.75	0.930339
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	2	20	10	5	0	0	5	10	10	20	40	30	12.66667	3.618834
Green mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green filamentous		1	0	1	35	5	5	0	35	30	35	30	20	16.41667	4.516734
Brown mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Macrophytes (%)		15	55	81	33.1	2	6	13	27	20	2	17	13	23.68	6.73
Total Algae (%)		3	20	11	40	5	5	5	45	40	55	70	50	29.08	6.80
Bare Substrate (%)		82	25	8	26.9	93	89	82	28	40	43	13	37	47.24	8.88

Site S3															
Transect		1	2	3	4	5	6	7	8	9	10	11	12	**Mean**	**S.E**
Width (m)		1.6	1.87	3.02	2.81	3.71	2.9	3.9	2.28	2.73	2.55	2.46	2.42		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0	15	0	0	0	0	0	3	10	20	2	4	4.5	1.96754
Watercress	*Nasturtium officinale*	0	0	0.01	0.01	0.05	0.5	1	1	4	0.5	0	0	0.589167	0.329569
Duckweed	*Lemna minor*	0	0.01	1	0.01	0	0.1	0	0	1	0.1	1	0	0.268333	0.127807
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Celery	*Apium nodiflorum*	0	0	1	0	0	0	0	0.5		0.5	0.5	1	0.318182	0.121967
Oxygen weed	*Elodea canadensis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Curly pondweed	*Potamogeton crispus*	0	0	0	0	0	0	0	0	0	0	0.5	0	0.041667	0.041667
Buttercup	*Ranunculus repens*	0.1	0	0	0.5	0	0	0	0	0	0	0	0	0.05	0.041742
Other macrophytes	*Forget-me-knot*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	10	40	45	60	70	0	50	80	85	100	55	60	54.58333	8.358862
Green mat		0	0	0	0	0	0	0	2	0	0	2	0	0.333333	0.224733
Green filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Macrophytes (%)		0.1	15.01	2.01	0.52	0.05	0.6	1	4.5	15	21.1	4	5	5.74	2.07
Total Algae (%)		10	40	45	60	70	0	50	82	85	100	57	60	54.92	8.41
Bare Substrate (%)		89.9	44.99	52.99	39.48	29.95	99.4	49	13.5	0	-21.1	39	35	39.34	9.71

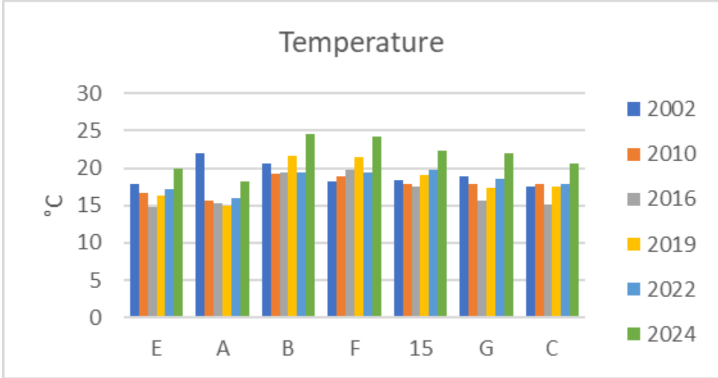
Site C														Mean	S.E
Transect		1	2	3	4	5	6	7	8	9	10	11	12		
Width (m)		0.43	1.15	2.1	2.1	2.25	2.17	1.5	1.7	1.73	2	2.25	2.5		
Macrophytes (%)															
Willow weed	*Persicaria sp.*	0	0	5	0	20	20	0	0	5	0	2	0	4.333333	2.182344
Watercress	*Nasturtium officinale*	10	5	0	0	0	0	1	0	5	5	0	0	2.166667	0.952137
Duckweed	*Lemna minor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cape pondweed	*Aponogeton distachyus*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Starwort	*Callitriche stagnalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Water Celery	*Apium nodiflorum*	30	10	10	4	5	5	5	1	10	15	10	0.1	8.758333	2.297082
Oxygen weed	*Elodea canadensis*	2	30	50	0	0	0	0	0	0	0	0	0	6.833333	4.641436
Curly pondweed	*Potamogeton crispus*	0	0	0	0	0	0	0	0	0	0	0	0	0	
Buttercup	*Ranunculus repens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other macrophytes	*Forget-me-knot*	0	0	0	0	0	0	0	5	10	1	0	0	1.333333	0.890466
Iron flocc		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitella	*Nitella hookeri*	2	10	10	60	60	40	30	70	60	50	30	50	39.33333	6.593538
Green mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green filamentous		0	0	1	5	10	10	10	10	10	10	30	15	9.25	2.34238
Brown mat		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown filamentous		0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Macrophytes (%)		42	45	65	4	25	25	6	6	30	21	12	0.1	23.43	5.68
Total Algae (%)		2	10	11	65	70	50	40	80	70	60	60	65	48.58	7.71
Bare Substrate (%)		56	45	24	31	5	25	54	14	0	19	28	34.9	27.99	5.09

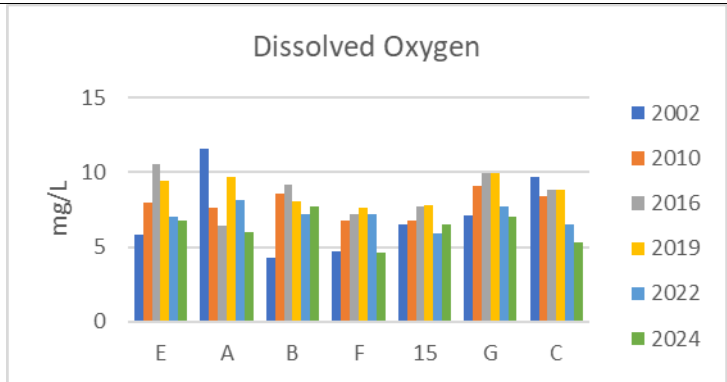
Appendix 6. Historical water quality, sediment quality and biological data (2002 – 2024)

6.1 Water Quality

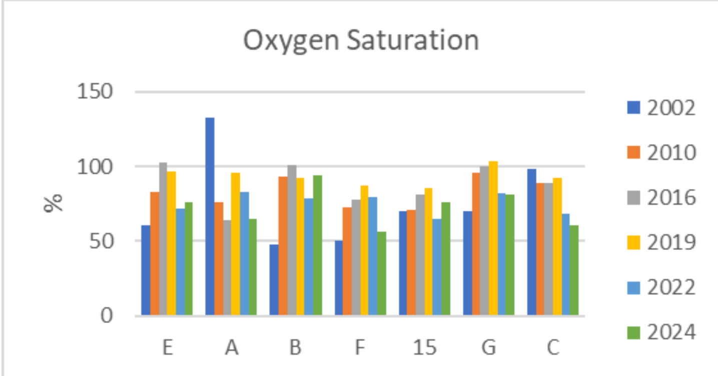
		E	A	B	F	15	G	C
Temperature (°C)	2002	17.9	22	20.7	18.3	18.4	18.9	17.6
	2010	16.6	15.6	19.2	18.9	17.9	17.8	17.8
	2016	14.8	15.3	19.5	19.7	17.5	15.6	15.2
	2019	16.3	15	21.7	21.4	19.1	17.4	17.6
	2022	17.2	16.0	19.5	19.5	19.7	18.6	17.9
	2024	19.9	18.2	24.5	24.2	22.4	22	20.6
Dissolved Oxygen (mg/L)	2002	5.79	11.55	4.25	4.73	6.51	7.07	9.67
	2010	8	7.6	8.6	6.8	6.8	9.1	8.4
	2016	10.5	6.4	9.2	7.2	7.7	9.9	8.8
	2019	9.44	9.71	8.05	7.66	7.83	9.9	8.83
	2022	7	8.12	7.18	7.22	5.88	7.70	6.47
	2024	6.8	6	7.7	4.6	6.5	7.00	5.3

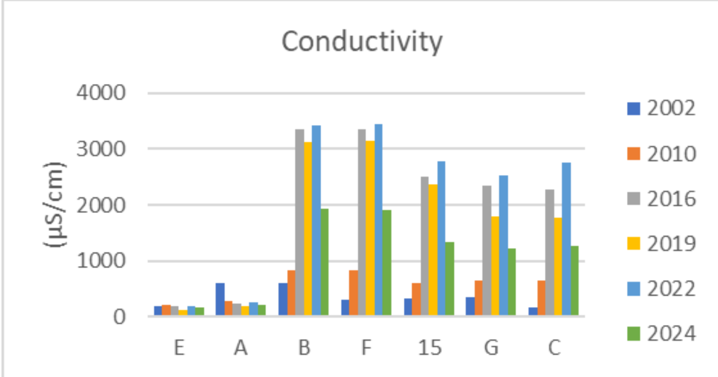
Corresponding graph

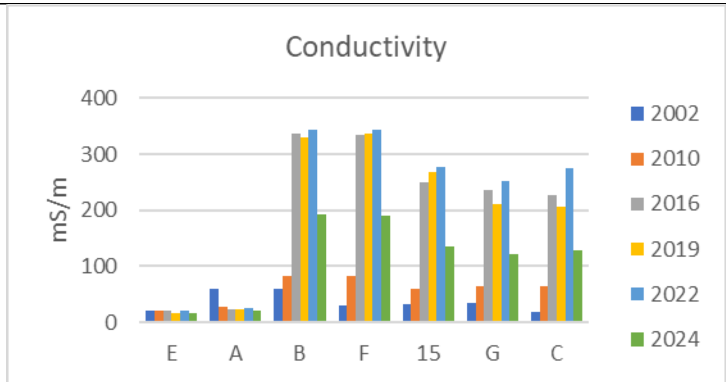




		E	A	B	F	15	G	C	Corresponding graph
Oxygen Saturation (%)	**2002**	61	132.4	47.5	50.4	70.2	70.2	98.5	
	2010	83	76	93	73	71	96	89	
	2016	103	64	101	78	81	100	89	
	2019	96.5	96.1	92.6	87	85.5	103.4	92.6	
	2022	71.9	82.8	78.4	79.5	64.5	82.3	68.5	
	2024	76	65	94	56.0	76	81	61	
Conductivity (µS/cm)	**2002**	202	610	598	307	334	358	176	
	2010	218	279	828	828	597	649	639	
	2016	199	228	3360	3340	2500	2350	2270	
	2019	134.7	184.1	3126	3139	2377	1800	1782	
	2022	203	256	3430	3440	2770	2530	2760	
	2024	162	219	1936	1908	1345	1218	1275	
Conductivity (mS/m)	**2002**	20.2	61	59.8	30.7	33.4	35.8	17.6	
	2010	21.8	27.9	82.8	82.8	59.7	64.9	63.9	
	2016	19.9	22.8	336	334	250	235	227	
	2019	16.1	23.7	331	337	268	210	206	
	2022	20.3	25.6	343	344	277	253	276	
	2024	16.2	21.9	193.6	190.8	134.5	121.8	127.5	

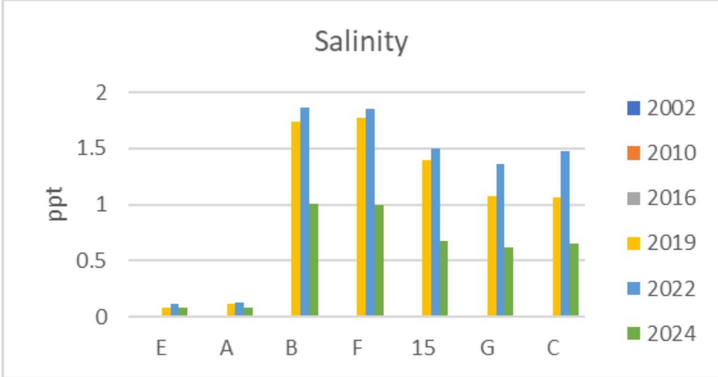


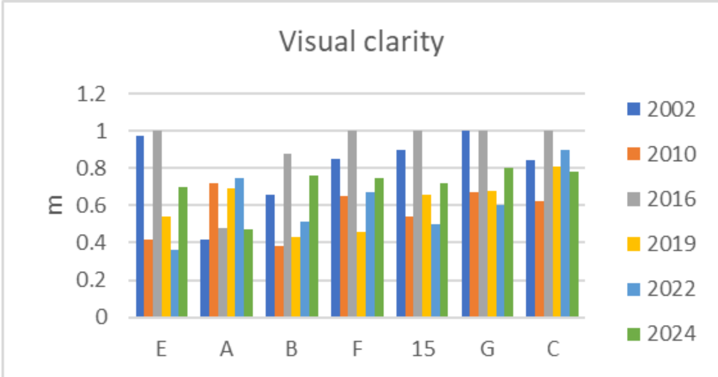


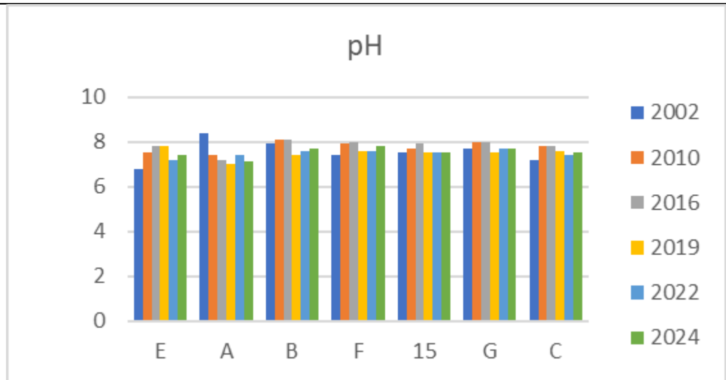


		E	A	B	F	15	G	C
Salinty (ppt)	2002							
	2010							
	2016							
	2019	0.08	0.11	1.74	1.77	1.39	1.08	1.06
	2022	0.11	0.12	1.86	1.85	1.5	1.36	1.48
	2024	0.08	0.08	1.01	1	0.68	0.62	0.65
Visual Clarity (m)	2002	0.97	0.42	0.66	0.85	0.9	1	0.84
	2010	0.42	0.72	0.38	0.65	0.54	0.67	0.62
	2016	1	0.48	0.88	1	1	1	1
	2019	0.54	0.69	0.43	0.46	0.66	0.68	0.81
	2022	0.36	0.75	0.51	0.67	0.5	0.6	0.9
	2024	0.7	0.47	0.76	0.75	0.72	0.8	0.78
pH (pH unit)	2002	6.8	8.4	7.9	7.4	7.5	7.7	7.2
	2010	7.5	7.4	8.1	7.9	7.7	8	7.8
	2016	7.8	7.2	8.1	8	7.9	8	7.8
	2019	7.8	7	7.4	7.6	7.5	7.5	7.6
	2022	7.2	7.4	7.6	7.6	7.5	7.7	7.4
	2024	7.4	7.1	7.7	7.8	7.5	7.7	7.5

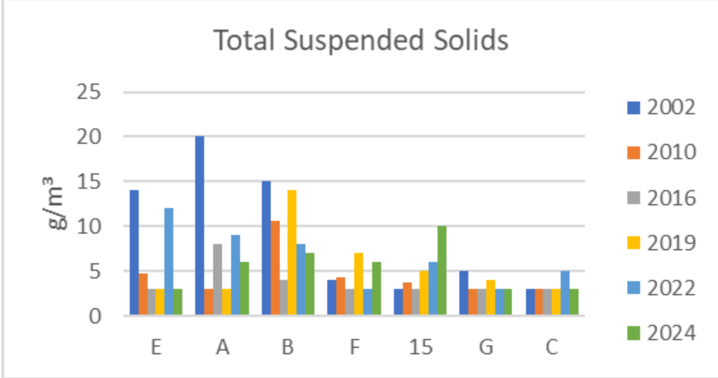
Corresponding graph

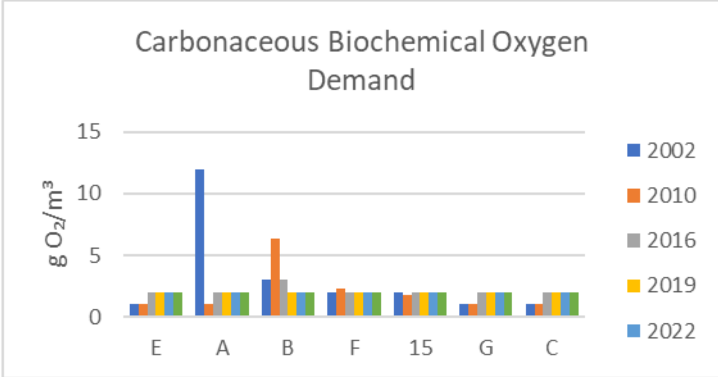


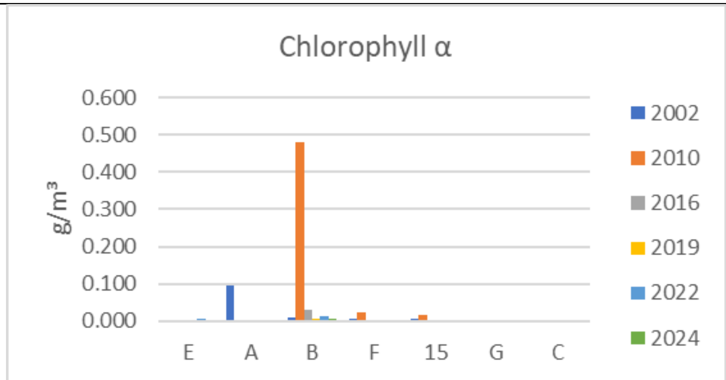




		E	A	B	F	15	G	C	Corresponding graph
Total Suspended Solids (g/m³)	2002	14	20	15	4	3	5	3	
	2010	4.7	3	10.6	4.3	3.7	3	3	
	2016	3	8	4	3	3	3	3	
	2019	3	3	14	7	5	4	3	
	2022	12	9	8	3	6	3	5	
	2024	3	6	7	6	10	3	3	
Carbonaceous Biochemical Oxygen Demand (g O_2/m³)	2002	1	12	3	2	2	1	1	
	2010	1	1	6.3	2.3	1.8	1	1	
	2016	2	2	3	2	2	2	2	
	2019	2	2	2	2	2	2	2	
	2022	2	2	2	2	2	2	2	
	2024	2	2	2	2	2	2	2	
Chlorophyll α (g/m³)	2002	0.003	0.097	0.011	0.005	0.005	0.003	0.003	
	2010	0.003	0.004	0.480	0.023	0.016	0.003	0.003	
	2016	0.003	0.003	0.031	0.003	0.003	0.003	0.003	
	2019	0.003	0.003	0.006	0.003	0.003	0.003	0.003	
	2022	0.008	0.003	0.013	0.003	0.003	0.003	0.003	
	2024	0.003	0.003	0.006	0.003	0.003	0.003	0.003	







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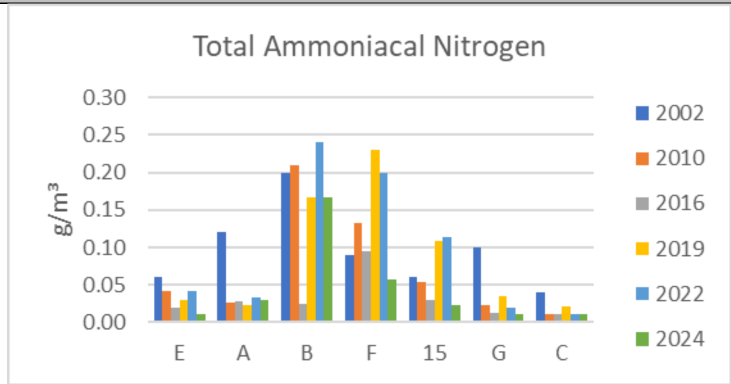
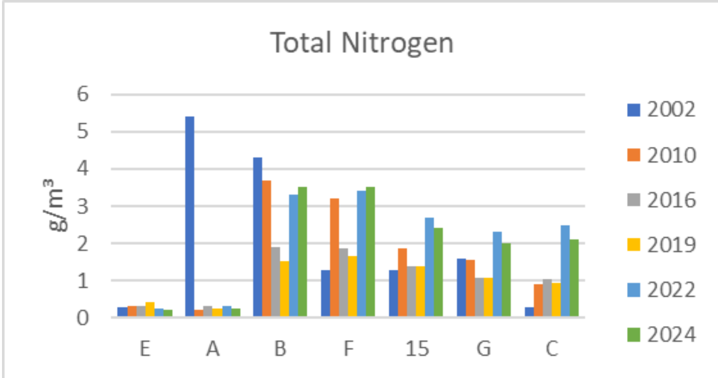
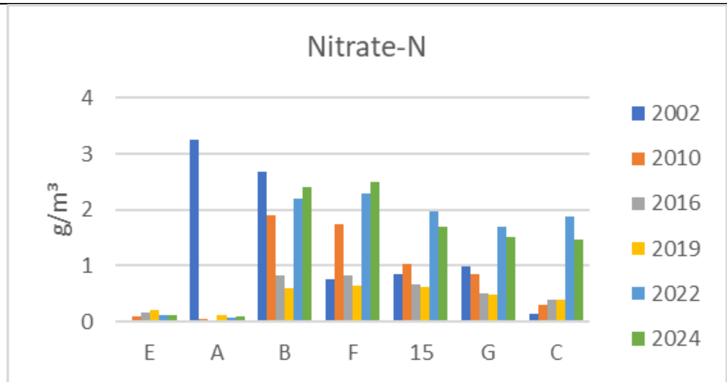
		E	A	B	F	15	G	C	Corresponding graph
Total Ammoniacal Nitrogen (g/m³)	**2002**	0.1	0.1	0.2	0.1	0.1	0.1	0.0	
	2010	0.0	0.0	0.2	0.1	0.1	0.0	0.0	
	2016	0.0	0.0	0.0	0.1	0.0	0.0	0.0	
	2019	0.0	0.0	0.2	0.2	0.1	0.0	0.0	
	2022	0.0	0.0	0.2	0.2	0.1	0.0	0.0	
	2024	0.0	0.0	0.2	0.1	0.0	0.0	0.0	
Total Nitrogen (g/m³)	**2002**	0.3	5.4	4.3	1.3	1.3	1.6	0.3	
	2010	0.32	0.22	3.7	3.2	1.86	1.57	0.91	
	2016	0.33	0.32	1.89	1.86	1.4	1.08	1.03	
	2019	0.44	0.25	1.53	1.65	1.4	1.08	0.94	
	2022	0.25	0.33	3.3	3.4	2.7	2.3	2.5	
	2024	0.23	0.25	3.5	3.5	2.4	2	2.1	
Nitrate-N (g/m³)	**2002**	0.032	3.26	2.68	0.761	0.844	0.992	0.152	
	2010	0.103	0.058	1.9	1.74	1.04	0.85	0.31	
	2016	0.157	0.015	0.82	0.82	0.67	0.51	0.4	
	2019	0.2	0.11	0.61	0.64	0.62	0.49	0.4	
	2022	0.116	0.082	2.2	2.3	1.97	1.7	1.89	
	2024	0.115	0.099	2.4	2.5	1.69	1.51	1.47	

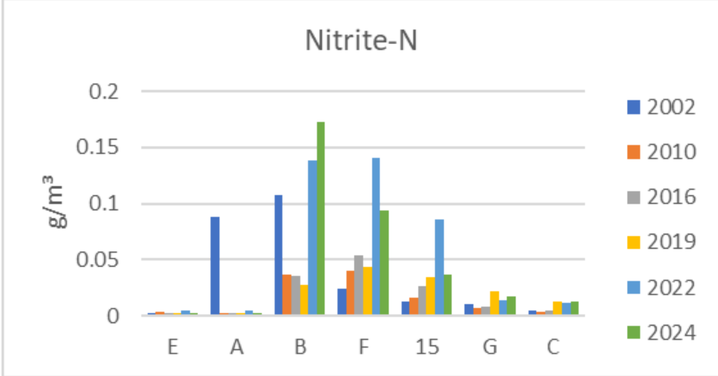


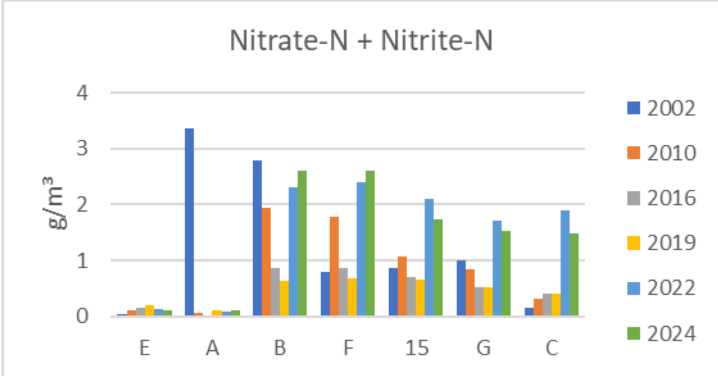


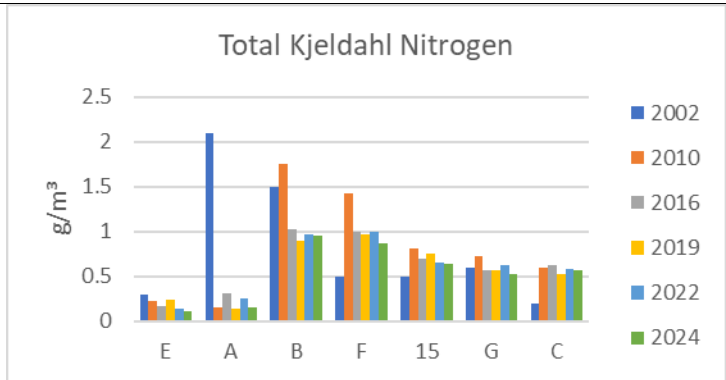


		E	A	B	F	15	G	C
Nitrite-N (g/m³)	2002	0.002	0.088	0.107	0.024	0.012	0.01	0.004
	2010	0.0032	0.002	0.036	0.04	0.0158	0.007	0.0034
	2016	0.002	0.002	0.035	0.054	0.026	0.008	0.005
	2019	0.002	0.002	0.027	0.044	0.034	0.022	0.013
	2022	0.004	0.004	0.138	0.141	0.086	0.014	0.011
	2024	0.002	0.002	0.173	0.094	0.036	0.017	0.013
Nitrate-N + Nitrite-N (g/m³)	2002	0.034	3.348	2.787	0.785	0.856	1.002	0.156
	2010	0.106	0.06	1.94	1.78	1.06	0.85	0.32
	2016	0.159	0.017	0.86	0.87	0.7	0.52	0.41
	2019	0.21	0.11	0.64	0.68	0.65	0.52	0.41
	2022	0.12	0.086	2.3	2.4	2.1	1.71	1.9
	2024	0.117	0.101	2.6	2.6	1.73	1.52	1.49
Total Kjeldahl Nitrogen (g/m³)	2002	0.3	2.1	1.5	0.5	0.5	0.6	0.2
	2010	0.22	0.155	1.75	1.43	0.81	0.72	0.6
	2016	0.17	0.31	1.03	0.99	0.7	0.56	0.62
	2019	0.23	0.14	0.89	0.96	0.75	0.56	0.52
	2022	0.13	0.25	0.96	0.99	0.65	0.62	0.58
	2024	0.11	0.15	0.95	0.87	0.63	0.52	0.57

Corresponding graph

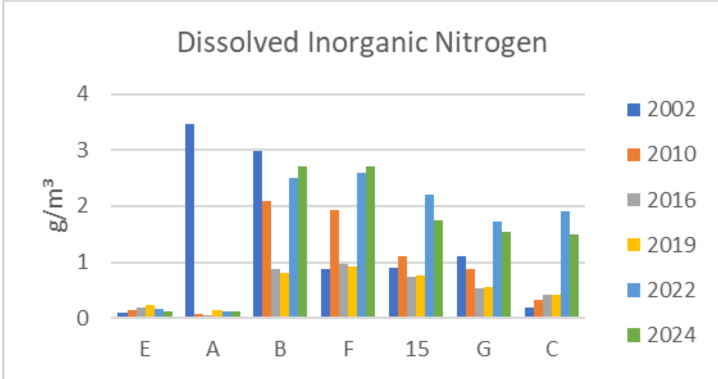


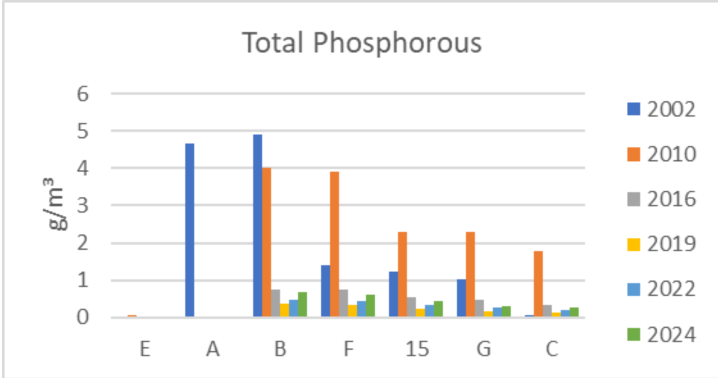


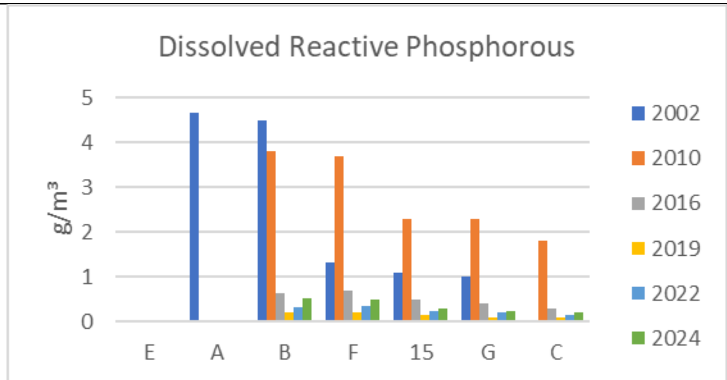


		E	A	B	F	15	G	C
Dissolved Inorganic Nitrogen (g/m³)	**2002**	0.09	3.47	2.98	0.87	0.91	1.1	0.2
	2010	0.148	0.086	2.1	1.92	1.11	0.87	0.32
	2016	0.179	0.044	0.88	0.96	0.73	0.53	0.41
	2019	0.24	0.133	0.8	0.92	0.76	0.55	0.43
	2022	0.161	0.119	2.5	2.6	2.2	1.73	1.91
	2024	0.128	0.13	2.7	2.7	1.75	1.53	1.5
Total Phosphorous (g/m³)	**2002**	0.019	4.66	4.89	1.41	1.22	1.04	0.051
	2010	0.058	0.025	4	3.9	2.3	2.3	1.77
	2016	0.04	0.037	0.74	0.74	0.55	0.46	0.35
	2019	0.036	0.026	0.38	0.34	0.24	0.164	0.144
	2022	0.041	0.031	0.49	0.44	0.33	0.28	0.2
	2024	0.04	0.029	0.69	0.61	0.45	0.32	0.28
Dissolved Reactive Phosphorous (g/m³)	**2002**	0.017	4.67	4.48	1.32	1.1	0.992	0.039
	2010	0.04	0.013	3.8	3.7	2.3	2.3	1.79
	2016	0.029	0.008	0.64	0.68	0.48	0.4	0.28
	2019	0.008	0.007	0.192	0.21	0.149	0.091	0.077
	2022	0.02	0.013	0.33	0.34	0.23	0.21	0.146
	2024	0.015	0.005	0.51	0.48	0.29	0.24	0.2

Corresponding graph

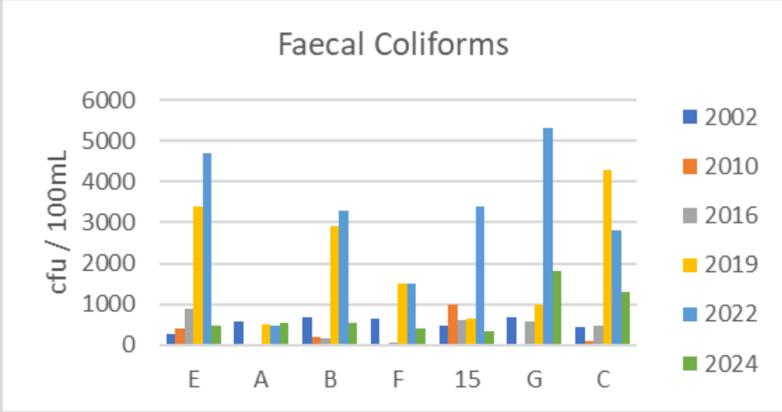


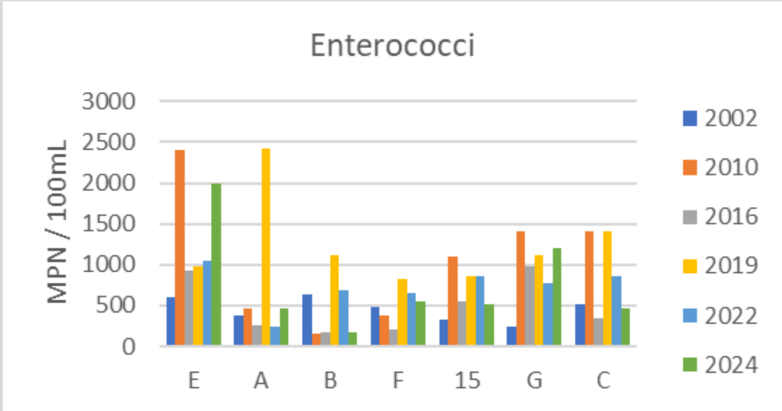




		E	A	B	F	15	G	C
Faecal Coliforms (cfu / 100mL)	**2002**	280	570	670	650	480	680	430
	2010	410	12	210	24	1000	39	100
	2016	900	22	150	70	600	590	470
	2019	3,400	510	2,900	1,500	660	1,000	4,300
	2022	4,700	490	3,300	1,500	3,400	5,300	2,800
	2024	460	560	540	410	340	1,800	1,300
Enterococci (MPN / 100mL)	**2002**	600	380	630	480	320	240	520
	2010	2400	460	150	370	1100	1400	1400
	2016	921	260	172	214	548	980	345
	2019	985	2,420	1,120	816	866	1,120	1,414
	2022	1,046	236	687	649	866	770	866
	2024	1,986	461	166	549	517	1,203	461

Corresponding graph

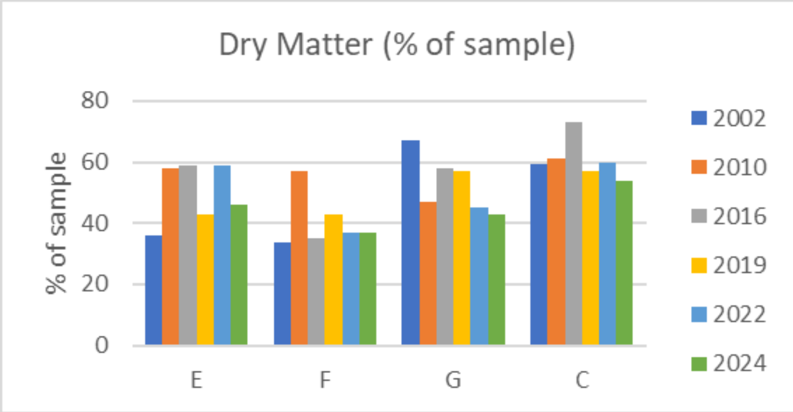


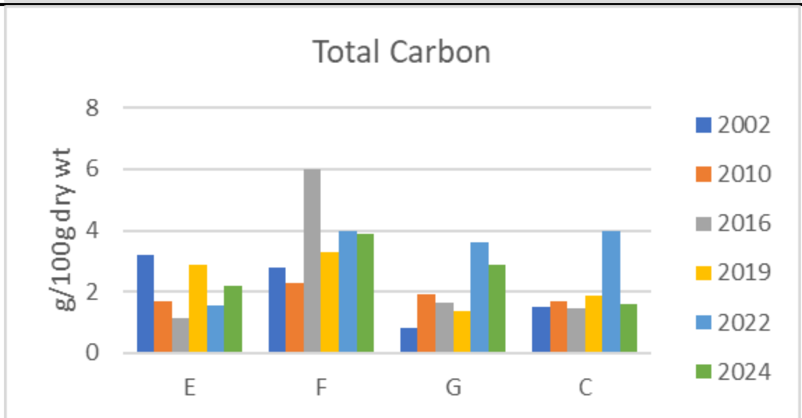


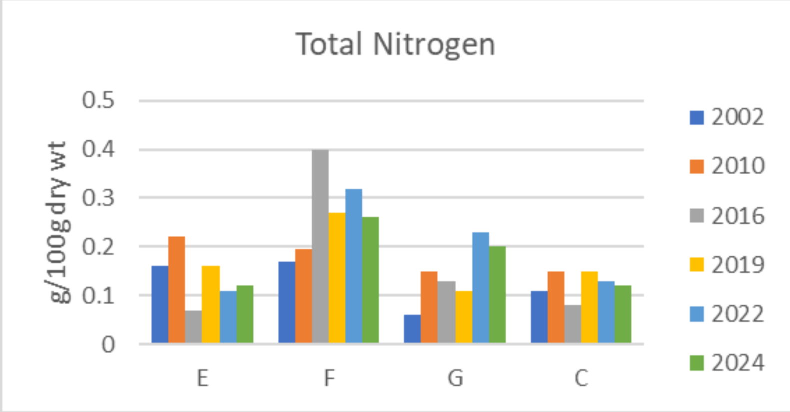
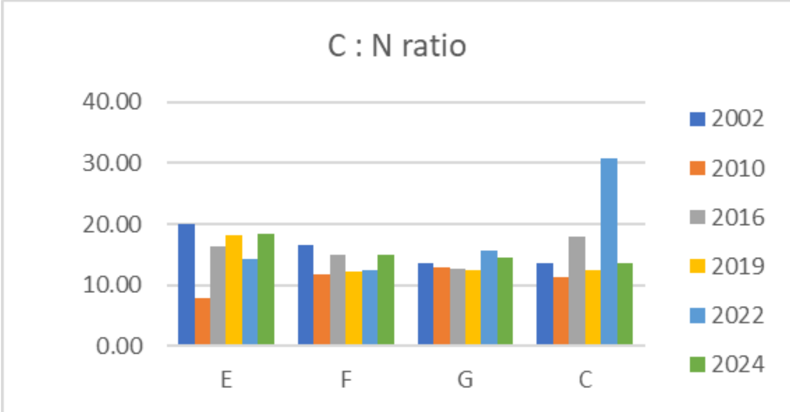
6.2 Sediment Quality

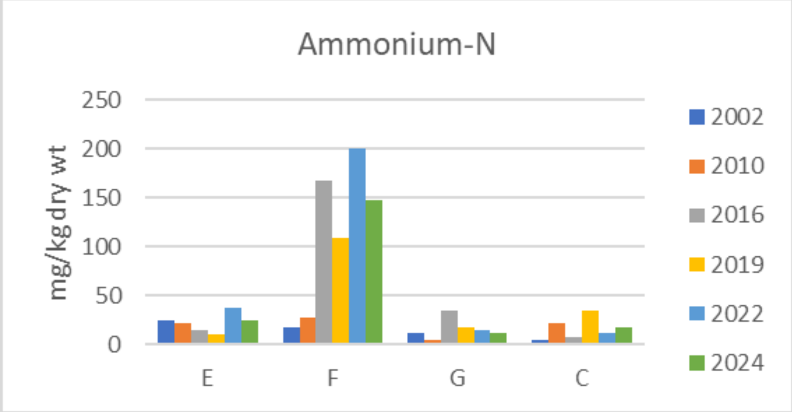
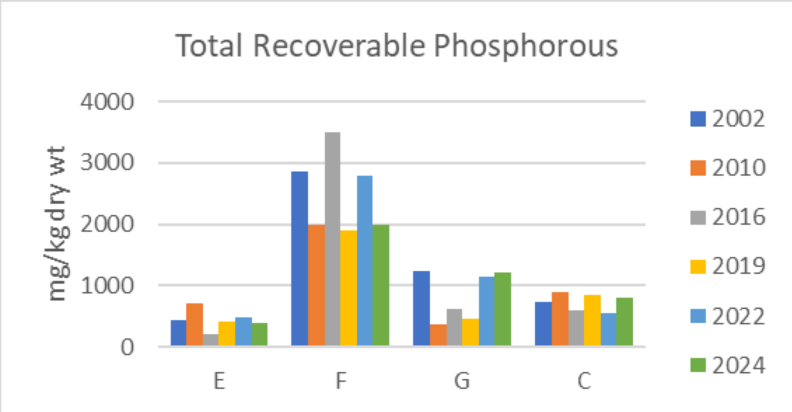
		E	F	G	C
Dry Matter (% of sample)	2002	35.9	33.9	66.9	59.1
	2010	58	57	47	61
	2016	59	35	58	73
	2019	43	43	57	57
	2022	59	37	45	60
	2024	46	37	43	54
Total Carbon (g/100g dry wt)	2002	3.184	2.805	0.822	1.496
	2010	1.71	2.3	1.93	1.71
	2016	1.14	6	1.65	1.44
	2019	2.9	3.3	1.36	1.86
	2022	1.56	4	3.6	4
	2024	2.2	3.9	2.9	1.62

Corresponding graph

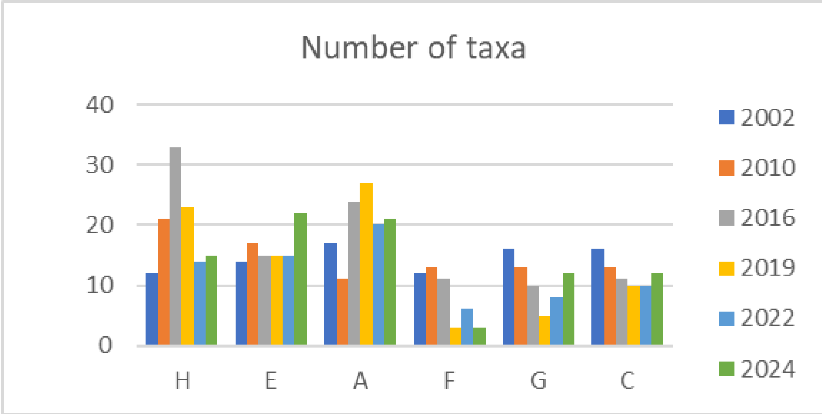
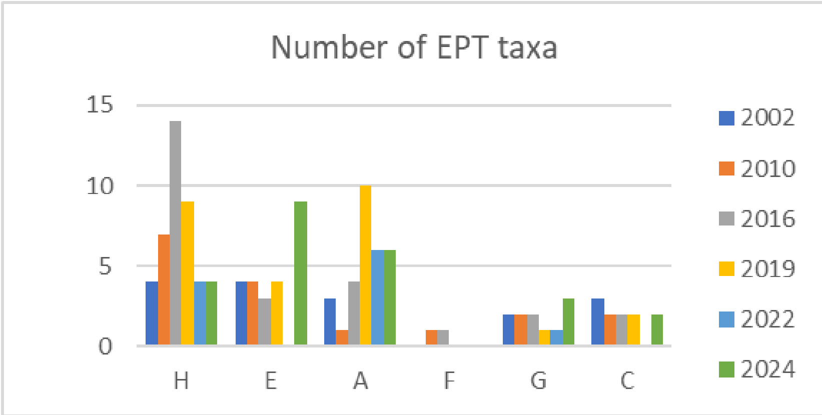


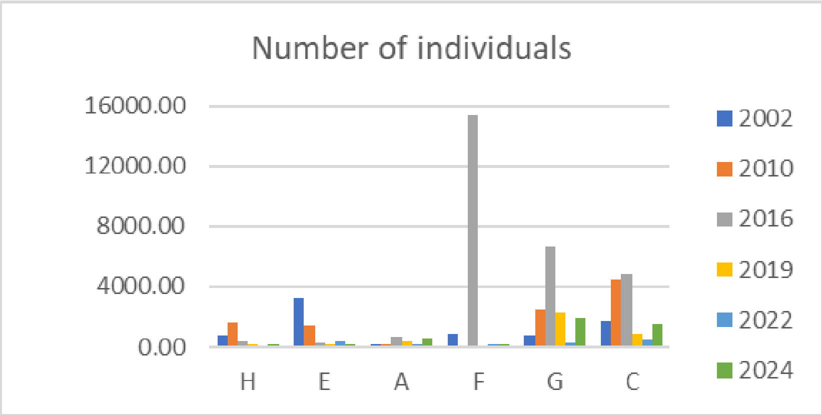
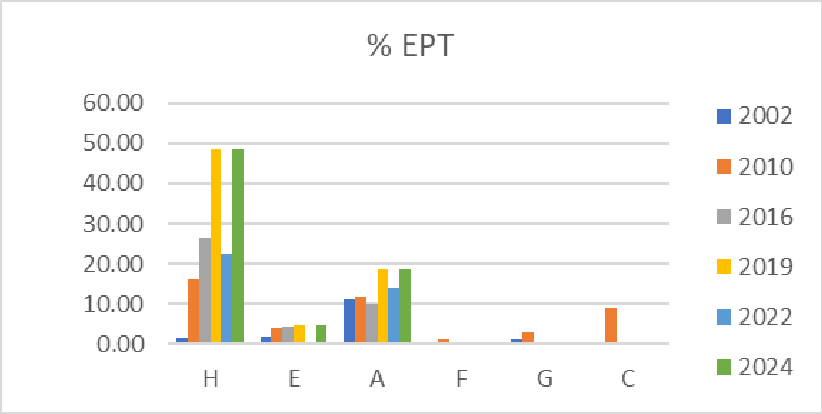


		E	F	G	C	Corresponding graph
Total Nitrogen (g/100g dry wt)	2002	0.16	0.17	0.06	0.11	
	2010	0.22	0.196	0.149	0.15	
	2016	0.07	0.4	0.13	0.08	
	2019	0.16	0.27	0.11	0.15	
	2022	0.11	0.32	0.23	0.13	
	2024	0.12	0.26	0.2	0.12	
C : N ratio	2002	19.90	16.50	13.70	13.60	
	2010	7.77	11.73	12.95	11.40	
	2016	16.29	15.00	12.69	18.00	
	2019	18.13	12.22	12.36	12.40	
	2022	14.18	12.50	15.65	30.77	
	2024	18.33	15.00	14.50	13.50	

		E	F	G	C	Corresponding graph
Ammonium-N (mg/kg dry wt)	**2002**	25	17	11	5	
	2010	22	28	5	22	
	2016	15	168	35	7	
	2019	10	109	17	34	
	2022	38	200	15	12	
	2024	24	148	11	18	
Total Recoverable Phosphorous (mg/kg dry wt)	**2002**	440	2860	1230	730	
	2010	700	2000	370	880	
	2016	194	3500	620	590	
	2019	400	1890	450	850	
	2022	480	2800	1150	540	
	2024	380	2000	1210	800	

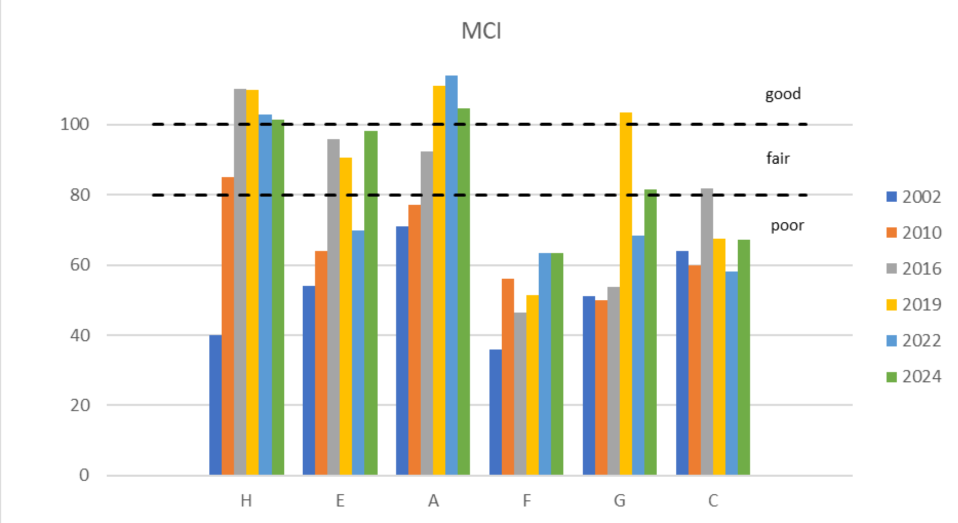
6.3 Macroinvertebrates

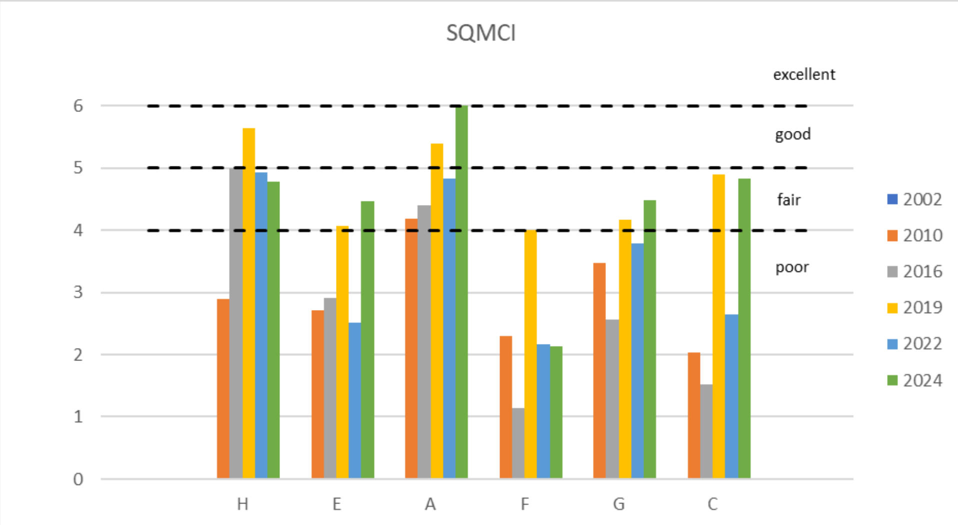
		H	E	A	F	G	C	Corresponding Grah
NO. TAXA	2002	12	14	17	12	16	16	
	2010	21	17	11	13	13	13	
	2016	33	15	24	11	10	11	
	2019	23	15	27	3	5	10	
	2022	14	15	20	6	8	10	
	2024	15	22	21	3	12	12	
NO. EPT TAXA	2002	4	4	3	0	2	3	
	2010	7	4	1	1	2	2	
	2016	14	3	4	1	2	2	
	2019	9	4	10	0	1	2	
	2022	4	0	6	0	1	0	
	2024	4	9	6	0	3	2	

		H	E	A	F	G	C	Corresponding Grah
NO. INDIVIDUALS	2002	748	3256	217	876	745	1747	
	2010	1636	1460	180	129	2500	4508	
	2016	384	294	669	15418	6675	4869	
	2019	192	147	412	103	2265	832	
	2022	49	360	181	199	316	451	
	2024	149	225	525	183	1911	1534	
% EPT	2002	1.50	1.70	11.10	0.00	1.30	0.02	
	2010	16.00	4.00	12.00	1.00	3.00	9.00	
	2016	26.56	4.42	10.16	0.00	0.00	0.02	
	2019	48.44	4.76	18.45	0.00	0.04	0.36	
	2022	22.45	0.00	13.81	0.00	0.32	0.00	
	2024	48.44	4.76	18.45	0.00	0.04	0.36	

		H	E	A	F	G	C
MCI	2002	40.00	54.00	71.00	36.00	51.00	64.00
	2010	85.00	64.00	77.00	56.00	50.00	60.00
	2016	110.30	95.73	92.42	46.36	53.80	81.82
	2019	110.00	90.53	111.19	51.33	103.60	67.40
	2022	102.86	69.73	113.90	63.33	68.25	58.20
	2024	101.33	98.18	104.67	63.33	81.67	67.33
SQMCI	2002	0	0	0	0	0	0
	2010	2.89	2.71	4.18	2.29	3.48	2.04
	2016	5.00	2.91	4.40	1.15	2.57	1.52
	2019	5.64	4.06	5.39	4.00	4.17	4.89
	2022	4.93	2.51	4.83	2.16	3.78	2.65
	2024	4.78	4.46	6.01	2.13	4.49	4.83

Corresponding Grah





ATTACHMENT 13

ASSESSMENT OF EFFECTS ON TE PURU STREAM HABITAT
18 APR 24

TO:	Watercare Services Limited	Date:	18 April 2024
FROM:	Laura Drummond	Job No:	67064

TE PURU STREAM WWTP DISCHARGE ASSESSMENT OF EFFECTS ON STREAM HABITAT

Bioresearches were engaged by Watercare Services Limited (**WSL**) to undertake an ecological assessment of the effects of discharging up to 6,000 m^3 per day of treated wastewater to the Te Puru Stream. WSL currently discharges treated wastewater from a trickle system, through a vegetated area to a farm pond that then discharges to a permanent tributary of the Te Puru Stream at a daily volume of 2,000 m^3. WSL is proposing to increase this daily volume to 6,000 m^3.

This memorandum describes the current ecological condition of the Te Puru Stream Tributary throughout six "impact" sites and one control site (Figure 1), associated with the Biological Monitoring programme (Bioresearches, 2024[1]). It then assesses the potential effects on stream habitats of the proposed of up to 6,000 m^3 per day on those stream sites by reference to the control site, and monitoring data from sites downstream of the existing discharge. For the avoidance of doubt, this assessment of effects does not assume effects from the existing treated wastewater discharge of 2,000 m^3 per day from part of the existing environment.

[1] Bioresearches (2024). Water Quality and Biological Assessment, Te Puru Stream Tributary, Maraetai. Report for Watercare Services Limited. pp 68

Figure 1. Map of the Te Puru Stream Tributary and the associated monitoring sites references within this memorandum.

Methodology

A site assessment was undertaken over the 31st January to 2nd February, 2024, throughout six impact sites (Site F, 15, S2, G, S3 and C) and one control site (Site E) within a permanent tributary to the Te Puru Stream, in association with the biotic monitoring programme[1]. The impact sites referenced within this memorandum, are located downstream of the discharge point. The control site is located within a separate tributary and upstream of the discharge point.

During the site assessment, stream characteristics were recorded, including water quality, width, depth, flow velocity, instream macrophytes and periphyton. General notes regarding substrates, deposited sediments, stream bank condition riparian yard condition and were taken.

Ecological Impact Assessment Methodology

Guidelines for undertaking Ecological Impact Assessments have been published by the Environmental Institute of Australia and New Zealand (EIANZ; Roper-Lindsay *et al.*, 2018). Chapter 5 of the Guidelines provides criteria for assigning value to habitat for assessment purposes. Ecological values have been assigned based on Table 1, adapted from Tables 5 and 6 of EIANZ 2018 (Appendix 2). Criteria for describing the magnitude of effects are given in Chapter 6 of the EIANZ Guidelines (Table 2.)

The level of effect can then be determined through combining the value of the ecological feature/attribute with the score or rating for magnitude of effect to create a criterion for describing level of effects (Table 3). The cell in italics in Table 3 represent 'significant' effect under the EIANZ 2018 guidelines. Cells with low or very low levels of effects requires careful assessment and analysis of the individual case. For moderate levels of effects or above, measures need to be introduced to avoid through design, or appropriate mitigation needs to be addressed (Roper-Lindsay *et al., 2018).*

Current Stream Conditions

The control site, Site E tributary consisted of a wide (average 2.16 m) and slow flowing stream with an average depth of 0.23 m. The stream banks were relatively incised and vertical and may not be inundated during regular flood flows. Substrates throughout Site E were predominantly comprised of silt and cobbles; and the hydrological heterogeneity relatively low, mainly consisting of run habitat with some small riffles upstream. Riparian vegetation was poor and consisted of herbaceous ground-cover with occasional exotic and native woody vegetation. However, due to the surrounding topography, shade was considered to be moderate.

The Te Puru Stream Tributary was considered to be of **moderate** ecological value.

The Te Puru Stream Tributary was wide, with an average width of 2.16 m (1.82 m – 2.69 m), and an average depth of 0.25m (0.12 m – 0.51 m), generally flowing within incised, vertical banks. Substrates were made up of silt with cobble and gravels. High silt proportions were recorded at effect sites downstream of the discharge pond, generally decreasing with distance from the discharge and gravels becoming more abundant. However, sediment plumes were present when the substrate was disturbed. Fish habitat/cover types observed during the survey comprised macrophytes, instream debris (e.g. wood), undercut banks and bankside vegetation. Hydrological variation throughout the tributary was considered to be moderate, with slow runs, fast runs, pools and riffle habitat present throughout the entire length.

Riparian vegetation throughout the Te Puru Tributary was variable, with the upstream reaches consisting of mixed exotic and native vegetation which transitioned to pastoral land and exotic trees towards the downstream reach. Due to this variability, riparian yard functions, particularly bank stability and shade were variable, with the lower reaches containing no significant riparian yard and evidence of bank erosion.


Photo 1 and Photo 2. Control Site E

Photo 3. Site F

Photo 4. Site 15

Photo 5. Site S2

Photo 6. Site G

Photo 7. Site S3

Photo 8. Site C

Potential Effects

This part of the memorandum assess the potential ecological effects of the proposed discharge of up to 6,000 m^3 per day of treated wastewater.

Water Quality Effects

As regards water quality, the proposed discharge of up to 6,000 m^3 of treated wastewater per day is expected to have a low magnitude of effect on the Te Puru tributary. In this respect, it is noted that while the volume of the discharge will increase, the quality of wastewater discharged is expected to improve reducing the concentrations of Total Nitrogen and nitrate-N. As discussed in *Water Quality and Biological Assessment, Te Puru Stream Tributary Maraetai 2024*, water quality parameters such as temperature, nitrogen species[2] and phosphorus species[3] experienced a spike immediately following discharge from the pond and decreased as water flows downstream. Conductivity was elevated and dissolved oxygen was low throughout the entire Te Puru Stream Tributary and the Control Site. By contrast, faecal coliforms and enterococci were higher at the most downstream sites (Site G and Site C) and the control site, than the sites closest to the discharge point. The surrounding pastoral and agricultural land use practices contribute to the enriched waters of the Te Puru Stream Tributary, and enrichment was not solely from the discharge of treated wastewater. As such, the quality of water associated with the discharge of 6,000 m^3 of treated wastewater to the Te Puru tributary and stream is expected to have a very level of effect.

[2] Total Nitrogen, Total Ammoniacal Nitrogen, Nitrate-N, Nitrite-N, Total Kjeldahl Nitrogen, Dissolved Inorganic Nitrogen.

[3] Total Phosphorus, Dissolved Reactive Phosphorus

Water Quantity Effects

The Control site, Site E, is of similar bank width and depth to the stream reaches downstream of the discharge point, however flow on average was between 5 L/s to 61 L/s slower. The volume of water discharged from the farm pond forms a significant proportion of the stream flow for the Te Puru Stream Tributary. The proposed discharge volume of 6,000 m^3 per day equates to an additional 0.067 m^3 per second or an additional 67 L/s under normal flow conditions (not allowing for attenuation or retention), and is considered to be of low magnitude. During the wetter seasons and rain events, the stream flow velocities will be higher with stream velocity calculations undertaken by Pattle Delamore Partners[4] (**PDP**) showing stream velocities at Site 15 to currently be 0.7 m/s during typical (90th percentile) rain events, with these modelled velocities increasing to 0.8 m/s following the increase in discharge. The most significant effect of the increase in discharge volume on the Te Puru Tributary is the potential for increases in erosion and scour effects, particularly during flood and storm events.

The proposed discharge of up to 6,000 m^3 per day may result in increases in depth and stream velocity. This in turn may result in a decrease in suitable fish habitat preferences, with velocities over 0.5 ms^{-1} and depths above 0.2 m – 0.3 m correlating in a decrease in suitable bully (*Gobiomorphus* sp.) habitat[5]. Bullies were selected for as the exemplar fish, as they have the lowest velocity threshold of the fish species present within the study area. The fastest flowing site within the Te Puru Stream Tributary was Site G, with an average flow velocity of 66 L/s, or 0.066 ms^{-1}. With the propose discharge of 6,000 m^3 per day, Site G is estimated to have an increase in flow velocities to approximately 133 L/s or 0.133 ms^{-1}, well below the 0.5 ms^{-1} threshold for bully habitat preference. The proposed daily discharge volume will be a minor shift in ecological baseline values, resulting in a low magnitude of effects and should not result in flow velocities throughout the tributary being permanently affected and result in a reduction of native fish habitat.

The increase in volume of water moving through the Te Puru tributary as a result of the discharge of 6,000 m^3 of treated wastewater per day is expected to have a low-level of effect on the aquatic ecosystem.

PDP assessments on bed and bank erosion show the majority of erosion will occur during storm events, and will be largely localised to meanders within the tributary. To minimise this potential erosion and scour during flood events, it is recommended infill riparian planting with deep rooting vegetation is undertaken within these more vulnerable meandering reaches. Recent work by Auckland Council[6] has shown cabbage

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[4] Pattle Delamore Partners Limite (2024). Beachlands Maraetai WWTP Resource Consent Renewal: Stream Hydraulic Assessment.

[5] Ian G. Jowett & Jody Richardson (1995) Habitat preferences of common, riverine New Zealand native fishes and implications for flow management, New Zealand Journal of Marine and Freshwater Research, 29:1, 13-23.

[6] Auckland Council (2023) New Zealand Riparian Species and Streambank Stability. Report by Auckland Council and Stantec. 22pp.

trees / tī kōuka (*Cordyline australis*) to be particularly effect in slope stabilisation, both within slopes and at the toe of slopes, and is recommended to be included within the riparian planting mix. This planting should first be concentrated within the meandering reaches within Watercare property boundaries. Further planting on the downstream reach will required to be discussed with the private property owners.

Summary

WSL is proposing to discharge up to 6,000 m³ per day of treated wastewater, to a permanent tributary of the Te Puru Stream. Currently, the tributary consists of a wide and slow stream with incised and scoured banks and poor condition riparian yard. The proposed discharge is expected to have a very low magnitude of effect on stream bank conditions, and native fauna habitats through the tributary under normal flow conditions, resulting in a very low level of effect. The proposed treated wastewater discharge will be of a higher quality than the present discharge, with reduced concentrations of Nitrogen species compared to current levels expected to occur. Increased velocities, and therefore the potential for scour and erosion, are likely to occur during high rainfall and flood events. To minimise the degree of erosion and scour to the Te Puru Stream Tributary, it is recommended in-fill and enhancement planting, for the purpose of bank stabilisation, is undertaken throughout meanders within Watercare property boundaries.

Regards,

Laura Drummond, M.Sc. (Hons), MEIANZ
Coastal & Freshwater Ecologist
T +64 9 379 9417 | **M** +64 27 254 9685 |
Babbage Consultants Limited

Appendix 1. Stream characteristic summary table. Adapted from the Water Quality and Biological Monitoring report[1].

	Control Site	Te Puru Stream Tributary					
Site	**E**	**F**	**15**	**S2**	**G**	**S3**	**C**
Date	31 January 2024	31 January 2024	Not assessed	31 January 2024	31 January 2024	31 January 2024	31 January 2024
Average Width (m)	2.16	2.36		2.36	2.17	2.69	1.82
Average Depth (m)	0.23	0.12		0.12	0.25	0.51	0.27
Flow (L/s)	10.24	15.8		31.73	66.39	22.62	40.49
Dominant substrate	Silt and cobble	Thick layer of fine organic material and silt, cobble		Bedrock, cobble	Silt, cobble and gravel	Silt, cobble and gravel	Silt, cobble and gravel
Fish Cover	Macrophytes, instream debris, undercut banks, bank vegetation	Macrophytes, instream debris, bank vegetation		Instream debris, bank vegetation	Macrophytes, instream debris, bank vegetation	Instream debris, bank vegetation, undercut banks	Macrophytes, instream debris, undercut banks, bank vegetation
No. of species	3	1		Not assessed	3	Not assessed	4
No. of fish	19	1			25		14
Fish IBI	26 - Poor	14 – Very Poor			26 - Poor		26 - Poor
Species recorded	Common bully, unidentified eel, koura	Unidentified eel			Mosquito fish, common bully, longfin eel		Common bully, mosquito fish, longfin eel, unidentified eel

Appendix 2. EIANZ methodology rubric

Table 1. Criteria for assigning value to habitat/species for assessment.

Value	Determining Factors
Very High	Nationally Threatened species found in the 'zone of influence' (ZOI) either permanently or seasonally. Area rates 'High' for at least three of the assessment matters of Representativeness, Rarity/distinctiveness, Diversity and Pattern, and Ecological Context. Likely to be nationally important and recognised as such.
High	Species listed as At Risk – Declining found in the ZOI either permanently or seasonally. Area rates 'High' for two of the assessment matters, and 'Moderate' and 'Low' for the remainder OR area rates 'High' for one of the assessment matters and 'Moderate' for the remainder. Likely to be regionally significant and recognised as such.
Moderate	Species listed as At Risk – Relict, Naturally Uncommon, Recovering found in the ZOI either permanently or seasonally. Locally uncommon or distinctive species. Area rates 'High' for one of the assessment matters, 'Moderate' or 'Low' for the remainder OR area rates as 'Moderate' for at least two of the assessment matters and 'Low' or 'Very Low' for the remainder. Likely to be important at the level of the Ecological District.
Low	Nationally and locally common indigenous species. Area rates 'Low' or 'Very Low' for majority of assessment matters, and 'Moderate' for one. Limited ecological value other than as local habitat for tolerant native species.
Negligible	Exotic species including pests, species having recreational value. Area rates 'Very Low' for three assessment matters and 'Moderate', 'Low' or 'Very Low' for the remainder.

Table 2. Criteria for describing the magnitude of effects (EIANZ 2018)

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

Table 3. Criteria for describing the level of effects (EIANZ 2018). Where text is italicised it indicates 'significant effects' where mitigation is required.

Magnitude of Effect	Ecological Value				
	Very High	High	Moderate	Low	Negligible
Very High	*Very High*	*Very High*	*High*	*Moderate*	Low
High	*Very High*	*Very High*	*Moderate*	Low	Very Low
Moderate	*High*	*High*	*Moderate*	Low	Very Low
Low	*Moderate*	Low	Low	Very Low	Very Low
Negligible	Low	Very Low	Very Low	Very Low	Very Low
Positive	Net Gain	Net Gain	Net Gain	Net Gain	Net Gain

APPLICABILITY AND LIMITATIONS

Restrictions of Intended Purpose

This report has been prepared solely for the benefit of WSL as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such party's sole risk.

Legal Interpretation

Opinions and judgements expressed herein are based on our understanding and interpretation of current regulatory standards, and should not be construed as legal opinions. Where opinions or judgements are to be relied on they should be independently verified with appropriate legal advice.

Maps and Images

All maps, plans, and figures included in this report are indicative only and are not to be used or interpreted as engineering drafts. Do not scale any of the maps, plans or figures in this report. Any information shown here on maps, plans and figures should be independently verified on site before taking any action. Sources for map and plan compositions include LINZ Data and Map Services and local council GIS services. For further details regarding any maps, plans or figures in this report, please contact Babbage Consultants Limited.

Reliability of Investigation

Babbage has performed the services for this project in accordance with the standard agreement for consulting services and current professional standards for environmental site assessment. No guarantees are either expressed or implied.

Recommendations and opinions in this report are based on discrete sampling data. The nature and continuity of matrix sampled away from the sampling points are inferred and it must be appreciated that actual conditions could vary from the assumed model.

There is no investigation that is thorough enough to preclude the presence of materials at the site that presently, or in the future, may be considered hazardous. Because regulatory evaluation criteria are constantly changing, concentrations of contaminants present and considered to be acceptable may in the future become subject to different regulatory standards, which cause them to become unacceptable and require further remediation for this site to be suitable for the existing or proposed land use activities.

ATTACHMENT 14

STAKEHOLDER ENGAGEMENT REPORT
12 JUN 24

Beachlands WWTP – Wastewater Discharge Consent Project

Stakeholder Engagement Report

12 June 2024

Watercare

TABLE OF CONTENTS

FIGURES

TABLES

1 INTRODUCTION

Watercare Services Limited ("**Watercare**") is responsible for the provision of potable (drinking) water and wastewater services in Auckland. Watercare is a Council-Controlled Organisation of the Auckland Council. The company's vision is to be "trusted by our communities to deliver exceptional performance every day".

Watercare is continually reviewing its activities and identifying maintenance, replacement, upgrading and new infrastructure projects to ensure it meets customer's needs, business objectives, statutory requirements, and growth projections.

In this context, Watercare proposes to facilitate the growth of the Beachlands and Maraetai communities through the upgrade of the Beachlands Wastewater Treatment Plant ("**WWTP**"), subsequently requiring an increase in the discharge of treated wastewater. To do so, Watercare needs to determine the most appropriate wastewater treatment and discharge solution for the service area and seeks resource consent and other approvals to provide for the Beachlands WWTP upgrade and service the projected growth of the Beachlands and Maraetai communities.

Over the past seven months (October 2023 – April 2024), a comprehensive consultation exercise has taken place to inform and seek feedback from Ngāi Tai ki Tāmaki (as Mana Whenua), key stakeholders, and members of the community to determine the Best Practicable Option ("**BPO**") for the treated wastewater discharge from the Beachlands WWTP. Thirty two different discharge options were initially considered. Through a series of technical workshops, these options were refined to five Short-Listed options with a diffuse discharge to the Te Puru Stream being selected as the BPO for the discharge of treated wastewater discharge from the Beachlands WWTP.

Engagement with Ngāi Tai ki Tāmaki, the iwi who hold mana whenua status over the Beachlands-Maraetai are, including Te Puru Stream and its tributaries, a, has been integral in the process to develop the resource consent application. Watercare is committed to ongoing and meaningful engagement with Ngāi Tai ki Tāmaki throughout the application process and, where granted, the detailed design process and the implementation and operation of any resource consents for the Beachlands WWTP.

Watercare organised two community information sessions, with local residents and interested parties attending over the two sessions in October and December 2023. To endeavour to engage the entirety of the Beachlands and Maraetai communities, direct emails were sent from a database of 2660 community email addresses, including follow up emails, inviting residents to attend. The information sessions were also advertised within the Pohutukawa Coastal newspaper, posts on the Pohutukawa Coastal Grapevine and Maraetai Group social media pages, and letters sent directly to the landowners potentially affected by one of the Short-List options.

Following confirmation of the BPO, Watercare emailed to those parties who registered to be kept updated on the project via the Watercare Beachlands WWTP email.

This report provides a summary of the engagement activities with the Local Board, mana whenua, key stakeholders and the wider community. The outcomes of these engagement activities are set out in the Appendices.

Watercare will continue to engage with Ngāi Tai ki Tamaki and key stakeholders post lodgement – records will be maintained through the Engagement Register.

1.1 Purpose of this Report

This Stakeholder Engagement Report provides a summary of the stakeholders involved, the engagement activities and the feedback received through the consultation and engagement process undertaken to support the reconsenting of the Beachlands WWTP operations including the discharge of treated wastewater from the WWTP.

While not a specific requirement under the Resource Management Act 1991 ("**RMA**"), Watercare recognises that consultation and engagement is an important way to inform and involve Mana Whenua, stakeholders and the community in a project, help identify effects on the environment and parties, and provide a process for developing appropriate mitigation and management measures.

Stakeholder engagement on major projects is also strongly supported by Watercare's Statement of Intent 2023 – 2026 ("**SOI**"), prepared in accordance with Section 64 and Schedule 8 of the Local Government Act 2002. The SOI outlines the company's strategic direction, activities, intentions and objectives. It reflects Watercare's commitment to engage with mana whenua and affected and interested parties in an open manner to address concerns of those parties where feasible.

1.2 Project Objectives

The Project Objectives have been specifically developed for the Beachlands WWTP project and have been used to inform the development of the criteria for assessing the potential discharge options for treated wastewater from the WWTP and assist in identifying the Preferred Option.

The Project Objectives include to work in partnership with the Ngāi Tai ki Tāmaki (as Mana Whenua) and engage with stakeholders and the community to identify the BPO to provide wastewater services for the Beachlands and Maraetai community. The BPO must:

- Recognise the significance of the Hauraki Gulf and the historic, traditional, cultural, and spiritual relationship of tangata whenua with the Hauraki Gulf and its islands[1].
- Give effect to Te Mana o te Wai[2].
- Keep our communities healthy.
- Protect the health of our environment, particularly the life supporting capacity of land, air, and water.
- Provide a solution that caters for planned growth that keeps the overall costs of service to customers (collectively) at sustainable levels.
- Be sustainable and resilient and minimise whole-of-life carbon emissions and optimise resource recovery[3].

[1] Section 3 (Purpose) of the Hauraki Gulf Marine Park Act
[2] Policy 1 NPS-FM, Water Services Act
[3] Watercare initiated their '40/20/20' vision for their capital works programme (reduce infrastructure carbon by 40 per cent, reduce cost by 20 per cent and have a 20 per cent year-on-year improvement in health and safety outcomes). This bullet recognises the carbon component of 40/20/20.

1.3 Project Timeframe & Stages

Engagement with mana whenua, stakeholders and the public was undertaken over three stages of the project to inform the BPO selection:

1. Long long-list assessment;
2. Long-list assessment; and
3. Short-list assessment

Figure 1 below and the following provides a summary of the Options Process (refer to the BPO Report provided as part of the Application Package for a full summary of the process):

1. The Long Long-List assessment, which identified 20 potential management options for the treated wastewater discharge, and involved a Fatal Flaw Assessment conducted by Watercare to identify options with clear significant defects, which were then removed from further consideration. During this stage Watercare met with and emailed Ngāi Tai ki Tāmaki Governance to provide overview of option selection process and timeline.
2. A Traffic Light Assessment which 'scored' the surviving long list options against various criteria, and a "BPO Test No.1" which compared the preliminary Short-List against the BPO definition, project objectives and relevant policy. Consultation with the community was undertaken for this stage, which included a Community Information Session and an Online Survey, to help determine which criteria the community most valued, to help determine how much weight each criterion was given within the Traffic Light Assessment. The Community Information Session and Online Survey provided the opportunity for the community to identify potential alternative management options, concerns, and initial preferences of management options.
3. The Short-List assessment then involved a Comparative Assessment, Multi Criteria Analysis ("MCA"), and "BPO Test No.2" which compared the best scoring option from the MCA against the BPO definition, project objectives and relevant policy. Consultation with the community was undertaken at this stage through Community Information Session 2, in which attendees and those on the emailing list could voice comments and questions, and vote on their most and least preferred options. Landowners directly affected by one of the short-listed options were directly sent a letter informing them about the implications of this option and informing them about the Community Information Session where this could be discussed at length.

On 1 March 2024, Option 2a being a diffuse discharge via an overland flow system to a tributary of Te Puru Stream, was chosen as the technical Preferred Option for the discharge of treated wastewater from the Beachlands WWTP scheme. Ngāi Tai ki Tāmaki and interested stakeholders were immediately informed of the chosen technical Preferred Option.

The engagement / consultation process with Ngāi Tai ki Tāmaki, stakeholders and interested parties is an ongoing one that will continue as the application progresses through the relevant RMA statutory phases.

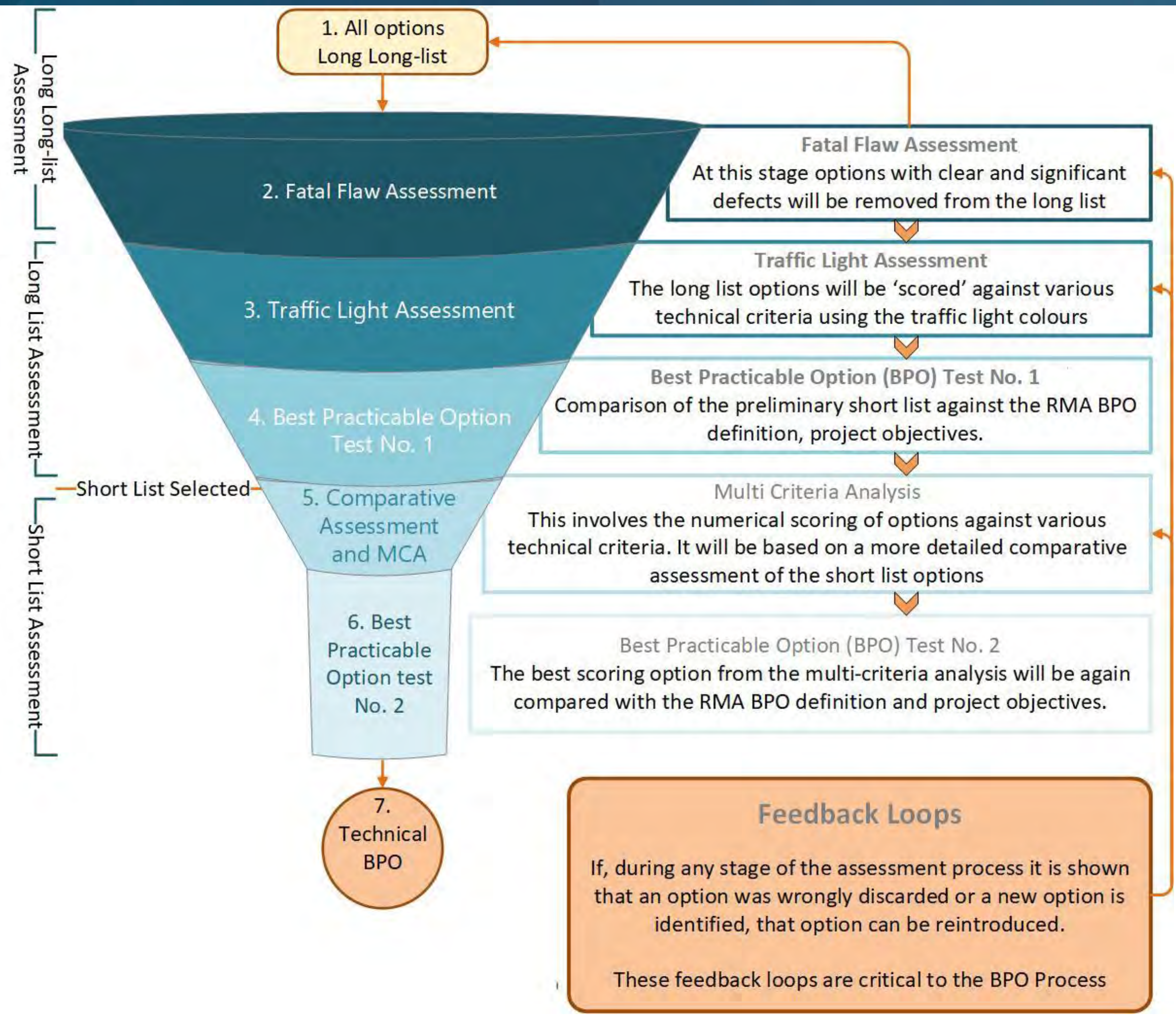


Figure 1. Beachlands Options Process.

2 ENGAGEMENT STRATEGY

The overall purpose of the engagement strategy has been, and continues to be, to ensure that the project objectives (Refer to Section 1.2) are achieved.

This purpose has been supported through the various types of engagement undertaken with Ngāi Tai ki Tāmaki as Mana Whenua, relevant stakeholders, those potentially affected by the project on the options being considered for the reconsenting of the discharges from the Beachlands WWTP and the public.

2.1 Types of engagement

There are different types of engagement between Watercare, mana whenua, stakeholders and the public, each serving a different purpose:

- **Inform** – Purpose is to provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions. Promise to the stakeholder 'We will keep you informed'.

- **Consult** – Purpose is to obtain public feedback on analysis, alternatives and/or decisions. Promise to the stakeholder 'We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influences the decision. We will seek your feedback on drafts and proposals'.

- **Involve** – Purpose is to work directly with the public throughout the process to ensure the public concerns and aspirations are consistently understood and considered. Promise to the stakeholder 'We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision'.

- **Collaborate** – Purpose is to partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution. Promise to the stakeholder 'We will work together with you to formulate solutions and incorporate your advice and recommendations into the decision to the maximum extent possible'.

2.2 Resource Management Act 1991

The consultation process outlined in this document will contribute to the development of the project and will support the requirements of the RMA.

The RMA states that an Assessment of Effects on the Environment submitted in support of a resource consent application should include an identification of the persons affected by the proposal, the consultation undertaken, if and any response to the views of persons consulted (Schedule 4 RMA).

Section 36A of the RMA clarifies that consultation is not mandatory by either an applicant or the local authority with respect to a resource consent application. However, best practice would normally incorporate consultation within project development and pre-application stages, particularly for large projects such as the Beachlands WWTP project.

The RMA provides for consultation with tangata whenua under sections 6(e), 7(a) and 8. Section 6(e) requires an applicant to recognise and provide for the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga. Section 7(a) requires an applicant to have particular regard to kaitiakitanga. Section 8 requires an applicant to take into account the principles of the Treaty of Waitangi.

3 STAKEHOLDER ENGAGEMENT

Table 1 below identifies project stakeholders and their level of engagement throughout the duration of the project.

Table 1: Beachlands WWTP – Wastewater Discharge Consent Stakeholders and Type of Engagement

Individual and Group	**Level of Engagement**			
	Inform Engagement Commitment: *'We will keep you informed'.*	**Consult** Engagement Commitment: *'We will keep you informed, listen to, and acknowledge concerns and aspirations, and provide feedback on how public input influences the decision. We will seek your feedback on drafts and proposals'.*	**Involve** Engagement Commitment: *'We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision'.*	**Collaborate** Engagement Commitment: *'We will work together with you to formulate solutions and incorporate your advice and recommendations into the decision to the maximum extent possible.'*
Mana Whenua	✓	✓	✓	✓
Local Board	✓	✓		
Landowners	✓		✓	
Media	✓			
Residents	✓	✓		
Wider Community	✓	✓		
Watercare internal staff and project team members	✓	✓	✓	✓

3.1 Stages of Project and Engagement Required

Table 2 below identifies the stages of project engagement required with relevant stakeholders.

Table 2: Stages of Project Engagement

Project Stage	Stakeholder	Communication	Timing
Long long-list assessment	Internal Watercare Staff & technical specialists		August 2023
	Ngāi Tai ki Tamaki	Meeting and email with Ngāi Tai ki Tāmaki Governance to provide overview of option selection process and timeline.	September 2023
Long list assessment	Mana Whenua	Project Options posted on the Mana Whenua Kaitiaki Forum.	October 2023
	Wider community	Direct Email to 2660 email addresses in database. Community Information Session 1. Online survey.	October 2023
Short list assessment	Ngāi Tai ki Tāmaki	Representatives present at the two Short List Workshops	November and December 2023
	Wider community	Direct Email to 2660 email addresses on database. Advertisement on Pohutukawa Coast newspaper. Social Media post on Pohutukawa Coast Grapevine and Maraetai Group. Community Information Session 2.	November 2023
	Key Stakeholders	Where offer to meet was accepted, individual meetings held with stakeholders to go through the 5 Short-List options and the options process to date.	November 2023
	Potentially Affected Landowners	Letters sent directly to affected landowners. Community Information Session 2.	November 2023
BPO Preferred Scheme	Potentially affected landowners	Email and letter sent directly to landowners.	March 2024
	Interested parties	Email sent directly to interested parties registered on the contact list.	March 2024
	Wider community	Update Watercare website for the Beachlands project .	March 2024
	Mana Whenua	Direct email to Ngāti Tai ki Tāmaki. Update Mana Whenua Kaitiaki Forum.	February 2024
	Ngāi Tai ki Tāmaki	Mana Whenua preparation of a Cultural Impact/Values Assessment.	Ongoing

Prepare Resource Consent	Potentially affected landowners	N/A as Watercare is the land owner for the WWTP	N/A
	Wider community and stakeholders	Public notification of the consent application. Opportunity to provide a submission on the consent application.	TBC following lodgement

3.2 Ngā Iwi Mana Whenua o Tāmaki Makaurau

Watercare regards their relationship with Ngā Iwi Mana Whenua o Tāmaki Makaurau as a collaborative partnership which recognizes the local iwi or hapū as kaitiaki or guardians of the land.

The Mana Whenua Kaitiaki Forum was established in 2012 to encourage discussion and guidance, and to share views on the management of water and wastewater. The forum's focus has widened to all Watercare projects affecting the strategic interests of mana whenua across the Auckland region. Watercare recognises and has offered each of the mana whenua entities an opportunity to be involved in projects directly outside the forum or working group.

Watercare has kept iwi groups informed of the project through the updates to the Kaitiaki Forum, which includes nominated representatives of all 19 mana whenua groups of the Auckland area. Watercare initially added the project to the Mana Whenua Kaitiaki Managers' List in September 2023 under the title "*Beachlands Wastewater Treatment Plant Discharge Renewal*".

Since addition to the list:

- Ngāi Tai ki Tāmaki registered interest in the project in September 2023, a summary of this engagement is set out below. Direct engagement with Ngāi Tai ki Tāmaki is ongoing and will continue beyond the lodgement of the application.
- Ngaati Te Ata Waiohua communicated with Watercare in mid-December 2023 that they wish to be updated on all projects in their rohe. Watercare will continue to update Ngaati te Ata as the project progresses.

In summary, engagement has occurred through the Kaitiaki Forum, and directly with Ngāi Tai ki Tāmaki. Parties will continue to be updated and actively involved in the engagement and consenting process.

3.2.1 Ngāi Tai ki Tāmaki Engagement Summary

During an engagement hui in April 2024, Ngāi Tai ki Tāmaki requested of Watercare to record that Ngāi Tai ki Tāmaki are the iwi taketake (original inhabitants) of the area and Ngāi Tai ki Tāmaki do not recognise or accept any other iwi or hapū Cultural Impact Assessments / Cultural Values Assessments or registration of interest that may be submitted on this kaupapa.

Ngai Tai ki Tāmaki have communicated that they wish to formally respond the application by way of a cultural statement however, this will occur following lodgement of the application. Acknowledging this, to date Ngāti Tai ki Tāmaki have provided informal input on cultural values and potential impacts related to the project/resource consent application via optioneering workshops, site visits and ongoing hui. The engagement with Ngāi Tai ki Tāmaki has been summarised in **Appendix A** and has included:

- **September 2023** - Early hui with Ngāi Tai ki Tāmaki Governance to introduce the project, extend invite to BPO workshops and discuss the proposed Long-Long List options to identify any cultural concerns with those options in the Long-Long List.
- **1 November 2023** - Ngāi Tai ki Tāmaki Taiaomaurikura representative attended a site visit to the WWTP to see the current operations and discuss the future options
- **7 November 2023** –Ngāi Tai ki Tāmaki Taiaomaurikura representative attended the BPO Workshop 3 to discuss the initial findings of the technical assessments of the short-list options.
- **5 December 2023** – Ngāi Tai ki Tāmaki Taiaomaurikura representatives attended the BPO Workshop 4 to discuss the final findings of the technical assessments of the short-list options and work through the technical preferred option; to gain a more detailed understanding of the different shortlisted options to inform future feedback they would be able to provide; and also to inform the technical team of the association, values and interests of Ngāi Tai ki Tāmaki with the affected area and perspectives (in a general sense) on wastewater discharges and treatment options.
- **22 February 2024** - Ngāi Tai ki Tāmaki Taiaomaurikura representatives attended a site visit to the WWTP to see the current operations and discuss the future options. Watercare and Ngāi Tai ki Tāmaki discussed informal commentary from Ngāi Tai ki Tāmaki on opportunities at the site for the expansion of the overland flow area and plantings options and potential opportunity for a water supply to a Ngāi Tai ki Tāmaki nursery project.
- **27 February – 1 March 2024** – Watercare provided Ngāi Tai ki Tāmaki Taiaomaurikura representatives with a draft of the proposed Public Notice Statement on Watercare announcing the technical preferred option to the public. Ngāi Tai ki Tāmaki provided suggested amendments to the statement which Watercare adopted as part of the final version of the Public Notice issued on 1 March 2024.
- **18 March 2024** – Hui with Ngāi Tai ki Tāmaki Taiaomaurikura representatives. Discussions included further options for the discharge of treated wastewater to the increased land application field and planting options through this area. Ngāi Tai ki Tāmaki also identified the desire for a reliable water source for a nursery to be developed on the Waste Management Whitford landfill site. Watercare committed to further investigate the feasibility of the water supply and provide a co-design role in the overland flow system detailed design phase.
- **2 April 2024** - Hui with Ngāi Tai ki Tāmaki Taiaomaurikura representatives. – continuation of the engagement process between Ngāi Tai ki Tāmaki and Watercare to progress discussions on key themes and opportunities related to the project. Discussions included an update on the proposed lodgement timeframe, summary of cultural commentary in the project Engagement Report, update on the preliminary work on the overland flow system, update on the response from ARPH re the use of water for the nursery, and discussed the process for provision of a response to the application.
- **15 April 2024** – Hui with Ngāi Tai ki Tāmaki Taiaomaurikura representatives – Further korero on the 2 April matters. Watercare will continue to have regular hui with Ngāi Tai ki Tāmaki following lodgement of the application. This will include working together to develop a cultural statement on the application.

While no formal feedback has been provided by Ngāi Tai ki Tāmaki, Watercare have understood that the key themes communicated by Ngāi Tai ki Tāmaki include:

- The cultural significance for Ngāi Tai ki Tāmaki of Te Puru Stream, the surrounding whenua and wider cultural landscape and Te Marae-o-Tai / Tāmaki Strait and Tikapa Moana / Hauraki Gulf.
- The historical grievance caused by the lack of engagement with Ngāi Tai ki Tāmaki on the original decision to place the discharge from the WWTP into the tributary of Te Puru Stream and Te Ruangaengae / Ruangaingai Stream (pumpstation location).
- Ngāi Tai ki Tāmaki has a preference for land based discharges of treated wastewater.
- Opposition to conveyance of wastewater out of the Beachlands service area for treatment and discharge in the rohe of another iwi.
- Opposition to a marine discharge and construction of any new structures within the coastal marine area of the Hauraki Gulf.
- Opposition to a direct discharge to Te Puru Stream and other waterways within the Ngāi Tai ki Tāmaki rohe.
- Subject to further investigation and support of the opportunities identified for co-design of the overland flow system and provision of water supply for a proposed nursery, Ngāi Tai ki Tāmaki provided a generally supportive response to the technical preferred option involving diffuse discharge (via overland flow system) to Te Puru Stream.

Watercare has been guided by the above themes in the selection of the BPO for the discharge application.

3.3 Local Board

Watercare, through its dedicated Stakeholder Liaison team, has undertaken direct engagement with central government, Auckland Council and the Franklin Local Board. This engagement has been summarised in the table below.

Date	Name
30.1.2024	Update to Elected Members re: final BPO February 2024
30.1.2024	Update to MP Judith Collins' office re: final BPO February 2024
30.1.2024	Email to Franklin Local Board re: final BPO to be available February 2024
24.11.23	Email from Priyan Perera (Head of Strategy and Planning) & Tanvir Bhamji (Resource Consenting Manager) re Community Information Sessions
23.11.23	Community Information Sessions follow up
21.11.23	Franklin Local Board provided an update re Beachlands land purchase letters to going out to the community, notice on social media and the Watercare webpage for Beachlands discharge consent renewal drop-in session.

13.11.23	Elected Members invited to 22 November Community Information Session
30.10.23	Final draft Beachlands Servicing Strategy & presentation to Franklin Local Board support team
27.10.23	Thanks to MP Judith Collins for attending Community Information Session
27.10.23	Email of Beachlands Servicing Strategy to Franklin Local Board Democracy Advisor
25.10.23	Email requesting attendance confirmation
17.10.23	Elected Member FYI re drop-in sessions at Beachlands
16.10.23	Elected Member update re process and timelines
26.9.23	Email to Elected Member re use of land for the Pony Club and a developer
26.9.23	Update to Franklin Local Board, Councillor & MP Judith Collins
22.9.23	Update from Helen Jansen, Stakeholder Liaison Advisor to the Franklin Local Board
19.9.23	Elected Member asking Tanvir Bhamji to follow up Pony Club question
18.9.23	Update provided to the Franklin Local Board from Tanvir Bhamji
11.9.23	Question from Malcolm Bell (Franklin Local Board) and resolution from business meeting on the Beachlands Servicing Strategy

3.4 Key Stakeholders

A range of stakeholders have been involved in this project , with diverse interests and influence. The level of engagement with these groups varied depending on the stakeholder and their interest. Details of the level of consultation with stakeholders is set out in Table 1 and Table 2 above. Those stakeholders engaged with by Watercare to date are:

- Environmental Defence Society;
- Hauraki Gulf Forum; and
- Auckland Regional Public Health.

Through the process, the project team communicated with local interested individuals, as they became involved during the process. People would either request to be sent information following a newsletter, respond via Watercare's website or would leave their contact details at a Community Information Session. A stakeholder engagement register and a stakeholder contact register is set out in **Appendix A and Appendix B** of this report.

3.5 Potentially Affected Landowners

Ahead of the Community Information Session 2, letters (Refer to **Appendix C**) were couriered and posted directly to 22 potentially affected landowners notifying them of the short-listed options, including that their land would be potentially affected if the final BPO was the land application discharge method. The notice invited parties to attend the Community Information Session 2 and also provided a direct contact person for any queries on the proposed options. Watercare acknowledged that, mailing complications meant some landowners received the letter after the information session was held. Twenty two potentially affected landowners were sent a letter with a number contacting Watercare directly. A summary of the feedback from the potential affected landowners was:

- Concerns over the acquisition of land for the discharge purposes;
- If the preferred option, how would land owners be compensated; and
- Requests to be updated as the BPO decision process progresses.

3.6 Public and Community interests

Community groups, businesses and the wider community were engaged at several times during the project. The community groups included the Pohutukawa Coast newspaper and Maraetai social media groups.

Primarily, groups were kept informed through social media, email updates, the Watercare website and community letters. The main opportunity for people to provide feedback to Watercare on the option selection process was through Community Information Sessions and the survey, which are described in more depth below. Additionally, the feedback channel on the Watercare Beachlands webpage was always open through a dedicated email address that was monitored and managed by the project team.

Two drop-in community information sessions provided both Watercare and the local community an opportunity for open communication around the project as it progressed, throughout the engagement stage. This provided an opportunity for Watercare to explain the project and the various options, and enabled the community to ask the project team questions, voice their concerns and rank the options from most to least preferred, in a more informal environment.

3.6.1 Community Information Session 1

Local businesses within the area were first contacted on 17 October 2023 via hand-delivered invitation posters and flyers for the Beachlands Community Information Session 1 which were delivered to local shops, kindergartens, restaurants and cafes. The wider community was also contacted on 20 October 2023, via emails sent to the database of approximately 2660 email addresses for the wider community inviting them to the Beachlands Information Session 1, with information on the Long-list of options and a survey link which enabled feedback on the Long-list options.

The Community Information Session 1 was held on 26 October 2023 at Te Puru Community Centre, a local well-resourced venue, to discuss the Long-list options. A total of 13 community members volunteered their contact details and a higher number attended the event. The following community comments were raised about the options (**Note: the options below are described in detail in Section 6.1 of the Alternatives Assessment Report**) :

Option 2a (diffuse discharge to tributary of Te Puru Stream)

- General opposition.

- Concerns regarding discharges polluting the stream.
- Concerns around the recreational impacts as Te Puru Stream is regularly used for swimming.
- Increased monitoring will be required in Te Puru Stream and the gulf if chosen.

Option 2b (direct discharge to tributary of Te Puru Stream)

- General strong opposition.
- Concerns surrounding Te Puru Stream flooding, and the protection of the Te Puru Sports Facility and surrounding properties.
- Concerns regarding the existing quality of the stream.
- Increased monitoring will be required in Te Puru Stream and the gulf if chosen.

Option 3 (100% irrigation to land)

- Mixture of support and opposition.
- Uncertainty surrounding the location of the discharge, potential soil type, ecology, and how it will impact groundwater.
- Support of this option as it does not discharge to the coastal environment or freshwater.
- Concerns surrounding how this will affect the aquifer and great need for monitored aquifers.

Option 3a (Irrigation to land and stream discharge)

- Mixture of support and opposition.
- Support of this option particularly in winter and during heavy rainfall events, given potential limited land soakage.
- Concerns surrounding the cost and who pays.

Option 4ae (Hauraki Gulf – Tāmaki Strait Mid)

- General opposition.
- Concern associated with the cost to develop.
- Concerns associated with the pollution in the coastal environment.

Some general comments also included:

- That housing development should be restricted to limit the need for an increase in discharges.
- The need to maintain water quality.

3.6.2 Online Survey

As part of the initial community wide email to the database of 2660 community email addresses, an online survey link was sent for the community to fill out, to help Watercare better understand the community concerns of the suggested options. A total of 61 respondents started the survey, with 23 respondents completing the survey and 38 respondents partially completing it. In summary the following information was gained from the survey:

- There was no concern from respondents regarding whether a potential option may have been missed when creating the long list. One respondent however noted that there was a lack of contextual information associated with each option, which made it difficult to make an informed decision on which is best.

- Three respondents noted that cultural values and mana whenua consultation and participation considerations are missing and would help to better assess the quality and feasibility of the options. Identifying which option has the lowest carbon footprint was also identified as a missing consideration.
- The Natural Environment and Public Health Protection, followed by Resilience and Financial Implications were identified as criteria that should have the most influence over the decision.
- The most preferred Short-List option by the respondents was the Hauraki Gulf Tāmaki Mid option (Option 4ae), while the least preferred was the land and stream option (Option 3a). The top four options however present very similar rank distribution scores.
- Various comments and concerns were raised by the respondents including:
  - There are multiple concerns of wastewater entering the Gulf and Te Puru Stream..
  - The opportunity for the discharge land to be used as an irrigation resource for livestock farming, however acknowledging a direct discharge option makes sense during winter when soil is already saturated.
  - One respondent notes that the soil is not free draining and is very muddy in winter.
  - Two respondents highlight that Mana Whenua needs to be directly involved in decision making.

3.6.3 Community Information Session 2

On 13 November 2023, direct emails were sent to the database of 2660 community email addresses and social media posts in the Pohutukawa Coast Grapevine and Maraetai Group were made that invited the community to the Community Information Session 2. Follow-up reminder emails were sent and social media posts made on 21 November 2023.

On 17 November 2023, Watercare also published a ¼ page ad and public notice in the Pohutukawa Coast newspaper advertising for the Community Information Session 2.

The Community Information Session 2 was held on 22 November 2023 to discuss the five Short-List options. A total of 13 community members volunteered their contact details however, a higher number attended the event. By way of summary, a mixed response was received in terms of what parties considered the BPO to be for the discharge of treated wastewater.

3.6.4 Website

The 'Projects around Auckland' section on Watercare's website houses specific web pages on current and proposed infrastructure projects that Watercare is involved in. The web page designated to the Beachlands WWTP discharge consent renewal[4] contains an overview of the project, a description of the consenting process, including the Long-List workshop and Short-list workshop outcomes and maps and descriptors depicting the five short-list options. The web page was progressively updated as the BPO process advanced.

The website provided details of the proposed resource consent process and confirmed that the resulting resource consent application will be publicly notified to allow the iwi, stakeholders and community to make a formal submission on the application if they choose. For immediate feedback

[4] Watercare - Beachlands WWTP discharge consent renewal

related to the Beachlands WWTP discharge consent or if people wanted to get in touch with the project team, a direct email address for the project was also included.

3.6.5 Social Media

As identified above, social media was an important engagement tool. The primary platform for communicating with local residents about upcoming meetings or community information sessions was the private Pohutukawa Coast Grapevine and Maraetai group pages on Facebook.

3.7 Engagement Summary

A summary of the engagement undertaken to inform the resource consent application is provided as **Appendix A** below.

4 ISSUES AND RESPONSES

Based on the engagement and analysis of options undertaken to date, the following are the key issues identified. Watercare's response to these issues are provided also.

4.1 Land acquisition

Option 3 (100% land irrigation – ground soakage) - would require Watercare to acquire approximately 750 hectares of privately owned land, if chosen as the preferred option. As outlined above, Watercare directly notified 22 potential affected landowners within the 750 hectare footprint.

As part of this notification, Watercare provided landowners with the opportunity for a one-on-one meeting to discuss the project, the Short-List options and the BPO process. A number of landowners accepted this meeting (Refer to **Appendix A**)

A number of those notified landowners accepted the invite to meet. Of those who were met with, they communicated with Watercare, via email, phone call or videocall, that they strongly opposed Option 3, identifying it as their least preferred option. The themes of the landowner feedback included:

- Opposition to being removed from their homes and land when there were other more viable options.
- Landowners identified concerns over investment into their properties which may not be recovered if land is acquired through the Public Works Act as well as property devaluation if there are discharges areas located close to their properties.
- One landowner identified that they have just undergone the resource consent process to subdivide their land and the option selection process has since halted the Sale and Purchase Agreement of one of their properties, potentially resulting in a real cost associated with the logistics of the private sale, which would otherwise not have been necessary.
- Another landowner identified that they have recently spent $100,000+ on a resource consent and plans to build a new house. Another landowner had questions over the process of land acquisition if Option 3 was the preferred option.

Following the completion of the BPO selection process, Watercare communicated with the landowners via email or phone call that Option 3 was the least BPO of the Short-List options and it would not be progressed as part of the new resource consents for discharges from the Beachlands WWTP site.

4.2 New discharges and coastal structures in Tikapa Moana / Hauraki Gulf

Option 4ae – Hauraki Gulf – Tamaki Mid identified the discharge of treated wastewater to the Hauraki Gulf through a new coastal outfall structure.

Ngāi Tai ki Tāmaki did not support this option. This position based on the impacts of the coastal environment a new coastal outfall structure, including the disturbance and loss of seabed habitat and the occupation of seabed within the Hauraki Gulf. Opposition was raised in respect of increasing the volume of a direct discharge of treated wastewater in the Gulf environment from an environmental and cultural perspective.

Ngāi Tai ki Tāmaki also identified that a coastal outfall and discharge activity would also mean that a number of other iwi and hapū entities would invite further interest to a proposal of that nature.

This option was also not supported by key stakeholders, including the Hauraki Gulf Forum and the Environmental Defence Society.

This feedback was taken into account as part of the Short-List workshop process and helped to guide the decision making process against the project criteria.

4.3 Direct discharge to the tributary of Te Puru Stream

Option 2b – Direct Discharge to Te Puru Stream - identified the direct discharge of treated wastewater to a tributary of Te Puru Stream or Te Puru Stream.

This option generated opposition from Ngāi Tai ki Tāmaki. The opposition was based on the impacts of a direct discharge of treated wastewater being discharged into a tributary of Te Puru Stream which is culturally significant to Ngāi Tai ki Tāmaki. Opposition was raised in respect to of increasing the volume of a direct discharge of treated wastewater into the tributary of Te Puru Stream and Te Puru Stream from an environmental and cultural perspective. The discharge to a land area planted with appropriate species with high water uptake prior to any discharge to a waterbody was discussed as an alternative option.

The feedback from Ngāi Tai ki Tāmaki was taken into account as part of the Short-List workshop process and helped to guide the decision making process against the project criteria and the selection of the BPO.

5 SUMMARY

In order to inform the resource consent application for the discharge of treated wastewater from the Beachlands WWTP and to ensure the project objectives are being met, Watercare has undertaken a range of engagement with Ngāi Tai ki Tāmaki, other iwi groups, stakeholders and the public. The nature and outcomes of this engagement are summarised within this report.

Watercare is committed to continue to engage with Ngāi Tai ki Tāmaki through the application, lodgement and post granting of any consents for the discharge activities to ensure that cultural values and interests are appropriately provided.

Appendix A. Stakeholder Engagement Register

Date	Stakeholder	Correspondence Method	Communication	Comment
21.9.23	Ngāi Tai ki Tāmaki – Governance	Hui	Early hui with Ngāi Tai ki Tāmaki Governance to introduce the project, extend invite to BPO workshops and discuss the proposed Long-Long List options to identify any cultural concerns with those options on the Long-Log List options	Feedback received that Ngāi Tai ki Tāmaki do not support the options that consider wastewater to be conveyed out of the Beachland catchment for treatment.
22.9.23	Ngāi Tai ki Tāmaki – Governance	Email	Summarised the matters discussed at the 22.9.23 hui and provided BPO methodology.	
17.10.23	Pine Harbour eatery Pepperjacks restaurant – Pine Harbour Pine Harbour ferry terminal building Beachlands **(BL)** Montessori Ambrosia café Beachlands superette Beachlands post office BL Wakeline Bakery Sunkist Bay - Reserve toilets Sunkist Bay - Jetty BL Medical Centre BL Pharmacy BL Super Liquor BL Barbershop BL Bakery BL SPCA BL Franklin vet BL o2bee café BL Sushi BL Countdown BL Mitre 10 Maraetai **(M)** lucky takeaways M Bakery café	Posters / flyers	Beachlands Info Session 1 invitation	

Date	Stakeholder	Correspondence Method	Communication	Comment
	M Wines M Fruit Farmers M Dairy M Beach Boat Club M Beach Café M Foreshore Restaurant M Beans on Beach Te Puru community centre			
20.10.23	Public / Wider Community	Approximately 2660 emails sent	Advertising community info session 1 and survey link.	
26.10.23	Priscilla Nisbet Simone Bealy David Briscoe Trevor Nisbet Lindsay Makintosh Lyn and Steve Melrose Reece Moody Judith Paul Cheshire Alison Terry Kerry and Theresa Stanaway	Community Information Session 1	In person information session on the project long list options.	
1.11.23	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Site visit to Beachlands WWTP	Watercare team held a site visit at the WWTP for a Ngāi Tai ki Tāmaki Taiaomaurikura team member. An overview of the current operations and the options being considered was provided. The group also went to where the Te Puru Stream discharge to the coast and Ngāi Tai shared some of the cultural kōrero of the area and the importance of the stream, the surrounding land and coastal area.	Site visit was held ahead of the BPO Workshop 3.

Date	Stakeholder	Correspondence Method	Communication	Comment
2.11.23	Environmental Defence Society (EDS)	Teams Meeting	Watercare Team provided a summary of the 5 Shortlist Options and the process to date to EDS representatives.	Meeting was followed up with a summary email of the Options selection process and each of the 5 options remaining. EDS requested to be kept informed as to the Preferred Option.
6.11.23	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Email	Pre-circulation of the BPO Workshop 3 information and agenda	
7.11.23	Ngāi Tai ki Tāmaki – Taiaomaurikura representative	Attendance at the BPO Workshop 3		Ngāi Tai ki Tāmaki Taiaomaurikura representative provided a brief cultural overview of the Beachlands / Maraetai area and informal commentary on the options being considered.
10.11.23	Auckland Regional Public Health (ARPH)	Teams Meeting	Watercare Team provided a summary of the 5 Shortlist Options and the process to date to EDS representatives.	Meeting was followed up with a summary email of the Options selection process and each of the 5 options remaining. ARPH requested to be kept informed as to the Preferred Option.
13.11.23	Wider Community	Social media post in Pohutukawa Coast Grapevine and Maraetai group	Advertising community info session 2.	
13.11.23		Direct emails sent to database and wider community. Sent to 2660 emails.	Advertising community info session 2.	
17.11.23		1/4pg ad in Pohutukawa Coast newspaper	Advertising community info session 2.	

Date	Stakeholder	Correspondence Method	Communication	Comment
17.11.23		Public notice in Pohutukawa Coast newspaper	Advertising community info session 2.	
20.11.23		letters couriered / sent to directly affected stakeholders	Advertising community info session 2.	
22.11.23	Carolyn Brooke Murray and Ros Stevens Dennis Bartlet Susan Browndouglas Paul Hebditch Jaap Groenewegen Maraget Sturt Dr Tony Booth Judith Clarke Glenn and Christine Gribble J Riddick Z Maxwell-Bulter R Butler	Community Information Session 2	In person information session covering the project Short List options	
25.11.23	Richie Han – Landowner at 781 Whitford Maraetai Rd	Email	On 25/11/23 I just received your letter dated 21/11/23 which informed me there is a community open day on 22 November which means I will never have a chance to attend the open day. For the record we do not approve any option that the WWTP will go through our land. Please kindly choose other options which do not affect our land.	Sent email update on Workshop 4 outcome on 11.12.23 – setting out that Watercare communicated with the landowners that Option 3 (land acquisition option) was the least BPO of the Short-List options and it would not be progressed.
30.11.23	Public	WSL webpage update.	Short-List options identified and updates on where to from here.	

Date	Stakeholder	Correspondence Method	Communication	Comment
29.11.23 & 1.12.23	Barbara Greive – Landowner at 5 and 11 Waikopua Rd, Whitford	Email	Concern regarding potential sale of property and how the release of info re the identification of land for WWTP land option has created issues with process. Thank you for talking to me on Wednesday. It allayed some initial concerns about the prospective impact and timing of the Options Assessment and subsequent process notified to us by Watercare, however we do not yet know what action the buyer of 5 Waikopua Road will take, so the concerns I raised with you remain current. You will appreciate that we have had little time to respond and put together information on the Options. However, please find attached the Feedback / Submission to Watercare from Barbara Grieve, Robin Grieve and Karen Edwards, joint owners of Nos 5 and 11 Waikopua Road on the proposed Short List Option 3, that would involve the compulsory acquisition of our property.	
5.12.23	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Attendance at BPO Workshop 4		Ngāi Tai ki Tāmaki Taiaomaurikura representatives provided a further cultural overview of the Beachlands / Maraetai area and the importance of Te Puru Stream and provided informal commentary on the options being considered.
6.12.23	Daniel Kuruppu	Email	Requested a copy of the discharge consent.	Forwarded at approval by Tanvir Bhamji.
7.12.23	ARPH	Email	Provided update on BPO Process and proposed a further hui date in Jan 2024	Hui booked for 16.1.24
7.12.23	Hauraki Gulf Forum (HGF) – Alex Rogers	Email	Watercare contacted HGF to provide a summary of the 5 Shortlist Options and the process to date.	A meeting was arranged for 25 January 2024 to talk through the options in detail. HGF identified their opposition to any new structures and discharges into the Hauraki Gulf.

Date	Stakeholder	Correspondence Method	Communication	Comment
9.12.23	Grant Bowring – Landowner at 90 Okaroro Rd	Email	Concerns raised over Watercare taking land and he has recently spent 100K plus on RC process and plans for a new house. Not sure whether to progress with the build now.	Sent email update on Workshop 4 outcome on 9.12.23 – that Option 3 (land acquisition option) was the least BPO of the Short-List options and it would not be progressed.
11.12.23	Stella – Landowner at 509 Whitford Maraetai Rd	Phone	Concerns raised over Watercare taking their land. Wanted to discuss what are the options for opposition.	Provided an update over Workshop 4 outcome that Option 3 (land acquisition option was the least BPO of the Short-List options and it would not be progressed) to Stella over the phone and she requested a follow up phone call once BPO confirmed.
18.12.23	Barbara Greive – Landowner at 5 and 11 Waikopua Rd, Whitford	Email	Request for an update on BPO.	Email sent - social media update.
18.12.23	Barbara Greive – Landowner at 5 and 11 Waikopua Rd, Whitford	Email	Receipt of LGOIMA request re BPO outcome.	Forwarded to governance team to manage.
19.12.23	Steven Kitchener (Mauri Farms)	Email	Received email asking why we did not inform this lessee of the options for potential land acquisition for the extension of the WWTP.	Watercare response - Apologises I didn't come back with a reply. Spoke with Steven on 19 December after a few attempts trying to catch each other. We spoke for approx. 12 minutes. His company leases/grazes approx. 500 hectares across Beachlands. He currently has a lease at our site for 47.5 hectares. He does not live in the area and so wasn't aware of the drop-in/open days. I explained to him that the letters were sent to the properties owners to inform them of the process we are following. We expect to have a confirmed option by early February. I apologised for not getting in touch with him in respect to the area he leases on our WWTP land. He was polite and very understanding. Action – We agreed that the best way to keep him informed is to include Steven details to the stakeholder register. @Helen Jansen can you please include him to the list.

Date	Stakeholder	Correspondence Method	Communication	Comment
20.12.23	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Email	Provision of minutes and Powerpoint slides from the BPO Workshop 4	
21.12.23	Public	WSL webpage updated.	Latest update of the BPO.	
8.1.24	Lyn Gribble	Email	Email received requesting context as to why the (obvious) solution to pipe wastewater to Mangere, which is currently under capacity, was not considered. She requested info on the ranking for the short-listed options. She also indicated that she has had issues with her tank water quality.	Watercare responded with links to webpage and informed that the options all options were considered as part of the BPO process including piping wastewater to different WWTPs. Advised Watercare do not supply potable water and to discuss concerns/issues with AC.
10.1.24	Public	Press release in Pohutukawa Coast Times	BPO release of updated information.	
16.1.24	Manbir – Landowner at 16 Clifton Rd	Phone	Raised questions over the process of land acquisition if Option 3 was the Preferred option	Provided update on process and advised that Option 3 (land acquisition option) was the least BPO of the Short-List options and it would not be progressed).. Said that updates could be found on the Watercare website and to get in touch if further questions came up.
16.1.24	ARPH Representative	Teams meeting	Watercare provided an update on the outcomes of the BPO Workshop 4 and confirmed that a BPO was still being worked through with a decision to be made Feb 2024. Update also provided on feedback from Open Day 2.	No specific comments provided by ARPH. Watercare provided email summary of the meeting on 16.1.24. ARPH were added to the stakeholder register so they would receive direct updates from Watercare as the process continued.
22.1.23	Angela Leung – Landowner at 415, 435, 465, and 467 Whitford-Maraetai Road, Whitford	Email	Advised they "strongly oppose to Option 3 and 3a of the Beachlands Wastewater Treatment	22.1.24 – Watercare responded with offer to meet online or in person.

Date	Stakeholder	Correspondence Method	Communication	Comment
			Plant's Options Assessment." For reasons set out in 22.1.24 email.	Meeting held on 25.1.24 on update on Workshop 4 outcome (that Option 3 (land acquisition option) was the least BPO of the Short-List options and it would not be progressed). Email sent on 25.1.24 following meeting to summarise matters discussed.
24.1.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Email	Watercare seeking to confirm a further hui to continue the korero on the BPO for Beachlands WWTP	
25.1.24	HGF Representative	Teams Meeting	Watercare provided an update on the outcomes of the BPO Workshop 4 and confirmed that a BPO was still being worked through with a decision to be made Feb 2024. Update also provided on feedback from Open Day 2.	HGF confirmed that the main opposition to coastal discharge option was the new structure and confirmed that iwi groups were aligned with this position. HGF were added to the stakeholder register so they would receive direct updates from Watercare as the process continued.
26.1.24	EDS Representatives	Teams Meeting	Watercare provided an update on the outcomes of the BPO Workshop 4 and confirmed that a BPO was still being worked through with a decision to be made Feb 2024. Update also provided on feedback from Open Day 2.	EDS asked questions around the options process and the alignment with statutory direction. EDS were added to the stakeholder register so they would receive direct updates from Watercare as the process continued.
29.1.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Email	Watercare seeking to confirm a further hui to continue the korero on the BPO for Beachlands WWTP	
5.2.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Email	Sent Ngāi Tai ki Tāmaki a hui request for a site visit on 22 February 2024.	Ngāi Tai ki Tāmaki accepted hui time and date

Date	Stakeholder	Correspondence Method	Communication	Comment
22.2.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Site visit to Beachlands WWTP		Watercare team held a site visit for a Ngāi Tai ki Tāmaki Taiaomaurikura team members. The group started at where the Te Puru Stream discharge to the coast and Ngāi Tai ki Tāmaki shared some of the cultural kōrero of the area and the importance of the stream, the surrounding land and coastal area. The group then went to the WWTP site and discussed the options being considered and talked through some informal commentary provided by Ngāi Tai ki Tāmaki on opportunities at the site for the expansion of the overland flow area and plantings and potential reuse options for a water supply to a Ngāi Tai ki Tāmaki nursery project. Watercare said it would like to further discuss opportunities with Ngāi Tai ki Tāmaki and further hui were proposed.
27.2.24 – 1.3.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Emails	Correspondence between Watercare and Ngāi Tai regarding the Public Notice Statement on Watercare announcing the technical preferred option to the public.	Ngāi Tai ki Tāmaki provided suggested amendments to the statement which Watercare adopted as part of the final version of the Announcement issued on 1 March 2024.
1.3.24	Ngāi Tai ki Tāmaki, stakeholders and public	Public Notice	Watercare release a Public Notice informing parties of the technical Preferred Option for the project being Option 2a	
14.3.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Teams Meeting	Watercare provided an overview of the BPO selection process from the start of the process in August 2023 up to the confirmation of the preferred technical option. Discussions included further options for the discharge of treated wastewater to the increased land application field and planting options through this area. Ngāi Tai also identified the desire for	Watercare to: - Progress conversations with ARPH about the use of treated wastewater for nursery supply - Investigate the feasibility of providing a reliable water supply to the nursery

Date	Stakeholder	Correspondence Method	Communication	Comment
			a reliable water source for a nursery to be developed on the Waste Management Whitford landfill site	- Continue to provide a co-design role for Ngāti Tai ki Tāmaki in as the overland flow system detailed design process continues. Next hui booked in for 2 April at Ngāi Tai offices.
27.3.24	ARPH	Email	Sent query requesting comments from ARPH on the opportunity proposed by Ngāi Tai ki Tāmaki to use treated wastewater as a water supply for their nursery.	ARPH provided initial comments via email dated 28.3.24 informing that use of water for nursery irrigation should be satisfactory give sufficient reliable treatment; there may be a standard or requirement for water for nurseries, e.g. mineral/solute content (e.g. nitrate, phosphate) or contaminant levels; and the nursery site will need to have an entirely separate potable water supply, whether from Watercare or a roof/tank or bore. Watercare communicated this with Ngāi Tai ki Tāmaki.
2.4.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Hui	Watercare provided an update on the proposed lodgement timeframe, summary of cultural commentary in the project Engagement Report, update on the preliminary work on the overland flow system, update on the response from ARPH re the use of water for the nursery, and discussed the process for provision of a CIA / CVA on the application.	Ngāi Tai ki Tāmaki were generally supportive of the timing for the application lodgement and wanted to provide a comment in the Engagement Report (Refer to Sec 3.2.1 above) on the status of mana whenua and not recognising other iwi or hapū within the project footprint and this commentary should be clear in the AEE and application. Watercare agreed to: - Continue to provide Ngāi Tai ki Tāmaki a role in the co-design of the overland flow system

Date	Stakeholder	Correspondence Method	Communication	Comment
				- Provide a draft copy of the Engagement Report for review of the cultural sections - Resource the development of the CIA / CVA for the project - Continue to work with Ngāi Tai ki Tāmaki on the nursery water supply opportunity. Next hui planned for 15 April 2024.
15.4.24	Ngāi Tai ki Tāmaki – Taiaomaurikura representatives	Hui	Hui to further progress matters discussed at the 2 April hui.	Further korero on the 2 April matters. Watercare will continue to have regular hui with Ngāi Tai ki Tāmaki following lodgement of the application on 19 April 2024. This will include working together to develop a cultural statement.

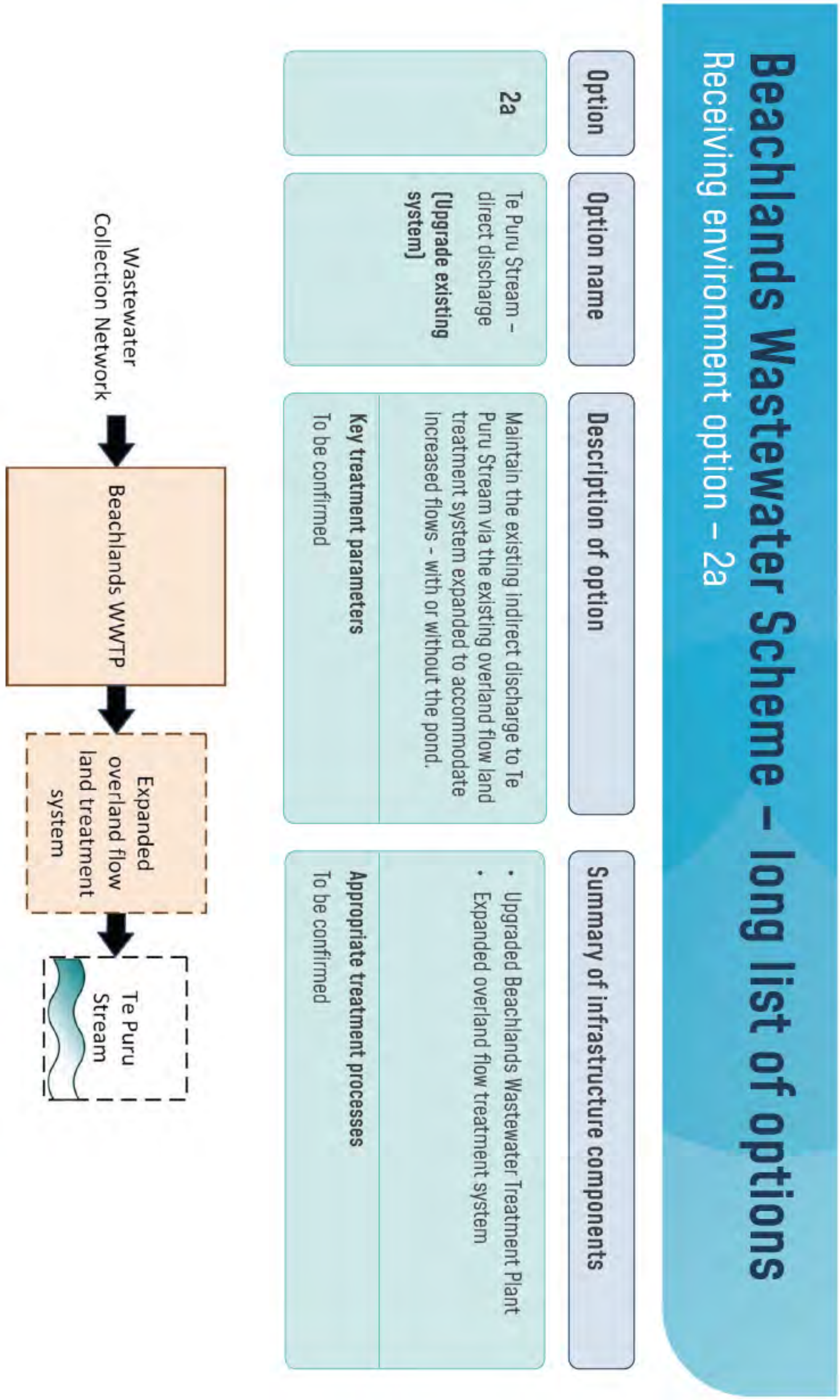
Appendix B. Stakeholder Contact Database

Group	Organisation	Contact Name	Title
Mana Whenua	Ngāi Tai ki Tāmaki	Revell Butler / Zaelene Maxwell Butler	Taiaomaurikura
Stakeholder	Environmental Defence Society	Gary Taylor	Chief Executive
Stakeholder	Auckland Regional Public Health	Leslie Breach	Health Protection Officer
Stakeholder	Hauraki Gulf Forum	Alex Rogers	Executive Officer
Landowner	509 Whitford Maraetai Rd	Stella	
Landowner	90 Okaroro Rd	Grant Bowring	
Landowner	781 Whitford Maraetai Rd	Richie Han	
Landowner	16 Clifton Rd	Manbir	
Landowner	415, 435, 465, and 467 Whitford-Maraetai Road, Whitford	Angela Leung	
Landowner	5 and 11 Waikopua Rd, Whitford	Barbara Grieve	

Appendix C. Examples of Watercare Engagement Information

COMMUNITY INFORMATION SESSION FLYER

EXAMPLES OF DISPLAY MATERIALS USED




Indicative Tāmaki Mid Outfall
N
Beachlands Wastewater Treatment Plant (WWTP)
Indicative discharge location for option 2a, 2b and 3a
0
0.75
1.5
Kilometres
Beachlands Wastewater Scheme
Stantec
Short List Discharge Options
Watercare
Legend
Indicative Ocean Outfall
Wastewater Catchments
Plant Site Designation
Beachlands Wastewater Treatment Plant Site Property Boundary

EXAMPLE OF LETTERS SENT TO LAND OWNERS

[Date]

[insert name of landowner and property address]

By Email [where known]: [insert]

Dear [insert]

Beachlands Wastewater Treatment Plant – Options for the Discharge of Treated Wastewater

Watercare Services Limited (Watercare) operates a wastewater treatment plant (WWTP) on Okaroro Drive in Beachlands.

Resource consents associated with the WWTP are due to expire in 2025 and 2026. Watercare therefore intends to apply, next year, to Auckland Council for the resource consents it needs to allow the WWTP to continue operating, and to be upgraded to service Beachlands' growing population. Those resource consents include a consent to discharge treated wastewater from the WWTP into the environment (Discharge Permit).

Watercare currently discharges highly treated wastewater from the WWTP into a tributary of the Te Puru Stream, from a location on its WWTP site on Okaroro Drive. Watercare in the process of assessing different possible options for the discharge of treated wastewater from the WWTP, one of which will be chosen and form the basis of the resource consent applications it lodges with Auckland Council next year.

Watercare initially prepared a long list of 17 possible options, which has now been narrowed down to 5 possible options (short list). A summary of the five different options is included as Annexure 1 to this letter.

Potential discharge option affecting your property

Watercare is writing to you as one option on the short list - Option 3 - involves discharges of treated wastewater to several hundred hectares of land near the WWTP across a number of different properties, including your property. The other options on the short list do not affect your property.

A map showing the extent of land that, under Option 3, would be required for land based disposal of treated wastewater is included as Annexure 2 to this letter.

The next stage in the project is for Watercare to progress from its short list of 5 options to a final preferred option, which will be the subject of an application to Auckland Council for a Discharge Permit. If Watercare's preferred option requires the acquisition of any land Watercare does not already own, this would be subject to a separate process under the Public Works Act 1981.

Providing your views

Watercare is keen to hear your views on the different options in the short list, and to explain to you what Option 3, if chosen as Watercare's preferred option, would mean for you and your property.

Please contact us on [insert details] if you would like one of our staff to arrange a meeting in person with you.

You can also find out more about the project and the different options on the short list by:

(a) Visiting Watercare's website: Watercare - Beachlands Wastewater Treatment Plant consent renewal;
(b) Attending a community open day that will be held on Wednesday 22 November from 5pm-7:30pm at the Te Puru Community Centre.

You are able to provide feedback to Watercare on forms that will be provided at the community open day or by email to [Watercare to insert details].

Please be aware that, depending on the option that is ultimately chosen, Watercare may be required under clause 6(1)(f) of Schedule 4 of the Resource Management Act 1991 to provide a summary of your feedback to Auckland Council, and that this may be made public through the RMA consenting process.

Yours sincerely

Priyan Perera

Head of Strategy and Planning

Watercare Services Limited

BPO ANNOUNCEMENT NOTICE

After careful consideration and evaluation of a range of discharge options, we have identified *option 2a - a diffuse discharge to a tributary of Te Puru Stream* as the preferred technical option for the future discharge from the Beachlands Wastewater Treatment Plant site.

While the diffuse discharge option (option 2a) is our preferred technical option, we remain committed to consulting with Mana Whenua, Ngāi Tai ki Tamaki, to further refine and develop the preferred option for the discharge of wastewater from the Beachlands Wastewater Treatment Plant.

We will now undertake the necessary in-depth technical assessments and reporting required as part of our resource consent application.

We appreciate the ongoing collaboration and input from all stakeholders as we continue to prioritise public health of the Beachlands and Maraetai community, environmental outcomes, cultural wellbeing, and the requirements of the community in our decision-making process.


Indicative location of the discharge to the Te Puru Stream options
Beachlands Wastewater Treatment Plant
0 0.25 0.5 1

ATTACHMENT 15

REQUEST FOR FURTHER INFORMATION UNDER SECTION 92 RMA 30 JUL 24

30 July 2024

Tanvir Bhamji
Watercare Services Limited
Private Bag 92521
Victoria Street west
AUCKLAND

Kia ora Tanvir

Resource consent application – s92 further information request and s37 timeframe extension

Application number:	DIS60433803
Applicant:	Watercare Services Limited
Proposed activity:	Replacement of the current wastewater discharge consent for the discharge of treated wastewater to land from the Beachlands Wastewater Treatment Plant
Site address:	100 Okaroro Drive, Beachlands

Thank you for submitting the above resource consent application.

Following consultation with the respective Council specialists, I am writing to advise you that the following further information and clarification is required under Section 92(1) of the Resource Management Act 1991 ("the Act") to allow for a full and accurate assessment of your application to be undertaken:

Freshwater Ecology

1. The submitted water quality, ecological, and human health effects assessment from Streamlined Environmental Limited, version F3, dated 27 May 2024, (**the ecological report**) states that the levels of a number of key nutrients are trending upwards due to increased discharge volumes in the current system. The primary ecological concern is that there appears to be limited certainty in respect of the length of time that Stages 1 and 2, and Stages 3 and 4 will be implemented. The noted issues of concern are:

- The assessment of actual and potential affects for Stages 1 and 2 apply the same operational limit of contaminant assessed, despite increased volume and load (coupled with increasing contaminant concentrations for several parameters).
- Stages 3 and 4 also apply the same operational limit for the assessment of actual and potential effects, also with an increased volume and contaminant loads. This Stage 3 and 4 effects envelope forms the focus of much of the assessment.

In addition, for all stages, it appears that an envelope of assessment that treats all discharges at maximum daily discharge flow has been applied. An indication of the average daily discharge flow and the maximum daily discharge flow would be useful in order to contextualise the likelihood / frequency of these different volumetric discharges, and how different these might occur in practice so that the ecological implications can be assessed.

Accordingly, please provide:

a. an updated ecological impact assessment that considers effects associated with the stage 1 and 2 average daily and maximum daily flow states;

b. an updated ecological impact assessment that considers effects associated with the stage 3 and 4 average daily flow states and how those relate to the maximum daily flow states (as only the maximum daily flow has been considered in the envelope of effects approach); and

c. clarification of what population will trigger the proposed upgrades that will take flows from stage 2 and beyond. For example, the assessment of environmental effects (**AEE**) states that upgrades will be initiated prior to population equivalent (**PE**) 18,000 but does not state when and only notes that they will be operational at PE 24,000. As such, there is a potential period of time between these two triggers that has not been adequately assessed. In the response, please include details as to when such upgrades will occur and an associated assessment.

2. The baseline condition of the upstream reaches of the subject stream system (baseline condition) is reported to be degraded by existing land practices. However, the submitted ecological report suggests that the stream's ecological values might be moderate, which is characteristic of a valued freshwater system. Accordingly, please provide further evidence beyond water quality, macroinvertebrate, and fish data and analyse it to determine the baseline ecological value of the stream using a value assessment framework that provides line of sight on the key contributors to ecological value. Furthermore, the National Policy Statement for Freshwater Management (**NPSFM**) requires assessing the effect on the potential ecological values of freshwater features. Please update the ecological report to assess the potential ecological value of potentially impacted freshwater ecosystems and consider effects on the potential ecological values.

   Note: the EIANZ provides a framework to determine freshwater ecological values. In addition, Boffa Miskel has advanced the EIANZ Ecology Impact Assessment framework for rivers and stream, which has been subsequently adopted by several consultancies. Council can provide this advanced framework if required.

3. Please provide the stream ecological value (**SEV**) scores for each survey site identified in Figure 29 of the ecological report. This will allow for a review of the various positions and justifications presented within the ecological report, such as shading, vegetation coverage, benthic structure, water depths, and stream profiles. Please also ensure that the SEV calculator is included.

4. It has been assessed that the farm pond may throttle high flow discharges. Please provide an explanation and assessment of whether fish passage over the structure is available, and a description of the passage structure if proposed. It should be noted that in order to comply with applicable regulations under the Auckland Unitary Plan (Operative in Part) (**AUP(OP)**), dams higher than 4m should provide fish passage.

5. Please provide an ecological value and effect assessment of the discharge on various significant ecological areas at each stage.

6. It is understood that the land disposal element of the proposed discharge system will avoid natural inland wetlands, in that it will be located a minimum of 100m from them. Please provide further evidence, which could include mapping the extent of the disposal area against landscape features, to confirm that there will be adequate land available to achieve this set back from all natural inland wetlands. Alternatively, please provide an addendum that addresses this, including any necessary consents under the National Environmental Standards for Freshwater and an associated effects assessment.

Water Quality

Emerging Organic Contaminant Assessment

7. Section 5.3.5 of the ecological report refers to the concentration and resulting high risk quotient for venlafaxine as being an anomaly. Please indicate how this value compares to other wastewater treatment plants (**WWTP**) as reported in Table 5 (if data are available), or other applicable data sets in New Zealand.

8. Sediment bioaccumulation risks of emerging organic contaminants (**EOCs**): Based on the authors' knowledge about sediment bioaccumulation of EOCs and available data, please provide an assessment as to the risk / potential of analysed personal care products and pharmaceuticals (**PCPPs**) (and other EOCs, where applicable) in the Beachlands WWTP discharge to sediment bioaccumulation in the downstream receiving environment, both at the Bridge Site (Site 15) and estuary.

Staged Assessment

9. Table 6 of the ecological report sets out the operational limits for key contaminants, with footnote 13 cross referencing Stantec and Watercare. Please provide the rationale / justification for the

Operational Limits presented in Table 6. Please include the process by which these limits were reached.

10. Please explain why there is no differentiation in the operational limits between:
    - 'Current and Short Term', noting this represents an increase from PE 11,000 to PE 18000; and
    - 'Long term Stage 1 and Stage 2 ', noting this represents a PE 24,000 to PE 30,000

11. The last bullet point on page 10 of the ecological report refers to TN, Amm-N and Nitrate-N concentrations are at Attribute Band B; and dissolved inorganic nitrogen (**DIN**) at levels expected to contribute to eutrophication (noting here that DIN is the sum of nitrite-nitrate-nitrogen (**NNN**), ammoniacal-nitrogen (**Amm-N**) and nitrate-nitrogen (**Nitrate-N**). Noting the current state assessment has been provided for PE 11,000, what are the expected concentrations (median, average, 95th percentile) and annual average loads of all key contaminants at the following stages:
    - PE 18,000 (prior to the long-term upgrades being operational).
    - PE 24,000
    - PE 30,000

    In the response, please provide an assessment of the water quality (with corresponding attribute state and other relevant benchmarking) at each PE threshold (PE 18,000, PE24,000 and PE30,000), for the following locations:
    - The treated effluent discharged from the WWTP (prior to overland distribution)
    - Treated effluent after overland flow, prior to discharge to the Farm Pond (noting this is also pending the final PDP assessment)
    - Farm Pond (Site B)
    - Discharge to the Te Puru Stream (exiting the farm pond)
    - At the Bridge Site (Site 15, zone of mixing)
    - Quarry Site
    - Te Puru Estuary

12. What is the expected percentage increase in DIN (noting that is it over 90% Nitrate-N), and what is the proportional increase in risks to eutrophication at the mixing zone (Site 15) and Te Puru Estuary.

13. What are the likely drivers of significant trends in increasing Nitrate-N and dissolved reactive phosphorus (**DRP**) in the discharge quality? Please provide an assessment of how this is likely to track up to PE 18,000 and up to the new long-term upgrades becoming operational.

14. Two bullet points on page 15 of the ecological report appear contradictory in that the first point refers to Amm-N as having an overall low contribution of 0.5% and unlikely to be significantly contributing to Amm-N downstream, but the second point refers to pond processes will increase Amm-N. Based on these statements, please provide:

- a detailed explanation of the processes in the pond (likely ammonification processes – what is driving this, and can it be mitigated?) that will continue to increase Amm-N;
- an estimate of Amm-N concentrations in the downstream receiving environment; and
- an assessment of how Amm-N concentration and loads in the farm pond will likely change over time as a result of increasing loads at PE 18,000, PE 24,000 and PE 30,000, and the capacity of the farm pond and upgraded overland flow system (**OFS**) to attenuate elevated Amm-N loads.

15. With section 3.4 of the ecological report, the second bullet point makes reference to marked increases in DRP and Nitrate-N and refers to 'operational changes and constraints'. Please provide details on what these 'operational changes and constraints' were, how these result in significantly increasing trends in DRP and Nitrate-N and explain what process will be put in place to mitigate the 'operational changes and constraints' prior to the upgrades being commissioned.

16. Please confirm if the Amm-N data in Table 8 are adjusted for pH? If not, please either make this adjustment or explain why it is not necessary to do so.

<u>Coastal Ecology</u>

17. Based on the operational results provided for the existing discharge quality, it appears that the existing discharge volume has exceeded the consent limit, with potential adverse effects on the coastal environment resulting due to the exceedance in discharge quality. Without additional treatment for the existing discharge quality, the proposal may not be supportable. Accordingly, please provide the discharge volume (not average volume) and discharge quality for all four stages along with an assessment of the likely adverse effects.

18. The submitted ecological report clearly identifies the current discharge quality and exceedances in respect of the ANZECC quality guidelines, as set out below:

- Dissolved reactive phosphorus and nitrate-N have shown a marked increase in concentration between 2018-2023, with median annual increases of 24% and 77%, respectively.
- Volume of discharge exceeded the maximum consented volume of 2,800m^3/day. Table 1(section 3.13 Ecological Report) indicates the volume discharged was 5619m^3 in 2018 and 4.331m^3/day.
- The discharge contains total copper, and total and dissolved zinc at concentrations above the Australian and New Zealand Guidelines (**ANZG**) 2018 default guideline values. To achieve

these standards some dilution and/or attenuation is required in the wastewater treatment system prior to discharge to the receiving environment in order to meet these standards.

- After attenuation through the overland and stream system, Total Nitrogen (**TN**) and Total Phosphorus (**TP**) loads contribute 32% and 44% of total load from the catchment to the marine coastal environment.

In respect of these matters, please provide answers to the following questions:

a. The daily volume of discharge from 2018 to 2023 almost doubled. Copper and zinc are toxic to marine life, with both exceeding the ANZEC guideline value in the existing discharge. There is no assessment in the **AEE** or ecological report to assist with understanding how the above breaches, including the exceedance of copper and zinc, could be avoided within the WWTP treatment during stages 1 and 2. Please provide this.

b. While Membrane Bioreactor (**MBR**) treatment will reduce the nutrient level in the discharge, what is proposed to manage the exceedance in the total copper and zinc?

c. Please provide the background level of TN and TP for the immediate receiving coastal waters and sediment**.**

d. Please provide an assessment to understand the effects of TN and TP on the coastal marine environment, and mainly in respect of algal blooms. Will the estimated TN and TP availability from all four stages be likely to enhance plant growth at the immediate receiving environment?

19. Please provide the follow details:

a. Chlorophil a (**chla**) concentration and the trend analysis result for chla for the period between 2018-2023.

b. The measures proposed to monitor or manage the potential occurrence of algal blooms / plants related to the proposed discharges at all stages.

20. With respect to the coastal marine environment, the following assessment is provided within the ecological report:

> *'The proposed discharge rates by MBR Stage 2 will have negligible effects on the salinity and the marine communities of Te Maraetai/Kellys Beach due to the relatively low discharge rates compared to other nearby streams and rivers, the rapid dilution, and the tolerance of intertidal biota to low salinities. There will be no change from the current WWTP scenario.*
>
> *With respect to the proposed discharge, estimated TN concentrations will decrease by 29% to 5 mg/L in the Long-term Stages 1 and 2 of the*

upgraded WWTP, and TP concentrations will reduce to 0.5 mg/L. Concentrations of these nutrients will be diluted 309× (50% percentile) by the time they reach the Te Puru Stream mouth, making them well below background concentrations in coastal waters. Given the rapid dilution rate, and the reduction of TN concentration in the proposed discharge from the expanded and upgraded WWTP, no increase in nutrient concentrations in coastal waters, or related adverse effects from increased nutrients, are likely to occur as a result of the proposed discharge. Other minor contaminants that are present in the treated wastewater at low concentrations will be diluted at a similar rate to TN and TP. There will be no change from the current WWTP scenario.

Potential effects on SEA-M1-42b Te Puru Stream estuary and SEA-M2-42a are anticipated to be low given the level of influence the treated wastewater discharge will have on nutrient concentrations and salinity in coastal waters.'

While this assessment is noted, neither the ecological report nor the AEE have included an assessment that supports the above in relation to the magnitude of overall effects on the coastal marine area (**CMA**).

It is further noted that the ecological value of the immediate receiving environment is provided from an intertidal survey at 14 stations around Te Maraetai / Kellys Beach. While the survey results identified different broad scale habitats with different species such as shellfish patches, seagrass, mudflats, shell banks & mangroves, no assessment of effects on those habitats or species is provided in the ecological report in relation to the proposed discharge.

In addition, the statement on SEA-M1 and SEA-M2 in the vicinity of the discharge does not include a site-specific assessment on the ecological values at the sites from the proposed discharge.

Taking the above into account, please provide the following:

a. A habitat or species-specific assessment of ecological effects from the proposed discharge for all four stages.

b. An assessment of effects on identified kaimoana species, including human health risk from the proposed discharge for all four stages. While there is no regulated, legal size limit for shellfish, such as cockles and pipi, should consent be granted for 35 years, the size and population of shellfish species would grow to harvestable size over the proposed duration. Accordingly, it is not agreed that the current size of the shellfish is a form of mitigation or reason not to consider human health effects from consuming shellfish.

c. Please confirm that the consent limits proposed for all four stages can be met without any exceedance in the discharge quality, as has occurred with the existing discharge.

d. Based on the breaches with the existing discharge quality consent limits, there is potential that the proposed discharge operational limits may exceed consented limits. Monitoring the discharge water and sediment quality, and coastal ecology is the only tool available to validate the proposal. Accordingly, please provide a draft monitoring plan for all four stages, that contains, but that is not necessarily limited to, the details below:

- The spatial and temporal extent of the key habitats (as appropriate) within the zone of influence in the immediate receiving environment of the proposed discharge.
- Benthic community (fauna and flora) abundance and diversity.
- A water quality analysis of key nutrients, chla etc. (if it is not monitored or included in the discharge quality).
- A sediment quality analysis (heavy metals, grain size, organic content, anoxic layer / redox potential).
- Spatial and temporal extent of algal blooms, should they arise.
- Suitability of kaimoana species for harvesting and human consumption, including species, size and number of samples to monitor.
- Reporting procedures.
- Monitoring design for the above aspects to include the number of samples, spacing of sample stations in relation to the proposed discharge location, frequency of sampling, methodology and reporting. The monitoring programme must be designed to deliver ecologically meaningful results and be statistically robust enough to detect potential changes to those matters listed above.

21. Please provide an assessment on cumulative effects on the ecology of the immediate receiving environment in the CMA (Te Puru Stream and Kellys Beach) in relation to the existing discharge and from the proposed discharge for all four stages.

22. With respect to the modelling within the Assessment of Proposed Te Puru Stream Discharge by DHI Water & Environment Limited, dated 28 March 2024 (**the modelling report**), please provide the modelled zone of influence and reasonable mixing zone for each stage of proposed discharges at the different sites identified in the modelling report.

23. The modeling report states:

> *'The higher levels of dilution that are achieved in the wider marine receiving environment (compared to the in-stream dilutions) mean that changes in nutrient concentrations in the wider marine receiving environment due to the proposed WWTP discharges would remain below detectable limits.'*

What are the detectable limits referred in the statement above for key contaminants in the discharge?

24. In respect of TN and TP in the estuary, please answer the following questions:

    a. What is the residence time of the TN and TP footprints for the Te Puru Estuary and Kelly Beach for each stage proposed.

    b. Please explain how the TN and TP loads in the table below were derived? What is the total load for TN and TP estimated for different discharge scenarios and why are there only three scenarios?

Table 1. Discharge Scenario data.

	Current	Short-Term	Long-Term Stage 2
Average daily dry weather discharge (m^3)	2,000	3,600	6,000
Average daily dry weather discharge (m^3/s)	0.023	0.042	0.069
Median TN load (kg/day)	14.0	25.0	30.0
Median TP load (kg/day)	2.0	3.6	6.0

25. There is a difference between the tide being in (mixing will occur in the estuary and beach area) and low tide when undiluted river water will be within the channel within the intertidal area and mixing will occur at the tide line. Has this been considered in modelling of the nutrient footprint?

26. The ecological report shows after the MBR is operational within the WWTP, attenuated TN and TP loads through the overland and stream system will contribute 50% and 70% of total catchment load to the marine coastal environment respectively, being approximately two-fold and three-fold increases as compared to the current situation of 32% and 44% respectively.

    Sufficient nutrients in water are known to be one of the conditions leading to toxic algae blooms, which is likely to have adverse effects on people involved in contact recreation, particularly those who eat watercress collected from Te Puru Stream. The ecological report indicates that occasional blooms of toxic cyanobacteria have been reported from the Beachlands-Maraetai coastline and blooms were also observed in Te Maraetai / Kellys Beach during the intertidal survey. However, the health risk from cyanobacteria as a result of the proposed increase in nutrient loads has not been assessed in detail in either the ecological or health risk reports. Please provide further assessment in this regard.

27. The ecological report states that the estimated loads from the upgraded WWTP represent a very small percentage of the TN and TP loads entering the inner Hauraki Gulf and Firth of Thames. Thus, the effects of the increased loads from the upgraded WWTP are assessed as being low. Please justify the reasons that the inner Hauraki Gulf and Firth of Thames are used instead of the immediate receiving environment for assessing the effect.

28. On 11 July 2024, Watercare Services Limited (**WSL**) provided a preliminary assessment of the Estuarine Trophic Index (**ETI)** for Te Puru Stream Estuary, based on ETI Tool 3, and applying the current state assessments. Please provide an assessment of the ETI at each of the anticipated states at PE 18,000, PE 24,000, and PE 30,000.

Hydrology and Stream Flow

29. The stream hydraulic assessment report uses 6,000 m^3/d discharge from the WWTP, converted to an average discharge rate of 0.07 m^3/s. It then uses this rate as an estimate of wastewater discharge contributions during wet weather events without any adjustment of the discharge from the WWTP due to wet weather flows (outflows would be expected to be greater when it's raining). The report also only provides an assessment at high stream flows, not at low.

    Noting the above, please provide an assessment of the effects of the discharge (the current, the maximum proposed, and a range of discharges, not just an average) under a range of climatic conditions (e.g. dry weather and a range of rainfall events, including the rainfall event resulting in maximum discharge from the plant and a relevant climate change scenario) on the depth, velocity and flow of water in both the tributary and the main stem of Te Puru Stream after confluence. Alterations in the rate of discharge and stream baseflows should be considered for dry and wet weather, and include consideration of climate change effects on high and low stream and discharge flows.

    Please also provide an assessment of the efficacy of the 'storm buffer ponds' under current and future growth projections, assessing a range of storm events and a consideration of a climate change scenario relevant to the duration sought for this consent.

30. While there are flow duration curves (naturalised) in the appendix to the stream hydraulic assessment report by Pattle Delamore Partners, they have no headings or graph labels, and there is no explanation of them in the report. The report also refers to a methodology in Appendix C but that appendix cannot be located and data from the gauging and water level recorder cannot be located. Please address these matters.

Overland Flow System and groundwater

31. Please provide a detailed and comprehensive conceptual site model (**CSM**) of the current site, hydraulic connectivity, and key transport pathways. It is noted that this is likely to change when the design of the upgraded OFS is finalised, however it is appropriate and expected that a detailed CSM is provided given the period of time before the upgraded OFS is operational.

32. It is acknowledged that the AEE and ecological report have provided an assessment that is based on the data available. In accordance with the initial review provided to WSL, please provide a complete assessment for the OFS when the full analytical data are available and incorporated into the assessment. Given the reliance on this assessment to both the assessment of the current treatment pathway (e.g., mass/flow ratios described in PDP 2 April 2024 memo) and the

assumptions adopted in the ecological report, the current assessment of the overland flow system needs to be updated.

Following this updated assessment, the findings and conclusions need to be incorporated into the AEE and ecological report to inform their assumptions and also to provide an updated assessment of the current attenuation pathway and treatment ratios provided by the overland flow system (currently regarded as incomplete).

33. The overland flow system memorandum 4 from Pattle Delamore Partners, dated 17 May 2024, states that: *'any potential contaminants form overland flow site migrating downwards through the regolith into GW expected to have flow path lengths no longer than hundreds of metres to the nearest stream discharge zone, no existing bores or GW takes occur within this area.'* However no details on groundwater use in the immediate environment have been provided. Please address this and provide further information on groundwater take and use, including any groundwater quality monitoring data in the vicinity of the WWTP.

34. The overland flow system memorandum 2 from Pattle Delamore Partners, dated 2 April 2024 (memorandum 2), states: '*the removal mechanisms for nitrogen and phosphorus in an overland flow system are relatively complex and are heavily influenced by the nature of the wastewater applied, the flowrate/loading rate, and the soils present at the site*.'

    In respect of this statement, please provide answers to the following questions:

    a. With regard to significantly increasing trends in Nitrate-N and DRP in the discharge, provide an assessment of how increasing concentrations an loads up to PE 18,000 will influence the treatment performance of the OSF. In the response, please provide an assessment to identify any critical processes that may be modified, such as the processes of nitrogen attenuation / removal in the OFS (e.g. volatilisation, biological nitrification – denitrification).

    b. Is there an upper limit as to the treatment efficacy after which it does not function, or declines?

    c. Please provide the information indicated in footnote 6, Table 1.

    d. The cross references supplied in Table 1 footnotes are not understood. Please address this by providing more updated applicable citations and cross-references to support the comparison.

    In respect of memorandum 2 and the overland flow system memorandum 3 (Interim) from Pattle Delamore Partners, dated 2 April 2024 (**memorandum 3**), please provide answers to the following questions:

    a. Confirm when the OSF upgrades will be operational and provide an assessment of the anticipated performance at the end of Stage 1, prior to the main WWTP upgrades being operational.

b. How will the upgrades to the OFS serve to reduce and manage the significantly increasing trends of Nitrate-N and DRP discharging into the farm pond?

c. How will the OFS affect the 95th percentile of data?, noting these data are of great interest given these are at levels that present toxic concentrations in the receiving environment.

d. Noting the above, please add the 95th percentile to Table 3, and incorporate into the assessment of the performance of the OFS.

e. In respect of Table 4, please explain the derivation of the ratios, and a justification for applying the conductivity when earlier the report refers to this as being relatively inert, whereas the nutrients undergo attenuation pathway processes.

f. The conductivity ratio from Table 3 equates to 141/122 = 1.15, but the ratio in Table 5 is 1.19. Please explain the differences.

g. Table 4 note 2 references future scenarios. Please indicate which scenarios incorporating climate change scenarios have been accounted for. If not, please update the assessment to provide for the consideration of climate change, appropriate to the purpose and duration of the consent applied for.

h. Page 6 of the memo states: '*flow ratios can then be used to determine the 'fraction' of each parameter which has been 'removed by treatment process' vs simple dilution*.' However, the data do not include the point of an assessment before the discharge reaches the pond itself – it includes only the data from the farm pond to the Site 15 (mixing zone), thus it does not account for the efficacy of the OFS itself. Please address this.

i. In respect of the Table 5 header, please state what processes other that dilution include. In the response, please provide specific details.

j. Page 7 states: *'it remain unclear what fractions of this reduction are attributable to the overland flow system vs. natural biological processes in the pond'*. This is repeated in the memo summary on page 8. On the basis of these statements and memorandum 3 (an incomplete assessment of the OFS), it is evident that the OFS assessment needs to be fully completed, with corresponding ecological, water quality, and modelling assessments updated accordingly, noting that the outcomes of the performance assessment of the OFS has a strong bearing on the assumptions incorporated into the ecological and modelling reports. Please address this.

<u>Human Health</u>

35. The assessment of microbiological effects and health risk from NIWA, dated April 2024 (**the health risk report**) has only considered norovirus (oral digestion route) in its quantitative microbial risk assessment (**QMRA**) through the swimming route. Justification has not been provided as to the

reason adenovirus (inhalation route) has not been included in the QMRA at the same time. Please address this.

36. The health risk report has not included emerging organic contaminant (**EOCs**) in its health risk assessment. The ecological report has estimated the ecological risk of EOCs in the proposed Beachlands WWTP discharge to the receiving environment based on monitoring of pharmaceuticals and personal care products at Beachland WWTP as well as literature on EOCs in wastewater from other WWTPs. Please provide a further health risk assessment in terms of EOCs.

37. The health risk and ecological reports show that the Kellys Beach location has been excluded from its QMRA for consumption of shellfish since juvenile cockles and pipi present there were found to not be near harvestable sizes. The reports consider that it is unlikely that shellfish are harvested from Kellys Beach for human consumption.

    However, the consent is for 35 years, and during this period of time, shellfish are expected to grow and reach harvestable sizes. The health risk report shows that an increase in flow will result in a noticeable increase in risk in marine environments than freshwater and shellfish at Kellys Beach are expected to be more likely to be influenced by the discharge as compared to the other three sites being assessed. Therefore, the QMRA should also include Kellys Beach in terms of shellfish consumption. Please address this.

38. The health risk report QMRA assessed the log reduction of norovirus required to reduce the added risk of infection to <1% for individual exposure (swimming, or consumption of shellfish or watercress) at each of the assessment sites. The report has not assessed the overall health risk from all the potential exposure routes. Please address this and include aggregated exposures into the assessment.

39. The health risk report has assessed microbiological water quality against Table 9 of the NPSFM. It states that: '*there are national targets for 80% of rivers to be suitable for swimming (blue, green and yellow category) by 2030 (Ministry for the Environment 2023)'.* The report uses a 95th percentile of 1,200 cfu/100ml as a national bottom line. This does not appear to accord with the NPSFM and the *Ministry for the Environment and Ministry of Health (2003) Microbiological Guidelines for Marine and Freshwater Recreational Areas (**MfE/MoH guideline**).* Please address this.

    Note:

    It is noted that the NPSFM has two *E. coli*-based metrics associated with human contact recreation. Table 9 applies year-round across all Freshwater Management Units and is assessed against selected State of Environment data on a monthly basis. While Table 22 applies over the summer bathing season at primary recreational contact sites, it specifies 95th percentile of 540 cfu/100ml as a national bottom line for freshwater contact recreation. This latter figure is consistent with the MfE/MoH guideline and will likely trigger a health warning if exceeded. Therefore, it is considered that using 95th percentile of 1,200 cfu/100ml as a trigger for swimmable is inappropriate, notwithstanding that it is understood that the stream is unsuitable for swimming largely due to microbiological input from the wider catchment.

40. With respect to human health risks from viruses in relation to coastal marine environment, the following assessment is provided within the ecological report:

> *'For marine sites log reductions ranged from 2-3 Kelly's Beach transect sites (depending on discharge scenario), but less than 1 for those further out in the bay and for all discharge scenarios.*
>
> *For shellfish consumption, an LRV (log reduction value) of 1 is sufficient to provide a risk of <1% for the current discharge scenario at all marine sites, while this increases but is below 2 for interim and Stage 2 discharge scenarios.'*

What does this mean for the people swimming at the beach sites and how will the health risks be managed? Please also clarify and assess the risk associated with shellfish consumption.

41. Please provide an assessment of risk to human health for shellfish gathering, applying the MfE (2003) Section F Microbiological Guidelines for Shellfish-Gathering Waters.

Environmental Management

42. In accordance with the proposed monitoring plans in Section 10 of the AEE, please provide draft plans for the following:

- Environmental management plan (overarching).
- Environmental monitoring plan.
- Operational management and contingency plan (**OMCP**).
- Overland flow design and operation management plan (noting this is a proposed co-design with Ngāi Tai ki Tāmaki), and indicate the timeframes for this development:
  - Riparian management plan (for the expanded OFS).
  - Earthworks management plan , including erosion and sediment control (for the expanded OFS).
- Draft consent conditions.

It is requested that you either provide this information, in writing, within 15 working days, or contact me to arrange an alternative timeframe.

Please note that pursuant to Section 95C of the Act, if the information is not or will not be submitted within the 15-day timeframe and an alternative timeframe has not been agreed, the application must be publicly notified. Please contact me as soon as possible to confirm that the information will be provided either within the 15 working days of the request or to agree alternative timeframes for the provision of the information requested.

If you do not reply in writing within 15 working days, or refuse to provide the information, the Council reserves the right to decline your application under Section 92A(3) of the Act, should it consider that it has insufficient information to enable it to determine the application.

Your attention is also drawn to the provisions of Sections 357A(1) and 357C of the Act which set out the rights of objection against this request for information.

Please also note that, pursuant to Sections 37 and 37A(3)(4) of the Act, the Council has determined that it is appropriate to double the timeframe available to notify this resource consent application given the special circumstances associated with it. These special circumstances are the complexity of the application and the level of assessment required to fully assess and evaluate its merits.

In extending this timeframe, the following matters have been considered:

- The interests of any person who may be affected by the extension.
- The interests of the community in achieving an adequate assessment of the proposal.
- Council's duty to avoid unreasonable delay.

The new timeframe within which the Council has to make a decision on notification of the application under Section 95 of the Act is 40 working days.

Pursuant to Sections 88B and 88C of the Act, the application is "on-hold" until all matters have been addressed.

If you wish to discuss the matters, please do not hesitate to contact me.

Yours sincerely
Mark Ross
Consultant Planner, Auckland Council

ATTACHMENT 16

WSL SECTION 92 RESPONSE
14 OCT 24

Watercare Services Limited
73 Remuera Road, Remuera,
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Private Bag 92521, Victoria Street West,
Auckland 1142, New Zealand
Telephone +64 9 442 2222
www.watercare.co.nz

14 October 2024

Warwick Pascoe / Mark Ross
Auckland Council
Private Bag 92300
Victoria Street West
Auckland 1142

Dear Warwick / Mark,

Beachlands Wastewater Treatment Plant Discharge Consent – DIS60433803

The following sets out Watercare's response to the Section 92 requests received by email on 30th July in relation to the Beachlands Wastewater Treatment Plant discharge consent.

The only technical report that has been updated based on the s92 questions and discussion with the Council Specialist (on 06/09) is the Ecology Assessment prepared by Streamlined. This report can be found in Attachment 1 of the s92 response. Additionally, see clarification below on the average flow and maximum flow.

A set of definitions is provided in the draft conditions.

Clarifications:

Average flow is referred to as the Annual Average Dry Weather Flow

Annual Average Dry Weather Flow (ADWF):
Annual Average Dry Weather Flow (**ADWF**): Average dry-weather flow means the flow in the wastewater network that would occur during a normal day in a dry weather period (i.e. three consecutive days of less than 5mm rainfall per day), including wastewater, trade waste and an allowance for groundwater infiltration.

For the purposes of compliance, the annual average dry weather flow shall be calculated every Calendar year based on the average dry weather flow recorded during the past year.

Maximum flow is referred to as the Peak Wet Weather Flow

Peak Dry Weather Flow (PDWF):
Peak dry weather flow is the peak flow to the wastewater treatment plant that would occur during a normal dry weather day.
Peak Wet Weather Flow (PWWF):
Peak wet weather flow is the peak flow to the wastewater treatment plant that would occur during wet weather.

Attachments:

1. Response to Q1 – Ecological Assessment v4 – October 2024
2. Response to Q6 – Vegetation Map
3. Response to Q8 – EOC sediment & biodata accumulation
4. Response to Q24 – DHI Te Puru
5. Response to Q30 – Beachlands FDC's and Methodology
6. Response to Q31 – CSM Schematic
7. Response to Q32 – OLFP Performance Investigation

8. Response to Q36 – Human Health Risks from EOC's
9. WSL Draft Consent conditions

Note: A draft s92 response was shared prior to the meeting with Auckland Council specialists on 06/09/2024. Following our discussions, a number of the s92 matters were resolved and these are marked as closed in the responses below.

I trust that the information and responses provided satisfies the further information request. However, if there are any further queries please do not hesitate to get in contact.

Yours faithfully,

Anshita Jerath

Senior Planner

Watercare Services Limited

<table>
<tr><th></th><th>Request</th><th>Response</th><th>Completed</th></tr>
<tr><td colspan="4">Freshwater Ecology</td></tr>
<tr><td>1.</td><td>The submitted water quality, ecological, and human health effects assessment from Streamlined Environmental Limited, version F3, dated 27 May 2024, (the ecological report) states that the levels of a number of key nutrients are trending upwards due to increased discharge volumes in the current system. The primary ecological concern is that there appears to be limited certainty in respect of the length of time that Stages 1 and 2, and Stages 3 and 4 will be implemented. The noted issues of concern are:
• The assessment of actual and potential affects for Stages 1 and 2 apply the same operational limit of contaminant assessed, despite increased volume and load (coupled with increasing contaminant concentrations for several parameters).
• Stages 3 and 4 also apply the same operational limit for the assessment of actual and potential effects, also with an increased volume and contaminant loads. This Stage 3 and 4 effects envelope forms the focus of much of the assessment.
In addition, for all stages, it appears that an envelope of assessment that treats all discharges at maximum daily discharge flow has been applied. An indication of the average daily discharge flow and the maximum daily discharge flow would be useful in order to contextualise the likelihood / frequency of these different volumetric discharges, and how different these might occur in</td><td>In response to Q1 a, b and c - The Streamlined Ecological Effects assessment report has been updated to clearly delineate all four stages of the assessment. Refer to Attachment 1 for the report.

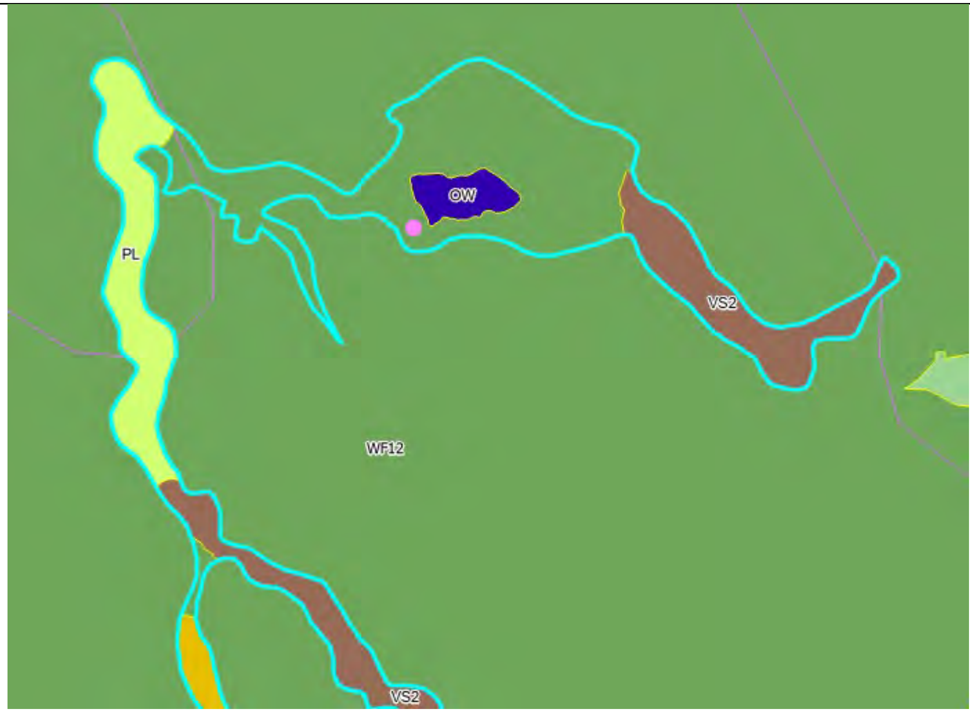
The table below provided an indication of the dry weather and wet weather discharges over the last 6 years.

<table>
<tr><th>Year</th><th>Average Dry Weather Flow</th><th>Peak Wet Weather Flow</th><th>Days above 2,200m^3/d</th></tr>
<tr><td></td><td>m^3/d</td><td>m^3/d</td><td>days</td></tr>
<tr><td>2019</td><td>1,830</td><td>3,420</td><td>117</td></tr>
<tr><td>2020</td><td>1,675</td><td>3,801</td><td>81</td></tr>
<tr><td>2021</td><td>1,809</td><td>3,601</td><td>88</td></tr>
<tr><td>2022</td><td>1,970</td><td>4,257</td><td>132</td></tr>
<tr><td>2023</td><td>2,063</td><td>4,331</td><td>144</td></tr>
<tr><td>2024</td><td>1,997</td><td>3,922</td><td>85</td></tr>
</table>
</td><td></td></tr>
</table>

	practice so that the ecological implications can be assessed. Accordingly, please provide: a. an updated ecological impact assessment that considers effects associated with the stage 1 and 2 average daily and maximum daily flow states; b. an updated ecological impact assessment that considers effects associated with the stage 3 and 4 average daily flow states and how those relate to the maximum daily flow states (as only the maximum daily flow has been considered in the envelope of effects approach); and c. clarification of what population will trigger the proposed upgrades that will take flows from stage 2 and beyond. For example, the assessment of environmental effects (AEE) states that upgrades will be initiated prior to population equivalent (PE) 18,000 but does not state when and only notes that they will be operational at PE 24,000. As such, there is a potential period of time between these two triggers that has not been adequately assessed. In the response, please include details as to when such upgrades will occur and an associated assessment.		
2.	The baseline condition of the upstream reaches of the subject stream system (baseline condition) is reported to be degraded by existing land practices. However, the submitted ecological report suggests that the stream's ecological values might be moderate, which is characteristic of a valued freshwater system. Accordingly, please provide further evidence beyond water quality, macroinvertebrate, and fish data and analyse it to determine the baseline ecological value of the stream	A moderate value stream can be degraded through the land use practices, which the expanded stream value assessment from Boffa Miskell recognises "a watercourse which contains fragments of its former values but has a high proportion of tolerant fauna, obvious water quality issues and/or sedimentation issues. Moderate to high degradation e.g. high-intensity agricultural catchment". The Te Puru Stream tributaries range from low to moderate ecological values, based on the presence of / lack of riparian vegetation; hard substrate; sustained water; fish habitat; macroinvertebrate habitat; erosion; ecological connectivity etc. It is acknowledged that the stream surrounding land use practices have degraded the quality of water.	

	using a value assessment framework that provides line of sight on the key contributors to ecological value. Furthermore, the National Policy Statement for Freshwater Management (NPSFM) requires assessing the effect on the potential ecological values of freshwater features. Please update the ecological report to assess the potential ecological value of potentially impacted freshwater ecosystems and consider effects on the potential ecological values. Note: the EIANZ provides a framework to determine freshwater ecological values. In addition, Boffa Miskel has advanced the EIANZ Ecology Impact Assessment framework for rivers and stream, which has been subsequently adopted by several consultancies. Council can provide this advanced framework if required.	Site A and Site E, which is outside the influences of the WWTP experienced high faecal coliform concentrations; also, to note is that despite the conductivity at these two sites being below the highly elevated levels of that at the influenced sites, these were still elevated and above the ANZG 80th percentile DGV. pH at Site A was very low and well below the DGV values. Only 3 to 4 fish species were sampled within the community, overall: thus, no clear trend of a higher diversity above the influences of the WWTP vs. below. The potential of streams is an estimate of the values or increase in ecological values under good land use practices i.e. in a rural environment such as this, fencing from stock and some degree of riparian planting. With good land use practices the potential of the stream would be or remain moderate. Stock are already excluded from most of the stream, and parts of the stream have been planted, for example the area downstream of the discharge from the large pond and downstream of the access road into the WWTP. Additional riparian planting will result in some ecological benefits such as an increase in shading, reducing the macrophyte growth and providing some temperature control in summer; additional aquatic habitat inputs, such as leaf litter, woody debris and woody habitat; and increase in filtration resulting in some reduction of nutrient inputs and other contaminants from the surrounding farmland.	
3.	Please provide the stream ecological value (SEV) scores for each survey site identified in Figure 29 of the ecological report. This will allow for a review of the various positions and justifications presented within the ecological report, such as shading, vegetation coverage, benthic structure, water depths, and stream profiles. Please also ensure that the SEV calculator is included.	No SEV's were undertaken. No reference to SEV's have been made in the EcIA or AEE. The biomonitoring measures many of the functions that are included within the SEV, i.e. widths, depths, flow, substrate, macrophytes, macroinvertebrates, fish, and records general information on the riparian vegetation. This information is readily available in the Biomonitoring Reports, including photographs of the site, from which parameters such as the quality of the riparian vegetation and degree of shading can be easily determined. This detailed information should be more than sufficient for an experience freshwater ecologist (both from Council and the Applicant) to verify the various positions and justifications presented within the ecological report.	
4.	It has been assessed that the farm pond may throttle high flow discharges. Please provide an explanation and assessment of whether fish passage over the structure	The farm pond provides continuous unimpeded flow via the stream outlet. No fish passage structure is required or proposed as the proposal will not impact the stream outlet from the pond.	Closed

	is available, and a description of the passage structure if proposed. It should be noted that in order to comply with applicable regulations under the Auckland Unitary Plan (Operative in Part) (AUP(OP)), dams higher than 4m should provide fish passage.		
5.	Please provide an ecological value and effect assessment of the discharge on various significant ecological areas at each stage.	Discharges should be confined to the stream banks, with the SEA-Terrestrial (SEA_T_428) experiencing no direct or permanent/consistent effects from the discharge. Effects of the discharge to the SEA will occur through uptake of nutrients via riparian yard root zone or overtopping banks during flood events. Given that uptake through the root zone would be limited to those species immediately along stream edges, should there be any affects, it is expected to be limited to those specific species. SEA_T_428 is based on the area meeting Criteria 2B, threatened species, and Criteria 3A, habitat diversity. The listed threatened species for the site are longfin eel (classified as 'At Risk – declining) and koura (classified as 'Not Threatened'. Both species are present throughout the catchment and not uncommon within the district. The habitat diversity criteria are *VS2, UC*. VS2 is 'kanuka scrub and forest ecosystem' which is listed as a regenerating ecosystem with a threat status of 'Least Concern', the entirety of which is located well above the discharge point from the pond; and UC, unclassified, much of which is shown on the GeoMaps biodiversity layer as 'planted'. Refer figure below). The ecological effects of the discharge on the terrestrial values of the SEA-T will be negligible, primarily due to the low threat status and lack of proximity of the discharge to the VS2 habitats, and on the aquatic values i.e. native eels, will be low, as neither of the main triggers for their decline, i.e. habitat loss and overfishing will be changed with the proposal. It should also be noted that the tributary that originates above the pond would be dry for some of the year without the input from the WWTP. Figure 1: SEA_T_428 Ecosystem Extent and point of discharge from the pond (purple dot). Source Map – Auckland Council GeoMaps.	

			
6.	It is understood that the land disposal element of the proposed discharge system will avoid natural inland wetlands, in that it will be located a minimum of 100m from them. Please provide further evidence, which could include mapping the extent of the disposal area against landscape features, to confirm that there will be adequate land available to achieve this set back from all natural inland wetlands. Alternatively, please provide an addendum that addresses this, including any necessary consents under the National Environmental Standards for Freshwater and an associated effects assessment.	The discharge of wastewater to the overland flow slopes may occur within 100 m of a natural inland wetland. However, there will be no hydrological link between the discharge and any natural inland wetlands. Any wastewater discharged to new overland flow areas will be captured and conveyed to a controlled discharge point in the farm pond. PDP has surveyed vegetation within the vicinity of the existing and proposed discharge areas. The results are provided in Figure 1 of **Attachment 2**. The following vegetation types were identified: 1) Exotic Pasture Grassland 2) Soft Rush - Mercer Grass - (Water Pepper) Rushland 3) Ti Kouka - Kohuhu / Harakeke Herbfield	

4) Crack Willow (>50%) - [Kanuka] / Water Pepper - Creeping Buttercup Treeland
5) Creeping Buttercup - Water Pepper - (Soft Rush) Herbfield
6) Kanuka / Manuka / (Woolly Nightshade) Shrubland
7) Pine (>50%) / Kanuka / Manuka - Woolly Nightshade Forest
8) Carex Geminata Sedgeland
9) Raupo Reedland
10) Grey Willow / Harakeke - Raupo Treeland
11) Poplar - Oak Exotic Treeland
12) Kahikatea / Kanuka - Manuka Forest

The vegetation types names follow Atkinson (1985), thus the order and symbols reflect dominance. This is relevant because the mix of dominant species determines whether an area is a wetland or not, i.e. if a species is an obligate (OBL) or facultative wetland (FACW) species (Clarkson et al., 2021). Areas with vegetation types 2, 4, 8, 9 and 10 on the map were identified as wetlands under the RMA based on the Rapid Test or Dominance and Prevalence tests (MfE, 2022). Areas with vegetation type 5 could also possibly be wetlands but the balance of wetland to non-wetland dominant species was marginal. Vegetation areas 9 and 10 are thought to be constructed or induced wetlands.

In vegetation area 2 (Soft Rush - Mercer Grass - (Water Pepper) Rushland), in the gully between areas B1 and B2, three representative samples (2 x 2 m plots) were taken. The results for the sample at the gully head came out as "improved pasture" so the extent of this wetland area could be reduced by approximately 75 m back towards the stream.

The catchment for the wetland area between B1 and B2 has also been mapped and is included in Figure 1. Area B2 is the preferred expansion area. If, during the detailed design, any impact on the hydrology of the existing natural wetlands cannot be avoided, then a consent will be sought at that time, along with any other relevant construction phase consents including earthworks or vegetation clearance consents.

Wetland delineation data sheets for the wetlands in the catchment – provided. The wetlands that meet the MfE Wetland Delineation Protocols (2024) are provided, including a summary of the plots and where appropriate, hydric soil and hydrology data. The plans accompanying

		the wetland delineation data sheets identify the location of the wetland plots and they are all further than 100m from the deliberately constructed water body where treated wastewater has been discharged since the construction of the Beachlands WWTP. Beachlands/Maraetai WWTP constructed treatment pond and associated wetlands are constructed wetlands under NPS-FW definition 3.21. **NPS-FM natural inland wetland 3.21** Natural inland wetland means a wetland (as defined in the Act) that is not: a. in the coastal marine area; or b. a deliberately constructed wetland, other than a wetland constructed to offset impacts on, or to restore, an existing or former natural inland wetland; or c. a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body; or d. a geothermal wetland; or e. a wetland that: (i) (ii) (iii) is within an area of pasture used for grazing: The WWTP pond is "a wetland that has developed in or around a deliberately constructed water body, since the construction of the water body;" Auckland Council have provided no evidence that these constructed wetlands surrounding the constructed pond have been induced and PDP staff (and other consultants) in the field have not observed that the constructed wetland area is notably "higher" up than the pond. Consequently, the wetlands around the constructed wastewater discharge pond are not natural inland wetlands (NPS-FW 3.12 (c)). PDP's ground-truthing has identified NPS-FM natural inland wetlands on the site, and we consider that treated wastewater from the overland flow area will avoid these natural inland wetlands as it is directed to the constructed treatment pond. AC have also raised the matter of whether the constructed wastewater discharge pond is a SEA under the Auckland Unitary Plan. Beachlands/Maraetai WWTP constructed treatment pond and associated wetlands have been in place well before the Council's SEA surveys in 2012-3.	

		SEA wetland (Ch L Schedule 3, Auckland Unitary Plan only) SEA_T_428 appears to have only been mapped from aerial coverage with no ground-truthing to verify that it meets any of the SEA factors or sub-factors. Auckland Council SEA assessors appear to have been unaware that the WWTP constructed pond and wetland were part of the existing infrastructure, deliberately constructed water body and NOT a "natural ecosystem".	
		Water Quality – Emerging Contaminants	
7.	Section 5.3.5 of the ecological report refers to the concentration and resulting high risk quotient for venlafaxine as being an anomaly. Please indicate how this value compares to other wastewater treatment plants (WWTP) as reported in Table 5 (if data are available), or other applicable data sets in New Zealand.	To clarify we stated in Section 5.3.5 that "As shown in **Table 17**, the only RQ >1 in the outlet is venlafaxine with an RQ of 1.7. Interestingly the RQ for venlafaxine in the farm pond is 23.1, but at the Bridge site it is 0.34 (**Table 17**). There is large variation in the two venlafaxine measurements (600 ng/L on 10th November and 40,000 ng/L on 11th November), with the latter value driving the high RQ at this site. This is likely an anomaly as there is a general significant attenuation between the farm pond discharge point and the Bridge site for PPCPs with an average of 2.9-fold reduction (see Section 4.4.1.5)." The anomaly is the value of 40,000 ng/L and is clearly an outlier based on the other measurements and the general attenuation observed from discharge and through the receiving environment. To our knowledge there are no publicly available data on venlafaxine in wastewater in New Zealand. However, Watercare have undertaken measurements of venlafaxine in effluents from 4 WWTPs: Army Bay; Mangere; Rosedale; and Warkworth. These data were provided to Streamlined Environmental Ltd for another project. Average concentrations (N=2) ranged from 200-700 ng/L at these WWTPs. The average concentration (N=2) from Beachlands WWTP effluent is 1500 ng/L. Internationally, a review by Melchor-Martínez et al (2021[1]) reported venlafaxine of 788–2982 ng/L in effluent from 5 sewage treatment plants in Canada.	Closed

[1] https://www.sciencedirect.com/science/article/pii/S2666016420300724

		This provides strong evidence that 40,000 ng/L for venlafaxine for one sample from the farm pond is an anomaly.	
8.	Sediment bioaccumulation risks of emerging organic contaminants (EOCs): Based on the authors' knowledge about sediment bioaccumulation of EOCs and available data, please provide an assessment as to the risk / potential of analysed personal care products and pharmaceuticals (PCPPs) (and other EOCs, where applicable) in the Beachlands WWTP discharge to sediment bioaccumulation in the downstream receiving environment, both at the Bridge Site (Site 15) and estuary.	Response has been prepared as an attachment. Refer to **Attachment 3**	Closed
	Water Quality – Staged Assessment		
9.	Table 6 of the ecological report sets out the operational limits for key contaminants, with footnote 13 cross referencing Stantec and Watercare. Please provide the rationale / justification for the Operational Limits presented in Table 6. Please include the process by which these limits were reached.	The proposed operational / consent concentrations have been based on the effluent quality that can be reliably achieved with the treatment technology at a given stage of the WWTP upgrade. The current operational limits are a rollover of the existing consent. The short-term upgrade limits are based on an improved concentration limit. These limits reflect the fact that the short-term upgrade will include capacity and minor upgrades to the existing plant. The long-term Stage 1 and Stage 2 operating limits reflect the improvement in treatment performance that is anticipated with the implementation of the new membrane bioreactor (MBR) technology that will be built as part of the long-term upgrade. These proposed operating limits proposed are in line with other WWTPs with a similar treatment technology. The operating limits on flow reflect the population growth that is anticipated at various stages. The proposed operational / consent concentration values were reached by a combination of local Watercare operational experience and known wastewater treatment technology performance.	

		Because the proposed operational / consent concentrations are technology based, the values do not change within a given technology (i.e. current WWTP or new WWTP). The WWTP upgrades will be designed to ensure that these limits will be met at all populations up to their respective design populations.	
10.	Please explain why there is no differentiation in the operational limits between: • 'Current and Short Term', noting this represents an increase from PE 11,000 to PE 18,000; and • 'Long term Stage 1 and Stage 2 ', noting this represents a PE 24,000 to PE 30,000	A staged approach to the upgrade of the Beachlands WWTP has been adopted to facilitate the anticipated growth that is expected in the existing WWTP catchment and the new Beachlands South development. Two sets of operational limits have been proposed to reflect the effluent quality of the treatment technologies at the different stages of the upgrade. In the short term an upgrade of the existing plant will be completed to increase the current capacity of 11,000 PE to 18,000 PE. This will facilitate growth in the short term while the design and construction of Stage 1 of the long-term upgrade is completed. The proposed 'Short Term' consent limits reflect the expected effluent quality based on the treatment process of the existing plant and have been based on the current consent conditions. The long-term upgrade strategy for the WWTP is to build a new treatment plant that includes a membrane bioreactor (MBR) technology. The proposed 'Long term Stage 1 and Stage 2' operational limits reflect the improved effluent quality that can be achieved with the MBR. The new MBR plant will be built in two stages to align the capacity of the plant with the anticipated population growth. As the treatment technology for Stage 1 and 2 of the long-term upgrades is the same, the proposed operational / consent limits for the two stages are also the same.	
11.	The last bullet point on page 10 of the ecological report refers to TN, Amm-N and Nitrate-N concentrations are at Attribute Band B; and dissolved inorganic nitrogen (DIN) at levels expected to contribute to eutrophication (noting here that DIN is the sum of nitrite-nitrate-nitrogen (NNN), ammoniacal-nitrogen (Amm-N) and nitrate-nitrogen (Nitrate-N). Noting the current state assessment has been provided for PE 11,000, what are the expected concentrations (median, average, 95th percentile) and	This is related to Q1 and will be provided in the updated effects assessment report. Note: Table 16 has this for nitrate and DRP. Ammonia is not applicable, and we discussed this in the report.	

	annual average loads of all key contaminants at the following stages: • PE 18,000 (prior to the long-term upgrades being operational). • PE 24,000 • PE 30,000 In the response, please provide an assessment of the water quality (with corresponding attribute state and other relevant benchmarking) at each PE threshold (PE 18,000, PE24,000 and PE30,000), for the following locations: • The treated effluent discharged from the WWTP (prior to overland distribution) • Treated effluent after overland flow, prior to discharge to the Farm Pond (noting this is also pending the final PDP assessment) • Farm Pond (Site B) • Discharge to the Te Puru Stream (exiting the farm pond) • At the Bridge Site (Site 15, zone of mixing) • Quarry Site Te Puru Estuary		
12.	What is the expected percentage increase in DIN (noting that is it over 90% Nitrate-N), and what is the proportional increase in risks to eutrophication at the mixing zone (Site 15) and Te Puru Estuary.	There will be a decrease in nitrate-N (and by inference DIN) from the current situation once the operational limits are introduced. We covered this in section 5.3.2.3 of the effects assessment report (V3 submitted) and have provided further clarification in the updated report (V4: to be submitted alongside these responses). We stated "The currently measured median DIN concentration in the WWTP discharge and the Bridge Site is 5.5 mg/L and 1.7 mg/L, respectively. The Bridge Site concentration is well above the accepted threshold for a degraded water body and eutrophication (1 mg/L). The proposed operational maximum DIN in the WWTP discharge during all stages of the upgrade: 4.1 mg/L for the Existing and Short-Term Stages and 2.5 mg/L for the new MBR Long-Term Stage 1 and 2 Stages, will be a reduction on what is presently in the WWTP	

		discharge (5.5 mg/L). This will result in a mean DIN concentration at the Bridge site from the proposed discharge of 1.3 mg/L for the Current and Short-Term Stages and 0.8 mg/L for the new MBR WWTP (Long-Term Stages 1 and 2), respectively (Table 17). We note that these proposed operational medians will require an improvement on the present DIN WWTP concentration of 5.5 mg/L. DIN would still be above the accepted threshold for a degraded water body and eutrophication for the Current and Short-Term Stages (but an improvement on current state) but below the same threshold for the new MBR WWTP (Long-Term Stages 1 and 2)." Te Puru Estuary site is covered in Section 5.5.1, stating (in V4 of the report which now has future stages included) "Concentrations of nitrogen (TN and nitrate-N) and phosphorus (TP and DRP) show a clear decrease in concentration down Te Puru stream with increasing distance from the WWTP due to dilution (See Section 4.4.1.2). Concentrations will be further decreased by rapid mixing with coastal waters. The levels of dilution in coastal surface waters predicted by DHI for the current WWTP discharge and proposed for the upgraded Short-Term, Long-Term Stage 1 and Long-Term Stage 2 are shown in Table 21." At the existing Short-Term Stage, the 50th percentile dilution factor at Te Puru stream mouth is 1,352×, which increases to 13,302× midway down Te Maraetai/Kellys Beach (northern transect), and to over 675,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach). Given a median discharge concentration of 7 mg/L for TN in the treated wastewater, concentrations due to the WWTP will be approximately 0.005 mg/L at Te Puru stream mouth, 0.0005 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.00001 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 1.0 mg/L in the treated discharge to approximately 0.0007 mg/L at the Te Puru stream mouth, 0.00008 mg/L at the northern transect on Te Maraetai/Kellys Beach, and <0.000001 mg/L in the neighbouring bays. At Long-Term Stage 1, the 50th percentile dilution factor at Te Puru stream mouth is 831×, which increases to 7,928× midway down Te Maraetai/Kellys Beach (northern transect), and to over 427,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay,	

		and Omana Beach). Given a median discharge concentration of 5 mg/L for TN in the MBR treated wastewater, concentrations will be approximately 0.006 mg/L at Te Puru stream mouth, 0.001 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.00001 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 0.5 mg/L in the treated discharge to approximately 0.0006 mg/L at the Te Puru stream mouth, 0.00006 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000001 mg/L in the neighbouring bays. At Long-Term Stage 2, the 50th percentile dilution factor at Te Puru stream mouth is 309×, which increases to 2554× midway down Te Maraetai/Kellys Beach (northern transect), and to over 180,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach). Given a median discharge concentration of 5 mg/L for TN in the treated wastewater, concentrations will be approximately 0.016 mg/L at Te Puru stream mouth, 0.002 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000028 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 0.5 mg/L in the treated discharge to approximately 0.0015 mg/L at the Te Puru stream mouth, 0.00019 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000003 mg/L in the neighbouring bays." We note that DIN was not included in the discussion. However, using the same 50th percentile dilution of 309x at Te Puru Stream mouth, and Short-Term and New WWTP (MBR) operational limits for DIN of 4.1 mg/L and 2.5 mg/L, respectively, concentrations at Te Puru Stream mouth will be approximately 0.013 mg/L (existing) and 0.008 mg/L (New WWTP (MBR). Therefore, DIN concentrations at this site (attributable to Beachlands WWTP) will be extremely low, lower than present, and expected to contribute a negligible amount to eutrophication in the estuary. As a side note, the design population for the Short-Term Upgrade (18,000 PE) was selected to accommodate the highest expected initial development rate of the Private Plan Change 60 housing development. This population also aligns with the maximum	

		that can be catered for by the existing WWTP without constructing major new civil infrastructure.	
13.	What are the likely drivers of significant trends in increasing Nitrate-N and dissolved reactive phosphorus (DRP) in the discharge quality? Please provide an assessment of how this is likely to track up to PE 18,000 and up to the new long-term upgrades becoming operational.	In 2022 carbon dosing source was changed from Methanol to Acetic Acid. The dosing regimen also changed from continuous to a setpoint based dose. The current setpoint is based on meeting the consent condition. Nitrate can be controlled by increasing the carbon dose. We will dose the appropriate volumes to meet the consent conditions, and this will be covered in the OMP. Part of the upgrade to the WWTP will include review of the chemical dosing and chemical storage.	
14.	Two bullet points on page 15 of the ecological report appear contradictory in that the first point refers to Amm-N as having an overall low contribution of 0.5% and unlikely to be significantly contributing to Amm-N downstream, but the second point refers to pond processes will increase Amm-N. Based on these statements, please provide: • a detailed explanation of the processes in the pond (likely ammonification processes – what is driving this, and can it be mitigated?) that will continue to increase Amm-N; • an estimate of Amm-N concentrations in the downstream receiving environment; and an assessment of how Amm-N concentration and loads in the farm pond will likely change over time as a result of increasing loads at PE 18,000, PE 24,000 and PE 30,000, and the capacity of the farm pond and upgraded overland flow system (OFS) to attenuate elevated Amm-N loads.	P52 of the affects assessment report discusses this. "With low concentrations of ammoniacal-N in the existing WWTP discharge it is clear that the farm pond is forming ammoniacal-N, presumably from nitrogen cycling processes such as ammonification of organic nitrogen formed from decomposition in the pond. It is only in the farm pond that concentrations of ammoniacal-N could be potentially toxic. Further, the WWTP is providing a low proportion of ammoniacal-N to total nitrogen (ca. 0.5%) being discharge from the WWTP. Therefore, the existing discharge from the Beachlands WWTP is unlikely to be significantly contributing to ammoniacal-N concentrations downstream." Regarding the first point, this was described on p51 in detail " The nitrogen cycle is complex with multiple species of N present, such as inorganic nitrogen – ammoniacal-N, nitrate-N, and nitrite-N – and organic nitrogen (consisting of many organic nitrogenous chemicals including amino acids, proteins, and other biological metabolites). Further, the nitrogen cycle (see Figure 1 below) will interconvert inorganic nitrogen species through processes such as nitrification, denitrification, and dissimilatory nitrate reduction to ammoniacal-N. Ammoniacal-N can also be formed from ammonification of organic nitrogen formed from decomposition of organic material." In terms of mitigation, we do not consider this necessary as the trend data (2020 to 2023) shows a 0% annual change in ammoniacal-N concentrations at the farm pond site. Further, there is low toxicity from site 15 which reduces further downstream (see next point). Finally, with population increase, a new overland flow system will be constructed. How this affects concentrations of all toxicants is unknown at this stage but we expect that treatment efficiency will be at the same level as current.	Closed

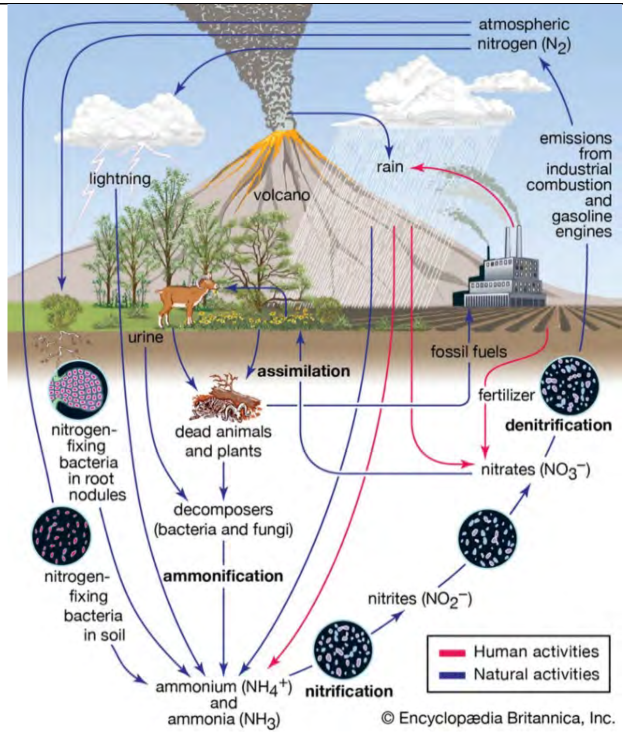


Figure 2: The nitrogen cycle.[2]

Regarding point 2, ammoniacal-N has been measured at downstream receiving environments so no need to estimate it (see Figure 19 of report). We reiterate the above statement that only in the farm pond that concentrations of ammoniacal-N could be potentially toxic, with concentrations at site 15 (proposed mixing zone) in NPS-FM attribute band B.

Regarding point 3, the Beachlands WWTP currently produces effluent with a very low level of ammoniacal-N. Based on the overland performance investigation, the overland

[2] https://www.britannica.com/science/nitrogen-cycle

flow slopes are effective at further reducing ammoniacal-N concentrations (see table below).

Table 1: Nitrogen Removal Efficiency by Overland Flow Slope Zone

Parameter	Zone A	Zone B	Zone C
Nitrate-N	21%	14%	4%
Total Nitrogen	24%	17%	6%
Ammoniacal-N	36%	55%	26%

Notes:

As discussed above, ammoniacal-N concentrations increase in the farm pond. The results from the performance investigation are presented below.

Table 2: Median Ammoniacal-N Concentrations (g/m³) Across Overland Flow System

WWTP Effluent	Zone A	Zone B	Zone C	Pond Outlet
0.057	0.030	0.030	0.044	0.102

Notes:

It is expected that in the future, the overland system expansion will continue to enable the slopes to efficiently reduce ammoniacal-N concentrations. This combined with low ammoniacal-N concentrations in the WWTP effluent is expected to result in very low concentrations of ammoniacal-N in the run-off from the slopes.

The effects of the increasing flows/loads on nitrogen cycling in the pond are difficult quantify. It also appears that the level of ammoniacal-N generation in the pond varies significantly as evidenced by the differences between the median concentrations reported in PDP Memorandum 2 and in the Performance Investigation Report (data presented above). It is possible that the generation of ammoniacal-N in the pond reduces as increasing wastewater flows reduce the residence time in the pond.

<table>
<tr>
<td>15.</td>
<td>With section 3.4 of the ecological report, the second bullet point makes reference to marked increases in DRP and Nitrate-N and refers to ‘operational changes and constraints’. Please provide details on what these ‘operational changes and constraints’ were, how these result in significantly increasing trends in DRP and Nitrate-N and explain what process will be put in place to mitigate the ‘operational changes and constraints’ prior to the upgrades being commissioned.</td>
<td>Refer to response in Q13.

The second part of the question is around how these changes affect trends. Trends are described in Section 3.1.5 of the effects assessment report, with nitrate (23.5% annual median increase between 2018-2023) and DRP (77.4% annual median increase between 2018-2023) the only significant increases over this time. It is clear from Table 2 and Figure 4 of the report that marked increases have occurred since 2022 for nitrate and 2021 for DRP.

Temporal trend analysis, using the same methodology as in the effects assessment report, was undertaken for DRP between 2018-2020 and 2021-2023, while for nitrate between 2018-2021 and 2022-2023 and results (Table 1) compared with the full dataset (2018-2023). The results show that DRP had a negative percent annual change between 2018-2023 (-3%) with an increase of 11% per year between 2021-2023, however none of these trends were significant. For nitrate-N there was a similar trend with an annual reduction of –4% between 2018-2020 and a 36% annual increase between 2021-2023. Only the 2021-2023 trend was significant (P<0.05).

The number of datapoints for each trend do not appear to influence the significance. For example, nitrate-N between 2018-2023 (N=48) has a non-significant trend, while between 2021-2023 (N=24) has a significant trend.

Therefore, the recent increases in DRP and nitrate-N are contributing to significant increases calculated between 2018-2023.

Table 1. Temporal trend analysis of DRP and Nitrate-N. Red highlighted text are significant (P<0.05).
<table>
<tr><th>Parameter/Date range</th><th>Method</th><th>N</th><th>Mean</th><th>Median</th><th>P</th><th>Percent annual change</th></tr>
<tr><td>DRP 2018-2023</td><td>Seasonal Kendall</td><td>72</td><td>0.35</td><td>0.28</td><td>0.000</td><td>24</td></tr>
<tr><td>DRP 2018-2020</td><td>Seasonal Kendall</td><td>36</td><td>0.22</td><td>0.20</td><td>0.880</td><td>-3</td></tr>
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DRP 2021-2023	Seasonal Kendall	36	0.47	0.49	0.299	11
NO3-N 2018-2023	Mann-Kendall	72	2.09	1.18	0.000	77
NO3-N 2018-2020	Mann-Kendall	48	0.86	0.37	0.715	-4
NO3-N 2021-2023	Seasonal Kendall	24	4.56	4.50	0.001	36

16. Please confirm if the Amm-N data in Table 8 are adjusted for pH? If not, please either make this adjustment or explain why it is not necessary to do so.

Ammoniacal-N concentrations in Table 8 of the effects assessment report were not adjusted for pH. We note that the NPS-FM attribute state for ammoniacal-N toxicity is based on pH 8 and a temperature of 20°C and that compliance with the numeric attribute states should be undertaken after pH adjustment but that a method for converting to standard temperature is not currently available.

The pH adjustment is required because unionised ammonia (NH_3) is more toxic than the ammonium ion ($NH4^+$) but the method of analysis does not differentiate between these two ammoniacal-N species. Therefore, the lower the pH, the lower the toxicity (a higher proportion of ammonium ion).

The Ministry for the Environment provides a guide to attributes in the NPS-FM, and specifically and appendix on ammonia adjustment calculations. The formula for pH adjustment is shown below. The ratio is a conversion ratio of the pH measured to pH 8 and is provided in a look up Table in pH increments of 0.1 from 6.0 to >9. Effectively, the ratio is >1 below pH 8 (reduces toxicity) and <1 above pH 8 (increases toxicity).

$$Conc_{pH\ 8} = \frac{Conc_{pH\ sample}}{Ratio} \qquad \text{Equation (1)}$$

It would be time consuming to perform ammoniacal-N adjustments for pH for each monitoring event as pH varies for each event. We note that for all sites where the receiving monitoring programme was undertaken between September 2023 and January 2024 median and 80th percentile pH ranges are 6.7-7.6 and 6.8-7.7, respectively.

		pH was below 8 on all but two occasions: pH 8.9 at the Quarry site on 13th November and pH 8.0 at Te Puru Park on 27th November. In summary, pH is almost always below pH 8 at the receiving environment sites, so an adjustment of ammoniacal-N to pH 8 will reduce concentration for attribute state comparison (and hence toxicity) accordingly. However, as the ecological effects assessment report is being updated, we will modify Table 8 to include pH adjusted ammoniacal-N concentrations (based on median pH at each site).	
Coastal Ecology			
17.	Based on the operational results provided for the existing discharge quality, it appears that the existing discharge volume has exceeded the consent limit, with potential adverse effects on the coastal environment resulting due to the exceedance in discharge quality. Without additional treatment for the existing discharge quality, the proposal may not be supportable. Accordingly, please provide the discharge volume (not average volume) and discharge quality for all four stages along with an assessment of the likely adverse effects.	Volume has exceeded consent limit not quality. In respect to effects, refer to Q1 above.	
18.	The submitted ecological report clearly identifies the current discharge quality and exceedances in respect of the ANZECC quality guidelines, as set out below: • Dissolved reactive phosphorus and nitrate-N have shown a marked increase in concentration between 2018-2023, with median annual increases of 24% and 77%, respectively. • Volume of discharge exceeded the maximum consented volume of 2,800m3/day. Table 1(section 3.13 Ecological Report) indicates the volume discharged was 5619m3 in 2018 and 4.331m3/day. • The discharge contains total copper, and total and dissolved zinc at concentrations above the	**Copper and zinc in freshwater and marine receiving environment** a. The daily volume of discharge from 2018 to 2023 almost doubled. Copper and zinc are toxic to marine life, with both exceeding the ANZEC guideline value in the existing discharge. We note that metal concentrations are not breaches as there are currently no consent conditions for metals in the discharge. It is not appropriate to compare WWTP discharge concentrations with ANZG (2018) DGVs as the DGVs are calculated for freshwater and marine species in their environment. Despite this, we note that "For the outlet, only total copper, and total and dissolved zinc exceed the DGV, at 1.3-fold, 2.0-fold, and 3.4-fold, respectively (Table 4)." These are minor exceedances. Further, metals were measured at the receiving environment sites (Table 9). We noted that "All metal concentrations were below the applicable ANZG 95% DGV.	Closed

	Australian and New Zealand Guidelines (ANZG) 2018 default guideline values. To achieve these standards some dilution and/or attenuation is required in the wastewater treatment system prior to discharge to the coastal receiving environment in order to meet these standards. • After attenuation through the overland and stream system, Total Nitrogen (TN) and Total Phosphorus (TP) loads contribute 32% and 44% of total load from the catchment to the marine coastal environment. In respect of these matters, please provide answers to the following questions: a. The daily volume of discharge from 2018 to 2023 almost doubled. Copper and zinc are toxic to marine life, with both exceeding the ANZEC guideline value in the existing discharge. There is no assessment in the AEE or ecological report to assist with understanding how the above breaches, including the exceedance of copper and zinc, could be avoided within the WWTP treatment during stages 1 and 2. Please provide this. b. While Membrane Bioreactor (MBR) treatment will reduce the nutrient level in the discharge, what is proposed to manage the exceedance in the total copper and zinc? c. Please provide the background level of TN and TP for the immediate receiving coastal waters and sediment. d. Please provide an assessment to understand the effects of TN and TP on the coastal marine	Chromium (total only), copper (total and dissolved) and zinc (total and dissolved) concentrations at the farm pond (B) site were more than 50% of the ANZG 95% DGV, but all had reduced to 50% or below by the Bridge site (15) site". So, an assessment of potential effects for metals was made based on monitoring data. We do not expect metal concentrations to increase over time and are likely to reduce once the MBR WWTP is commissioned (see next point). **Management of zinc and copper levels** b. While Membrane Bioreactor (MBR) treatment will reduce the nutrient level in the discharge, what is proposed to manage the exceedance in the total copper and zinc? As for the first point, we note that metal concentrations are not breaches as there are currently no consent conditions for metals in the discharge. We note that both copper and zinc have markedly higher total vs dissolved concentrations in the discharge (Table 4: copper 1.9/1.4 µg/L and zinc 28/16 µg/L for total/dissolved), so reducing particulate matter in the discharge will reduce discharge total metal concentrations. Total suspended sediment (TSS) will reduce from around 7 mg/L currently to 5 mg/L with MBR so, notwithstanding potential reductions from the MBR process over the current activated sludge process, total metal concentrations will reduce accordingly. **Background levels of TN and TP** c. Please provide the background level of TN and TP for the immediate receiving coastal waters and sediment. The nearest Auckland Council marine water quality monitoring site is at the mouth of the Wairoa River, approximately 13 km from Kellys Beach. Median TN concentrations for the last three years of available data (2018–2022) were 0.18 mg/L (25th–75th quartiles: 0.14–0.21), while median TP concentrations were 0.024 mg/L	

	environment, and mainly in respect of algal blooms. Will the estimated TN and TP availability from all four stages be likely to enhance plant growth at the immediate receiving environment?	(25^{th}–75^{th} quartiles:0.02–0.029) (Kelly & Kamke, 2023).[3] Historically water quality in the mouth of Turanga Estuary, Whitford was also monitored by Auckland Council. Turanga Estuary was last monitored in 2015, when median TN was 0.005 mg/L and median TP was 0.019 mg/L (Williams *et al.*, 2017)[4] (Note that the Turanga Estuary medians were only based on 6 months of data). Marine sediment concentrations of TN and TP in the vicinity of Kellys Beach are not routinely monitored by Auckland Council or other agencies. Coast and Catchment collected marine sediment data from the Wairoa Embayment in 2018 and 2021 as part of new marine farm applications. Mean TN concentrations at the unfarmed control sites were 0.04 g/100 g in 2018 and 0.058 ± 0.009 S.E. g/100 g in 2021 (Sim-Smith *et al.*, 2018; Sim-Smith & Kelly, 2021)[5]. No information could be found on background sediment concentrations of TP in the area. **Effects of TP and TN on algal blooms (also see response to Q.26 on *Lyngbya*)** d. Please provide an assessment to understand the effects of TN and TP on the coastal marine environment, and mainly in respect of algal blooms. Will the estimated TN and TP availability from all four stages be likely to enhance plant growth at the immediate receiving environment?	

[3] Kelly, S.; Kamke, J. (2023). Coastal and estuarine water quality in Tāmaki Makaurau / Auckland 2021–2022 annual data report. Auckland Council Technical report 2023/19. Auckland Council, Auckland. 61 pp.

[4] Williams, P.; Vaughan, M.; Walker, J. (2017). Marine water quality annual report 2015. Auckland Council Technical Report no. 2017/015. Auckland Council, Auckland. 48 pp.

[5] Sim-Smith, C.; Kelly, S.; Bramley, G. (2018). Ecological assessment of Kauri Bay oyster farm to support a farm extension. Coast and Catchment report no. 2018-11 prepared for Pahiki Marine Farms. 32 pp.

Sim-Smith, C.; Kelly, S. (2021). Ecological assessment of a proposed oyster farm: Wairoa Estuary, Clevedon. Coast and Catchment report no. 2021-01 prepared for Pakihi Marine Farms Ltd. 38 pp.

		High inputs of nutrients into coastal environments can cause excessive primary production. In New Zealand coastal waters, nitrogen (not phosphorus) is almost always the limiting nutrient for primary production (Valiela *et al.*, 1997; Neill & Rees, 2003; Howarth & Marino, 2006; Plew *et al.*, 2018)[6], therefore only the TN concentrations are considered in the assessment of effects. Plew *et al.* (2018) developed the following eutrophication risk categories for NZ estuaries based on TN (for macroalgae) and chl-*a* (for phytoplankton) concentrations: 1. Macroalgae: a. Minimal eutrophication <80 mg/m^3 or if salinity is < 5 ppt b. Moderate eutrophication 80–200 mg/m^3 c. High eutrophication 200–320 mg/m^3 d. Very high eutrophication ≥320 mg/m^3 2. Phytoplankton (for estuaries <30 ppt salinity): a. Minimal eutrophication chl-*a*<5 µg/L b. Moderate eutrophication chl-*a* 5–10 µg/L c. High eutrophication chl-*a* 10–16 µg/L d. Very high eutrophication chl-*a* ≥16 µg/L	

[6] Valiela, I.; McClelland, J.; Hauxwell, J.; Behr, P.J.; Hersh, D.; Foreman, K. (1997). Macroalgal blooms in shallow estuaries: Controls and ecophysiological and ecosystem consequences. Limnology and Oceanography 42(5, part 2): 1105–1118.

Neill, G.B.; Rees, T.A.V. (2003). Nitrogen status and metabolism in the green seaweed Enteromorpha intestinalis: an examination of three natural populations. Marine Ecology Progress Series 249: 133–144.

Howarth, R.W.; Marino, R. (2006). Nitrogen as the limiting nutrient for eutrophication in coastal marine ecosystems: evolving views over three decades. Limnology and Oceanography 51(1, part 2): 364–376.

Plew, D.; Dudley, B.; Shankar, U.; Zeldis, J. (2018). Assessment of the eutrophication susceptibility of New Zealand estuaries. NIWA client report 2018206CH prepared for the Ministry for the Environment. 64 pp.

Water quality samples collected by Watercare at Te Puru Stream mouth between Sep 2023 and Jan 2024 show that the median TN concentration at Te Puru Park was 0.76 mg/L. This was used as the current concentration at the stream mouth. Changes in the discharged TN concentration at the stream mouth were calculated for each stage based on the effluent concentration and the changes in the dilution factor. Table 1 shows that the changes in discharged TN at the stream mouth are much smaller than the measured current TN concentration, and. TN concentrations at the stream mouth will increase by only 0.0157 mg/L (2%) from current to Long-Term Stage 2 due to less dilution in the stream during the later stages.

Table 1. Estimated TN at Te Puru Stream mouth

Stage	TN in effluent (mg/L)	Dilution factor (50%tile)	Discharged TN at stream mouth (mg/L)	Estimated total TN (0.76 +/- change in discharge) (mg/L)
Current	7	13018	0.00054	0.76*
Short-term	7	1352	0.00518	0.7646
Stage 1	5			
Stage 2	5	309	0.0162	0.7756

* Measured concentration

TN concentrations in Kellys Bay were not measured but based on the modelled dilution factors at the mid bay (Northern transect; 109,282) and stream mouth (13,018), TN concentrations in the mid bay are estimated to be 8.4 x lower than at the stream mouth, resulting in an estimated concentration of 0.090 mg/L. Table 2 gives the estimated TN concentrations in the mid bay based on changes in the effluent concentration and dilution factors for each of the stages.

Table 2. Estimated TN in Kellys Beach (northern transect).

Stage	TN in effluent (mg/L)	Dilution factor (50%tile)	Discharged TN at N transect (mg/L)	Estimated total TN (current + change in discharge) (mg/L)
Current	7	109,282	0.000064	0.090

Short-term	7	13302	0.00053	0.0905
Stage 1	5			
Stage 2	5	2554	0.00196	0.0919

Based on Table 1 above, TN concentrations (0.76 mg/L or 760 mg/m^3) at the Te Puru stream mouth correspond to the 'very high eutrophication' category in Plew *et al.* (2018). However, salinity at Te Puru Park was typically very low (median 7.8 ppt) but highly variable (range 0.1–33.7). The low salinity will inhibit the growth of marine macroalgae, and Plew *et al.* (2018) states that if salinity is <5 ppt the 'minimal eutrophication' category is applied regardless of the TN concentration.

Given the low salinity at the stream mouth, the TN concentration at mid-beach is likely to provide a better indication of the eutrophication potential of the discharge. Estimated mid-beach concentrations for all four stages were around 0.09 mg/L or 90 mg/m^3. This corresponds to the 'moderate eutrophication' category in Plew *et al.* (2018), which is described as "*Ecological communities are slightly impacted by additional macroalgae growth arising from nutrient levels that are elevated*. *Limited macroalgae cover (0-20%) and low biomass (50-200 g/m^2 WW) of opportunistic macroalgal blooms and with no growth of algae in the underlying sediment. Sediment quality transitional.*"

Median measured chl-*a* concentrations at Te Puru Park were 1.4 µg/L (Table 8 in effects assessment report), well below the 'minimal eutrophication' limit of 5 µg/L. Furthermore, there is little potential for TN concentrations in the discharge to increase phytoplankton growth due to the similarity in the TN concentrations in the immediate receiving coastal environment (stream mouth and mid-beach) during all four stages (Tables 1 and 2). Furthermore, the Te Puru tidal creek has a very short flushing time (4–5.5 hrs; Zeldis *et al.*, 2001)[7], and therefore phytoplankton will be flushed from the estuary faster than they grow (Plew *et al.*, 2018). The figure below from Plew *et al.* (2018) shows the impact of TN and flushing times on phytoplankton

[7] Zeldis, J.; Pattinson, P.; Gray, S.; Walshe, C.; Hamilton, D.J.; Hawes, I. (2001). Assessment of effects of sewage plant inflow on Te Puru Stream, Estuary and adjacent Tamaki Strait waters. NIWA client report no. CHC01/84 prepared for Earth Consult Ltd and Manukau Water Ltd. 34 pp.

		growth. The figure clearly illustrates that when the flushing times are ≤3 days, phytoplankton will be flushed from the estuary faster than they can grow, and therefore TN concentrations can be very high and still have a negligible effect on phytoplankton concentrations, thus the estuary will fall into the 'A) minimal eutrophication' category. Overall, given the lack of change in TN concentrations in the immediate receiving coastal environment during all four stages it is most unlikely that marine plant growth will be increased in the immediate coastal receiving environment. The effect of the upgraded WWTP on marine plant growth is assessed as **less than minor.**	
19.	Please provide the follow details: a. Chlorophil a (chla) concentration and the trend analysis result for chla for the period between 2018-2023. The measures proposed to monitor or manage the potential occurrence of algal blooms / plants related to the proposed discharges at all stages.	Chla was not measured in WWTP between 2018 and 2023 so no state or trend can be undertaken. This was stated in Section 4.4.1.2 of the effects assessment report. We presented chla in the receiving environment sites (between September 2023 and January 2024) in Figure 24 and Table 8. This would be through a consent condition for coastal receiving environment monitoring.	Closed
20.	With respect to the coastal marine environment, the following assessment is provided within the ecological report: *'The proposed discharge rates by MBR Stage 2 will have negligible effects on the salinity and the marine communities of Te Maraetai/Kellys Beach due to the relatively low discharge rates compared to other nearby streams and rivers, the rapid dilution, and the tolerance of intertidal biota to low salinities. There will be no change from the current WWTP scenario.* *With respect to the proposed discharge, estimated TN concentrations will decrease by 29% to 5 mg/L in the Long-term Stages 1 and 2 of the upgraded WWTP, and TP concentrations will reduce to 0.5 mg/L. Concentrations of these nutrients will be diluted 309× (50% percentile) by the time they reach the Te Puru*	**a. Assessment of effects on Te Puru Estuary and Kellys Beach** Instead of a habitat or species-specific assessment it is more appropriate to consider the main potential effects of the discharged wastewater on the coastal receiving environment and provide an assessment of effects for each of those effects. The main potential effects of discharged wastewater on the coastal receiving environment are: i. increased dissolved nutrients, which may lead to increased phytoplankton or macroalgal growth; ii. increased concentrations of heavy metals, and other contaminants in the water, which may adversely affect marine organisms; iii. changes to the physical and chemical composition of the water (e.g., pH, dissolved oxygen, salinity, turbidity); iv. changes to the physical and chemical composition of the seabed (e.g., oxygen depletion, increased nutrients, accumulation of contaminants);	Closed

	Stream mouth, making them well below background concentrations in coastal waters. Given the rapid dilution rate, and the reduction of TN concentration in the proposed discharge from the expanded and upgraded WWTP, no increase in nutrient concentrations in coastal waters, or related adverse effects from increased nutrients, are likely to occur as a result of the proposed discharge. Other minor contaminants that are present in the treated wastewater at low concentrations will be diluted at a similar rate to TN and TP. There will be no change from the current WWTP scenario. *Potential effects on SEA-M1-42b Te Puru Stream estuary and SEA-M2-42a are anticipated to be low given the level of influence the treated wastewater discharge will have on nutrient concentrations and salinity in coastal waters.'* While this assessment is noted, neither the ecological report nor the AEE have included an assessment that supports the above in relation to the magnitude of overall effects on the coastal marine area (CMA). It is further noted that the ecological value of the immediate receiving environment is provided from an intertidal survey at 14 stations around Te Maraetai / Kellys Beach. While the survey results identified different broad scale habitats with different species such as shellfish patches, seagrass, mudflats, shell banks & mangroves, no assessment of effects on those habitats or species is	v. changes to the benthic community due to direct impacts of the wastewater, or through flow-on effects up the food chain; vi. increased risk of microbial contamination of shellfish that are consumed by humans and from water contact activities. Importantly, the effects of treated wastewater are not necessarily negative. Moderate increases in nutrient loads can increase productivity, with associated increases in the abundance and diversity of marine biota. Point i)—is assessed in the response to Q.18 (d) above. The effect of the upgraded WWTP on marine plant growth is assessed as **less than minor.** Point ii)—measurement of metal concentrations in the wastewater effluent show that only copper and zinc exceed the freshwater ANZG (2018)[8] DGVs in the discharge. Total copper concentrations were 1.9 µg/L while total zinc concentrations were 28 µ/g L at the discharge point. However, Cu and Zn concentrations had reduced to 0.4 µg/L and 1.2 µg/L, respectively, by Site 15, both of which are below the ANZG DGVs. Concentrations of metals in the wastewater are not expected to change with the upgrade. Based on that observation, it is extremely unlikely that copper or zinc in the discharge will have a tangible ecological effect on the surrounding coastal environment. This is consistent with the response to Q18 (a) and (b). This is supported by Table 3, which provides estimated concentrations of discharged total copper and zinc at the stream mouth based on the modelled dilution rates (dissolved concentrations were lower, so risks will be lower). For all four stages, the concentrations of copper and zinc at the stream mouth are well below the ANZG (2018) DGVs (1.3 µg/L for Cu and 8 µg/L for Zn) for the protection of 95% of species in marine waters. Therefore, the risk of heavy metals adversely affecting the marine community is assessed as **negligible.**	

[8] ANZG (2018). Australian and New Zealand guidelines for fresh and marine water quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia. Available from www.waterquality.gov.au/anz-guidelines (Accessed October 2021).

provided in the ecological report in relation to the proposed discharge.
In addition, the statement on SEA-M1 and SEA-M2 in the vicinity of the discharge does not include a site-specific assessment on the ecological values at the sites from the proposed discharge.

Taking the above into account, please provide the following:

a. A habitat or species-specific assessment of ecological effects from the proposed discharge for all four stages.
b. An assessment of effects on identified kaimoana species, including human health risk from the proposed discharge for all four stages. While there is no regulated, legal size limit for shellfish, such as cockles and pipi, should consent be granted for 35 years, the size and population of shellfish species would grow to harvestable size over the proposed duration. Accordingly, it is not agreed that the current size of the shellfish is a form of mitigation or reason not to consider human health effects from consuming shellfish.
c. Please confirm that the consent limits proposed for all four stages can be met without any exceedance in the discharge quality, as has occurred with the existing discharge.
d. Based on the breaches with the existing discharge quality consent limits, there is potential that the proposed discharge operational limits may exceed consented limits. Monitoring the discharge water and sediment quality, and coastal ecology is the only tool available to validate the proposal. Accordingly, please

Table 3. Concentration of total copper and zinc in the wastewater effluent and at the stream mouth.

Stage	Concentration in effluent (µg/L)		Dilution factor (50%tile)	Discharged concentration at stream mouth (µg/L)	
	Cu	Zn		Cu	Zn
Current	1.9	28	13018	0.00015	0.0022
Short-term	1.9	28	1352	0.00141	0.0207
Stage 1	1.9	28			
Stage 2	1.9	28	309	0.00615	0.0906

Similarly, Risk Quotients (RQs) based on marine predicted no-effect concentrations (PNEC) for Emerging Organic Contaminants (EOC) in the wastewater effluent were given in Table 18 of the Ecological Assessment of Effects. A RQ >1 indicates a potential effect. Table 4 lists the EOCs that had a RQ >1 at the outlet and gives the RQ at the stream mouth based on the modelled dilution factors. Given that the RQs at the stream mouth for all parameters are much less than 1, the effects of EOCs on the marine community is assessed as **negligible.**

Table 4. RQ of EOCs at the stream mouth at all four stages. RQs>1 are given in red.

Analyte	**RQ Outlet**	**Current**	**Short-term**	**Stage 2**
Diclofenac	10.0	0.0007	0.007	0.032
Diltiazem	1.3	0.0001	0.0009	0.004
Lamotrigine	2.5	0.0002	0.0018	0.008
Sucralose	3.4	0.0003	0.0025	0.011
Sulfamethoxazole	2.5	0.0002	0.0018	0.008
Triclosan	1.4	0.0001	0.0010	0.0045
Venlafaxine	17.0	0.0013	0.0136	0.055

provide a draft monitoring plan for all four stages, that contains, but that is not necessarily limited to, the details below:

- The spatial and temporal extent of the key habitats (as appropriate) within the zone of influence in the immediate receiving environment of the proposed discharge.
- Benthic community (fauna and flora) abundance and diversity.
- A water quality analysis of key nutrients, chla etc. (if it is not monitored or included in the discharge quality).
- A sediment quality analysis (heavy metals, grain size, organic content, anoxic layer / redox potential).
- Spatial and temporal extent of algal blooms, should they arise.
- Suitability of kaimoana species for harvesting and human consumption, including species, size and number of samples to monitor.
- Reporting procedures.

Monitoring design for the above aspects to include the number of samples, spacing of sample stations in relation to the proposed discharge location, frequency of sampling, methodology and reporting. The monitoring programme must be designed to deliver ecologically meaningful results and be statistically robust enough to detect potential changes to those matters listed above.

Point iii)—Most of the physical parameters e.g., pH, DO, in the discharged WWTP are not expected to markedly change with the upgrade. Median operational limits for BOD_5 and TSS will be reduced from 7 mg/L to 5 mg/L, which, if anything, will improve the quality of the discharge.

The increased volume of the discharge will result in an increased flow rate from 23 L/s currently to 69 L/s at Long-Term Stage 2. This is likely to result in a very small decrease in salinity. However, intertidal species, particularly those living near estuary mouths, are highly tolerant of low salinity. Salinity measurements in Te Puru Park varied from 0.1–33.7 ppt, therefore, the marine biota inhabiting that area are highly tolerant of low and variable salinities. Overall, the effect of changes to physical parameters in stream water on the marine community is assessed as **negligible.**

Points iv & v)—Given that the effects on the water quality at the stream mouth and Kellys Beach are assessed as negligible to less than minor, the seabed and seabed community are highly unlikely to change. Therefore, the effects of the seabed and seabed community is assessed as **less than minor.**

Point vi)—is assessed in the response to b) iii) below.

Overall, the effects of the wastewater discharge on the marine environment and community of Te Puru Estuary and Kellys Beach is assessed as **less than minor.**

b. Assessment of effects on kai moana species.

Several kai moana species are present in Kelly's Beach (cockles, pipis, Pacific oysters, blue mussels). Potential adverse effects on shellfish can be caused by high nutrient or high suspended solid concentrations, and potential adverse human health effects can occur if shellfish have high levels of faecal bacteria in their flesh.

i. <u>Effects of nutrients on shellfish</u>

Moderate increases in nutrient concentrations can increase productivity, with associated increases in the abundance and growth of shellfish. However, excessive

		concentrations of some nutrients can be toxic to shellfish or result in anoxic seabed conditions. Ammoniacal-N is the only nutrient with a recommended guideline for marine waters in the Australia and New Zealand guidelines for fresh and marine and waters (ANZG, 2018). The default guideline value (DGV) for ammoniacal-N for 95% protection of species is 0.91 mg/L. Concentrations of ammoniacal-N (NH_3-NH_4-N) at Te Puru Park are much lower than the DGV, with a median of 0.04 mg/L and a 95%ile of 0.22 mg/L. Note that ammoniacal-N is the sum of ammonia and ammonium, so the concentration of ammonia in ambient seawater conditions is lower than that of ammoniacal-N. The Canadian guideline for the long-term exposure to nitrates in marine waters is 45 mg/L (CCME, 2012)[9], which is 90 times higher than the median nitrate concentration at Te Puru Park (0.5 mg/L). Given the concentrations of ammoniacal-N, nitrates in Te Puru Park are much lower than the guideline values, and that further dilution will occur before the water reaches the mid to lower beach where the shellfish occur, the effects of discharged nutrients on kai moana species is assessed as **negligible.** ii. <u>Effects of TSS on shellfish</u> High total suspended sediment (TSS) concentrations can result in reduced filtration and clearance rates, growth and survival of shellfish. For example, adult pipis, cockles and scallops can continue to feed at high concentrations of suspended sediment for short durations (<1 week), but in the long term, show adverse effects at TSS concentrations of more than 60–70 mg/l, 300–350 mg/l, and 100 mg/l, respectively (Wilber & Clarke, 2001; Nicholls *et al.*, 2003; Hewitt & Norkko, 2007;	

[9] CCME (2012). Canadian water quality guidelines for the protection of aquatic life: nitrate. Canadian Council of Ministers of the Environment, Winnipeg, Canada.

		Coppede Cussioli, 2018)[10]. These concentrations are much higher than the TSS concentration in the wastewater effluent (median 7.8 mg/L; 80th percentile 10.2 mg/L), and therefore the effects of discharged TSS on kai moana species is assessed as **negligible.** iii. <u>Human health risks associated with shellfish consumption</u> Cockles and pipis were found throughout most of the mid to lower intertidal at Kellys Beach. However, all were well below harvestable size (~30 mm for cockles and ~50 mm for pipi). Council state that these shellfish will grow to harvestable size over the duration of the consent, however, monitoring of numerous shellfish populations around the Auckland Region (and further afield) indicates that factors other than harvesting are preventing the growth of cockles and pipis to harvestable size. Complete harvest bans are in place at Umupuia, Whangateau, Eastern Beach, Cheltenham Beach and Cockle Bay, but even in these areas the increase in the harvestable population is very slow or non-existent (Berkenbusch *et al.*, 2023; Hauraki Gulf Forum, 2023; Berkenbuisch & Hill-Moana, 2024)[11].	

[10] Wilber, D.H.; Clarke, D.G. (2001). Biological effects of suspended sediments: a review of suspended sediment impacts on fish and shellfish with relation to dredging activities in estuaries. North American Journal of Fisheries Management 21(4): 855–875.

Nicholls, P.; Hewitt, J.; Halliday, J. (2003). Effects of suspended sediment concentrations on suspension and deposit feeding marine macrofauna. NIWA client report HAM2003-077 for Auckland Regional Council. National Institute of Water and Atmospheric Research, Hamilton.

Hewitt, J.E.; Norkko, J. (2007). Incorporating temporal variability of stressors into studies: An example using suspension-feeding bivalves and elevated suspended sediment concentrations. Journal of Experimental Marine Biology and Ecology 341(1): 131–141.

Coppede Cussioli, M. (2018). Ecological effects of turbidity variations in and around dredging areas in the Port of Tauranga. PhD thesis. The University of Waikato, Hamilton, New Zealand.

[11] Berkenbuisch, K.; Hill-Moana, T. (2024). Intertiday shellfish monitoring in the northern North Island region, 2023–24. New Zealand Fisheries Assessment Report 2024/35. Fisheries New Zealand, Wellington, New Zealand. 110 pp.

		Given the current lack of harvestable shellfish at Kellys Beach, and the general lack of harvestable shellfish populations around the Auckland Region, it is unlikely that Kellys Beach will sustain a harvestable shellfish population in the future. See response to Q.37 for details on the human health risks. If the shellfish exposure route is present or may be present in the future, a QMRA would be the most appropriate way to estimate public health risks. Shellfish are filter feeders and can bioaccumulate pathogens. The end effect of the bioaccumulation process is that a person consuming shellfish will tend to receive a higher dose of pathogens, if present, than someone swimming in the same water in which the shellfish is grown. **c. Consent limits** The existing Consent limits will be rolled over until the short-term upgrade is completed. Proposed consent limits for the short -term upgrade and long-term upgrade stages 1 and 2 can be met without exceedance in the discharge quality. **d. Draft monitoring plan** Consent conditions are being proposed that require the provision of a monitoring plan to be submitted to Council for certification. The conditions specify the parameters, frequency and locations to be monitored. A detailed monitoring plan will be provided to Council for certification if consent is granted.	

Berkenbusch, K.; Neubauer, P.; Hill-Moana, T. (2023). Intertidal shellfish monitoring in the northern North Island region, 2022–23. New Zealand Fisheries Assessment Report 2023/32. Fisheries New Zealand, Wellington. 129 pp.

Hauraki Gulf Forum (2023). State of our Gulf 2023: Hauraki Gulf / Tīkapa Moana / Te Moananui-ā-Toi state of the environment report 2023. Prepared by Kelly, S.; Sim-Smith, C.; Lee, S.; Van Kampen, P. Hauraki Gulf Forum, Auckland. 194 pp.

<table>
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<td>It is recommended that an ecological monitoring plan for Kellys Beach and Te Puru Stream include:

• Regular water quality sampling at Te Puru Park for nitrogen, phosphorus, physical parameters, chl-a, TSS, E. coli, faecal coliforms and enterococci.
• An annual summer survey of Kellys Beach for nuisance macroalgae and cyanobacteria.
• A shellfish survey of Kellys Beach every 3 years to determine the abundance and mean size of pipis and cockles.
• Analysis of sediment quality in Te Puru Estuary and Kellys Beach every 3 years for grainsize, total phosphorus, total nitrogen, total organic carbon, and key heavy metals.

Given that the cumulative effects on the coastal receiving environment are assessed as less than minor (see below), the monitoring of the spatial extent of marine habitats and benthic macrofaunal communities is not warranted.</td>
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<tr>
<td>21.</td>
<td>Please provide an assessment on cumulative effects on the ecology of the immediate receiving environment in the CMA (Te Puru Stream and Kellys Beach) in relation to the existing discharge and from the proposed discharge for all four stages.</td>
<td>Table 5 summarises the assessment of ecological effects of the WWTP upgrade on individual areas for the immediate receiving coastal environment. The assessment of effects is the same for all four stages. Overall, the cumulative effects on Te Puru Estuary and Kellys Beach is assessed as less than minor.

Table 5. Assessment of Effects for the WWTP upgrade on Te Puru Estuary and Kellys Beach.

<table>
<tr><th>Area</th><th>Assessment</th></tr>
<tr><td>Marine primary production</td><td>Less than minor</td></tr>
<tr><td>Heavy metals</td><td>Negligible</td></tr>
<tr><td>EOCs</td><td>Negligible</td></tr>
<tr><td>Physical parameters</td><td>Negligible</td></tr>
<tr><td>Seabed and its community</td><td>Less than minor</td></tr>
<tr><td>Cyanobacteria</td><td>Less than minor</td></tr>
<tr><td>Shellfish growth and survival</td><td>Negligible</td></tr>
</table>
</td>
<td>Closed</td>
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</table>

22.	With respect to the modelling within the Assessment of Proposed Te Puru Stream Discharge by DHI Water & Environment Limited, dated 28 March 2024 (the modelling report), please provide the modelled zone of influence and reasonable mixing zone for each stage of proposed discharges at the different sites identified in the modelling report.	The marine model focused on assessing the level of dilution that could be achieved within the marine receiving environment and was never intended to do in-stream near-field modelling. As stated in the DHI report the marine model extends upstream into the Te Puru stream where it is influenced by tides. This is well below the point of discharge so the marine model cannot address the mixing zone question.	Closed
23.	The modelling report states: *'The higher levels of dilution that are achieved in the wider marine receiving environment (compared to the in-stream dilutions) mean that changes in nutrient concentrations in the wider marine receiving environment due to the proposed WWTP discharges would remain below detectable limits.'* What are the detectable limits referred in the statement above for key contaminants in the discharge?	The Watercare Laboratory Services minimum detection limit for TN is 0.01 mg/L and TP is 0.004 mg/L. The DHI report states that the current TN and TP concentrations immediately downstream of the Whitford-Maraetai Road bridge is estimated as 0.12 mg/L and 0.01 mg/L, respectively. TN concentrations are estimated to increase to 0.23 mg/L and 0.44 mg/L, while TP concentrations are estimated to increase to 0.04 mg/L and 0.0.7 mg/L under short-term and long-term stage 2, respectively. Minimum dilutions near the Te Puru Stream Mouth and at Kellys Beach are estimated to be 10 to 20-fold (current), 5 to 10-fold (short-term), and 3 to 6-fold (long-term Stage 2). Whether these changes could be observed (based on dilutions and MDL) is borderline at these sites. However, the statement specifies the <u>wider</u> marine receiving environment. Minimum dilutions in Shelley Bay, Omana and Pohutukawa Bay are estimated to range from 5000 to 6000-fold (current), 2000 to 3000-fold (short-term) and 1000 to 1500-fold (long-term Stage 2). Even at the long-term Stage 2 scenario (lowest dilutions (1000-fold) and maximum concentrations) TN and TP would be estimated to be 0.00044 mg/L, and 0.00007 mg/L, respectively, or 23-fold and 57-fold lower than the MDL at Shelley Bay, Omana and Pohutukawa Bay.	Closed

<table>
<tr>
<td>24.</td>
<td>In respect of TN and TP in the estuary, please answer the following questions:
a. What is the residence time of the TN and TP footprints for the Te Puru Estuary and Kelly Beach for each stage proposed.

b. Please explain how the TN and TP loads in the table below were derived? What is the total load for TN and TP estimated for different discharge scenarios and why are there only three scenarios?

Table 1. Discharge Scenario data.
<table>
<tr><th></th><th>Current</th><th>Short-Term</th><th>Long-Term Stage 2</th></tr>
<tr><td>Average daily dry weather discharge (m³)</td><td>2,000</td><td>3,600</td><td>6,000</td></tr>
<tr><td>Average daily dry weather discharge (m³/s)</td><td>0.023</td><td>0.042</td><td>0.069</td></tr>
<tr><td>Median TN load (kg/day)</td><td>14.0</td><td>25.0</td><td>30.0</td></tr>
<tr><td>Median TP load (kg/day)</td><td>2.0</td><td>3.6</td><td>6.0</td></tr>
</table>
</td>
<td>a) Residence time could be quantified by modelling a one-off release of contaminants and tracking how dilution reduces over time but quantifying this would add nothing to the assessment of effects which is based on dilution for a continuous release
b) Refer to attachment 4 for a detailed response

<table>
<tr><th></th><th>Current</th><th>Short-Term</th><th>Long-Term Stage 1</th><th>Long-Term Stage 2</th></tr>
<tr><td colspan="5">Attenuated WWTP loads</td></tr>
<tr><td>Mean annual TN load (kg/yr)</td><td>1979</td><td>3239</td><td>617</td><td>771</td></tr>
<tr><td>Mean annual TP load (kg/yr)</td><td>233</td><td>382</td><td>255</td><td>318</td></tr>
<tr><td colspan="5">Te Puru Catchment</td></tr>
<tr><td>Mean annual TN load (kg/yr)</td><td>3,825</td><td>3,825</td><td>3,825</td><td>3,825</td></tr>
<tr><td>Mean annual TP load (kg/yr)</td><td>270</td><td>270</td><td>270</td><td>270</td></tr>
<tr><td colspan="5">Combined</td></tr>
<tr><td>Mean annual TN load (kg/yr)</td><td>5805</td><td>7064</td><td>4442</td><td>4597</td></tr>
<tr><td>Mean annual TP load (kg/yr)</td><td>504</td><td>652</td><td>525</td><td>589</td></tr>
<tr><td colspan="5">WWTP percentage of total load</td></tr>
<tr><td>TN</td><td>34%</td><td>46%</td><td>14%</td><td>17%</td></tr>
<tr><td>TP</td><td>46%</td><td>59%</td><td>49%</td><td>54%</td></tr>
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<td>Closed</td>
</tr>
<tr>
<td>25.</td>
<td>There is a difference between the tide being in (mixing will occur in the estuary and beach area) and low tide when undiluted river water will be within the channel within the intertidal area and mixing will occur at the tide line. Has this been considered in modelling of the nutrient footprint?</td>
<td>Figure 6 of the DHI report shows the different sites that are used at different stages of the tide to extract an appropriate dilution at the water's edge as the tide rises and falls up and down Kellys Beach. So, the QMRA for Kellys Beach considers a "tide-line" worst case dilution for all states of tide.</td>
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<td>26.</td>
<td>The ecological report shows after the MBR is operational within the WWTP, attenuated TN and TP loads through the overland and stream system will contribute 50% and 70% of total catchment load to the marine coastal environment respectively, being approximately two-fold</td>
<td>Occasional blooms of the nuisance cyanobacteria Okeania spp. (previously called Lyngbya majuscula) have been reported from the Beachlands-Maraetai coastline. The cyanobacteria produces toxins that can cause seaweed dermatitis if the cyanobacteria</td>
<td>Closed</td>
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</table>

	and three-fold increases as compared to the current situation of 32% and 44% respectively. Sufficient nutrients in water are known to be one of the conditions leading to toxic algae blooms, which is likely to have adverse effects on people involved in contact recreation, particularly those who eat watercress collected from Te Puru Stream. The ecological report indicates that occasional blooms of toxic cyanobacteria have been reported from the Beachlands-Maraetai coastline and blooms were also observed in Te Maraetai / Kellys Beach during the intertidal survey. However, the health risk from cyanobacteria as a result of the proposed increase in nutrient loads has not been assessed in detail in either the ecological or health risk reports. Please provide further assessment in this regard.	is abraded against the skin or breathing issues if dried material or aerosolised toxins are inhaled (Wilcox, 2007; Smith *et al.*, 2024)[12]. In the late 1970s *Okeania* spp. were reported as seasonally dominant species around Motukaraka/Flat Island, and throughout the 2000's there were regular occurrences of *Okeania* spp. blooms around the Beachlands and Omana area (Sutherland & Hawes, 2002[13]; Wilcox, 2007). However, no *Okeania* spp. blooms have been recorded from the Beachlands area since 2007. Note that the ecological reports states that **NO** *Okeania* spp. were observed in Te Maraetai/Kellys Beach during the intertidal survey (the statement by Council under Q.26 of this document saying the cyanobacteria were observed during the intertidal survey is incorrect). Little is known about the drivers of *Okeania* spp. blooms and Auckland Council states that "*The drivers of cyanobacterial blooms are complex and it is very difficult to predict or explain where they may occur, as well as their size and duration. This is because numerous environmental conditions need to be met to enable the rapid growth of the cyanobacteria (calm weather conditions, plenty of light, warm seawater temperatures and sufficient nutrients to sustain their growth), followed by the right conditions to dislodge blooms (i.e., stormy weather*)" (Auckland Council, 2024)[14].	

[12] Wilcox, M. (2007). A summer bloom of the marine benthic cyanobacterium Lyngbya majuscula at Musick Point, Eastern Beach and Howick. Auckland Botanical Society Journal 62(1): 102–103.

Smith, K.; Puddick, J.; Biessy, L.; Rhodes, L.; Cressey, P. (2024). Managing marine harmful algal blooms in recreational settings: a review of international approaches to guide risk management practice in Aotearoa New Zealand Cawthron report no. 4038 prepared for Health New Zealand/Te Whatu Ora. Cawthron Institute, Nelson. 50 pp.

[13] Sutherland, D.; Hawes, I. (2002). Survey of Lyngbya majuscula in Te Puru Estuary and adjacent Tamaki Strait waters. NIWA client report CHC02/35 prepared for Earth Consult Ltd and Manakau Water Ltd. National Institute of Water and Atmospheric Research, Christchurch, New Zealand. 9 pp.

[14] Auckland Council (2024) Auckland Council warms public to avoid black algae on two Waiheke Island beaches and Kawakawa Bay. Our Auckland. Available from: https://ourauckland.aucklandcouncil.govt.nz/news/2023/12/algae-on-waiheke-island-december-2023/ (accessed 1 March 2024).

		Growth of phytoplankton and cyanobacteria are affected by the concentration of nutrients, not annual loads. Despite the fact that annual TN and TP loads are increasing by 50% and 70%, respectively, the resulting concentrations of TN and TP in the water downstream of the discharge will be very similar to current concentrations due to the proportional increase in the discharge volume and the decrease in the TN (from 7 to 5 mg/L) and TP (from 1 to 0.5 mg/L) concentrations in the discharged effluent (see Tables 1 & 2 in our response to Q18(d)). Therefore, based on nutrient concentrations, there is no increase in the ecological or health risks from *Okeania* spp. over current conditions. Given that no *Okeania* spp. blooms have been recorded from the Beachlands area for the last 17 years, it is highly unlikely that current conditions significantly increase the chances of an *Okeania* spp. bloom occurring. This concurs with the conclusions of Zeldis *et al.* (2001) who stated that "*The low nutrient and chl-a levels we have recorded in Kelly's Cove, and the shore residence time of water within the estuary, do not suggest that excessive nutrient loading of the water column would cause L. majuscula outgrowth, in the water column of either environment*." A subsequent survey to document the occurrence of *Okeania* spp. around the Beachlands-Maraetai area also found no evidence that nutrients from the WWTP discharge were causing the cyanobacteria growth, with much higher densities of *Okeania* spp. found around Motukaraka than Kellys Beach and Te Puru Estuary (Sutherland & Hawes, 2002). Overall, the increase in the occurrence of cyanobacteria blooms due to the upgraded WWTP is assessed as **less than minor.**	
27.	The ecological report states that the estimated loads from the upgraded WWTP represent a very small percentage of the TN and TP loads entering the inner Hauraki Gulf and Firth of Thames. Thus, the effects of the increased loads from the upgraded WWTP are assessed as being low. Please justify the reasons that the inner Hauraki Gulf and Firth of Thames are used instead of the immediate receiving environment for assessing the effect.	Te Puru Estuary and Kelly's Beach have very short flushing times (4–5.5 hrs for the estuary; Zeldis *et al.*, 2001) due to their small size. Estuary water will quickly enter the Tamaki Strait where currents of ≤0.2m/s will disperse and transport the nutrients into to the inner Hauraki Gulf and Firth of Thames within approximately 3-8 days (J. Oldman, DHI, pers. comm.). Uptake of nutrients by phytoplankton is not instantaneous—it depends on the nitrogen concentration, the specific growth rate of plankton, the half saturation coefficient for TN, and the ratio of chl-*a* to tissue N content of phytoplankton (see p. 21 of Plew *et al.*, 2018 for more details). The figure given above in response to Q.18 shows that when the flushing time is ≤3 days, phytoplankton growth is essentially independent of TN	Closed

		concentration because the phytoplankton will be flushed from the estuary before they can grow. Given the very short flushing time of Te Puru Estuary, it is more appropriate to compare the discharged TN and TP loads with the inner Hauraki Gulf and Firth of Thames, where phytoplankton will have time to assimilate the discharged nutrients, rather than the immediate receiving coastal environment.	
28.	On 11 July 2024, Watercare Services Limited (WSL) provided a preliminary assessment of the Estuarine Trophic Index (ETI) for Te Puru Stream Estuary, based on ETI Tool 3, and applying the current state assessments. Please provide an assessment of the ETI at each of the anticipated states at PE 18,000, PE 24,000, and PE 30,000.	The ETI score for the current state of Te Puru Stream Estuary (which mostly consists of a muddy, mangrove lined tidal creek) was calculated using Tool 3 (https://shiny.niwa.co.nz/Estuaries-Screening-Tool-3/), which allows the ETI to be calculated when no or few values are known for the primary indicator nodes and secondary indicator nodes. Input parameters were: • Tidal river estuary • 5–40% intertidal (the estuary is defined as the portion of the stream that has marine influence that is landward of Kelly's Beach) • 0–3 days flushing time (from Zeldis *et al.*, 2001) • 5–30 ppt salinity • 1.4 mg chl-*a*/m^3 (Table 8 in the effects assessment report); • 500–600 mg/m^3 TN for all four Stages (see Table 1 in Q.18). (There were minimal differences in the TN concentrations for all four Stages). Seasonality, water column stratification, closure duration and sediment loads were left at the default values as no information was available for these parameters. The overall ETI score was 0.25 for all four stages, which puts it at the upper limit of band 'A'–"*Ecological communities are slightly healthy and resilient*" (Zeldis & Plew, 2022)[15]. Note that the preliminary assessment provided on 11 July was based on a TN concentration of 600–700 mg/m^3, which was taken from Fig. 18 of the effects assessment report. More accurate calculations of the TN concentrations (Table 1 in	Closed

[15] Zeldis, J. & Plew, D. (2022) Predicting and scoring estuary ecological health using a Bayesian Belief Network. *Frontiers in Marine Science*, 9, 898992. 10.3389/fmars/2022.898992

		Q.18) show that TN concentrations are in the 500–600 mg/m³ band, which improves the ETI band from 'B' to 'A'.	
Hydrology and Stream Flow			
29.	The stream hydraulic assessment report uses 6,000 m3/d discharge from the WWTP, converted to an average discharge rate of 0.07 m3/s. It then uses this rate as an estimate of wastewater discharge contributions during wet weather events without any adjustment of the discharge from the WWTP due to wet weather flows (outflows would be expected to be greater when it's raining). The report also only provides an assessment at high stream flows, not at low. Noting the above, please provide an assessment of the effects of the discharge (the current, the maximum proposed, and a range of discharges, not just an average) under a range of climatic conditions (e.g. dry weather and a range of rainfall events, including the rainfall event resulting in maximum discharge from the plant and a relevant climate change scenario) on the depth, velocity and flow of water in both the tributary and the main stem of Te Puru Stream after confluence. Alterations in the rate of discharge and stream baseflows should be considered for dry and wet weather, and include consideration of climate change effects on high and low stream and discharge flows. Please also provide an assessment of the efficacy of the 'storm buffer ponds' under current and future growth projections, assessing a range of storm events and a consideration of a climate change scenario relevant to the duration sought for this consent.	Our assessment indicates that, during the lowest flow event that was considered (i.e., 90th percentile rainfall event with existing wastewater discharges, the increase in velocity due to the increase in average wastewater discharge was minimal (up 0.3 m/s to 1.1 m/s as per Table 3). Therefore, it is our assessment that during lower flow events, the effect of erosion would be even less during average wastewater discharges. We can update our assessment to include the scenario of low stream flow and maximum wastewater discharge if necessary. We consider that it would be unreasonable for the pond outlet to see 36,200 m^3/d due to the attenuation within the Farm Pond. If this is the case, the pond outlet would need to be redesigned to throttle the flows. We would anticipate that the Farm Pond volume and outlet would require modification to reduce downstream flows that the stream would receive. Our initial assessment is that this future maximum discharge flow and velocities would be less than the present day 2-year ARI stormwater peak flow that we have analysed and outlined in Table 2 (i.e., 0.4 m^3/s vs. 0.62 m^3/s). During our stream gauging (see table below), we measured normal (i.e., low) stream flows of approx. 0.014-0.018 m^3/s, immediately downstream of the Farm Pond. This compares to a present average wastewater discharge of 0.021 m^3/s (see Table 1), indicating that the majority of flow within the tributary is currently wastewater during dry periods. This would indicate that it can be assumed for future low stream flows the majority, if not all, stream flow would consist of wastewater for the tributary immediately downstream of the Farm Pond. As part of our assessment, we have assessed a range of rainfall events including 90th percentile, 2-year ARI, 5-year ARI and 10-year ARI (refer Table 2 and 3). The climate change scenario we have applied is RCP8.5 for the period of 2081-2100 as outlined in Table 2.	

		We would anticipate that wastewater discharges from wet weather flows would not coincide with high stream flows caused by rainfall within the upstream catchment. We would expect that the wastewater network, the storage within the WWTP itself, the overland flow and the storage within the Farm Pond would result in attenuation. This attenuation would result in the wastewater discharge not coinciding with the peak runoff from the catchment. It is therefore our assessment that high stream flow and maximum wastewater discharge would not be seen by the stream concurrently and reduce peaks however it is unclear if amendments are required to the pond outlet to control volumes. In regard to other items raised: • We have not assessed the main stem after the confluence as further down the stream the wastewater discharge is a minor proportion of flow during high/wet weather stream flows. As shown in Table 2, the wastewater discharge at the bridge contributes to 1% of flow during a 10-year ARI storm event. • The 'storm buffer ponds' are assumed to be the post-treatment buffer Lagoon. Both the lagoon and WWTP Buffer Pond upstream of the plant will reduce the discharge volumes. The Storm Buffer Pond will continue to be used as it is currently, ie to store peak wet weather influent flows in excess of the WWTP hydraulic capacity. The Post-Treatment Buffer Lagoon will mainly be used as a buffer for maintenance and servicing. It will be used less for stormwater buffering. <u>Further Information</u> Further to the discussion on Thursday 12/09/24 with Helen, we have provided additional information for low flows particularly with respect to downstream points Point C and the Quarry. Table 2 of the stream hydraulic assessment (dated 26 March 2024) showing wastewater contributions has been updated to include the downstream points, the low flows have	

been added to a separate Table 2A and a table of the stream gauging (Table 2B) has now been included.

Table 2A: Wastewater Contributions to Typical/Low Stream Flow

Scenario[1]	Location[2]	Estimated Wastewater Discharge (m^3/s)	Estimated Low Stream Flow (m^3/s)	Estimated % Wastewater Contribution
Existing	Reach between pond outlet and bridge	0.021	0.021 [3]	~100%
Future		0.07	0.07 [3]	~100%
Existing	Bridge	0.021	0.025 [4]	~85%
Future		0.07	0.075 [4]	>95%
Existing	Confluence/Point C	0.021	0.046 [4]	~45%
Future		0.07	0.096 [5]	>70%
Existing	Quarry/Point Q	0.021	0.056 [4]	~40%
Future		0.07	0.106 [5]	>65%

Notes:

1. The existing scenario assumes existing ADF WWTP discharge as per A02803201L001. The future scenario assumes future ADF WWTP as per A02803201L001.

2. Refer to A02803201L001 Appendix A for specific locations of these points.

3. Refer to A02803201L001 Table 1.

4. Gaugings as per A02803201L001 Appendix C and gauging results Table 2B.

5. Includes an estimated contribution of the larger separate catchment, being the difference of the flow gauging at the location and the estimated upstream 0.021m^3/s.

Table 2B: Gauging Results

Location[1]	Flow Gauging (m^3/s) 19/01/2024
Bridge	0.025
Point C	0.046
Quarry	0.056

Notes:

1. Refer to A02803201L001 Appendix A for specific locations of these points.

The following limitations and assumptions apply to this assessment:

1. Wastewater flows are estimated to be contributing 100% of stream low flow at the pond due to:
    a. constant WWTP discharges
    b. no runoff (surface and ground) occurring.

		2. The above wastewater contribution percentages are estimates and are indicative only. They are based on: a. pond discharges equating to existing WWTP averaged daily flow (totalised from hourly data) and future average daily discharge of 6000 m3/d. b. single round flow gaugings at Bridge, Point C Confluence and the Quarry sites. c. single round flow gaugings (Jan 2024) have been used to calculate wastewater % contributions in the low flow scenario. 3. No assessment has been made to modify stream flows by modifying the pond outlet.	
30.	While there are flow duration curves (naturalised) in the appendix to the stream hydraulic assessment report by Pattle Delamore Partners, they have no headings or graph labels, and there is no explanation of them in the report. The report also refers to a methodology in Appendix C but that appendix cannot be located and data from the gauging and water level recorder cannot be located. Please address these matters.	**Attachment 5** has been recompiled and is attached to this response. The explanation of the FDCs is contained within the methodology included with attachment 5. This document is attached with these responses. Water level recorder data was used to determine the relationship between rainfall and stream flow. We used this data to compare against our surrogate catchment. We can attach a graph showing the water level recorder data. Results show little variation in flow indicating the pond likely acts as a buffer limiting the natural stream variation from rainfall events. A summary of the gauging data will be provided in the final response.	
		Overland Flow System and groundwater	
31.	Please provide a detailed and comprehensive conceptual site model (CSM) of the current site, hydraulic connectivity, and key transport pathways. It is noted that this is likely to change when the design of the upgraded OFS is finalised, however it is appropriate and expected that a detailed CSM is provided given the period of time before the upgraded OFS is operational.	A conceptual site model for the existing overland flow system has been prepared and is attached to this response (**Attachment 6**). As acknowledged in PDP Memorandum 4, this may change in the future with improvements.	Closed
32.	It is acknowledged that the AEE and ecological report have provided an assessment that is based on the data available. In accordance with the initial review provided to	The full report on the Overland Flow Performance (A028030001R001) is attached to this response. – Refer to **Attachment 7**	Closed

<table>
<tr><td></td><td>WSL, please provide a complete assessment for the OFS when the full analytical data are available and incorporated into the assessment. Given the reliance on this assessment to both the assessment of the current treatment pathway (e.g., mass/flow ratios described in PDP 2 April 2024 memo) and the assumptions adopted in the ecological report, the current assessment of the overland flow system needs to be updated.
Following this updated assessment, the findings and conclusions need to be incorporated into the AEE and ecological report to inform their assumptions and also to provide an updated assessment of the current attenuation pathway and treatment ratios provided by the overland flow system (currently regarded as incomplete).</td><td>While there is some variability in the results, as expected with a natural system, the more detailed sampling regime shows largely similar trends to those set out in PDP Memorandum 2. In particular, the results of the additional sampling confirm that the dilution assessment completed in Memorandum 2 are valid and that there is no substantial variation in electrical conductivity through the system (other than due to dilution).</td><td></td></tr>
<tr><td>33.</td><td>The overland flow system memorandum 4 from Pattle Delamore Partners, dated 17 May 2024, states that: ‘any potential contaminants form overland flow site migrating downwards through the regolith into GW expected to have flow path lengths no longer than hundreds of metres to the nearest stream discharge zone, no existing bores or GW takes occur within this area.’ However no details on groundwater use in the immediate environment have been provided. Please address this and provide further information on groundwater take and use, including any groundwater quality monitoring data in the vicinity of the WWTP.</td><td>PDP is not aware of any groundwater use within the vicinity of the WWTP. As presented in Figure 2 attached to PDP Memorandum 4, the closest known bores are
Bore 8953 approximately 0.7 km northeast of the overland flow site (upgradient)
Bore 20029 approximately 1.5 km to the west of the overland flow site (cross gradient)
Bore 20412 approximately 2 km west-northwest of the overland flow site (downgradient).
PDP has requested an updated bore search from Auckland Council and any new bores will be included in the final s92 response.

PDP is unaware of any groundwater quality data for the aquifer in the vicinity of the WWTP. For wider context we have provided groundwater quality information from other bores in the Beachlands Waitemata aquifer:

<table><tr><td colspan="4">Beachlands Waitemata Aquifer Quality</td></tr><tr><td>Parameter</td><td>Bore 1911 KWL (28/2/2000) mg/L</td><td>Bore 23094 PDP (4/4/2008) mg/L</td><td>Bore 20758 GWE (2020) mg/L</td></tr><tr><td>pH</td><td>7.06</td><td>7.7</td><td>7.6</td></tr></table></td><td></td></tr>
</table>

Boron	0.13	0.032	0.026
Iron	0.69	0.48	1.8
Dissolved Arsenic		< 0.0010	< 0.0001
Dissolved Cadmium		< 0.00005	
Dissolved Chromium		< 0.0005	
Dissolved Copper	<0.05	< 0.0005	< 0.0002
Dissolved Lead		< 0.00010	0.0026
Dissolved Nickel		< 0.00050	
Dissolved Zinc	<0.05	0.053	
Total Hardness	230	180	180
Li	-	0.03	
Mg	8	9.6	9
Mn	0.12	0.094	
Sodium	35	36	30
Potassium	4	2.3	2.3
Chloride	31	37	30
Nitrite-N		< 0.0020	
Nitrate-N	0.07	< 0.0020	0.0032
Ammonia-N	0.19	0.04	
Sulphate	13	6.6	5.5
Total coliforms	-	<2/100ml	

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<tr><td>Faecal coliforms</td><td>-</td><td><2/100ml)</td><td></td></tr>
<tr><td>Escherichia coli</td><td>-</td><td><2/100ml)</td><td><1 MPN/100 mL</td></tr>
</table>
In general, the Beachlands Waitemata aquifer is considered high quality.

It should be noted that the impact of the overland flow system on groundwater is considered minor. An assessment of the flow pathways for any infiltration of the wastewater into the soil has been carried out to support this statement. The existing and proposed OLF areas are in the headwaters of the Te Puru Stream tributary. Most of the catchment is over Waitemata Group rocks with some sitting on basement greywacke. Percolation beneath the OLF areas is expected to go both shallow to perched systems in the Waitemata Group feeding the stream and deep to the regional groundwater system: a 90:10% split is assumed. Shallow groundwater flow paths from beneath the OLF areas are expected to enter the Te Puru Stream upstream of the junction with the main stem at monitoring point C, approximately 950m downstream of the bridge into the treatment plant site, giving a shallow groundwater catchment area of 3.4km^2. For a maximum sized OLF system of 11.25ha at a PE of 30,000 this covers 3.3% of the local catchment. Based in typical infiltration rates for a saturated soil (158mm/yr), some 1% of the ADWF sent to the OLF system is expected to return to the Te Puru stream tributary above Point C via the shallow groundwater system. The component that recharges the deep groundwater system is expected to mix with the groundwater throughflow of 2,700m^3/d (PDP, 2012) and raise the background N concentration by 0.005 g/m^3. This is similar to background N in the regional groundwater as shown in the table above.
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<td>34.</td>
<td>The overland flow system memorandum 2 from Pattle Delamore Partners, dated 2 April 2024 (memorandum 2), states: ‘the removal mechanisms for nitrogen and phosphorus in an overland flow system are relatively complex and are heavily influenced by the nature of the wastewater applied, the flowrate/loading rate, and the soils present at the site.’
In respect of this statement, please provide answers to the following questions:</td>
<td>Part A:
a. Under the proposed short term upgrades wastewater quality is intended to remain constant until the long-term upgrades are completed at PE 18,000. Increasing flows over this period are expected to drive higher nutrient loads.

Improvements to the overland flow system are expected to be carried out as part of the short-term upgrades as per Section 10.5 of the AEE. Further description of the potential improvements is provided in the response to question b. in Part B below.</td>
<td>Closed</td>
</tr>
</table>

	a. With regard to significantly increasing trends in Nitrate-N and DRP in the discharge, provide an assessment of how increasing concentrations an loads up to PE 18,000 will influence the treatment performance of the OSF. In the response, please provide an assessment to identify any critical processes that may be modified, such as the processes of nitrogen attenuation / removal in the OFS (e.g. volatilisation, biological nitrification – denitrification). b. Is there an upper limit as to the treatment efficacy after which it does not function, or declines? c. Please provide the information indicated in footnote 6, Table 1. d. The cross references supplied in Table 1 footnotes are not understood. Please address this by providing more updated applicable citations and cross-references to support the comparison. In respect of memorandum 2 and the overland flow system memorandum 3 (Interim) from Pattle Delamore Partners, dated 2 April 2024 (memorandum 3), please provide answers to the following questions: a. Confirm when the OSF upgrades will be operational and provide an assessment of the anticipated performance at the end of Stage 1, prior to the main WWTP upgrades being operational. b. How will the upgrades to the OFS serve to reduce and manage the significantly increasing trends of Nitrate-N and DRP discharging into the farm pond? c. How will the OFS affect the 95th percentile of data?, noting these data are of great interest given these are	It is anticipated that the current slope removal efficiencies can be maintained or improved through improvements to the existing overland flow slopes and/or expansion of the overland flow slopes. The details of any improvement or expansion will form part of the Overland Flow Design and Operation Management Plan. b. The efficacy of overland flow treatment varies based on the construction of the slope, the distribution of wastewater, the quality and quantity of wastewater applied and a range of environmental factors. In general, lower loading rates (both volume and concentration) are expected to result in higher quality effluent. However, net removal efficiency may be greater at higher concentrations, i.e., a higher percentage of nutrients may be removed when concentrations are higher at the same hydraulic loading rate. For Beachlands, the main factor which can be controlled, outside of WWTP effluent quality, is the hydraulic loading rate. The hydraulic loading rate can be modified by improving the existing dispersal system to maximise distribution across all of the slope area or by constructing new overland flow areas. The details of proposed upgrades/expansions will be provided in the Overland Flow Design and Operation Management Plan to ensure that treatment efficacy does not decline. c. Please refer to Table 6 of the *Beachlands Wastewater Treatment Plant – water quality, ecological and human health effects assessment* prepared by Aquatic Environmental Services, Coast & Catchment and Streamlined Environmental and submitted with the Consent Application. d. Full references for each of the overland flow system results presented are supplied in the final section of Memorandum 2. **Part B:** a. Improvements to the overland flow system are anticipated to be completed at the same time as the short-term WWTP upgrades. The exact nature and timing of the upgrades will be set out in the Overland Flow Design and Operation Management Plan to be provided within 6 months of the commencement of the consent.	

	at levels that present toxic concentrations in the receiving environment. d. Noting the above, please add the 95th percentile to Table 3, and incorporate into the assessment of the performance of the OFS. e. In respect of Table 4, please explain the derivation of the ratios, and a justification for applying the conductivity when earlier the report refers to this as being relatively inert, whereas the nutrients undergo attenuation pathway processes. f. The conductivity ratio from Table 3 equates to 141/122 = 1.15, but the ratio in Table 5 is 1.19. Please explain the differences. g. Table 4 note 2 references future scenarios. Please indicate which scenarios incorporating climate change scenarios have been accounted for. If not, please update the assessment to provide for the consideration of climate change, appropriate to the purpose and duration of the consent applied for. h. Page 6 of the memo states: 'flow ratios can then be used to determine the 'fraction' of each parameter which has been 'removed by treatment process' vs simple dilution.' However, the data do not include the point of an assessment before the discharge reaches the pond itself – it includes only the data from the farm pond to the Site 15 (mixing zone), thus it does not account for the efficacy of the OFS itself. Please address this. i. In respect of the Table 5 header, please state what processes other that dilution include. In the response, please provide specific details. j. Page 7 states: 'it remain unclear what fractions of this reduction are attributable to the overland flow system vs.	b. Based on the results of the overland flow performance investigation, there is a clear trend that increased residence times on the overland flow slopes promotes higher treatment efficiency. It is acknowledged that the existing dispersal system is not performing optimally. Wastewater is not dispersed evenly both across the four zones of the existing system and within each individual zone. Replacement of the dispersal system is expected to promote greater removal efficiencies in the overland flow system. For reference, the relative removal efficiencies from the three zones samples in the Performance Investigation are re-produced below. Zones A and B have lower flows and better dispersion compared to Zone C and the increase in nitrogen removal efficiency is clear. **Table 1: Nitrogen Removal Efficiency by Zone** **Parameter** / **Zone A** / **Zone B** / **Zone C** Nitrate-N / 21% / 14% / 4% Total Nitrogen / 24% / 17% / 6% Ammoniacal-N / 36% / 55% / 26% *Notes:* Similarly, the overall loading rate to the system can be reduced by expanding the overland flow area to Area B2 identified in PDP Memorandum 1. This is the preferred expansion area. Area B2 has even and gentle slopes which make it highly suited to overland flow. The grade of Area B2 is significantly flatter than the current overland flow system. It is expected that a new overland flow system could outperform the existing slopes, noting that the Zone C results are most representative of the current overall performance. There is sufficient available space within Area B2 to provide an additional 500 m of overland flow slope width as set out in the land requirement assessment completed by PDP (Memorandum 1). This remains true if the potential wetland catchment is excluded (refer response to Question 6).	

natural biological processes in the pond'. This is repeated in the memo summary on page 8. On the basis of these statements and memorandum 3 (an incomplete assessment of the OFS), it is evident that the OFS assessment needs to be fully completed, with corresponding ecological, water quality, and modelling assessments updated accordingly, noting that the outcomes of the performance assessment of the OFS has a strong bearing on the assumptions incorporated into the ecological and modelling reports. Please address this.

c. We have assessed the performance of the overland flow slopes under 95th percentile conditions by comparing the median performance of the overland flow system to the performance under the highest concentrations in the effluent applied to the top of the slopes. It should be noted that this assessment has only 10 data points available and therefore the highest concentration recorded for each parameter has been used.

Generally, the overland flow slopes perform worse for nitrogen but significantly better for phosphorus species under elevated concentrations as shown below. Note that negative removal values indicate an increase in concentrations and Pond Outlet % changes have been calculated relative to the effluent applied to the top of the overland flow slopes.

Table 2: Removal Efficiency at Median vs. Max Concentration

Parameter	Zone A	Zone B	Zone C	Pond Outlet
Median:				
Nitrate-N	21%	14%	4%	36%
Total Nitrogen	24%	17%	6%	29%
Ammoniacal-N	36%	55%	26%	-95%
Total Phosphorus	-17%	-7%	-10%	21%
DRP	-30%	-4%	-11%	26%
Max Concentration (95th Percentile):				
Nitrate-N	14%	12%	4%	39%
Total Nitrogen	17%	16%	8%	36%
Ammoniacal-N	37%	45%	60%	-130%
Total Phosphorus	8%	31%	15%	45%
DRP	8%	26%	7%	60%

Notes:

It should be noted that the peak nitrate-N and total nitrogen concentrations occurred under elevated wet weather flows. The reduced performance is most likely due to the higher flows increasing the discharge to Zones A and B. This reduces the residence time and therefore the treatment capacity. The performance of Zone C, which treats a higher volume of flow under dry weather flows, appears to be generally unaffected. Overall, the performance of the combined slope/pond system does not appear to be adversely affected by increased nitrogen concentrations.

For both total and dissolved reactive phosphorus, the system performs significantly better than under median concentrations. For DRP, under median conditions, the concentration of DRP increased by between 4% - 30% across the overland flow slopes. Under peak concentrations, there was a 8% - 26% decrease in DRP concentration across the slopes with an overall combined system reduction of 60%. This is thought to be due to the equilibrium between dissolved phosphorus in the wastewater and adsorbed phosphorus in the surface soils. When concentrations are high, phosphorus is adsorbed, and when concentrations are low, it is desorbed.

For reference, the absolute median and max values from the Performance Investigation Data set are provided below.

Table 3: Absolute Median and Max Concentration

Parameter (g/m³)	**WWTP**	**Zone A**	**Zone B**	**Zone C**	**Pond Outlet**
Median:					
Nitrate-N	3.4	2.2	2.7	3.3	2.3
Total Nitrogen	4.7	3.2	3.8	4.4	3.6
Ammoniacal-N	0.057	0.03	0.03	0.044	0.102
Total Phosphorus	0.35	0.5	0.48	0.33	0.27
DRP	0.23	0.33	0.28	0.25	0.19
Max Concentration (95th Percentile):					
Nitrate-N	5.1	4.4	4.5	4.9	3.1
Total Nitrogen	6.4	5.3	5.4	5.9	4.1
Ammoniacal-N	0.11	0.068	0.06	0.044	0.25
Total Phosphorus	1.24	1.14	0.86	1.05	0.48

DRP	0.98	0.9	0.73	0.91	0.39
Notes:					

d. Table 3 has been reproduced below using the 95th percentiles for contaminants assessed in Memorandum 2. Note that these statistics have been taken from the Sep 2023 – Feb 2024 (n=62) data set and not the Overland Flow Performance Investigation data set (n=10) as was used in the response to c. above.

The 95th percentile data indicates that the overland flow/pond system currently provides similar levels of removal as a percentage of the influent wastewater at the 95th percentile concentrations as well as median concentrations.

However, while these statistics provide a useful comparison, and demonstrate the effectiveness of the system under higher concentrations, we do not consider that it is appropriate to repeat the dilution assessment using the 95th percentile data. Since electrical conductivity is not affected by treatment processes, the 95th percentile electrical conductivity is unlikely to be linked to high nitrogen or phosphorous loads/concentrations. Instead, it could indicate a low level of dilution from inflow and infiltration in the reticulation network, or alternatively, an increase in the intrusion of saline groundwater.

Table 4: 95th Percentile concentrations across the Overland Flow/Pond system

Parameter	WWTP Effluent	U/S Pond (Site A)[2]	Farm Pond (Site B)	Tributary (Site E)[2]	Site 15
Nitrate-N (mg/L)	6.33	0.12	3.75	0.15	2.13
Total Nitrogen (mg/L)	7.60	0.40	4.80	0.43	2.70
Ammoniacal-N[1] (mg/L)	0.32	0.06	0.48	0.03	0.33
Total Phosphorus (mg/L)	2.55	0.07	0.79	0.05	0.4

Dissolved Reactive Phosphorus (mg/L)	1.51	0.03	0.64	0.03	0.36
Conductivity (µS/cm)	232	24	209	19	134

Notes:
1. *N=26 for ammoniacal nitrogen due to insufficient detection limits on WWTP samples prior to 4/12/23.*
2. *N = 20*
3. *N = 62 for all other samples*

e. Conductivity has been used to derive the flows through the system precisely because it is inert. As confirmed by the Overland Flow Performance Investigation, conductivity is not influenced by any processes in the overland flow slope or ponds. Therefore, the only way the electrical conductivity of the wastewater can change as if flows through the system is by dilution with fresh water from the environment.

The ratios have been derived by applying a mass balance to each stage of the process where:

$$c_1V_1 + c_2V_2 = c_3V_3$$

and

$$V_1 + V_2 = V_3$$

The electrical conductivity for the influent wastewater, inflows of freshwater into the pond, outflow of the pond, the tributary (Site F) and Site 15 are all known. By setting the influent wastewater (V_1) equal to an arbitrary value of 1 'flow unit' the above equations can be solved simultaneous to find the ratio of flows upstream of the pond (V_2) and out of the pond (V_3). This exercise was repeated for the confluence above Site 15.

Once the flows, and therefore dilution was identified using electrical conductivity, the dilution factor could be removed from the nitrogen and phosphorous parameters to understand the level of attenuation provided by the overland flow slope/pond system:

		$(c_1 - c_{removed})V_1 + c_2V_2 = c_3V_3$ $$c_{removed} = c_1 - \frac{c_3V_3 - c_2V_2}{V_1}$$ Assuming that any removal from the "freshwater" stream is negligible compared to the removal in the wastewater stream. f. Table 4 does not present the ratio of conductivity; it presents flows at different points in the system as a ratio of the influent wastewater flow. The ratio of 141/122 does not match the results presented in Table 4 because that calculation ignores the non-zero electrical conductivity of the upstream freshwater flows. g. The future scenario referenced in Table 4 was on the basis that stream flows remained consistent with the flows during the sampling period (Sep 2023 – Feb 2024). This comparison was intended to be indicative only and to demonstrate the rising proportion of wastewater in the system as flows increase. It should also be noted that the flows in the system were calculated as a ratio only, and therefore are indicative of potential median conditions over the sampling period. They are not directly comparable to specific scenarios of either wastewater or stream flow. Another aspect to note is that at times there may be zero flow within the stream. As detailed in the Overland Flow Performance Report (A028030001R001), for most of the sampling period (April – June 2024), there was negligible dilution across the farm pond indicating the stream would be dry if not for the existing wastewater discharge. h. At the time PDP memorandum 2 was prepared, no sampling had been completed at the base of the overland flow slopes. Therefore, the assessment presented in Memorandum 2 included the combination of attenuation on the overland flow slopes and within the farm pond as a single step in the treatment process.	

		PDP's report on the Overland Flow Performance Investigation (A028030001R001) provides further details on the individual contribution of the Overland Flow Slope and the Farm Pond. i. Other processes include: a. Sedimentation b. Adsorption c. Ion exchange d. Volatilisation e. Biological nitrification f. Biological denitrification g. Plant uptake h. Immobilisation i. Humification j. Leaching below the root zone PDP has completed an investigation into the performance of the Overland Flow Slopes. It is attached to this response.	
		Human Health	
35.	The assessment of microbiological effects and health risk from NIWA, dated April 2024 (the health risk report) has only considered norovirus (oral digestion route) in its quantitative microbial risk assessment (QMRA) through the swimming route. Justification has not been provided as to the reason adenovirus (inhalation route) has not been included in the QMRA at the same time. Please address this.	Section 3.1.1 of the QMRA report explains why the oral ingestion route was considered and the respiratory route was not. In cases where effluent is well treated, the Individual Infection Risk (IInfR) through oral ingestion is higher than the risk of infection through inhalation. Managing the risks from the oral ingestion route will ensure risks for the respiratory route will be managed, assuming the same health-based targets are applied to both. To elaborate on the reasoning in the QMRA report, norovirus is commonly used as the reference pathogen for assessing Gastrointestinal (GI) risks and adenovirus for Acute Febrile Respiratory Illness (AFRI) risks in marine environments. The marine guidelines have distinct breakpoint risk values for AFRI and GI within each microbiological assessment category (MAC). For instance, category A represents less than 1% Individual Illness Risks (IIR) for GI and less than 0.3% IIR for AFRI. These values differ by a factor of approximately three.	

		Recent New Zealand QMRAs have indicated that, with the current modelling parameters, the absolute risks for GI are consistently higher by a factor of more than three times than for AFRI. This disparity exists because, under our specific conditions of concern, the oral ingestion route involves larger volumes of water ingested and higher pathogen concentrations compared to the inhalation route. The end result is higher GI than AFRI risks. Consequently, meeting a MAC category for GI also ensures meeting the AFRI category, but not necessarily the other way around. The reported risk also includes an extra safety factor. Instead of comparing QMRA results against marine guidelines, we use the NPS-FM values. The NPS-FM uses IInfR, unlike the marine guidelines, which use IIR. IInfR values for a given exposure are consistently higher than IIR because not all infected individuals become ill. Thus, meeting the NPS-FM bottom line of 1% would ensure compliance with the category A marine guideline for GI and AFRI risks.	
36.	The health risk report has not included emerging organic contaminant (EOCs) in its health risk assessment. The ecological report has estimated the ecological risk of EOCs in the proposed Beachlands WWTP discharge to the receiving environment based on monitoring of pharmaceuticals and personal care products at Beachlands WWTP as well as literature on EOCs in wastewater from other WWTPs. Please provide a further health risk assessment in terms of EOCs.	EOCs were outside the scope of the human health risk report by NIWA as it is a quantitative microbial risk assessment (QMRA). Consumption of drinking water or aquatic species containing EOCs are the two main potential sources of human health risk in this case. There is very little information on human health risks from EOCs. Attachment Y describes the current understanding focussed on drinking water, noting the consumption of aquatic species is covered in our response to Q8. Further response in **Attachment 8**	Closed
37.	The health risk and ecological reports show that the Kellys Beach location has been excluded from its QMRA for consumption of shellfish since juvenile cockles and pipi present there were found to not be near harvestable sizes. The reports consider that it is unlikely that shellfish are harvested from Kellys Beach for human consumption. However, the consent is for 35 years, and during this period of time, shellfish are expected to grow and reach harvestable sizes. The health risk report shows that an	See response to Q20. If the shellfish exposure pathway exists for shellfish collected from Kellys Beach, either now or in the future, a QMRA will be undertaken to assess those risks.	Closed

	increase in flow will result in a noticeable increase in risk in marine environments than freshwater and shellfish at Kellys Beach are expected to be more likely to be influenced by the discharge as compared to the other three sites being assessed. Therefore, the QMRA should also include Kellys Beach in terms of shellfish consumption. Please address this.		
38.	The health risk report QMRA assessed the log reduction of norovirus required to reduce the added risk of infection to <1% for individual exposure (swimming, or consumption of shellfish or watercress) at each of the assessment sites. The report has not assessed the overall health risk from all the potential exposure routes. Please address this and include aggregated exposures into the assessment.	Risks are reported for each individual activity and event in accordance with the standard approach for assessing microbiological effects and health risks related to the impacts of wastewater discharges in recreational settings, including shellfish gathering and swimming. The risks from dilute, well-treated wastewater are generally acute, and each activity is treated as a separate and independent event. However, there may be situations where an individual swims in contaminated water, and additionally consumes uncooked or lightly cooked watercress and shellfish. This exposes them multiple times and in close temporal proximity to risks associated with the discharge of the treated wastewater. The resulting risks will be as high or higher than any individual event. Neither the Microbiological Water Quality Guidelines nor the NPS-FM provides guidance on aggregating multiple risks. Risk aggregation is a complex task, though it is commonly carried out for drinking water. The challenges in aggregating risk include which routes to aggregate. For example, the water quality at the time of a swim controls swimming risks, while food consumption risks reflect water quality for a period leading up to the kai collection. Ignoring these and other challenges, the pragmatic approach adds up the estimated individual risks for each activity. The resulting estimates will be highly conservative and overestimate the actual risk, but they may be informative. Focusing only on the two sites in the Te Puru Stream where we have estimated multiple risks, the resulting risk estimates created by simple addition are provided below. The combined risk estimates are:	

<table>
<tr>
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<table>
<tr><td></td><td colspan="7">Log Reduction Values (LRV)</td></tr>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>Bridge</td><td>75.5</td><td>63.7</td><td>37.7</td><td>6.9</td><td>1.2</td><td>0.1</td><td>0.01</td></tr>
<tr><td>Quarry</td><td>75.1</td><td>62.6</td><td>36.2</td><td>6.6</td><td>1.2</td><td>0.1</td><td>0.01</td></tr>
</table>
This assumes the worst-case scenario of Stage 2 (greatest flows) and the largest meal size.

Note: These risks are unreasonably high for LRV 1 and 2, as a significant proportion of the population is expected to have immunity from norovirus.
</td>
<td></td>
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<tr>
<td>39.</td>
<td>The health risk report has assessed microbiological water quality against Table 9 of the NPSFM. It states that: ‘there are national targets for 80% of rivers to be suitable for swimming (blue, green and yellow category) by 2030 (Ministry for the Environment 2023)’. The report uses a 95th percentile of 1,200 cfu/100ml as a national bottom line. This does not appear to accord with the NPSFM and the Ministry for the Environment and Ministry of Health (2003) Microbiological Guidelines for Marine and Freshwater Recreational Areas (MfE/MoH guideline). Please address this.

Note:
It is noted that the NPSFM has two E. coli-based metrics associated with human contact recreation. Table 9 applies year-round across all Freshwater Management Units and is assessed against selected State of Environment data on a monthly basis. While Table 22 applies over the summer bathing season at primary recreational contact sites, it specifies 95th percentile of 540 cfu/100ml as a national bottom line for freshwater contact recreation. This latter figure is consistent with the</td>
<td>The estimated risks have been assessed against the NPS-FM. The NPS-FM has set a national freshwater benchmark for human contact at the 95th percentile of E. coli at 540 cfu/100mL, as shown in Table 22 as the bottom line. The results of the QMRA cannot be directly connected with Table 22 as the attribute bands are not presented in terms of average individual infection risk (IInfR). However, it is possible to align the benchmark from Table 22 with Table 9, which aligns with the Blue category, representing an average infection risk of 1% or less (the bottom line). The 95th percentile of E. coli, equating to 1200 cfu/100mL, represents a predicted average infection risk of 3% and the yellow-orange boundary on Table 9. The QMRA report presents the results against the attribute bands (blue, green, yellow, etc.) from Table 9. The report notes the level of treatment required, expressed in terms of log reduction values (LRV), to meet the 1% IInfR, as specified by the NPS-FM in Table 22.

Figure 2.9 in the report presents the median (>260 cfu/100mL) and 95th percentile values (>1200 cfu/100mL) for NPS-FM Band E(Red). It demonstrates that the stream falls into the E band, so by definition, it would not meet the NPS-FM bottom line.</td>
<td></td>
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</table>

	MfE/MoH guideline and will likely trigger a health warning if exceeded. Therefore, it is considered that using 95th percentile of 1,200 cfu/100ml as a trigger for swimmable is inappropriate, notwithstanding that it is understood that the stream is unsuitable for swimming largely due to microbiological input from the wider catchment.		
40.	With respect to human health risks from viruses in relation to coastal marine environment, the following assessment is provided within the ecological report: *'For marine sites log reductions ranged from 2-3 Kelly's Beach transect sites (depending on discharge scenario), but less than 1 for those further out in the bay and for all discharge scenarios.* *For shellfish consumption, an LRV (log reduction value) of 1 is sufficient to provide a risk of <1% for the current discharge scenario at all marine sites, while this increases but is below 2 for interim and Stage 2 discharge scenarios.'* What does this mean for the people swimming at the beach sites and how will the health risks be managed? Please also clarify and assess the risk associated with shellfish consumption.	Providing the engineered barriers in the WWTP reduces the level of pathogens in treated wastewater by a factor of 1000 below the level in untreated wastewater (i.e., 3 Log10 reduction), we expect the average risk of norovirus infection for anyone swimming on a random day to be less than a 1% chance of infection per swim. See response to Q20 regarding shellfish risks. If the shellfish exposure pathway exists for shellfish collected from Kellys Beach, either now or in the future, a QMRA will be undertaken to assess those risks.	
41.	Please provide an assessment of risk to human health for shellfish gathering, applying the MfE (2003) Section F Microbiological Guidelines for Shellfish-Gathering Waters.	According to Section F of the Guidelines, the Guidelines should only be applied to waters "…where a prior sanitary survey has shown there are no point sources of pollution of public health concern." Meeting the guidelines does not guarantee safety when wastewater discharges impact water. Given the presence of the WWTP discharge, we suggest the guidelines should not be applied in this situation as they specifically exclude situations such as this. We suggest a QMRA is the most appropriate way to assess the incremental risks from a WWTP. Though we note that no specific risk-based targets for shellfish gathering are available, we suggest the NPS-FM provides an appropriate comparator.	Closed

Environmental Management			
42.	In accordance with the proposed monitoring plans in Section 10 of the AEE, please provide draft plans for the following: • Environmental management plan (overarching). • Environmental monitoring plan. • Operational management and contingency plan (OMCP). • Overland flow design and operation management plan (noting this is a proposed co-design with Ngāi Tai ki Tāmaki), and indicate the timeframes for this development: o Riparian management plan (for the expanded OFS). o Earthworks management plan, including erosion and sediment control (for the expanded OFS). Draft consent conditions.	Management Plans will be a requirement of the Consent Conditions. Proposed draft conditions have been provided, refer to **Attachment 9.**	
Water Quality			
43.	Section 2.4 of the AEE refers to the dosing of wastewater using acetic acid and aluminum sulphate (Alum) to assist in the removal of nitrogen and phosphorus, respectively. Please describe this process in more detail, providing a description of the 'chemical dosing strategy' (section 2.4.3, p17) that is used to manage nitrate and dissolved reactive phosphorus. In the response, please describe how / if the adjustment to the 'chemical dosing strategy' has contributed to significantly increasing trends in nitrate and DRP in the recent trend analysis period. Please also describe how the dosing strategy will be applied in the future as anticipated loads and concentration of nitrogen and phosphorus are expected to be treated up to PE 18,000, and post commissioning of the upgrade et PE 24,000.	Refer to Q13	

<table>
<tr><td>44.</td><td>Table 2-1 (p16) of the AEE, footnote 3, refers to nitrate data being excluded ‘due to steady increase in concentrations compared to previous 4 years’. As this data is relevant to the AEE, please update Table 2-1 to include this nitrate data for the period 2022-2023. It can be presented as an additional line item to allow the authors to highlight the differences if required.</td><td>Refer to Q13</td><td></td></tr>
<tr><td>45.</td><td>Figure 2-3 of the AEE provides population projections, and Figure 2-20 provides Connected Population estimate against timing of the upgrades. The relationship between the growth model and stepped staged approach is important. The year at which the PE 24000 is reached is approximately at the year 2043, as per Figure 2-3. This does not align with the stepped staged approach displayed in Figure 2-20 (which suggests this is reached around the year 2033). It would be useful to see these two figures aligned. Specifically, please indicate at what year the respective PE of 18,000, 24000, and 30,000 are expected to be reached. In the response, please also include the anticipated duration for each of the four stages 1. Current up to Short term upgrade; 2. Short term upgrade; 3. Long-term Stage 1, 4. Long term Stage 2. This information will be useful to assist with assessing the duration of the discharge conditions that will be occurring across the time periods indicated.</td><td>The population estimates presented in Figure 2-3 are outdated and therefore differ slightly from the those shown in Figure 2-20.

A summary of the upgrade timing, duration, population and capacity is presented below. Please note that the timeframes are indicative based on the latest available information from the property developer.

<table>
<tr><th></th><th>Current</th><th>Short Term Upgrade</th><th>Long term Upgrade -Stage 1</th><th>Long term Upgrade -Stage 2</th></tr>
<tr><td>Period</td><td>2023-2026</td><td>2026-2032</td><td>2032-2038</td><td>2038-2056</td></tr>
<tr><td>Duration</td><td>3 years</td><td>6 years</td><td>6 years</td><td>18 years</td></tr>
<tr><td>Population</td><td>9,704-10,124</td><td>10,124-15,603</td><td>15,603 – 22,291</td><td>22,291 – 29,238</td></tr>
<tr><td>WWTP Design Capacity</td><td>10,000</td><td>18,000</td><td>24,000</td><td>30,000</td></tr>
</table></td><td>Closed</td></tr>
</table>

ATTACHMENT 17

SECTION 92 RESPONSE
ECOLOGY ASSESSMENT
9 OCT 24
ATTACHMENT 1

Aquatic Environmental Sciences

COAST & CATCHMENT ENVIRONMENTAL CONSULTANTS

Streamlined ENVIRONMENTAL

Beachlands Wastewater Treatment Plant – water quality, ecological and human health effects assessment

Action	Personnel	Version	Date
Preparation of draft for external review	Mike Stewart (Streamlined Environmental Ltd), Mark James (Aquatic Environmental Sciences Ltd), Carina Sim-Smith (Coast and Catchment Ltd).	D1	28/03/24
External review	Iris Tscharntke (Watercare), Luke Faithful (Mitchell Daysh), Paula Hunter and Jim Bradley (Stantec), Padraig McNamara and Warren Bangma (Simpson Grierson)	D2	09/04/24
Preparation of final for release	Mike Stewart, Mark James	F1	16/04/24
Approval of final report	Mike Stewart	F2	16/04/24
Updated to include comments from Mark Wollina (Stantec)	Mike Stewart, Mark James	F3	27/05/24
Updated to include questions from Auckland Council through s92 process	Mike Stewart, Mark James	F4	09/10/24

Report WSL2303–F4

Prepared for Watercare Services Ltd

October 2024

Stewart, M., James, M., and Sim-Smith, C. (2024). Beachlands Wastewater Treatment Plant – water quality, ecological and human health effects assessment. Report WSL2303–F4, Streamlined Environmental, 140 pp.

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New Zealand

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Contents

Executive Summary

Introduction

The Beachlands Wastewater Treatment Plant (**WWTP**) operated by Watercare Services Limited (**Watercare**) currently services around 11,000 people and discharges treated wastewater via an overland flow system to a tributary of Te Puru Stream where it flows downstream and joins other tributaries to form the Te Puru Stream which subsequently flows into the estuary at Te Puru Park approximately 7km downstream.

Upgrades to the existing Beachlands WWTP and an expansion of the overland flow system are required due to the projected future growth (up to 30,000 people) in Beachlands and Maraetai communities and the WWTP coming to the end of its design life. The current WWTP discharge consent expires on 31st December 2025.[1]

Therefore, Watercare is submitting an application to Auckland Council (**Council**) to renew the Beachlands WWTP discharge consent, which includes proposed changes to discharge quality and overland flow system expansion and requires an ecological effects assessment to support this application. This report provides an assessment of the potential ecological effects of treated wastewater discharges into a tributary of Te Puru Stream, via an overland flow system, associated with the continued operation of the Beachlands WWTP.

The existing WWTP discharge

For the existing WWTP discharge:

- There has been full compliance with the current consent (number 26875) conditions between 2018-2023 for all parameters except discharge volume, which has exceeded the maximum consented volume of 2,800 m^3/day each year.
- Dissolved reactive phosphorus (**DRP**) and nitrate-N have shown a marked increase in concentration between 2018-2023, with median annual increases of 24% and 77%, respectively.
- Annual median decreases of 5-day carbonaceous Biochemical Oxygen Demand (**$cBOD_5$**) (1.6%), conductivity (16%), total suspended solids (**TSS**) (7.4%), and pH (0.5%) have been observed between 2018-2023.
- Ammoniacal-N, nitrite-N, faecal coliforms, and *Escherichia coli* (***E. coli***) have remained unchanged over this time.
- Based on limited sampling, total copper and total and dissolved zinc are at concentrations above the Australian and New Zealand Guidelines (**ANZG**) 2018 default guideline values (**DGVs**), suggesting some dilution and/or attenuation is required in the wastewater treatment system prior to discharge into the receiving environment.
- Emerging organic contaminant (**EOC**) concentrations were acquired from limited sampling and literature.

[1] https://www.watercare.co.nz/About-us/Projects-around-Auckland/Beachlands-WWTP-discharge-consent-renewal

- After attenuation through the existing overland flow and stream system, Total Nitrogen (**TN**) and Total Phosphorus (**TP**) loads contribute 34% and 46% of total load from the catchment to the marine coastal environment.
- Viruses have not been measured in the Beachlands WWTP. A quantitative microbial risk assessment (**QMRA**) was undertaken to assess the enteric illness risk of viruses in the discharge.

The proposed WWTP discharge

For the proposed WWTP discharge:

- Th consent application relates to WWTP discharges over four stages: Current and Short-Term with the existing WWTP treatment; and Long-Term Stages 1 and 2 planned with a new Membrane Bioreactor (**MBR**) WWTP treatment. Concentrations of various parameters are not expected to change between Current and Short-Term, and between Long Term Stages 1 and Stage 2.
- The population being serviced and the annual daily flows are expected to increase from current (11,000 people and 2,200 m^3/day average daily flow (**ADF**)) to Long-Term Stage 2 (30,000 people and 6,000 m^3/day ADF). Maximum wastewater daily flows (also called peak wet weather flow (**PWWF**)) are expected to increase from current (4,500 m^3/day) to Long-Term Stage 2 (36,200 m^3/day). We note that the assessment of effects uses the ADF and not the PWWF. We have approached it this way because the overland flow system (current and proposed expansion) will buffer wet weather flows, primarily in the pond, effectively removing effects from wet weather discharges.
- The overland flow expansion to accommodate the increased flows will likely require a new area to the south of the stream for overland treatment and collection system to convey the discharge into the stream and avoid erosion. For nutrients we have assumed that this expanded overland system would provide the same level of attenuation that is achieved with the current system.
- The Current and Short-Term stages will upgrade components of the current WWTP are provided in the AEE, however major improvements in discharge quality will be through commissioning of the MBR WWTP.
- After commissioning of the MBR WWTP new operational limits[2] will apply as follows:
    - Median $cBOD_5$ and TSS concentrations will be < 5.0 mg/L (compared with <7.0 mg/L for the Current and Short-Term stages and up to 5.7 mg/L and 11 mg/L currently measured, respectively).
    - Median TN will be < 5.0 mg/L (compared with <7.0 mg/L for the Current and Short-Term stages).
    - 95^{th} percentile $cBOD_5$ and TSS concentrations will reduce from 15 mg/L to 9 mg/L, while TN concentrations will reduce from 16 mg/L to 11 mg/L for the Current and Short-Term stages.
    - Ammoniacal-N concentrations will be similar to those for the Current and Short-Term stages.

[2] Following conservative principles, we have used these operational limits for our assessment of effects. However, it is expected that actual concentrations will be less than these operational limits and no worse than current concentrations, i.e. no deterioration in discharge quality from current state.

- NO_x-N concentrations will see a large reduction, with median concentrations reducing to <2.0 mg/L (compared with <3.5 mg/L for the Current and Short-Term stages and 5.1 mg/L currently measured) and 95th percentile concentrations reducing from 11 mg/L to 4.5 mg/L for the Current and Short-Term stages and 6.4 mg/L currently measured.
- DIN concentrations will see a large reduction, with median concentrations reducing to <2.5 mg/L (compared with operational limits of <4.1 mg/L for the Current and Short-Term stages and 5.5 mg/L currently measured), and 95th percentile concentrations reducing from 14 mg/L to 7.5 mg/L for the Current and Short-Term stages and 6.8 mg/L currently measured.
- TP/DRP concentrations will see a reduction, with median concentration concentrations reducing to <0.5 mg/L (compared with <1 mg/L for the Current and Short-Term stages and 0.73 mg/L currently measured), and 95th percentile concentrations reducing from 3.0 mg/L to 1.0 mg/L for the Current and Short-Term stages and 1.09 mg/L currently measured.
- Faecal coliform (**FC**) concentrations will remain unchanged throughout the staged upgrade.
- TN and TP loads will contribute 50% and 70% of total catchment load to the marine coastal environment, respectively, including accounting for attenuation.

- It is unlikely to be possible to expand the existing overland flow discharge system proportional to the predicted rise in WWTP effluent flows due to capacity issues. Potentially suitable land for an appropriately sized overland flow system is available if land on the south side of the stream within WSL's property is utilised, however engineering solutions are required to manage this.

The existing freshwater environment

For the existing freshwater environment (upstream sites are regarded as the "existing environment" i.e. without the WWTP):

- The catchment is low relief, rural pasture with areas of exotic forestry and regenerating native bush in stream gullies.
- There is a clear demarcation of freshwater and saline environments (tidal influence) below the Quarry site approximately 3km downstream of the discharge location.
- The flows in the Te Puru Stream network appear to be highly dependent on rainfall.
- Pattle Delamore Partners (**PDP**) derived theoretical stream flows from water level sensor and stream gauging to inform the potential for erosion under a 3-fold increase in wastewater flows.
- Water is generally well oxygenated, with dissolved oxygen (**DO**) similar upstream and downstream of the WWTP discharge.
- $cBOD_5$ is at low concentrations and similar upstream and downstream of the WWTP discharge.
- Water temperature is slightly elevated at sites downstream relative to sites upstream of the WWTP discharge.
- Low pH appears to be more an issue than high pH in the receiving environment and appears to be driven by the upstream farm pond site, not the WWTP discharge.

- Conductivity at all sites is above ANZG DGV but there is a clear influence of the WWTP discharge on conductivity in sites downstream.
- There is evidence of minor salinity ingress into the WWTP (influent maximum 2.4 parts per thousand (**ppt**) and discharge maximum 1.4 ppt) and environment sites upstream (maximum salinity 1.4 ppt) of Te Puru Park which has a known saline influence (maximum salinity 32.4 ppt). There is a clear linear relationship between salinity and conductivity so elevated conductivity observed is likely to be due to saline water intrusion into Beachlands WWTP.
- TSS and turbidity are low and at similar concentrations in receiving environment sites upstream of the Quarry site and unrelated to the WWTP discharge.
- Nitrogen concentrations are elevated at sites downstream of the WWTP discharge relative to concentrations observed upstream. Ammoniacal-N and nitrate-N concentrations at the potential mixing zone[3] –site 15 (hereafter called the Bridge site) approximately 350 m below the pond discharge – place them in NPS-FM attribute band B for toxicity. Dissolved inorganic nitrogen (**DIN**) at the same site is above levels that would be expected to contribute to eutrophication.
- Phosphorus shows a similar pattern to nitrogen with concentrations downstream markedly higher than concentrations upstream of the WWTP discharge.
- Chlorophyll *a* (**Chla**) is not measured in the influent or discharge. Concentrations are slightly elevated at the farm pond and the next downstream site, but back to upstream levels by the Bridge site.
- Bacteria – *E. coli*, FC, and enterococci – concentrations are higher upstream of the WWTP discharge, suggesting catchment sources dominate.
- All metal concentrations measured were below the applicable ANZG 95% DGV.
- Pharmaceutical and personal care products (**PPCPs**) measured show an average attenuation of 2.9-fold from the WWTP outlet to the Bridge site (15).
- Sediment phosphorus appears to be higher at the Bridge site than the farm pond. However, other studies show that sediment P appears to be relatively static over decadal timeframes.
- Temporal trend analysis was undertaken on water quality data collected from the upstream farm pond (A) and farm pond (B) sites from February 2020 to March 2023. Only nitrate in the farm pond showed a meaningful (>1% annual change) and significant ($p<0.05$) trend.
- Stream ecology surveys were undertaken by Bioresearches in 2016, 2019, 2022, and 2024. Sites were grouped into 'reference' sites (above the WWTP discharge) and 'effect' sites (below the WWTP discharge). For the most recent survey:
    - Macrophyte diversity and the percentage of macrophyte and algae cover generally increased downstream of the discharge. However, the majority of the substrates in the tributary are soft bottom and thus unlikely to develop nuisance levels of periphyton.

[3] We have identified the Bridge (Site 15) as the potential mixing zone site as it is sufficiently downstream to accommodate reasonable mixing from the existing farm pond and diffuse discharge from the proposed areas identified as potentially suitable for an expansion of the Beachlands overland flow system (see Section 3.2.2: **Figure 10**). Between the farm pond and the Bridge site is also Watercare land.

- Higher numbers of macroinvertebrate species were noted at the reference sites. Species numbers in the effects sites increased with distance from the WWTP discharge.
- The percentage of sensitive species **(%EPT**) ranged from 22-30% at the reference sites, with either no EPT taxa recorded or virtually 0% EPT at effect sites.
- The Macroinvertebrate Community Index (**MCI**) indices placed reference sites on the border between 'good' and 'fair' (and above the AUP (**Auckland Unitary Plan**) minimum of 94 for rural areas) with effect sites in 'fair' and 'poor' categories (and below the AUP minimum of 94 for rural areas).
- The Semi-Quantitative Macroinvertebrate Community Index (**SQMCI**) showed similar results to MCI with reference sites in the 'fair' or 'excellent' category (and above the NPS-FM NBL of 4.5) and effect sites in the 'poor' or 'fair' category (with only site F below the NPS-FM NBL of 4.5).
- Bioresearches noted that the poor macroinvertebrate scores downstream of the discharge are likely due to a combination of stressors, including the decreased riparian vegetation and hard substrate at downstream sites. The relatively high level of nutrients and conductivity downstream, as a result of the current discharge, would contribute to increased plant growth and poor macroinvertebrate communities.
- Native fish species abundance and diversity were higher at reference sites than effect sites.
- A fish Index of Biotic Integrity (**IBI**) allows comparison with other Auckland streams and rated reference sites in 'poor' or 'fair' categories and effect sites in 'very poor' or 'poor' categories.
- For trends from 2016-2024:
  - For most sites the number of macrophyte and algae taxa appear to be stable or increasing since 2016, with generally more taxa recorded at effects sites. A similar trend is noted for percentage macrophyte/algae cover.
  - For macroinvertebrates the number of taxa appear to be stable or declining at the reference sites and generally lower but stable or increasing at the effect sites.
  - %EPT has remained very low and between 0% and 3% for effect sites.
  - MCI scores for reference sites have been relatively consistent and mostly above the AUP minimum for rural areas of 94.
  - In contrast to the reference sites, at the effects sites all but one MCI value has been below the AUP minimum for rural areas of 94. Sites F and G have shown signs of improvement since 2016, with site G showing a general decline.
  - As for MCI there is a general increasing trend in the SQMCI scores (i.e. improving) for the effect sites.
  - Numbers of native fish species were generally low (1-5) for reference sites and 0-4 for effect sites with no apparent temporal trends observed.
  - The number of native fish at reference site H was declining from 2016 (38) to 2022 (14) but returned to near 2016 numbers in 2024 (36). Reference sites E and A showed a general increase in the number of native fish. Site F had consistently very low numbers of native fish with the other effect sites variable.

        - Fish IBI appears to be reducing at reference site H, but stable or increasing at reference sites E and A. For effect sites, site F has either no fish or a very low Fish IBI, while sites S2 and G appear to be generally improving.
    - The improvement in MCI and SQMCI scores at site F (closest to the WWTP discharge) is promising, however improved water quality in the future WWTP discharge (primarily lower concentrations of toxic nitrate and ammonia, and conductivity) is required to further improve the macroinvertebrate communities downstream.

The existing marine coastal environment

For the existing marine coastal environment:

- The lower, estuarine reaches of Te Puru Stream are strongly influenced by seawater inflow during high tide, with salinities of 20–35 ppt at high tide but decreasing to 5–15 ppt during low tide.
- The mouth of Te Puru Stream is designated as a Significant Ecological Area–Marine 1 (**SEA-M1**) due to the variety of saline vegetation and coastal vegetation present and the intact ecological sequence from estuarine to freshwater wetlands.
- Te Maraetai/Kellys Beach and the surrounding coastal area is designated as a Significant Ecological Area–Marine 2 (**SEA-M2**) due to the variety of intertidal habitats present that provide a habitat for a wide variety of marine organisms. An intertidal survey of Te Maraetai/Kellys Beach found that:
    - The upper shore is very muddy with abundant crustacean burrows. Mangroves line the stream bank around the entrance to Te Puru Stream.
    - The mid to lower shore is sandy with scattered shell/rock. Low lying shell banks are present in some areas.
    - Juvenile cockles and pipi were present in low to high densities across the mid to lower sandflats, but no shellfish were found that were near harvestable size.
    - Three small patches (each 2 m × 1 m) of moderately dense seagrass were observed near the low tide mark.
    - Intertidal sandstone reef platforms are present on either side of the bay that provide a habitat for a range of common intertidal species.
- The area between west Beachlands and Motukaraka/Flat is designated as a SEA-M1 due to the presence of large shellbanks that are used as high tide roosts by wading and coastal birds. Extensive seagrass beds have developed over this area over the last decade.
- Most of Whitford embayment, including the area around Motukaraka is designated as a SEA-M2 due to the presence of large areas of intertidal flats that provide a habitat for a wide range of marine species. The intertidal flats also provide feeding and roosting areas for a variety of coastal and wading birds. The intertidal macrofaunal community is typical of sheltered northern estuaries.
- Sunkist Bay, west of Te Maraetai/Kellys Beach, grades from sand at the high tide mark to shell and bedrock on the lower intertidal area. Shellfish (cockles, pipis and wedge shells) abundances in this bay were low.
- Omana Beach, east of Te Maraetai/Kellys Beach, is a sandy/shelly beach with no shellfish beds.

- Maraetai Beach is a popular recreational beach that is designated as a SEA-M2 due to the long sandy beach that provides extensive feeding areas for wading and coasting birds.
- Subtidal areas approximately 3 km offshore of Te Maraetai/Kellys Beach were surveyed by underwater video. Substrates comprised sandy-mud to muddy-sand, interspersed with patches of dense shell. The Mediterranean fan worm, an unwanted organism, was the only common epifaunal species observed. Other species that were occasionally observed included sponges, hydroids, bryozoans, horse mussels, 11-armed starfish, and sea cucumbers. No rocky reefs, living biogenic habitats, or regionally significant benthic species were observed in the survey.

Effects of discharges during the Current Stage

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during the Current Stage can be summarised as follows:

- The proposed annual average discharge volume is 2,200 m^3/day at this stage, which is a slight increase, but comparable, to the existing annual median for 2022 (1,947 m^3/day) and 2023 (2,038 m^3/day). A discharge at this slightly increased flow is likely to result in a <u>low effect</u> on stream bank erosion, and <u>negligible</u> effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge does not appear to be impacting on receiving environment sites. A proposed maximum operational discharge limit of 7 mg/L is marginally higher than the WWTP discharge in 2023/24 (median 5.7 mg/L). A discharge with this potential increase in $cBOD_5$ (noting the operational limit is a maximum concentration) is not expected to impact significantly on $cBOD_5$ (or DO) in the pond or further downstream.
- The current Beachlands WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge is expected to result in <u>low</u> impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current Beachlands WWTP discharge appears to be having <u>negligible</u> impacts on pH at sites downstream and this is expected to remain the same for the proposed discharge during the Current stage.
- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. The NIWA Stream Health Monitoring and Assessment Kit (**SHMAK**) report suggests that direct effects from conductivity on stream life does not occur until conductivity reaches levels found in brackish water or seawater, well above conductivity at these sites. Further, elevated conductivity may lead to reduced DO, but there are no apparent effects on DO downstream attributable to the current WWTP discharge. As stated earlier there was evidence of minor salinity in the current WWTP discharge. There are no proposed new discharge standards for conductivity and salinity but concentrations of salts are not expected to increase as a result of the proposed discharge. Accordingly, it is expected that conductivity in the proposed discharge will

contribute to low/moderate effects on stream ecology downstream compared with upstream. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should also reduce the effects of conductivity.

- The current Beachlands WWTP discharge has consistently low TSS (mean from 2018-2023 of 7.4 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The discharge concentration limits under the Current Stage (7 mg/L) should see a decrease in TSS of approximately 1.06-fold compared to the current discharge and contribute to improved water quality downstream of the discharge.
- Between 2018 and 2023 ammoniacal-N has been consistently around 0.40 mg/L in discharges from the Beachlands WWTP, reflected by equal median and 95th percentile concentrations of 0.40 mg/L. However, recent measurements with a more sensitive detection limit show that the median is more like 0.04 mg/L in the discharge.
  - Ammoniacal-N makes up around 0.5% of TN being discharged from the WWTP and is unlikely to be significantly contributing to ammoniacal-N concentrations downstream.
  - Processes in the pond will continue to increase ammoniacal-N levels downstream but would be expected to meet the NBL for ammoniacal-N toxicity and be unlikely to impact on species found downstream.
  - For these reasons we have not estimated ammoniacal-N concentrations downstream for any of the proposed discharge stages.
- A maximum operational median nitrate-N concentration (3.5 mg/L) will likely result in an NPS-FM attribute band B for toxicity at the Bridge site (1.1 mg/L). This is the same attribute band as the Bridge site currently.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median concentration of 4.1 mg/L would mean a DIN concentration at the Bridge site of 1.3 mg/L, above the accepted threshold for eutrophication.
- For DRP, a maximum operational median concentration of 1.000 mg/L would mean a DRP concentration at the Bridge site of 0.251 mg/L, resulting in an NPS-FM attribute band D and potentially an increase of DRP concentration at Bridge site currently (0.182 mg/L: also NPS-FM attribute band D). Note that 1.0 mg/L is an operational limit and we would not expect concentrations to get this high in the discharge and change from the existing levels.
- After attenuation through the overland and stream system, TN and TP loads will contribute 34% and 46% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same during the Current Stage. Zinc, copper and chromium appear to be increasing at the farm pond site (and to a lesser extent at the Bridge site) to near ecological guideline values as a result of the influence of Beachlands WWTP discharge.
- All sediment metal concentrations were below the ANZG DGV, with only zinc reported at concentrations that were increased downstream of the influence of Beachlands WWTP relative to upstream.

- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream.
- The majority of EOCs will present negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase during the Current Stage. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA assessed mean infection risks, which are summarised as:
    - For watercress consumption, a log reduction of 5 (100,000-fold reduction) is required to reduce the current risk of infection to <1% at the Te Puru stream sites.
    - For swimming, a log reduction of >4 (<10,000-fold) is required to reduce risks to below 1% at Te Puru stream sites. It was noted that swimming is unlikely at these sites.
    - For marine sites, swimming health risks were currently low with a log reduction of <2 (<100-fold) required at Kelly's Beach transect sites, and <1 (<10-fold) for those further out in the bay.
    - For shellfish consumption, a log reduction of 1 (10-fold) is sufficient to provide a risk of <1% currently at all marine sites.
    - We note that the QMRA looks at the added risk from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

Effects of discharges during the Short-Term Stage

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during the Short-Term Stage can be summarised as follows:

- The proposed annual average discharge volume is 3,600 m^3/day at this stage, compared to the existing annual median for 2023 of 2,038 m^3/day. A discharge at this increased annual average discharge volume is likely to result in a low effect on stream bank erosion, and negligible effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge does not appear to be impacting on receiving environment sites. A proposed maximum operational discharge limit of 7 mg/L during the Short-Term Stage is marginally higher than the WWTP discharge in 2023/24 (median 5.7 mg/L). A discharge with this potential increase in concentration (noting the operational limit is a maximum concentration) is not expected to impact significantly on $cBOD_5$ (or DO) in the pond or further downstream.
- The current Beachlands WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge during the Short-Term Stage is expected to continue to result in low impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current Beachlands WWTP discharge appears to be having negligible impacts on pH at

sites downstream and this is expected to remain the same for the proposed discharge during the Short-Term Stage.

- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. Implications of increased conductivity are discussed in relation to the Current stage and not repeated here. It is expected that conductivity in the proposed discharge during the Short-Term Stage will contribute to low/moderate effects on stream ecology downstream compared with upstream. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should reduce the effects of conductivity.
- The current Beachlands WWTP discharge has consistently low TSS (mean from 2018-2023 of 7.4 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The maximum operational discharge concentrations under the Short-Term Stage (7 mg/L) should see a decrease in TSS of approximately1.06-fold compared to the current discharge and contribute to improved water quality downstream of the discharge.
- For ammoniacal-N – and the reasons discussed in relation to the Current stage – we have not estimated ammoniacal-N concentrations downstream
- A maximum operational median nitrate-N concentration (3.5 mg/L) for the Short-Term Stage will likely result in an NPS-FM attribute band B for toxicity at the Bridge site (1.1 mg/L). This is the same attribute band as the Bridge site currently.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median concentration of 4.1 mg/L for the Short-Term Stage would mean a DIN concentration at the Bridge site of 1.3 mg/L, above the accepted threshold for eutrophication.
- For DRP, a maximum operational median concentration of 1.000 mg/L for the Short-Term Stage would mean a DRP concentration at the Bridge site of 0.251 mg/L, resulting in an NPS-FM attribute band D and potentially an increase of DRP concentration at Bridge site currently (0.182 mg/L: also NPS-FM attribute band D). Note that 1.0 mg/L is an operational limit and we would not expect concentrations to get this high in the discharge and change from the existing levels.
- After attenuation through the overland and stream system, TN and TP loads will contribute 46% and 59% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources now and with future upgrades.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same for the Short-Term Stage. Zinc, copper and chromium appear to be increasing at the farm pond site (and to a lesser extent at the Bridge site) to near ecological guideline values as a result of the influence of Beachlands WWTP discharge.
- All sediment metal concentrations were, and will continue to be for the Short-Term Stage, below the ANZG DGV, with only zinc reported at concentrations that were increased downstream of the influence of Beachlands WWTP relative to upstream.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream for each stage of the proposed future discharge.

- The majority of EOCs will present negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase for the Short-Term Stage. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA assessed mean infection risks, which are summarised as:
  - For watercress consumption, a log reduction of 5 (100,000-fold reduction) is required to reduce the risk of infection to <1% at the Te Puru stream sites. There was little difference in risk between the discharge stages.
  - For swimming, a log reduction of >4 (<10,000-fold) is required to reduce risks to below 1% at Te Puru stream sites. There was little difference in risk between the discharge stages and it was noted that swimming is unlikely at these sites. For marine sites, swimming health risks were low with a log reduction of <2 (<100-fold) required at Kelly's Beach transect sites, and <1 (<10-fold) for those further out in the bay.
  - For shellfish consumption, a log reduction of 1-2 (10-fold to 100-fold) is sufficient to provide a risk of <1% at all marine sites.
  - We note that the QMRA looks at the added risk from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

Effects of discharges during Long-Term Stage 1

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during Long-Term Stage 1 Stage can be summarised as follows:

- The proposed annual average discharge volume limit is 4,800 m^3/day at this stage, compared to the existing annual median for 2023 of 2,038 m^3/day. With this increase in annual average discharge volume the discharge is still likely to result in a low effect on stream bank erosion, and negligible effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge does not appear to be impacting on receiving environment sites. A maximum proposed operational discharge limit of 5 mg/L for Long-Term Stage 1 is marginally lower than the WWTP discharge in 2023/24 (median 5.7 mg/L). This potential decrease (noting the operational limit is a maximum concentration) is not expected to change the impact significantly on $cBOD_5$ (or DO) in the pond or further downstream.
- The current WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge during Long-Term Stage 1 is expected to continue to result in low impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current WWTP discharge appears to be having negligible impacts on pH at sites

downstream and this is expected to remain the same for the proposed discharge during Long-Term Stage 1.

- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. Implications of increased conductivity are discussed in for the Current stage and not repeated here. It is expected that conductivity in the proposed discharge will have to low/moderate effects on stream ecology downstream compared with upstream during Long-Term Stage 1. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should reduce the effects of conductivity.
- The current Beachlands WWTP discharge has consistently low TSS (median 7.8 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The discharge concentrations under Long-Term Stage 1 (5 mg/L) should see a decrease in TSS of approximate 1.6-fold compared to the existing discharge and contribute to improved water quality downstream of the discharge.
- For ammoniacal-N – and the reasons discussed in relation to the Current stage – we have not estimated ammoniacal-N concentrations downstream under any stage of the proposed WWTP upgrade.
- A maximum operational median limit of nitrate-N concentrations (2.0 mg/L) for Long-Term Stage 1 will likely result in an NPS-FM attribute band A for toxicity at the Bridge site. This is an improvement on the attribute band (B) for the Bridge site currently and would satisfy the requirement for an improvement under the NPS-FM.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median of 2.5 mg/L for Long-Term Stage 1 would mean a DIN concentration at the Bridge site from the proposed discharge of around 0.8 mg/L, below the accepted threshold for eutrophication and a major improvement on DIN for the Bridge site currently (1.7 mg/L).
- For DRP, a maximum operational median concentration of 0.500 mg/L for Long-Term Stage 1 would mean a DRP concentration at the Bridge site of 0.125 mg/L, resulting in an NPS-FM attribute band D but a decrease of DRP concentration at this site compared to the Bridge site currently (0.182 mg/L (also NPS-FM attribute band D). The proposed median DRP concentrations during Long-Term Stage 1 will contribute to improved water quality downstream compared with the current WWTP discharge, satisfying the intent of the NPS-FM.
- After attenuation through the proposed expanded overland and stream system, TN and TP loads will contribute 45% and 49% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources currently and with the future upgrades.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same, or reduced, during Long-Term Stage 1, with the MBR upgrade.
- All sediment metal concentrations are currently and will be expected to be for Long-Term Stage 1, below the ANZG DGV.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream as a result of the proposed discharge.

- The majority of EOCs will present negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase for Long-Term Stage 1, and with the MBR upgrade there may be a reduction in concentrations. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA for Long-Term Stage 1 upgrade was not undertaken. At the time the QMRA was undertaken there were 3 discharge stages proposed for the WWTP upgrade, with no Long-Term Stage 1 stage. Further, the interim stage (in the QMRA report) terminology was subsequently updated to Short-Term stage. No QMRA modelling has been undertaken for the Long-Term Stage 1 stage with risks, due to the installation of the MBR at Long-Term Stage 1, similar but lower than the Long-Term Stage 2 stage.

Effects of discharges during Long-Term Stage 2

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during Long-Term Stage 2 can be summarised as follows:

- The proposed annual average discharge volume is 6,000 m^3/day at this stage, compared to the existing annual median for 2023 of 2,038 m^3/day. With this increase in annual average discharge volume the discharge is still likely to result in a low effect on stream bank erosion, and negligible effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge also does not appear to be impacting on receiving environment sites. A proposed maximum operational discharge limit of 5 mg/L for Long-Term Stage 2 is marginally lower than the WWTP discharge in 2023/24 (median 5.7 mg/L). This potential decrease (noting the operational limit is a maximum concentration) is not expected to change significantly on $cBOD_5$ (or DO) in the pond or further downstream.
- The current Beachlands WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge is expected to result in low impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current Beachlands WWTP discharge appears to be having negligible impacts on pH at sites downstream and this is expected to remain the same for the proposed discharge during Long-Term Stage 2.
- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. Implications of increased conductivity are discussed in relation to the Current stage and not repeated here. It is expected that conductivity in the proposed discharge will continue to contribute to low/moderate effects on stream ecology downstream compared with upstream during Long-Term Stage 2. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should also reduce the effects of conductivity.

- The current WWTP discharge has consistently low TSS (median 7.8 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The discharge concentrations during Long-Term Stage 2 (5 mg/L) should see a decrease in TSS of approximate 1.6-fold compared to the existing discharge and contribute to improved water quality downstream of the discharge.
- For ammoniacal-N – and the reasons discussed in the Current stage – we have not estimated ammoniacal-N concentrations downstream under any stage of the proposed WWTP upgrade.
- A maximum operational median nitrate-N concentration (2.0 mg/L) during Long-Term Stage 2 will likely result in an NPS-FM attribute band A for toxicity at the Bridge site. This is an improvement on the attribute band (B) for the Bridge site currently and would satisfy the requirement for an improvement under the NPS-FM.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median of 2.5 mg/L during Long-Term Stage 2 would mean a DIN concentration at the Bridge site from the proposed discharge of around 0.8 mg/L, below the accepted threshold for eutrophication and a major improvement on DIN for the Bridge site currently (1.7 mg/L).
- For DRP, a maximum operational median concentration of 0.500 mg/L during Long Term Stage 2 would mean a DRP concentration at the Bridge site of 0.125 mg/L, resulting in an NPS-FM attribute band D but a decrease of DRP concentration at this site compared to the Bridge site currently (0.182 mg/L: also NPS-FM attribute band D). The proposed median DRP concentrations under the Long-Term Stage 2 WWTP upgrade will contribute to improved water quality downstream compared with the current WWTP, satisfying the intent of the NPS-FM.
- After attenuation through the proposed expanded overland and stream system, TN and TP loads will contribute 50% and 54% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources currently and with the future upgrades.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same, or reduced, for Long-Term Stage 2, with the MBR upgrade.
- All sediment metal concentrations are currently and will be expected to be for Long-Term Stage 2, below the ANZG DGV.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream as a result of the proposed discharge.
- The majority of EOCs will present negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase for Long-Term Stage 2, and with the MBR upgrade there may be a reduction in concentrations. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA assessed mean infection risks, which are summarised as:

- For watercress consumption, a log reduction of 5 (100,000-fold reduction) is required to reduce the risk of infection to <1% at the Te Puru stream sites. There was little difference in risk between the discharge stages.
- For swimming, a log reduction of >4 (<10,000-fold) is required to reduce risks to below 1% at Te Puru stream sites. There was little difference in risk between the discharge stages and it was noted that swimming is unlikely at these sites. For marine sites, swimming health risks were low with a log reduction of <3 (<1000-fold) required at Kelly's Beach transect sites, and <1 (<10-fold) for those further out in the bay.
- For shellfish consumption, a log reduction of <2 (<10-fold) is sufficient to provide a risk of <1% at all marine sites.
- We note that the QMRA looks at the added risk from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

Overall summary and conclusions

- The reference sites upstream provide a basis for considering the existing environment without the input of the WWTP noting that there can be changes in habitat as one moves downstream. The reference sites would be currently classified as degraded based on microbial contaminants and DRP is close to band D. With the WWTP contaminants added downstream the stream would be considered to be degraded on the basis of microbial contaminants, TN, nitrate-N, DIN, DRP and macroinvertebrate indices.
- The intertidal marine community at Kelly's Beach is typical of sheltered beaches around the Auckland region. The only threatened marine species (excluding birds) observed during the survey was seagrass, which was present in three very small patches on the lower shore. The area of seagrass cover is too small to meet the criteria of biogenic habitat.
- Overall, the potential ecological effects of the discharge on the freshwater ecological communities under the four proposed stages can be summarised as follows:
    - The proposed discharge operational limits for the Current and Short-Term Stages will likely result in similar water quality compared to the current water quality results and is highly likely to result in no significant change in the overall macroinvertebrate and fish community downstream compared to the most recent survey results.
    - The proposed discharge operational limits for Long-Term Stages 1 and 2, following the MBR upgrade, will result in an improvement in water quality compared to the current water quality results and is highly likely to result in an improvement in the overall macroinvertebrate and fish community downstream compared to the most recent survey results although the improvements may not be measurable. The overall magnitude of this effect will likely continue to be moderate but the effect from the WWTP cannot be easily separated from other variables (i.e. higher quality riparian vegetation and shading upstream) and stressors (sedimentation and nutrient input from adjacent farmland and side tributaries).
- Overall, the potential ecological effects of the discharge on the coastal marine environment under the 4 Stages covered by the consent application can be summarised as follows:
    - The proposed discharge rates under all four stages will have negligible effects on the salinity and the marine communities of Te Maraetai/Kellys Beach due to the

relatively low discharge rates compared to other nearby streams and rivers, the rapid dilution, and the tolerance of intertidal biota to low salinities. There will effectively be no change in salinity under any of the four stages from the existing WWTP.

- Nitrogen, and to a lesser extent, phosphorus, are the two primary limiting nutrients of concern in coastal waters. Proposed median TN and TP discharge concentrations will be 7 mg/L and 1.0 mg/L for the Current and Short-Term Stages, and 5 mg/L and 0.5 mg/L for Long-Term Stages 1 and 2. The WWTP discharge flow will increase over the term of the consent, therefore concentrations of these nutrients will be diluted (50% percentile) by 13,018× (Current), 1,352× (Short-Term), 831× (Long-Term Stage 1), and 309× (Long-Term stage 2) by the time they reach the Te Puru Stream mouth. This will result in nutrient concentrations being well below background concentrations in coastal waters under all four stages. Given the rapid dilution rate under all four stages, no increase in nutrient concentrations in coastal waters, or related adverse effects from increased nutrients, are likely to occur. Other minor contaminants that are present in the treated wastewater at low concentrations will be diluted at a similar rate to TN and TP. There will effectively be no change from the current WWTP.
- Potential effects on SEA-M1 site at Te Puru Stream estuary and SEA-M2 site at Te Maraetai/Kellys Beach are anticipated to be low given the level of influence the treated wastewater discharge under all four stages will have on nutrient concentrations and salinity in coastal waters. There will effectively be no change from the existing WWTP.
- Mean annual attenuated TN and TP loads from the existing WWTP by the time they reach the mouth of the Te Puru Stream are currently 1,979 kg/year and 233 kg/year, respectively. With respect to the proposed discharge:
  - For the Short-Term Stage, mean annual attenuated TN loads are estimated to increase 1.6-fold from current to 3,239 kg/year, and mean annual attenuated TP loads are estimated to increase 1.6-fold from current to 382 kg/year.
  - For Long-Term Stage 1, mean annual attenuated TN loads are estimated to increase 1.6-fold from current to 3,085 kg/year, and mean annual attenuated TP loads are estimated to increase 1.1-fold from current to 255 kg/year.
  - For Long-Term Stage 2, mean annual attenuated TN loads are estimated to increase 1.9-fold from current to 3,856 kg/year, and mean annual attenuated TP loads are estimated to increase 1.4-fold from current to 318 kg/year.

In comparison, TN loads for the Tamaki River, Wairoa River, Piako River, and Waihou River are around 60,000, 160,000, 1,415,000 and 2,168,000 kg/year, respectively, while TP loads for the Piako River, and Waihou River are 74,000 and 121,000 kg/year, respectively. Given that the estimated loads from the proposed discharge from the expanded and upgraded WWTP represent a very small percentage of the TN and TP loads entering the inner Hauraki Gulf and Firth of Thames, the effects of the increased loads from the proposed discharge for all stages assessed are expected to be less than minor.

1. Introduction

Watercare provides the majority of Auckland's urban area and satellite townships with wastewater services in the form of a public wastewater network and associated wastewater treatment and discharge facilities.

The WWTP currently services around 11,000 people and discharges treated wastewater via an overland flow system to a tributary of Te Puru Stream where it flows downstream and joins other tributaries to form the Te Puru Stream which subsequently flows into the estuary at Te Puru Park.

Upgrades to the existing Beachlands WWTP and an expansion of the overland flow system are required due to the projected future growth (up to 30,000 people) in Beachlands and Maraetai communities and the WWTP coming to the end of its design life. The WWTP discharge consent expires on 31st December 2025.[4]

Therefore, Watercare is submitting an application to renew the Beachlands WWTP discharge consent, which includes the proposed changes to discharge quality and overland flow system expansion and requires an ecological effects assessment for this application.

2. Scope of this report

This report provides an assessment of the potential ecological effects of treated wastewater discharges into a tributary of Te Puru Stream associated with the continued operation of an expanded Beachlands WWTP. Our assessment includes:

- A summary of the existing and proposed future (upgraded) WWTP operations and discharges, including consent compliance and discharge quality state and trends (**Section 3**).
- A summary of the existing water quality and ecology in the freshwater and marine receiving environments (**Section 4**).
- A description of the effects of the continued discharge of treated wastewater on the receiving environments currently and with the proposed future expanded and upgraded system (**Section 5**).

[4] https://www.watercare.co.nz/About-us/Projects-around-Auckland/Beachlands-WWTP-discharge-consent-renewal

3. Description of the existing and proposed future (upgraded) WWTP

3.1 Existing WWTP

3.1.1 Location, treatment, and monitoring sites

The Beachlands-Maraetai (Beachlands) WWTP is at 100 Okaroro Drive, Beachlands, approximately 3 km from Beachlands and 6 km from Maraetai (by road). The Beachlands WWTP is an activated sludge plant with biological nutrient removal (**BNR**) (Watercare, 2023). The following main unit processes are:

- Screenings and grit removal;
- Four-stage Bardenpho lagoon;
- Clarifier;
- Disk filtration;
- UV disinfection;
- Staged sludge digestion lagoons;
- Sludge drying beds;
- Stormflow buffer lagoon for raw wastewater; and
- Post-treatment lagoon for storm events.

The treated effluent is trickled through long pipes with holes, about 30 cm off the ground. The treated effluent then flows overland through grasses and bush towards a pond (**Figure 2**). The pond is formed by a small tributary of the Te Puru Stream (Site A) and dammed near Site B at the downstream end. From there the tributary flows downstream and joins other tributaries to form the Te Puru Stream (at the Bridge site (15))[5] (see **Figure 1** for locations and **Figure 3** for photos of Sites B and the Bridge (15)**)**. The Te Puru Stream flows into the estuary at Te Puru Park. Higher salinity water is detected up as far as just below the quarry site (**Figure 1**).

[5] We have identified the Bridge (Site 15) as the potential mixing zone site as it is sufficiently downstream to accommodate reasonable mixing from the existing farm pond and the proposed areas identified as potentially suitable for an expansion of the Beachlands overland flow system (see Section 3.2.2: **Figure 10**).

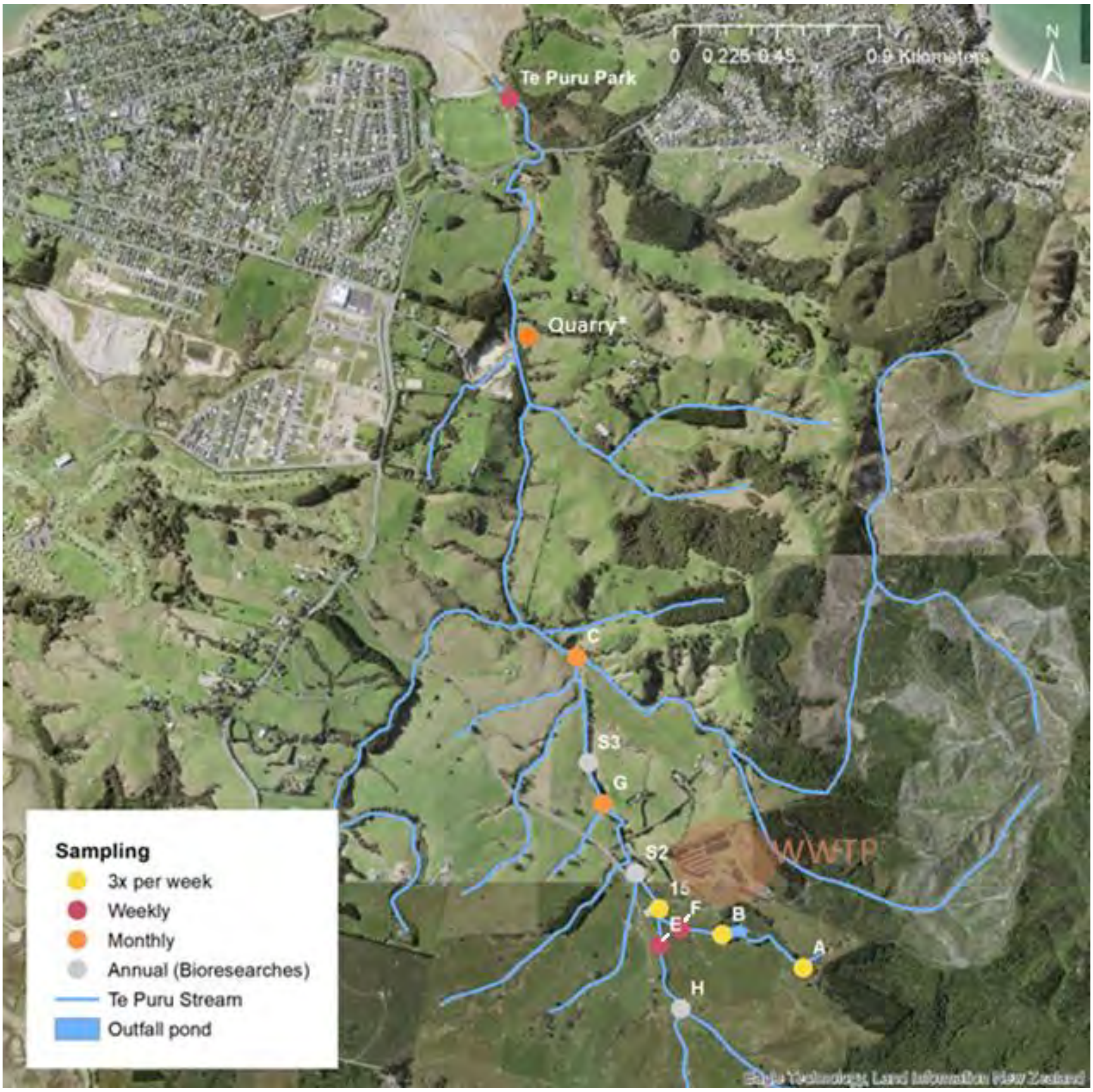

Figure 1. Location of Beachlands WWTP (brown oval), stream and river networks and water quality and annual ecology (Bioresearches) monitoring sites.

Figure 2. Trickle feed pipes (top) and farm pond (bottom).

Figure 3. Farm pond (B) (left) and Bridge (15) (right) sites.

3.1.2 Monitoring data

Watercare supplied discharge monitoring data for the Beachlands WWTP from January 2018 to December 2023 in excel format. These data were used for comparison with consent conditions (compliance: Section 3.1.3), to describe the discharge quality state (Section 3.1.4) and temporal trend changes (Section 3.1.5) from 2018-2023.

Further, Watercare have been undertaking extensive water quality monitoring of the WWTP influent and discharge and receiving environment sites since early September 2023[6]. Monitoring is ongoing at the time of writing, however data from 11th September to 24th January 2024 (inclusive)[7,8] were appended to the existing data from 2018-2023 and used to describe a more detailed current state for the discharge (this section) and receiving environment (Section 4).

[6] These data are collected in parallel to compliance monitoring data and are treated separately in this assessment.

[7] Monitoring data is being updated and maintained by Coast & Catchment Environmental Consultants in an online excel spreadsheet. Data were downloaded on 7th February 2024.

[8] A separate assessment of the dataset from 11th September to 19th February (inclusive) showed that apart from slightly higher variability for most parameters there was minimal difference between the two datasets. In the extended dataset, conductivity appears to have increased slightly in the outlet and also at the Bridge site, while nitrate has reduced slightly in the outlet but there is no change at Bridge site.

The sites monitored and frequency of monitoring are (**Figure 1**):

- WWTP influent and effluent (3 times per week).
- Farm Pond Tributary: Upstream of farm pond (Site A), farm pond (Site B), downstream of farm pond at confluence with Te Puru Stream (The farm pond tributary confluence (site 15); hereafter called the Bridge site) (3 times per week).
- Te Puru Stream: Upstream of Farm Pond Tributary (Site E) (weekly).
- Farm pond tributary: Between farm pond and confluence (Site F) (weekly).
- Two sites in Te Puru Stream downstream of confluence with farm pond tributary (Sites G and C: monthly).
- Te Puru Park: Where Te Puru Stream discharges into the marine environment (weekly).
- Quarry (weekly).[9]

The parameters measured were:

- Conductivity (mS/m).
- Temperature (°C).
- pH.
- Dissolved oxygen (DO: mg/L).
- Total Suspended Solids (TSS: mg/L).
- Volatile Suspended Solids (VSS: mg/L).
- 5-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$: mg/L).
- Turbidity (NTU).
- Total nitrogen (TN: mg/L).
- Total phosphorus (TP: mg/L).
- *Escherichia coli* (*E. coli*: cfu/100mL).
- Faecal coliforms (FC: cfu/100mL).
- Enterococci (cfu/100mL).
- Ammoniacal-N (NH_4-N: mg/L)
- Nitrate-N (NO_3-N: mg/L).
- Nitrite-N (NO_2-N: mg/L)
- Dissolved reactive phosphorus (DRP: mg/L).
- Chlorophyll *a* (Chla: mg/L).

Further, metals and the metalloid arsenic[10], and pharmaceutical and personal care products (PPCPs) were measured in water on 10th and 11th December 2023 at WWTP influent and effluent sites, and the three sites in the Farm Pond Tributary (A, B, 15). Metals and phosphorus were also measured in surface sediment from the three sites in Farm Pond Tributary (A, B, 15). Metals are discussed in Section 3.1.6 and PPCPs in Section 3.1.7.

[9] Quarry monitoring only from late November 2023.

[10] Arsenic is a metalloid, which is a non-metal with metal properties. For simplicity arsenic will be described as a metal throughout this report.

3.1.3 Compliance with consent conditions

Performance of the Beachlands WWTP against relevant parameters specified in the wastewater discharge permit (consent number 26875) from 2018-2023 is shown in **Table 1**.

Discharge volume has been the only non-compliant discharge parameter over this time period, and consistently above the consent limit of 2,800 m^3/day. TSS has, at times, been very close to the 90^{th} percentile consent limit of ≤15 mg/L (**Table 1**).

In 2019 ammoniacal-N was close to the 95^{th} percentile winter limit of ≤5 mg/L but has been very low (<1 mg/L) over the last 3 winter periods (**Table 1**).

90^{th} percentile DRP concentrations ranged from 0.47 mg/L in 2020 to 0.96 mg/L in 2023, well below the consent limit of ≤5 mg/L (**Table 1**).

Table 1. Summary of annual discharge compliance for Beachlands WWTP from 2018-2023. Cells bolded red exceed consent limit and show non-compliance.

Parameter	Units	Statistic	Consent limit	2018	2019	2020	2021	2022	2023
Discharge volume	m^3/day	Maximum	2,800	**5,619**	**3,420**	**3,801**	**3,601**	**4,257**	**4,331**
$cBOD_5$	mg/L	90^{th} percentile	≤15	3.3	3.4	7.2	4.6	2.6	2.5
TSS	mg/L	90^{th} percentile	≤15	13.4	11.0	15.0	13.2	10.1	10.8
FC	cfu/100mL	Median	≤14	2	2	2	2	2	2
DRP	mg/L	90^{th} percentile	≤5	0.62	0.70	0.47	0.90	0.74	0.96
NO_3-N	mg/L	90^{th} percentile	≤15	2.8	3.6	4.3	5.6	6.9	8.4
NH_4-N	mg/L	95^{th} percentile	≤4 (Nov-Apr)	1.3	1.5	1.8	0.9	2.1	1.4
NH_4-N	mg/L	95^{th} percentile	≤5 (May-Oct)	3.4	4.2	3.6	0.9	0.5	0.4

3.1.4 Discharge quality state (2018-2024)

The annual median discharge characteristics for the Beachlands WWTP for each calendar year from January 2018 to December 2023 are summarised in **Table 2**, along with the extensive monitoring undertaken for this assessment (2023/24). We note the latter data, although extensive (n=59 for most parameters), it is not for a full year and does not include data for winter and autumn seasons. Importantly it covers some of the drier parts of the year (see Section 4.2). A graphical presentation of these data (normalised to 2018 data) is provided in **Figure 4**.

DRP and nitrate-N have shown a marked increase in concentration since 2018. DRP has been increasing regularly over the 6 years and at 2023 (full year of data) was 2.93-fold higher than in 2018, while in 2023/24 (incomplete year of data) was 4.65-fold higher than 2018 (**Table 2** and **Figure 4**). The nitrate-N discharge concentration showed a large stepwise increase in 2022 (8.24-fold higher than 2018), which has been maintained over 2023 and 2023/24 (**Table 2** and **Figure 4**). The NH_4-N median is biased by many values below detection limit (0.4 mg/L) between 2018-2023. These high detection limits were present in the 2023-24 data from September until 4^{th} December. When these data are included (value set at detection limit) the median was 0.40 mg/L.

However, when these data were not included the median (0.04 mg/L) was 10-fold lower. The reason for the change since 2018 was operational changes and constraints (pers. comm. Tanvir Bhamji, Watercare).

$cBOD_5$ and conductivity have shown a marked increase in 2023/24 compared to 2018 (4.75-fold and 4.15-fold increase, respectively), which was not seen in the intervening years (maximum of 1.6-fold and 1.8-fold increase, respectively) (**Table 2** and **Figure 4**). We note that the 2023/24 data is incomplete and is indicative only and temporal trends show that both have been decreasing between 2018 and 2023 (Section 3.1.5.).

The remaining parameters have remained reasonably static over the 6-year time period (**Table 2** and **Figure 4**).

The significance and non-significance of these temporal trends is investigated further in Section 3.1.5.

Table 2. Beachlands WWTP discharge annual medians from 2018-2023.

Parameter	Units	2018	2019	2020	2021	2022	2023	2023-24[1]
Discharge volume	m^3/day	1895	1772	1523	1716	1947	2038	1786
$cBOD_5$	mg/L	1.20	0.97	1.95	1.50	1.00	1.15	5.7
Conductivity	µS/cm	334	384	609	179	125	117	1385
DRP	mg/L	0.19	0.22	0.16	0.37	0.36	0.54	0.73
NO_3-N	mg/L	0.48	0.24	0.16	0.78	3.96	5.66	5.10
NO_2-N	mg/L	0.02	0.02	0.02	0.02	0.02	0.02	0.02
NNN	mg/L	0.48	0.24	0.19	0.78	4.00	5.85	5.12
NH_4-N[2]	mg/L	0.40	0.52	0.40	0.40	0.40	0.40	0.04
pH		7.10	7.10	7.00	7.10	7.00	6.90	7.2
TSS	mg/L	7.00	7.00	11.00	9.00	5.50	5.10	7.8

[1] Based on extensive Watercare monitoring described in Section 3.1.2. Note this is indicative as it is not for a full year and does not include winter and autumn data.

[2] Note: NH_4-N median data for 2018-2023 is biased by many values below detection limit (0.4 mg/L). These were not included in 2023-24 data, resulting in a median 10-fold lower.

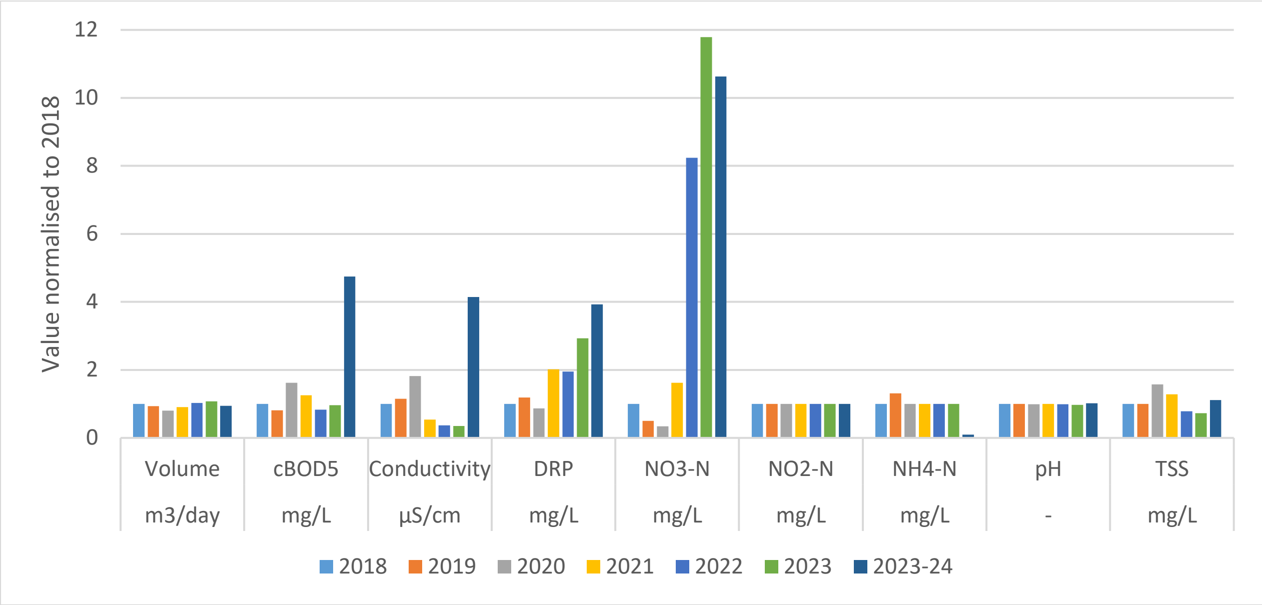

Figure 4. Beachlands WWTP discharge annual <u>medians</u> for 2018 to 2024 normalised to 2018 data.

3.1.5 Discharge quality trends (2018-2023)

3.1.5.1 Methods

Temporal trend analysis were undertaken using data from over the last 6 years.

The statistical tool 'Time Trends' (version 10.0) (NIWA, 2023) was used to assess temporal trends of water quality parameters of the receiving environment. Data were tested for seasonality and, if detected, then the Seasonal Kendall test was used to assess the significance of trends over time. If seasonality was not detected, then the Mann-Kendall test was used. In both cases, the direction and magnitude of the significance of any temporal trend in the data is reported.

We based our interpretation of the trend analysis results on Scarsbrook (2006), who considered both the statistical significance of the trend and whether or not it was meaningful. A statistically significant trend does not imply a meaningful trend, which is defined as a trend likely to be relevant from a management perspective. A meaningful trend is defined as one in which the trend is statistically significant ($p < 0.05$) and has an absolute magnitude of change of > 1% per year (which can be either positive or negative). Trends were categorised as follows:

- **No significant change** – The null hypothesis for the test was **not** rejected ($p > 0.05$). In the following results tables, non-significant trends are shown with an arrow to indicate the direction of the trend (increasing ↑; decreasing ↓; no change →).
- **Significant increase/decrease** – The null hypothesis for the test was rejected ($p < 0.05$) and the test statistic value was less than 1% per year. In the following results tables, significant trends are shown with a bold arrow to indicate the direction of the trend (increasing **🡅**; decreasing **🡇**; no change **➔**).
- **'Meaningful' increase/decrease** – The null hypothesis or the test was rejected ($p < 0.05$) and the test statistic value was greater than 1% per year. Increasing meaningful

trends are indicated in the following results tables by being highlighted in **red (↑)**. Decreasing meaningful trends are indicated in the following results tables by being highlighted in **blue (↓)**.

3.1.5.2 Results and discussion

Table 3 summarises the results of the temporal trend analyses of the Beachlands WWTP discharge between January 2018 and December 2023, with full results presented in Appendix 1.

Despite the discharge volume being non-compliant since 2018 (Section 3.1.3), there has been a slight (although not significant: p=0.894) decrease over this time period of -0.2% per year (**Table 3**).

$cBOD_5$ has also been reducing since 2018 by around 1.6% per year, although this has not been significant (p=0.626) (**Table 3**). We note the 2023/24 monitoring data (although an incomplete year) has shown an increase of 4.75-fold for $cBOD_5$ on 2018 data (see Section 3.1.4).

Conductivity has been decreasing significantly (p=0.000) and meaningfully (16.4% median annual decrease) in the discharge since 2018 (**Table 3** and **Figure 5: Top**). The decrease is consistent with that of the influent which is decreasing significantly (p=0.000) and meaningfully (18.7% median annual decrease) (**Figure 5: Bottom**). We note the 2023/24 monitoring data (although an incomplete year) has shown an increase of 4.15-fold for conductivity on 2018 data (see Section 3.1.4). This marked increase requires further investigation by Watercare as conductivity is a potential stressor of ecological communities downstream of the discharge. A trigger for conductivity should be considered that would result in further work to establish the cause and what can be done to mitigate the issue. It should also be noted that new piping for an expanded network will reduce risk of saltwater ingress.

TSS has been decreasing significantly (p=0.012) and meaningfully (7.4% median annual decrease) in the discharge since 2018 (**Table 3** and **Figure 6: Top**). The decrease is consistent with that of the influent in terms of the direction of the trend (decreasing) and the magnitude (4.5% median annual decrease) (**Figure 6: Bottom**) but the trend is not significant (p=0.402).

pH has been decreasing significantly (p=0.000) but not meaningfully (0.5% median annual decrease in the discharge since 2018 (**Table 3**). pH is not measured in the influent, so no comparison could be undertaken.

As discussed above DRP has been increasing significantly (p=0.000) and meaningfully (23.5% median annual increase) in the discharge since 2018 (**Table 3** and **Figure 7**).

Nitrate-N has been increasing significantly (p=0.000) and meaningfully (77.4% median annual increase) in the discharge since 2018 (**Table 3** and **Figure 8**). Prior to mid-2020 concentrations were relatively static but have been ramping up consistently since this time (**Figure 8**). Nitrate-N (and NH_4N) concentrations in the discharge are a function of nitrification/denitrification processes occurring in the WWTP, so it appears that a significant change to the WWTP process may have occurred since mid-2020, leading to marked increases in nitrate-N since this time.

Ammoniacal-N concentrations have remained static since 2018 with a percent median annual change of 0.0% (**Table 3**). We noted previously that these data are skewed by too many censored data (below detection limit).

Faecal coliforms and *E. coli* concentrations in the discharge have remained very low and static (percent median annual change is 0) since 2018 (**Table 3**).

Table 3. Summary of trend analysis between 2018 and 2023 for parameters measured in the Beachlands WWTP discharge.[11] Significant increasing trends are bold arrows with meaningful decreasing and increasing trends highlighted in blue and red, respectively. Non-bold arrows show direction of non-significant changes.

Parameter	Unit	Method	Mean	Median	P	Percent median annual change	Trend
Discharge volume	m^3/day	Seasonal Kendall	1854	1843	0.894	-0.2	↓
$cBOD_5$	mg/L	Seasonal Kendall	1.6	1.3	0.626	-1.6	↓
Conductivity		Seasonal Kendall	359	320	0.000	-16.4	**↓**
TSS	mg/L	Mann-Kendall	7.5	6.9	0.012	-7.4	**↓**
pH		Seasonal Kendall	7.0	7.0	0.000	-0.5	**↓**
DRP	mg/L	Seasonal Kendall	0.35	0.28	0.000	23.5	**↑**
NO_3-N	mg/L	Mann-Kendall	2.09	1.18	0.000	77.4	**↑**
NO_2-N	mg/L	Mann-Kendall	0.09	0.02	0.199	0.0	→
NH_4-N[1]	mg/L	Seasonal Kendall	0.54	0.40	0.001	0.0	→
FC	cfu/100mL	Mann-Kendall	3	2	0.025	0	→
E. coli	cfu/100mL	Mann-Kendall	2	2	0.503	0	→

[1] A trend for NH4-N was not possible due to too many censored data (below detection limit).

[11] Seasonal Kendall method used for all parameters except for TSS for which a Mann Kendall method was used.

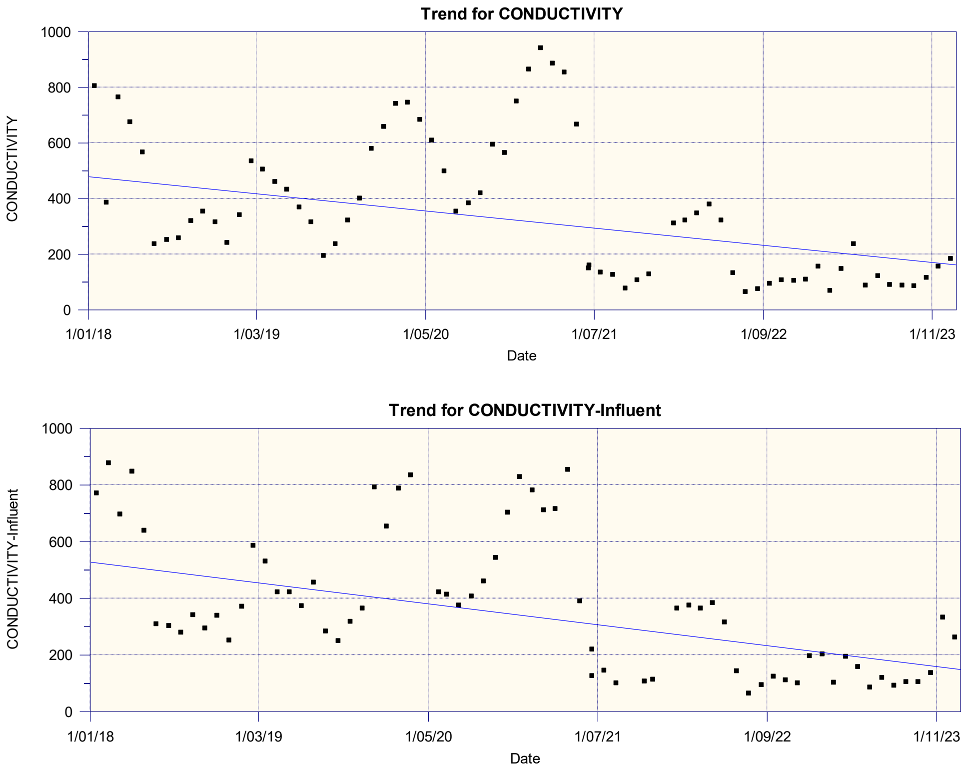

Figure 5. Significant and meaningful decrease in conductivity in discharge (top) and influent (bottom) from Beachlands WWTP discharge between 2018 and 2023. Values are monthly medians, and the line represents the median annual slope.

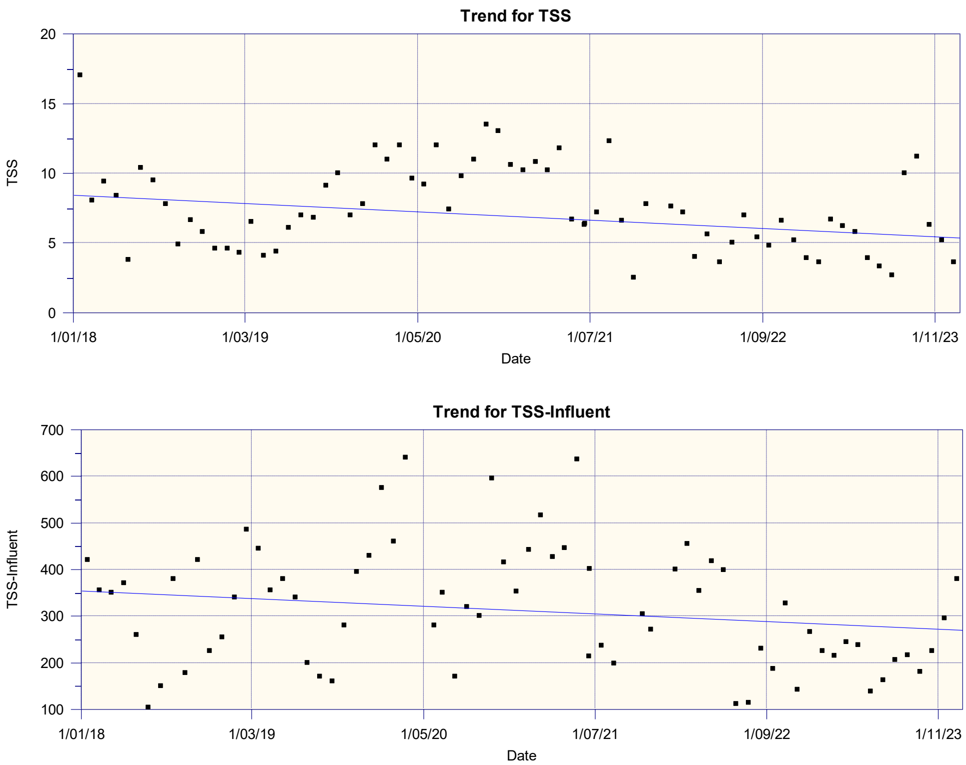

Figure 6. Significant and meaningful decrease in TSS in discharge (top) and non-significant decrease in influent (bottom) from Beachlands WWTP discharge between 2018 and 2023. Values are monthly medians, and the line represents the median annual slope.

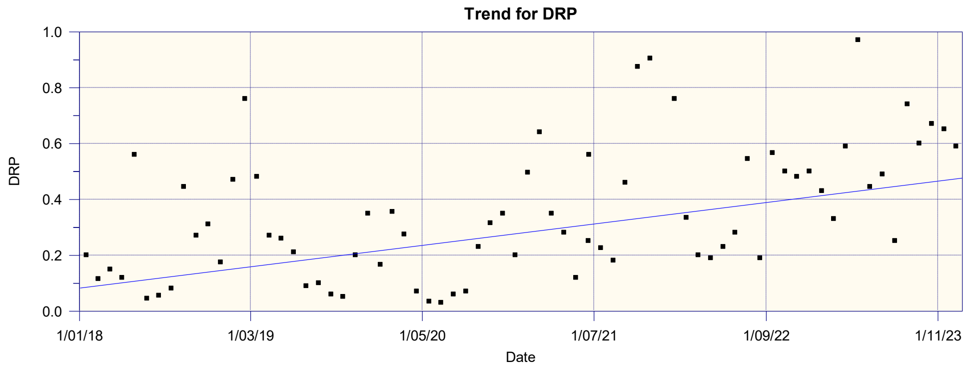

Figure 7. Significant and meaningful increase in DRP in discharge from Beachlands WWTP discharge between 2018 and 2023. Values are monthly medians, and the line represents the median annual slope.

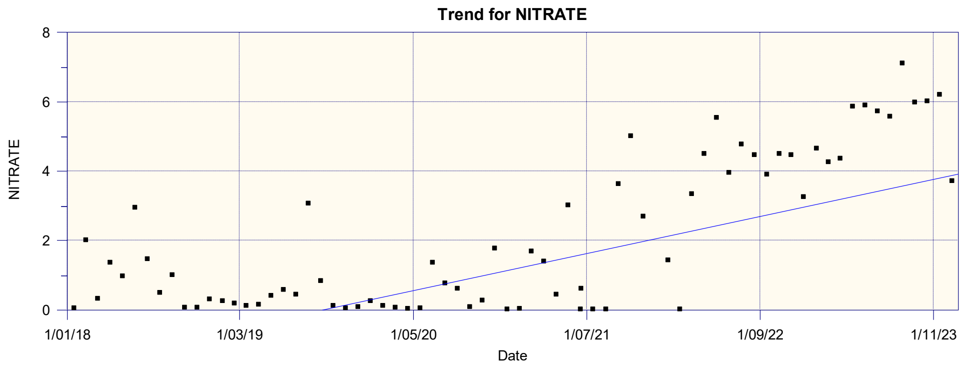

Figure 8. Significant and meaningful increase in nitrate-N in discharge from Beachlands WWTP discharge between 2018 and 2023. Values are monthly medians, and the line represents the median annual slope.

3.1.6 Metals

Total and dissolved metal concentrations were measured on 10th and 11th December 2023 from the WWTP inlet and outlet. Mean and standard deviations of each concentration are presented in **Table 4**, with comparison against the ANZG 2018 95% freshwater DGV. We note the DGV is not designed for wastewater samples and is included to provide context only.

For the inlet, total and dissolved chromium, copper, mercury, and zinc exceed the DGV by around 2-fold to 33-fold (total copper) (**Table 4**).

For the outlet, only total copper, and total and dissolved zinc exceed the DGV, at 1.3-fold, 2.0-fold, and 3.4-fold, respectively (**Table 4**). These data suggest that, based on limited sampling, minimal attenuation and/or dilution of copper and zinc would be required in the wastewater treatment system prior to discharge into the receiving environment. Receiving environment metal concentrations were measured at the same time and are described in Section 4.4.1.4.

Table 4. Mean and standard deviation (n=2) of total and dissolved metal concentrations reported from the inlet and outlet of Beachlands WWTP on 10th/11th December 2023 and comparison with ANZG (2018) DGVs. Bolded values exceed the guideline.

Location	Parameter	Unit	Mean	Standard Deviation	ANZG 95% DGV
Inlet	Arsenic-dissolved	µg/L	0.70	0.03	13
	Arsenic-total	µg/L	1.20	0.14	13
	Cadmium-dissolved	µg/L	<0.05	NA	0.2
	Cadmium-total	µg/L	0.08	0.01	0.2
	Chromium-dissolved	µg/L	**1.5**	0.4	1.0
	Chromium-total	µg/L	**4.0**	1.5	1.0
	Copper-dissolved	µg/L	**2.9**	0.4	1.4
	Copper-total	µg/L	**46.0**	1.4	1.4
	Lead-dissolved	µg/L	0.2	NA	3.4
	Lead-total	µg/L	1.7	0.4	3.4
	Mercury-dissolved	µg/L	**0.10**	0.06	0.06
	Mercury-total	µg/L	**0.10**	0.06	0.06
	Nickel-dissolved	µg/L	1.5	0.4	11
	Nickel-total	µg/L	2.8	0.1	11
	Zinc-dissolved	µg/L	**18**	11	8
	Zinc-total	µg/L	**115**	7	8
Outlet	*Arsenic-dissolved*	µg/L	0.53	0.01	13
	Arsenic-total	µg/L	0.56	0.01	13
	Cadmium-dissolved	µg/L	<0.05	NA	0.2
	Cadmium-total	µg/L	<0.05	NA	0.2
	Chromium-dissolved	µg/L	<0.5	NA	1.0
	Chromium-total	µg/L	0.6	0.1	1.0
	Copper-dissolved	µg/L	1.4	0.0	1.4
	Copper-total	µg/L	**1.9**	0.1	1.4
	Lead-dissolved	µg/L	<0.1	NA	3.4
	Lead-total	µg/L	<0.1	NA	3.4
	Mercury-dissolved	µg/L	<0.05	NA	0.06
	Mercury-total	µg/L	<0.05	NA	0.06
	Nickel-dissolved	µg/L	1.1	0.0	11
	Nickel-total	µg/L	1.3	0.2	11
	Zinc-dissolved	µg/L	**16**	11	8
	Zinc-total	µg/L	**28**	1	8

NA = Not applicable.

3.1.7 EOCs

3.1.7.1 PPCPs

Watercare have developed an analytical suite of pharmaceutical and personal care products and wastewater markers (**PPCPs**). PPCPs were measured in the inlet (influent) and outlet (discharge) of Beachlands WWTP on 10th and 11th November 2023, with the results summarised in **Figure 9**. The concentrations are generally markedly lower in the discharge than the influent. Potential effects of these PPCPs are described in Section 5.3.5.

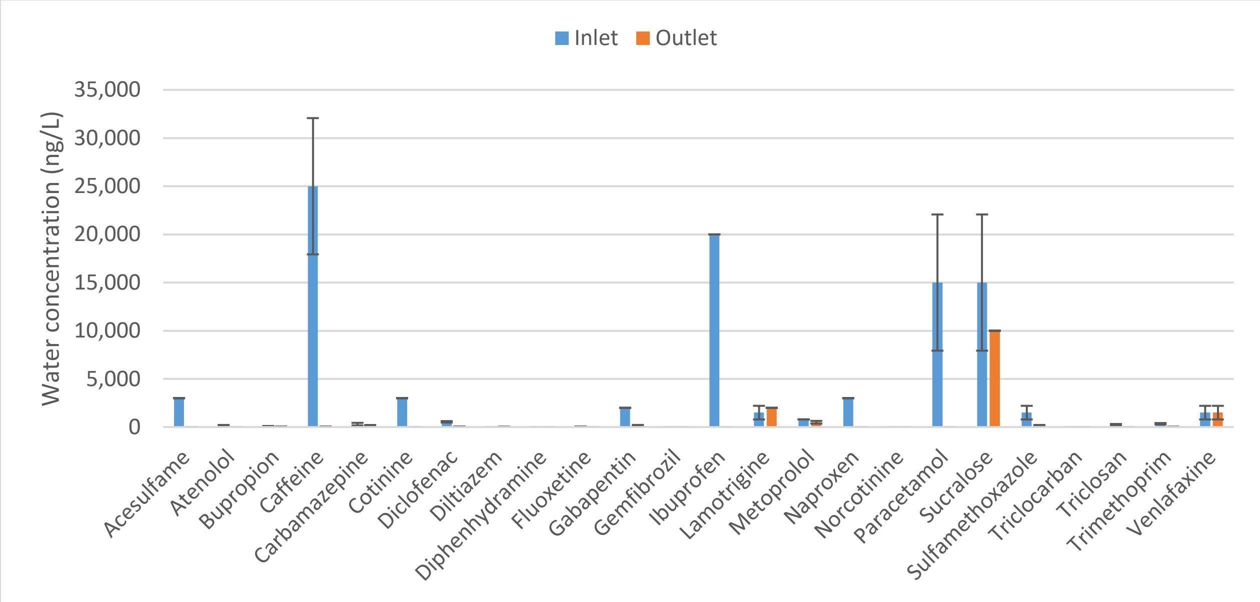

Figure 9. Mean and standard deviation (n=2) of PPCP concentrations reported from the inlet and outlet of Beachlands WWTP on 10th/11th December 2023.

3.1.7.2 EOCs from literature review

The Watercare PPCP analyte suite does not include other EOCs of potential risk, especially those of industrial origin. Therefore EOC data have been appended from recent surveys of three similar sized WWTPs in Auckland. To fulfil resource consent condition requirements for the proposed South-West, Omaha and Wellsford WWTP discharges, Watercare contracted SEL to undertake an ecological risk assessment on EOCs (Stewart, 2022). The assessment included measuring 125 EOCs in the treated wastewater of Waiuku, Omaha, and Wellsford WWTPs. Mean concentrations of the 35 EOCs that were detected in at least one of the three are summarised in **Table 5**. Potential effects of these PPCPs are described in Section 5.3.5.

Table 5. Mean concentration of EOCs of the treated discharge from Waiuku, Omaha, and Wellsford WWTPs undertaken in 2022 (Stewart, 2022).

Class	Analyte[1]	Auckland 2022 Mean concentration (ng/L)
Akylphosphate flame retardant	TBEP	79
	TBP	32
	TCEP	63
	TCPP	896
	TDCP	53
	TiBP	20
	TPP	2.3
Alkylphenol	Tech-NP-equivalents	108
Antimicrobial	Chlorophene	3.6
	Chloroxylenol	7.2
Insecticide	DEET	56
Nitro and polycyclic musk fragrance	Cashmeran	14
	Galaxolide	276
	Tonalide	15
Pharmaceutical	Acetaminophen	19
	Carbamazepine	163

Class	Analyte[1]	Auckland 2022 Mean concentration (ng/L)
	Diclofenac	60
	Ibuprofen	11
	Naproxen	75
	Salicylic acid	43
Plasticiser	BBP	3.9
	Bisphenol A	16
	DBP	16
	DEHP	29
	DEP	9.5
	DMP	3.6
Plasticiser metabolite	MBP	14
	MEHP	32
	MMP	3.9
PFAS	PFOS	7.9
	PFHxA	9.1
	PFHpA	3.2
	PFOA	6.6
	PFNA	1.9
	PFDA	1.6

[1] TBEP = Tris-(2-butoxyethyl) phosphate; TBP = Tributyl-phosphate; TCEP= Tris(2-chloroethyl) phosphate; TCPP = Tris (1-chloro-2-propyl) phosphate; TDCP = Tris[2-chloro-1-(chloromethyl)ethyl] phosphate; TiBP = Tri-isobutyl-phosphate; TPP = Triphenylphosphate; Tech-NP-equivalents = Technical nonylphenol equivalents; DEET = N, N-Diethyl-meta-toluamide; BBP = Butylbenzylphthalate; DBP = Di-n-butylphthalate; DEHP = Diethylphthalate; DEP = Diethylphthalate; DMP = Dimethylphthalate; MBP = Monobutyl-phthalate acid ester; MEHP = Monoethylhexyl phthalate acid ester; MMP = Monomethyl phthalate acid ester; PFOS = Perfluorooctanesulfonic acid; PFHxA = Perfluorohexanoic acid; PFHpA = Perfluoroheptanoic acid; PFOA = perfluorooctanoic acid; PFNA = Perfluorononanoic acid; PFDA = Perfluorodecananoic acid.

3.1.8 Viruses (QMRA)

Viruses have not been measured in wastewater at the Beachlands WWTP but NIWA undertook a quantitative microbial risk assessment (QMRA) as part of an overall assessment of microbial health risks (Wood and Stott, 2024) to assess potential human health risks from viruses in the treated wastewater. This is summarised in Section 5.3.6.

3.2 Future (upgraded) WWTP

3.2.1 Discharge quality

The proposed WWTP discharge will occur over four stages. The first (Current) stage will involve discharges from the WWTP in its present form. Next comes the Short-Term Stage involving discharges following an upgrade of the existing WWTP, and finally Long-Term Stages 1 and 2 involving new Membrane Bioreactor (**MBR**) WWTP treatment.

The WWTP is currently operating at its design capacity and has limited scope to accept any additional growth. The short-term upgrade will alleviate this constraint by upgrading components of the existing WWTP[12]. The long-term upgrade will involve construction of a new WWTP replacing the existing one, albeit using the same biological treatment process. The current bioreactor lagoon will be replaced with new concrete tanks termed activated sludge reactors (**ASR's**). The secondary clarifier and disc filters will be replaced by new ultrafiltration (**UF**) MBR's.

[12] See AEE Section 2.7.1 to 2.7.3 for full description of the upgrades.

The upgrades will include increased capacity with the MBR also providing improved discharge concentrations for some contaminants. The predicted characteristics for the staged approach for the upgrades is shown in **Table 6**. These are operational limits thus represent the maximum expected concentration and load for the type of treatment plant in operation. Following conservative principles, we have used these operational limits for our assessment of effects. However, it is expected that actual concentrations to be less than these operational limits and no worse than current concentrations, i.e. no deterioration in discharge quality from current state.

The population being serviced and the annual daily flows (ADF) are expected to increase from current (11,000 people and 2,200 m^3/day ADF) to Long-Term Stage 2 (30,000 people and 6,000 m^3/day ADF). Maximum wastewater daily flows (also called peak wet weather flow (**PWWF**)) are expected to increase from current (4,500 m^3/day) to Long-Term Stage 2 (36,200 m^3/day). We note that the assessment of effects (Section 5) uses the ADF and not the maximum treated PWWF. We have approached it this way because the overland flow system (current and proposed expansion) will buffer wet weather flows, primarily in the pond, effectively removing effects from wet weather discharges.

After commissioning of the new MBR WWTP, operational limits for median $cBOD_5$ and TSS concentration will reduce from 7.0 mg/L to 5.0 mg/L, or 71% of the existing WWTP operational limits (compared with current measured values of 5.7 and 11 mg/L). 95th percentile $cBOD_5$ and TSS concentrations will reduce from 15 mg/L to 9 mg/L (60% of existing operational limits), while TN concentrations will reduce from 16 mg/L to 11 mg/L (69% of existing operational limits) (**Table 6**).

Operational limits for ammoniacal-N concentrations will see a small reduction from existing, with median concentrations reducing from 0.6 mg/L to 0.5 mg/L (83% of existing operational limit), while 95th percentile concentrations will remain unchanged (3.0 mg/L) (**Table 6**).

NO_x-N is the sum of nitrate-N and nitrite-N (NNN) which is predominantly nitrate-N (88.9%-99.6% of NNN, see **Table 2**). After commissioning of the new MBR WWTP, operational limits for NO_x-N concentrations will see a large reduction, with median concentrations reducing from 3.5 mg/L to 2.0 mg/L (57% of existing operational limits) and 95th percentile concentrations reducing from 11 mg/L to 4.5 mg/L (41% of existing operational limit) (**Table 6**). This compares with a current measured median discharge concentration of 5.1 mg/L and 95th%ile of 6.4 mg/L

Dissolved inorganic nitrogen (DIN) is the sum of NNN and ammoniacal-N which is reflected in the discharge characteristics. After commissioning of the new MBR WWTP, the operational limits for DIN concentrations will see a large reduction, with median concentrations reducing from 4.1 mg/L to 2.5 mg/L (61% of existing operational limit), and 95th percentile concentrations reducing from 14 mg/L to 7.5 mg/L (54% of existing operational limit) (**Table 6**). This compares with a current measured median discharge concentration of 5.5 mg/L and 95th%ile of 6.8 mg/L.

After commissioning of the new MBR WWTP, operational limits for TP/DRP concentrations will see a large reduction from 1.0 mg/L to 0.5 mg/L (50% of existing operational limits), and 95th percentile concentrations reducing from 3.0 mg/L to 1.0 mg/L (54% of existing operational limits) (**Table 6**). This compares with a current measured median discharge concentration of 0.73 mg/L and 95th%ile of 1.09 mg/L.

FC concentrations will remain unchanged throughout the staged upgrade.

Table 6. Current, short-term and long-term staged Beachlands WWTP operational limits predicted based on the type of treatment system.[13]

Influent Flows and Loads	Units	Existing WWTP		New WWTP (MBR)	
		Current	Short-Term	Long-Term Stage 1	Long-Term Stage 2
Design population	P.E.	11,000	18,000	24,000	30,000
Annual average daily flow	m^3/day	2,200	3,600	4,800	6,000
Maximum treated wastewater daily flow	m^3/day	4,500	8,700	28,900	36,200

Effluent Median concentrations	Units	Existing WWTP	New WWTP (MBR)
		Current and Short-Term	Long-Term Stage 1 and Stage 2
$cBOD_5$	mg/L	7.0	5.0
TSS	mg/L	7.0	5.0
NH_4-N	mg/L	0.6	0.5
NO_x-N (NNN)	mg/L	3.5	2.0
DIN	mg/L	4.1	2.5
TN	mg/L	7.0	5.0
DRP and TP	mg/L	1.0	0.5
Faecal coliform	cfu/100mL	<10	<10

Effluent 95th percentile concentrations	Units	Existing WWTP	New WWTP (MBR)
		Current and Short-Term	Long-Term Stage 1 and Stage 2
$cBOD_5$	mg/L	15	9
TSS	mg/L	15	9
NH_4-N	mg/L	3.0	3.0
NO_x-N (NNN)	mg/L	11	4.5
DIN	mg/L	14	7.5
TN	mg/L	16	11
DRP and TP	mg/L	3.0	1.0
Faecal coliform	cfu/100mL	100	100

Effluent Loads	Units	Existing WWTP		New WWTP (MBR)	
		Current	Short-Term	Long-Term Stage 1	Long-Term Stage 2
Median $cBOD_5$ load	kg/day	15	25	24	30
Median TSS load	kg/day	15	25	24	30
Median NH_4-N load	kg/day	1.3	2.2	2.4	3.0
Median NO_x-N load	kg/day	7.7	13	10	12
Median DIN load	kg/day	9.0	15	12	15
Median TN load	kg/day	15	25	24	30
Median DRP and TP load	kg/day	2.2	3.6	2.4	3.0[14]

[13] Provided by Andrew Slaney (Stantec) by email on 12th April 2024, and after further discussions with Watercare. The 95th percentiles were based on observed performance and also literature values of similar BNR plants. FC and *E. coli* numbers are interchangeable.

[14] The median DRP/TP load provided in **Table 6** at Long-Term Stage 2 (3.0 kg/day) is 50% of the load used by DHI (2024) to calculate WWTP loads relative to catchment (see Section 3.3). This was a result of more recent follow-up work leading to the revisions. The outcome will be less of an effect from P loads to the marine receiving environment than concluded in this report.

3.2.2 Overland flow expansion

The proposed 3-fold increase in discharge volumes requires an appropriate scaled expansion of the overland flow system. PDP (2024a) have undertaken a preliminary assessment of the current overland flow system, determined if the system can be expanded, and identified potential expansion areas for further investigation (**Figure 10**).

PDP consider that it is unlikely to be possible to expand the existing overland flow discharge area proportional to the predicted rise in WWTP effluent flows. This is primarily due to the steeply incised banks of the stream which exist throughout the entire reach except for the pond area where the current system operates. Due to the steep banks the overland flow is at a higher risk of causing erosion/damage to the stream banks.

Potentially suitable land for an appropriately sized overland flow system is available if land on the south side of the stream within Watercare's property is utilised (see **Figure 10**). However, the new overland flow system would require a collection system to safely convey the discharge into the stream and avoid erosion. Diffuse discharge to the stream will be challenging without significant earthworks and riparian vegetation disturbance.

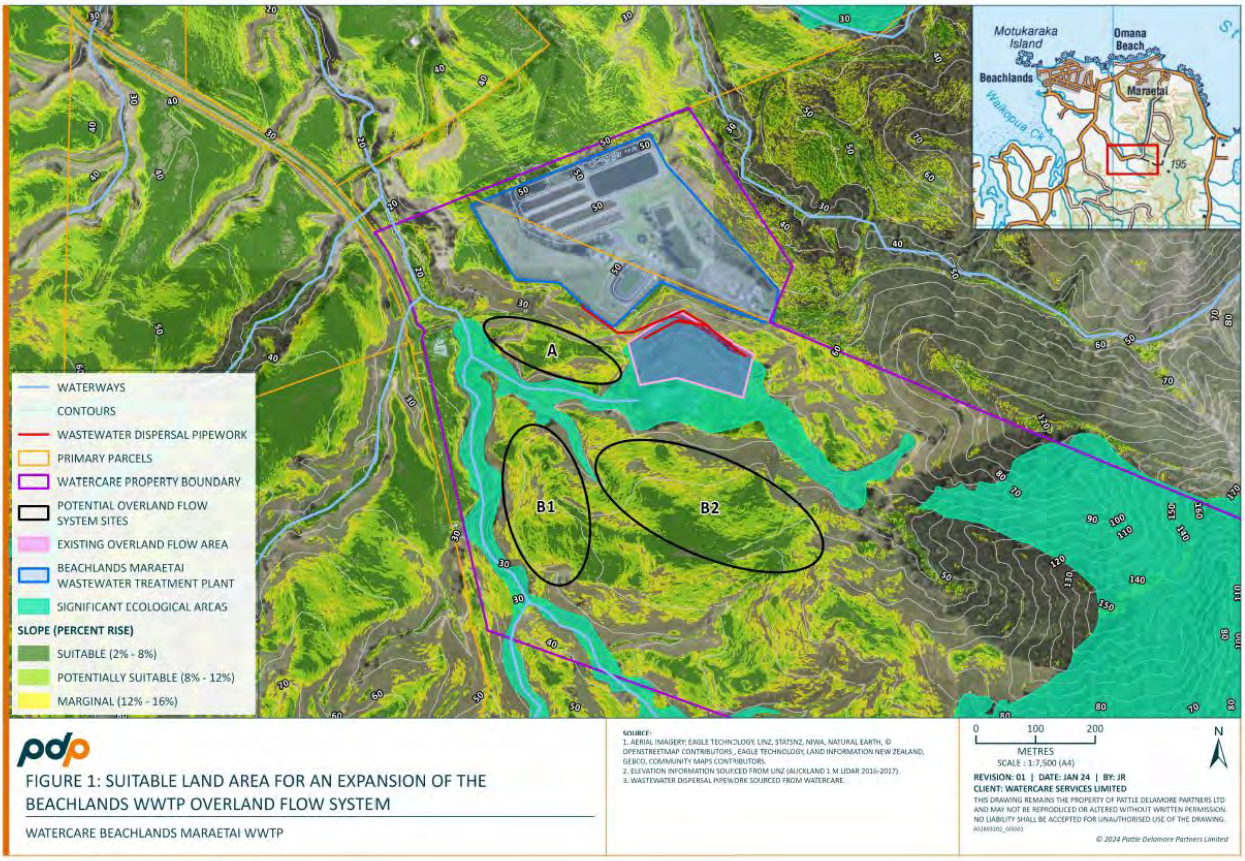

Figure 10. Suitable land area for an expansion of the Beachlands WWTP overland flow system (PDP, 2024a).

3.3 WWTP loads and proportion of catchment loads

DHI provided attenuated TN and TP loads[15] for the Current and Short-Term stages and Long-Term Stages 1 and 2, along with catchment loads (**Table 7**) (DHI, 2024).

Attenuated TN annual loads from the proposed discharge are expected to increase from the current load of 1,979 kg/year to 3,239 kg/year, 3,085 kg/year and 3,856 kg/year for Short-Term stage, Long-Term Stage 1 and Long-Term Stage 2, respectively, an approximate 1.6-fold to 2-fold increase. The contribution of Beachlands WWTP TN loads to the total load entering the estuarine environment is currently 34%, which will increase to 46%, 45%, and 50% at Short-Term stage, Long-Term Stage 1, and Long-Term Stage 2 respectively (**Table 7**).

Attenuated TP annual loads from the proposed discharge are expected to increase from the current load of 233 kg/year to 382 kg/year, 255 kg/year and 318 kg/year for Short-Term stage, Long-Term Stage 1 and Long-Term Stage 2, respectively, an approximate 1.1-fold to 1.4-fold increase. The contribution of Beachlands WWTP TP loads to the total load entering the estuarine environment is currently 46%, which will increase to 59%, 49%, and 54% at the Short-Term stage, Long-Term Stage 1, and Long-Term Stage 2 respectively (**Table 7**).

Table 7. Mean annual TN and TP loads for Beachlands WWTP outlet and Te Puru catchment.

Scenario	Unit	WWTP stage			
WWTP		**Current**	**Short-Term**	**Long-Term Stage 1**	**Long-Term Stage 2**
TN	kg/year	1,979	3,239	3,085	3,856
TP	kg/year	233	382	255	318
Te Puru Catchment		**Current**	**Short-Term**	**Long-Term Stage 1**	**Long-Term Stage 2**
TN	kg/year	3,825	3,825	3,825	3,825
TP	kg/year	270	270	270	270
Combined		**Current**	**Short-Term**	**Long-Term Stage 1**	**Long-Term Stage 2**
TN	kg/year	5,805	7,064	6,910	7,681
TP	kg/year	504	652	525	589
WWTP percentage of total load		**Current**	**Short-Term**	**Long-Term Stage 1**	**Long-Term Stage 2**
TN	%	34%	46%	45%	50%
TP	%	46%	59%	49%	54%

3.4 Summary of the existing and proposed discharge

For the existing WWTP discharge:

- There has been full compliance with the current consent (number 26875) conditions between 2018–2023 for all parameters except discharge volume, which has exceeded the maximum consented volume of 2,800 m^3/day each year.

[15] WWTP loads are calculated from the discharge with attenuation through the overland and stream system.

- Dissolved reactive phosphorus (DRP) and nitrate-N have shown a marked increase in concentration between 2018–2023, with annual increases of 24% and 77%, respectively due to operational changes and constraints.
- Annual median decreases of 5-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) (1.6%), conductivity (16%), total suspended solids (TSS) (7.4%), and pH (0.5%) have been observed between 2018–2023.
- Ammoniacal-N, nitrite-N, faecal coliforms, and *Escherichia coli* (*E. coli*) have remained unchanged over this time.
- Based on limited sampling, total copper, and total and dissolved zinc are at concentrations above the ANZG 2018 default guideline values (DGVs), suggesting some dilution and/or attenuation is required in the wastewater treatment system prior to discharge into the receiving environment.
- Emerging organic contaminant (EOC) concentrations were acquired from limited sampling and literature.
- After attenuation through the overland and stream system, TN and TP loads contribute 32% and 44% of total catchment load to the marine coastal environment.
- Viruses have not been measured in Beachlands WWTP. A quantitative microbial risk assessment (QMRA) was undertaken to assess the enteric illness risk of viruses in the discharge.

For the proposed discharge from the WWTP:

- The existing WWTP will initially undergo a capacity upgrade before the start of the Short-Term stage.
- The existing WWTP will undergo upgrades for water quality when a new MBR WWTP is commissioned for Long-Term Stages 1 and 2.
- The population being serviced and the annual daily flows are expected to increase from current (11,000 people and 2,200 m^3/day ADF) to Short-Term (18,000 people and 3,600 m^3/day ADF), to Long-Term Stage 1 (24,000 people and 4,800 m^3/day ADF), and finally Long-Term Stage 2 (30,000 people and 6,000 m^3/day ADF).
- The overland flow expansion to accommodate the increased flows will likely require a new area to the south of the stream and a collection drain to convey the discharge into the stream and avoid erosion.
- After commissioning of the new MBR WWTP (Long-Term Stages 1 and 2) new operational limits will be introduced that will have the following effect:
    - Median $cBOD_5$ and TSS concentrations will be < 5.0 mg/L (compared with <7.0 mg/L for the Current and Short-Term stages and up to 5.7 mg/L and 11 mg/L currently measured, respectively).
    - 95^{th} percentile $cBOD_5$ and TSS concentrations will be <9 mg/L and TN concentrations be <11 mg/L (compared with <15 mg/L and 16 mg/L for the Current and Short-Term stages, respectively).
    - Operational limits for median TN will be < 5.0 mg/L (compared with <7.0 mg/L for the Current and Short-Term stages and 6.4 mg/L currently measured).
    - Ammoniacal-N concentrations (<0.5 mg/L) will be similar to those for the Current and Short-Term stages (0.6 mg/L).

- NO_x-N concentrations will see a large reduction, with median concentrations reducing to <2.0 mg/L (compared with <3.5 mg/L for the operation limits for Current and Short-Term stages and 5.1 mg/L currently measured) and 95th percentile concentrations reducing to 4.5 mg/L (compared with 11 mg/L for the Current and Short-Term stages and 6.4 mg/L currently measured).
- DIN concentrations will see a large reduction, with operation limits for median concentrations reducing to <2.5 mg/L (compared with <4.1 mg/L for the Current and Short-Term stages and 5.5 mg/L currently measured), and 95th percentile concentrations reducing from 14 mg/L to 7.5 mg/L for the Current and Short-Term stages and 6.8 mg/L currently measured.
- Operational TP/DRP concentration limits will see a reduction, with median concentration concentrations reducing to <0.5 mg/L (compared with <1 mg/L for the Current and Short-Term stages and 0.73 mg/L currently measured), and 95th percentile operation limits for concentrations reducing from 3.0 mg/L to 1.0 mg/L for the Current and Short-Term stages and 1.09 mg/L currently measured.
- Faecal coliform (**FC**) concentrations will remain unchanged throughout the staged upgrade.
- TN and TP loads will contribute 50% and 70% of total catchment load to the marine coastal environment, respectively, including accounting for attenuation.

4. Description of the existing environment

4.1 Physical setting

The catchment surrounding Beachlands WWTP is low relief, mainly in dairy and sheep pasture, with areas of exotic forestry on open land and regenerating native bush in stream gullies and some open slopes (Zeldis et al., 2001).

4.2 Hydrology

The hydrological profile of the discharge stream network is shown in **Figure 1**. A series of tributaries join Te Puru Stream at various locations above and below the wastewater discharge.

The entrance of Te Puru Stream to the estuary is over a riffle section of steeply inclined stream bed at all tidal stages, clearly defining the upper limit of saline influence to below the Quarry site (Zeldis et al., 2001).

Rainfall is continuously monitored by the Council at Clevedon Coast RAWS @ Forest site.[16] Between 2019 and 2023 annual rainfall ranged from 867 mm to 1803 mm, with an average of 1272 mm.

2023 was the wettest year in the last five, with 1803mm of rain (average of 150mm per month). Rainfall between 11th September 2023 and 19th February 2024 (consistent with collection of water quality data) was 514mm or around 100mm per month. October 2023 (66mm), January 2024 (57mm), and February 2024 (6mm) were particularly dry months.

4.3 Hydrodynamics

The flows in the Te Puru Stream network appear to be highly dependent on rainfall. As part of an assessment of the effects of the Beachlands WWTP discharge on Te Puru Stream, estuary and Tamaki Straight, Zeldis et al. (2001) undertook a hydrological assessment of the stream network, including stream gauging. The survey was undertaken during a dry period with low catchment inflow and high WWTP discharge, approximating a worst-case scenario. The Quarry site had reduced flow over time once effects of rainfall runoff had cleared and stabilised at 48 L/s, while the farm pond increased and stabilised to 10 L/s, concluding that over dry periods the farm pond contributed around 20% of the total stream system flow at the Quarry site.

PDP installed a water level sensor downstream side of the bridge culvert on 27th October 2023 and supplemented this with stream flow gauging at various cross sections between the Farm Pond and Bridge sites on 27th October 2023, 15th November 2023, and 18th January 2024 (PDP, 2024b). Flow duration curves were calculated at the Bridge site, a point between the Farm Pond and the Bridge site, and at the Quarry site. Flow curves were used to derive theoretical stream flows and particularly the contribution of the WWTP discharge in the stream during storm events, to inform

16 https://environmentauckland.org.nz/Data/DataSet/Export/Location/659012/DataSet/Rainfall/Continuous/Interval/Latest

the potential for erosion from the proposed discharge (which represents a 3-fold increase in wastewater flows compared to the existing discharge consent).

4.4 Water and sediment quality state

4.4.1 Comparison of existing water quality between sites and with applicable standards and guidelines

Results from the extensive receiving environment data measured by Watercare between September 2023 and January 2024 (see Section 3.1.2) are presented as box and whisker plots, which show the distribution of data into upper and lower quartiles (boxes, which span the interquartile range (IQR)). The boxes have capped lines extending vertically (whiskers) which indicate the range from the 25th percentile minus 1.5 x IQR and the 75th percentile plus 1.5 x IQR. Values outside the whiskers are considered "outliers" and are shown as points. The mean value is presented as a cross. The Beachlands WWTP discharge data are included in the box and whisker plots for context.

Water quality statistics appropriate for comparison with the applicable guidelines were calculated on the same data and summarised in **Table 8** along with the applicable guideline, which is discussed below.

DO, ammoniacal-N, nitrate-N, DRP, and *E. coli* concentrations were compared to the numeric attribute state thresholds for rivers defined by the 2020 National Policy Statement for Freshwater Management (NPS-FM: MfE, 2024) to classify the 'state' of the studied waterways into attribute bands of A, B, C, or D. Specific reference is made to the national bottom line (**NBL**) where the concentrations exhibit the most significant effects. We note that ammoniacal-N and nitrate-N are focused on toxicity rather than potential for eutrophication.

Where no NPS-FM numeric attribute state thresholds are available – namely for conductivity, TSS, and TP – comparisons were made to relevant ANZG (2018) default guideline values (DGV) for physical and chemical stressors.[17] The ANZG Guidelines for Fresh and Marine Water Quality superseded the previous ANZECC (2000) guidelines in 2018 and are provided as an online tool (Australian and New Zealand Governments, 2018). Physical and chemical stressor DGVs for aquatic ecosystems are now classified by climate and source of river flow, allowing for natural variation in environmental conditions (Hale et al., 2012; McDowell et al., 2013). For this assessment we have used the REC classification of 'warm-wet low elevation' watercourses.

For DIN we have assessed levels against a median threshold of 1 mg/L. At present there is no agreed attribute state for DIN in the NPS-FM but general consensus is that waterbodies that are >1 mg/L are degraded and an appropriate threshold for lowland streams in agricultural settings (Expert Conferencing for proposed Southland Water and Land Plan: Southland Regional Council, 2019).

A temperature guideline was obtained from the Council's water quality index guideline values for freshwater sites throughout the region.

[17] DGVs have been defined as indicating that there is a 'potential risk' of adverse effects at a site.

Table 8. Comparison of receiving environment water quality parameters from September 2023 to January 2024 with applicable guideline. Exceedances of AC and ANZG (2018) guidelines and NPS-FM national bottom line (NBL) are bolded red.

Site/Parameter		WWTP Inlet	WWTP Outlet	Upstream Farm Pond (A)	Farm Pond (B)	Farm Pond downstream (F)	Bridge (15)	Tributary upstream (E)	Quarry	Te Puru Park[1]	Statistic	Guideline Value	Source[2]
Number of data	N	57	58	57	57	19	58	19	11	19			
DO	mg/L	0.1	0.8	**1.2**	**3.6**	7.4	5.2	5.9	7.0	5.6	1-day minimum (summer)[3]	4.0	NPS-FM NBL
Temperature	°C	23.0	25.7	**22.3**	**25.4**	**25.5**	**23.2**	**21.6**	**21.9**	23.3	Maximum (summer)[3]	17.7	AC
pH	unitless	7.40	7.30	6.80	7.50	7.70	7.40	7.24	7.50	7.74	80th %ile	7.70	ANZG WWLE
pH	unitless	7.10	7.04	**6.60**	**7.20**	7.56	**7.20**	**7.00**	**7.10**	7.26	20th %ile	7.26	ANZG WWLE
$cBOD_5$	mg/L	230	5.7	1.1	1.1	1.1	0.7	0.5	0.9	0.7	Median	No guideline	
Volatile Solids	mg/L	237	7.0	4.6	5.2	6.0	4.9	4.4	11.6	10.4	Median	No guideline	
Conductivity	µS/cm	2,442	2,072	**213**	**1,552**	**1,236**	**965**	**176**	**557**	18,760	80th %ile	115	ANZG WWLE
Salinity	ppt	0.9	0.7	0.1	0.6	0.6	0.3	0.1	0.2	5.6	Median	No guideline	
TSS	mg/L	395	10.2	**12.4**	**12.0**	**13.9**	**9.5**	8.3	**50.8**	66.0	80th %ile	8.8	ANZG WWLE
Turbidity	NTU	160	2.0	**15.0**	**7.0**	**6.2**	**10.4**	**13.4**	**60.0**	55.0	80th %ile	5.2	ANZG WWLE
TN	mg/L	71.0	7.3	0.23	**4.6**	**4.7**	**2.4**	**0.31**	**1.10**	1.10	80th %ile	0.292	ANZG WWLE
NH_4-N		51.5	0.04	0.03	0.29	0.21	0.07	0.02	0.04	0.04	Median		
NH_4-N@pH8[4]	mg/L	24.6	0.02	0.01	0.14	0.13	0.03	0.01	0.02	0.02	Median	0.24	NPS-FM NBL
(Attribute Band)		NA	NA	(A)	(B)	(B)	(A)	(A)	(A)	NA			
NH_4-N		63.1	0.32	0.05	0.48	0.35	0.24	0.03	0.10	0.22	95th %ile		
NH_4-N@pH8[4]	mg/L	30.2	0.14	0.02	0.23	0.22	0.11	0.01	0.05	0.11	95th %ile	0.40	NPS-FM NBL
(Attribute Band)		NA	NA	(A)	(B)	(B)	(B)	(A)	(A)	NA			
NO_3-N	mg/L	0.02	5.1	0.02	**2.8**	**3.2**	1.6	0.1	0.6	0.5	Median	2.4	NPS-FM NBL
(Attribute Band)		NA	NA	(A)	**(C)**	**(C)**	(B)	(A)	(A)	NA			
NO_3-N	mg/L	1.3	6.4	0.1	**3.8**	**3.8**	2.1	0.1	0.9	0.8	95th %ile	3.5	NPS-FM NBL
(Attribute Band)		NA	NA	(A)	**(C)**	**(C)**	(B)	(A)	(A)	NA			
NO_2-N	mg/L	0.020	0.020	0.002	0.002	0.002	0.002	0.002	0.002	0.002	Median	No guideline	
DIN (mg/L)	mg/L	52.67	5.52	0.05	**3.19**	**3.42**	**1.72**	0.14	0.47	0.54	Median	1.00	SRC
TP	mg/L	9.07	1.12	**0.045**	**0.580**	**0.596**	**0.297**	**0.030**	**0.100**	0.087	80th %ile	0.024	ANZG WWLE
DRP[5]	mg/L	4.92	0.73	0.014	**0.374**	**0.370**	**0.182**	0.014	**0.034**	0.027	Median	0.018	NPS-FM
(Attribute Band)		NA	NA	(C)	**(D)**	**(D)**	**(D)**	(C)	**(D)**	NA			

Site/Parameter		WWTP Inlet	WWTP Outlet	Upstream Farm Pond (A)	Farm Pond (B)	Farm Pond downstream (F)	Bridge (15)	Tributary upstream (E)	Quarry	Te Puru Park[1]	Statistic	Guideline Value	Source[2]
Number of data	N	57	58	57	57	19	58	19	11	19			
DRP[5] (Attribute Band)	mg/L	6.51	1.09	0.026	**0.499**	**0.503**	**0.251**	0.026	**0.066**	0.046	95th %ile	0.054	NPS-FM NBL
		NA	NA	(B)	**(D)**	**(D)**	**(D)**	(B)	**(D)**	NA			
Chla	mg/L	ND	ND	0.0009	0.0019	0.0023	0.0007	0.0006	0.0018	0.0014	Median	No guideline	
E. Coli	cfu/100mL	4,800,000	2	**1,250**	**510**	**540**	**540**	**930**	**480**	530	Median	130	NPS-FM NBL
E. Coli	cfu/100mL	10,200,000	17	**4,815**	**2,460**	**1,530**	**3,415**	**3,780**	**2,650**	6,320	95th %ile	1200	NPS-FM NBL
FC	cfu/100mL	8,200,000	2	1,750	650	770	715	1,300	590	690	Median	No guideline	
Enterococci	cfu/100mL	1,400,000	2	97	86	130	230	480	365	110	Median	No guideline	

[1] Te Puru Park has saline influence so is shown for perspective only.

[2] NPS FM = National Policy Statement for Freshwater Management (2020); AC = Auckland Council water quality index guideline; ANZG WWLE = Australian and New Zealand Governments default guideline values for REC classification of warm-wet low elevation; SRC = Southland Regional Council (2019).

[3] Summer defined as November-April. The NPS-FM attribute states require are a 7-day mean minimum (the mean value of 7 consecutive daily minimum values), and a 1-day minimum that is the lowest daily minimum across an entire summer period. The data provided do not fulfil these requirements so are indicative only.

4 Ammoniacal-N adjusted to pH 8 using the methodology in (Ministry for the Environment, 2018). The NPS-FM attribute state for ammoniacal-N toxicity is based on pH 8 and a temperature of 20°C and compliance with the numeric attribute states should be undertaken after pH adjustment to pH 8.

[5] DRP does not have a NBL in the NPS-FM, however for consistency with other parameters the threshold is between attribute state C and D.

4.4.1.1 Physical stressors

DO

DO data are indicative as they do not fulfil the requirements in the NPS-FM for which derivation of attribute states require a 7-day mean minimum (the mean value of 7 consecutive daily minimum values), and a 1-day minimum that is the lowest daily minimum across an entire summer period.

The existing Beachlands WWTP discharge has low DO as a minimum, with DO of 0.8 mg/L (**Table 8**). The median DO across sites ranges between 7-9 mg/L and is increasing with distance down Te Puru Stream (**Figure 11**). The minimum DO for the Bridge site (5.2 mg/L) is higher than upstream of the farm pond (3.6 mg/L). Based on these data, the existing discharge from the Beachlands WWTP does not appear to be impacting on DO in the pond or further downstream.

The NPS-FM numeric attribute state for DO is for a summer minimum of 4.0 mg/L when it is more likely to be an issue (**Table 8**) and the 2023/24 data are limited, with monitoring up to 24th January only. The 5-year data included parameters for upstream farm pond (A) and farm pond (B), although with a shorter time frame (February 2020 to March 2023). Minimum DO over the summer months ranged from 6.4-8.1 mg/L upstream of the farm pond (A) and between 7.4-10.9 mg/L at the farm pond (B) (data not shown). Based on the 5-year monitoring data, both sites are well oxygenated and above the NPS-FM summer minimum numeric attribute state of 4.0 mg/L. However, as shown in **Figure 11**, minimum DO for the WWTP outlet (0.8 mg/L), upstream farm pond (A) (1.2 mg/L) and farm pond (B) (3.6 mg/L), indicating that low DO is exhibited upstream of the existing WWTP discharge and in the farm pond during summer.

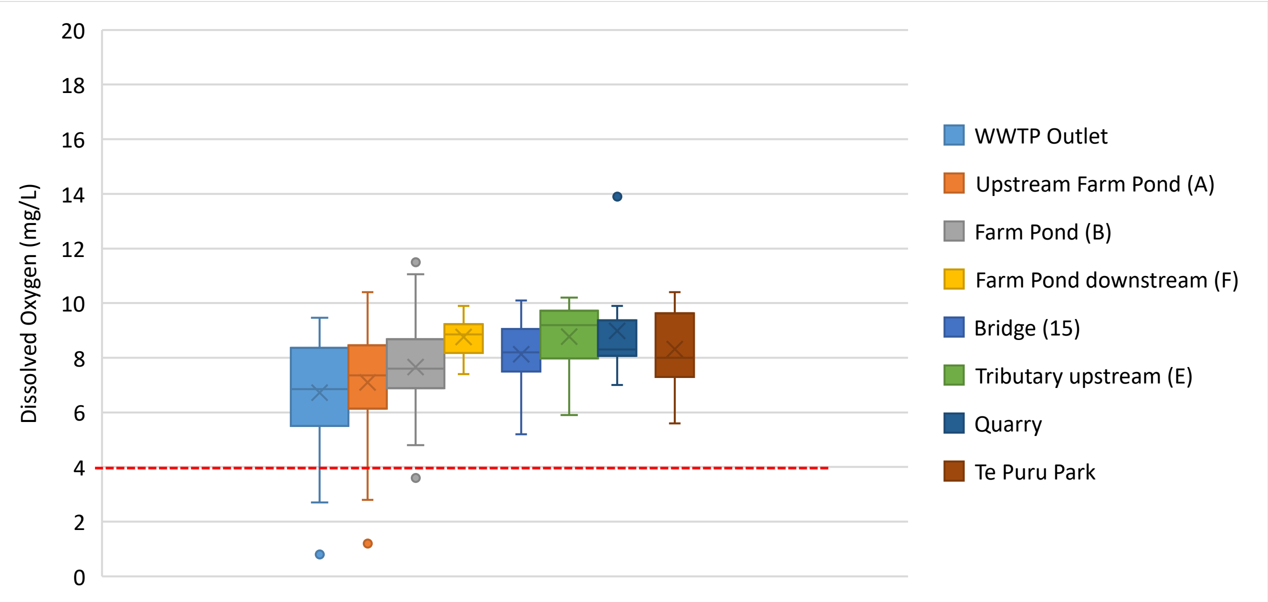

Figure 11. Box and whisker plot of dissolved oxygen (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. The NPS-FM summer minimum DO (4 mg/L) is shown by a dashed red line.

Further, these data support the 2023/24 data that the existing Beachlands WWTP does not appear to be impacting on DO in the pond.

cBOD$_5$

cBOD$_5$ is a measure of oxygen depletion from carbonaceous sources, where increased BOD can result in reduced dissolved oxygen. cBOD$_5$ from the existing Beachlands WWTP discharge is variable (**Figure 12**) with a median value of 5.7 mg/L, which is at least 5-fold higher than the median of the receiving environment sites (**Table 8**). For receiving environment sites there is generally low variability of cBOD$_5$ and negligible difference between the upstream farm pond (A) site and the farm pond (B) site (**Figure 12**). The Bridge site (15) reported very low cBOD$_5$ (median 0.7 mg/L). Elevated cBOD$_5$ in the existing discharge from the Beachlands WWTP do not appear to be impacting on cBOD$_5$ (nor DO) in the pond.

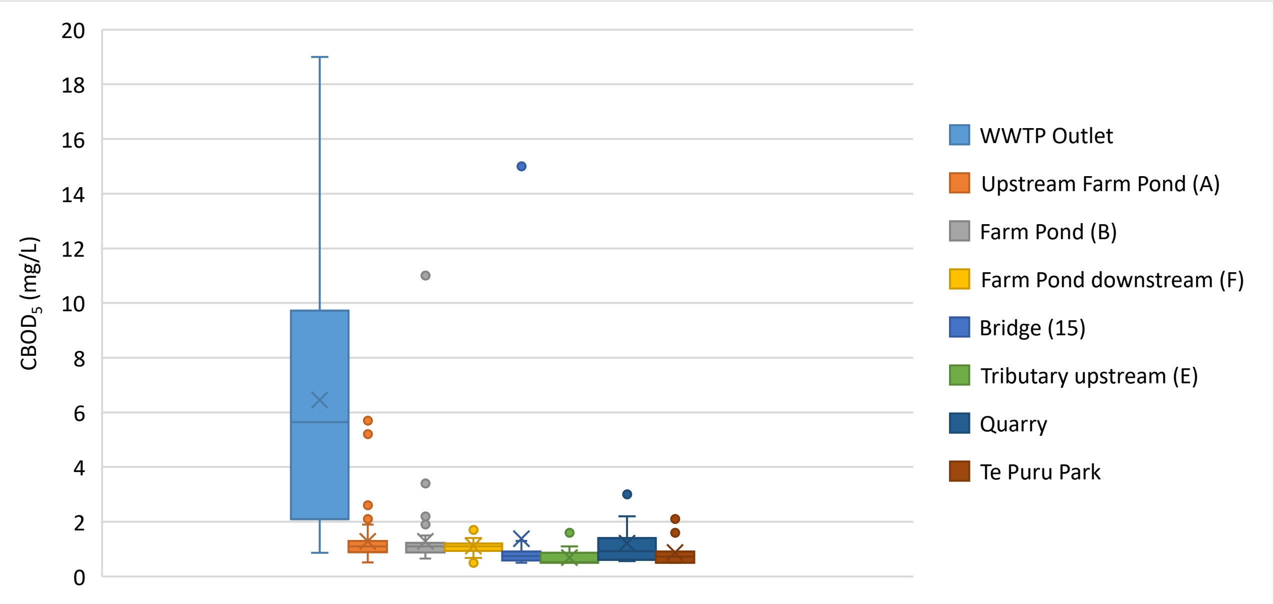

Figure 12. Box and whisker plot of cBOD$_5$ (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: upper outliers are not shown in the graph.

Water temperature

The existing Beachlands WWTP discharge has a median temperature (18.4°C) similar to the farm pond (B) (18.4°C) and downstream of the farm pond (F) (19.3°C). The upstream sites – Farm Pond upstream (A) (15.4°C) and Tributary upstream (E) (15.0°C) have markedly lower median temperatures, while the Bridge site (15) (17.3°C) is intermediate (**Figure 13**). Further downstream (Quarry and Te Puru Park) water temperature is variable. Based on these data, the existing Beachlands WWTP discharge appears to be having a slight impact on temperature in the pond and downstream as far as the Bridge site.

The Council set a water temperature guideline of 17.7°C during summer (**Table 8**) and the 2023/24 data are limited, with monitoring up to 24th January 2024 only. As for above, the 5-year data provided a maximum water temperature over the summer months of between 20.6-22.7°C upstream of the farm pond (A) and between 21.0-23.1°C at the farm pond (B) (data not shown). For both sites water temperatures are high in summer and well above the AC guideline of 17.7°C. Further, these data show that during times of heat stress there is very little difference between water temperatures in the upstream and downstream sites suggesting the existing Beachlands WWTP discharge is having only low impacts on water temperature in the farm pond.

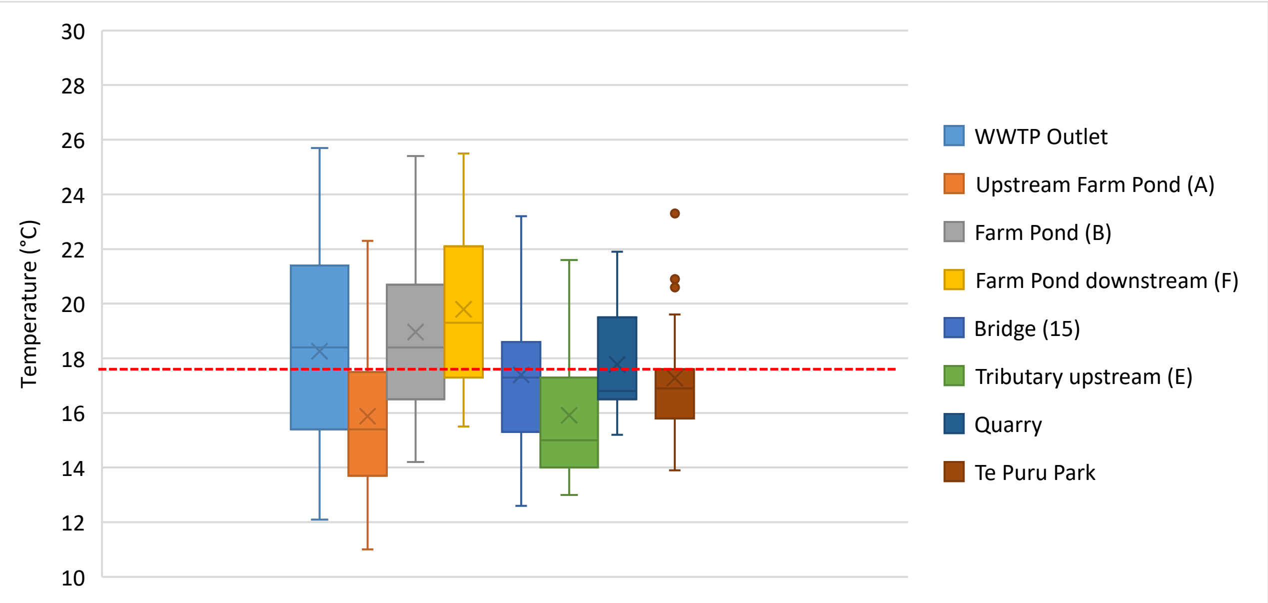

Figure 13. Box and whisker plot of temperature (°C) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. The AC summer water temperature guideline of 17.7°C is shown by a dashed red line.

pH

Low pH appears to be more an issue than high pH in the receiving environment, with most sites showing a 20th percentile pH below the ANZG DGV of 7.26, with only Te Puru Park (80th percentile 7.74) marginally exceeding the ANZG DGV 80th percentile of 7.70 (**Table 8**). The low pH appears to be driven by the upstream farm pond site (A) which has a consistently lower pH than the other sites (**Figure 14**) and a 20th percentile pH of 6.60. The existing Beachlands WWTP discharge appears to be having a negligible impact on pH at the farm pond and sites further downstream.

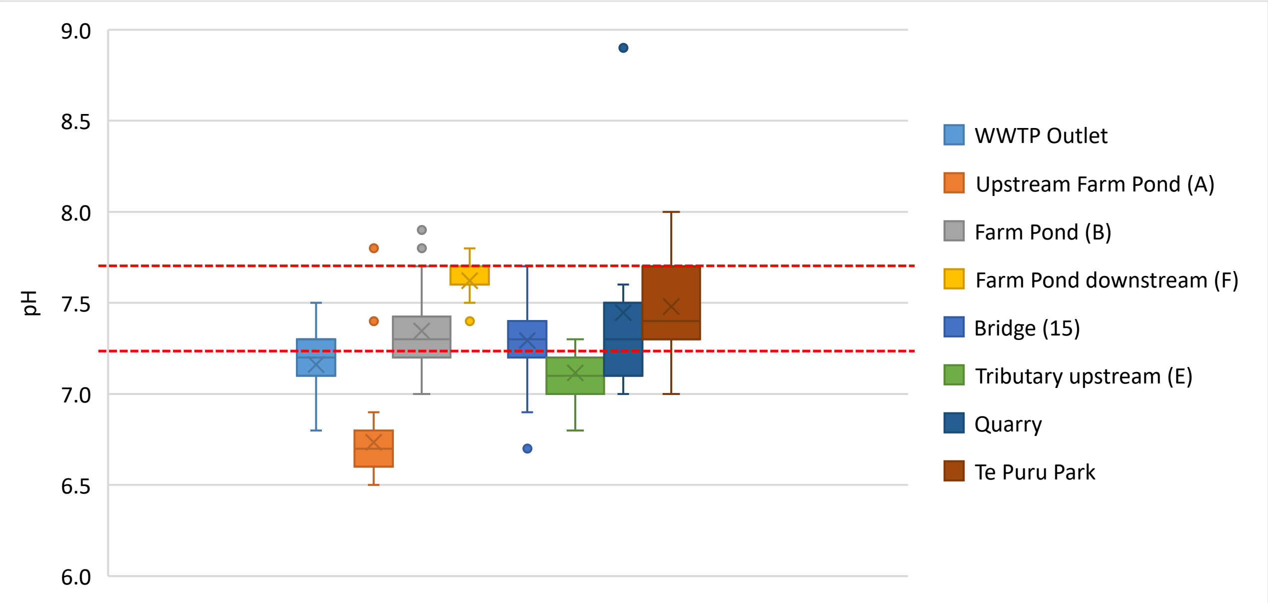

Figure 14. Box and whisker plot of pH measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. The ANZG 80th/20th percentile DGVs for pH (7.70/7.26) are shown by a dashed red lines.

Conductivity and salinity

The ANZG 80th percentile DGV for conductivity is 155 µS/cm. All receiving environment sites are above this DGV (**Table 8**). 80th percentile conductivity for sites upstream of the Beachlands WWTP discharge influence – Upstream Farm Pond (A) (213 µS/cm) and Tributary upstream (E) (176 µS/cm) – marginally exceed the DGV. In contrast, the Beachlands WWTP discharge 80th percentile conductivity value (2,072 µS/cm) is very high, and is reflected in sites downstream of its influence: Farm Pond (B) (1552 µS/cm); Farm Pond downstream (F) (1236 µS/cm); Bridge site (15) (965 µS/cm); and the Quarry site (557 µS/cm) (**Table 8**). There is a clear influence of the existing Beachlands WWTP discharge on conductivity downstream (**Figure 15**). By the confluence (the Bridge site) the 80th percentile conductivity value (965 mg/L) exceeds the ANZG 80th percentile DGV of 115 mg/L by 8.4-fold.

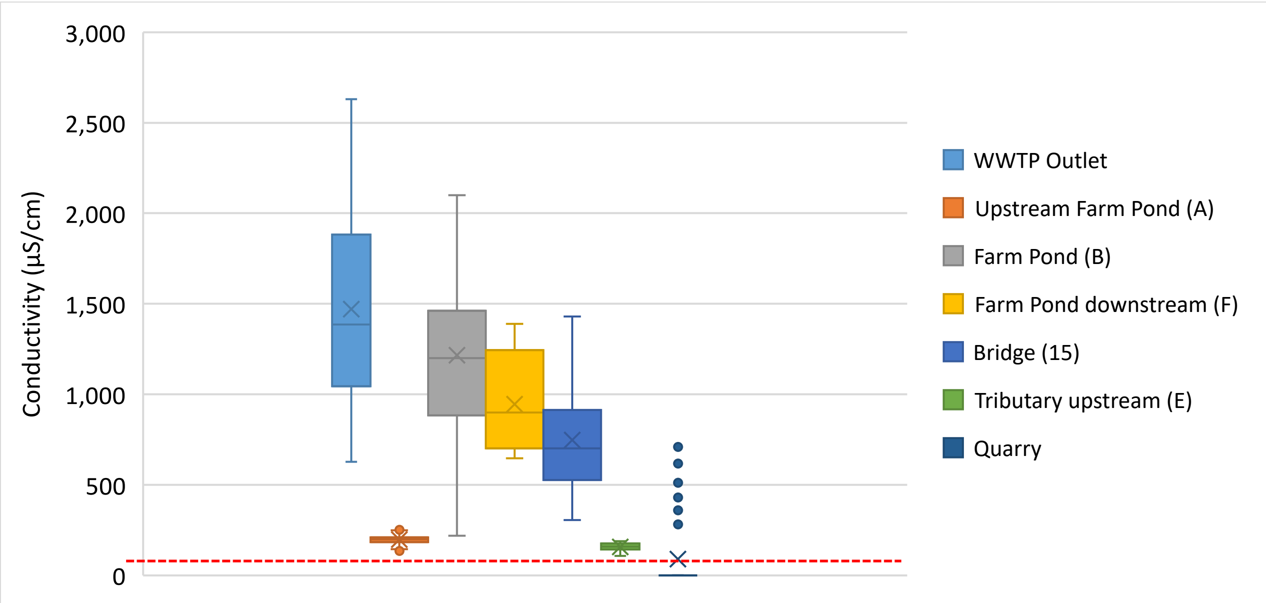

Figure 15. Box and whisker plot of conductivity measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: Te Puru site not included as it has a significant saline influence. The ANZG 80th percentile DGV for conductivity is 155 µS/cm is shown by a dashed red line.

In terms of salinity, there was evidence of minor salinity ingress into the WWTP (influent maximum 2.4 ppt and discharge maximum 1.4 ppt) and environment sites upstream (maximum salinity 1.4 ppt) of Te Puru Park which has a known saline influence (maximum salinity 32.4 ppt).

TSS and turbidity

The ANZG DGV 80th percentile for TSS is 8.8 mg/L. All receiving environment sites downstream of the discharge and site A upstream of the discharge exceed this DGV. Only the tributary upstream (E) site is below this DGV (**Table 8**). The existing discharge from the Beachlands WWTP has consistently low TSS (median 7.8 mg/L and 80th percentile 10.2 mg/L). There appears to be little difference in TSS between receiving sites, until a large increase at Quarry and Te Puru Park (**Figure 16**). The Quarry site increase is presumably due to the activities at that site, while Te Puru Park has tidal flushing that will stir up fine sediment.

Turbidity shows a consistent pattern to TSS. The ANZG DGV 80th percentile for turbidity is 5.2 NTU, and all receiving environment sites, including those upstream of the discharge, exceed this DGV (**Table 8**). The existing discharge from the Beachlands WWTP has consistently low turbidity (median 1.6 NTU and 80th percentile 2.0 NTU). The elevated receiving environment turbidity appears to be due to catchment effects with consistently higher turbidity noted at the sites upstream of the WWTP discharge influence (**Figure 17**). As for TSS, markedly higher turbidity is observed at the Quarry and Te Puru Park sites, which are likely to be catchment and/or activity related.

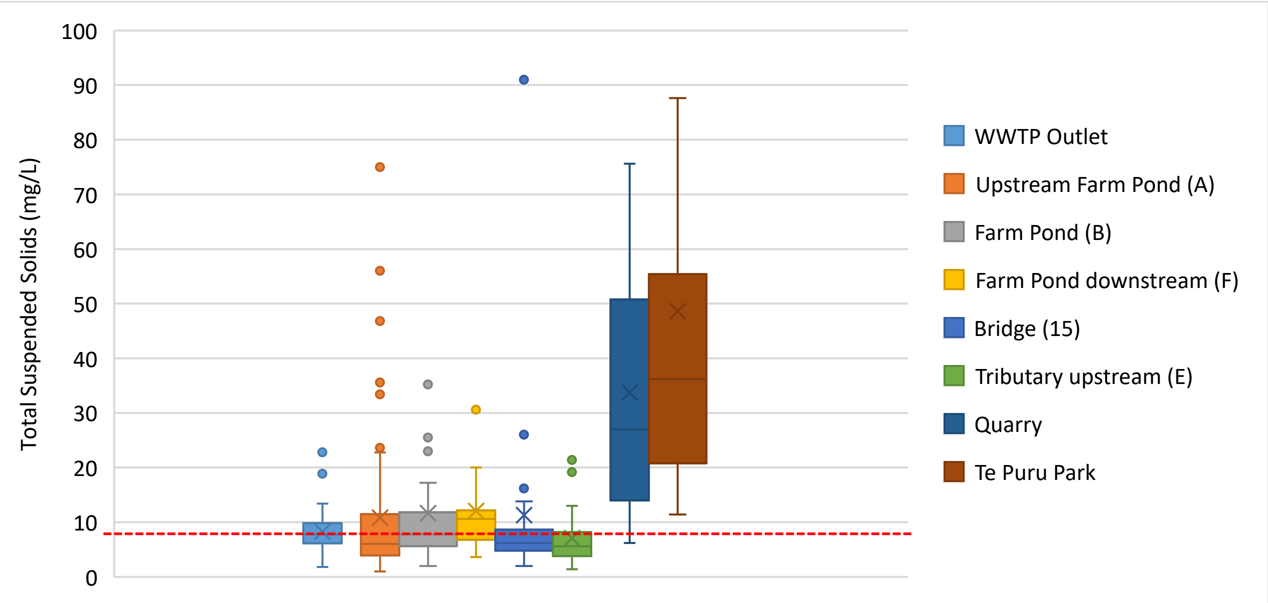

Figure 16. Box and whisker plot of TSS (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: upper outliers are not shown in the graph. The ANZG DGV 80th percentile for TSS (8.8 mg/L) is shown by a dashed red line.

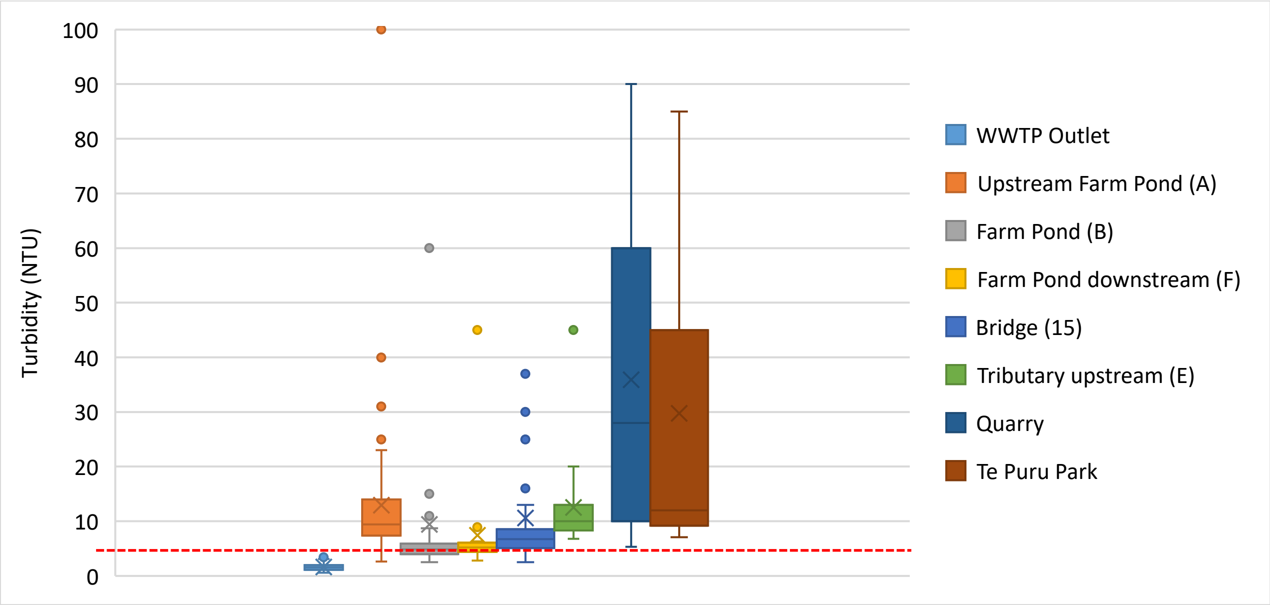

Figure 17. Box and whisker plot of turbidity (NTU) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: upper outliers are not shown in the graph. The ANZG DGV 80th percentile for turbidity (5.2 NTU) is shown by a dashed red line.

4.4.1.2 Nutrients

Nitrogen

The nitrogen cycle is complex with multiple species of N present, such as inorganic nitrogen – ammoniacal-N, nitrate-N, and nitrite-N – and organic nitrogen (consisting of many organic nitrogenous chemicals including amino acids, proteins, and other biological metabolites). Further, the nitrogen cycle will interconvert inorganic nitrogen species through processes such as nitrification, denitrification, and dissimilatory nitrate reduction to ammoniacal-N. Ammoniacal-N can also be formed from ammonification of organic nitrogen formed from decomposition of organic material.

The ANZG DGV 80th percentile for TN is 0.292 mg/L. The 80th percentile values for site A upstream of the farm pond (0.23 mg/L) and the tributary upstream (E) site (0.31 mg/L) are marginally below and above this DGV, respectively (**Table 8**), suggesting catchment TN concentrations are relatively low. In contrast, sites that are influenced by the existing Beachlands WWTP discharge have markedly elevated TN compared to the upstream sites, ranging from 8-fold above the DGV at site Bridge site (15) to 16-fold at the farm pond (B). TN concentrations are reducing with distance from the WWTP (**Figure 18**).

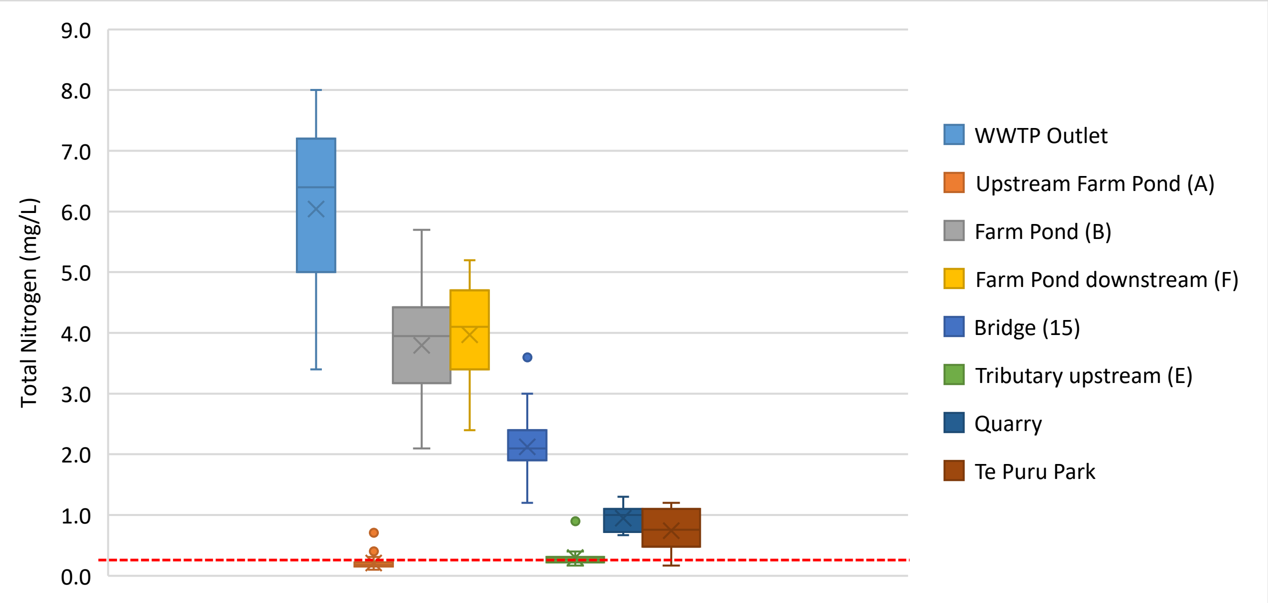

Figure 18. Box and whisker plot of TN (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. The ANZG DGV 80th percentile for TN (0.292 mg/L) is shown by a dashed red line.

Ammoniacal-N concentrations are similar between the WWTP outlet and concentrations upstream of the influence of Beachlands WWTP (**Figure 19**). The farm pond (B) site has elevated ammoniacal-N concentrations but these reduce further downstream (**Figure 19**).

Median and 95th percentile ammoniacal-N concentrations from the WWTP discharge values are 0.04 mg/L and 0.38 mg/L, respectively (**Table 8**). The farm pond (B) site has median and 95th percentile values of 0.29 mg/L and 0.48 mg/L, respectively, placing it in NPS-FM attribute band C for ammonia toxicity for both metrics, impacting regularly on the 20% most sensitive species. The farm pond downstream (F) and Bridge site (15) sites are both in NPS-FM attribute band B for ammonia toxicity impacting occasionally on the 5% most sensitive species. Both upstream sites have ammoniacal-N concentrations that would place them in NPS-FM attribute band A, a 99% species protection level, with no observed effect on any species tested.

With low concentrations of ammoniacal-N in the existing WWTP discharge it is clear that the farm pond is forming ammoniacal-N, presumably from nitrogen cycling processes such as ammonification of organic nitrogen formed from decomposition in the pond. It is only in the farm pond that concentrations of ammoniacal-N could be potentially toxic. Further, the WWTP is providing a low proportion of ammoniacal-N to total nitrogen (ca. 0.5%) being discharge from the WWTP. Therefore, the existing discharge from the Beachlands WWTP is unlikely to be significantly contributing to ammoniacal-N concentrations downstream.

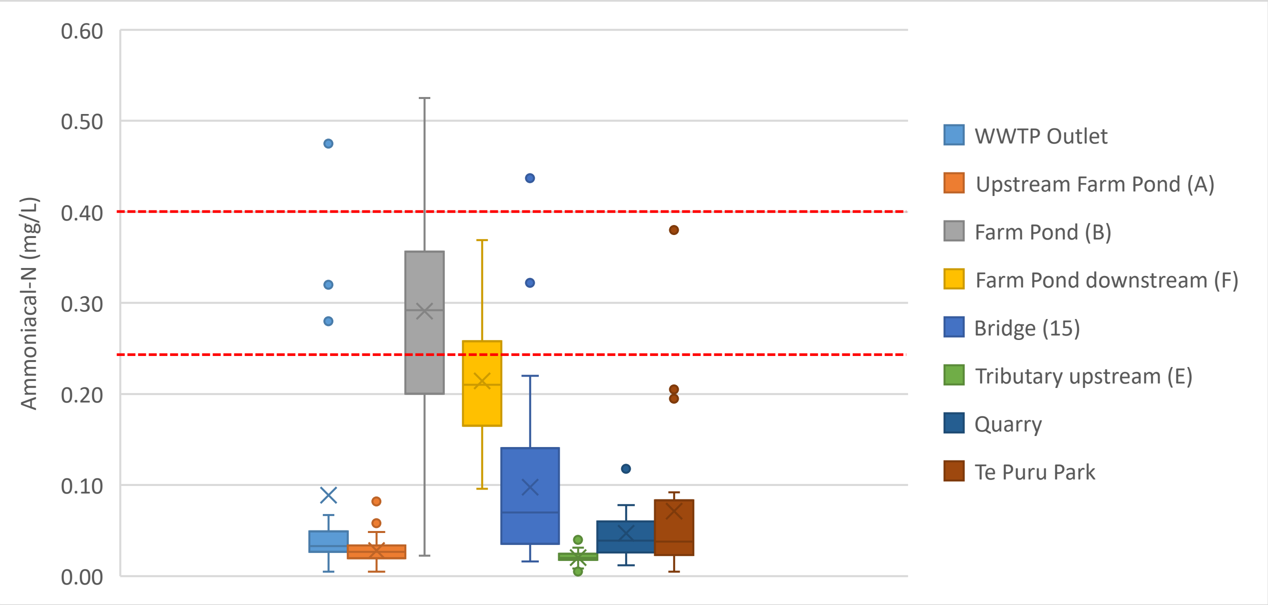

Figure 19. Box and whisker plot of ammoniacal-N (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. The NPS-FM 95th percentile (0.4 mg/L) and median (0.24 mg/L) NBL for ammoniacal-N are shown by dashed red lines.

Nitrate-N with a median of 5.1 mg/L and a 95th percentile of 6.4 mg/L (**Table 8**) shows a similar trend to TN (**Figure 18**). Based on median and 95th percentile metrics, both the farm pond site (B) and next site downstream (F) would be placed in NPS-FM attribute band C for nitrate toxicity, not meeting the NBL (2.4 mg/L and 3.5 mg/L, for median and 95th percentile, respectively). Concentrations of nitrate-N above the NBL will show growth effects on up to 20% of species, mainly sensitive species such as fish, but no acute effects. The Bridge site (15) site would be placed in attribute band B for nitrate toxicity showing some growth effect on up to 5% of species. Both upstream sites have nitrate-N concentrations that would place them in NPS-FM attribute band A, which would be unlikely to show effects even on sensitive species.

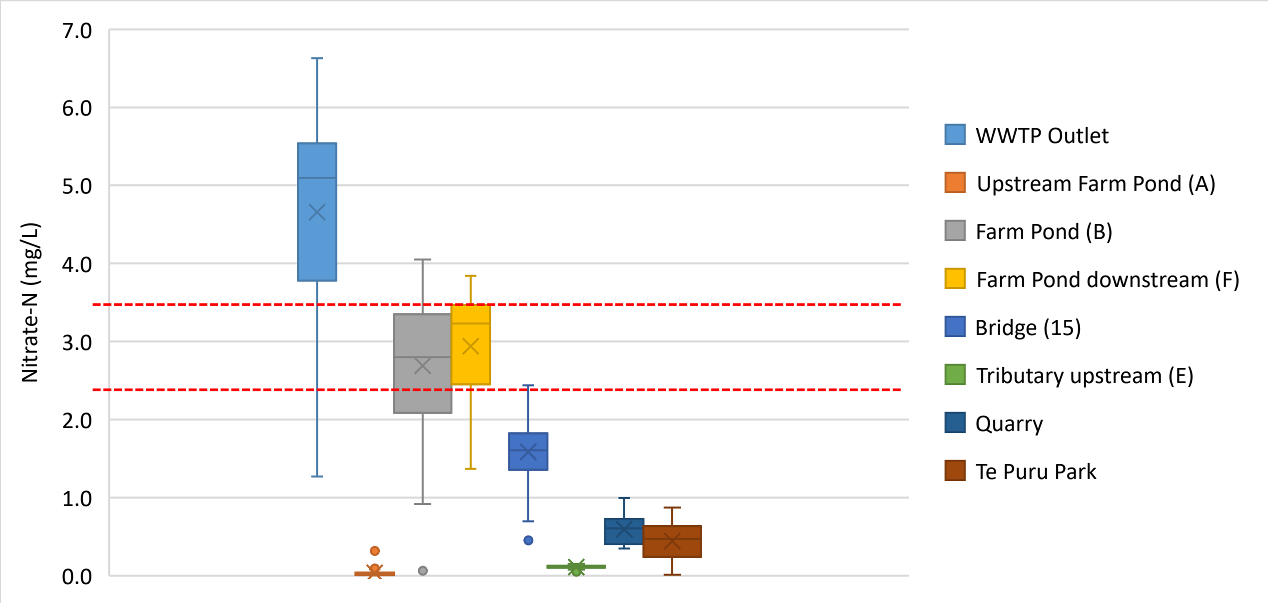

Figure 20. Box and whisker plot of nitrate-N (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. The NPS-FM 95th percentile (3.5 mg/L) and median (2.4 mg/L) NBL for nitrate-N toxicity are shown by dashed red lines.

DIN is calculated from the sum of ammoniacal-N, nitrate-N, and nitrite-N and summarised in **Figure 21**. The concentration profile for DIN is very similar to nitrate-N (**Figure 20**) which is due to DIN in WWTP outlet and receiving environment sites generally consisting of over 90% nitrate-N. The Bridge site (15) median concentration (1.72 mg/L) exceeds the level considered to be degraded in terms of potential for eutrophication of 1.0 mg/L applied in some recent expert caucusing for regional plans.

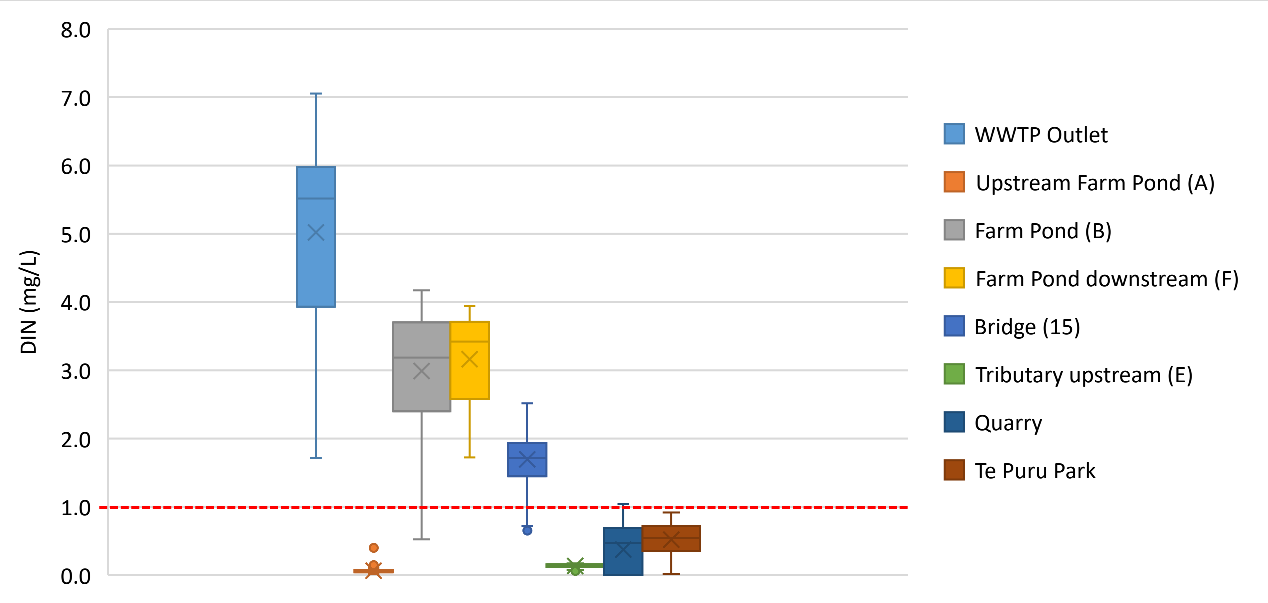

Figure 21. Box and whisker plot of DIN (mg/L) calculated[18] from monitoring of Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. A eutrophication guideline (1.0 mg/L) for DIN is shown by dashed red line.

[18] DIN calculated as the sum of ammoniacal-N, nitrate-N, and nitrite-N.

Phosphorus

The 80th percentile TP concentrations are above the ANZG DGV (0.024 mg/L) at all receiving environment sites, although only marginally (<2-fold above DGV) at upstream sites. There is a general reduction in TP with distance from the Beachlands WWTP (**Figure 22**). The WWTP discharge has median and 80th percentile concentrations of 0.86 mg/L and 1.12 mg/L. TP is relatively consistent at the farm pond site (B) and next downstream site (F) with 80th percentile concentrations of 0.580 mg/L and 0.596 mg/L, respectively, around 25-fold higher than the DGV. The Bridge site (15) has 80th percentile concentration of 0.297 mg/L, 12-fold higher than the DGV (**Table 8**).

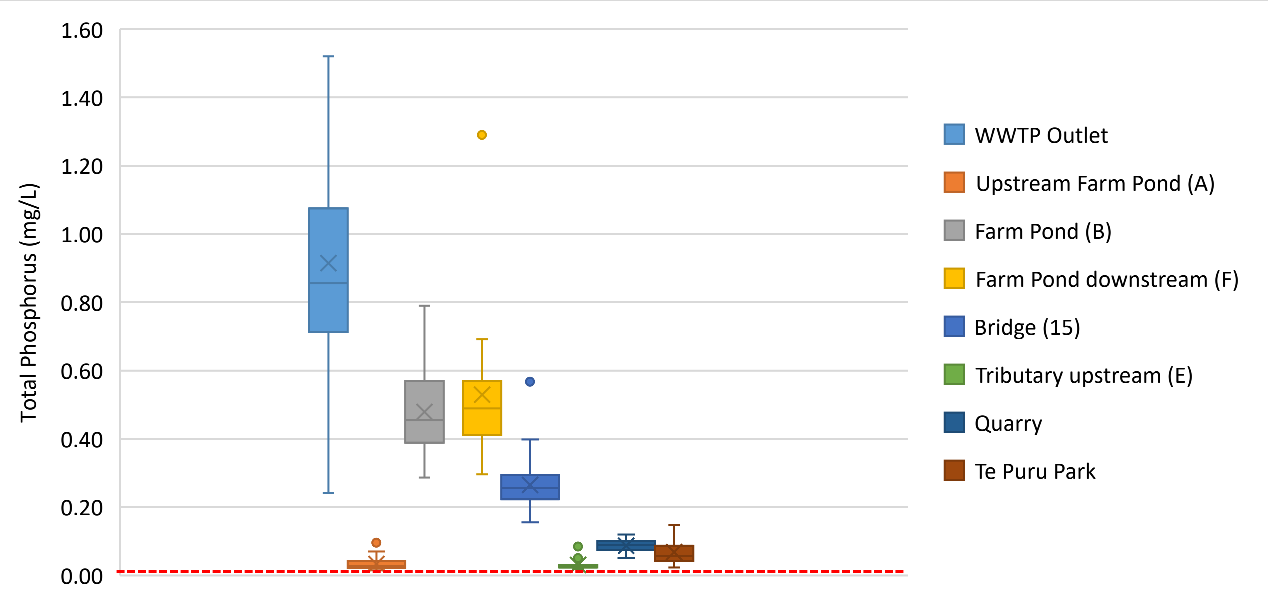

Figure 22. Box and whisker plot of TP (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: upper outliers are not shown in the graph. The ANZG DGV 80th percentile for TP (0.024 mg/L) is shown by a dashed red line.

DRP shows a similar trend to TP, with relatively low concentrations upstream of the influence of Beachlands WWTP and elevated concentrations downstream but reducing with distance from the discharge (**Figure 23**).

The NPS-FM attribute states for all sites downstream of the discharge are consistent between the metric (median or 95th percentile), with all in attribute band D (**Table 8**). Attribute band D corresponds to ecological communities impacted by substantial DRP above natural reference conditions and, when in combination with other conditions, can favour eutrophication which in turn drives excessive primary production, potentially leading to anoxic conditions with significant changes in hypoxia sensitive macroinvertebrate and fish communities.

Both upstream sites would be placed in attribute band C (median) or B (95th percentile). Ecological communities are slightly impacted by minor DRP elevation (B) or impacted by moderate DRP elevation (C) above natural reference conditions.

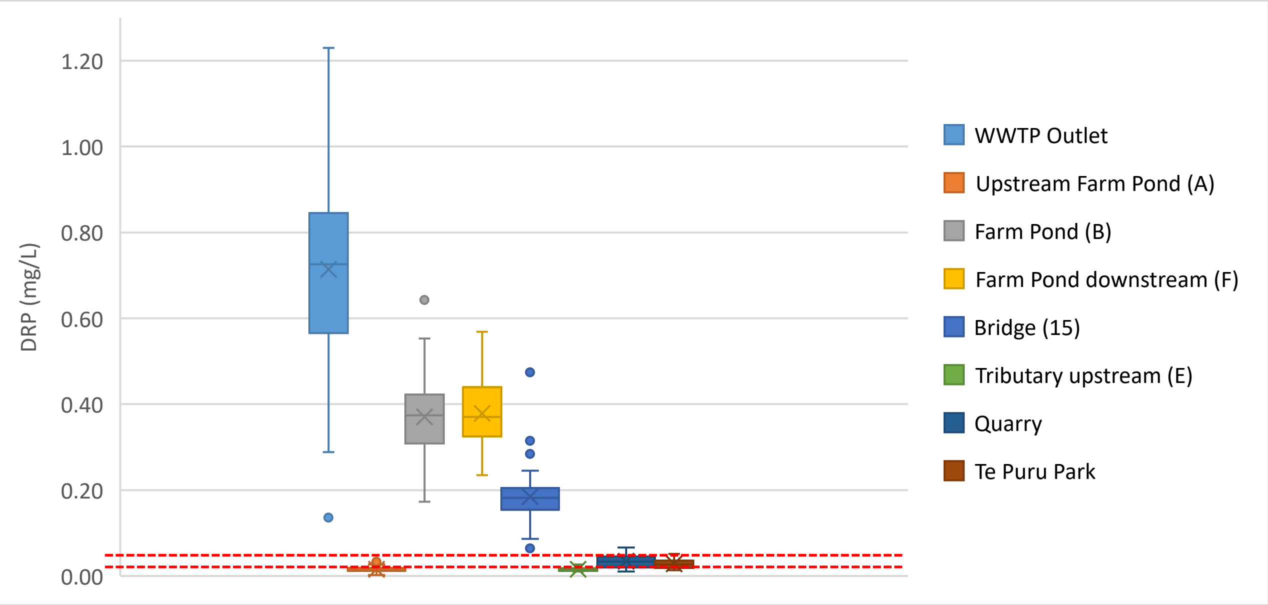

Figure 23. Box and whisker plot of DRP (mg/L) measured from Beachlands WWTP outlet and receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: upper outliers are not shown in the graph. The NPS-FM 95th percentile (0.054 mg/L) and median (0.018 mg/L) attribute band C threshold for DRP are shown by dashed red lines.

<u>Chla</u>

Chla is not measured in the Beachlands WWTP influent or discharge. Concentrations are slightly elevated at the farm pond (B) and farm pond downstream (F) site, but back to upstream levels by the Bridge (15) site. The Quarry site has high variability and relatively high values but this does not appear to be as a consequence of the existing wastewater discharge.

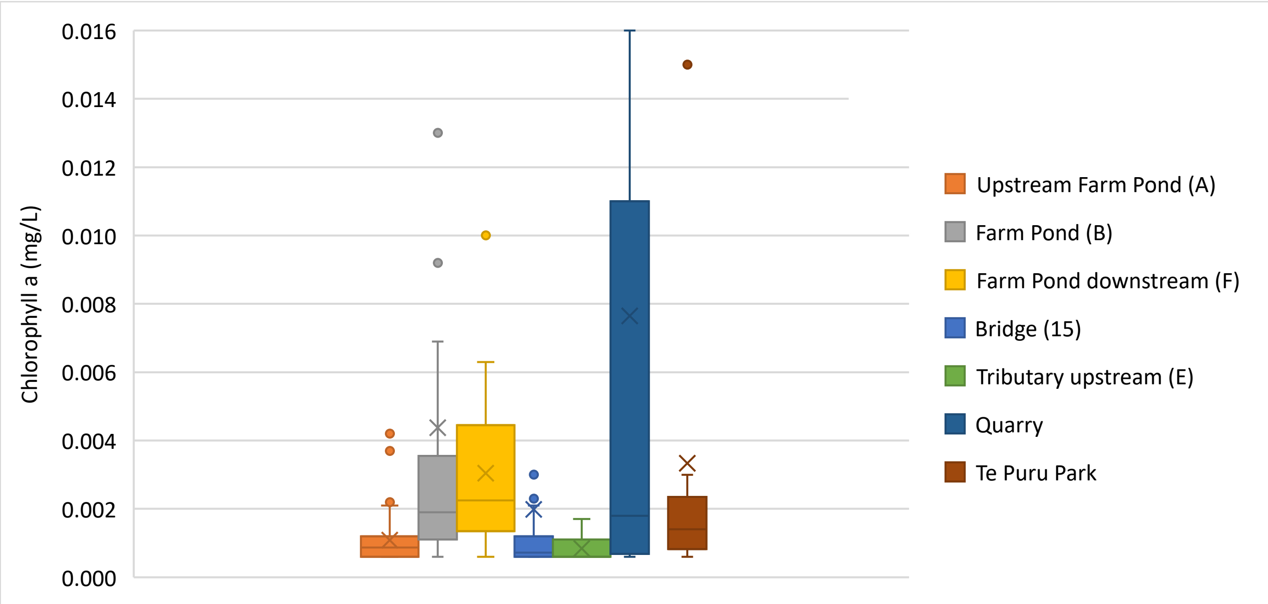

Figure 24. Box and whisker plot of Chla (mg/L) measured from receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points.

4.4.1.3 Bacteria

A full Quantitative Microbial Risk Assessment (QMRA) has been carried out by NIWA and is reported separately. In this report we focus on the data from monitoring in terms of concentrations and changes further down the stream.

Bacteria – *E. coli*, FC, and enterococci – are at extremely low concentrations (median 2 cfu/100 mL for all three) in the existing Beachlands WWTP discharge (**Table 8**). For the receiving environment sites, bacteria concentrations are highly variable (**Figure 25**) and higher upstream of the WWTP, suggesting catchment sources dominate. Based on median and 95th percentile concentrations, *E. coli* is in NPS-FM attribute band E (Red) for all sites, which corresponds to an average infection risk (from Campylobacter) of >7%.

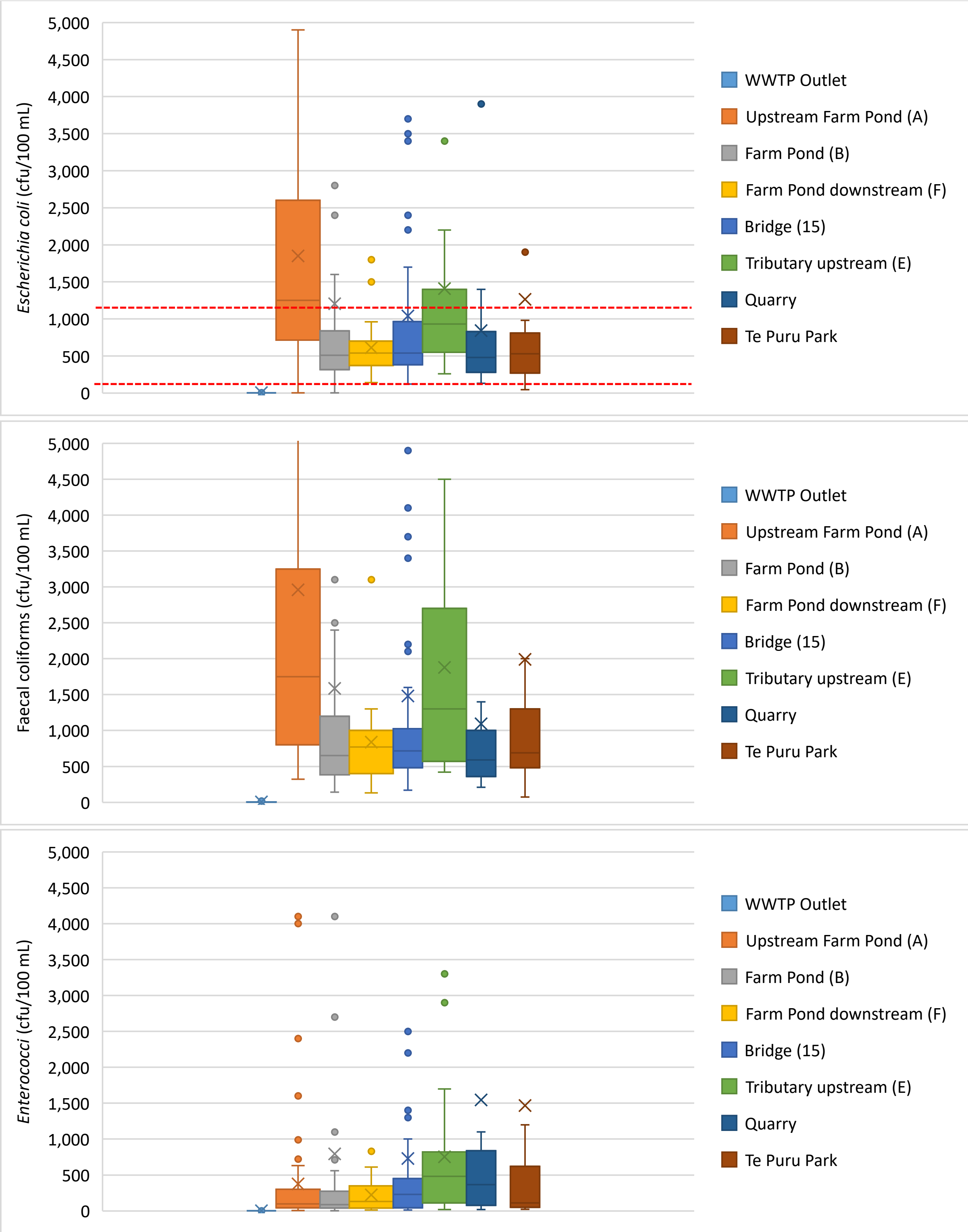

Figure 25. Box and whisker plots of *E. coli*, FC, and *enterococci* (cfu/100mL) measured from receiving environment sites from 11th September 2023 to 24th January 2024. The boxes denote 75th (top), 50th (middle), and 25th (bottom) percentiles, with whiskers extending 1.5 x 25th/75th percentiles. The mean value is presented as a cross. "Outliers" are shown as points. Note: upper outliers are not shown in the graph. The 95th percentile (1200 cfu/100 mL) and median (130 cfu/100 mL) NPS-FM attribute band E (Red) for *E. coli* are shown by dashed red lines.

4.4.1.4 Metals

Total and dissolved metal concentrations were measured at the upstream farm pond (site A), farm pond (site B), and Bridge site (site 15) on 10th and 11th December 2023, with results summarised in **Table 9**. All metal concentrations were below the applicable ANZG 95% DGV. Chromium (total only), copper (total and dissolved) and zinc (total and dissolved) concentrations at the farm pond (B) site were more than 50% of the ANZG 95% DGV, but all had reduced to 50% or below by the Bridge site (15) site. For the WWTP outlet, only total copper, and total and dissolved zinc exceeded the DGV (see **Table 4**).

Table 9. Mean and standard deviation (n=2) of total and dissolved metal concentrations reported from receiving environment sites on 10th/11th December 2023 and comparison with ANZG (2018) DGVs.

Site	Parameter	Unit	Mean	Standard Deviation	ANZG 95% DGV
Upstream Farm Pond (A)	Arsenic-dissolved	µg/L	0.36	0.02	13
	Arsenic-total	µg/L	0.48	0.07	13
	Cadmium-dissolved	µg/L	<0.05	NA	0.2
	Cadmium-total	µg/L	<0.05	NA	0.2
	Chromium-dissolved	µg/L	<0.50	NA	1.0
	Chromium-total	µg/L	0.57	NA	1.0
	Copper-dissolved	µg/L	0.21	NA	1.4
	Copper-total	µg/L	0.40	0.08	1.4
	Lead-dissolved	µg/L	0.11	NA	3.4
	Lead-total	µg/L	<0.10	NA	3.4
	Mercury-dissolved	µg/L	<0.05	NA	0.06
	Mercury-total	µg/L	<0.05	NA	0.06
	Nickel-dissolved	µg/L	0.23	0.01	11
	Nickel-total	µg/L	0.34	0.04	11
	Zinc-dissolved	µg/L	<1.0	NA	8
	Zinc-total	µg/L	1.3	NA	8
Farm Pond (B)	Arsenic-dissolved	µg/L	0.76	0.03	13
	Arsenic-total	µg/L	0.95	0.06	13
	Cadmium-dissolved	µg/L	<0.05	NA	0.2
	Cadmium-total	µg/L	<0.05	NA	0.2
	Chromium-dissolved	µg/L	<0.50	NA	1.0
	Chromium-total	µg/L	0.57	NA	1.0
	Copper-dissolved	µg/L	0.87	0.12	1.4
	Copper-total	µg/L	1.14	0.23	1.4
	Lead-dissolved	µg/L	<0.10	NA	3.4
	Lead-total	µg/L	<0.10	NA	3.4
	Mercury-dissolved	µg/L	<0.05	NA	0.06
	Mercury-total	µg/L	<0.05	NA	0.06
	Nickel-dissolved	µg/L	0.89	0.15	11
	Nickel-total	µg/L	1.04	0.09	11
	Zinc-dissolved	µg/L	5.8	1.6	8
	Zinc-total	µg/L	7.4	2.1	8

Site	Parameter	Unit	Mean	Standard Deviation	ANZG 95% DGV
Bridge (15)	Arsenic-dissolved	µg/L	0.57	0.11	13
	Arsenic-total	µg/L	0.70	0.12	13
	Cadmium-dissolved	µg/L	<0.05	NA	0.2
	Cadmium-total	µg/L	<0.05	NA	0.2
	Chromium-dissolved	µg/L	<0.50	NA	1.0
	Chromium-total	µg/L	0.50	NA	1.0
	Copper-dissolved	µg/L	0.60	0.04	1.4
	Copper-total	µg/L	0.80	0.03	1.4
	Lead-dissolved	µg/L	<0.10	NA	3.4
	Lead-total	µg/L	<0.10	NA	3.4
	Mercury-dissolved	µg/L	<0.05	NA	0.06
	Mercury-total	µg/L	<0.05	NA	0.06
	Nickel-dissolved	µg/L	0.6	0.0	11
	Nickel-total	µg/L	0.7	0.1	11
	Zinc-dissolved	µg/L	2.2	0.2	8
	Zinc-total	µg/L	2.8	0.3	8

NA = Not applicable.

Surficial sediments were measured for metals and phosphorus at the upstream farm pond (A), farm pond (B), and Bridge (15) sites on 10th November 2023. Metal results are summarised in **Figure 27**, with phosphorus in **Figure 28**.

All sediment metal concentrations were below the ANZG DGV, and, with the exception of zinc which appears to be increasing downstream of the influence of the Beachlands WWTP, metal concentrations appear to be relatively similar for the three sites (**Figure 27**).

4.4.1.5 EOCs

Watercare measured PPCPs on 10th/11th November 2023 at the upstream farm pond (A), farm pond (B), and Bridge (15) sites with mean (±1 SD) concentrations shown in Figure 26.

Concentrations at the upstream farm pond (A) were very low, with most PPCPs below detection limits. Mean concentrations of those detected were caffeine (50 ng/L), lamotrigine (10 ng/L), sucralose (90 ng/L), and triclosan (10 ng/L). The presence of low levels of wastewater markers caffeine and sucralose suggest sources of wastewater to the upstream site, probably from septic tanks.

Concentrations of PPCPs from the farm pond (B) site were consistently higher than the Bridge (15) site, suggesting significant attenuation between the farm pond discharge point and the Bridge site. Further, the attenuation from the outlet to the Bridge site (for PPCPs above detection limits for all sites) ranged from 0.9-fold (caffeine) to 5.3-fold (metoprolol), with an average of 2.9-fold (data not shown). In the absence of any other EOC data measured, this provides an indication of attenuation by the current overland and stream system.

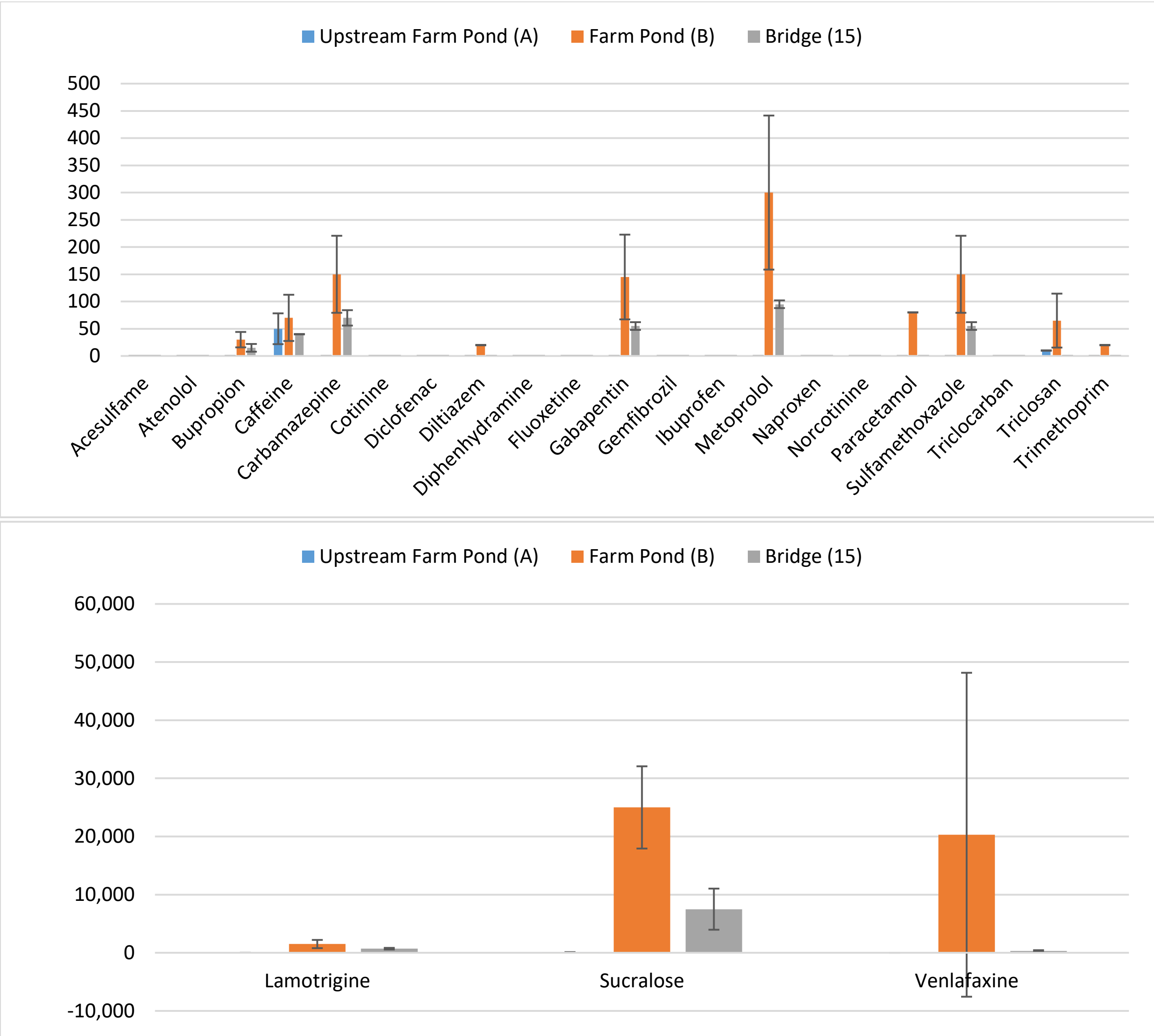

Figure 26. Mean and standard deviation (ng/ml, n=2) of PPCP concentrations reported from receiving environment sites sampled on 10th/11th December 2023. Note: different concentration scales. Blanks indicate concentrations below DL.

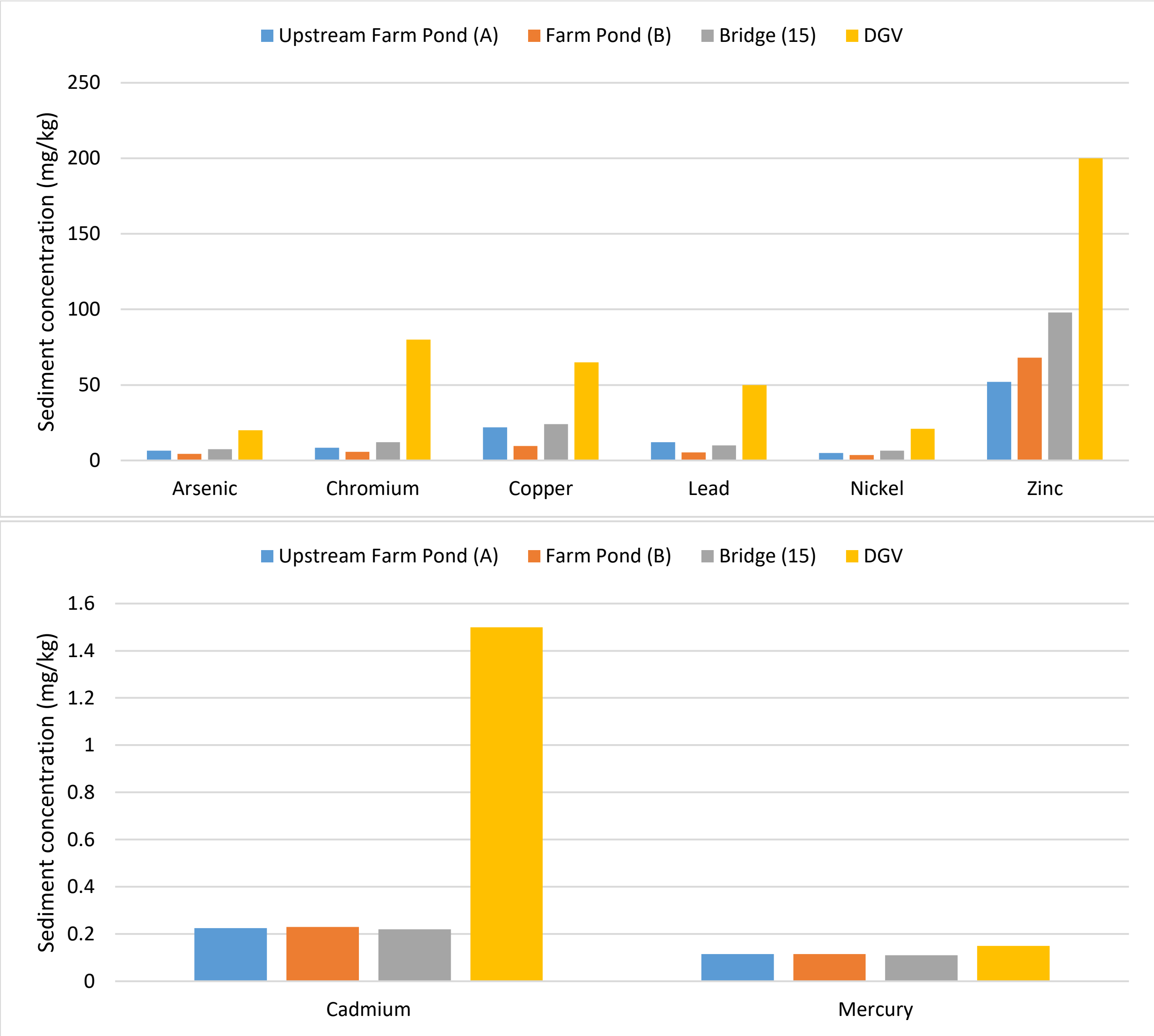

Figure 27. Sediment metal concentrations (mg/kg, dry weight) for receiving environment sites sampled on 10th November 2023.

4.4.1.6 Sediment phosphorus

There are no ecological effects guidelines for P in sediment. Sediment P concentrations are increasing from upstream of the farm pond (860 mg/kg), to the farm pond (1,500 mg/kg) and Bridge site (15) (2,000 mg/kg) (**Figure 28**). Previously, sediment P concentrations were measured in 2000 and 2010 (summarised in Earth Consult, 2010). Average TP concentrations in 2000 and 2010 were similar, at 9440 mg/kg, and 10,020 mg/kg, respectively. The authors concluded that despite a continued flux of phosphorus entering the pond between 2000 and 2010, the static concentrations suggest the pond sediment has the capacity to adsorb additional phosphorus from the water column. Concentrations in 2000 and 2010 were around 5-fold to 10-fold higher than the current TP sediment concentrations. Variability may be due to differences in collection methodologies.

Further, Bioresearches have measured sediment P on 6 occasions between 2002 and 2024. At Site F (between pond and the Bridge site), TP has remained relatively stable, ranging from 1,890 mg/kg to 3,500 mg/kg (Bioresearches, 2024a). Importantly, there is no observable trend in sediment P concentrations at this site.

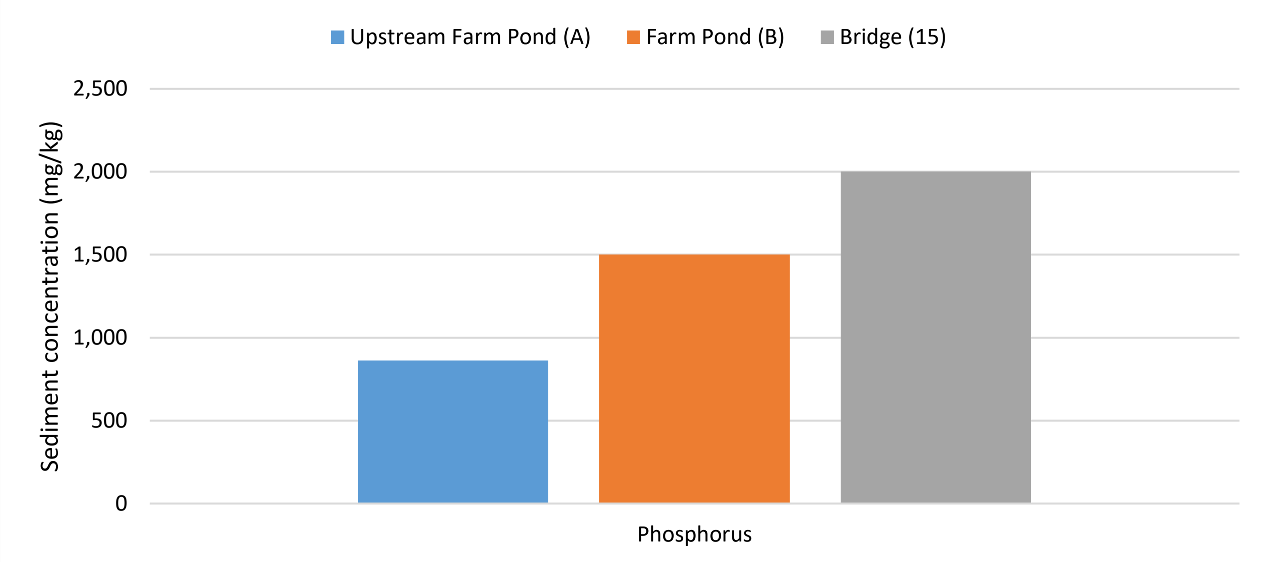

Figure 28. Phosphorus concentrations (mg/kg, dry weight) for receiving environment sites sampled on 10th November 2023.

4.5 Water and sediment quality trends

Temporal trend analysis was undertaken on water quality data collected from the upstream farm pond (A) and farm pond (B) sites from February 2020 to March 2023. Only selected parameters that are likely to be impacted by the existing Beachlands WWTP discharge, namely water temperature, ammoniacal-N, nitrate-N, TP, and DRP were assessed. Full results are presented in **Appendix 2.**

For the upstream farm pond (A) site there were no significant trends for all parameters, suggesting changes to catchment land use that may affect water quality at this site are not occurring on this time scale.

For the farm pond (B) site there was a significant (p=0.002) and meaningful (43% annual change) increase in nitrate-N. All other trends were not statistically significant. The large annual increase in nitrate-N observed at the farm pond (B) site is consistent with a large annual increase (77%) in nitrate-N in the discharge (albeit over a longer time period of 2018-2023: **Table 3**). There has been a large step-wise increase in nitrate-N in the discharge since 2020 (see **Table 2**).

4.6 Stream ecology

4.6.1 Sites and methods

Bioresearches have undertaken water quality and ecological surveys at selected Te Puru Stream and tributaries. For Watercare, surveys have been undertaken in September 2016 (Bioresearches, 2016), September 2019 (Bioresearches, 2019), December 2022 (Bioresearches, 2022), and February 2024 (Bioresearches, 2024a).

Sites and sampling undertaken are summarised in **Figure 29** and **Table 10**. Water quality has been described in Section 4.4, which is bed on the extensive monitoring undertaken, so only biological indicators are summarised in this section.

Sites are grouped in Reference Tributary (H and E), Farm Pond Tributary (A and F), and Te Puru Stream Tributary (S2, G, S3, and C) (**Figure 29**).

Figure 29. Bioresearches sampling site locations in Te Puru Stream tributaries (blue lines – Reference Tributary, Farm Pond Tributary and Te Puru Stream Tributary), site locations (yellow circles) and the location of the wastewater treatment plant (Bioresearches, 2024a).

Table 10. Sample types taken at each site (Bioresearches, 2024a).

Site	Sample types
A	Water Quality, Macroinvertebrates and Fish, Macrophytes
B	Water Quality
F	Water Quality, Sediment, Quality, Macroinvertebrates and Fish, Macrophytes
H	Macroinvertebrates and Fish, Macrophytes
E	Water Quality, Sediment Quality, Macroinvertebrates and Fish, Macrophytes
15	Water Quality
S2	Macrophytes, macroinvertebrates
G	Water Quality, Sediment Quality, Macroinvertebrates and Fish, Macrophytes
S3	Macrophytes
C	Water Quality, Sediment Quality, Macroinvertebrates and Fish, Macrophytes

Methods are described in detail in Bioresearches (2024a) and summarised here.

At each site the percentage cover (proportion of the total line width impinged) of algae and/or macrophytes was recorded along twelve random replicate transects which ran from bank to bank.

Macroinvertebrates were sampled from instream habitats to obtain semi-quantitative data in accordance with Stark et al. (2001). For all sites except the upper reference Site H sampling was undertaken using protocol 'C2: soft-bottomed, semi-quantitative'. Macroinvertebrates were preserved and identified to the lowest practicable level and counted to enable biotic indices to be calculated.

Several biotic indices were calculated, namely the number of taxa, the number and percentage of Ephemeroptera (mayflies); Plecoptera (stoneflies) and Trichoptera (caddisflies) recorded in a sample (%EPT), the Macroinvertebrate Community Index (MCI) and the Semi-Quantitative Macroinvertebrate Community Index (SQMCI) (Stark and Maxted, 2007a). EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment but exclude Oxyethira and Paroxyethira as these taxa are not sensitive and can proliferate in degraded habitats. The MCI and SQMCI are based on the average sensitivity score for individual taxa recorded within a sample, although the SQMCI is calculated using coded abundances instead of actual scores.

Stark and Maxted (2007b) defined the following habitat quality for the MCI and SQMCI scores, respectively:

- ≥ 120 and ≥ 6.0 are indicative of excellent habitat quality.
- 100 – 119 and 5.0 – 5.9 are indicative of good habitat quality.
- 80 – 99 and 4.0 – 4.9 are indicative of fair habitat quality.
- < 80 and < 4.0 are indicative of poor habitat quality

These metrics were used by Bioresearches to describe habitat quality.

MCI and QMCI are also included in the NPS-FM 2020 (MfE, 2024) with corresponding Attribute States. The NBL sits between attribute states C and D and is 90 (MCI) and 4.5 (QMCI). We note that the NPS-FM attribute bands are determined using annual samples taken between December and March (inclusive) with either fixed counts of at least 200 individuals, or full counts, and with current state calculated as the five-year median score. Therefore, MCI and QMCI reported here are indicative only.

MCI is also a requirement in the Auckland Unitary Plan (operative in part) (hereafter AUP) with an applicable minimum MCI for Auckland rivers and streams of 94 in rural areas, marginally above the NPS-FM NBL of 90 (see Section 5.1 and **Table 12** for further discussion).

Freshwater fish were sampled using three baited Gee's minnow traps which were deployed overnight at each site. Electric fishing was only effective at Sites A, H and E as the high conductivity at sites downstream of the pond prevented effective operation of the machine. All fish captured by electric fishing were identified and counted, and their size estimated before being returned to their habitats. A Fish Index of Biotic Integrity (IBI) for the Auckland Region was calculated for each site based on fish species present, altitude and distance inland (Joy and Henderson, 2004). New Zealand Freshwater Fish Database forms were completed for each site.

The current (2024) survey results (31st January to 2nd February 2024) are summarised in the following sections, with previous results provided as further context of changes.

4.6.2 Current (2024) results

4.6.2.1 Macrophytes and algae

In 2024, willow weed (*Persicaria* sp.) was the most prevalent, identified at six sites, with water forget-me-not (*Myosotis laxa*) found at five sites, and watercress (*Nasturtium officinale*) and water celery (*Apium nodiflorum*), each present at four sites (**Figure 30**). Macrophyte diversity and the percentage of macrophyte and algae cover generally increased downstream. Differences in macrophyte/algae community composition were observed between reference and effect sites, with Nitella and filamentous algae being largely absent at reference sites H and A but a significant proportion of sites G, S3, and C (**Figure 30**).

Note that the majority of the substrates in the lower tributary and Te Puru Stream are soft bottom, therefore not suitable for assessing periphyton biomass and periphyton blooms would be unlikely to occur or would be short-lived.

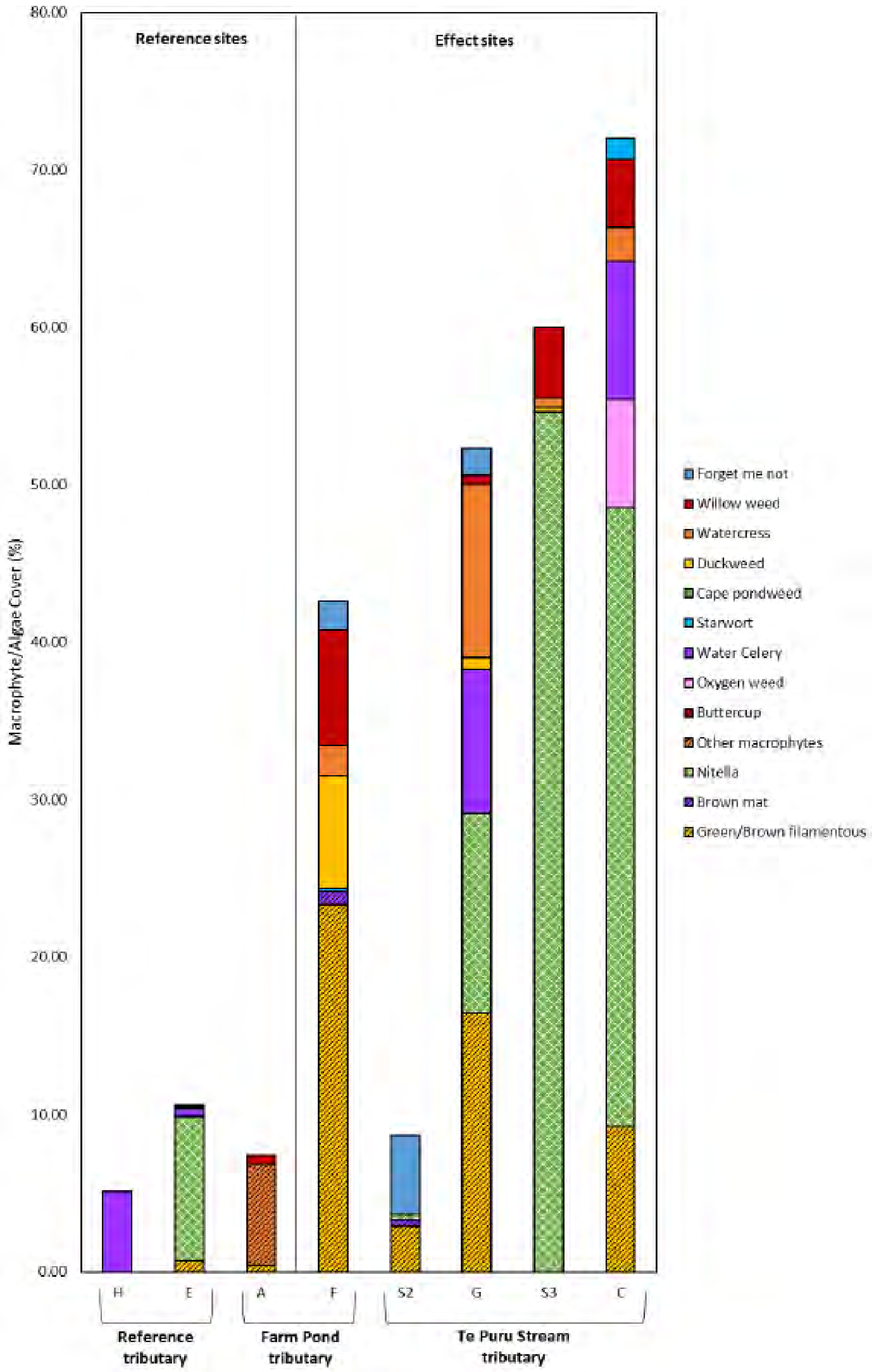

Figure 30. Macrophyte and algae % cover by species for the Te Puru Stream Tributaries (Bioresearches, 2024a).

The percentage of macrophyte and algae cover generally increased downstream, with the highest percentage of bare substrate recorded at Site H (94.9 %), Site A (92.6 %), and Site E (88.6%). Notably, three sites downstream of the farm pond (G, S3, and C) displayed macrophyte and algae cover exceeding 50 %. Watercress (see QMRA, section 5.3.6) was found at F, G, S3, and C effect sites.

4.6.2.2 Macroinvertebrates

A summary of number of taxa, % EPT, MCI, and SQMCI indices for 2024 sampling sorted by reference sites (H, E, A) and effect sites (F, G, C) is shown in **Figure 31**.

Macroinvertebrate diversity is identified by number of species present. Higher numbers of taxa (15-22 species) were present at the reference sites, with site F (closest to the pond discharge) recording only 3 species. Species numbers increased further downstream with sites G and C both recording 12 taxa (**Figure 31**). With the exception of reference Site A and effect Site C, macroinvertebrates were dominated by the freshwater snail (*Potamopyrgus antipodarum*), ranging from 28% (Site H) to 98% (Site F). Sites A and C were dominated by the freshwater amphipod (*Paracalliope fluviatilis*), comprising 63 % and 80 % of the individuals, respectively.

The percentage of sensitive species (%EPT) ranged from 22-30% at the reference sites, with no EPT taxa recorded at Site F and virtually 0% at effect sites further downstream (Sites G and C) (**Figure 31**).

MCI indices place reference sites (98-105) on the border between 'good' (>100) and 'fair' (80-99) quality habitat. In contrast, Site F had the lowest MCI of 63 well into the 'poor' quality habitat (<80), while sites G (82: fair) and C (67: poor) showed some improvement further downstream (**Figure 31**). The relatively low MCI of 98 for Site E was attributed to low water levels and potentially a lack of aquatic habitat at the time of sampling. In summary, all the reference sites has MCI indices above and all the effect sites had MCI indices below the AUP MCI minimum of 94.

SQMCI, which considers the relative abundance of taxa as well as the MCI score, showed similar results to MCI, with reference Sites H and E reported as 4.8, and 4.5 in the 'fair' category (4.0-4.9), and Site A (6.0) just into the 'excellent' category (≥6.0). Site F showed the lowest SQMCI (2.1; poor), while sites G (4.5) and C (4.8) in the 'fair' category (**Figure 31**). Only site F had a SQMCI value below the NPS-FM NBL of 4.5.

Bioresearches noted that the poor macroinvertebrate scores downstream of the discharge are likely due to a combination of stressors, such as the decreased riparian vegetation and hard substrate at downstream sites, along with effects caused by the discharge itself such as increased temperature, nutrient input (including potentially toxic nutrients such as ammonium), and suspended sediment. Macroinvertebrate and native fish communities did not appear to fully recover at the most downstream sites and lacked more sensitive taxa. The overall magnitude of effect of all activities on the tributary and stream environment can be classified as moderate.

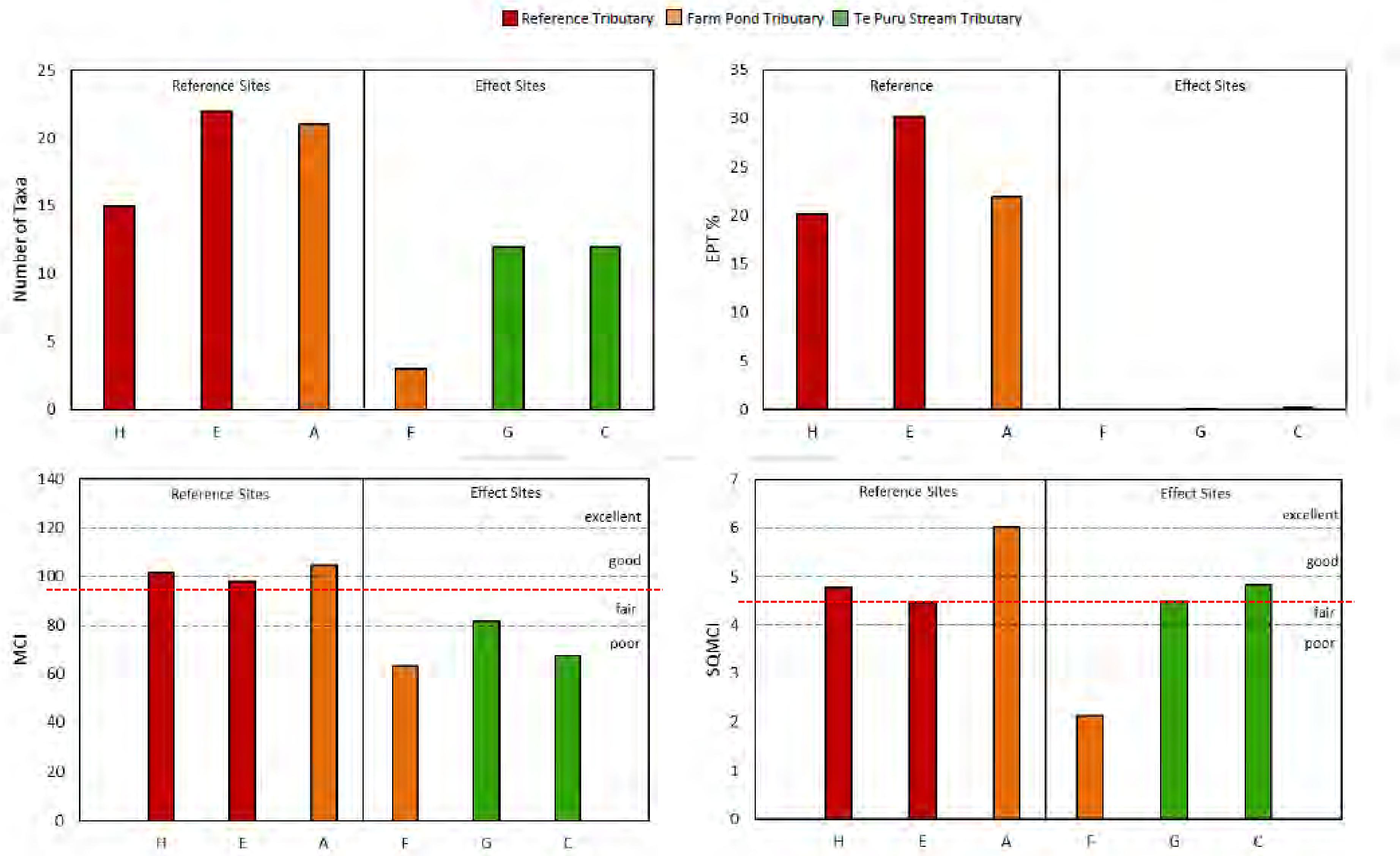

Figure 31. Macroinvertebrate community results for 2024 – number of taxa, EPT%, MCI and SQMCI (Bioresearches, 2024a). AUP minimum MCI for rural areas (94) and NPS-FM SQMCI NBL (4.5) are designated by a red dashed line.

4.6.2.3 Fish

Between 3 and 4 native fish species – an unidentified eel species (*Anguilla* spp.), and three species listed at 'Not Threatened' (Dunn et al., 2017): banded kōkopu (*Galaxias fasciatus*); common bully (*Gobiomorphus cotidianus*); and Cran's bully (*G. basalis*) – were recorded at the reference sites (H, E, and A). The number of native fish at these sites ranged from 19 (Site E) to 36 (Site H).

At effect sites the high conductivity precluded electric fishing, with gee minnow and hand nets used to sample native fish communities. Both native fish species biodiversity and abundance decreased at the effect Sites C and F compared to the reference sites. Effect site F recorded only one unidentified eel, while Sites C and F recorded only common bully, tuna (eels), and the introduced mosquito fish (*Gambusia affinis*), with total numbers of fish 14 at Site C and 25 at Site G (with 21 of these common bully).

Fish IBI are shown in **Figure 32.** In comparison to other Auckland streams, given the altitude and distance from the sea, reference sites rated as 'fair' for species diversity at Sites H and A (both 34), and 'poor' for site E (26). Site F was rated as 'very poor' (14), while Sites G and C were both poor' (26) (**Figure 32**).

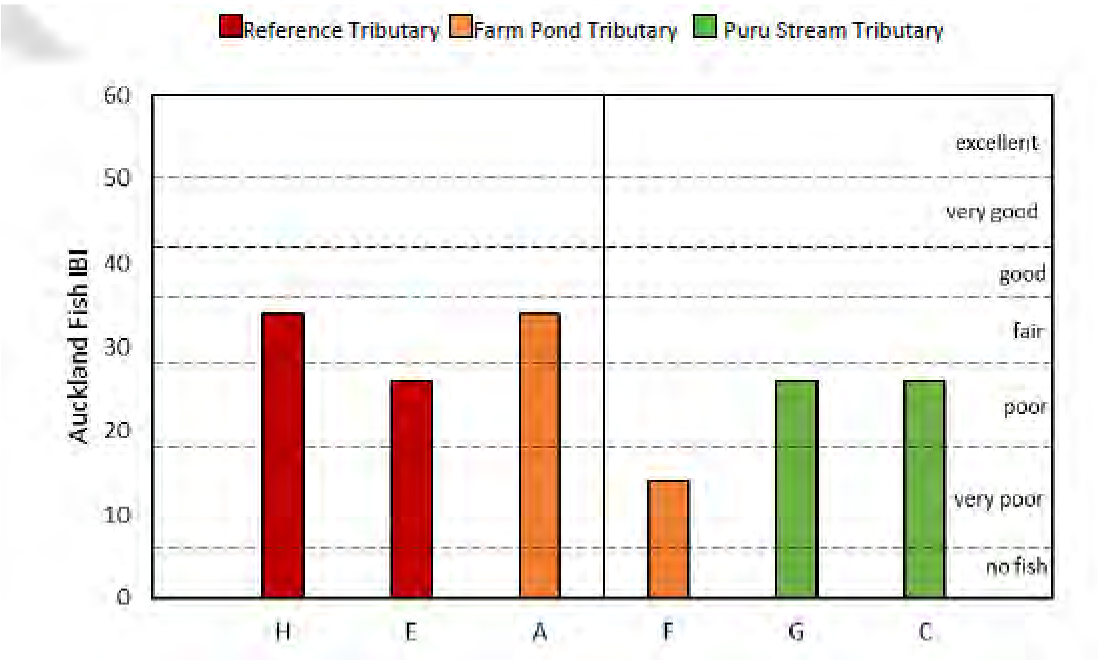

Figure 32. Auckland Fish IBI scores for sites on the Te Puru Stream Tributaries (Bioresearches, 2024a).

A search of fish records from the New Zealand Freshwater Fish Database for the Te Puru Stream catchment recorded seven native and one introduced fish species (*Gambusia affinis*) around the wider Te Puru Stream catchment between 1991 and 2022. No additional species were recorded in the 2024 study, however. Cran's bully (recorded at Site H in 2024) was last recorded in 1991.

4.6.3 Trends

4.6.3.1 Macrophytes and algae

Number of taxa and percentage macrophyte/algae cover for 2016, 2019, 2022, and 2024 are shown in **Figure 33**. For most sites the number of taxa appear to be stable or increasing since 2016, with generally more taxa recorded at downstream sites. A similar trend is noted for percentage macrophyte/algae cover.

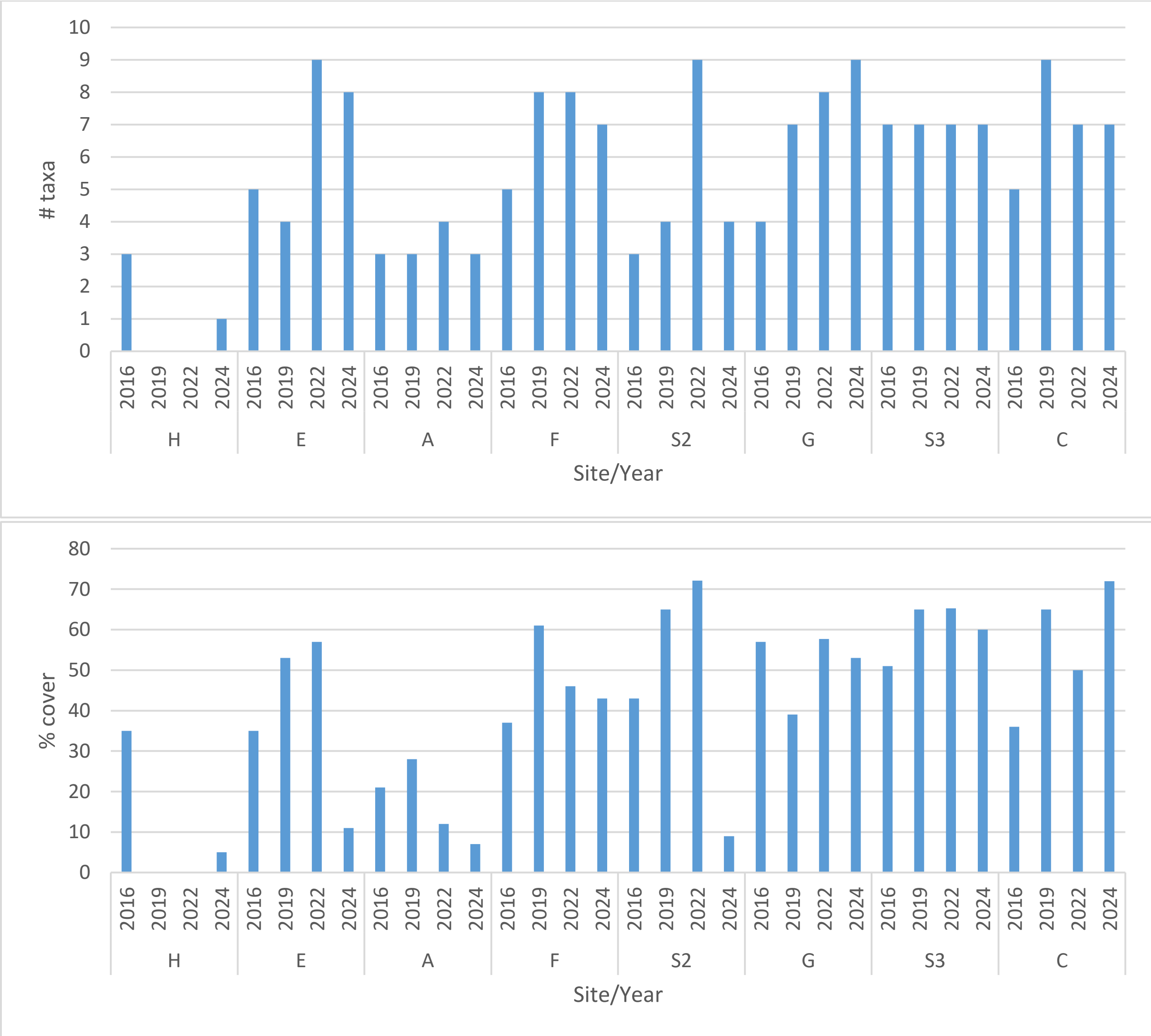

Figure 33. Number of taxa and percentage cover of macrophytes and algae for 2016, 2019, 2022, and 2024.

4.6.3.2 Macroinvertebrates

Number of taxa, % EPT, MCI, and SQMCI for 2016, 2019, 2022, and 2024 are shown in **Figure 34**.

The number of taxa appear to be stable or declining at the reference sites (H, E, A) and generally lower but stable or increasing at the effect sites (F, S2, G) (**Figure 34**).

%EPT have been highest for reference site H, although very variable (4%-48%), with a marked decrease in 2024 compared to previous years. Reference site A has had intermediate and relatively stable %EPT (6%-18%), while site E has had the lowest of the reference sites (0%-9%). The three effect sites have had 0% EPT between 2018-2022, with this trend continuing for site F, but minor recovery observed at site S2 (3%) and G (2%) in 2024 (**Figure 34**). As stated earlier, EPT are three orders of insects that are generally sensitive to organic or nutrient enrichment.

MCI scores for reference sites H, E, and A have been relatively consistent and mostly above the AUP minimum for rural areas of 94. Site E was showing a decline from 2016 (MCI 96) in 2019 (MCI 91) and 2022 (MCI 70) but has since recovered to a value of 98 in 2024. Similarly, effect site MCI have been relatively consistent since 2016, but in contrast to the reference sites, all but one MCI value has been below the AUP minimum for rural areas of 94 (**Figure 34**). Site F (MCI 46-63) has always been well below 94 but has been increasing from 46 in 2016 to 63 in 2024. Site S2 has shown a general improvement in MCI scores and in 2019 was above 94. Site G has shown a general decline in scores from 82 in 2016 to 67 in 2024.

SQMCI show a similar pattern to MCI, with reference sites generally above and effect sites generally below the NPS-FM NBL of 4.5 (**Figure 34**). Reference site E was an exception, being below 4.5 in 2016, 2019, and 2022, but at 4.5 in 2024. As for MCI there is a general increasing trend in the SQMCI scores for the effect sites.

The improvement in MCI and SQMCI scores at site F (closest to the WWTP discharge) are promising, however improved water quality in the proposed WWTP discharge (primarily lower concentrations of toxic nitrate and ammonia, and conductivity), and riparian planting downstream is required to contribute to further improving the macroinvertebrate communities downstream.

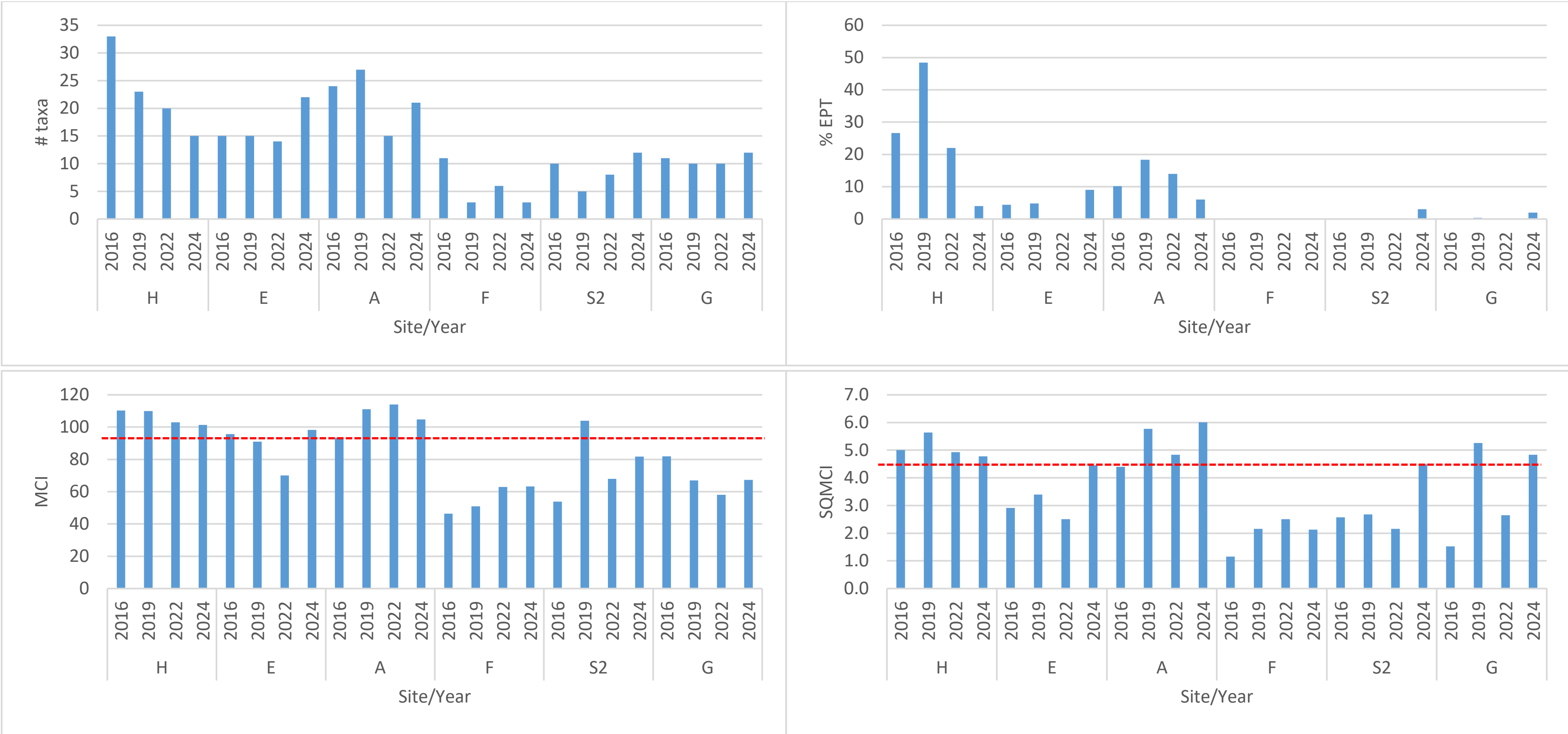

Figure 34. Number of taxa, % EPT, MCI and SQMCI of macroinvertebrates for 2016, 2019, 2022, and 2024. AUP minimum MCI for rual areas (94) and NPS-FM SQMCI NBL (4.5) are designated by a red dashed line.

4.6.3.3 Fish

The number of native species, number of native fish, and fish IBI for 2016, 2019, 2022, and 2024 are shown in **Figure 35**.

The number of native species and native fish were generally higher at reference sites (H,E,A) than effect sites (F,S2,G). Numbers of native species were generally low (1-5) for reference sites and 0-4 for effect sites with no apparent temporal trends were observed. The number of native fish at reference site H was declining from 2016 (38) to 2022 (14) but returned to near 2016 numbers in 2024 (36) (**Figure 35**). Reference sites E and A showed a general increase in the number of native fish. As for other ecological metrics, site F had the lowest native species (0 or 1) and number of native fish (0-2). Site S2 showed a marked increase in the number of native fish in 2024 (25) from previous (maximum 6 in 2022) but as noted in the previous section 21 of these were common bully. Site G had variable fish numbers ranging from 4 in 2019 to 25 in 2016 (**Figure 35)**.

Fish IBI showed a similar pattern with a consistently higher index for the reference sites – site H (34-52); site E (14-34); and site A (28-38) – higher than effect sites: site F (0-14); site S2 (14-28); and site G (14-28) (**Figure 35)**. Fish IBI appears to be reducing at reference site H, but stable or increasing at reference sites E and A. For effect sites, site F has either no fish or a very low Fish IBI, while sites S2 and G appear to be generally improving.

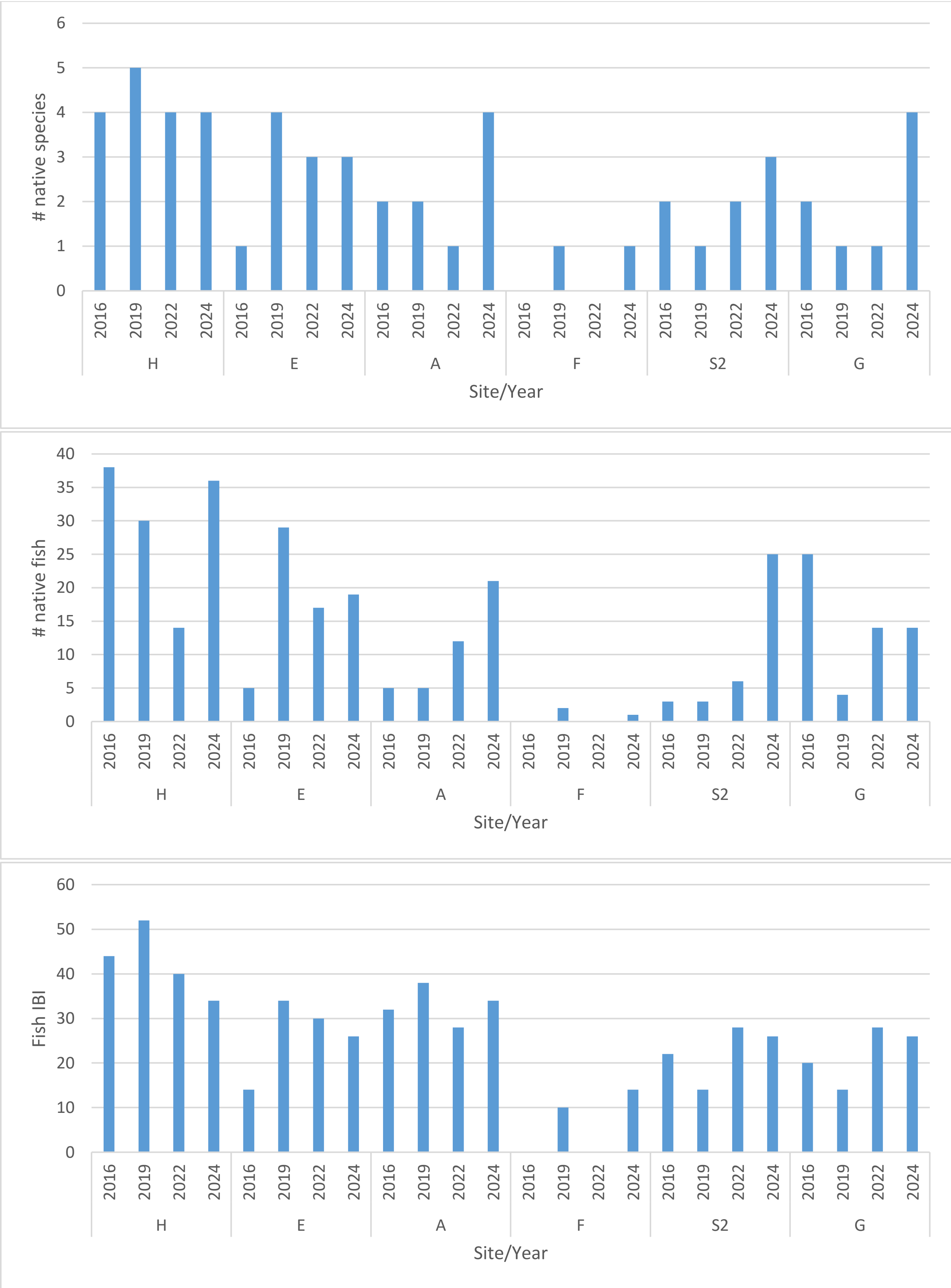

Figure 35. Number of native species, native fish, and Fish IBI for 2016, 2019, 2022, and 2024.

4.7 Marine coastal receiving environment

4.7.1 Te Maraetai/Kellys Beach & Te Puru Stream entrance

Te Puru Stream enters the marine coastal environment at Te Maraetai/Kellys Beach, which is located between Beachlands and Maraetai (**Figure 36**). The lower, estuarine reaches of Te Puru Stream north of the Whitford-Maraetai Rd are strongly influenced by seawater inflow during high tide, with salinities of 20–35 (ppt) at high tide, but decreasing to 5–15 ppt during low tide (Zeldis *et al.*, 2001). The entrance to Te Puru Stream is designated as a Significant Ecological Area (SEA)–Marine 1 (**Figure 36** (SEA-M1-42b)) in the AUP due to the variety of saline vegetation and coastal vegetation present (e.g., raupo (*Typha orientalis*), clubrush (*Bolboschoenus* sp.), sedges (*Schoenoplectus* sp.)), and the intact ecological sequence from estuarine to freshwater wetlands. Various threatened birds utilise the area including banded rail (*Gallirallus philippensis*), Caspian tern (*Hydroprogne caspia*), South Island pied oystercatchers (*Haematopus finschi*), and pied shags (*Phalacrocorax varius*).

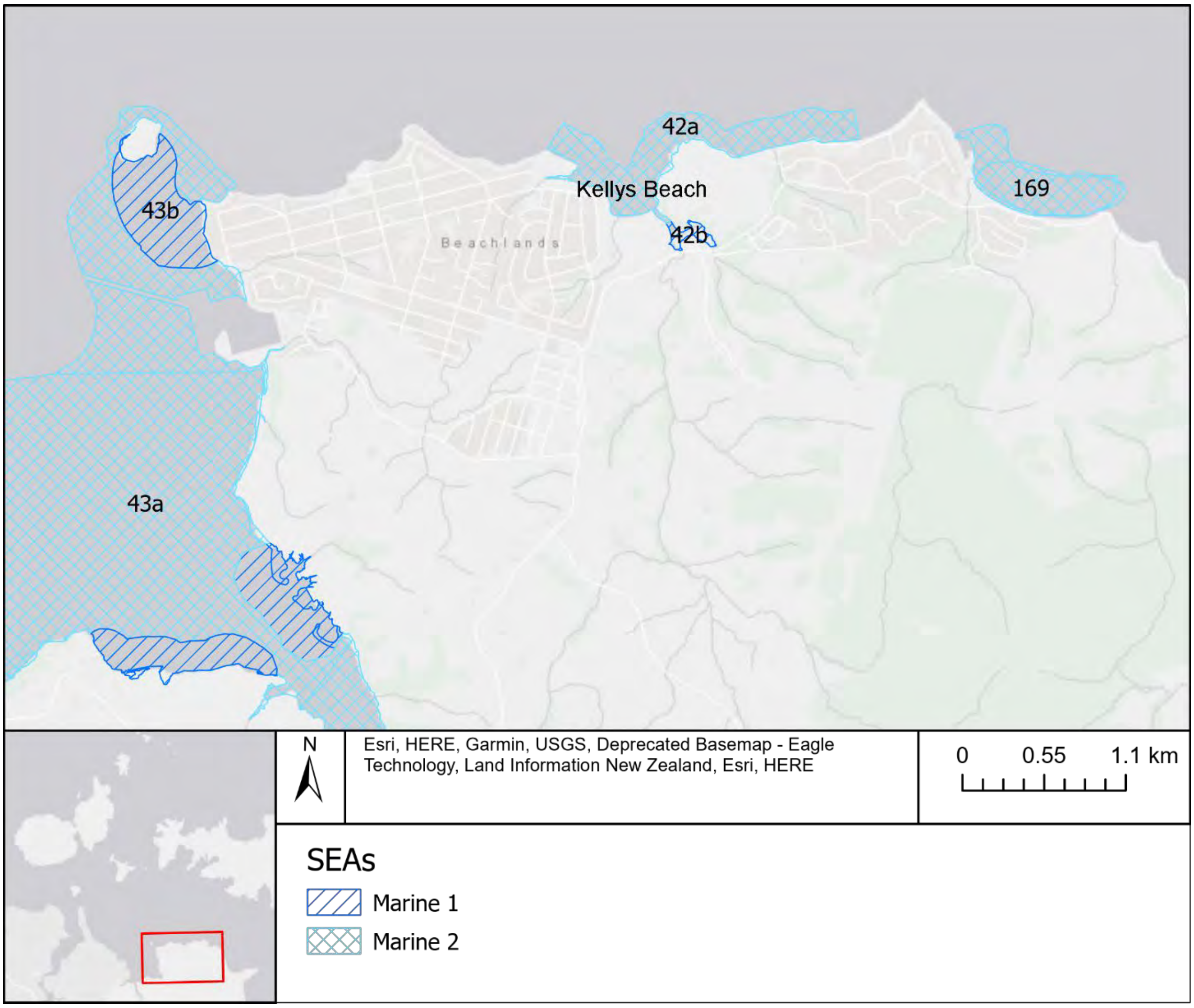

Figure 36. Auckland Unitary Plan Significant Marine Ecological Areas around Te Maraetai/Kellys Beach.

4.7.1.1 Intertidal survey of Te Maraetai/Kellys Beach

Te Maraetai/Kellys Beach and the surrounding coastal area is designated as a SEA-Marine 2 (**Figure 36**, (SEA-M2-42a)) due to the variety of intertidal habitats present (mudflats, sandflats, rock platforms) that provide a habitat for a wide variety of marine organisms. A survey of the intertidal area around Te Maraetai/Kellys Beach was conducted on 21st December 2023 around low tide to describe the intertidal marine community of the coastal receiving environment. The survey involved:

- Investigation of shellfish and seagrass abundance at 14 pre-planned stations around the bay. At each station a 0.25 m^2 quadrat was placed on the seabed and the density of shellfish and seagrass were semi-qualitatively assessed as follows:
  - shellfish—none, low (<10), moderate (10–30), high (>30)).
  - seagrass—none, sparse (<20% cover), moderate (20–50% cover), dense (>50% cover).
- A walkover of the sandstone platform reefs that are present on either side of the bay. General observations were made on the abundance and type of biota present on the reefs, particularly any kai moana species that were present.

The stream banks either side of the entrance to Te Puru stream are around 1–2 m above the water level and are densely covered with medium sized (2–3 m high) mangroves (**Figure 37A**). The substrate around the stream on the upper half of the beach is very soft, knee-deep mud with abundant crustacean burrows (**Figure 37B** & **Figure 39A**). Half-way down the beach the substrate becomes sandy with mixed shell and pebble (**Figure 39C**). Low lying shell banks are present in some areas that mainly comprised cockle and pipi shells (**Figure 37C–D**), and an area of plain sand was present near the low tide mark (**Figure 37F**).

Three small patches of moderately dense seagrass (*Zostera muelleri* subsp. *novazelandica*) were observed on the lower intertidal flats outside of the survey stations. These patches were each approximately 2 m × 1 m in size (**Figure 37E** & **Figure 38**).

Seagrass is listed as an "At Risk: Declining" species under the New Zealand Threat Classification System (NZTCS) due to the overall seagrass population being very large, but subject to low to high ongoing or predicted decline. The NZTCS includes the following qualifier for its classification of seagrass:

a) it is a non-endemic species that is secure overseas; and
b) the seagrass population experiences extreme fluctuations (de Lange et al., 2017).

Seagrass meadows, which are defined as >60% coverage over an area larger than 10,000 m^2, are an important biogenic habitat (Anderson et al., 2019). However, the patches of seagrass present were much too small to meet the criteria of biogenic habitat.

Very small cockles (*Austrovenus stutchburyi*) and pipis (*Paphies australis*) were found at all the survey stations apart from the two uppermost stations on the shore (**Figure 38** & **Figure 39E–F**). Densities ranged from low to high. No shellfish were found that were near harvestable sizes of approximately 30 mm for cockles and 50 mm for pipis.

Intertidal sandstone reef platforms are present on either side of the bay. The upper portions of the reefs on the eastern side of the bay were densely covered with modest barnacles (*Austrominius modestus*) and small Pacific oysters (*Crassostrea gigas*), none of which were considered to be of harvestable size (**Figure 40A, E**). Dense patches of Neptune's necklace (*Hormosira banksii;* **Figure 40B**) and small clumps of *Codium fragile* subsp. *novae-zelandiae* (**Figure 40C**) were present in the rock pools and on the lower portions of the reef. A range of common intertidal species were present on the reef and in rock pools including cat's eyes (*Lunella smaragda*), spotted black top shells (*Diloma aethiops*), mud whelks (*Cominella glandiformis;* **Figure 40E**), spotted whelks (*Cominella maculosa*), dark rock shells (*Haustrum haustorium*), blue mussels (*Mytilus planulatus*; **Figure 40F**), mud crabs (*Austrohelice crassa*), glass shrimps (*Palaemon affinis*) and triplefins.

The sandstone reefs on the western side of the bay were lower in height than those on the eastern side (**Figure 41A–B**), and the areas near the stream were covered in a layer of fine mud (**Figure 41C**). Abundances of Pacific oysters and Neptune's necklace were much lower on the western reef (**Figure 41D**). On the midshore, clumps of brown filamentous algae (**Figure 41E**) and coralline turf were present in the rock pools. Near the low tide mark the rocks were covered in the blue tube worm (*Spirobranchus cariniferus;* **Figure 41F**). A similar suite of invertebrates to the eastern reef were present on the western reef.

Several coastal and seabirds were observed on the intertidal flats during the survey. These included New Zealand dotterels (*Charadrius obscurus*), variable oystercatchers (*Haematopus unicolor*), black-backed gulls (*Larus dominicus*), and white-faced herons (*Egretta novaehollandiae*). A nesting area for New Zealand dotterels on the upper beach west of Te Puru Stream had been cordoned off.

In summary, the intertidal marine community at Kelly's Beach is typical of sheltered beaches around the Auckland region. The only threatened marine species (excluding birds) observed during the survey was seagrass, which was present in three very small patches on the lower shore well away from the stream entrance.

Several kai moana species were observed to be present on Kelly's Beach (cockles, pipis, oysters, mussels), however, all were too small to be deemed of harvestable size. Given their very small size it is unlikely that shellfish are harvested from Kelly's Beach for human consumption.

Figure 37. Habitats present on the intertidal mud/sand flats in Kelly's Beach: A. Mangroves surrounding the entrance to Te Puru Stream. B. Deep, soft mud with abundant crustacean burrows on the stream banks of the upper shore. C–D. Shell banks on the mid to lower shore. E. Small patches of seagrass on the lower shore. F. Sandy areas on the lower shore.

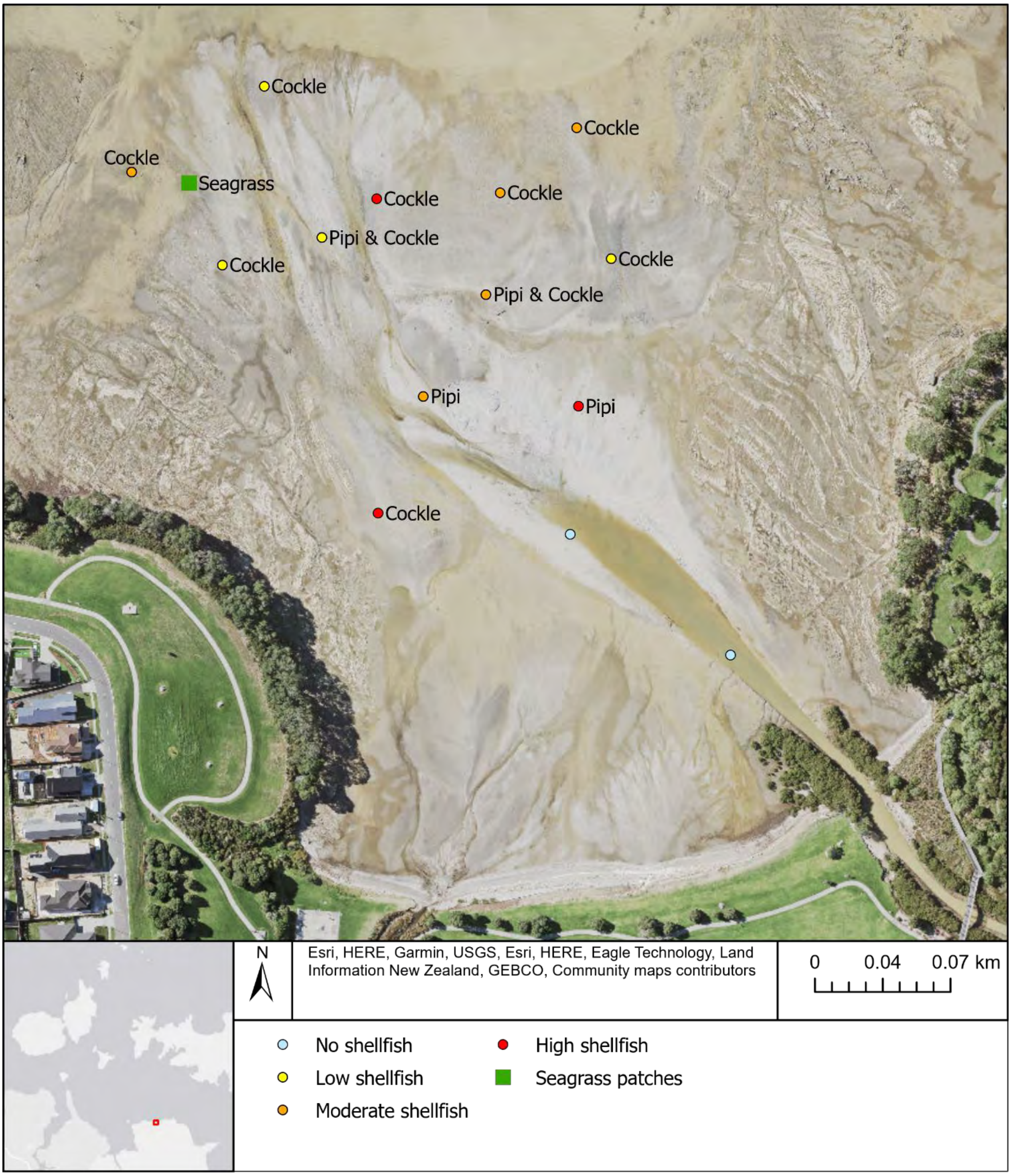

Figure 38. Abundance of shellfish at the inspection stations around Kelly's Beach. No seagrass was found within any of the inspection stations, but small patches of moderately dense seagrass were observed at the location shown.

Figure 39. Examples of the substrate and shellfish found at inspection stations: A. Soft mud with burrows. B. Sandy mud with shells. C. Sand interspersed with dense shell and rock. D. Sand. E. Juvenile cockles found at one inspection station. F. Juvenile pipis found at one inspection station.

Figure 40. The sandstone reef on the eastern side of Kelly's Beach: A. Rocks covered with Pacific oysters and Neptune's necklace. B. A dense patch of Neptune's necklace. C. *Codium fragile* subsp. *novae-zelandiae*. D. *Scytothamnus australis*. E. Mud whelks, Pacific oysters, and modest barnacles. F. A clump of small blue mussels.

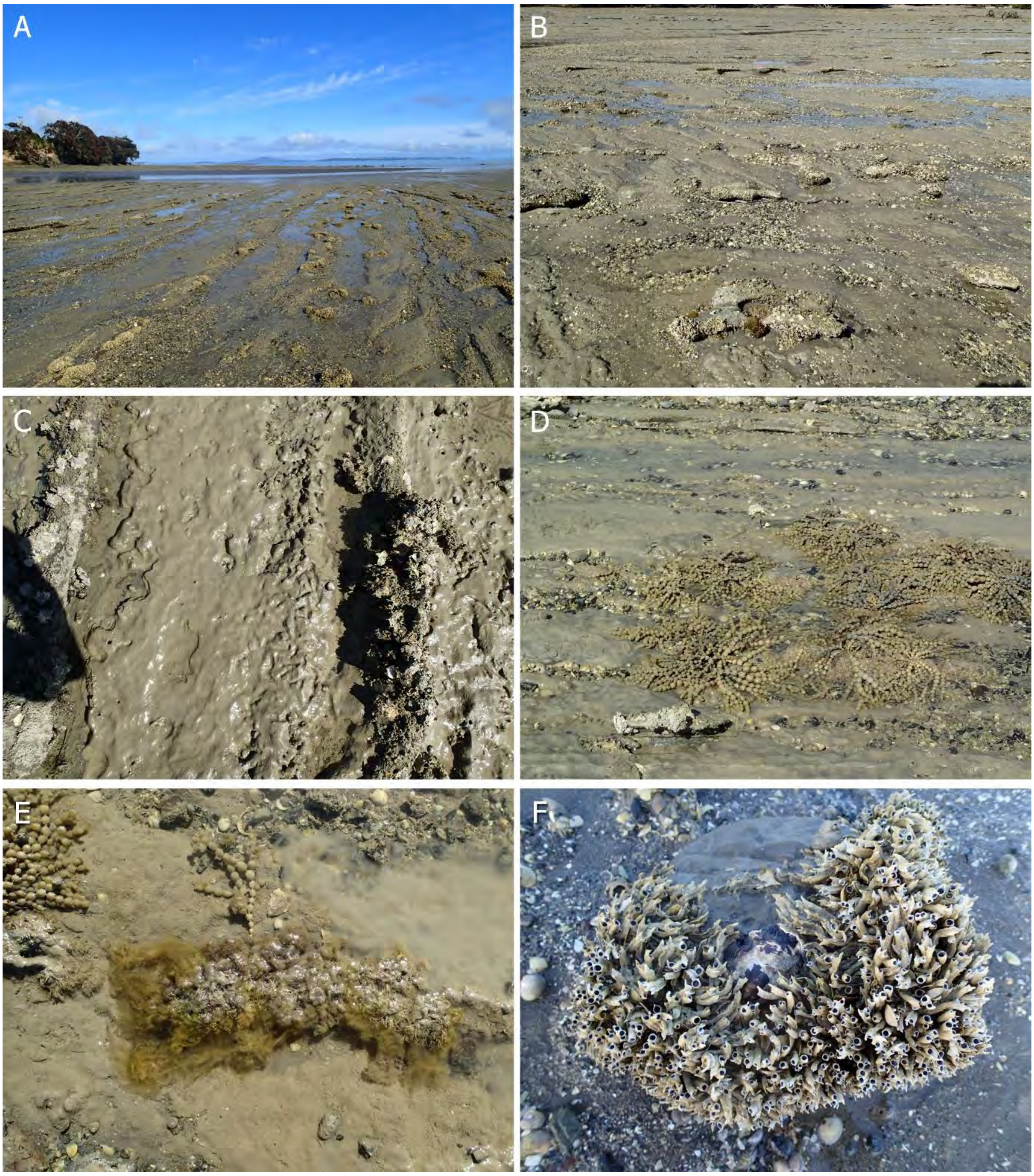

Figure 41. The sandstone reef on the western side of Kelly's Beach: A–B. Low-lying sandstone reefs. C. A layer of mud covering the sandstone. D. Clumps of Neptune's necklace. E. Brown filamentous algae. F. The blue tube worm.

4.7.2 Beachlands & Maraetai

The area between west Beachlands and Motukaraka/Flat Island (**Figure 36** (SEA-M1-43b)) is designated as a SEA-Marine 1 due to the presence of large shellbanks that are used as high tide roosts by wading and coastal birds. The substrate is sandy, becoming coarser towards Motukaraka (Chiaroni et al., 2010). Seagrass beds have developed over this area over the last decade or so and the substrates around the seagrass beds are softer due to the accumulation of fine sediment

(Jackson et al., 2022). No seagrass was recorded in Whitford embayment, including around Motukaraka, by Chiaroni et al. (2010), however, large patches of seagrass are visible in Google Earth satellite imagery from around 2014 onwards, and extensive areas of seagrass are now present south of Motukaraka (**Figure 42**) and further west on the intertidal flats between Turanga and Waikopua Creeks. Jackson et al. (2022) found that the most common species present within the seagrass beds were crabs (*Austrohelice crassa, Hemigrapsus crenulatus, Macrophthalmus hirtipes*), shrimps, gastropods, including bubble shells (*Haminoea zelandiae*), wedge shells and cockles.

Most of Whitford embayment, including the area around Motukaraka is designated as a SEA-Marine 2 (**Figure 36,** (SEA-M2-43a)) due to the presence of large areas of intertidal mud, sand and shellflats that provide a habitat for a wide range of marine species. The intertidal flats also provide feeding and roosting areas for a variety of coastal and wading birds. Intertidal macrofauna samples taken between Pine Harbour and the entrance to Waikopua Creek found that the macrofaunal community was typical of sheltered northern estuaries, mainly comprising polychaetes, bivalves and amphipods. Species richness (6–23 taxa/core) and abundance (24–340/core) were moderate (Jackson et al., 2022).

Sunkist Bay, west of Te Maraetai/Kellys Beach, grades from sand at the high tide mark to shell and bedrock on the lower intertidal area. Chiaroni et al. (2010) found shellfish (cockles, pipis and wedge shells (*Macomona liliana*)) abundances in this bay were low. Omana Beach, east of Te Maraetai/Kellys Beach, is a sandy/shelly beach. Chiaroni et al. (2010) did not find any visible biological features or adult shellfish beds in this bay.

Maraetai Beach is a popular recreational beach that is designated as a SEA-Marine 2 and Marine 2w (**Figure 36,** (SEA-M2-169)) due to the long sandy beach that provides extensive feeding areas for wading and coasting birds. Further east around the coast is Umupuia Beach where cockles have been monitored by the Ministry for Primary Industries for over twenty years. Harvesting of cockles from Umupuia has been prohibited since 2008, and subsequently, the number of harvestable-sized cockles has increased from around 5.0 million to around 23.4 million (**Figure 43**; (Berkenbusch et al., 2023)).

Occasional blooms of the nuisance cyanobacteria *Okeania* spp. (previously called *Lyngbya majuscula*) have been reported from the Beachlands-Maraetai coastline. In the late 1970s *Okeania* spp. were reported as seasonally dominant species around Motukaraka, and throughout the 2000's there were regular occurrences of the *Okeania* spp. blooms around the Beachlands and Omana area. No *Okeania* spp. blooms were observed in Te Maraetai/Kellys Beach during the intertidal survey. Little is known about the drivers and impacts of cyanobacterial blooms (Auckland Council, 2024).

Figure 42. Seagrass beds covering the intertidal area south of Motukaraka/Flat Island (photo: J. McMeeking, Feb 2024).

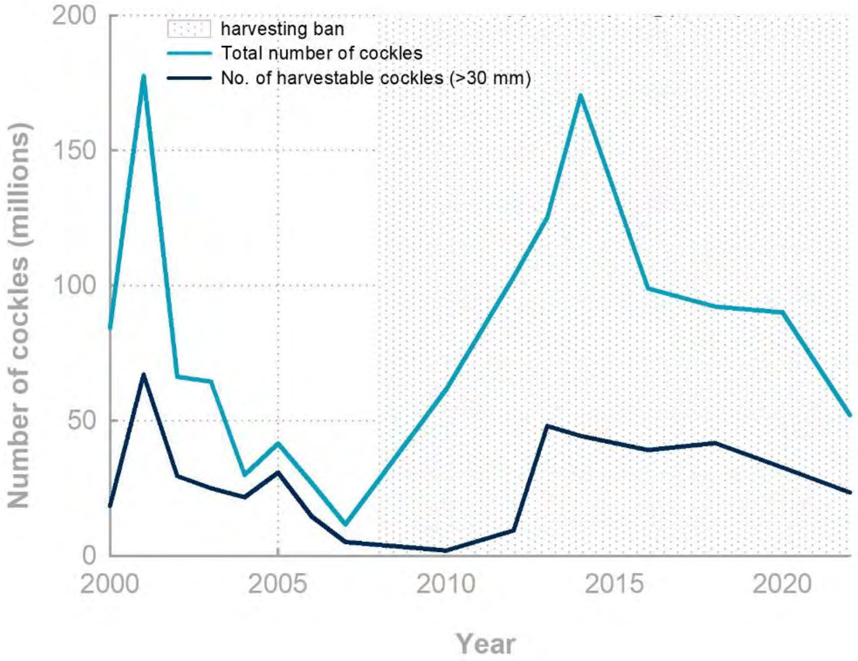

Figure 43. Estimated number of cockles present in the survey area of Umupuia Beach between 2000 and 2022. Data from Berkenbusch et al. (2023).

4.7.3 Tamaki Strait

Tidal currents directly offshore of the Beachlands-Maraetai coastline are moderate (<0.25 cm/s) and substrates are predominantly muddy sand, though large patches of shell hash occur in places (Chiaroni et al., 2010). An underwater video survey was conducted approximately 3 km offshore of Te Maraetai/Kellys Beach on 6th November 2023. The survey found that that habitat throughout the region was sandy-mud to muddy-sand interspersed with patches of dense shell (**Figure 44**). The Mediterranean fan worm (*Sabella spallanzanii*), an unwanted organism, was the only common epifaunal species observed. Other species that were occasionally observed included sponges, hydroids, bryozoans, horse mussels (*Atrina zelandica*), 11-armed starfish (*Coscinasterias muricata*) and sea cucumbers (*Australostichopus mollis*) (**Figure 45**). No rocky reefs, living biogenic habitats, or regionally significant benthic species were observed in the survey (Kelly and Alder, 2023).

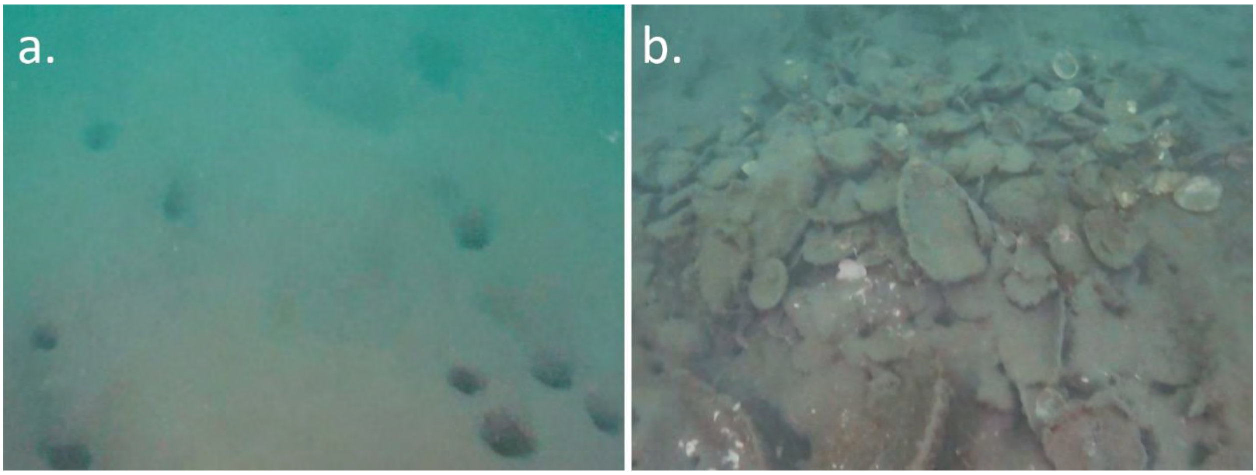

Figure 44. Habitat characteristics in the survey area: a) uniform sandy-mud/muddy-sand with burrows, and b) dense shell (including mussel shell) covered by a thin sediment layer.

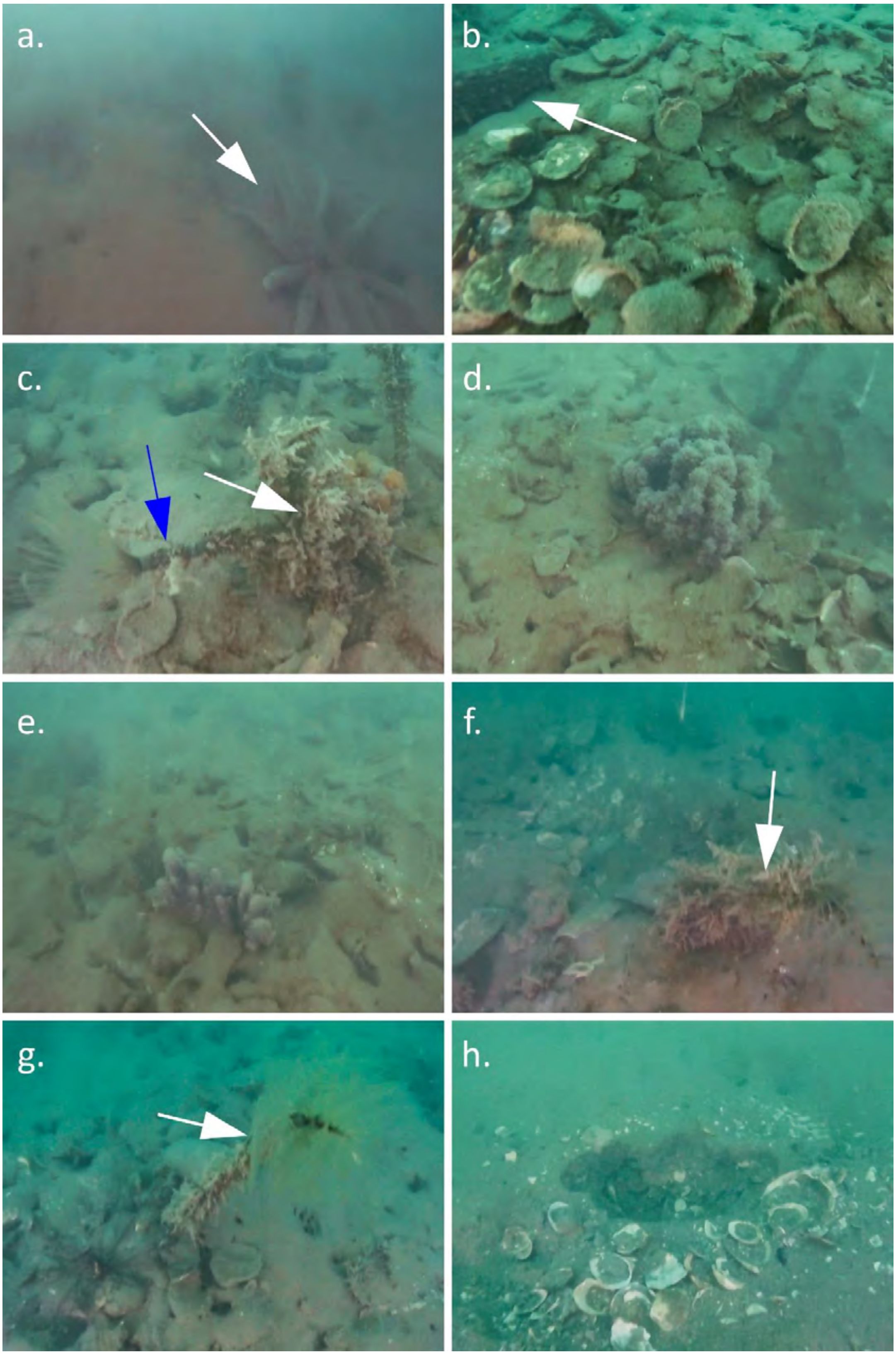

Figure 45. Examples of biota observed along video transects, including a) 11-armed starfish, b) sea cucumber, c) what appears to be a heavily fouled horse mussel (white arrow) with Mediterranean fan worm (blue arrow), d) and e) unidentified sponges, f) what appears to be a heavily fouled horse mussel with hydroids and Mediterranean fan worm, g) Mediterranean fan worm on shell, h) ray feeding pit? Note that images have been enhanced for colour and clarity.

4.8 Summary of the current environment

For the existing freshwater environment (upstream sites regarded as the "existing environment" i.e. without the WWTP):

- The catchment is low relief, rural pasture with areas of exotic forestry and regenerating native bush in stream gullies.
- There is a clear demarcation of freshwater and saline environments below the Quarry site.
- The flows in the Te Puru Stream network appear to be highly dependent on rainfall.
- PDP derived theoretical stream flows from water level sensor and stream gauging to inform to inform the potential for erosion during a 3-fold increase in wastewater flows.
- Water is generally well oxygenated, with DO similar upstream and downstream of the WWTP discharge.
- $cBOD_5$ is at low concentrations and similar upstream and downstream of the WWTP discharge.
- Water temperature is slightly elevated at sites downstream relative to sites upstream of the WWTP discharge.
- Low pH appears to be more an issue than high pH in the receiving environment and appears to be driven by the upstream farm pond site, not the WWTP discharge.
- Conductivity at all sites is above ANZG DGV but there is a clear influence of the WWTP discharge on conductivity in sites downstream.
- There is evidence of minor salinity ingress into the WWTP (influent maximum 2.4 ppt and discharge maximum 1.4 ppt) and environment sites upstream (maximum salinity 1.4 ppt) of Te Puru Park which has a known saline influence (maximum salinity 32.4 ppt). There is a clear linear relationship between salinity and conductivity so elevated conductivity observed is likely to be due to saline water intrusion into Beachlands WWTP.
- TSS and turbidity are low and at similar concentrations in receiving environment sites upstream of the Quarry site and unrelated to the WWTP discharge.
- Nitrogen concentrations are elevated at sites downstream of the WWTP relative to concentrations observed upstream. Ammoniacal-N and nitrate-N concentrations at the potential mixing zone – Bridge site (15) – place them in NPS-FM attribute band B for toxicity. Dissolved inorganic nitrogen (DIN) at the same site is at a level considered to be degraded and likely to contribute to eutrophication.
- Phosphorus shows a similar pattern to nitrogen with concentrations downstream markedly higher than concentrations upstream of the WWTP discharge.
- Chlorophyll *a* is not measured in the influent or discharge. Concentrations are slightly elevated at the farm pond and the next downstream site, but back to upstream levels by the Bridge site.
- Bacteria – *E. coli*, FC, and enterococci – concentrations are higher upstream of the WWTP, suggesting catchment sources dominate.
- All metal concentrations measured were below the applicable ANZG 95% DGV.
- Pharmaceutical and personal care products (PPCPs) measured show an average attenuation of 2.9-fold from the WWTP outlet to the Bridge site (15).

- Sediment phosphorus appears to be higher at the Bridge site than the farm pond. However, other studies show that sediment P appears to be relatively static over decadal timeframes.
- Temporal trend analysis was undertaken on water quality data collected from the upstream farm pond (A) and farm pond (B) sites from February 2020 to March 2023. Only nitrate in the farm pond showed a meaningful (>1% annual change) and significant ($p<0.05$) trend.
- Stream ecology surveys were undertaken in 2016, 2019, 2022, and 2024. Sites were grouped into 'reference' sites (above the WWTP discharge) and 'effect' sites (below the WWTP discharge) For the most recent survey:
  - Macrophyte diversity and the percentage of macrophyte and algae cover generally increased downstream of the discharge.
  - Higher numbers of macroinvertebrate species were noted at the reference sites. Species numbers in the effects sites increased with distance from the WWTP discharge. Bioresearches noted that the poor macroinvertebrate scores downstream of the discharge are likely due to a combination of stressors, including the decreased riparian vegetation and hard substrate at downstream sites.
  - The percentage of sensitive species (%EPT) ranged from 22-30% at the reference sites, with either no EPT taxa recorded or virtually 0% EPT at effect sites.
  - The Macroinvertebrate Community Index (MCI) indices placed reference sites on the border between 'good' and 'fair' (and above the AUP minimum of 94 for rural areas) with effect sites in 'fair' and 'poor' categories (and below the AUP minimum of 94 for rural areas).
  - The Semi-Quantitative Macroinvertebrate Community Index (SQMCI) showed similar results to MCI with reference sites in the 'fair' or 'excellent' category (and above the NPS-FM NBL of 4.5) and effect sites in the 'poor' or 'fair' category (with only site F below the NPS-FM NBL of 4.5).
  - Native fish species abundance and diversity were higher at reference sites than effect sites.
  - A Fish Index of Biotic Integrity (IBI) allows comparison with other Auckland streams and rated reference sites in 'poor' or 'fair' categories and effect sites in 'very poor' or 'poor' categories.
  - For trends from 2016-2024:
    - For most sites the number of macrophyte and algae taxa appear to be stable or increasing since 2016, with generally more taxa recorded at downstream sites. A similar trend is noted for percentage macrophyte/algae cover.
    - For macroinvertebrates the number of taxa appear to be stable or declining at the reference sites and generally lower but stable or increasing at the effect sites.
    - %EPT has remained very low and between 0% and 3% for effect sites.
    - MCI scores for reference sites have been relatively consistent and mostly above the AUP minimum for rural areas of 94.
    - In contrast to the reference sites, all but one MCI value has been below the AUP minimum for rural areas of 94. Sites F and G have shown signs of improvement since 2016, with site G a general decline.
    - As for MCI there is a general increasing trend in the SQMCI scores for the effect sites.

        - Numbers of native fish species were generally low (1-5) for reference sites and 0-4 for effect sites with no apparent temporal trends were observed.
        - The number of native fish at reference site H was declining from 2016 (38) to 2022 (14) but returned to near 2016 numbers in 2024 (36). Reference sites E and A showed a general increase in the number of native fish. Site F had consistently very low numbers of native fish with the other effect sites variable.
        - Fish IBI appears to be reducing as reference site H, but stable or increasing at reference sites E and A. For effect sites, site F has either no fish or a very low Fish IBI, while sites S2 and G appear to be generally improving.
    - The improvement in MCI and SQMCI scores at site F (closest to the WWTP discharge) is promising, however improved water quality in the future WWTP discharge (primarily lower concentrations of toxic nitrate and ammonia, and conductivity) is required to contribute to further improve the macroinvertebrate communities downstream.
    - Macroinvertebrate and native fish communities did not appear to fully recover at the most downstream sites and lacked more sensitive taxa. The overall magnitude of effect of all activities on the tributary and stream environment can be classified as moderate.

For the existing marine coastal environment:

- The lower, estuarine reaches of Te Puru Stream are strongly influenced by seawater inflow during high tide, with salinities of 20–35 ppt at high tide but decreasing to 5–15 ppt during low tide.
- The entrance to Te Puru Stream is designated as a Significant Ecological Area–Marine 1 due to the variety of saline vegetation and coastal vegetation present and the intact ecological sequence from estuarine to freshwater wetlands.
- Te Maraetai/Kellys Beach and the surrounding coastal area is designated as a Significant Ecological Area–Marine 2 due to the variety of intertidal habitats present that provide a habitat for a wide variety of marine organisms. An intertidal survey of Te Maraetai/Kellys Beach found that:
    - The upper shore is very muddy with abundant crustacean burrows. Mangroves line the stream bank around the entrance to Te Puru Stream.
    - The mid to lower shore is sandy with scattered shell/rock. Low lying shell banks are present in some areas.
    - Juvenile cockles and pipi were present in low to high densities across the mid to lower sandflats, but no shellfish were found that were near harvestable size.
    - Three small patches (each 2 m × 1 m) of moderately dense seagrass were observed near the low tide mark.
    - Intertidal sandstone reef platforms are present on either side of the bay that provide a habitat for a range of common intertidal species.
    - In summary, the intertidal marine community at Kelly's Beach is typical of sheltered beaches around the Auckland region. The only threatened marine species (excluding birds) observed during the survey was seagrass, which was present in three small patches on the lower shore. The area of seagrass cover is much too small to meet the criteria of biogenic habitat.

- The area between west Beachlands and Motukaraka/Flat is designated as a Significant Ecological Area-Marine 1 due to the presence of large shellbanks that are used as high tide roosts by wading and coastal birds. Extensive seagrass beds have developed over this area over the last decade.
- Most of Whitford embayment, including the area around Motukaraka is designated as a Significant Ecological Area-Marine 2 due to the presence of large areas of intertidal flats that provide a habitat for a wide range of marine species. The intertidal flats also provide feeding and roosting areas for a variety of coastal and wading birds. The intertidal macrofaunal community is typical of sheltered northern estuaries.
- Sunkist Bay, west of Te Maraetai/Kellys Beach, grades from sand at the high tide mark to shell and bedrock on the lower intertidal area. Shellfish (cockles, pipis and wedge shells) abundances in this bay were low.
- Omana Beach, east of Te Maraetai/Kellys Beach, is a sandy/shelly beach with no shellfish beds.
- Maraetai Beach is a popular recreational beach that is designated as a Significant Ecological Area-Marine 2 due to the long sandy beach that provides extensive feeding areas for wading and coasting birds.
- Subtidal areas approximately 3 km offshore of Te Maraetai/Kellys Beach were surveyed by underwater video. Substrates comprised sandy-mud to muddy-sand, interspersed with patches of dense shell. The Mediterranean fan worm, an unwanted organism, was the only common epifaunal species observed. Other species that were occasionally observed included sponges, hydroids, bryozoans, horse mussels, 11-armed starfish, and sea cucumbers. No rocky reefs, living biogenic habitats, or regionally significant benthic species were observed in the survey.

5. Assessment of environmental effects

5.1 Introduction

The matters associated with the proposed discharge of treated wastewater reaching the receiving environments that require assessment include:

- Deteriorating water quality and general health through increases in nutrients, metal and organic toxicants, and microbial contaminants.
- Effects of the proposed discharge on stream ecology and the marine receiving environment.
- Potential for nuisance plant growths, including macroalgae and phytoplankton.
- Changes to benthic fauna and indirectly the food web leading to fish and birds.
- Increased risk of microbial contaminations for shellfish gathering (including aquaculture) and for recreation.

We now address the actual and potential effects of the proposed discharge on the receiving environment by comparing water quality and ecological values from sites upstream of the influence of the WWTP discharge with sites downstream of the influence of the WWTP. The environment at the reference sites upstream is considered the "existing state" i.e. without the WWTP contaminants noting that the habitat can change downstream. We then assess the actual and potential effects of the proposed discharge from the expanded and upgraded WWTP and whether they will improve the health of the receiving environment downstream.

For the avoidance of doubt, for the purposes of this assessment we have excluded the current discharge from the WWTP from the existing "environment" for the purposes of section 104(1)(a) of the Resource Management Act 1991 (**RMA**).

Whether the effects of the proposed discharge are the same, better or worse than those of the current discharge has also been noted in our assessment. For the purposes of section 104(1)(b) of the RMA, the NPS-FM and AUP require that effects from the discharge are managed to either maintain, or maintain and enhance, the existing environment (see later in this section); and in the context of that assessment a comparison between the effects of the proposed discharge and those of the existing discharge can be made.

We identify separate freshwater and marine sections in the receiving environment to assess the actual and potential effects of the proposed discharge from the expanded and upgraded WWTP.

For an observed effect, we have determined if discharged wastewater will satisfy the objective of negligible, very low or low level of effects in the receiving environment, broadly following the framework described in the Ecological Impact Assessment (EcIA) EIANZ guidelines (**Table 11**) (Roper-Lindsay et al., 2018).

Table 11. Criteria for describing magnitude of effect (from Roper-Lindsay et al. 2018)

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

The objectives and policies provided within the AUP are clear around water quality and integrated management, specifically that it needs to be either maintained at current levels or enhanced (if above NBLs) or improved (if below NBLs). Applicable parts of the AUP are summarised below.

E1.2. Objectives [rp/rcp]

1. Freshwater and sediment quality is maintained where it is excellent or good and progressively improved over time in degraded areas.
2. The mauri of freshwater is maintained or progressively improved over time to enable traditional and cultural use of this resource by Mana Whenua.
3. Stormwater and wastewater networks are managed to protect public health and safety and to prevent or minimise adverse effects of contaminants on freshwater and coastal water quality.

E1.3. Policies [rp/rcp/dp]

Freshwater quality and ecosystem health interim guidelines

1. Manage discharges, until such time as objectives and limits are established in accordance with Policy E1.3(7), having regard to:
   a. the National Policy Statement for Freshwater Management National Bottom Lines;
   b. the Macroinvertebrate Community Index as a guideline for freshwater ecosystem health associated with different land uses within catchments in accordance with Policy E1.3(2); or
   c. other indicators of water quality and ecosystem health.
2. Manage discharges, subdivision, use, and development that affect freshwater systems to:
   a. maintain or enhance water quality, flows, stream channels and their margins and other freshwater values, where the current condition is above National Policy

Statement for Freshwater Management National Bottom Lines and the relevant Macroinvertebrate Community Index guideline **Table 12**); or

b. enhance water quality, flows, stream channels and their margins and other freshwater values where the current condition is below national bottom lines or the relevant Macroinvertebrate Community Index guideline (**Table 12**).

3. Require freshwater systems (3) to be enhanced unless existing intensive land use and development has irreversibly modified them such that it practicably precludes enhancement.

Table 12. Macroinvertebrate Community Index guideline for Auckland rivers and streams (AUP Table E1.3.1).

Land use	Macroinvertebrate Community Index guideline
Native forest	123
Exotic forest	111
Rural areas	94
Urban areas	68

By synthesising the intention of the above policies a summary of whether upstream sites – upstream farm pond (A) and tributary upstream (E) (reference or "existing" environment sites without the WWTP influence) – are degraded is provided in **Table 13**. All nutrient concentrations at these sites are at concentrations below the NPS-FM NBL or expert conference accepted threshold for degradation. *E. coli* concentrations are contributing to a degraded environment at these sites with concentrations that exceed the NPS-FM NBL. MCI indices at the tributary upstream site (93) and upstream farm pond (108) are below and above the AUP value of 94, respectively. Fish IBI indices are well above those specified by Joy and Death (2004).

Table 13. Summary of degraded nature of two upstream sites against relevant guidelines specified in AUP. Thresholds exceeded are bolded red. Note the upstream sites provide an indication of the "existing environment" without the WWTP.

Attribute	Statistic	Numeric threshold	Source	Upstream Farm Pond (A)	Tributary upstream (E)	Degraded?
DIN	Median	1.0	SRC 2019	0.05	0.14	No
DRP	Median	0.018	NPS-FM NBL	0.014	0.014	No
DRP	95th %ile	0.054	NPS-FM NBL	0.026	0.026	No
NH_4-N	Median	0.24	NPS-FM NBL	0.027	0.020	No
NH_4-N	95th %ile	0.4	NPS-FM NBL	0.047	0.032	No
NO_3-N	Median	2.4	NPS-FM NBL	0.02	0.11	No
NO_3-N	95th %ile	3.5	NPS-FM NBL	0.13	0.15	No
E. coli	Median	130	NPS-FM NBL	**1,250**	**930**	Yes
E. coli	95th %ile	1,200	NPS-FM NBL	**4,815**	**3,780**	Yes
Macroinvertebrates (MCI)	Median (last 4 surveys)	94	AUP	108	**93**	Yes (E only)
Fish (IBI)	Average (last 3 surveys)	23	Joy and Death (2004)	33	30	No

5.2 Hydrology

Increased flow rates under the proposed discharge may lead to physical effects, such as erosion of stream channels, or resuspension and transport of sediment from stream beds further downstream. Higher discharge volumes may lead to improvements during dry conditions but ultimately lead to greater dilution of saltwater in marine environments, leading to potential adverse effects on marine species.

Bioresearches undertook a site assessment to identify the potential effects of the proposed discharge of up to 6,000 m^3/day (Bioresearches, 2024b). Sites assessed where those monitored in the stream assessment (Section 4.6), namely six 'effect' sites (F, 15, S2, G, S3 and C) and one control site (E). During the site assessment, stream characteristics were recorded, including water quality, width, depth, flow velocity, instream macrophytes and periphyton. General notes regarding substrates, deposited sediments, stream bank condition riparian yard condition and were taken.

Both the control site (E) and effect sites have similar width (average 2.16m for both, but effect sides ranging from 1.82-2.69m) and depth (0.23m for E and 0.25m (range 0.12-0.51m) for effect sites). Stream substrates are also similar with silt and cobble at site E and silt, cobble, and gravel at effect sites, with the silt reducing with distance from the discharge. Riparian vegetation was poor at site E and variable at effect sites. Importantly, it was noted that the lower reaches contained no significant riparian yard and evidence of bank erosion.

Using bully as a reference fish as they have the lowest tolerance to increases velocities (so worst-case), Bioresearches concluded that the increase in depths and stream velocities from the proposed discharge is unlikely to result in flow velocities throughout the tributary being permanently affected and result in a reduction of native fish habitat.

They concluded that the most significant effect of the proposed discharge volume on the Te Puru Tributary is the potential for increases in erosion and scour, particularly during flood and storm events and recommended to minimise erosion and scour that infill riparian planting with deep rooting vegetation is undertaken throughout the Te Puru Stream Tributary, particularly where erosion and scour is evident. This would also benefit invertebrate and fish habitats downstream through shading and reducing runoff effects.

As part of a stream hydraulic assessment, PDP (2024b) assessed current stream bank and bed erosion through site visits on 6th September 2023, 27th October 2023, and 18th January 2024. They noted that there is evidence of current stream bank erosion between the farm pond and bridge site, and near the confluence with Te Puru Stream, but minimal erosion at the Quarry site. Erosion was likely caused by storm events. They modelled estimated velocities for the current and added future increase in discharge volume and found that during high flow events (90th percentile flows) there was minimal increase in flows from the future discharge (0.3 m/s) and no effect at higher flows. They concluded that any increase in erosive potential due to the proposed discharge is expected to be minor resulting in a low effect on stream bank erosion. This suggests that riparian planting suggested by Bioresearches may not be required to mitigate erosion through increased flows.

In terms of the marine environment, the estimated dry weather stream discharge will increase from ~2200 m^3/day to ~6000 m^3/day (DHI, 2024), which corresponds to a 23 L/s and 69 L/s, respectively. Most intertidal species, particularly those living near estuary mouths, are highly tolerant of low salinity, and river flows onto nearby intertidal areas can be much higher than the predicted flows from Te Puru Stream. By comparison, the 5-year, 7-day mean annual low flow rates for the nearby Wairoa River is 415 L/s, respectively (Johnson, 2021). Therefore, the increase flow rate from the proposed discharge is considered to be negligible.

5.3 Potential effects on Te Puru Stream water quality

5.3.1 Physical stressors

DO and $cBOD_5$

DO is critical to supporting healthy aquatic ecosystems and the NPS-FM specifies a summer daily minimum NBL of >4 mg/L for rivers below point sources.

High BOD can result in low DO concentrations as oxygen is consumed during organic matter decomposition, which in turn can impact on aquatic biota, as well as result in the proliferation of bacterial and fungal growths. The general MfE guideline to protect against nuisance bacterial or fungal growths is <2 mg/L (soluble) however where the discharge is predominantly treated sewage then the BOD limit of 5 mg/L is adequate (Ministry for the Environment, 1992).

Based on the recent extensive water quality monitoring, the existing Beachlands WWTP discharge has at times a low minimum DO (noting that measurements are spot measurements and not diurnal). However, based on monitoring at receiving environment sites this does not appear to be impacting on DO in the pond or further downstream, and this is not expected to change for any future stages of the updated WWTP. Accordingly, there are no DO standards included as part of the proposed discharge from the new MBR WWTP.

Between 2018 and 2023 the median $cBOD_5$ in the Beachlands WWTP discharge has been <2 mg/L (**Table 2**) and declining at 1.6% per annum (**Table 3**). The recent elevated $cBOD_5$ in the Beachlands WWTP discharge in 2023/24 (median 5.7 mg/L) does not appear to be impacting on $cBOD_5$ (nor DO) in the pond or further downstream. All receiving environment sites are well below the MfE guideline of <2 mg/L. The proposed median operational limit for the Current Short-Term Stage discharge is 7 mg/L, which is marginally higher than the WWTP discharge in 2023/24 (median 5.7 mg/L). This potential increase (noting the operational limit is a maximum concentration) is not expected to impact significantly on $cBOD_5$ or DO in the pond or further downstream during the Short-Term Stage. The proposed median operational limit for the new MBR WWTP (Long-Term Stage 1 and Long-Term Stage 2) are an approximate 1.4-fold and 1.14-fold decrease in $cBOD_5$ from the Short-Term Stage and 2023/24 levels, respectively. Therefore, $cBOD_5$ in the proposed discharge for the new MBR WWTP (both stages) is expected to continue to have a negligible effect on the environment. The reduction in $cBOD_5$ in the future MBR stages will contribute to improved water quality downstream of the discharge compared to the present discharge.

Water temperature

Water temperature is not measured routinely as part of the existing Beachlands WWTP discharge. Recent extensive monitoring of the discharge and receiving environment sites show that

Beachlands WWTP appears to be impacting on temperature in the pond and downstream as far as the Bridge site. The 5-year data provided by Watercare for the upstream of the farm pond (A) and farm pond (B) sites showed maximum water temperature over the summer months of between 20.6-22.7°C upstream of the farm pond (A) and between 21.0-23.1°C at the farm pond (B).

For both sites water temperatures are high in summer and well above the AC guideline of 17.7°C. The 2013 National Objective Framework provides attribute states for temperatures to protect ecosystem health with <18°C being attribute state A (where no thermal stress occurs), and attribute state B <20°C (minor stress). River water temperatures greater than 24°C have been shown to be stressful to a range of invertebrate taxa and fish species and temperatures around 24–27°C potentially result in some sensitive invertebrates, particularly some insects, being severely stressed and some fish eliminated, if such temperatures persist. Occasionally the pond outlet (Site B) and Farm Pond downstream (Site F) are above 24°C but only for very short periods. The sites further downstream do not reach this critical temperature.

These data show that during times of heat stress there is very little difference between water temperatures in the upstream and downstream sites suggesting the existing Beachlands WWTP is showing minimal impacts on water temperature in the farm pond. There are no water temperature standards proposed for the new MBR WWTP, but temperature at all 4 discharge stages of the WWTP is not expected to change from existing, resulting in low changes in temperature at downstream sites compared with upstream sites.

pH

Low pH appears to be more an issue than high pH in the receiving environment, with most sites showing a 20th percentile pH below the ANZG DGV of 7.26. The existing Beachlands WWTP discharge appears to be contributing negligible impacts on pH at the farm pond and sites further downstream. There are no pH standards proposed for the new MBR WWTP, but pH at all 4 discharge stages of the WWTP is not expected to change from existing, resulting in negligible changes in pH at downstream sites.

Conductivity and salinity

Conductivity increases with water temperature. This is clear from the recent extensive water quality monitoring data, which shows a general increase in conductivity and water temperature across all sites from September to January. A potential effect of high conductivity is reduced DO, but as shown above, effects on DO are not apparent downstream of the existing Beachlands WWTP discharge.

All receiving environment sites monitored between September 2023 and January 2024 had 80th percentile concentrations above the ANZG 80th percentile DGV (155 µS/cm). However, sites upstream of the discharge only marginally exceed this DGV and there is a clear influence of the existing Beachlands WWTP discharge on conductivity downstream. By the confluence (the Bridge site) the 80th percentile conductivity value (965 mg/L) exceeds the ANZG 80%ile DGV of 115 mg/L by 8.4-fold.

The DGV indicates that there is a 'potential risk' of adverse effects at a site, when the value is exceeded (McDowell et al., 2013). In terms of effects on aquatic life, the Stream Health Monitoring and Assessment Kit (SHMAK) report (NIWA, 2019) states that "the dissolved salts measured by conductivity usually do not have a direct effect on stream life until they reach levels found in brackish water or seawater (greater than about 5,000 µS/cm).” Conductivity at all receiving environment sites receiving the wastewater discharge are well below 5,000 µS/cm, suggesting that any effects would be indirect.

There was evidence of minor salinity ingress into the WWTP (influent maximum 2.4 ppt (7% salinity) and discharge maximum 1.4 ppt (4% salinity), and environment sites upstream (maximum salinity 1.4 ppt) of Te Puru Park which has a known saline influence (maximum salinity 32.4 ppt). There is a clear linear relationship between salinity and conductivity[19]. Therefore, elevated conductivity observed is likely to be due to saline water intrusion into Beachlands WWTP.

There are no discharge standards for conductivity and salinity proposed for the new MBR WWTP. Water-tight connections associated with new connections (and population growth) will reduce saltwater intrusion into the new MBR WWTP, diluting the saline influence (and elevated conductivity) in the future. We also recommend a trigger for conductivity which would result in an assessment of the cause and if any mitigation is appropriate.

TSS and turbidity

TSS levels can have an impact on receiving environments and communities by directly affecting physiological processes of invertebrates and fish and availability of light for photosynthesizing plants (algae, periphyton, macrophytes). There are also impacts on aesthetics and recreation through changes in water clarity and colour. 80^{th} percentile TSS concentrations above 8.8 mg/L exceed the ANZG DGV.

The existing Beachlands WWTP discharge has consistently low TSS (median 7.8 mg/L and 80^{th} percentile 10.2 mg/L). There appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater influence, until a large increase at the Quarry and Te Puru Park sites, which is likely due the quarry activity and tidal influence, respectively. The Current and Short-Term Stages of the WWTP upgrade have a proposed operation median TSS concentration limit of <7mg/L, which is a decrease of 1.1-fold from the existing discharge concentration (7.8 mg/L).

The proposed operational median TSS concentration limit of <7mg/L from the new MBR WWTP discharge (Long-Term Stages 1 and 2) should see an approximate 1.4-fold decrease in TSS from the existing levels (**Table 6**). TSS from the discharge of all stages of the proposed upgrade of the WWTP will continue to result in a negligible effect on the environment. Overall, the reduction in TSS in the future (at all stages) will contribute to improved water quality downstream of the discharge, compared to at present.

5.3.2 Nutrient concentrations

A major concern with discharges from a WWTP and other industries is the potential for acute and chronic ammoniacal-N toxicity. Ammoniacal-N toxicity will depend on both pH and temperature

[19] The extensive water quality monitoring data shows a strong linear relationship between salinity and conductivity particularly when salinity is consistently above 0.5 ppt (R^2 = 0.95, 0.93, 0.95 for Beachlands WWTP inlet, outlet and Te Puru Park, respectively.

of the receiving waters. The NPS-FM sets a NBL for ammonia toxicity based on an annual median (0.24 mg/L) and annual 95th percentile (0.40 mg/L), based on a pH dependent correction factor applied to standardise the ammoniacal-N concentration to pH 8 (Ministry for the Environment, 2018). As stated in Section 4.4.1.2, the existing Beachlands WWTP discharge has very low ammoniacal-N concentrations (and ca. 0.5% of TN being discharged from the WWTP) and is unlikely to be significantly contributing to ammoniacal-N concentrations downstream.

Median and 95th percentile concentrations are proposed for ammoniacal-N as part of the application for discharge consent. The concentrations are not expected to increase significantly in the future and will be very low in the discharge, and not contributing significantly to elevated nitrogen downstream. Processes in the pond will continue to increase ammoniacal-N levels downstream (see **Table 8**) but would be expected to meet the NBL for ammoniacal-N toxicity and be unlikely to impact on species found downstream. We note that for these reasons we have not estimated ammoniacal-N concentrations downstream.

At high concentrations nitrate-N can be toxic to aquatic fauna and humans while considerably lower concentrations are also a concern as they can lead to increased risk of nuisance plant growth (algae, macrophytes). The NPS-FM sets a NBL for nitrate toxicity based on an annual median (2.4 mg/L) and annual 95th percentile (3.5 mg/L).

In some cases plant growth can be limited by both N and P. The ANZG DGV to avoid increased risk of eutrophication is 0.024 mg/L for TP. For DRP, the NPS-FM has attribute states for DRP in rivers to protect ecosystem health. There is no NBL for DRP in the NPS-FM but attribute state B (median >0.006 and ≤0.010 mg/L; 95th percentile >0.021 and ≤0.030 mg/L) corresponds to ecological communities being slightly impacted by minor DRP elevation above natural reference conditions, attribute state C (median >0.010 and ≤0.018 mg/L; 95th percentile >0.030 and ≤0.054 mg/L) corresponds to ecological communities being slightly impacted by moderate DRP elevation above natural reference conditions. Attribute states A and D bookmark lower and higher concentrations and correspond to similar natural reference conditions and substantial DRP elevation above natural reference conditions, respectively.

To assess the actual and potential effects of the key nutrients nitrate-N and DRP in the proposed discharge on Te Puru Stream, estimation of concentrations for median WWTP discharge data were calculated based on the assumption that the expanded overland flow system (and a pond/wetland area) would provide the same level of attenuation that is achieved with the current system. The expanded overland flow system has not yet been designed and the plan will be developed with input from iwi. However, PDP (2024c) noted that the overland flow system could be designed to mimic the existing system.

5.3.2.1 Median data

The current measured median water quality concentrations and NPS-FM attribute bands for nitrate-N, ammoniacal-N, and DRP for receiving environment sites are summarised in **Table 14**. For nitrate-N, based on median concentrations, the Bridge site (potential mixing zone) is in attribute state B, whereas the Quarry site and both upstream sites are in attribute state A. For ammoniacal-N the Bridge site (potential mixing zone) and the Quarry sites are in attribute state A band the same state as both upstream sites. For DRP, All sites influenced by the existing WWTP discharge are in attribute state D with upstream sites in attribute state C.

Attenuation of nitrate-N and DRP from the WWTP discharge to the quarry site based on median concentrations is summarised in **Table 15**. Based on current median data, nitrate-N and DRP concentrations would be 32% (3.2-fold reduction), and 25% (4.0-fold reduction) of the WWTP discharge concentration at the Bridge site (potential mixing zone), respectively.

Table 14. Summary of current measured water quality median concentrations and NPS-FM attribute bands for nitrate-N, ammoniacal-N, and DRP at receiving environment sites with median WWTP outlet concentrations. The Bridge site (potential mixing zone) is highlighted grey.

Parameter (mg/L)	WWTP Outlet (Median)	Farm Pond (B)	Farm Pond downstream (F)	Bridge (15)	Quarry	Upstream Farm Pond (A)	Tributary upstream (E)
Nitrate-N (Attribute Band)	5.1	2.8	3.2	1.6	0.6	0.02	0.11
	NA	(C)	(C)	(B)	(A)	(A)	(A)
Ammoniacal-N	0.04	0.29	0.21	0.07	0.04	0.03	0.02
Ammoniacal-N @pH8 (Attribute Band)	0.02	0.14	0.13	0.03	0.02	0.01	0.01
	NA	(B)	(B)	(A)	(A)	(A)	(A)
DRP (Attribute Band)	0.726	0.374	0.370	0.182	0.034	0.014	0.014
	NA	(D)	(D)	(D)	(D)	(C)	(C)

Table 15. Percentage of median nitrate-N and DRP WWTP outlet concentrations at receiving environment sites based on current median water quality data. The Bridge site (potential mixing zone) is highlighted grey.

Parameter (mg/L)	WWTP Outlet	Farm Pond (B)	Farm Pond downstream (F)	Bridge (15)	Quarry
Nitrate-N	100	55%	63%	32%	12%
DRP	100	52%	51%	25%	5%

Based on attenuation calculated in **Table 15**, potential water quality concentrations were calculated at receiving environment sites (**Table 16**).

With the marked reduction in median nitrate-N operational limit from the Current and Short-Term stages to the Long-Term Stages 1 and 2 of the proposed WWTP upgrade (see **Table 6**), the median concentration at the Bridge site (potential mixing zone) would be 1.1 mg/L (NPS-FM attribute band B), and 0.6 mg/L (NPS-FM attribute band A), respectively. Quarry sites would be 0.4 mg/L, and 0.2 mg/L, for Current and Short-Term and Long-Term Stages 1 and 2 respectively, placing them both in NPS-FM attribute band A (**Table 16**).

For the Current and Short-Term Stages operational limits for DRP will be <1.000 mg/L, with a median DRP concentration at the Bridge site (potential mixing zone) of 0.251 mg/L, placing it in NPS-FM attribute band D (**Table 16**). After the new MBR WWTP is installed (Long-Term Stages 1 and 2) operational maximum median DRP concentration will reduce to <0.500 mg/L, with a median DRP concentration at the Bridge site of 0.125 mg/L, placing it in NPS-FM attribute band D (**Table 16**). There would be an approximate 1.4-fold increase in DRP for the Current and Short-Term Stages and an approximate 1.5-fold decrease in DRP for the new MBR WWTP from DRP currently measured in the WWTP discharge. There would be no change to the attribute band (D) for any of the four Stages from that currently observed (**Table 14**). It is not feasible to reduce DRP in the discharge to a level that would improve the attribute band from D to C (**Table 16**) as upstream sites are very close to the attribute band D threshold of 0.018 mg/L, however the improvement on the current median concentration of ca. 0.73 mg/L to 0.50 mg/L (**Table 16**) proposed from the new MBR WWTP will contribute to improved water quality downstream, satisfying the intent of the AUP.

Table 16. Summary of <u>potential</u> water quality <u>median</u> concentrations and NPS-FM attribute bands for nitrate-N and DRP at receiving environment sites with <u>median</u> operational limits for WWTP outlet concentrations for existing (Current and Short-Term) and new (Long-Term Stage 1 and Stage 2) WWTP stages (see Table 6). The Bridge site (potential mixing zone) is highlighted grey.

Parameter /Stage	WWTP Outlet	Farm Pond (B)	Farm Pond downstream (F)	Bridge (15)	Quarry	Upstream Farm Pond (A)	Tributary upstream (E)
Nitrate-N Existing Current (Attribute Band)	3.5	1.9	2.2	1.1	0.4	0.02	0.1
	NA	(B)	(B)	(B)	(A)	(A)	(A)
Nitrate-N Existing Short-Term (Attribute Band)	3.5	1.9	2.2	1.1	0.4	0.02	0.1
	NA	(B)	(B)	(B)	(A)	(A)	(A)
Nitrate-N New (MBR) Long-Term Stage 1 (Attribute Band)	2.0	1.1	1.3	0.6	0.2	0.02	0.1
	NA	(B)	(B)	(A)	(A)	(A)	(A)
Nitrate-N New (MBR) Long-Term Stage 2 (Attribute Band)	2.0	1.1	1.3	0.6	0.2	0.02	0.1
	NA	(B)	(B)	(A)	(A)	(A)	(A)
DRP Existing Current (Attribute Band)	1.000	0.515	0.510	0.251	0.046	0.014	0.014
	NA	(D)	(D)	(D)	(D)	(C)	(C)
DRP Existing Short-Term (Attribute Band)	1.000	0.515	0.510	0.251	0.046	0.014	0.014
	NA	(D)	(D)	(D)	(D)	(C)	(C)
DRP New (MBR) Long-Term Stage 1 (Attribute Band)	0.500	0.258	0.255	0.125	0.023	0.014	0.014
	NA	(D)	(D)	(D)	(D)	(C)	(C)
DRP New (MBR) Long-Term Stage 2 (Attribute Band)	0.500	0.258	0.255	0.125	0.023	0.014	0.014
	NA	(D)	(D)	(D)	(D)	(C)	(C)

5.3.2.2 95th percentile data

We have not assessed the 95th percentiles and changes downstream as a result of improved levels in the proposed discharge as there will be considerable mixing of water and the peaks will be attenuated and unlikely to be manifest below the pond. As for the median assessment above attenuation of ammoniacal-N is not included as any peaks will also be attenuated in the pond and downstream and levels are very low in the discharge and changes downstream are due to pond processes.

5.3.2.3 DIN

As stated earlier, DIN is calculated from the sum of ammoniacal-N, nitrate-N, and nitrite-N, with generally >90% of DIN in the discharge and receiving environment consisting of nitrate-N.

Conversely, nitrite-N is negligible and around 0.1% of DIN for most receiving environment sites and as stated earlier ammoniacal-N in the discharge has little effect on the downstream concentrations.

Therefore, assuming the same attenuation for DIN as for nitrate-N, potential water quality concentrations of DIN were calculated at receiving environment sites (**Table 17**). The currently measured median DIN concentration in the WWTP discharge and the Bridge Site is 5.5 mg/L and 1.7 mg/L, respectively. The Bridge Site concentration is well above the accepted threshold for a degraded water body and eutrophication (1 mg/L). The proposed operational maximum DIN in the WWTP discharge during all stages of the upgrade: 4.1 mg/L for the Existing and Short-Term Stages and 2.5 mg/L for the new MBR Long-Term Stage 1 and 2 Stages, will be a reduction on what is presently in the WWTP discharge (5.5 mg/L). This will result in a mean DIN concentration at the Bridge site from the proposed discharge of 1.3 mg/L for the Current and Short-Term Stages and 0.8 mg/L for the new MBR WWTP (Long-Term Stages 1 and 2), respectively (**Table 17**). We note that these proposed operational medians will require an improvement on the present DIN WWTP concentration of 5.5 mg/L. DIN would still be above the accepted threshold for a degraded water body and eutrophication for the Current and Short-Term Stages (but an improvement on current state) but below the same threshold for the new MBR WWTP (Long-Term Stages 1 and 2).

Table 17. Summary of potential water quality median concentrations for DIN at receiving environment sites with median WWTP outlet concentrations for existing (Current and Short-term) and new (Long-term Stage 1 and Stage 2) WWTP stages (see Table 6). The Bridge site (potential mixing zone) is highlighted grey.

Parameter/Stage	WWTP Outlet	Farm Pond (B)	Farm Pond downstream (F)	Bridge (15)	Quarry	Upstream Farm Pond (A)	Tributary upstream (E)
DIN Existing Current	4.1	2.3	2.6	1.3	0.5	0.1	0.1
DIN Existing Short-Term	4.1	2.3	2.6	1.3	0.5	0.1	0.1
DIN New (MBR) Long-Term Stage 1	2.5	1.4	1.6	0.8	0.3	0.1	0.1
DIN New (MBR) Long-Term Stage 2	2.5	1.4	1.6	0.8	0.3	0.1	0.1

5.3.2.4 Discussion

Nitrogen (predominantly nitrate-N and ammoniacal-N) in Beachlands WWTP discharge is having a clear impact on downstream sites, with catchment influence low, as evidenced by low nitrate-N in upstream sites.

For the existing WWTP (Current and Short-Term) predictions are that the operational limits will result in the following:

- Median nitrate-N concentrations (3.5 mg/L) will likely result in an NPS-FM attribute band B for toxicity at the Bridge site (1.1 mg/L). This is the same attribute band as the current WWTP.

- For DIN – and assuming the same attenuation as for nitrate-N – a median concentration of 4.1 mg/L would mean a DIN concentration at the Bridge site of 1.3 mg/L, above the accepted threshold for eutrophication but an improvement on DIN concentration from the current WWTP (1.7 mg/L). This will require an improvement on the present DIN WWTP concentration of 5.5 mg/L.
- For DRP, the median concentration of 1.0 mg/L would mean a DRP concentration at the Bridge site of 0.25 mg/L, resulting in an NPS-FM attribute band D and potentially an increase of DRP concentration at this site compared to the current WWTP (0.18 mg/L: also NPS-FM attribute band D).

For the New MBR WWTP (Long-Term Stages 1 and 2) significant reduction in future proposed median nitrate-N concentrations (2.0 mg/L) in the discharge from current (5.1 mg/L), and assuming the expanded overland flow system will attenuate nitrate-N to the same level as current, will likely result in nitrate-N concentrations at the potential mixing zone (the Bridge site) of around 0.6 mg/L, leading to a change in the NPS-FM attribute band for toxicity from B (current) to A (future). This would satisfy the requirement for an improvement under the NPS-FM.

Between 2018 and 2023 ammoniacal-N has been consistently around 0.40 mg/L in Beachlands WWTP, reflected by equal median and 95th percentile concentrations of 0.40 mg/L. However, recent measurements with a more sensitive detection limit show that the median is more like 0.04 mg/L in the existing discharge.

The NPS-FM attribute states for ammoniacal-N are based on pH 8 and a temperature of 20°C, with the NBL of 0.40 mg/L (as a 95th percentile). Hickey (2002, 2001) derived site specific ammoniacal-N guidelines for Te Puru Stream of 4.12 mg/L (based on pH 7.5 and 80% species protection) and the farm pond of <0.6 mg/L (based on pH >9.0 and acute protection of species).

High pH (maximum pH 9.26 and average pH 8.12) was noted in the farm pond during diurnal monitoring over 4 days in late February 2002 (Nagels and Maunder, 2002) with maximum and average values at a site (named site S2, just downstream of the Bridge site) of pH 7.46, and 7.38, respectively. Current monitoring has not captured the high pH in the farm pond with 80th percentile and maximum pH of 7.5 and 7.9, respectively. Current pH at the Bridge site is similar to Nagels and Maunder (2002) and the farm pond with maximum and average pH of 7.7 and 7.3, respectively.

The potential mixing zone (the Bridge site) pH values are well below pH 8, and adjustments for pH (as required under the NPS-FM) provides more conservatism to the results.

For ammoniacal-N higher concentrations are proposed as operational limits for the existing and new WWTP upgrades than the WWTP is currently discharging. However, as stated above, processes in the farm pond are primarily determining ammoniacal-N concentrations downstream.

For DIN, there will be a significant reduction in median DIN in the WWTP discharge from 5.5 mg/L (currently measured) to 4.1 mg/L and 2.5 mg/L for the Current and Short-Term stages, and new MBR WWTP (Long-Term Stage 1 and 2), respectively stage. This would translate to a concentration of around 1.3 mg/L and 0.8 mg/L at the potential mixing zone (the Bridge site), for the Current and Short-Term, and Long-term Stage 1 and 2 and even lower concentrations further downstream. With the Current and Short-Term Stages, the DIN concentrations in the discharge would still result in levels generally considered degraded but will be an improvement on current state. With the new MBR WWTP (Long-term Stage 1 and 2) Stages the DIN concentrations in the discharge would be unlikely to result in levels generally considered degraded. In summary, all four stages of the WWTP upgrade will lead to a reduction in DIN (and hence an improvement) from that currently measured.

Phosphorus (both total and dissolved) in Beachlands WWTP is having a clear impact on downstream sites, with catchment influence low, as evidenced by lower TP and DRP concentrations in upstream sites compared with downstream sites. The downstream ecological communities are currently potentially impacted by elevated phosphorus concentrations, however this is only one component among other drivers contributing to ecological stress such as shade (or lack of), the width of stream, and the stream substrate. The potential mixing zone (the Bridge site) has 80th percentile TP concentrations 12-fold higher than the ANZG DGV, while DRP is in the NPS-FM attribute band D, below the NBL, for the median concentrations.

Between 2018 and 2023 DRP has been increasing in the existing Beachlands WWTP discharge by 24% per annum. TP measurement in the WWTP is not required under existing consent conditions. Median concentrations from the 2023/24 extensive monitoring are 0.7 mg/L. The proposed median DRP operational limit concentration is 1.0 mg/L for the Current and Short-Term stages of the WWTP upgrade, and 0.5 mg/L for the new MBR WWTP (Long-Term Stages 1 and 2) (TP has the same limits). This would lead to an approximate 1.4-fold increase in DRP for the Current and Short-Term Stages and an approximate 1.5-fold decrease in DRP for the new WWTP (Long-Term Stages 1 and 2) from currently measured DRP at the potential mixing zone (the Bridge site). Notwithstanding other contributors to ecological stress, it is expected that elevated phosphorus concentrations would be expected to potentially continue to contribute to a high level of effect on the environment compared with upstream. As stated above, the NPS-FM attribute band will not change as a result of the proposed discharge as D is the lowest band and upstream sites have DRP concentration near this threshold.

The requirement to improve water quality where it is contributing to degradation would be satisfied by decreases in the proposed DRP concentrations from the MBR WWTP (Long-Term Stages 1 and 2) Stage of the upgrade.

5.3.3 Bacteria

E. coli, FC, and enterococci are at extremely low concentrations (median 2 cfu/100 mL for all three) in the existing Beachlands WWTP discharge. For the receiving environment sites, bacteria concentrations are highly variable and higher upstream of the WWTP, suggesting catchment sources dominate. Based on median and 95th percentile concentrations, *E. coli* is in NPS-FM attribute band E (Red) for all sites, which corresponds to an average infection risk (from Campylobacter) of >7%.

With respect to the effects of the proposed discharge, FC and *E. coli* concentrations will also remain unchanged throughout all four stages of the WWTP upgrade. Therefore, risks from bacteria are negligible compared to catchment sources now and with all four stages of the future upgrades.

5.3.4 Metals

Total and dissolved metal concentrations were measured in the existing WWTP discharge and at the upstream farm pond (site A), farm pond (site B), and Bridge (site 15) on 10th and 11th December 2023. For the WWTP outlet, exceedance of the ANZG 95% DGV was only observed for total copper (1.4-fold), and total zinc (3.5-fold) and dissolved zinc (2-fold). Of note, chromium (total only), copper (total and dissolved) and zinc (total and dissolved) concentrations at the farm pond (B) site were more than 50% of the ANZG 95% DGV, but all had reduced to 50% or below by the Bridge (15) site.

Surficial sediments were measured for metals at the upstream farm pond (A), farm pond (B), and Bridge (15) sites on 10th November 2023. All sediment metal concentrations were below the ANZG DGV, with only zinc reported at concentrations that were increased downstream of the influence of Beachlands WWTP relative to upstream.

There are no discharge concentrations for metals currently proposed as part of the proposed discharge consent for the upgraded Beachlands WWTP. Concentrations of metals in the discharge at all future stages of the WWTP upgrade are not expected to increase, however with the proposed increase in discharge volume proposed, then assuming concentrations are static, loads will increase proportionally.

Although based on only two monitoring events, zinc, copper, and chromium appear to be increasing at the farm pond site (and to a lesser extent at the Bridge site) to near ecological guideline values as a result of the influence of Beachlands WWTP discharge. Further monitoring, through consent conditions is considered warranted to ensure metals are not increasing to above DGVs downstream as a result of the WWTP.

5.3.5 EOCs

To estimate the ecological risk of EOCs in the proposed Beachlands WWTP discharge to the receiving environment, hazard risk quotients (RQs) were calculated. The RQ was calculated as EOC concentration/ predicted no-effect concentration (PNEC), with a value >1 indicating a potential ecological effect.

Generally, for many EOCs, a PNEC – or no observed effect concentration (NOEC) – is extracted from literature reports. To our knowledge, the most complete database for ecotoxicity of EOCs is the NORMAN[20] Ecotoxicology Database, where lowest freshwater and marine PNECs for many EOCs are provided. PNECs are updated periodically, so most recent PNECs were used for this assessment.[21]

Freshwater RQs for PPCPs measured by Watercare at Beachlands WWTP outlet and receiving environment sites are summarised in **Table 18**. RQs were only summarised for PPCPs reported above detection limit from at least one site. As shown in **Table 18**, the only RQ >1 in the outlet is venlafaxine with an RQ of 1.7. Interestingly the RQ for venlafaxine in the farm pond is 23.1, but at

[20] NORMAN is a network of reference laboratories, research centres and related organisations for monitoring of emerging environmental substances. NORMAN has a membership of more than 70 leading laboratories and authorities across Europe and North America.

[21] https://www.norman-network.com/nds/ecotox/lowestPnecsIndex.php accessed 22-02-24.

the Bridge site it is 0.34 (**Table 18**). There is large variation in the two venlafaxine measurements (600 ng/L on 10th November and 40,000 ng/L on 11th November), with the latter value driving the high RQ at this site. This is likely an anomaly as there is a general significant attenuation between the farm pond discharge point and the Bridge site for PPCPs with an average of 2.9-fold reduction (see Section 4.4.1.5).

Table 18. Risk quotients for PPCPs measured by Watercare at Beachlands WWTP outlet and receiving environment sites based on freshwater PNEC. Blanks denote PPCP was below detection limit. RQ>1 are bolded red.

Analyte	FW PNEC (ng/)	RQ Outlet	RQ Upstream Farm Pond (A)	RQ Farm Pond (B)	RQ Bridge (15)
Bupropion	1110	0.04		0.03	0.01
Caffeine	1200	0.03	0.04	0.06	0.03
Carbamazepine	2000	0.10		0.08	0.04
Cotinine	10000	0.00			
Diclofenac	50	1.00			
Diltiazem	230	0.13		0.09	
Fluoxetine	100	0.10			
Gabapentin	1000000	<0.001		<0.001	<0.001
Lamotrigine	8000	0.25	0.001	0.19	0.09
Metoprolol	8600	0.06		0.03	0.01
Paracetamol	46000			0.002	
Sucralose	29700	0.34	0.003	0.84	0.25
Sulfamethoxazole	600	0.25		0.25	0.09
Triclosan	110	0.09	0.09	0.59	
Trimethoprim	120000	<0.001		<0.001	
Venlafaxine	880	**1.70**		**23.1**	0.34

As stated above the RQ in **Table 18** were calculated using PNECs derived for freshwater species. RQ calculated using PNECs derived for marine species are also necessary as the ultimate receiving environment is the coastal marine environment. Marine RQ calculated from Beachlands WWTP outlet and receiving environment sites are summarised in (**Table 19**). At the Bridge site, only sucralose (RQ 2.5) and venlafaxine (RQ 3.4) present with minor potential for ecological risk. However, as noted above, attenuation from the farm pond to the Bridge site (approximately 350m) is 2.9-fold, so significantly higher attenuation is expected between the Bridge site and Quarry site (a distance of around 2.5km), likely reducing the RQ to well below 1 at the Quarry site, and not requiring further dilution to reduce the ecological risk to marine species.

For EOC WWTP data supplemented from literature (see Section 3.1.7.2), freshwater and marine RQs were calculated based on literature wastewater discharge concentrations and freshwater and marine PNEC, respectively. Results (**Table 20**) suggest that most EOCs are present in treated wastewater at concentrations below effects concentrations for freshwater and marine species. RQ>1 were noted for diclofenac (RQ=1.19 for freshwater and RQ=12.0 for marine), ibuprofen (RQ=10.0 for marine), MEHP (RQ=1.7 for marine), and PFOS (RQ=12 for freshwater and RQ=61 for marine) (**Table 20**).

Table 19. Risk quotients for PPCPs measured by Watercare at Beachlands WWTP outlet and receiving environment sites based on marine PNEC. Blanks denote PPCP was below detection limit. RQ>1 are bolded red.

Analyte	Marine PNEC (ng/L)	RQ Outlet	RQ Upstream Farm Pond (A)	RQ Farm Pond (B)	RQ Bridge (15)
Bupropion	110	0.4		0.3	0.14
Caffeine	8700	<0.001	0.01	0.01	0.005
Carbamazepine	200	1.0		0.8	0.35
Cotinine	1000	0.01			
Diclofenac	5	**10.0**			
Diltiazem	23	**1.3**		0.9	
Fluoxetine	10	1.0			
Gabapentin	100000	<0.001		0.001	0.001
Lamotrigine	800	**2.5**	0.01	**1.9**	0.9
Metoprolol	860	0.6		0.3	0.11
Sucralose	2970	**3.4**	0.03	**8.4**	**2.5**
Sulfamethoxazole	60	**2.5**		**2.5**	0.9
Triclosan	6.9	**1.4**	**1.5**	**9.4**	
Trimethoprim	12000	<0.001			
Venlafaxine	88	**17.0**		**231**	**3.4**

We reiterate that these RQ are based on discharge concentrations from literature for WWTPs. For the PPCPs measured, significant attenuation (2.9-fold) is observed in the freshwater environment from the Farm Pond site to the Bridge site, and likely much higher attenuation to the Quarry site. It is likely that the same degradation/immobilisation processes contributing to the observed attenuation of PPCPs is occurring for most of the literature EOCs, with the notable exception of PFOS, which is highly resistant to degradation. We recommended that a monitoring programme for EOCs is included as a consent condition to better understand the risks of EOCs.

In summary, the majority of EOCs will result in negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few that will be present in the proposed WWTP discharge at concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Accordingly, overall, the effects on the environment from EOCs present in the discharge at all future stages of the proposed WWTP upgrade are likely to be between negligible and low. However, we recommended that a monitoring programme for EOCs is included as a consent condition to better understand the risks of EOCs.

Table 20. Freshwater and marine risk quotients calculated for literature EOCs in treated wastewater (from Table 5). RQ>1 are bolded red.

Class	Analyte[1]	FW PNEC (ng/)	Marine PNEC (ng/L)	FW RQ	Marine RQ
Akylphosphate flame retardant	TBEP	24000	2400	0.003	0.033
	TBP	37000	35000	0.001	0.001
	TCEP	65000	6500	0.001	0.010
	TCPP	260000	64000	0.003	0.014
	TDCP	1100	1000	0.049	0.053
	TiBP	11000	1100	0.002	0.018
	TPP	170	370	0.014	0.006
Alkylphenol	Tech-NP-equivalents	300	300	0.360	0.360
Antimicrobial	Chlorophene	540	54	0.007	0.067
	Chloroxylenol	7050	700	0.001	0.010
Insecticide	DEET	88000	8800	0.001	0.006
Nitro and polycyclic musk fragrance	Cashmeran	850	400	0.016	0.034
	Galaxolide	7000	440	0.039	0.628
	Tonalide	23	220	0.634	0.066
Pharmaceutical	Acetaminophen	46000	13400	<0.001	0.001
	Carbamazepine	2000	200	0.081	0.813
	Diclofenac	50	5.0	**1.19**	**12**
	Ibuprofen	11	1.1	0.98	**10**
	Naproxen	1700	170	0.044	0.443
	Salicylic acid	18000	20000	0.002	0.002
Plasticiser	BBP	5200	750	0.001	0.005
	Bisphenol A	240	16000	0.067	0.001
	DBP	10000	1000	0.002	0.016
	DEHP	1300	1300	0.023	0.023
	DEP	73000	1200	<0.001	0.008
	DMP	192000	19200	<0.001	<0.001
Plasticiser metabolite	MBP	2310	230	0.006	0.062
	MEHP	190	19	0.170	**1.7**
	MMP	14700	1470	<0.001	0.003
PFAS	PFOS	0.65	0.13	**12**	**61**
	PFHxA	140000	14000	<0.001	0.001
	PFHpA	500	50	0.006	0.064
	PFOA	180	18	0.037	0.369
	PFNA	1000	100	0.002	0.019
	PFDA	170	17	0.009	0.094

[1] TBEP = Tris-(2-butoxyethyl) phosphate; TBP = Tributyl-phosphate; TCEP= Tris(2-chloroethyl) phosphate; TCPP = Tris (1-chloro-2-propyl) phosphate; TDCP = Tris[2-chloro-1-(chloromethyl)ethyl] phosphate; TiBP = Tri-isobutyl-phosphate; TPP = Triphenylphosphate; Tech-NP-equivalents = Technical nonylphenol equivalents; DEET = N, N-Diethyl-meta-toluamide; BBP = Butylbenzylphthalate; DBP = Di-n-butylphthalate; DEHP = Diethylphthalate; DEP = Diethylphthalate; DMP = Dimethylphthalate; MBP = Monobutyl-phthalate acid ester; MEHP = Monoethylhexyl phthalate acid ester; MMP = Monomethyl phthalate acid ester; PFOS = Perfluorooctanesulfonic acid; PFHxA = Perfluorohexanoic acid; PFHpA = Perfluoroheptanoic acid; PFOA = perfluorooctanoic acid; PFNA = Perfluorononanoic acid; PFDA = Perfluorodecananoic acid.

5.3.6 Viruses (QMRA)

5.3.6.1 Methodology

The QMRA used norovirus as a reference pathogen for human health risks from human sources (i.e. wastewater) citing previous epidemiological evidence (Landrigan et al., 2020; Sinclair et al., 2009) and evidence from previous QMRAs (Soller et al., 2010; Stott and Wood, 2022). Importantly, norovirus was not considered in the 2004 QMRA for Beachlands (Stott and McBride, 2004) due to no published dose-response model at that time. Therefore, the current QMRA provides a more robust assessment of human health risks than in 2004.

As stated in Section 3.1.8, viruses have not been measured in Beachlands WWTP. Therefore, and consistent with many of the more recent New Zealand QMRAs (Cressy, 2021; Dada, 2021; Stott et al., 2023; Wood and Hudson, 2023), a distribution of standard factors of norovirus influent concentrations of minimum, median, and maximum values of $1x10^3$, $1x10^5$, and $1x10^7$ genome copies/L, respectively were used.

Simulations of 10-fold, 100-fold, 1,000-fold and 10,000-fold, 100,000-fold, 1,000,000-fold and 10,000,000-fold reductions (or 1, 2, 3, 4, 5, 6, and 7 log reduction value: LRV) of norovirus by Beachlands WWTP were used. It was noted that in 2004, log reductions for Beachlands WWTP ranged from 4.3-6.0 for adenovirus and rotavirus.

Exposure sites for the QMRA are shown in **Figure 46** and **Figure 47**. Marine exposure sites (for primary contact recreation, or swimming) were Magazine Bay, Shelly Bay, Pohutukawa Bay, Omana, Umupuia (Inner), Sunkist Bay, Te Puru stream mouth (**Figure 46**) and Kelly's Beach mid beach. It was noted that Kelly's mid beach is covered by part of the day so transects were chosen along the water edge (**Figure 47**).

Freshwater sites – Bridge, C and Quarry sites – were consistent with water quality monitoring sites (**Figure 46**) and included contact recreation and watercress consumption exposure risks. It was noted that it is unlikely that the Te Puru stream will be used for recreational activities but that watercress was noted at several sites along the stream including site F (upstream of bridge site), site C and sites G and C (Bioresearches, 2024a). Watercress consumption risks were based on raw harvested watercress with large (250g) and small (40g) meal sizes approximated. It was noted that due to uncertainties with norovirus internalisation on watercress the health risks are precautionary.

Shellfish exposure was assessed at three sites, Wairoa West Bay, Clevedon, and Umupuia (Outer) (**Figure 46**) Shellfish risks were not assessed for Kelly's Beach as they are likely too small to harvest (see Section 4.7.1.1).

Figure 46. Location of QMRA assessment sites. Red = River sites, Blue = Marine (swim), Black = Marine (shellfish) (Wood and Stott, 2024).

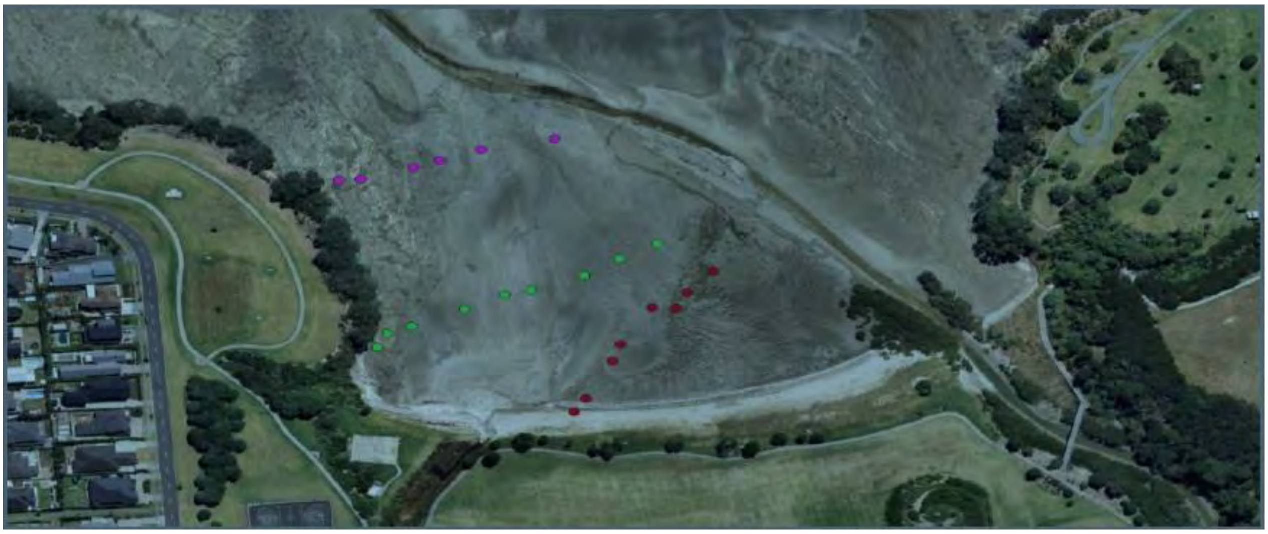

Figure 47. Location of QMRA assessment sites on Kelly's Beach. Pink - Northern, green – Mid, dark red - Eastern transect (Wood and Stott, 2024).

Dilutions of treated wastewater were informed by estimated flows in Te Puru Stream (PDP, 2024b) and hydrodynamic modelling of the discharge in the wider marine environment (DHI, 2024). Current, interim, and Stage 2 discharge volumes (see **Table 6**, Section 3.2) were modelled.

Infection risks were calculated as individual infection risks (IInfR) for each exposure event: swimming or consumption of shellfish or watercress. The QMRA used Monte Carlo statistical modelling to allow for ranges of likely conditions including infrequent but highly influential elevated virus concentrations.

5.3.6.2 Health risks due to consumption of watercress

Health risks from consumption of raw (uncooked) watercress at the Bridge, C, and Quarry sites are summarised in **Figure 48**, considering the different discharge stages[22], the range of log reduction values (LRV) for norovirus, and the large meal size. There was little difference in risk between the current, interim/Short-Term, and Long-Term Stage 2 discharge stages (**Figure 48**). The Bridge site exhibited the highest risk, with an LRV of 5 required to reduce the risk of infection to <1%. The large meal size was considered appropriate for the assessment, and it was noted that reducing the meal size to 40g does not result in a linear reduction of risk.

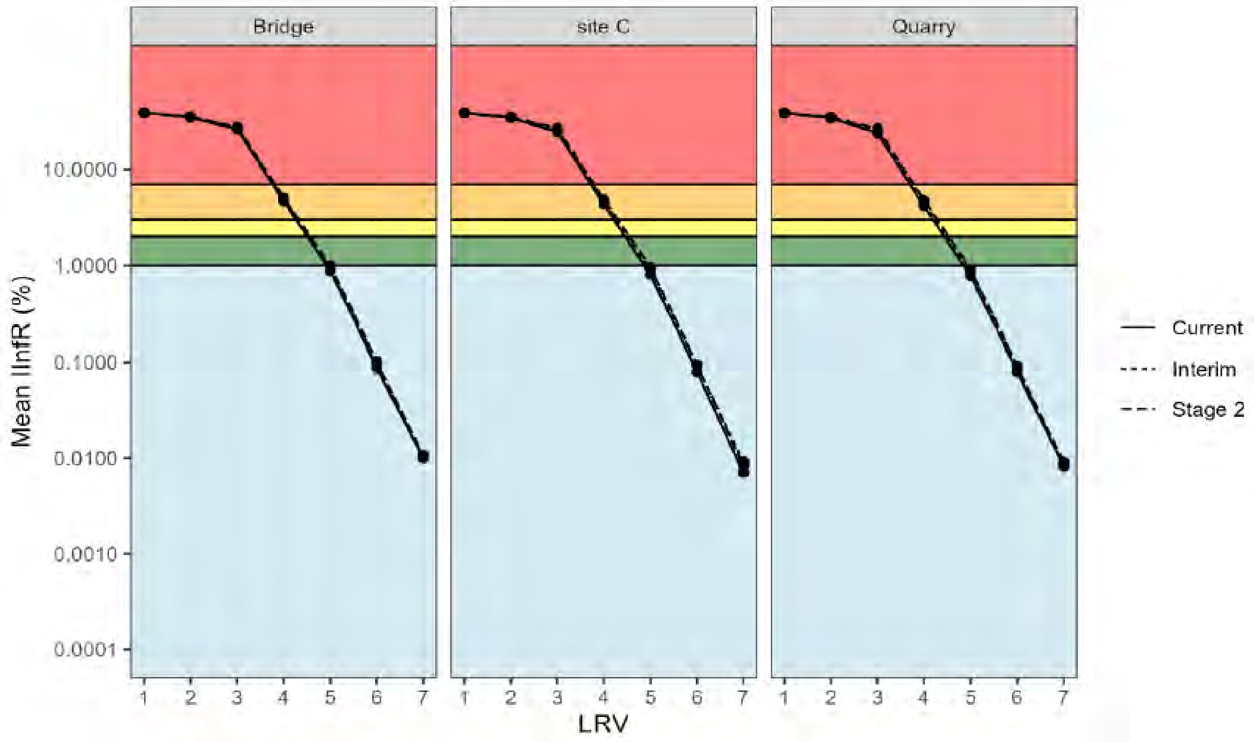

Figure 48. Mean infection risk (IInfR) from consumption of watercress harvested at three sites in the Te Puru stream assuming a meal size of 250 g. The colours relate to the NPS-FM categories: blue IInfR < 1% per event, green 1 -2%, yellow 2-3%, orange 3-7% and red >7% (Wood and Stott, 2024).

5.3.6.3 Health risks due to swimming

Health risks due to swimming were summarised for the three riverine sites (Bridge, Quarry and Te Puru stream mouth) and nine marine sites (**Figure 49**). Swimming risks were highest at the Bridge and Quarry sites with an LRV >4 required to reduce risks to below 1%. It was noted that the discharge stages had little effect on the Bridge and Quarry sites (nor site C, not shown in

[22] We note that at the time the QMRA was undertaken there were 3 discharge stages proposed for the WWTP upgrade. There was no Long-Term Stage 1 stage. Further, the interim stage was subsequently updated to Short-Term stage. No QMRA modelling has been undertaken for the Long-Term Stage 1 stage with risks, due to the installation of the MBR at Long-Term Stage 1, similar but lower than the Long-Term Stage 2 stage.

Figure 49), but did have an effect on the marine swimming sites (**Figure 49**). As noted earlier, swimming at the Bridge, Quarry and C sites is unlikely.

Swimming health risks at the marine sites were low, due to the high dilution, with an LRV of at 2-3 required for Te Puru Stream Kelly's Beach transect sites (depending on discharge stage), but less than 1 for those further out in the bay and for all discharge stages (**Figure 49**).

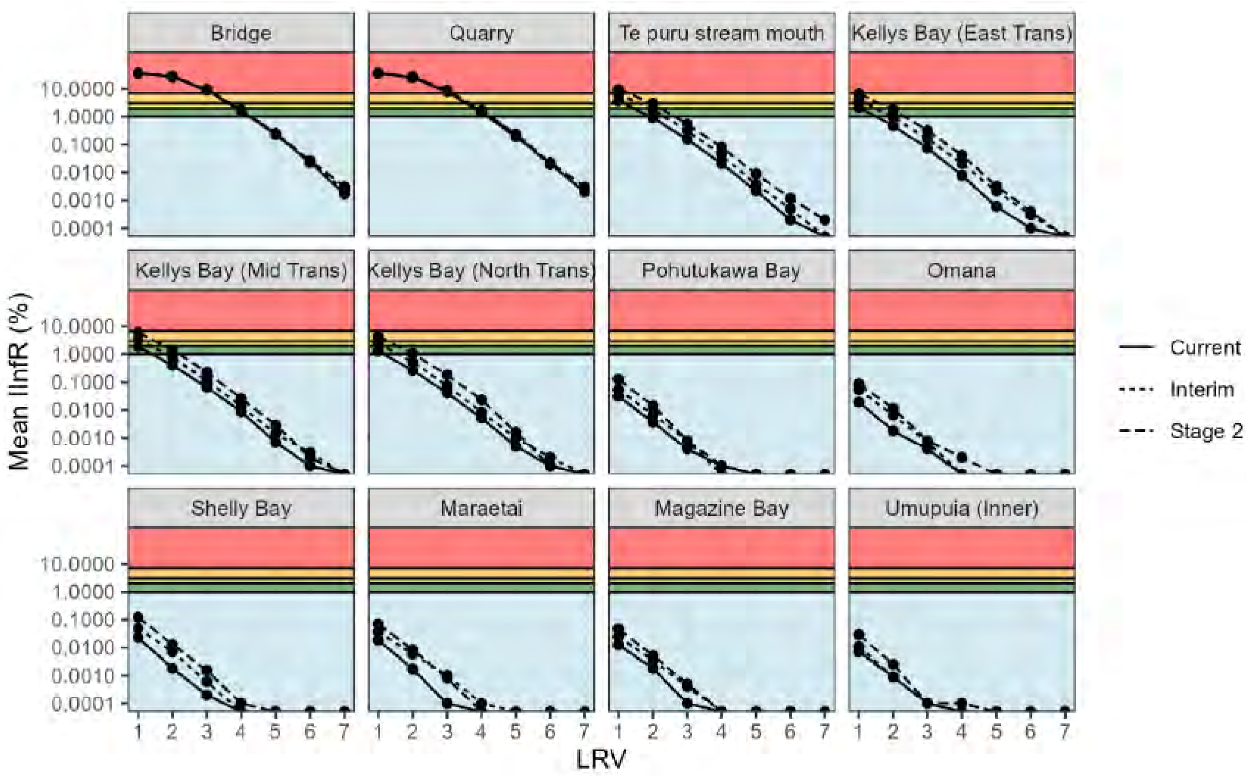

Figure 49. Mean infection risk (IInfR) from swimming at 12 sites (3 river and 9 marine). The colours relate to the NPS-FM categories: blue IInfR < 1% per event, green 1 -2%, yellow 2-3%, orange 3-7% and red >7% (Wood and Stott, 2024).

5.3.6.4 Health risks due to shellfish consumption

Shellfish consumption risks (mean IInfR) for shellfish harvested from Sunkist Bay, Umupuia (Outer) and Wairoa West Bay and for current, Short-Term, and Long-Term Stage 2 discharge stages are summarised in **Figure 50**. Under the current discharge stage, an LRV of 1 is sufficient to provide a risk of <1%, while this increases but is below 2 for Short-Term and Long-Term Stage 2 discharge stages.

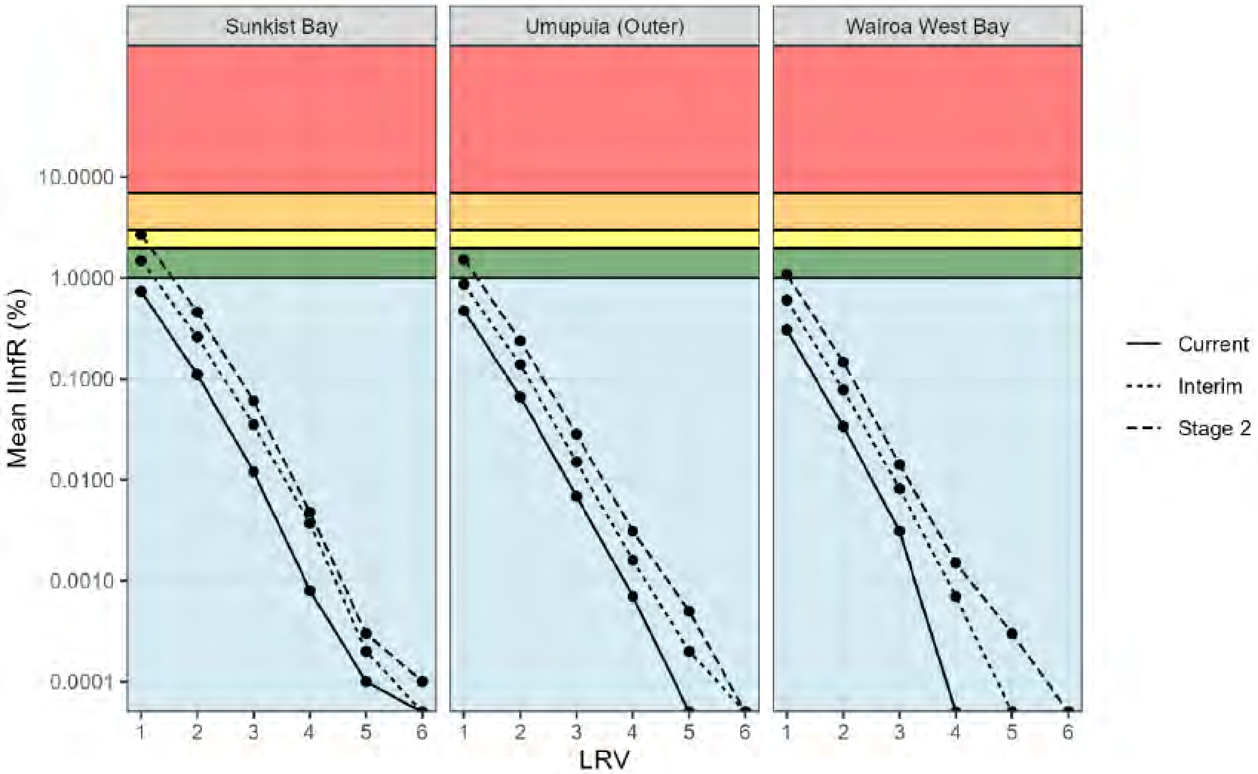

Figure 50. Mean infection risk (IInfR) from shellfish consumption from three sites. The colours relate to the NPS-FM categories: blue IInfR < 1% per event, green 1 -2%, yellow 2-3%, orange 3-7% and red >7% (Wood and Stott, 2024).

5.3.6.5 Summary of human health risks from viruses

The QMRA provided mean infection risks summarised as:

- For watercress consumption, a log reduction of 5 is required to reduce the risk of infection to <1% at the Te Puru stream sites.
- For swimming, a log reduction of >4 required to reduce risks to below 1% at Te Puru stream sites, while it was noted that swimming is unlikely at these sites. For marine sites log reductions ranged from 2-3 Kelly's Beach transect sites (depending on discharge stage), but less than 1 for those further out in the bay and for all discharge stages.
- For shellfish consumption, an LRV of 1 is sufficient to provide a risk of <1% for the current discharge stage at all marine sites, while this increases but is below 2 for interim and Stage 2 discharge stages.

We note that the QMRA looks at the added risk from the proposed discharge from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

5.4 Potential effects on aquatic ecology of Te Puru Stream and tributaries

Bioresearches summarised in their 2024 report (Bioresearches, 2024a) that the effects of the discharge from Beachlands WWTP in the upper Te Puru Tributary were varied, however predominantly limited to a short length of stream of at least 200m downstream of the discharge pond (Site F), with conductivity and nutrients affected for a greater distance.

Water quality parameters, such as temperature, conductivity, and nutrients (nitrogen and phosphorus), that increased immediately downstream of the discharge pond, appeared to correspond with a localised decrease in the presence of native fish and pollutant sensitive macroinvertebrates. This has been an ongoing trend since 2002.

Nuisance aquatic plant growth coincided with increased conductivity and bioavailable nutrient concentrations (DIN and DRP) below the farm pond. It was noted that this could also be attributed in part to the lack of shading at downstream sites, substrate, and the ongoing observed level of stock access to streams.

Macroinvertebrate and native fish communities did not appear to fully recover at the most downstream sites and lacked more sensitive taxa. The proposed MBR WWTP will result in an improvement in water quality compared to the current water quality results and is highly likely to result in an improvement in the overall macroinvertebrate and fish community downstream compared to the most recent survey results. The overall magnitude of this effect will likely continue to be moderate but the effect from the WWTP cannot be easily separated from other variables (i.e. higher quality riparian vegetation and shading upstream) and stressors (sedimentation and nutrient input from adjacent farmland and side tributaries). Riparian planting would also help improve the tributary and stream habitat.

5.5 Potential effects on coastal water quality

5.5.1 Water quality

Nitrogen, and to a lesser extent, phosphorus, are the two primary limiting nutrients of concern in coastal waters. Small increases in these nutrients can lead to increased productivity, but excessive concentrations can result in nuisance phytoplankton and macroalgal booms, increased turbidity, and reduced dissolved oxygen near the seabed.

Median concentrations proposed in treated wastewater discharge following the MBR upgrade are 5 mg/L TN, 0.5 mg/L for TP/DRP (**Table 6**). Concentrations of nitrogen (TN and nitrate-N) and phosphorus (TP and DRP) show a clear decrease in concentration down Te Puru stream with increasing distance from the WWTP due to dilution (See Section 4.4.1.2). Concentrations will be further decreased by rapid mixing with coastal waters. The levels of dilution in coastal surface waters predicted by DHI for the current WWTP discharge and proposed for the upgraded Short-Term, Long-Term Stage 1 and Long-Term Stage 2 are shown in **Table 21.**

At the existing Short-Term Stage, the 50^{th} percentile dilution factor at Te Puru stream mouth is 1,352×, which increases to 13,302× midway down Te Maraetai/Kellys Beach (northern transect), and to over 675,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach).

Given a median discharge concentration of 7 mg/L for TN in the treated wastewater, concentrations due to the WWTP will be approximately 0.005 mg/L at Te Puru stream mouth, 0.0005 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.00001 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 1.0 mg/L in the treated discharge to approximately 0.0007 mg/L at the Te Puru stream mouth, 0.00008 mg/L at the northern transect on Te Maraetai/Kellys Beach, and <0.000001 mg/L in the neighbouring bays.

At Long-Term Stage 1, the 50th percentile dilution factor at Te Puru stream mouth is 831×, which increases to 7,928× midway down Te Maraetai/Kellys Beach (northern transect), and to over 427,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach). Given a median discharge concentration of 5 mg/L for TN in the MBR treated wastewater, concentrations will be approximately 0.006 mg/L at Te Puru stream mouth, 0.001 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.00001 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 0.5 mg/L in the treated discharge to approximately 0.0006 mg/L at the Te Puru stream mouth, 0.00006 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000001 mg/L in the neighbouring bays.

At Long-Term Stage 2, the 50th percentile dilution factor at Te Puru stream mouth is 309×, which increases to 2554× midway down Te Maraetai/Kellys Beach (northern transect), and to over 180,000× by the neighbouring bays (Shelly Bay, Pohutukawa Bay, and Omana Beach). Given a median discharge concentration of 5 mg/L for TN in the treated wastewater, concentrations will be approximately 0.016 mg/L at Te Puru stream mouth, 0.002 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000028 mg/L in the neighbouring bays. Similarly, the concentration of TP will be diluted from 0.5 mg/L in the treated discharge to approximately 0.0015 mg/L at the Te Puru stream mouth, 0.00019 mg/L at the northern transect on Te Maraetai/Kellys Beach, and 0.000003 mg/L in the neighbouring bays.

Background concentrations of TN and TP are not available for Te Maraetai/Kellys Beach, but long-term Auckland Council monitoring data are available for Wairoa Estuary, Clevedon, which has a ‘good’ water quality index rating. Five-year (2018–2022) median concentration of TN and TP are 0.179 mg/L and 0.024 mg/L, respectively (Kelly and Kamke, 2023). Thus, TN and TP concentrations in the proposed discharged for all stages assessed would be diluted to below background levels of coastal waters before it reaches the Te Puru stream mouth. Given the rapid dilution rate, and the reduction of TN concentration in the proposed discharge from the expanded and upgraded MBR WWTP, no increase in nutrient concentrations in coastal waters, or related adverse effects from increased nutrients, are likely to occur as a result of the proposed discharge. Other minor contaminants that are present in the treated wastewater at low concentrations will be diluted at a similar rate to TN and TP.

Table 21. Modelled percentile dilution estimates in surface waters at various coastal locations in the Current, Short-term, Long-Term Stage 1, and Long-Term Stage 2 stages.

	Percentiles	Wairoa West Bay, Clevedon	Umupuia	Maraetai	Magazine Bay	Shelly Bay	Pohutukawa Bay	Omana	Umupuia	Sunkist Bay	Northern Transect	Mid Transect	Eastern Transect	Te Puru stream mouth
Current	1	87,460	28,893	9,418	15,687	8,430	4,917	6,568	30,707	16,841	20	20	18	10
	2	102,886	40,684	13,051	20,692	14,796	8,858	11,539	43,850	22,124	51	37	26	12
	5	169,673	60,176	25,919	41,002	30,195	20,487	25,043	61,614	53,019	166	102	61	25
	10	404,592	126,271	92,283	101,842	67,523	73,432	77,840	121,590	90,970	471	284	231	75
	20	796,418	878,355	404,477	653,117	314,554	308,489	343,279	811,851	627,861	2,779	1,099	985	177
	30	1,529,184	1,414,678	894,811	1,068,633	745,212	874,640	822,967	1,406,233	1,349,843	9,755	3,090	2,729	483
	50	7,648,008	6,274,904	2,330,568	3,039,283	3,020,719	3,075,059	2,558,304	6,181,807	4,128,785	109,282	35,287	25,395	13,018
Short-Term	1	40,061	16,070	5,124	8,144	3,327	2,133	3,005	16,447	7,056	9	10	9	5
	2	47,019	19,505	6,256	10,497	5,278	3,414	5,470	18,748	9,395	22	16	12	6
	5	77,641	28,399	12,404	19,304	11,187	8,532	11,519	29,520	22,525	62	41	25	10
	10	182,109	57,839	38,287	45,850	23,501	26,320	33,232	55,930	38,069	141	92	73	28
	20	353,346	326,394	126,483	236,530	91,293	82,324	111,794	331,880	187,430	579	283	241	61
	30	619,869	537,466	340,083	390,367	228,630	224,694	309,756	528,949	365,840	1,878	600	532	123
	50	2,383,171	1,635,168	628,247	1,027,488	714,192	675,055	695,563	1,677,036	1,031,517	13,302	3,680	2,782	1,352
Long-Term Stage 1	1	29,673	12,238	4,084	6,355	2,426	1,596	2,396	12,315	5,363	7	8	7	4
	2	35,055	14,455	4,947	8,316	3,845	2,508	4,324	14,108	7,114	15	12	10	5
	5	58,087	21,827	9,720	14,862	8,226	6,213	8,876	22,794	16,546	46	30	19	7
	10	129,378	44,161	28,589	34,503	17,030	18,796	24,588	42,911	28,115	102	65	51	21
	20	261,576	240,155	88,229	161,604	60,625	54,660	78,947	244,033	130,672	376	192	161	46
	30	448,658	389,890	239,422	281,846	153,505	143,205	219,627	384,435	246,851	1,173	389	346	88
	50	1,650,209	1,149,961	451,795	702,428	463,334	427,695	479,722	1,164,964	665,243	7,928	2,163	1,657	831

	Percentiles	Wairoa West Bay, Clevedon	Umupuia	Maraetai	Magazine Bay	Shelly Bay	Pohutukawa Bay	Omana	Umupuia	Sunkist Bay	Northern Transect	Mid Transect	Eastern Transect	Te Puru stream mouth
Long-Term Stage 2	1	19,284	8,406	3,044	4,566	1,526	1,060	1,786	8,183	3,670	6	6	5	3
	2	23,092	9,405	3,638	6,136	2,413	1,601	3,178	9,467	4,833	9	8	7	4
	5	38,533	15,254	7,037	10,420	5,266	3,894	6,233	16,068	10,566	29	19	12	5
	10	76,648	30,483	18,891	23,155	10,560	11,273	15,944	29,893	18,160	62	38	28	14
	20	169,805	153,917	49,975	86,679	29,958	26,995	46,099	156,186	73,913	174	100	82	31
	30	277,446	242,315	138,760	173,324	78,380	61,716	129,498	239,920	127,862	468	179	159	53
	50	917,246	664,754	275,343	377,368	212,476	180,334	263,880	652,891	298,970	2,554	646	532	309

5.5.2 Nutrient loads

Mean annual attenuated TN and TP loads from the current WWTP are estimated to be 1,979 kg/year and 233 kg/year, respectively (DHI, 2024). With respect to the proposed discharge:

- By the Short-Term Stage, mean annual attenuated TN loads are estimated to increase 1.6-fold from current to 3,239 kg/year, and mean annual attenuated TP loads are estimated to increase 1.6-fold from current to 382 kg/year.
- By Long-Term Stage 1, mean annual attenuated TN loads are estimated to increase 1.6-fold from current to 3,085 kg/year, and mean annual attenuated TP loads are estimated to increase 1.1-fold from current to 255 kg/year.
- By Long-Term Stage 2, mean annual attenuated TN loads are estimated to increase 1.9-fold from current to 3,856 kg/year, and mean annual attenuated TP loads are estimated to increase 1.4-fold from current to 318 kg/year.

While these increases in loads represent a large percentage increase, the absolute values need to be considered in context with other nutrient inputs into the inner Hauraki Gulf and Firth of Thames. TN loads for the Tamaki River, Wairoa River, Piako River, and Waihou River are around 60,000, 160,000, 1,415,000 and 2,168,000 kg/year, respectively, while TP loads for the Piako River, and Waihou River are 74,000 and 121,000 kg/year, respectively (DHI, 2024; Vant, 2022).[23] Given that the estimated loads from the proposed discharge from the expanded and upgraded WWTP represent a very small percentage of the TN and TP loads entering the inner Hauraki Gulf and Firth of Thames, the effects of the increased loads from the proposed discharge for all stages assessed are expected to be less than minor.

5.6 Summary of the ecological effects of proposed discharge

5.6.1 Effects of Discharges during the Current Stage

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during the Current Stage can be summarised as follows:

- The proposed annual average discharge volume is 2,200 m^3/day at this stage, which is a slight increase, but comparable, to the existing annual median for 2022 (1,947 m^3/day) and 2023 (2,038 m^3/day). A discharge at this slightly increased flow is likely to result in a <u>low effect</u> on stream bank erosion, and <u>negligible</u> effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge does not appear to be impacting on receiving environment sites. A proposed maximum operational discharge limit of 7 mg/L is marginally higher than the WWTP discharge in 2023/24 (median 5.7 mg/L). A discharge with this potential increase in $cBOD_5$ (noting the operational limit is a maximum concentration) is not expected to impact significantly on $cBOD_5$ (or DO) in the pond or further downstream.

[23] Loads for the Piako and Waihou Rivers are an annual mean value for 2011–2020.

- The current Beachlands WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge is expected to result in <u>low</u> impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current Beachlands WWTP discharge appears to be having <u>negligible</u> impacts on pH at sites downstream and this is expected to remain the same for the proposed discharge during the Current stage.
- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. The NIWA Stream Health Monitoring and Assessment Kit (**SHMAK**) report suggests that direct effects from conductivity on stream life does not occur until conductivity reaches levels found in brackish water or seawater, well above conductivity at these sites. Further, elevated conductivity may lead to reduced DO, but there are no apparent effects on DO downstream attributable to the current WWTP discharge. As stated earlier there was evidence of minor salinity in the current WWTP discharge. There are no proposed new discharge standards for conductivity and salinity but concentrations of salts are not expected to increase as a result of the proposed discharge. Accordingly, it is expected that conductivity in the proposed discharge will contribute to <u>low/moderate</u> effects on stream ecology downstream compared with upstream. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should also reduce the effects of conductivity.
- The current Beachlands WWTP discharge has consistently low TSS (mean from 2018-2023 of 7.4 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The discharge concentration limits under the Current Stage (7 mg/L) should see a decrease in TSS of approximately 1.06-fold compared to the current discharge and contribute to <u>improved</u> water quality downstream of the discharge.
- Between 2018 and 2023 ammoniacal-N has been consistently around 0.40 mg/L in discharges from the Beachlands WWTP, reflected by equal median and 95th percentile concentrations of 0.40 mg/L. However, recent measurements with a more sensitive detection limit show that the median is more like 0.04 mg/L in the discharge.
    - Ammoniacal-N makes up around 0.5% of TN being discharged from the WWTP and is unlikely to be significantly contributing to ammoniacal-N concentrations downstream.
    - Processes in the pond will continue to increase ammoniacal-N levels downstream but would be expected to meet the NBL for ammoniacal-N toxicity and be unlikely to impact on species found downstream.
    - For these reasons we have not estimated ammoniacal-N concentrations downstream for any of the proposed discharge stages.
- A maximum operational median nitrate-N concentration (3.5 mg/L) will likely result in an NPS-FM attribute band B for toxicity at the Bridge site (1.1 mg/L). This is the same attribute band as the Bridge site currently.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median concentration of 4.1 mg/L would mean a DIN concentration at the Bridge site of 1.3 mg/L, above the accepted threshold for eutrophication.

- For DRP, a maximum operational median concentration of 1.000 mg/L would mean a DRP concentration at the Bridge site of 0.251 mg/L, resulting in an NPS-FM attribute band D and potentially an increase of DRP concentration at Bridge site currently (0.182 mg/L: also NPS-FM attribute band D). Note that 1.0 mg/L is an operational limit and we would not expect concentrations to get this high in the discharge and change from the existing levels.
- After attenuation through the overland and stream system, TN and TP loads will contribute 34% and 46% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same during the Current Stage. Zinc, copper and chromium appear to be increasing at the farm pond site (and to a lesser extent at the Bridge site) to near ecological guideline values as a result of the influence of Beachlands WWTP discharge.
- All sediment metal concentrations were below the ANZG DGV, with only zinc reported at concentrations that were increased downstream of the influence of Beachlands WWTP relative to upstream.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream.
- The majority of EOCs will present <u>negligible</u> ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase during the Current Stage. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA assessed mean infection risks, which are summarised as:
    - For watercress consumption, a log reduction of 5 (100,000-fold reduction) is required to reduce the current risk of infection to <1% at the Te Puru stream sites.
    - For swimming, a log reduction of >4 (<10,000-fold) is required to reduce risks to below 1% at Te Puru stream sites. It was noted that swimming is unlikely at these sites.
    - For marine sites, swimming health risks were currently low with a log reduction of <2 (<100-fold) required at Kelly's Beach transect sites, and <1 (<10-fold) for those further out in the bay.
    - For shellfish consumption, a log reduction of 1 (10-fold) is sufficient to provide a risk of <1% currently at all marine sites.
    - We note that the QMRA looks at the <u>added</u> risk from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

5.6.2 Effects of Discharges during the Short-Term Stage

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during the Short-Term Stage can be summarised as follows:

- The proposed annual average discharge volume is 3,600 m^3/day at this stage, compared to the existing annual median for 2023 of 2,038 m^3/day. A discharge at this increased annual average discharge volume is likely to result in a low effect on stream bank erosion, and negligible effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge does not appear to be impacting on receiving environment sites. A proposed maximum operational discharge limit of 7 mg/L during the Short-Term Stage is marginally higher than the WWTP discharge in 2023/24 (median 5.7 mg/L). A discharge with this potential increase in concentration (noting the operational limit is a maximum concentration) is not expected to impact significantly on $cBOD_5$ (or DO) in the pond or further downstream.
- The current Beachlands WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge during the Short-Term Stage is expected to continue to result in low impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current Beachlands WWTP discharge appears to be having negligible impacts on pH at sites downstream and this is expected to remain the same for the proposed discharge during the Short-Term Stage.
- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. Implications of increased conductivity are discussed in relation to the Current stage and not repeated here. It is expected that conductivity in the proposed discharge during the Short-Term Stage will contribute to low/moderate effects on stream ecology downstream compared with upstream. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should reduce the effects of conductivity.
- The current Beachlands WWTP discharge has consistently low TSS (mean from 2018-2023 of 7.4 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The maximum operational discharge concentrations under the Short-Term Stage (7 mg/L) should see a decrease in TSS of approximately1.06-fold compared to the current discharge and contribute to improved water quality downstream of the discharge.
- For ammoniacal-N – and the reasons discussed in relation to the Current stage – we have not estimated ammoniacal-N concentrations downstream
- A maximum operational median nitrate-N concentration (3.5 mg/L) for the Short-Term Stage will likely result in an NPS-FM attribute band B for toxicity at the Bridge site (1.1 mg/L). This is the same attribute band as the Bridge site currently.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median concentration of 4.1 mg/L for the Short-Term Stage would mean a DIN concentration at the Bridge site of 1.3 mg/L, above the accepted threshold for eutrophication.
- For DRP, a maximum operational median concentration of 1.000 mg/L for the Short-Term Stage would mean a DRP concentration at the Bridge site of 0.251 mg/L, resulting in an

NPS-FM attribute band D and potentially an increase of DRP concentration at Bridge site currently (0.182 mg/L: also NPS-FM attribute band D). Note that 1.0 mg/L is an operational limit and we would not expect concentrations to get this high in the discharge and change from the existing levels.

- After attenuation through the overland and stream system, TN and TP loads will contribute 46% and 59% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources now and with future upgrades.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same for the Short-Term Stage. Zinc, copper and chromium appear to be increasing at the farm pond site (and to a lesser extent at the Bridge site) to near ecological guideline values as a result of the influence of Beachlands WWTP discharge.
- All sediment metal concentrations were, and will continue to be for the Short-Term Stage, below the ANZG DGV, with only zinc reported at concentrations that were increased downstream of the influence of Beachlands WWTP relative to upstream.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream for each stage of the proposed future discharge.
- The majority of EOCs will present negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase for the Short-Term Stage. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA assessed mean infection risks, which are summarised as:
    - For watercress consumption, a log reduction of 5 (100,000-fold reduction) is required to reduce the risk of infection to <1% at the Te Puru stream sites. There was little difference in risk between the discharge stages.
    - For swimming, a log reduction of >4 (<10,000-fold) is required to reduce risks to below 1% at Te Puru stream sites. There was little difference in risk between the discharge stages and it was noted that swimming is unlikely at these sites. For marine sites, swimming health risks were low with a log reduction of <2 (<100-fold) required at Kelly's Beach transect sites, and <1 (<10-fold) for those further out in the bay.
    - For shellfish consumption, a log reduction of 1-2 (10-fold to 100-fold) is sufficient to provide a risk of <1% at all marine sites.
    - We note that the QMRA looks at the added risk from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

5.6.3 Effects of Discharges during Long-Term Stage 1

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during Long-Term Stage 1 Stage can be summarised as follows:

- The proposed annual average discharge volume limit is 4,800 m^3/day at this stage, compared to the existing annual median for 2023 of 2,038 m^3/day. With this increase in annual average discharge volume the discharge is still likely to result in a low effect on stream bank erosion, and negligible effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge does not appear to be impacting on receiving environment sites. A maximum proposed operational discharge limit of 5 mg/L for Long-Term Stage 1 is marginally lower than the WWTP discharge in 2023/24 (median 5.7 mg/L). This potential decrease (noting the operational limit is a maximum concentration) is not expected to change the impact significantly on $cBOD_5$ (or DO) in the pond or further downstream.
- The current WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge during Long-Term Stage 1 is expected to continue to result in low impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current WWTP discharge appears to be having negligible impacts on pH at sites downstream and this is expected to remain the same for the proposed discharge during Long-Term Stage 1.
- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. Implications of increased conductivity are discussed in for the Current stage and not repeated here. It is expected that conductivity in the proposed discharge will have to low/moderate effects on stream ecology downstream compared with upstream during Long-Term Stage 1. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should reduce the effects of conductivity.
- The current Beachlands WWTP discharge has consistently low TSS (median 7.8 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The discharge concentrations under Long-Term Stage 1 (5 mg/L) should see a decrease in TSS of approximate 1.6-fold compared to the existing discharge and contribute to improved water quality downstream of the discharge.
- For ammoniacal-N – and the reasons discussed in relation to the Current stage – we have not estimated ammoniacal-N concentrations downstream under any stage of the proposed WWTP upgrade.
- A maximum operational median limit of nitrate-N concentrations (2.0 mg/L) for Long-Term Stage 1 will likely result in an NPS-FM attribute band A for toxicity at the Bridge site. This is an improvement on the attribute band (B) for the Bridge site currently and would satisfy the requirement for an improvement under the NPS-FM.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median of 2.5 mg/L for Long-Term Stage 1 would mean a DIN concentration at the Bridge site from the proposed discharge of around 0.8 mg/L, below the accepted threshold for eutrophication and a major improvement on DIN for the Bridge site currently (1.7 mg/L).

- For DRP, a maximum operational median concentration of 0.500 mg/L for Long-Term Stage 1 would mean a DRP concentration at the Bridge site of 0.125 mg/L, resulting in an NPS-FM attribute band D but a decrease of DRP concentration at this site compared to the Bridge site currently (0.182 mg/L (also NPS-FM attribute band D). The proposed median DRP concentrations during Long-Term Stage 1 will contribute to improved water quality downstream compared with the current WWTP discharge, satisfying the intent of the NPS-FM.
- After attenuation through the proposed expanded overland and stream system, TN and TP loads will contribute 45% and 49% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources currently and with the future upgrades.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same, or reduced, during Long-Term Stage 1, with the MBR upgrade.
- All sediment metal concentrations are currently and will be expected to be for Long-Term Stage 1, below the ANZG DGV.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream as a result of the proposed discharge.
- The majority of EOCs will present <u>negligible</u> ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase for Long-Term Stage 1, and with the MBR upgrade there may be a reduction in concentrations. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA for Long-Term Stage 1 upgrade was not undertaken. At the time the QMRA was undertaken there were 3 discharge stages proposed for the WWTP upgrade, with no Long-Term Stage 1 stage. Further, the interim stage (in the QMRA report) terminology was subsequently updated to Short-Term stage. No QMRA modelling has been undertaken for the Long-Term Stage 1 stage with risks, due to the installation of the MBR at Long-Term Stage 1, similar but lower than the Long-Term Stage 2 stage.

5.6.4 Effects of discharges during Long-Term Stage 2

The actual and potential ecological effects of the proposed discharge on the freshwater and marine receiving environment during Long-Term Stage 2 can be summarised as follows:

- The proposed annual average discharge volume is 6,000 m^3/day at this stage, compared to the existing annual median for 2023 of 2,038 m^3/day. With this increase in annual average discharge volume the discharge is still likely to result in a <u>low effect</u> on stream bank erosion, and <u>negligible</u> effects on the coastal marine environment.
- Based on monitoring at receiving environment sites occasional low DO in the current discharge does not appear to be impacting on DO in the pond or further downstream. $cBOD_5$ in the current WWTP discharge also does not appear to be impacting on receiving environment sites. A proposed maximum operational discharge limit of 5 mg/L for Long-

Term Stage 2 is marginally lower than the WWTP discharge in 2023/24 (median 5.7 mg/L). This potential decrease (noting the operational limit is a maximum concentration) is not expected to change significantly on $cBOD_5$ (or DO) in the pond or further downstream.

- The current Beachlands WWTP discharge is showing minimal effects on water temperature in the farm pond. There are no water temperature standards proposed for the upgraded WWTP discharge, but the proposed discharge is expected to result in low impacts on temperature at downstream sites compared with upstream sites.
- Low pH appears to be more an issue than high pH in the receiving environment. The current Beachlands WWTP discharge appears to be having negligible impacts on pH at sites downstream and this is expected to remain the same for the proposed discharge during Long-Term Stage 2.
- There is a clear influence of the current Beachlands WWTP discharge on conductivity downstream, with all sites showing conductivity manyfold above the ANZG DGV, indicating a 'potential risk' of adverse effects. Implications of increased conductivity are discussed in relation to the Current stage and not repeated here. It is expected that conductivity in the proposed discharge will continue to contribute to low/moderate effects on stream ecology downstream compared with upstream during Long-Term Stage 2. Riparian planting and installation of new pipes for the network along with a trigger for further work on causes should also reduce the effects of conductivity.
- The current WWTP discharge has consistently low TSS (median 7.8 mg/L) and there appears to be little difference in TSS for the receiving environment sites upstream and downstream of the wastewater discharge. The discharge concentrations during Long-Term Stage 2 (5 mg/L) should see a decrease in TSS of approximate 1.6-fold compared to the existing discharge and contribute to improved water quality downstream of the discharge.
- For ammoniacal-N – and the reasons discussed in the Current stage – we have not estimated ammoniacal-N concentrations downstream under any stage of the proposed WWTP upgrade.
- A maximum operational median nitrate-N concentration (2.0 mg/L) during Long-Term Stage 2 will likely result in an NPS-FM attribute band A for toxicity at the Bridge site. This is an improvement on the attribute band (B) for the Bridge site currently and would satisfy the requirement for an improvement under the NPS-FM.
- For DIN – and assuming the same attenuation as for nitrate-N – a maximum operational median of 2.5 mg/L during Long-Term Stage 2 would mean a DIN concentration at the Bridge site from the proposed discharge of around 0.8 mg/L, below the accepted threshold for eutrophication and a major improvement on DIN for the Bridge site currently (1.7 mg/L).
- For DRP, a maximum operational median concentration of 0.500 mg/L during Long Term Stage 2 would mean a DRP concentration at the Bridge site of 0.125 mg/L, resulting in an NPS-FM attribute band D but a decrease of DRP concentration at this site compared to the Bridge site currently (0.182 mg/L: also NPS-FM attribute band D). The proposed median DRP concentrations under the Long-Term Stage 2 WWTP upgrade will contribute to improved water quality downstream compared with the current WWTP, satisfying the intent of the NPS-FM.

- After attenuation through the proposed expanded overland and stream system, TN and TP loads will contribute 50% and 54% of total load from the catchment to the marine coastal environment.
- Risks from bacteria are negligible compared to catchment sources currently and with the future upgrades.
- Although based on only two monitoring events water metal concentrations are currently at 50% or below the ANZG DGV at the Bridge site and would be expected to be the same, or reduced, for Long-Term Stage 2, with the MBR upgrade.
- All sediment metal concentrations are currently and will be expected to be for Long-Term Stage 2, below the ANZG DGV.
- Further monitoring, through consent conditions is warranted to ensure metals are not increasing to above DGVs downstream as a result of the proposed discharge.
- The majority of EOCs will present negligible ecological effects based on measured and literature treated WWTP discharge concentrations. Most of the few EOCs that are present in concentrations above ecological effects concentrations will likely be significantly attenuated and/or diluted in the freshwater and marine environments and present with low risk of adverse effects. Concentrations of EOCs, and hence risks, are not expected to increase for Long-Term Stage 2, and with the MBR upgrade there may be a reduction in concentrations. Further monitoring, through consent conditions is warranted to better understand the risks of EOCs.
- A QMRA assessed mean infection risks, which are summarised as:
    - For watercress consumption, a log reduction of 5 (100,000-fold reduction) is required to reduce the risk of infection to <1% at the Te Puru stream sites. There was little difference in risk between the discharge stages.
    - For swimming, a log reduction of >4 (<10,000-fold) is required to reduce risks to below 1% at Te Puru stream sites. There was little difference in risk between the discharge stages and it was noted that swimming is unlikely at these sites. For marine sites, swimming health risks were low with a log reduction of <3 (<1000-fold) required at Kelly's Beach transect sites, and <1 (<10-fold) for those further out in the bay.
    - For shellfish consumption, a log reduction of <2 (<10-fold) is sufficient to provide a risk of <1% at all marine sites.
    - We note that the QMRA looks at the added risk from the WWTP, there is still existing risks from other sources but these are not part of QMRA.

5.6.5 Overall summary and conclusions

- The reference sites upstream provide a basis for considering the existing environment without the input of the WWTP noting that there can be changes in habitat as one moves downstream. The reference sites would be currently classified as degraded based on microbial contaminants and DRP is close to band D. With the WWTP contaminants added downstream the stream would be considered to be degraded on the basis of microbial contaminants, TN, nitrate-N, DIN, DRP and macroinvertebrate indices.
- The intertidal marine community at Kelly's Beach is typical of sheltered beaches around the Auckland region. The only threatened marine species (excluding birds) observed during the survey was seagrass, which was present in three very small patches on the lower shore. The area of seagrass cover is too small to meet the criteria of biogenic habitat.

- Overall, the potential ecological effects of the discharge on the freshwater ecological communities under the four proposed stages can be summarised as follows:
  - The proposed discharge operational limits for the Current and Short-Term Stages will likely result in similar water quality compared to the current water quality results and is highly likely to result in no significant change in the overall macroinvertebrate and fish community downstream compared to the most recent survey results.
  - The proposed discharge operational limits for Long-Term Stages 1 and 2, following the MBR upgrade, will result in an improvement in water quality compared to the current water quality results and is highly likely to result in an improvement in the overall macroinvertebrate and fish community downstream compared to the most recent survey results although the improvements may not be measurable. The overall magnitude of this effect will likely continue to be moderate but the effect from the WWTP cannot be easily separated from other variables (i.e. higher quality riparian vegetation and shading upstream) and stressors (sedimentation and nutrient input from adjacent farmland and side tributaries).
- Overall, the potential ecological effects of the discharge on the coastal marine environment under the 4 Stages covered by the consent application can be summarised as follows:
  - The proposed discharge rates under all four stages will have negligible effects on the salinity and the marine communities of Te Maraetai/Kellys Beach due to the relatively low discharge rates compared to other nearby streams and rivers, the rapid dilution, and the tolerance of intertidal biota to low salinities. There will effectively be no change in salinity under any of the four stages from the existing WWTP.
  - Nitrogen, and to a lesser extent, phosphorus, are the two primary limiting nutrients of concern in coastal waters. Proposed median TN and TP discharge concentrations will be 7 mg/L and 1.0 mg/L for the Current and Short-Term Stages, and 5 mg/L and 0.5 mg/L for Long-Term Stages 1 and 2. The WWTP discharge flow will increase over the term of the consent, therefore concentrations of these nutrients will be diluted (50% percentile) by 13,018× (Current), 1,352× (Short-Term), 831× (Long-Term Stage 1), and 309× (Long-Term stage 2) by the time they reach the Te Puru Stream mouth. This will result in nutrient concentrations being well below background concentrations in coastal waters under all four stages. Given the rapid dilution rate under all four stages, no increase in nutrient concentrations in coastal waters, or related adverse effects from increased nutrients, are likely to occur. Other minor contaminants that are present in the treated wastewater at low concentrations will be diluted at a similar rate to TN and TP. There will effectively be no change from the current WWTP.
  - Potential effects on SEA-M1 site at Te Puru Stream estuary and SEA-M2 site at Te Maraetai/Kellys Beach are anticipated to be low given the level of influence the treated wastewater discharge under all four stages will have on nutrient concentrations and salinity in coastal waters. There will effectively be no change from the existing WWTP.
  - Mean annual attenuated TN and TP loads from the existing WWTP by the time they reach the mouth of the Te Puru Stream are currently 1,979 kg/year and 233 kg/year, respectively. With respect to the proposed discharge:

  - For the Short-Term Stage, mean annual attenuated TN loads are estimated to increase 1.6-fold from current to 3,239 kg/year, and mean annual attenuated TP loads are estimated to increase 1.6-fold from current to 382 kg/year.
  - For Long-Term Stage 1, mean annual attenuated TN loads are estimated to increase 1.6-fold from current to 3,085 kg/year, and mean annual attenuated TP loads are estimated to increase 1.1-fold from current to 255 kg/year.
  - For Long-Term Stage 2, mean annual attenuated TN loads are estimated to increase 1.9-fold from current to 3,856 kg/year, and mean annual attenuated TP loads are estimated to increase 1.4-fold from current to 318 kg/year.
- In comparison, TN loads for the Tamaki River, Wairoa River, Piako River, and Waihou River are around 60,000, 160,000, 1,415,000 and 2,168,000 kg/year, respectively, while TP loads for the Piako River, and Waihou River are 74,000 and 121,000 kg/year, respectively. Given that the estimated loads from the proposed discharge from the expanded and upgraded WWTP represent a very small percentage of the TN and TP loads entering the inner Hauraki Gulf and Firth of Thames, the effects of the increased loads from the proposed discharge for all stages assessed are expected to be less than minor.

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Appendix 1. Summary of analysis of trends between 2018 and 2023 for Beachlands WWTP discharge quality

Meaningful increasing trend = statistically significant AND >1% annual change

Meaningful decreasing trend = statistically significant AND >1% annual change

Parameter	Unit	Method	Seasonal variation	Mean	Max	Min	Median	Kendall statistic	P	Median annual slope	Percent annual change	Likelihood	Trend direction and confidence
Discharge	m^3/day	Seasonal Kendall	0.000	1854	3515	0	1843	-4	0.894	-3.50	-0.2	0.578	Trend unlikely
BOD	mg/L	Seasonal Kendall	0.000	1.6	5.9	0.5	1.3	-10	0.626	-0.02	-1.6	0.687	Decreasing trend about as likely as not
Conductivity	**µS/cm**	**Seasonal Kendall**	**0.000**	**359**	**941**	**64**	**320**	**-77**	**0.000**	**-52.58**	**-16.4**	**1.000**	**Decreasing trend virtually certain**
TSS	**mg/L**	**Mann-Kendall**	**0.254**	**7.5**	**17.0**	**2.5**	**6.9**	**-520**	**0.012**	**-0.51**	**-7.4**	**0.994**	**Decreasing trend very likely**
pH		Seasonal Kendall	0.000	7.0	7.3	6.7	7.0	-75	0.000	-0.03	-0.5	1.000	Decreasing trend virtually certain
DRP	**mg/L**	**Seasonal Kendall**	**0.000**	**0.35**	**0.97**	**0.03**	**0.28**	**84**	**0.000**	**0.07**	**23.5**	**1.000**	**Increasing trend virtually certain**
NO_3-N	**mg/L**	**Mann-Kendall**	**0.058**	**2.09**	**7.10**	**0.02**	**1.18**	**1101**	**0.000**	**0.91**	**77.4**	**1.000**	**Increasing trend virtually certain**
NO_2-N	mg/L	Mann-Kendall	0.089	0.09	1.70	0.02	0.02	188	0.199	0.00	0.0	0.900	Increasing trend possible
NNN	**mg/L**	**Mann-Kendall**	**0.054**	**2.19**	**7.20**	**0.02**	**1.19**	**1090**	**0.000**	**0.92**	**77.9**	**1.000**	**Increasing trend virtually certain**
NH_4-N	mg/L	Seasonal Kendall	0.004	0.54	2.60	0.04	0.40	-53	0.001	0.00	0.0	1.000	Decreasing trend virtually certain
Faecal Coliforms	cfu/100mL	Mann-Kendall	0.281	3	10	2	2	-370	0.025	0.00	0	0.988	Decreasing trend very likely
E. coli	cfu/100mL	Mann-Kendall	0.794	2	5	2	2	-81	0.503	0.00	0	0.754	Decreasing trend about as likely as not

Appendix 2. Summary of analysis of trends for selected parameters between 2020 and 2023 for upstream farm pond and farm pond sites

Site	Parameter	Unit	Method	Seasonal variation	Mean	Max	Min	Median	Kendall statistic	P	Median annual slope	Percent annual change	Likelihood	Trend direction and confidence
Upstream	Temperature	°C	Seasonal Kendall	0.000	17.3	22.7	12.9	16.9	0	1.000	0.033	0.2	0.500	No detectable trend
Upstream	NH_4-N	mg/L	Mann-Kendall	0.633	0.40	0.40	0.40	0.40	0	1.000	0.000	0.0	0.500	No detectable trend
Upstream	NO_3-N	mg/L	Seasonal Kendall	0.014	0.04	0.16	0.02	0.02	-1	1.000	0.000	0.0	0.876	Trend exceptionally unlikely
Upstream	TP	mg/L	Mann-Kendall	0.124	0.09	0.18	0.02	0.07	5	0.856	0.000	0.0	0.572	Trend unlikely
Upstream	DRP	mg/L	Mann-Kendall	0.075	0.025	0.050	0.010	0.023	-3	0.927	0.000	0.0	0.573	Trend extremely unlikely
Downstream	Temperature	°C	Seasonal Kendall	0.000	18.2	23.1	12.6	18.3	0	1.000	0.054	0.3	0.500	No detectable trend
Downstream	NH_4-N	mg/L	Seasonal Kendall	0.032	0.40	0.43	0.40	0.40	1	1.000	0.000	0.0	0.500	Trend exceptionally unlikely
Downstream	NO_3-N	mg/L	Mann-Kendall	0.918	1.57	3.12	0.02	1.68	70	0.002	0.716	42.7	0.999	Increasing trend virtually certain
Downstream	TP	mg/L	Seasonal Kendall	0.010	0.33	0.56	0.10	0.35	1	1.000	0.082	23.3	0.549	Trend exceptionally unlikely
Downstream	DRP	mg/L	Seasonal Kendall	0.006	0.201	0.330	0.030	0.228	3	0.371	0.049	21.6	0.831	Increasing trend about as likely as not

ATTACHMENT 18

SECTION 92 RESPONSE
OVERLAND FLOW SITE VEGETATION TYPE MAP
ATTACHMENT 2

pdp

FIGURE 1: BEACHLANDS OVERLAND FLOW SITE VEGETATION TYPE MAP

WATERCARE BEACHLANDS MARAETAI WWTP

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.
2. ROAD INFORMATION SOURCED FROM LINZ.
3. VEGETATION TYPES CREATED BY PDP FEB 24.

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CLIENT: WATERCARE SERVICES LIMITED

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ATTACHMENT 19

SECTION 92 RESPONSE
SUMMARY OF SEDIMENT & BIOTA ACCUMULATION BY EOCS & PPCPS
ATTACHMENT 3

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Attachment 3: Summary of sediment and biota accumulation by EOCs and PPCPs

Question 8 from Auckland Council's S92 response for the application by Watercare to reconsent Beachlands WWTP is provided below.

"Sediment bioaccumulation risks of emerging organic contaminants (EOCs): Based on the authors' knowledge about sediment bioaccumulation of EOCs and available data, please provide an assessment as to the risk / potential of analysed personal care products and pharmaceuticals (PCPPs) (and other EOCs, where applicable) in the Beachlands WWTP discharge to sediment bioaccumulation in the downstream receiving environment, both at the Bridge Site (Site 15) and estuary."

This attachment provides the response to this question.

PPCPs were not measured in the sediment from the receiving environment sites (we note sediment was collected from upstream farm pond (A), farm pond (B), and Bridge (15) sites once on 10 November 2023). Further, the literature data used for EOCs was as a water concentration. Our understanding is that this is primarily unfiltered so will be total rather than dissolved concentrations.

As we have no measured sediment concentrations, we can't compare these concentrations with sediment effects thresholds such as predicted no effects concentrations (PNECs). Accurate derivation of a predicted effects concentration (PEC) for each chemical is complex (European Centre for Ecotoxicology and Toxicology of Chemicals, 2004) and requires detailed knowledge of the local conditions. Therefore, a high level assessment is provided here.

As EOCs/PPCPs are a large range of chemicals they will encompass a wide range of physico-chemical properties, ranging from highly water soluble to very low water solubility. However, predictions on how an individual chemical may partition between sediment and water can be made based on organic carbon normalised sorption coefficient (Koc) acknowledging that for most chemicals sorption is driven primarily by organic carbon content of the sediment. Further, although not specifically mentioned by Council, bioaccumulation in biota for most chemicals occurs through a similar process. We have included a bioaccumulation concentration factor (BCF) for each. A summary of results is provided in **Table 1**, with discussion in the following sections.

Sediment accumulation

Koc provides the organic-carbon normalised distribution coefficient potential of a chemical. This is effectively the affinity of that chemical to sediment. The higher the affinity the less mobile the chemical is in the water phase. The FAO mobility classification[1] based on Koc is:

- <10 Highly mobile
- 10-100 Mobile
- 100-1,000 Moderately mobile
- 1,000-10,000 Slightly mobile
- 10,000-100,000 Hardly mobile
- >100,000 Immobile

Bioaccumulation potential

Bioconcentration factors (BCF) may be used to estimate potential bioaccumulation of EOCs in biota. Although the bioaccumulation factor (BAF) is more ecologically relevant than BCF because it includes dietary, respiratory, and dermal exposures, it is calculated from field-caught fish, so requires EOC measurements (Costanza et al., 2012). Costanza et al. (2012) also showed that for the majority (86%) of high and medium production volume chemicals there was no difference between BCF and BAF. The US EPA define a chemical with a BCF <1000 as having a low bioconcentration potential (US EPA, 2012), while ECHA define a chemical as fulfilling the bioconcentration criterion when BCF >2000 (European Chemicals Agency, 2017).

Discussion

This high level assessment shows that 8 out of 54 EOCs have high soil/sediment affinity and potential for bioaccumulation in biota: the surfactant nonylphenol; the antimicrobials chlorophene and triclosan; the fragrances galaxolide and tonalide; and the plasticisers BBP, DPB, and DEHP. All 8 were assessed in the effects assessment report as low ecological risk in water.

As stated previously EOCs were not measured in the receiving environment sediment so a direct assessment cannot be made of those concentrations with sediment PNECs. The 15% (8

[1] https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-reporting-environmental-fate-and-transport#II_C

out of 54) of the EOCs included in the effects assessment report that have the physico-chemical properties required to bind strongly to sediment are also bioaccumulative so are likely to be the highest risk in terms of accumulation in sediment and biota. However, toxicity (PNEC) to sediment dwelling organisms and higher trophic level biota would also need to be considered. For many EOCs these are provided by the NORMAN database for sediment, plus fish and mollusc (marine and freshwater) biota.

A complication of assessing bioaccumulation of EOCs in biota is that there is even less known about distribution of EOCs in biota than water and sediment. This would need to be a watching brief through a consent condition for monitoring (see below).

A more detailed assessment should be included as a consent condition, which specifically measures EOCs in receiving environment sediment (upstream, farm pond, site 15 and the estuary).

We note that the upgrade to MBR will reduced total suspended sediment in the WWTP discharge which will reduce the concentrations of EOCs with strong affinity to particulate matter, and more likely to bioaccumulate in biota, in the discharge and hence risk to sediment dwelling organisms and higher trophic level biota in the receiving environment.

Table 1. Summary of soil adsorption and mobility classification and potential for bioaccumulation of EOCs in biota. Koc and BCF were extracted from the Chemspider database[2] and are pH dependent for some chemicals. Chemicals which have the highest affinity for sediment and potential for bioaccumulation in biota are bolded red.

Class	Analyte	CAS#	Koc (pH 5.5/7.4)	FAO mobility classification	BCF (pH 5.5/7.4)	Potential for bioaccumulation in Biota?
Akylphosphate flame retardant	TBEP	78-51-3	1,814	Slightly	250	No
	TBP	126-73-8	2,565	Slightly	406	No
	TCEP	115-96-8	141	Moderately	7	No
	TCPP	13674-84-5	433	Moderately	34	No
	TDCP	13674-87-8	1,410	Slightly	176	No
	TiBP	126-71-6	2,458	Slightly	383	No
	TPP	115-86-6	4,135	Slightly	792	No
Alkylphenol	**Tech-NP-equivalents**	**84852-15-3**	**51,196/51,148**	**Hardly**	**26,628/26,603**	**Yes/Yes**
Antimicrobial	**Chlorophene**	**120-32-1**	**5,300/5,280**	**Slightly**	**1,120/1,116**	**Yes/Yes**
	Chloroxylenol	88-04-0	1,495/1,489	Slightly	191/190	No/No
Insecticide	DEET	134-62-3	392	Moderately	29	No
Nitro and polycyclic musk fragrance	Cashmeran	33704-61-9	3,863	Slightly	720	No
	Galaxolide	**1222-05-5**	**40,212**	**Hardly**	**19,002**	**Yes**
	Tonalide	**21145-77-7**	**32,039**	**Hardly**	**13,834**	**Yes**
Pharmaceutical	Acetaminophen	103-90-2	39	Mobile	1	No
	Carbamazepine	298-46-4	415	Moderately	32	No
	Diclofenac	15307-86-5	298/5	Moderately/Mobile	68/1	No/No
	Ibuprofen	15687-27-1	122/2	Moderately/Mobile	16/1	No/No
	Naproxen	22204-53-1	181/3	Moderately/Mobile	20/1	No/No
	Salicylic acid	69-72-7	1	Mobile	1	No/No
Plasticiser	**BBP**	**85-68-7**	**8,300**	**Slightly**	**2,096**	**Yes**
	Bisphenol A	80-05-7	2,242/2,240	Slightly/Slightly	337/336	No/No
	DBP	**84-74-2**	**8,404**	**Slightly**	**2,133**	**Yes**
	DEHP	**117-81-7**	**480,322**	**Immobile**	**607,695**	**Yes**
	DEP	84-66-2	715	Moderately	68	No

[2] http://www.chemspider.com/

Class	Analyte	CAS#	Koc (pH 5.5/7.4)	FAO mobility classification	BCF (pH 5.5/7.4)	Potential for bioaccumulation in Biota?
	DMP	131-11-3	252	Moderately	16	No
Plasticiser metabolite	MBP	131-70-4	7/1	Highly/Highly	1	No
	MEHP	4376-20-9	88/9	Mobile/Highly	25/2	No/No
	Monomethyl-PAE	4376-18-5	1	Highly	1	No
PFAS	PFOS	1763-23-1	1	Highly	1	No
	PFHxA	307-24-4	1	Highly	1	No
	PFHpA	375-85-9	2	Highly	1	No
	PFOA	335-67-1	5	Highly	2	No
	PFNA	375-95-1	17/16	Mobile/Mobile	11	No
	PFDA	335-76-2	46/43	Mobile/Mobile	44/42	No/No
PPCP	Acesulfame	33665-90-6	1	Highly	1	No
	Atenolol	29122-68-7	1	Highly	1	No
	Bupropion	34911-55-2	25/718	Mobile/Mobile	3/82	No/No
	Caffeine	58-08-2	34	Mobile	1	No
	Cotinine	486-56-6	25/29	Mobile/Mobile	1	No
	Diltiazem	34933-06-7	2/74	Highly/Mobile	1/10	No/No
	Diphenhydramine	58-73-1	3/106	Highly/Moderately	1/17	No/No
	Fluoxetine	54910-89-3	4/15	Highly/Mobile	1/3	No/No
	Gabapentin	60142-96-3	1	Highly	1	No
	Gemfibrozil	25812-30-0	690/11	Moderately/Mobile	137/2	No/No
	Lamotrigine	84057-84-1	111/194	Moderately/Moderately	6/11	No/No
	Metoprolol	37350-58-6	1/2	Highly/Highly	1	No
	Norcotinine	17114-40-8	13/15	Mobile/Mobile	1	No
	Sucralose	56038-13-2	19	Mobile	1	No
	Sulfamethoxazole	723-46-6	44/3	Mobile/Highly	1	No
	Triclocarban	101-20-2	45	Mobile	11	No
	Triclosan	**3380-34-5**	**17,458/12,559**	**Hardly/Hardly**	**5,935/4,270**	**Yes/Yes**
	Trimethoprim	738-70-5	1	Highly	1	No
	Venlafaxine	93413-69-5	1/24	Highly/Mobile	1/3	No/No

References

Costanza, J., Lynch, D.G., Boethling, R.S., Arnot, J.A., 2012. Use of the bioaccumulation factor to screen chemicals for bioaccumulation potential. Environ. Toxicol. Chem. 31, 2261–2268.

European Centre for Ecotoxicology and Toxicology of Chemicals, 2004. Soil and Sediment Risk Assessment of Organic Chemicals. ECETOC Technical Report No. 92.

European Chemicals Agency, 2017. Guidance on Information Requirements and Chemical Safety Assessment Part C: PBT/vPvB assessment Version 3.0 June 2017.

US EPA, 2012. Sustainable Futures / P2 Framework Manual 2012 EPA-748-B12-001 5. Estimating Physical / Chemical and Environmental Fate Properties with EPI Suite™.

ATTACHMENT 20

SECTION 92 RESPONSE
TE PURU STREAM DISCHARGE ASSESSMENT
UPDATE TO PAGE 24
ATTACHMENT 4

Attachment 4 – DHI Te Puru Stream – Page 24 updated

Immediately downstream of the Whitford-Maraetai Road bridge the predicted TN and TP concentrations combining catchment inputs and the Current WWTP discharge are 0.86 mg/L and 0.08 mg/L respectively.

These estimates are made up of the Current WWTP discharge contribution of 0.13mg/L and 0.01 mg/L for TN and TP respectively and the catchment derived concentrations of 0.73 and 0.05 mg/L for TN and TP respectively.

The combined estimates are very similar to actual monitoring data from Te Puru Park of 0.74 and 0.07 mg/L for TN and TP respectively.

Immediately downstream of the Whitford-Maraetai Road bridge the increase in mean annual TN concentration for the Short-Term discharge scenario is 0.07 mg/L while the increase in mean annual TP is 0.04 mg/L. For the Long-Term Stage 1 scenario these increases are estimated to be 0.07 mg/L for TN and 0.09 mg/L for TP. For the Long-Term Stage 2 scenario these increases are estimated to be 0.09 mg/L for TN and 0.12 mg/L for TP.

These values reflect the combination that the WWTP discharge makes to the average Te Puru Stream flow (Figure 4) and the percentage increase in TN and TP loads shown in Table 8.

Towards the mouth of the Te Puru Stream the incoming tide provides significant additional dilution to the dilution that occurs in-stream meaning that the average level of dilution at the Te Puru Stream mouth ranges from greater than 10,000-fold under the Current scenario greater than 1,300-fold under the Short-Term and greater than 300-fold under the Long-Term Stage 2 scenario (Table 2).

This results in very low nutrient concentrations relating to the WWTP discharges in the marine receiving environment.

For example, within the mouth of the Te Puru Stream under the Long-Term Stage 1 scenario the maximum increases in TN is 0.005 mg/L while for TP the maximum increase is estimated to be 0.002 mg/L.while under the Long-Term Stage 2 scenario (when the predicted dilution at this site is the lowest of all the scenarios considered) the maximum increases in TN and TP are 0.001 mg/L.

As such, increases in TN and TP within the marine receiving environment due to all three future WWTP discharge scenarios will be below detectable limits.

The effect of the WWTP discharge in terms of in-stream nutrients (i.e. upstream of the Quarry site) is discussed in detail in Stewart et al. (2024).

ATTACHMENT 21

SECTION 92 RESPONSE
TE PURU STREAM
FLOW DURATION CURVE METHOD
ATTACHMENT 5

Te Puru Stream Flow Duration Curve Method

In order to develop a synthetic flow record for the Te Puru Stream at the Bridge, the Auckland Council Flow monitoring site on the Mangemangeroa Stream was used as a surrogate. The Mangemangeroa Stream catchment is of broadly similar size, with a similar landuse and is the closest monitored catchment to the Te Puru catchment (approximately 8 km separation).

To correlate the two sites, relative catchment area was used as a scaling factor. The Te Puru Stream has a catchment of 2.109km^2 at the bridge and the Mangemangeroa Stream Catchment is 4.756km^2 based on the MFE River Environment Classification Network. Thus, the synthetic Te Puru Stream flow record was created by scaling the Mangemangeroa flow record by 0.424. Flow in the surrogate timeseries was compared to flow gaugings obtained by PDP staff and found to be relatively similar for the dates measured.

Once the flow had been synthetically developed for the Te Puru Stream at the Bridge, flow gauging comparisons were done to determine the scaling factor to create synthetic flow records further down the catchment at locations C and Quarry (as shown in Appendix A of A02803201L001). Using the comparison flow gaugings scaling factors of 1.84 and 2.24 were used to develop flow records at C and Quarry respectively.

Auckland Council provided PDP with the flow timeseries from 14/07/2000 through to 01/03/2023. This is the most up to date processed data that Auckland Council holds.

Manual gaugings undertaken at the bridge site compared relatively well with synthetic flow record. For example, for a gauged flow of 24 l/s the synthetic flow indicated 18l/s at the site. This indicates at these flows the synthetic flow record will be conservative (i.e. estimated dilution of wastewater will be less than reality).

For the sites further down the Te Puru catchment, these were again scaled based on flow gaugings as no further information was available to be able to translate the flow series to. Further long term data capture is recommended to enable refinement of the flow duration curves.

PDP has provided the following datasets:

- Te Puru Catchment Flow Duration Curve (FDC) without Naturalisation at the Bridge (i.e. with the wastewater flow still included)
- Te Puru Catchment FDC with Naturalisation at the Bridge
- Te Puru Catchment C FDC without Naturalisation
- Te Puru Catchment C FDC with Naturalisation
- Te Puru Quarry Catchment FDC without Naturalisation
- Te Puru Quarry Catchment FDC with Naturalisation

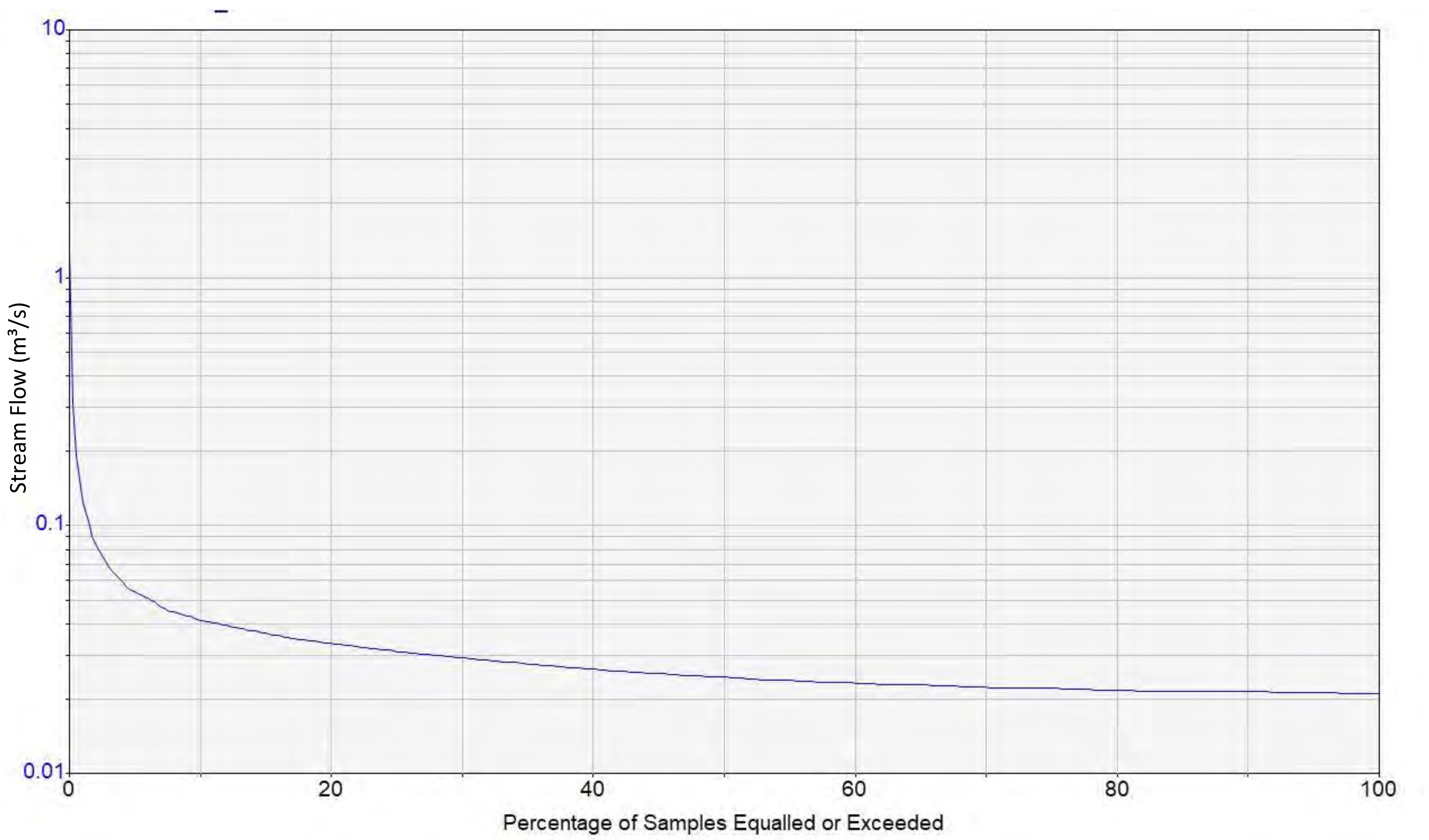


FIGURE 1: BRIDGE SITE FLOW DISTRIBUTION CURVE – WITHOUT NATURALISATION

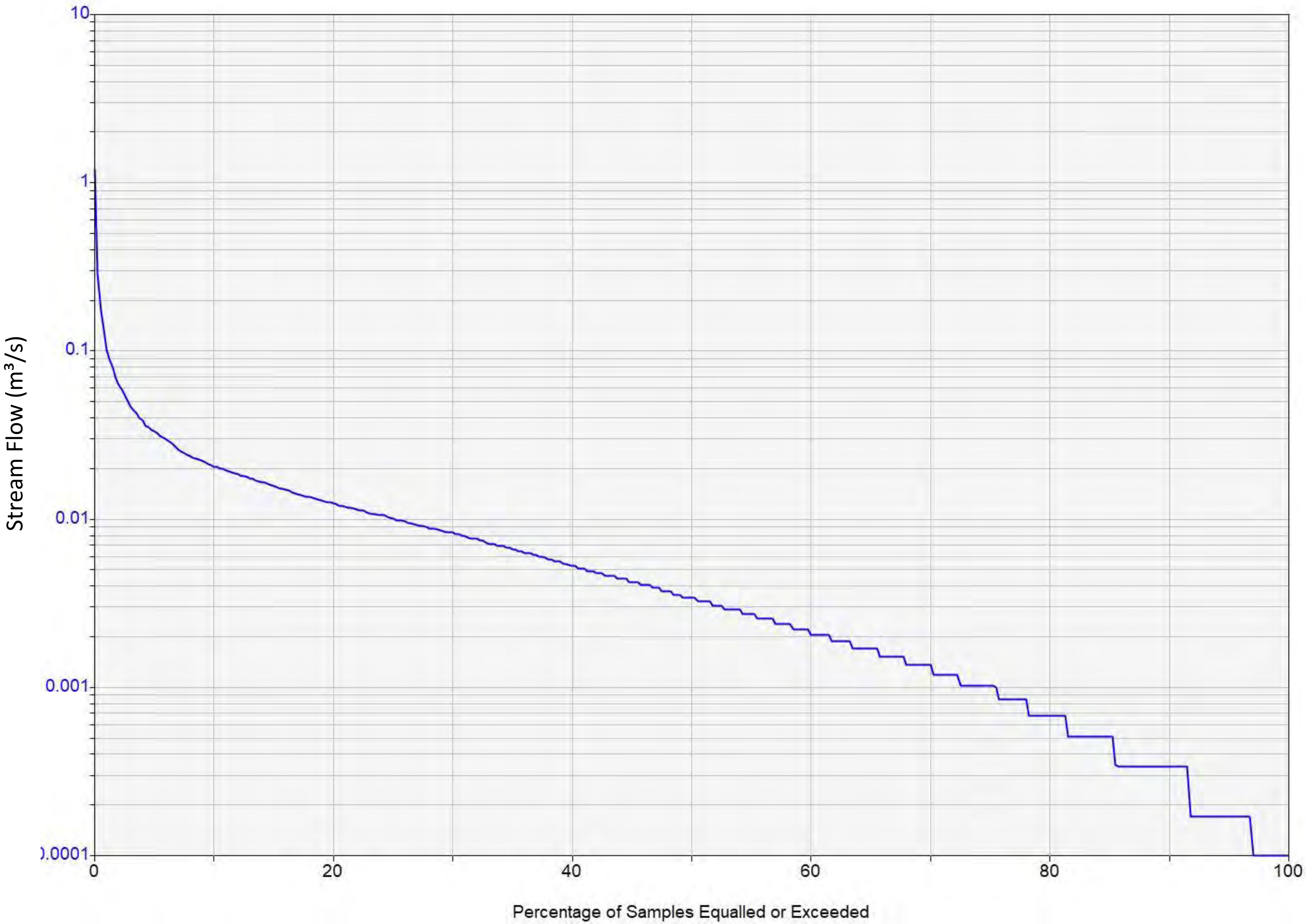


FIGURE 2: BRIDGE SITE FLOW DISTRIBUTION CURVE – WITH NATURALISATION

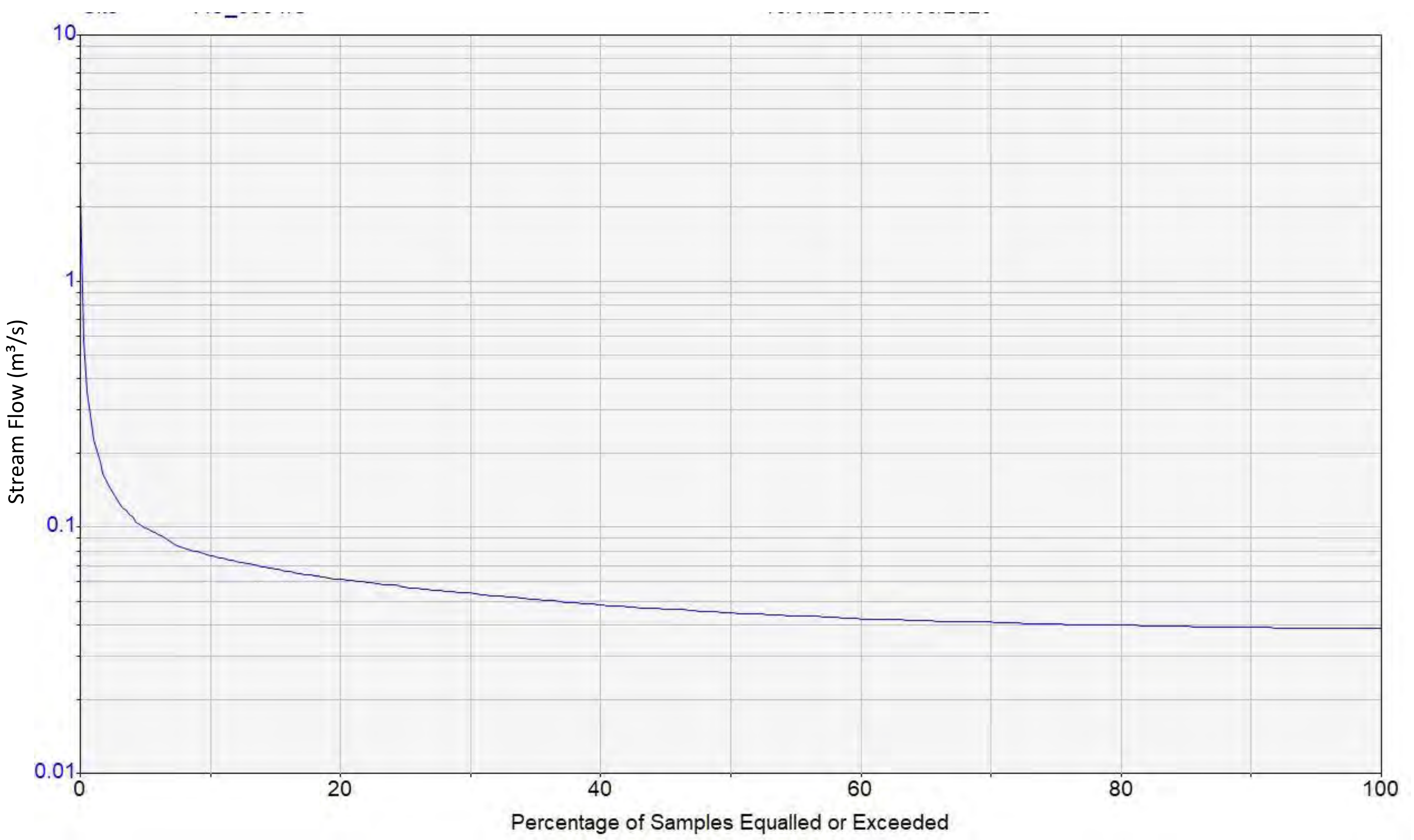


FIGURE 3: SITE C FLOW DISTRIBUTION CURVE – WITHOUT NATURALISATION

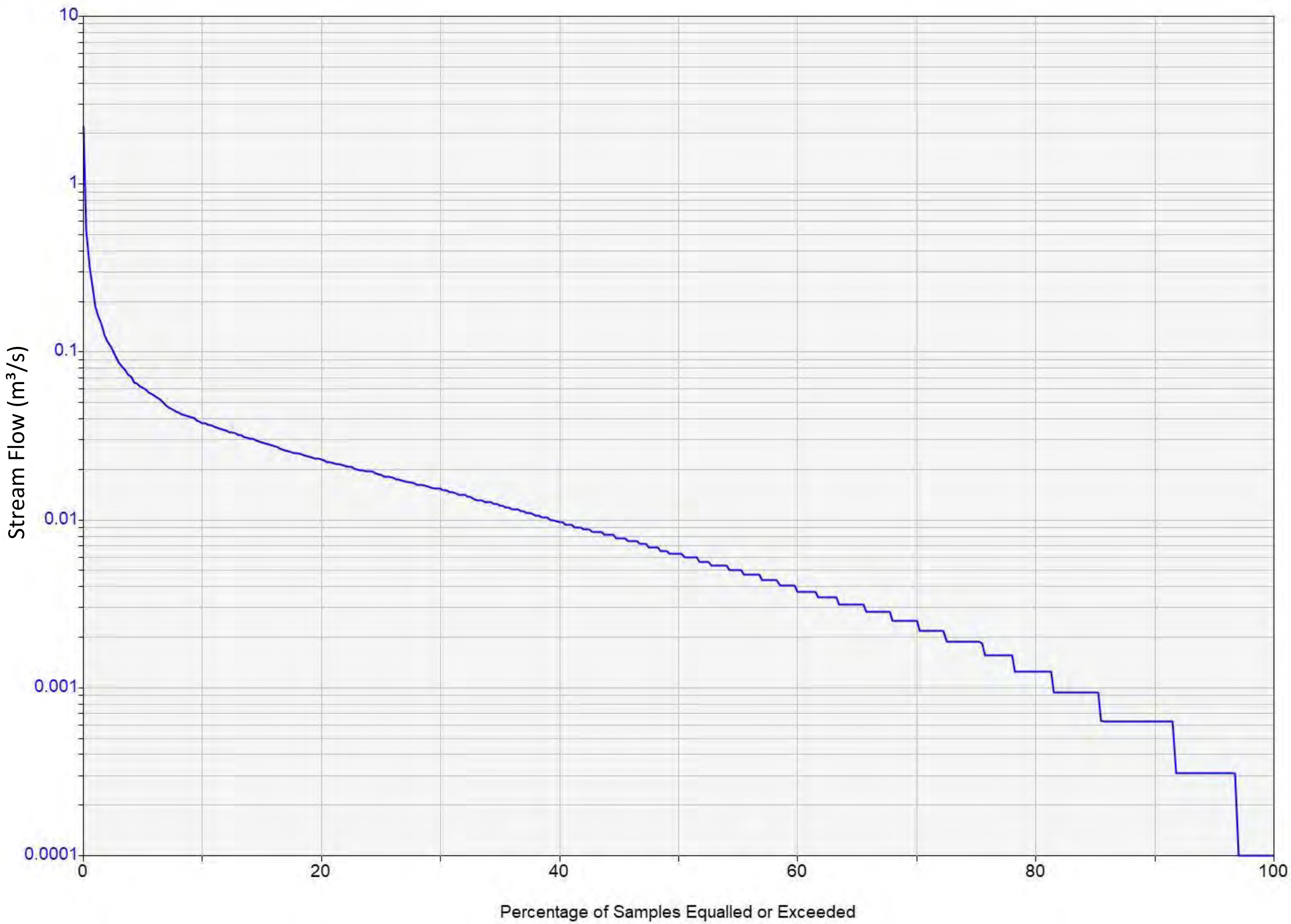


FIGURE 4: SITE C FLOW DISTRIBUTION CURVE – WITH NATURALISATION

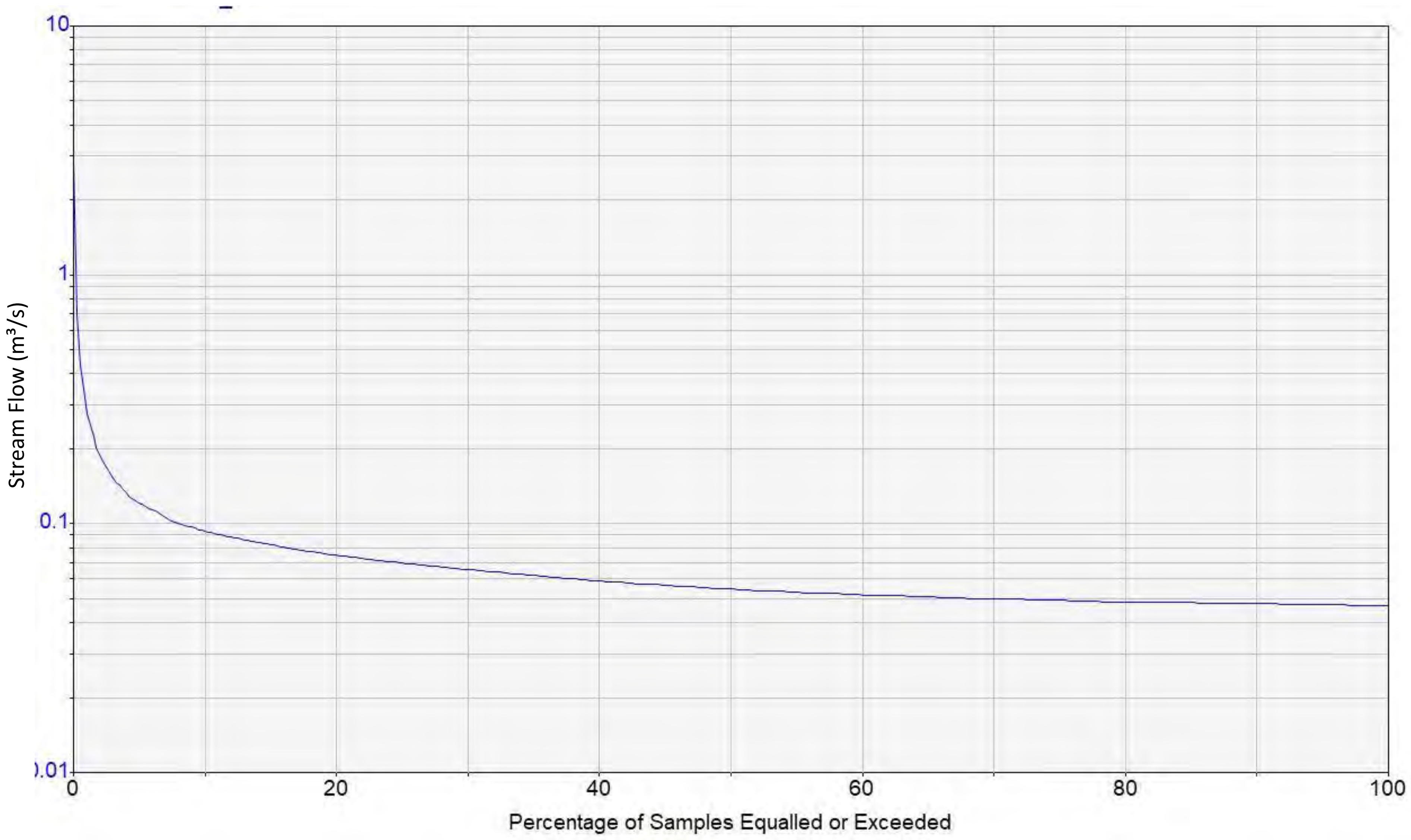


FIGURE 5: QUARRY SITE FLOW DISTRIBUTION CURVE – WITHOUT NATURALISATION

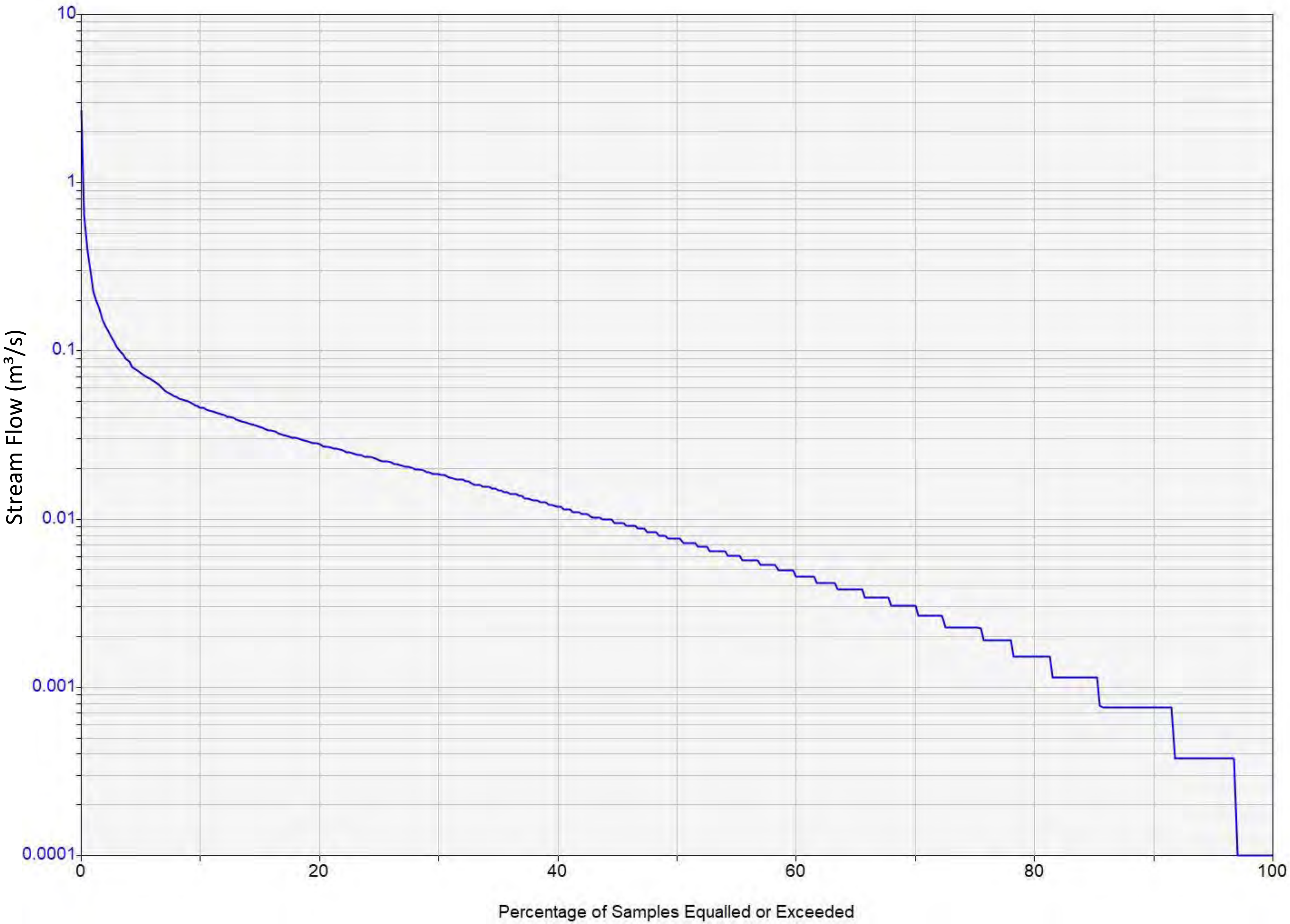
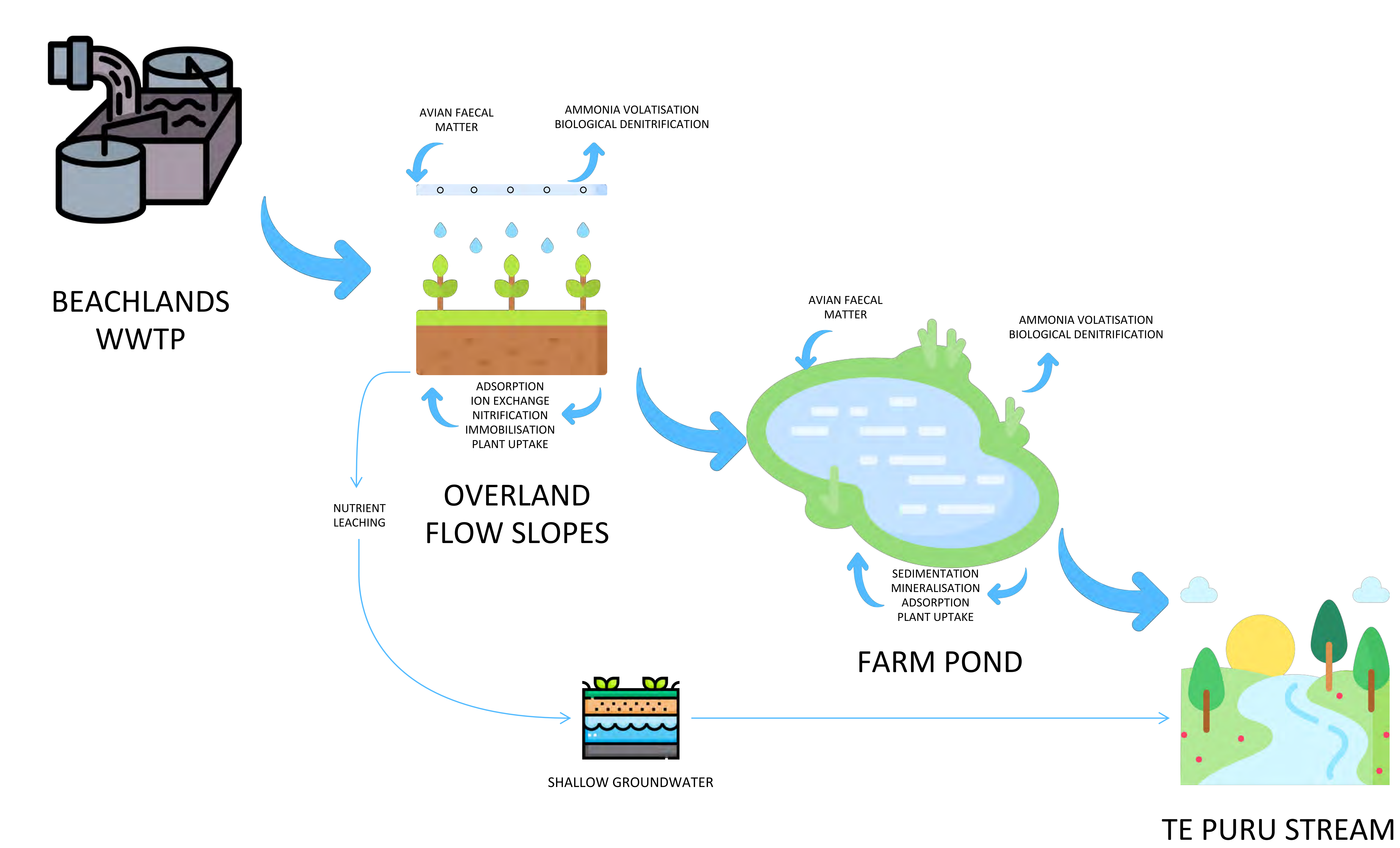


FIGURE 6: QUARRY SITE FLOW DISTRIBUTION CURVE – WITH NATURALISATION

ATTACHMENT 22

SECTION 92 RESPONSE
OVERLAND FLOW SYSTEM
CONCEPTUAL SITE MODEL
ATTACHMENT 6



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CLIENT: WATERCARE SERVICES LTD

PROJECT: A028030001 - BEACHLANDS OVERLAND FLOW SYSTEM

FIGURE 2: OVERLAND FLOW SYSTEM CONCEPTUAL SITE MODEL

ATTACHMENT 23

SECTION 92 RESPONSE
OVERLAND FLOW SYSTEM PERFORMANCE
ATTACHMENT 7

Beachlands WWTP Overland Flow System Performance

Prepared for

Watercare Services Limited

August 2024

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Quality Control Sheet

TITLE Beachlands WWTP Overland Flow System Performance

CLIENT Watercare Services Limited

ISSUE DATE 19 August 2024

JOB REFERENCE A028030001

D R A F T

Revision History

REV	Date	Status/Purpose	Prepared By	Reviewed by	Approved
0	19/08/24	Draft – For Review	Kimberley Murphy Oliver Hunt	Daryl Irvine	Alan Pattle

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Reviewed by

Approved by

SIGNATURE

Daryl Irvine

Alan Pattle

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Appendices

1.0 Background

Watercare Services Ltd (**Watercare**) submitted a resource consent application for the discharge of treated wastewater from the Beachlands Wastewater Treatment Plant (**WWTP**). The consent will provide for projected population growth and an increase in the capacity of the WWTP to 30,000PE over a proposed 35-year term. The Best Practicable Option (**BPO**) for the discharge was identified as the continued use and expansion of the existing Overland Flow System (**OLF**) which is used to create a diffuse discharge from the Beachlands WWTP to the Te Puru Stream.

Pattle Delamore Partners (**PDP**) previously completed a desktop assessment of the existing OLF treatment performance, outlined in PDP's memorandum *"Beachlands WWTP: Assessment of Overland Flow System Treatment Performance – Memorandum 2"* (PDP, 2024). Following the recommended outcomes from this assessment, Watercare has engaged PDP to complete a more detailed investigation into the performance of the OLF and pond at Beachlands.

This investigation aims to assess the performance of the overland flow slope and the farm pond individually to determine their respective contributions to wastewater treatment post discharge from the WWTP. This assessment will help the design of any new or expanded OLF. The investigation involves site inspections, sampling of treated wastewater at various points within the overland flow and farm pond system, and measurement and analysis of water quality parameters to quantify treatment efficiency.

This report has been prepared to describe the methodology used and the results of the OLF and Pond investigations undertaken between 9 April 2024 and 12 June 2024.

2.0 Investigations

2.1 Overland Flow System and Farm Pond Overview

2.1.1 Treated Wastewater Sampling Methodology

Grab samples of treated wastewater were collected weekly from the system. One sample of the discharged treated wastewater taken from the dispersal pipes at the top of the zones[1], a set of wastewater samples was collected from the bottom of the slope from each zone (labelled A Bottom, B Bottom, and C Bottom,

[1] Note that for the first two sampling rounds separate samples were taken from the top of each zone (A Top, B Top, and C Top). Due to consistent results across the top of the zones this was reduced to only one sample to represent all the dispersed wastewater from round three onwards.

respectively), and finally samples were also collected at the inlet and outlet of the farm pond.

The collected treated wastewater samples were sent to Hill Laboratories for analysis. All samples were tested for the following parameters:

- pH
- Electrical Conductivity (EC)
- Chloride
- Sodium
- Carbonaceous Biochemical Oxygen Demand (BOD)
- Turbidity
- Total Nitrogen (TN)
- Ammoniacal-N (NH_4-N)
- Nitrite-N (NO_2-N)
- Total Kjeldahl Nitrogen (TKN)
- Total Oxidised Nitrogen (TON)
- Total Phosphorus (TP)
- Dissolved Reactive Phosphorus (DRP)
- Escherichia coli (*E. coli*)
- Faecal coliforms
- Chlorophyll a[2]

All sampling was carried out on days without heavy rain to minimise dilution of samples on the slope from rainfall and to manage health and safety risks. PDP also took field measurements of dissolved oxygen (DO), pH, conductivity, and temperature at each sampling location shown in Figure 1.

D R A F T

[2] Note that for the first four sampling rounds, testing was conducted for chlorophyll-a. Due to the results showing non-detects this was not included in testing from round five onwards.

FIGURE 1: SAMPLING LOCATIONS

WATERCARE BEACHLANDS MARAETAI WWTP

SOURCE:
1. AERIAL IMAGERY: EAGLE TECHNOLOGY, LINZ, STATSNZ, NIWA, NATURAL EARTH, © OPENSTREETMAP CONTRIBUTORS., EAGLE TECHNOLOGY, LAND INFORMATION NEW ZEALAND, GEBCO, COMMUNITY MAPS CONTRIBUTORS.

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METRES
SCALE : 1:1,500 (A4)
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CLIENT: WATERCARE SERVICES LIMITED

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3.0 General Field Observations

Based on PDP's visits to the overland flow site, one scoping and ten sampling visits, the following observations have been made:

- The slope area is densely vegetated, and there were a large number of birds frequently observed in the farm pond.
- The pond inlet sampling point was shallow, measuring less than 5 cm in depth, and stagnant.
- The highest flow rate was consistently observed in Zone C, while Zones A and B generally exhibited lower flows and at times zero flow was observed in the dispersion lines in Zones A and B.
- Channelisation was observed at the bottom of the slope, where the discharged treated wastewater formed streams in each zone especially at the bottom of Zone C (Refer to Appendix B for site photographs).

As noted in Memorandum 1, the dispersal system operates on demand via gravity from the WWTP (PDP, 2024). The dispersal system does not evenly distribute wastewater across the slopes and sub-optimal maintenance of the dispersion lines has exacerbated this problem. The discharge of wastewater across the slope varies significantly based on the instantaneous flowrate of wastewater from the WWTP. There are currently no systems in place to control or measure this variation in flow within the overland flow system. This means that the results should be interpreted with caution, particularly when considering the overall overland flow system performance.

Based on the observations, Zone C is the primary zone dispersion of low to average dry weather flows. Lower discharge rates have been observed in Zone A and Zone B, these zones have consistently had the lowest application rate during PDP's site visits. The field observations for each sample round are summarised in Table 1 below.

Table 1: Field Observations

Sample Round	Date	Weather Conditions	Comments
1	09/04/2024	Sunny, partially cloudy	
2	17/04/2024	Sunny, partially cloudy	
3	30/04/2024	Cloudy, light showers	• There were decreased pond and inlet levels compared to preceding rounds. • No wastewater was discharged from the top of zones A or B, and consequently minimal flows were observed at the bottom of zones A and B. These results should be interpreted with caution and could be influenced by sediment disturbed during the sampling procedure.
4	03/05/2024	Sunny, partially cloudy	• There were decreased pond and inlet levels compared to preceding rounds. • No wastewater was discharged from the top of zones A or B, and consequently minimal flows were observed at the bottom of zones A and B. These results should be interpreted with caution and could be influenced by sediment disturbed during the sampling procedure.
5	08/05/2024	Sunny, clear skies	
6	14/05/2024	Cloudy	• There were decreased pond and inlet levels compared to preceding rounds. • Decreased wastewater was discharged from the top of zones A or B, and consequently minimal flows were observed at the bottom of zones A and B. These results should be interpreted with caution and could be influenced by sediment disturbed during the sampling procedure.
7	22/05/2024	Sunny	• Heavy rainfall of 49.8 mm was recorded at a nearby weather station on the previous day. Results for this round may be indicative of wet weather wastewater flows.
8	31/05/2024	Sunny, partially cloudy	• Higher flows and the formation of bubbles were observed at the bottom of Zones A and C. These bubbles were assumed to be naturally occurring foam. • 27.6 mm of rainfall was recorded at a nearby weather station over the two days before this sample round. Results for this round may be indicative of wet weather wastewater flows.
9	07/06/2024	Cloudy, light showers	• No treated wastewater was being discharged to the overland flow area. Watercare advised this was due to a power failure, which was to be restored later that day. These results should be interpreted with caution and could be influenced by sediment disturbed during the sampling procedure. • PDP observed signs of recent stock presence within and surrounding the overland flow area including manure and pugging.
10	12/06/2024	Sunny, partially cloudy	• 22.4 mm of rainfall was recorded at a nearby weather station two days before this sample round. Results for this round may be indicative of wet weather wastewater flows.

4.0 Results and Discussion

4.1 Assessment Methodology

PDP has reviewed the sampling results and analysed the treatment efficiency across the different system. Based on comparison of key contaminant concentrations at different stages in the disposal system we have provided commentary on:

- The general treatment effectiveness of the overland flow area.
- Performance of and variance between individual zones of the overland flow area.
- Overall treatment effectiveness of the combined overland flow/pond system.
- Estimated contribution of the farm pond to overall treatment performance.

This section presents the results from the ten rounds of sampling and compares them with the assumptions and findings previously documented in Memorandum 2 (PDP, 2024). The full set of plots for each parameter are shown in Appendix A. The raw laboratory results are shown in Appendix C.

4.2 Wastewater Flows

During the sampling period wastewater flows ranged from 850 m^3/d to 3750 m^3/d. Most samples were collected during average flow conditions (dry weather) between 1,300 and 1,700 m^3/d, however, three samples were collected during elevated flow conditions between 2,600 and 3,200 m^3. These elevated flow conditions coincided with rainfall. The sampling dates are presented below in Figure 2 in relation to the daily effluent flowrate and rainfall data obtained from the Auckland Airport weather station.

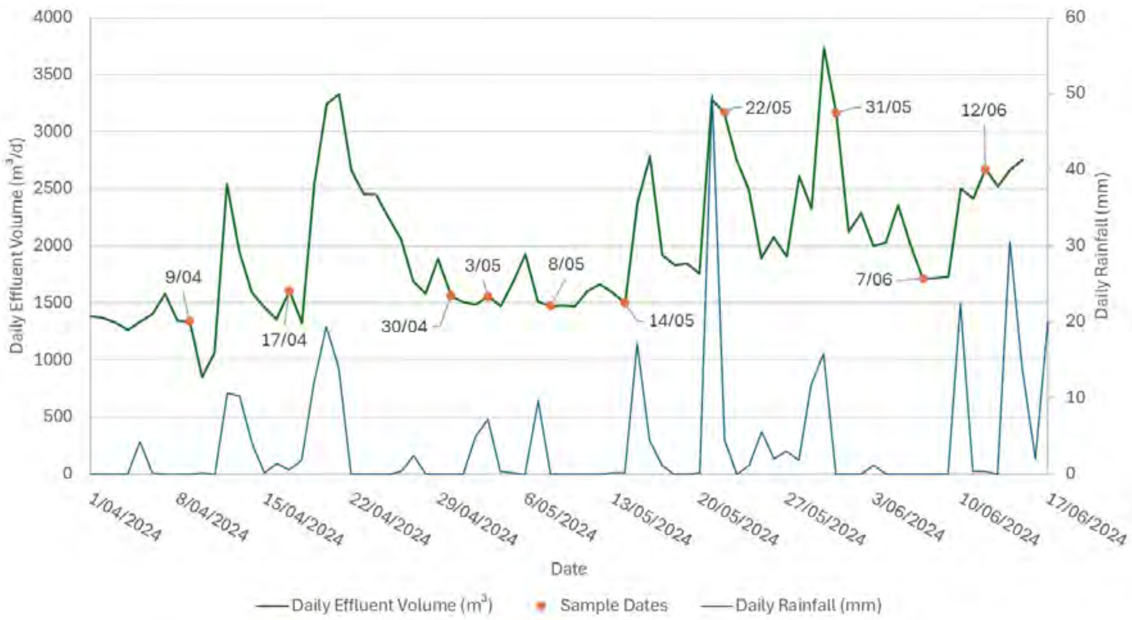

Figure 2: Wastewater flows and rainfall during the sampling period.

4.3 Dilution Assessment

During the previous performance assessment (PDP Memorandum 2), electrical conductivity (EC) was used as a proxy for dilution to provide an estimate of the treatment provided through the combined overland flow/pond system.

As shown below in Figure 3, both Total Sodium and EC showed very little variation from the top of the slope to the outlet of the pond. This contrasts with the previous data set where there was an approximately 15% reduction in electrical conductivity from 141 to 122 mS/m. Over this set of sampling data, the electrical conductivity was slightly higher, with a median of 156 mS/m at the top of the slope and 157 mS/m at the outlet of the pond.

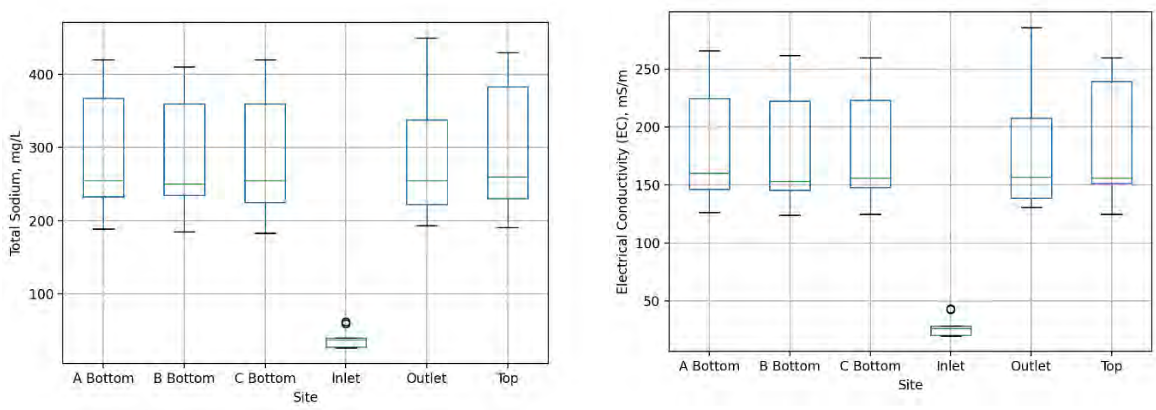

Figure 3: Box and Whisker Plots for Electrical Conductivity and Total Sodium.

Comparison of the individual sampling results shows that conductivity varied from 125 mS/m to 260 mS/m in the WWTP effluent as shown below in Figure 4. Conductivity in the bottom of slope samples and the pond outlet were generally closely matched to the effluent quality. Changes in conductivity from the WWTP effluent to the pond outlet ranged from a 15% increase to a 15% decrease. There was no obvious trend considering WWTP effluent flowrate or rainfall. The pond may allow for a small amount of buffering which could explain the slight variation in pond outlet in electrical conductivity.

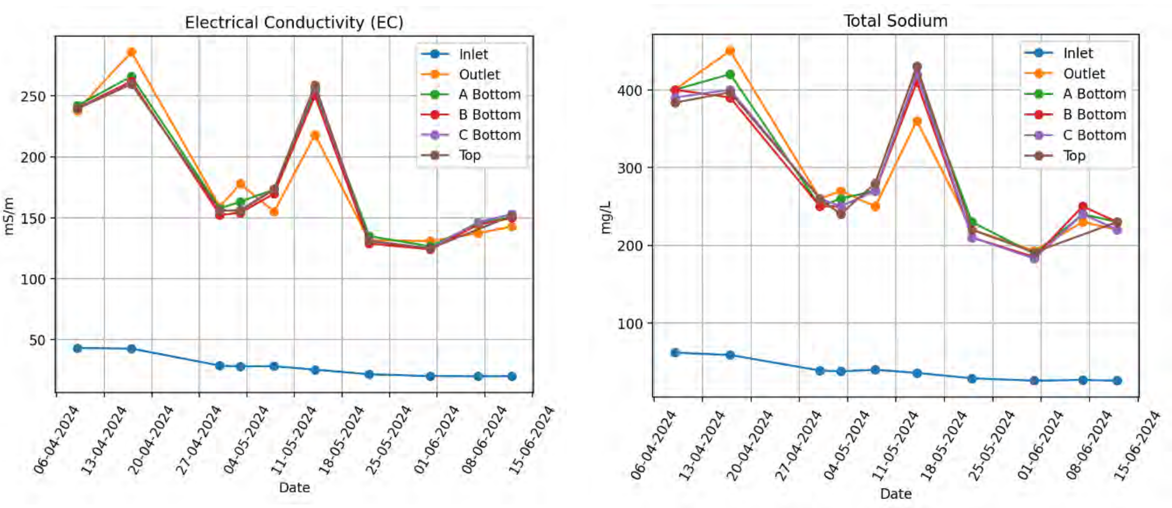

Figure 4: Line graphs for electrical conductivity and total sodium.

Overall, it is estimated that dilution through inflow into the pond is lower in this data set compared to the larger dataset previously reported on. However, the results support the use of electrical conductivity as a proxy for dilution. The assumptions and conclusions made in dilution assessment prepared in Memorandum 2 are supported by the results of this sampling (PDP, 2024).

4.4 Total Nitrogen Performance

The total nitrogen (TN) levels in the treated wastewater discharge were marginally lower than the previously reported median of 5.02 g/m³. The total nitrogen levels at the farm pond outlet ranged from 3.0 to 4.9 g/m³, which is consistent with the previously reported median concentration of 3.7 g/m³.

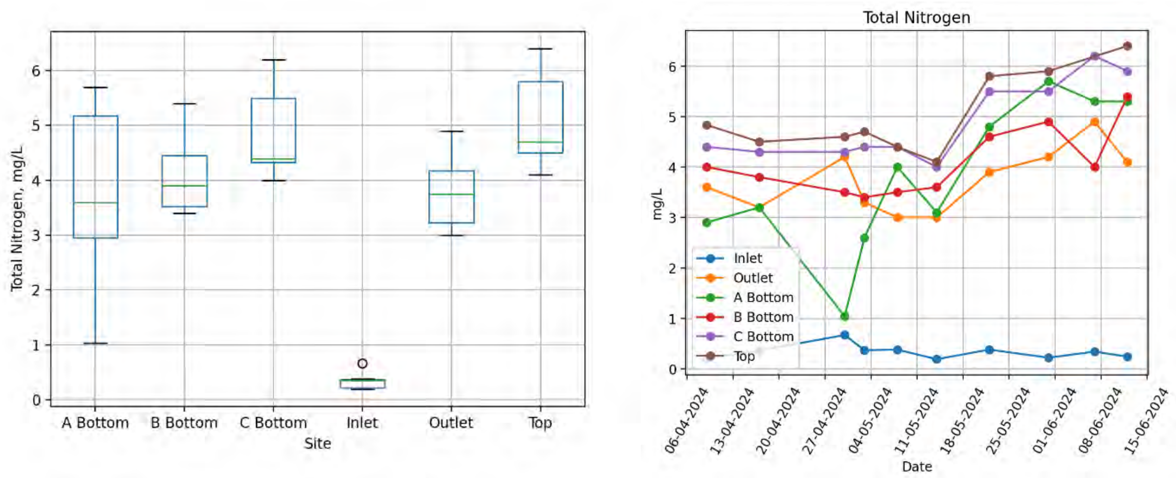

Figure 5: Box and whisker plot of total nitrogen concentrations and results for individual sampling rounds.

Based on the sampling results, the following observations have been made:

- Some TN removal was observed across all zones, although the removal efficiency varied.
- Zone A exhibited the highest TN removal, with median reduction of 24%, followed by Zones B and C with 17% and 6% median removal respectively.
- The lower removal efficiency in Zone C is likely due to higher flow rates, steeper slopes, and greater channelisation, resulting in lower retention time on the OLF slope and thus lower treatment levels.

- As noted above, flows in Zone C account for most of the total flow. Considering the 6% reduction in Zone C, the results indicate the pond is still the primary means of TN removal. However, the higher levels of removal in Zones A and B indicate that there is potential for higher levels of removal than is currently being achieved in Zone C. Good design and operation of the slopes will be key to achieving improved results.
- The median combined OLF slope and pond reduction in TN is 29%, which is consistent with the approximate 30% removal determined in Memorandum 2 (PDP, 2024).

4.5 Ammoniacal Nitrogen Performance

Median ammoniacal nitrogen levels in the treated wastewater discharge were higher in this sampling set than the larger data set used in Memorandum 2 (0.06 g/m^3 vs 0.03 g/m^3).

Across the overland flow slope ammoniacal nitrogen levels dropped. Median concentrations at the bottom were 0.03 g/m^3 for Zone A and Zone B and 0.045 g/m^3 for Zone C. As for total nitrogen, this indicates that the ability of Zone C to nitrify ammoniacal nitrogen is inhibited by the observed higher flowrate and lower slope retention time.

At the farm pond outlet, the median ammoniacal nitrogen concentration was 0.10 g/m^3. It is noted that the pond outlet median concentration is lower than the median concentration of 0.28 g/m^3 reported in Memorandum 2 (PDP, 2024).

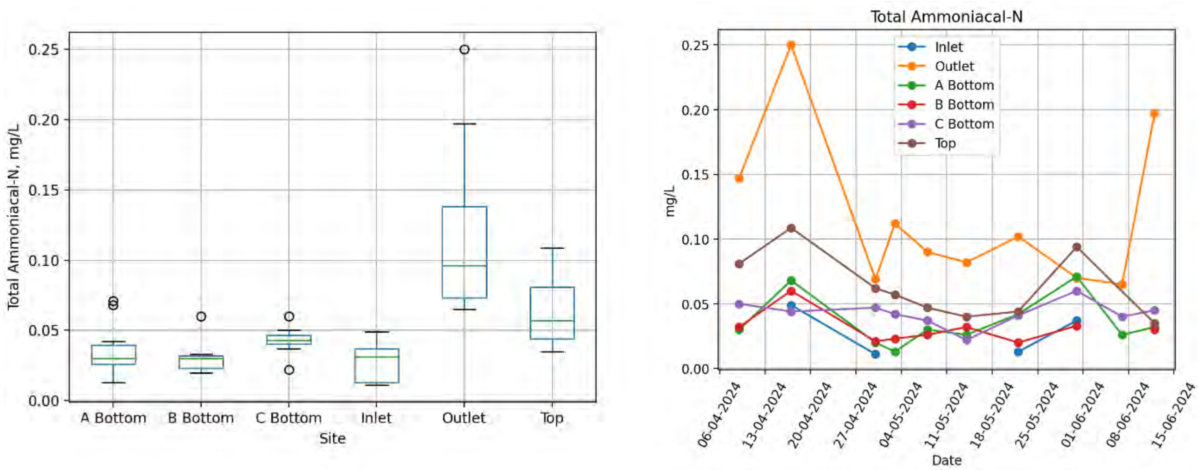

Figure 6: Ammoniacal Nitrogen Concentrations

Based on the sampling results, the following observations have been made:

- Overall, there is a decrease in ammoniacal nitrogen from the top to the bottom of the OLF slope, with removal efficiency varying across the zones. Zone B demonstrated the highest median removal efficiency at 55%, followed by Zone A and Zone C at 36% and 26%, respectively. This general decease in ammoniacal nitrogen across the OLF slope suggests that the existing setup adequately maintains aerobic conditions for the current treated wastewater flows and loads.
- The lower removal rate in Zone C is likely attributed to higher flow rates, steeper slopes, and greater channelisation, resulting in lower retention time on the OLF slope and thus lower treatment levels.
- There is an increase in ammoniacal nitrogen in the pond as was previously assumed in Memorandum 2. Over this sampling period the median ammoniacal nitrogen concentration increases 95% from the top of slope to the farm pond outlet. This is substantially lower than the nearly 900% increase previously reported in Memorandum 2. There were two detections above 0.15 g/m^3 in the second and final rounds of sampling, however, at no point did values exceed the median of the previous data set (0.28 g/m^3).
- As previously reported, the generation of ammoniacal nitrogen is likely due to mineralisation (ammonification) of organic nitrogen within an anaerobic base layer in the pond, and potential contamination from avian life consistently present during sampling.
- It should be noted that this elevated ammoniacal nitrogen concentration did not persist in the downstream environment. Refer Memorandum 2 for details (PDP, 2024).

4.6 Nitrate Performance

The nitrate levels in the treated wastewater discharge were generally lower than previously reported, ranging from 0.82 to 5.1g/m^3 with a median concentration of 3.4 g/m^3, compared to the previously reported median of 5.02 g/m^3. At the farm pond outlet, the nitrate levels were also slightly lower, with a median concentration of 2.3g/m^3, compared to the previously reported median concentration of 2.7 g/m^3.

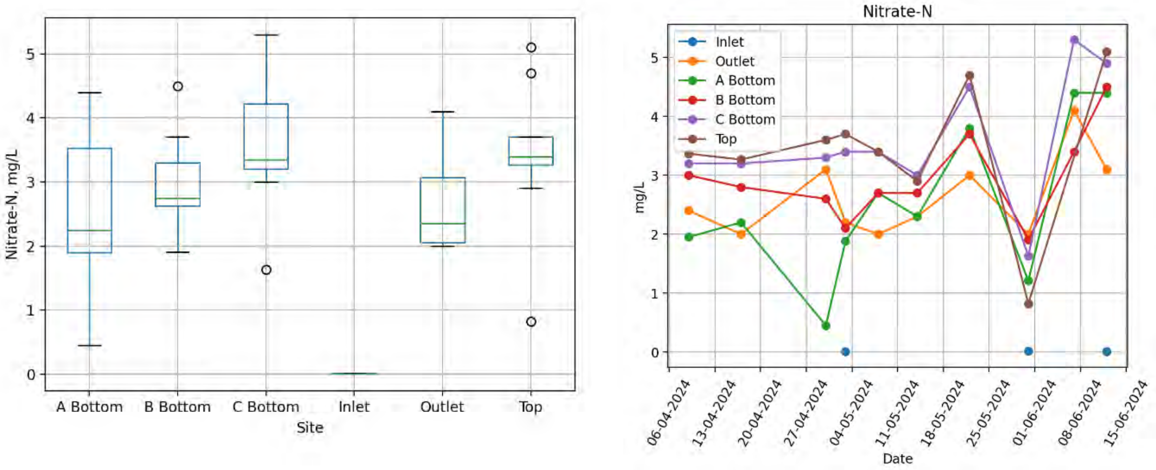

Figure 7: Nitrate Concentrations

Based on the sampling results, the following observations have been made:

- Similar to the TN results, Zone A exhibited the highest nitrate removal, with a median of 21%, followed by Zone B with 14% and Zone C with 4%.
- The lower removal efficiency in Zones B and C is likely due to higher flow rates, steeper slopes, and greater channelisation, resulting in lower retention time on the OLF slope and thus lower treatment levels.
- Based on estimates of the flows to through zone, the results indicate the pond is still the primary means of nitrate removal. However, the higher levels of removal in Zones A and B indicate the potential for achieving higher levels of removal through improved wastewater dispersion and improvements to the grade of the slopes. Good design and operation of the slopes will be key to achieving improved results.
- The combined OLF slope and pond provided a median 36% reduction in nitrate, which is consistent with the 36% previously reported in Memorandum 2.
- It is noted that the results from sampling round 8 are an outlier and has been excluded from the assessments above. In this sampling round the nitrite nitrogen concentrations were significantly higher than usual. The total nitrite + nitrate nitrogen (NNN) concentration was consistent with the other sampling rounds before and after. It is assumed that a process upset in the WWTP resulted in an incomplete nitrification process. Nitrite and NNN concentrations are plotted below in Figure 8 for reference.

While this is an exception, it is noted that there was a high concentration of nitrite being discharged to the overland flow system. We see that the nitrite is removed (converted to nitrate) effectively both on the overland flow slopes and within in the pond. Nitrite was not detected at the base of Zone A indicating that a slope with a lower flowrate and a longer residence time can be effective at converting any residual nitrite in the WWTP effluent.

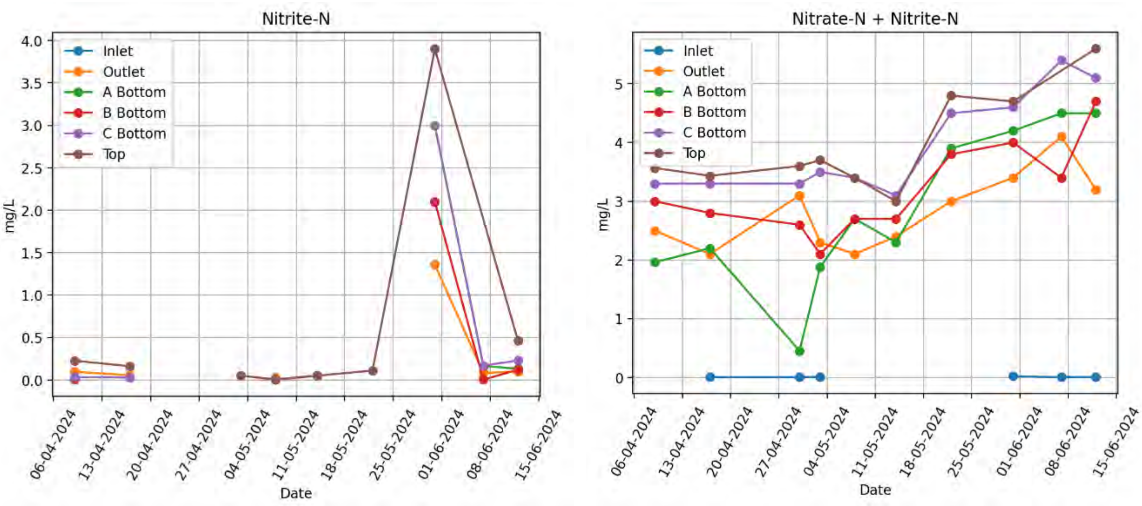

Figure 8: Nitrite Nitrogen and Nitrite + Nitrate Nitrogen Sampling Results (non-detects not plotted)

4.7 Organic Nitrogen

Organic nitrogen concentrations were not reported on in the interim assessment. Over the full sampling period, the median concentration in the WWTP effluent was 1.01 g/m³. At the farm pond outlet, the median concentration was 0.87 g/m³. Organic concentrations across the system are presented below in Figure 8.

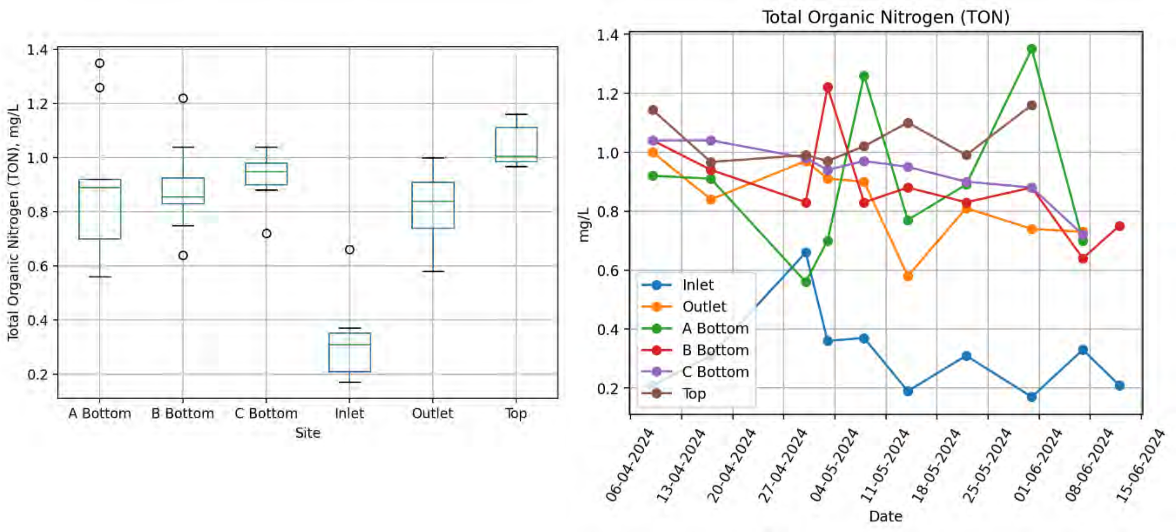

Figure 9: Total Organic Nitrogen Sampling Results (non-detects not plotted)

Based on the sampling results, the following observations have been made:

- As per other nitrogen species, the concentrations of organic nitrogen generally reduced across the system. The median reduction in concentration across Zones A, B and C was 15%, 16%, and 7% respectively. From the top of slope to pond outlet, there was a 13% reduction in organic nitrogen.
- The change in organic nitrogen concentration in zone A was highly variable. This is likely to due to the frequent low discharge flows observed in Zone A which at times made it difficult to collect samples without disturbing sediment or plant matter in the shallow discharge.
- Zone C had the lowest removal which is likely due to the higher discharge rate and reduced slope retention time.
- Considering the majority of wastewater is discharged to Zone C, the results indicate that the pond still has a large impact on organic nitrogen removal. However, in contrast to nitrate nitrogen, the overland flow slopes provided >50% of the total observed reduction in organic nitrogen.
- Higher reduction rates in Zones A and B indicate that greater removal rates can be achieved with lower application rates and longer retention times.

4.8 Total Phosphorus Performance

Total phosphorus (TP) levels in the treated wastewater discharge were lower than previously reported, with a median concentration of 0.35 g/m³ compared to a median of 0.87 g/m³ reported in Memorandum 2 (PDP, 2024).

Similarly, TP levels at the farm pond outlet were lower than previously reported, with a median 0.27 g/m³ compared to the previously reported median concentration of 0.47 g/m³.

D R A F T

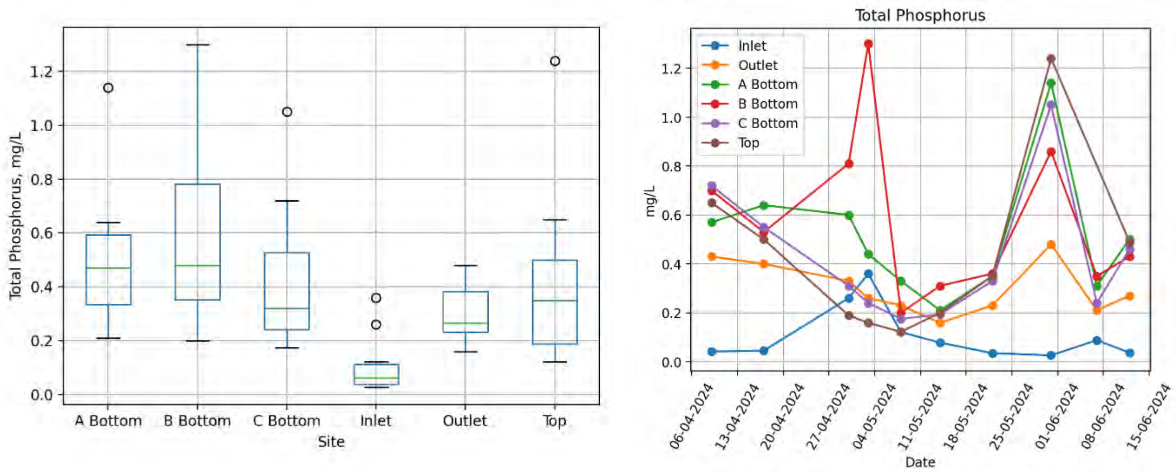

Figure 10: Total Phosphorus Concentrations

Based on the sampling results, the following observations have been made:

- There were generally increases in TP levels across all zones. The median increases for Zone A, B and C respectively were 17%, 7% and 10%.
- There was a large variety of TP concentrations recorded which appear to be primarily driven by changing concentrations in the effluent wastewater rather than environmental factors.
- Increases in TP is likely associated with an increase in suspended sediment as the treated wastewater flows down the OLF slope, as evidenced by the increase in turbidity across the slope areas (See Appendix A).
- There may also be an equilibrium between phosphorus in the wastewater and in the surface soils. In sampling round 8, when phosphorus concentrations were much higher than usual, there were reductions across the overland flow slopes in both TP and DRP. This could indicate that some phosphorus was adsorbing on the overland flow slope. Since concentrations in the effluent are generally lower than the longer-term data set used in Memorandum 2 (0.35 g/m³ vs. 0.87 g/m³), the overall increase in phosphorus concentrations across the overland flow slopes

could be as a result of phosphorus adsorbed at previous higher concentrations now desorbing while wastewater effluent concentrations are lower.

- Despite the fluctuations in WWTP effluent, pond outlet concentrations were relatively consistent over the ten sampling rounds. The pond appears to buffer wastewater flows and provides some dampening to fluctuating WWTP effluent. Overall, there was a median reduction in TP concentration over the combined overland flow/pond system of 20%. The pond is providing for the majority of the removal as well as compensating for increased TP concentrations at the base of the overland slopes.
- Note that the results for Zone B in round 4 have been excluded from this assessment. The sample was likely to have excessive TP due sediment collected sampling under low flow conditions. Similarly, the WWTP issue highlighted in the nitrate results above appears to also have affected phosphorus concentrations. Round 8 has been excluded from the removal efficiencies described above.

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4.9 Dissolved Reactive Phosphorus Performance

Apart from the sediment impacted samples described above, Dissolved Reactive Phosphorus (DRP) trends closely follow Total Phosphorus. DRP levels in the treated wastewater discharge were lower than previously reported, with a median concentration of 0.23 g/m³ based on the lab results, compared to the previously reported median of 0.73 g/m³. At the farm pond outlet, DRP levels were also lower, with an average of 0.19 g/m³ compared to the previously reported median concentration of 0.38 g/m³.

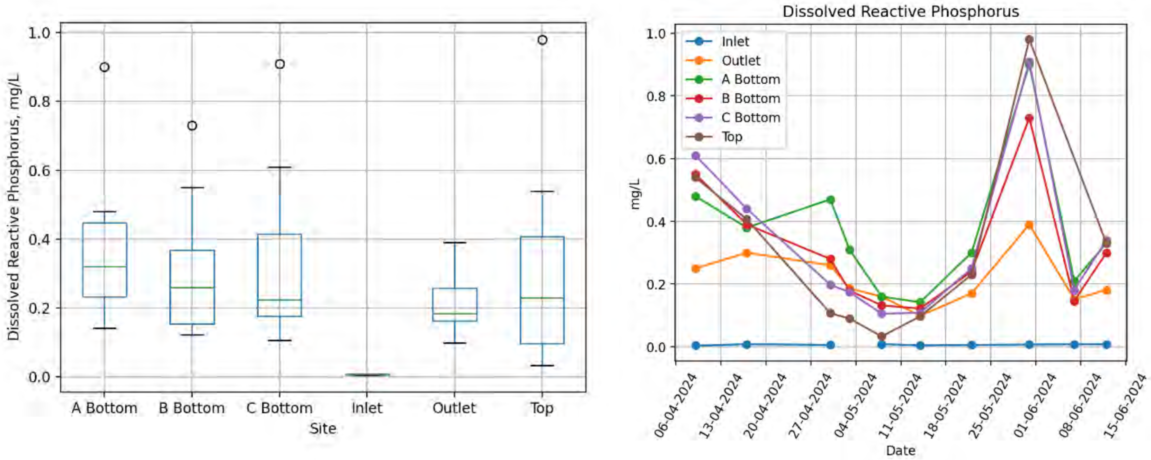


Figure 11: Dissolved Reactive Phosphorus Concentrations

Based on the sampling results, the following observations have been made:

- Similar to the trend observed from TP removal performance, the treatment performance varied across the zones with increases of 30%, 4%, and 11% for Zones A, B, and C respectively.
- Similar to the pond outlet concentrations of TP, DRP outlet concentrations were relatively consistent, and changes reflected the fluctuating treated wastewater concentrations.
- As observed with the total phosphorus results, all the DRP removal was achieved in the pond. Overall, the combined slope/pond system achieved a median DRP reduction of 26%. This would indicate that the pond is providing approximately 35% reduction in DRP when allowing for an average increase across the slopes of 10%.

4.10 *E. Coli* and Faecal Coliforms

E. Coli and Faecal Coliform concentrations were generally similar throughout the sampling. The results across the slopes and pond are presented below in Figure 12. As predicted in PDP Memorandum 2, there are significant increases across the slopes and through the pond. *E. Coli* and Faecal Coliform concentrations are generally low in the treated wastewater with median concentrations of 5 and 20 cfu/100 mL respectively (PDP, 2024). At the pond outlet the median concentration for both was 250 cfu/100 mL.

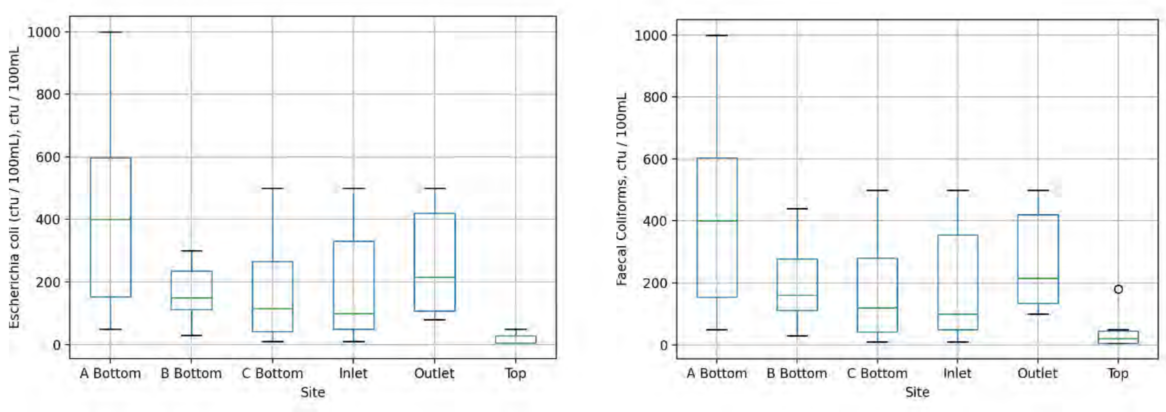


Figure 12: *E. Coli* and Faecal Coliform Box and Whisker Plots

The median increase in concentration across the combined system was a 19-fold increase for both *E. Coli* and Faecal Coliforms. Based on the sampling results, it appears that the overland flow slopes are the primary contributor to increasing faecal contamination with approximately 2/3^{rds} of the total median increase occurring on the slopes.

It's likely that this faecal contamination is from environmental sources. For most of the sampling, it is assumed that the faecal matter is avian. However, in the eighth round of sampling there were signs (pugging, faecal matter) that cattle had been inside the overland flow area. This is likely to contribute to the increasing faecal load observed.

It is strongly recommended that cattle and other farm animals are prevented from accessing the overland flow area, either intentionally or unintentionally.

4.11 Other Observations

The key observations and conclusions based on the available laboratory results are as follows:

- BOD levels were generally below the laboratory detection limit of 2 g/m³ across all samples collected from the OLF slope, including the treated wastewater from the dispersion lines. No detectable increase in BOD was generated across the OLF slope or through the pond. Outliers in BOD levels were noted in samples collected from the bottom of Zone B and the inlet from the third, fourth and sixth rounds of sampling, this was due to low wastewater flow in these zones, leading to disturbance and sediment pickup during sample collection.

  PDP highlighted the risk of increasing BOD concentrations in Memorandum 2, however, no increase in BOD was detected. It appears that this risk is low with the slope grade and planting of the existing OLF.

- Turbidity levels slightly increased as treated wastewater flowed through the OLF slope, with notably elevated levels at the inlet and bottom of Zones A and B during the third sampling round. These are considered outliers due to low wastewater flow in these zones, leading to disturbance and sediment pickup during sample collection. The general increase in turbidity across the slope highlights the risk identified in Memorandum 2 regarding potential TSS increases in certain OLF systems. However, the water discharged from the slopes still has excellent clarity with turbidity <5 NTU on average.

- Chlorophyll-a levels were below the laboratory detection limit of 0.003 g/m³ across all samples, except for the inlet in the first four sampling rounds. This indicates that there is not significant growth of algae except for the stagnant area near the pond inlet which returned slightly higher chlorophyll-a levels consistent with observations of algal growth during sampling. Due to the consistent results below the laboratory detection limit, testing for chlorophyll-a was discontinued for last six sampling rounds.

- From the initial laboratory results, the samples from dispersion lines (A Top, B Top, and C Top) show roughly equal contaminant concentrations. This was expected; however, it was necessary to confirm that residence time in the dispersal system was not modifying the nature of the influent wastewater. From the third round of sampling onwards, only one sample has been collected from the dispersion lines at the top of Zone A, B or C.

5.0 Summary

Based on the sampling results obtained, the following general conclusions have been drawn:

- Concentrations of sodium and chloride as well as electrical conductivity are consistent across all sampling locations except for the pond inlet. This indicates that flows out of the farm pond are almost entirely wastewater over the sampling period. Considering this, previous assumptions (Memorandum 2) about negligible change in electrical conductivity (other than due to dilution) through the system are likely correct.

- The overland flow system, excluding the pond, provides additional removal for a variety of nitrogen species including ammoniacal nitrogen (26%-55%), nitrate nitrogen (4%-21%), organic nitrogen (7%-16%). Overall, the overland flow slope total nitrogen removal efficiency ranged from 6% to 24%. These removal rates are based on the median removal rates for each of the three zones within existing overland flow system.

  Despite these removal rates, the results demonstrate that, under the current system, the pond provides most of the system nitrogen removal. Most wastewater flows through Zone C which consistently produced the lowest nitrogen removal results; median total nitrogen removal for Zone C was 6%. Comparatively, the combined slope/pond system resulted in a median nitrogen reduction of 29% from the top of slope to the farm pond outlet.

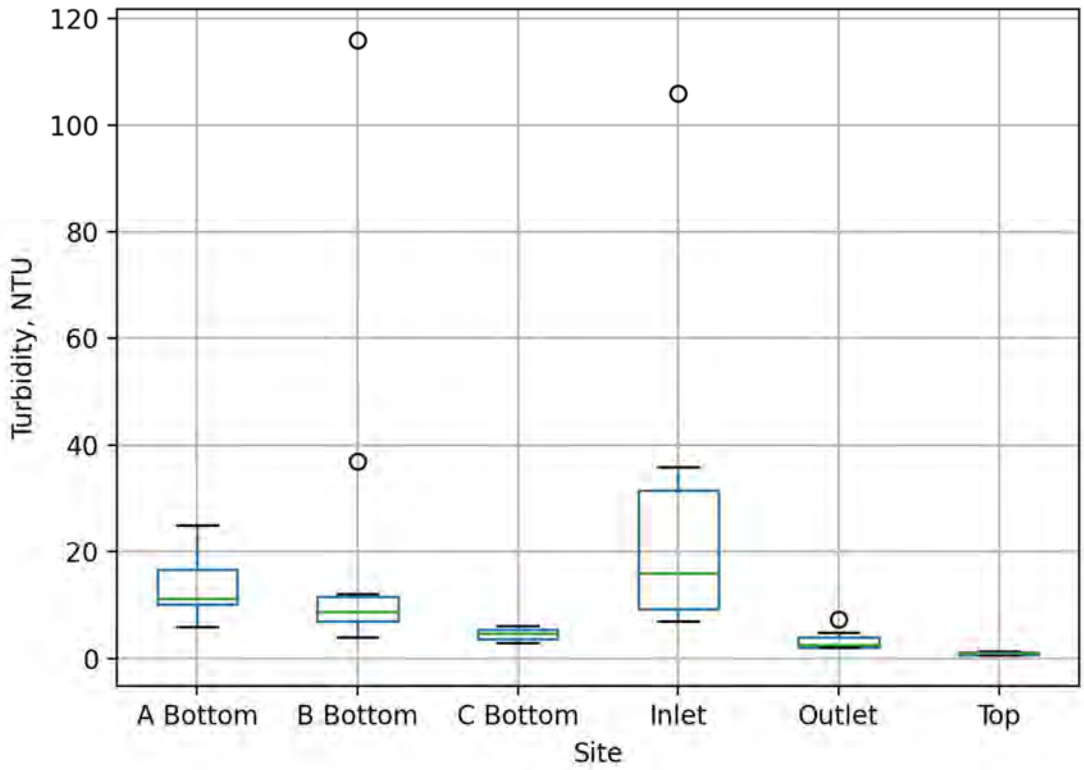
- During the sampling period, phosphorus concentrations typically increased from the top to bottom of the OLF slopes. The largest increases were seen when wastewater flows were low, resulting in longer retention times. It is thought that phosphorus concentration the surface soils are in equilibrium with phosphorus concentrations in the wastewater. During the sampling period, the median total phosphorus concentration was only 40% of the long-term median. As a result of the decreased wastewater concentration, it is likely that phosphorus is desorbing from the surface soils. If phosphorus concentrations increased, it is possible that the equilibrium would shift and phosphorus in the wastewater would adsorb to the surface soils. The OLF slopes may inhibit gains from future WWTP upgrades targeting greater phosphorus removal until a new equilibrium is reached.

For the sampling period, the total removal across the slope/pond system was 20% and 26% for total phosphorus and dissolved reactive phosphorus respectively. Allowing for a 10% increase across the overland flow slopes, this indicates that the pond is providing removal rates of approximately 30% of the applied wastewater concentration for total phosphorus and 36% for dissolved reactive phosphorus.

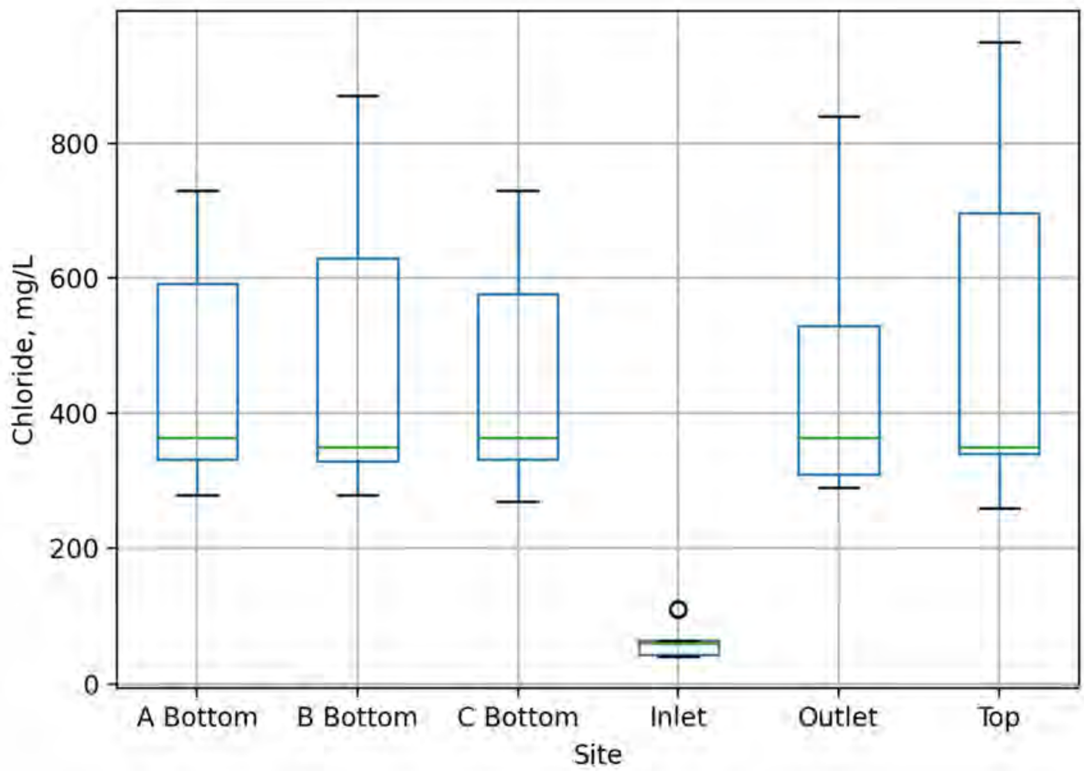
- Based on the field observations made over the sampling and the results described in this report, it is clear the uneven and inconsistent nature of the dispersion system is reducing the level of treatment provided by the overland flow slopes. The absence of gentle, well graded slopes and rapid concentration/channelisation of wastewater within Zones B and C is reducing the nitrogen attenuation capacity of these zones. An improved dispersion system and better preparation of the slopes to promote sheet flow may result in improved performance of the existing overland flow system.
- Despite good performance observed for specific contaminants in Zones A and B, the performance investigation shows that the pond provides the majority of treatment for key contaminants including total nitrogen, nitrate-nitrogen, total phosphorus and dissolved reactive phosphorus.
- Conversely, ammoniacal-nitrogen concentrations generally decrease over the overland flow slopes before concentrations increase in the pond. As detailed in Memorandum 2, this is thought to be due to mineralisation of organic nitrogen in anaerobic areas of the pond/pond base. Avian faecal matter may also make a minor contribution to this increase.
- Risks of increase BOD and TSS/turbidity concentrations highlighted in Memorandum 2 were not realised in the sampling completed to date. However, there is a clear increase in faecal contamination post discharge to the top of the overland flow slopes. Faecal coliform counts increase both over the slopes and through the pond, most likely from avian sources, and in select instances from cattle accessing the overland flow area. Generally, faecal coliform counts were consistent with those detected in the upstream catchment.

Generally, the sampling completed confirms the assumptions made and anticipated results previously set out in PDP Memorandum 2. However, as highlighted in Memorandum 2, the pond currently appears to provide the majority of additional treatment. Improvement to the distribution system and better preparation of the overland flow slopes to avoid rapid concentration of wastewater may improve the performance of the overland flow slopes in the future.

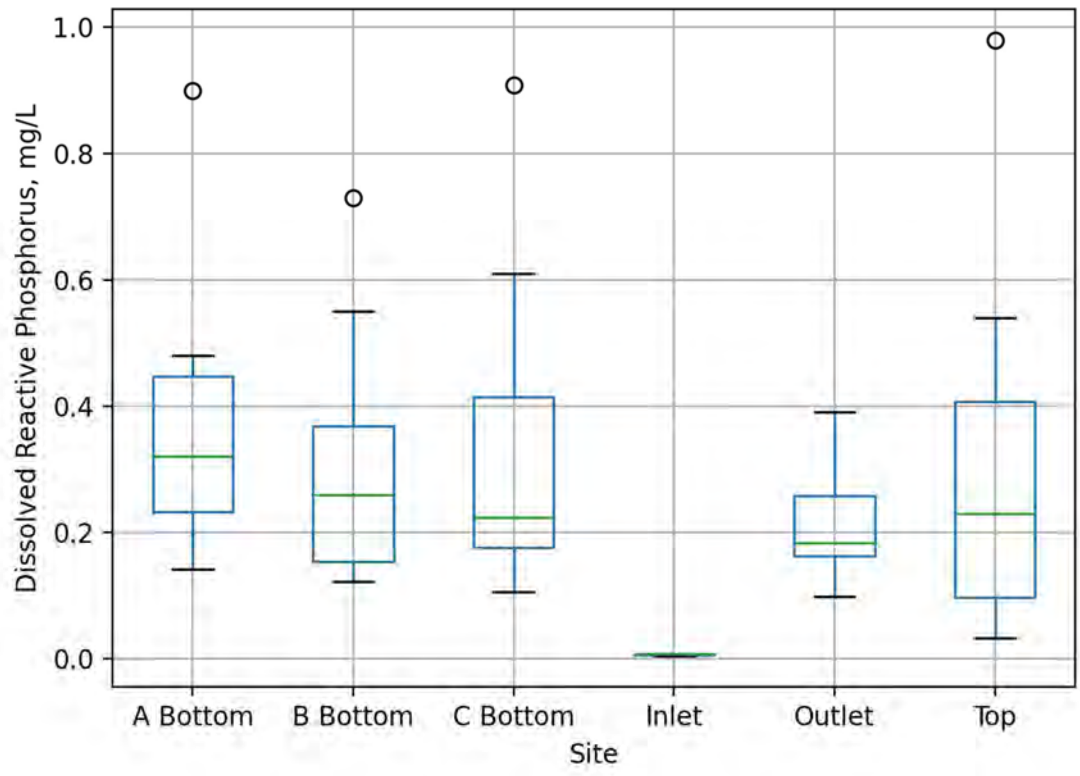
Appendix A: Graphical Results



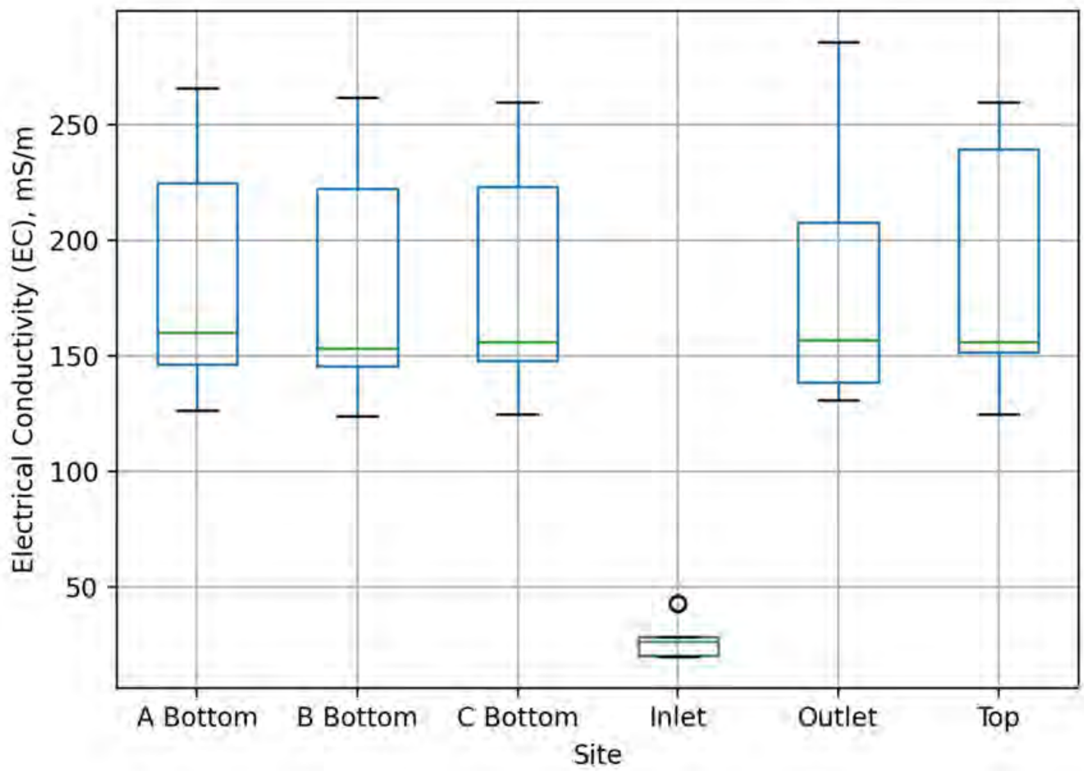
Turbidity, NTU
120
100
80
60
40
20
0
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site



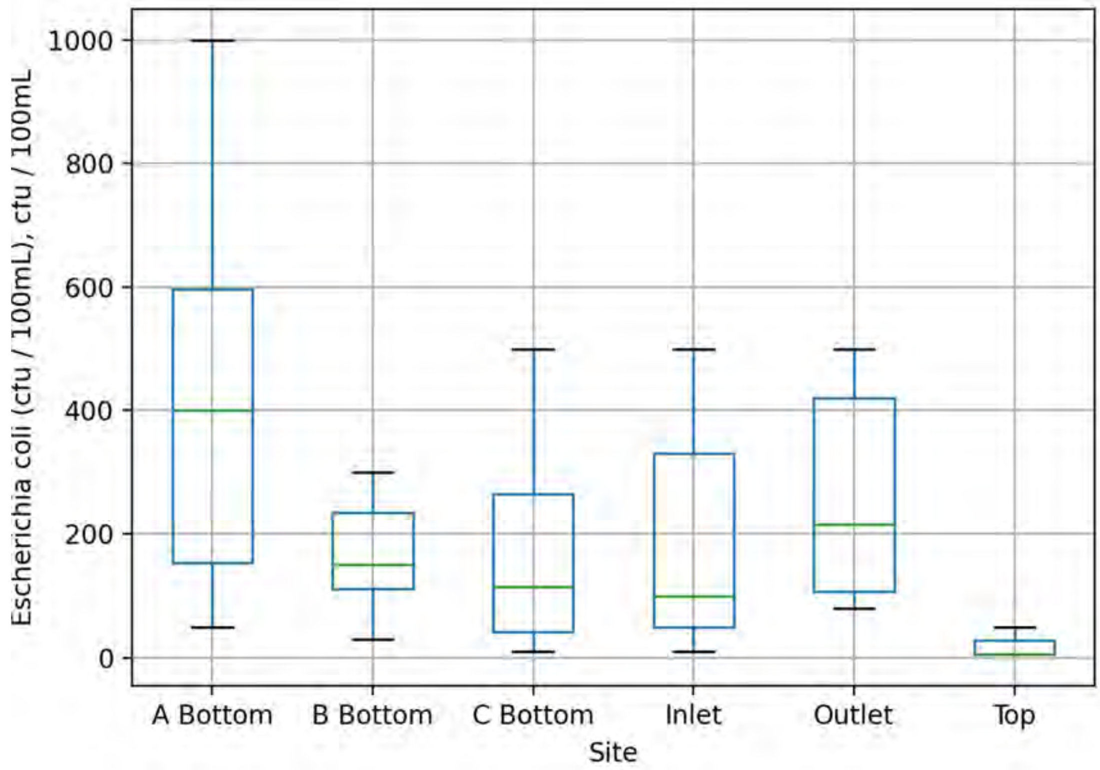
Chloride, mg/L
800
600
400
200
0
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site



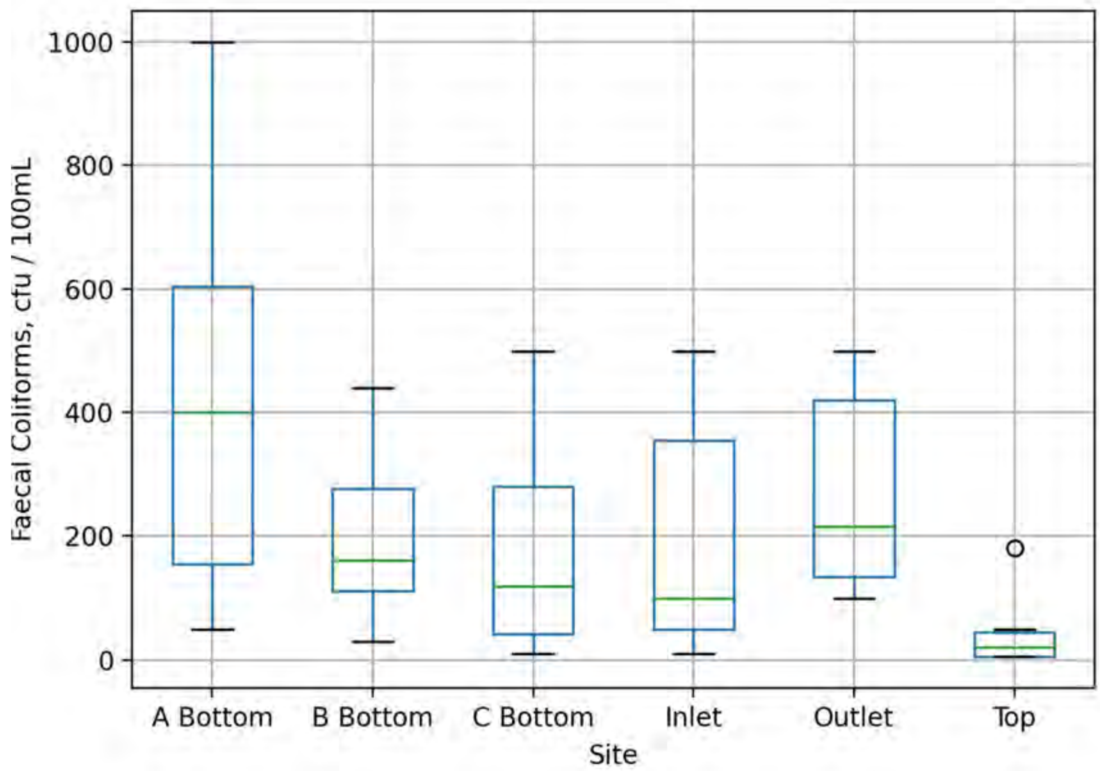
1.0
0.8
0.6
0.4
0.2
0.0
Dissolved Reactive Phosphorus, mg/L
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site



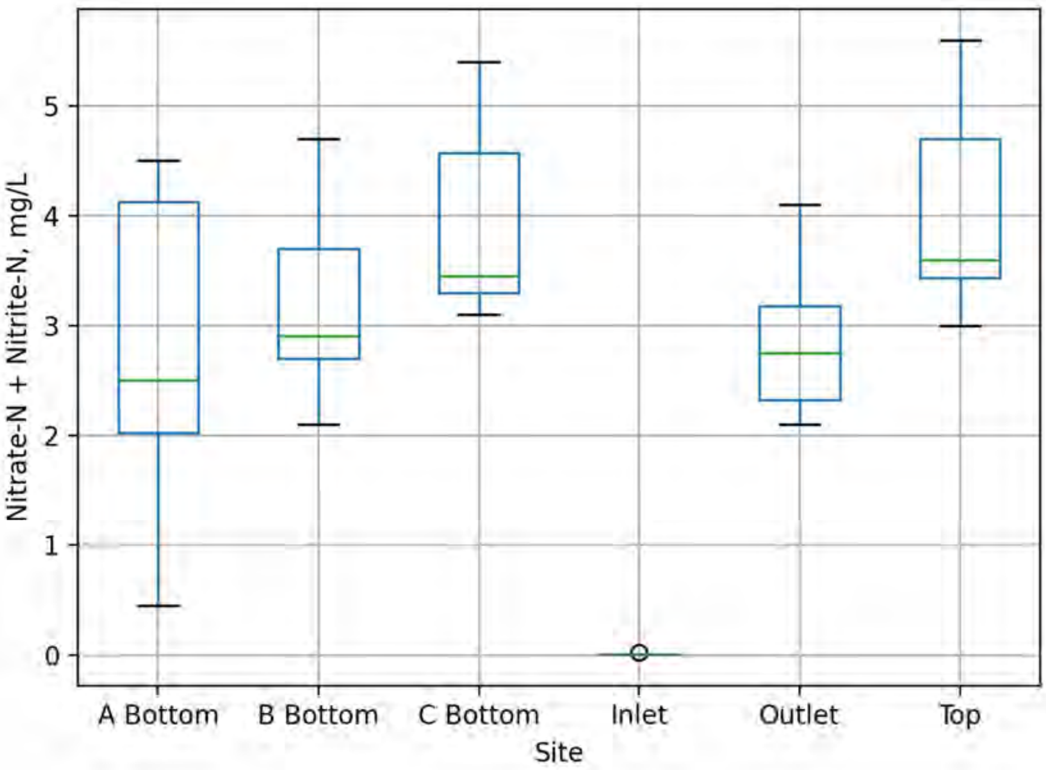
250
200
150
100
50
Electrical Conductivity (EC), mS/m
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

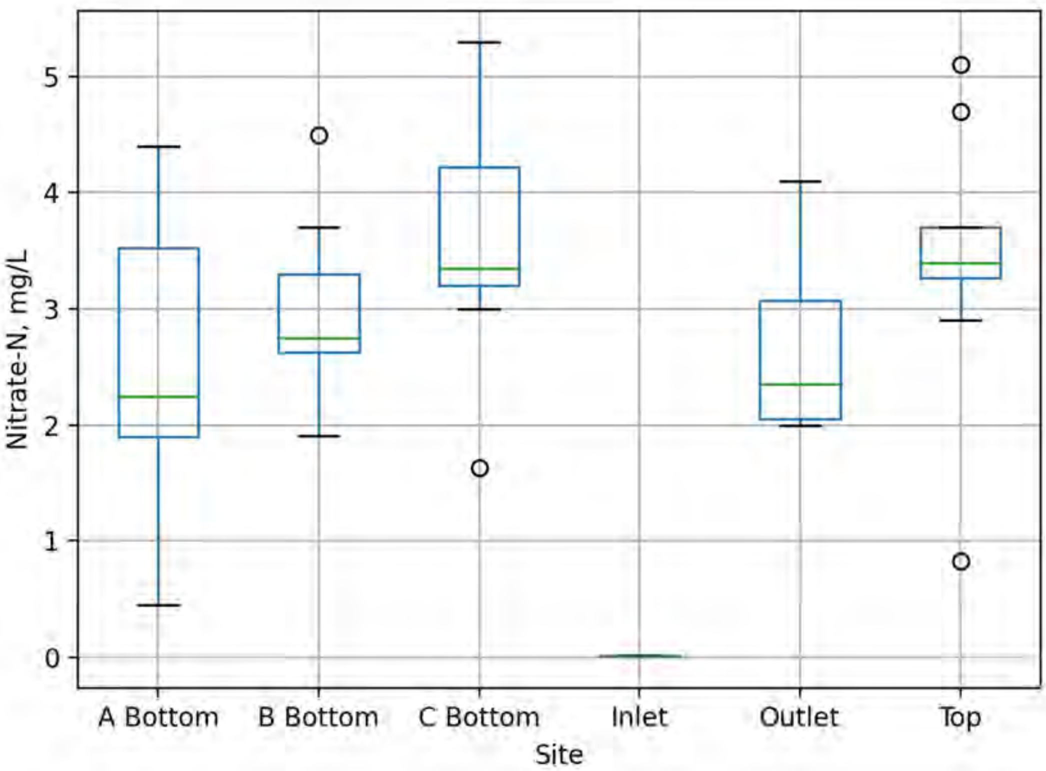


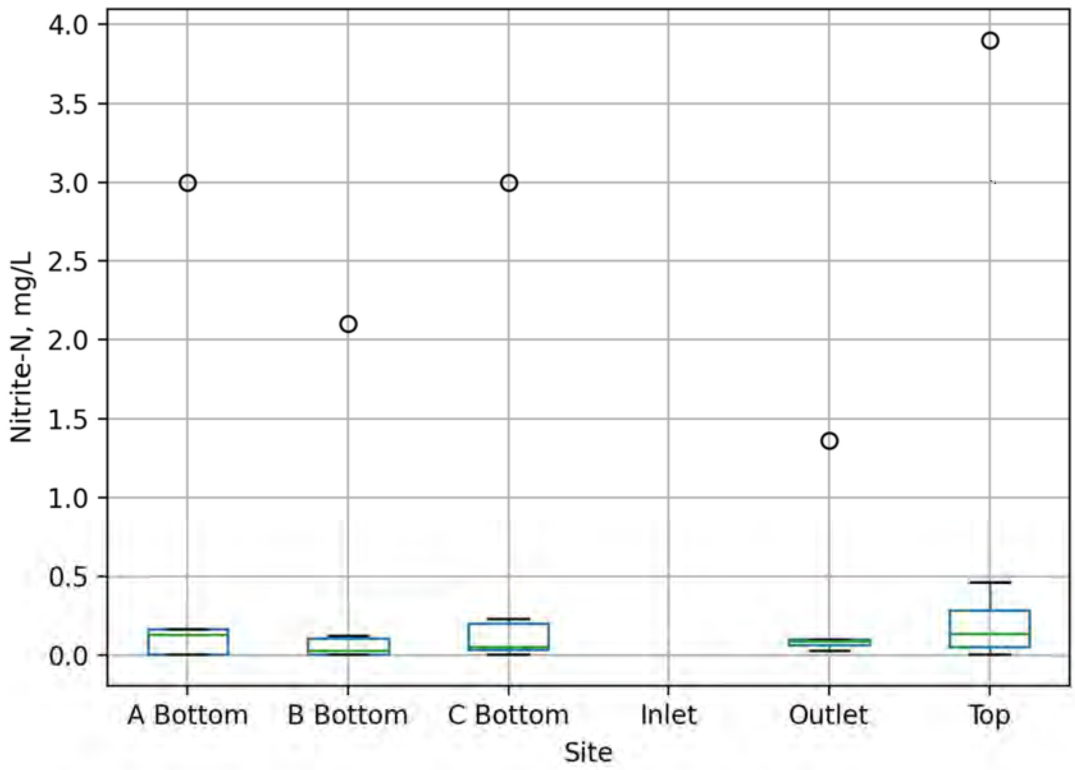
Escherichia coli (cfu / 100mL), cfu / 100mL
1000
800
600
400
200
0
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

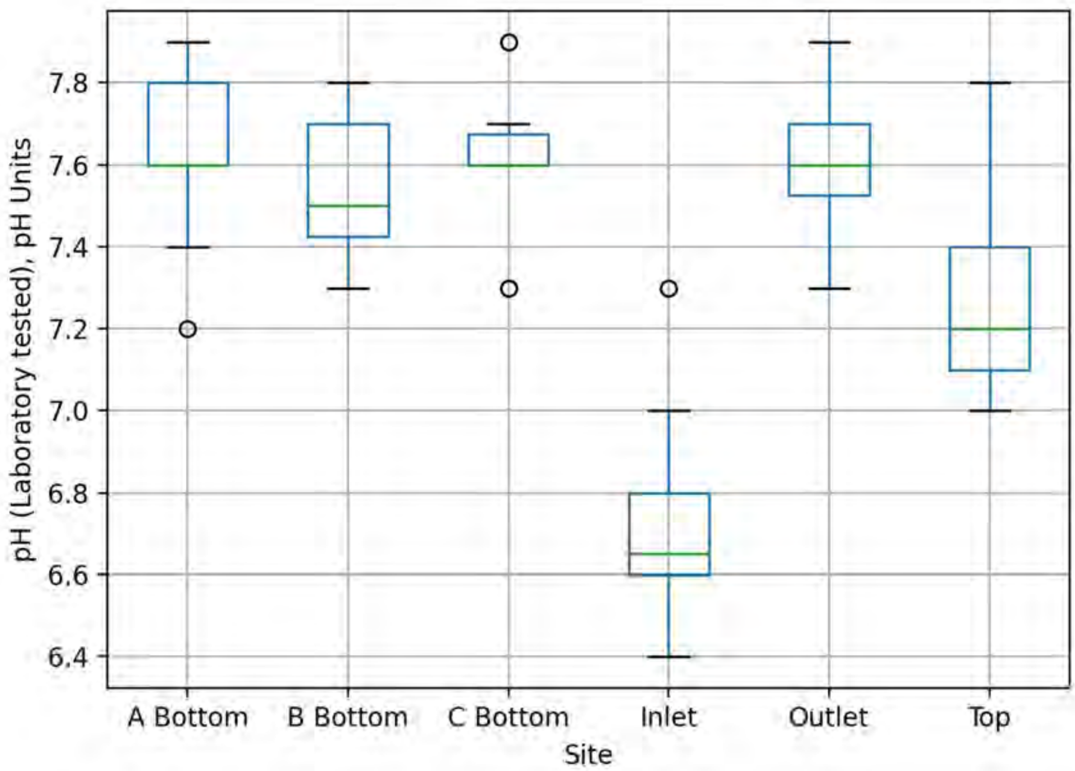


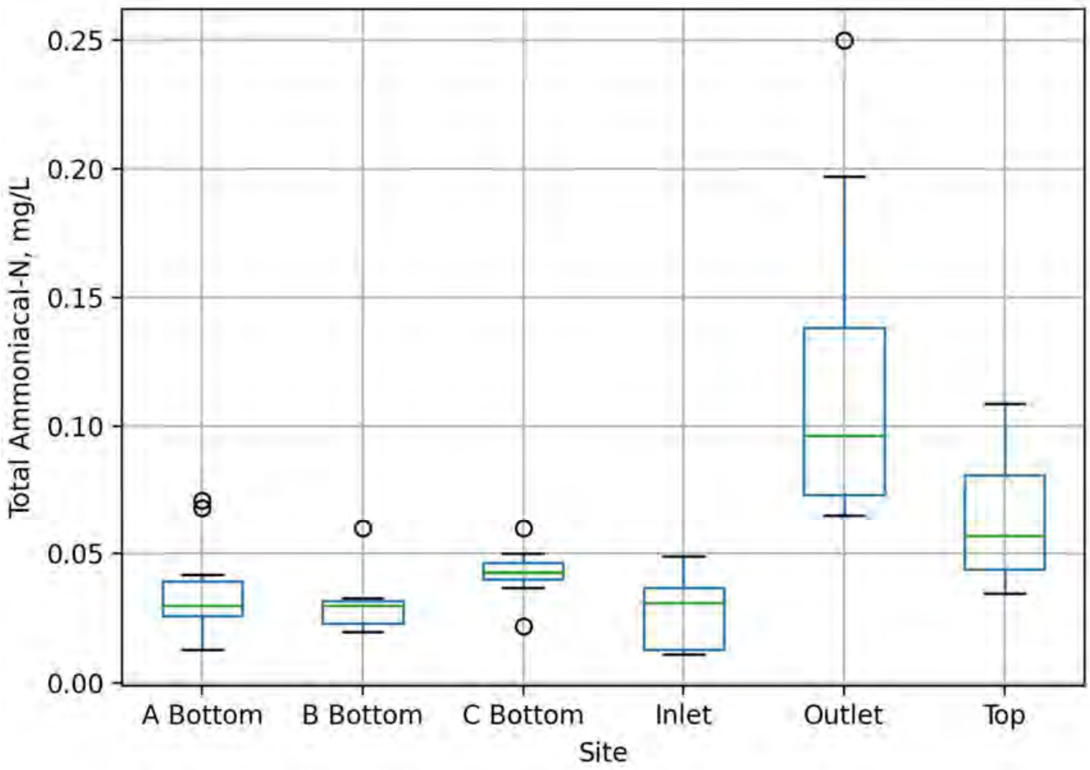
Faecal Coliforms, cfu / 100mL
1000
800
600
400
200
0
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

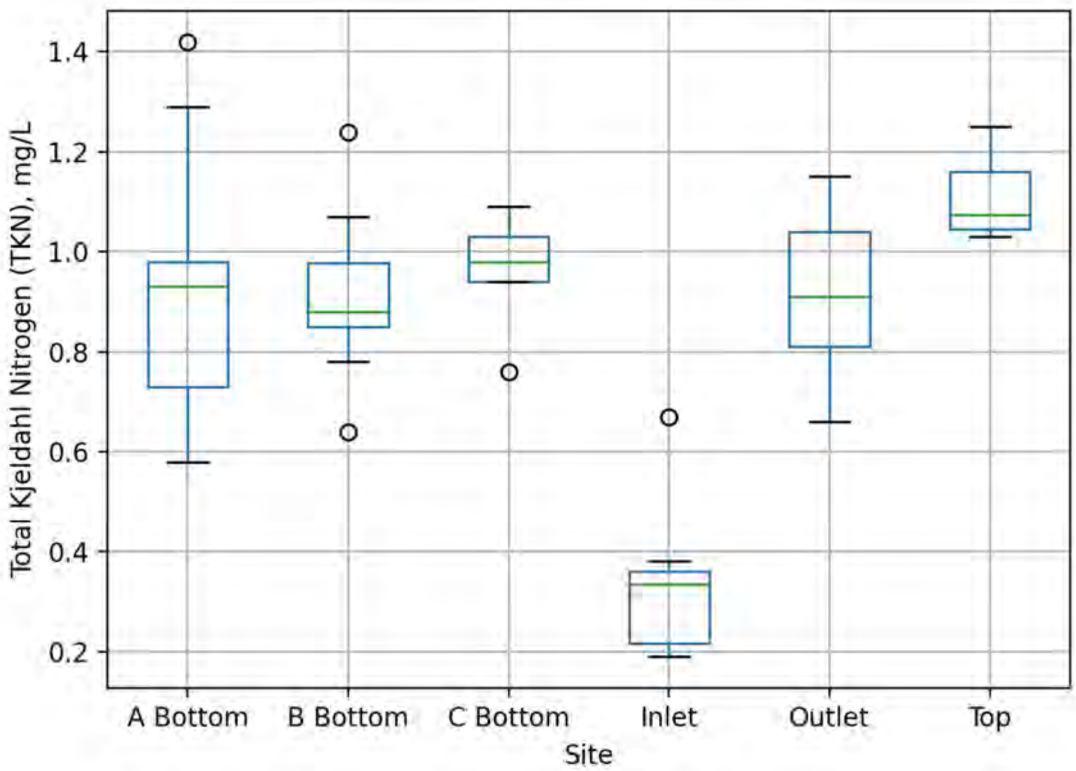

Nitrate-N + Nitrite-N, mg/L
0
1
2
3
4
5
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

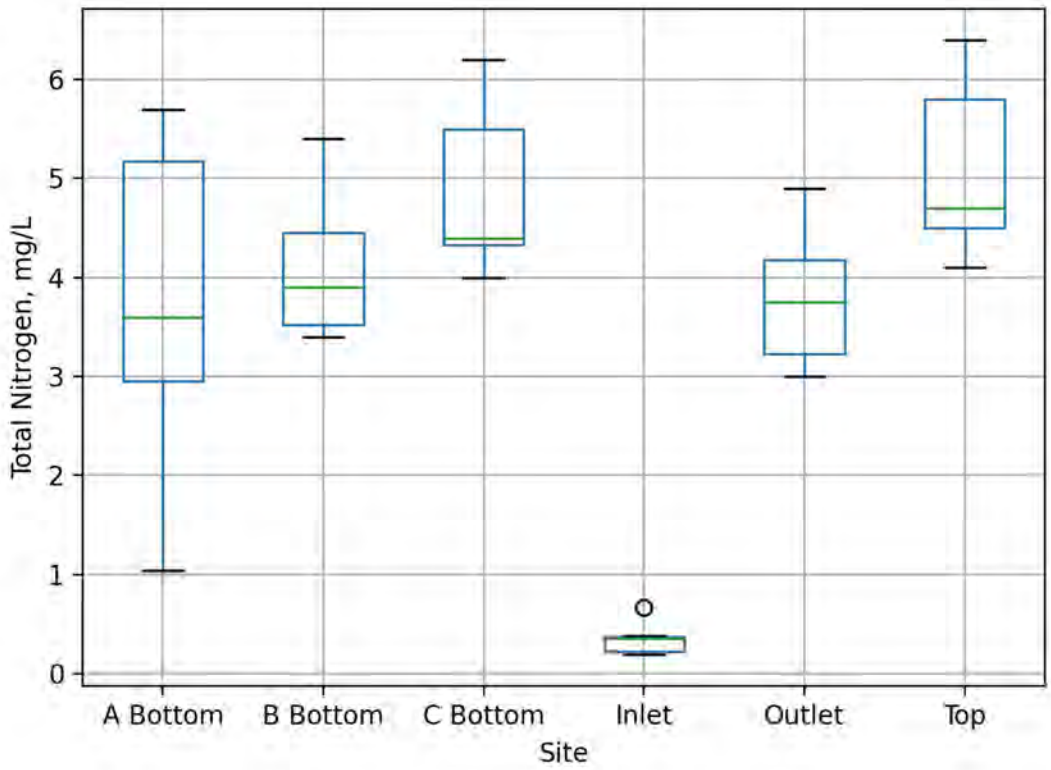

Nitrate-N, mg/L
0
1
2
3
4
5
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

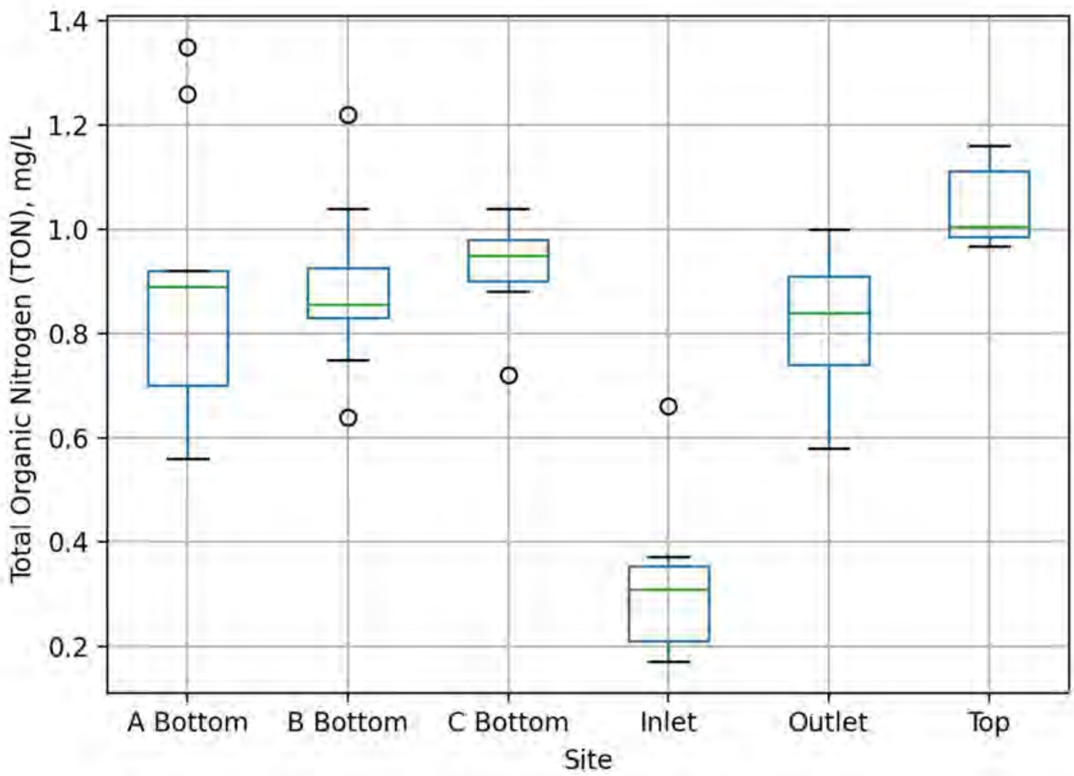

4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Nitrite-N, mg/L
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

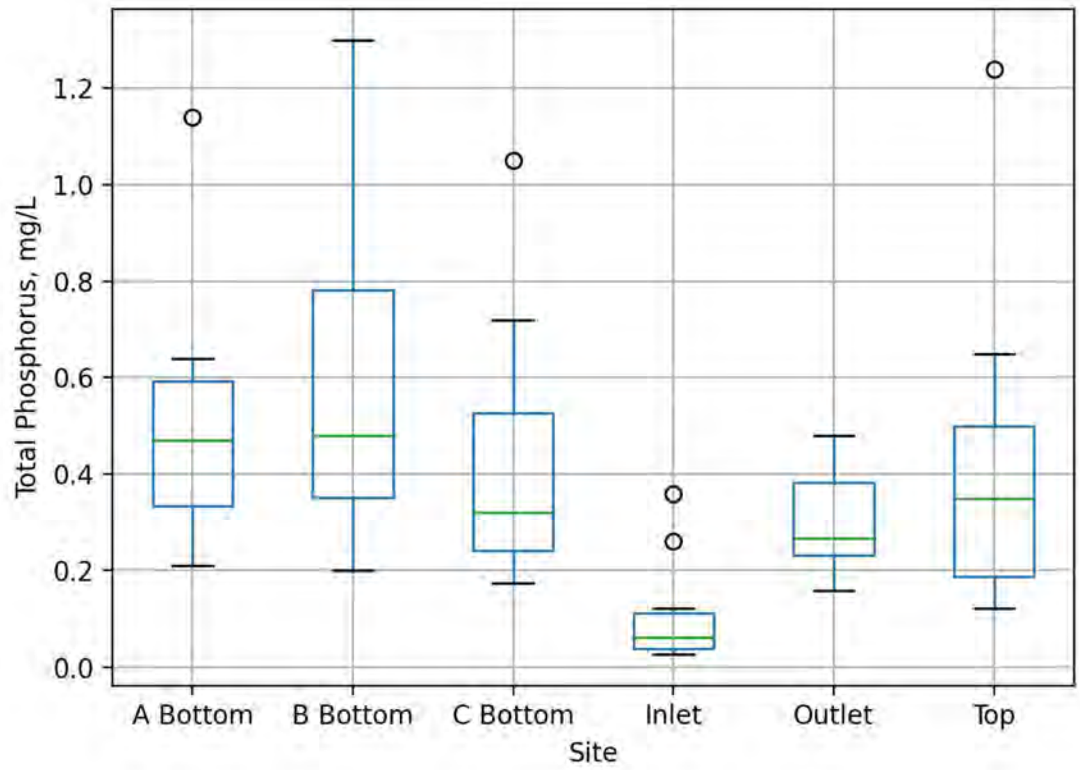

7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
pH (Laboratory tested), pH Units
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

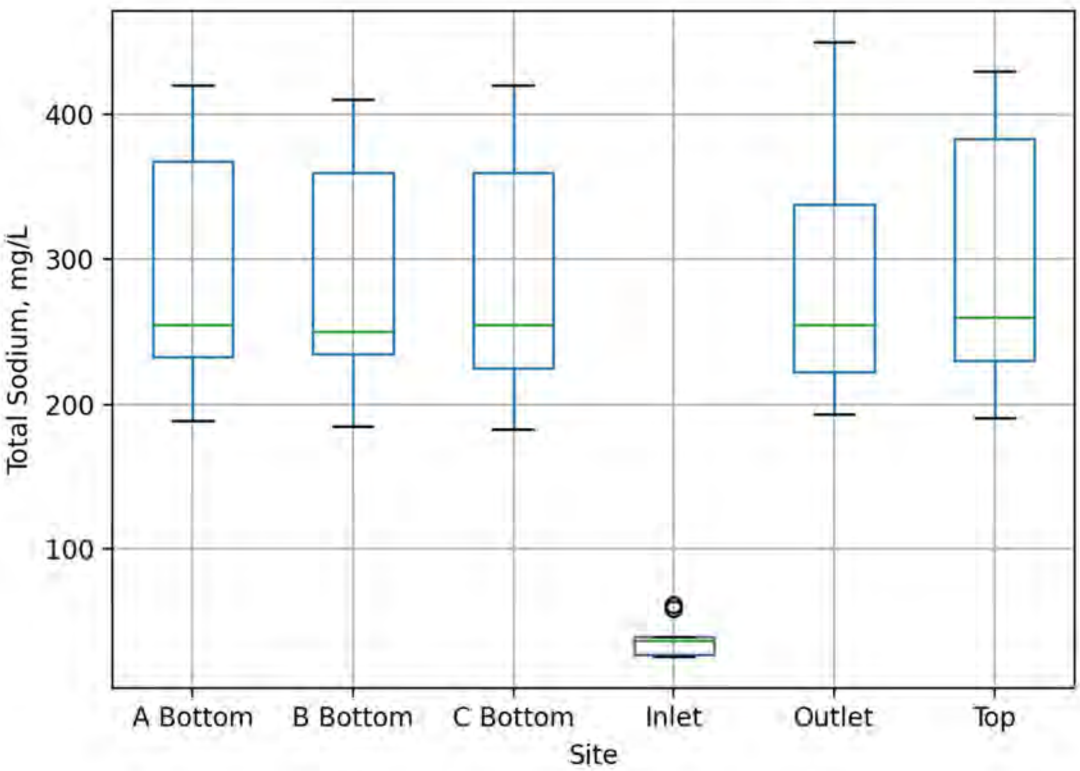

Total Ammoniacal-N, mg/L
0.25
0.20
0.15
0.10
0.05
0.00
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

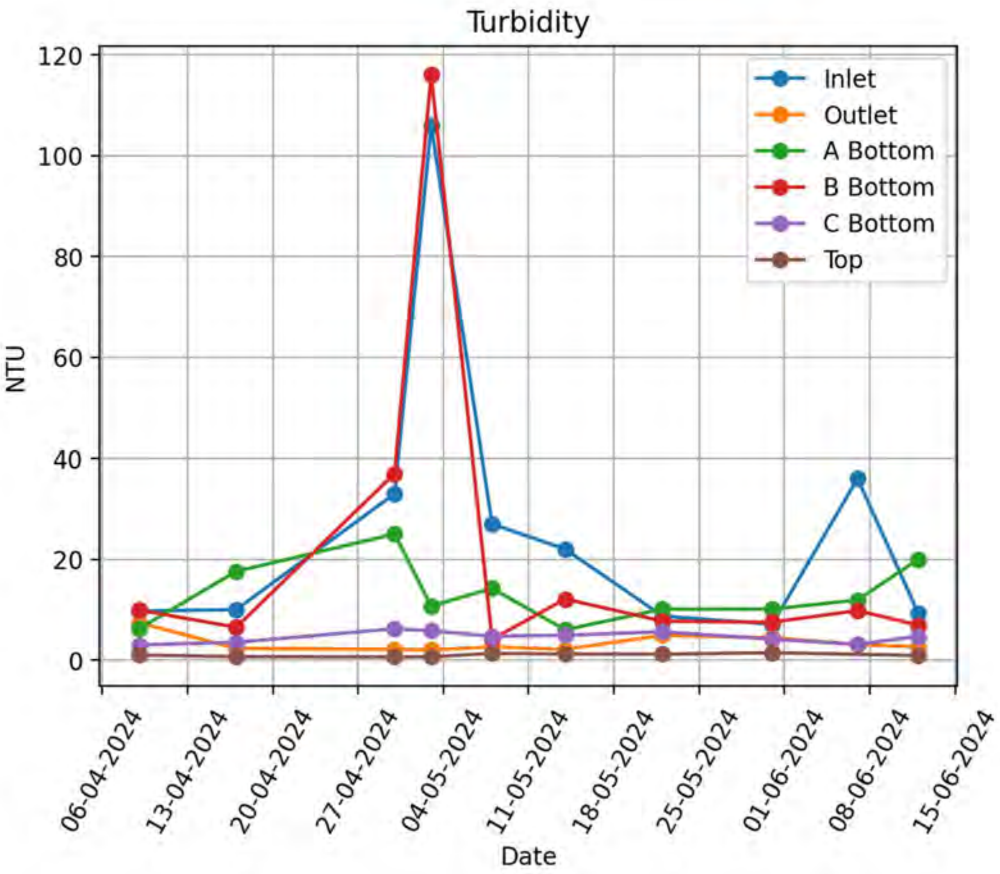

Total Kjeldahl Nitrogen (TKN), mg/L
1.4
1.2
1.0
0.8
0.6
0.4
0.2
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

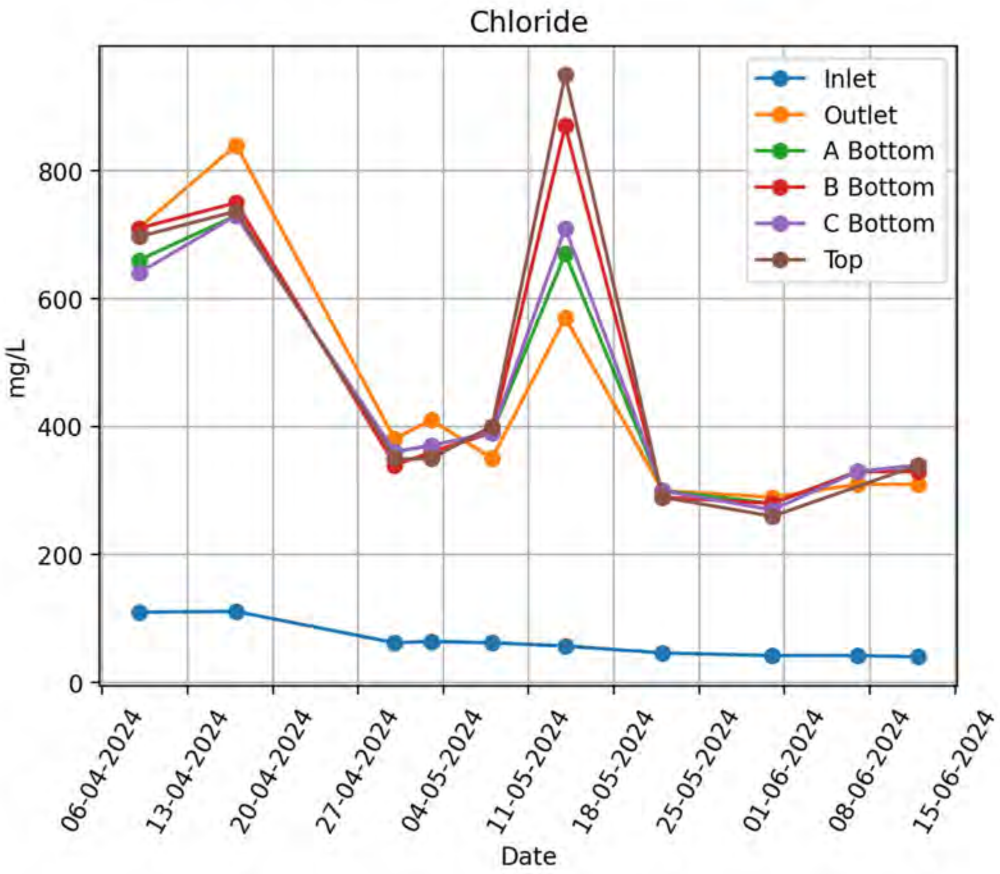

Total Nitrogen, mg/L
6
5
4
3
2
1
0
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

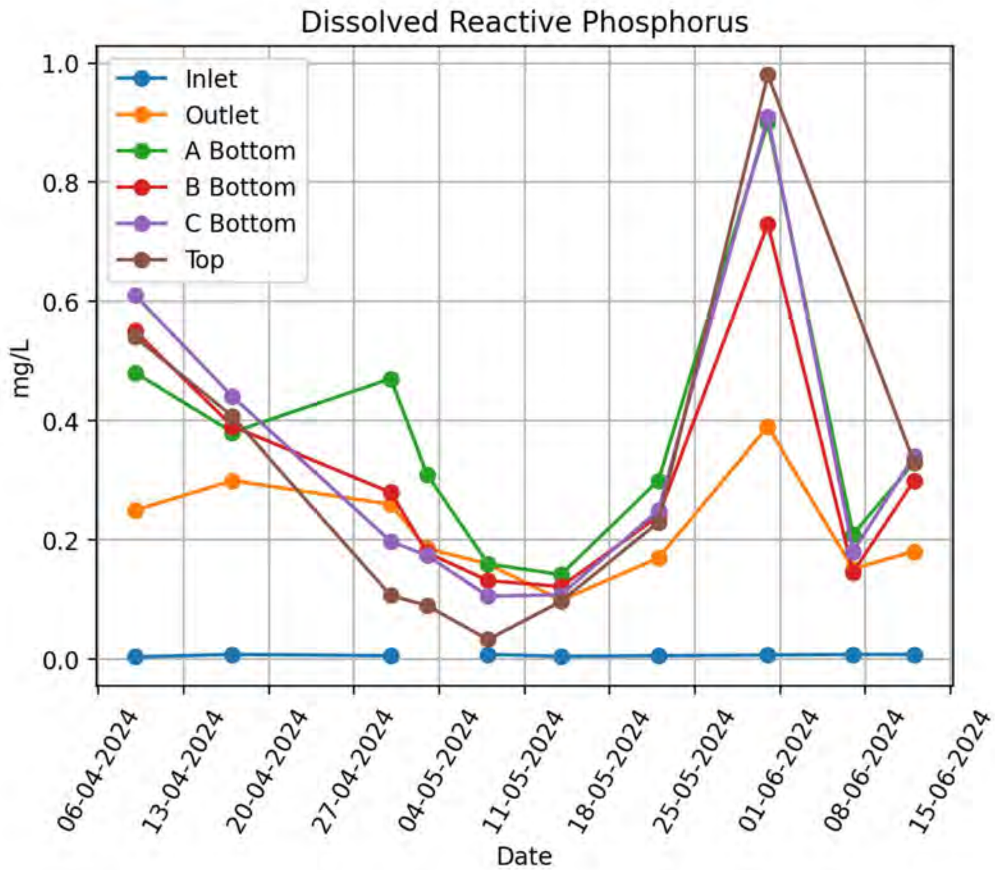

Total Organic Nitrogen (TON), mg/L
1.4
1.2
1.0
0.8
0.6
0.4
0.2
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site


Total Phosphorus, mg/L
0.0
0.2
0.4
0.6
0.8
1.0
1.2
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site

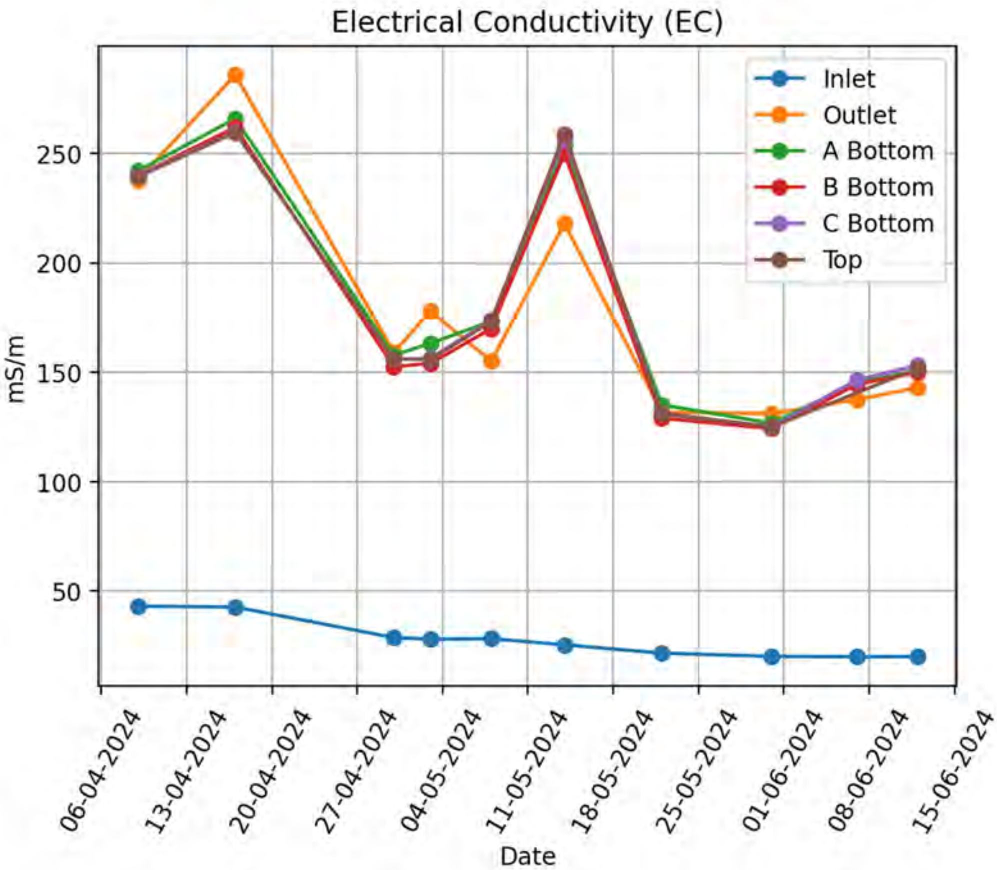

Total Sodium, mg/L
100
200
300
400
A Bottom
B Bottom
C Bottom
Inlet
Outlet
Top
Site


Turbidity
NTU
0
20
40
60
80
100
120
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

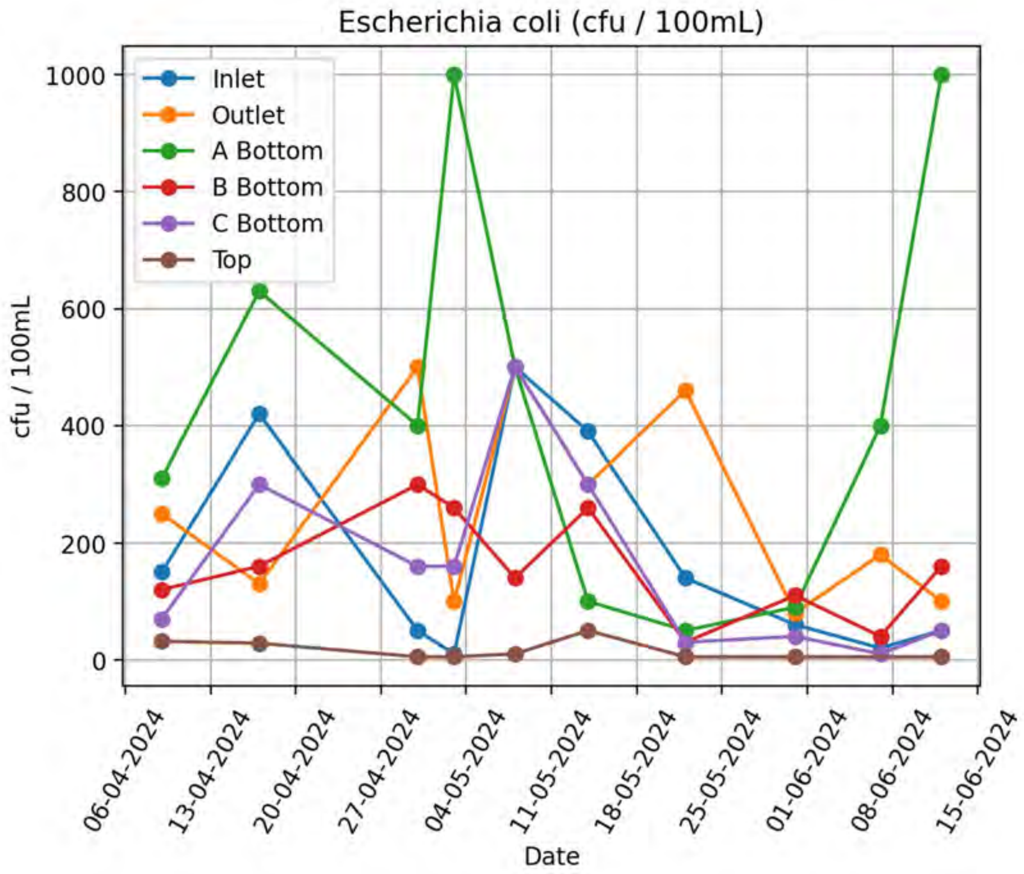

Chloride
mg/L
0
200
400
600
800
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

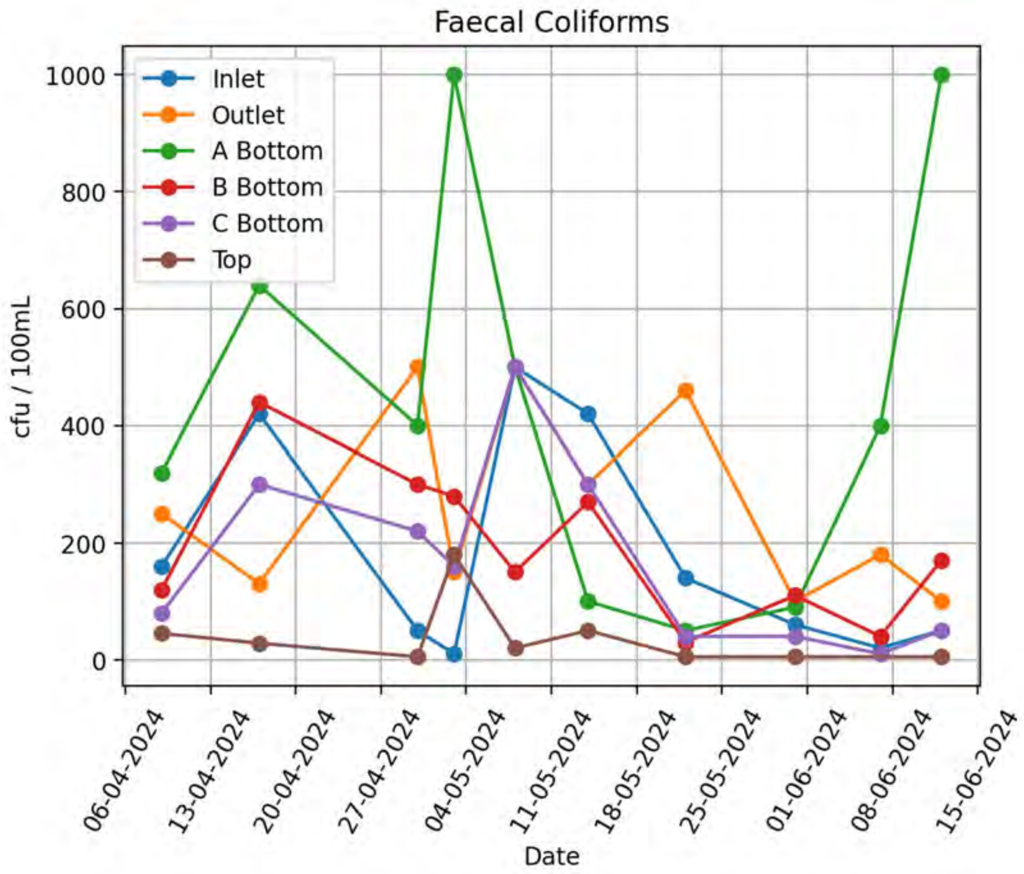


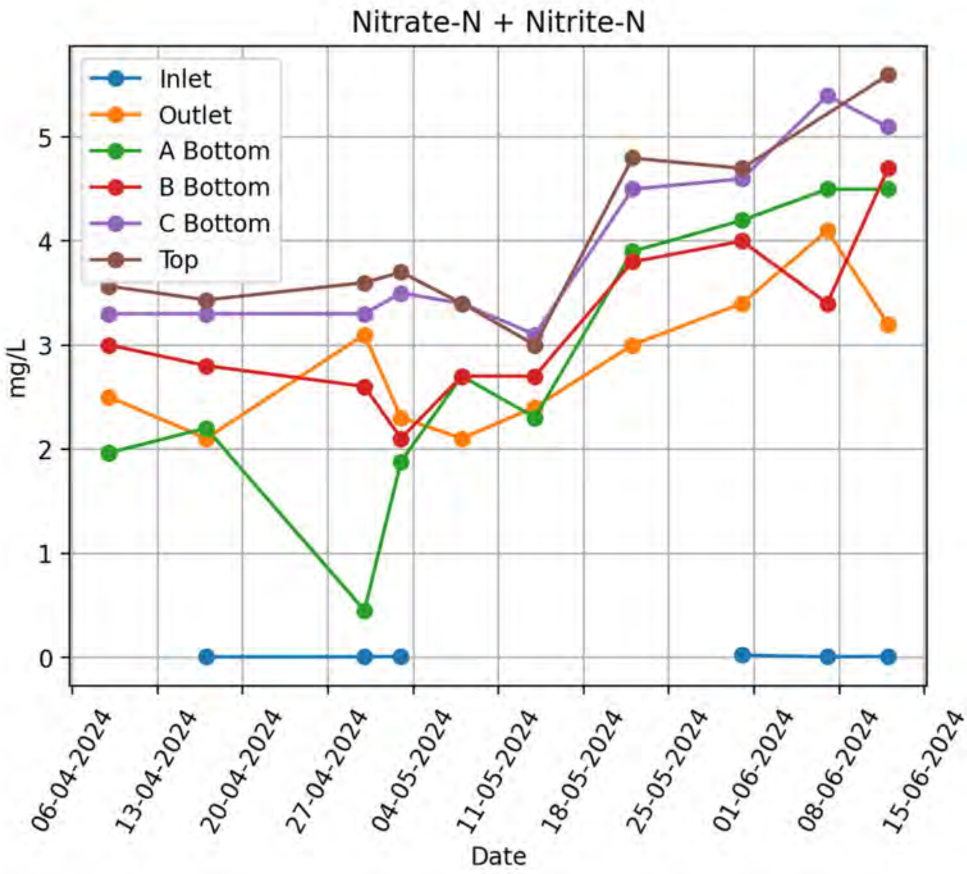
Dissolved Reactive Phosphorus
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
mg/L
0.0
0.2
0.4
0.6
0.8
1.0
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

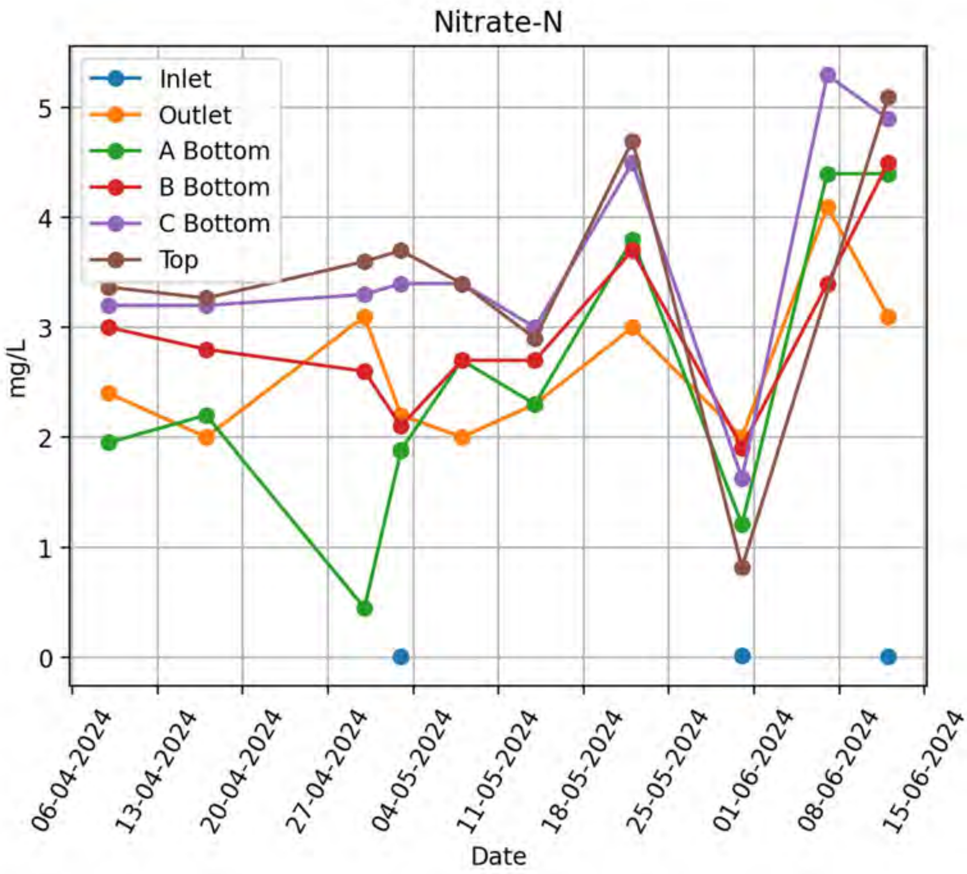


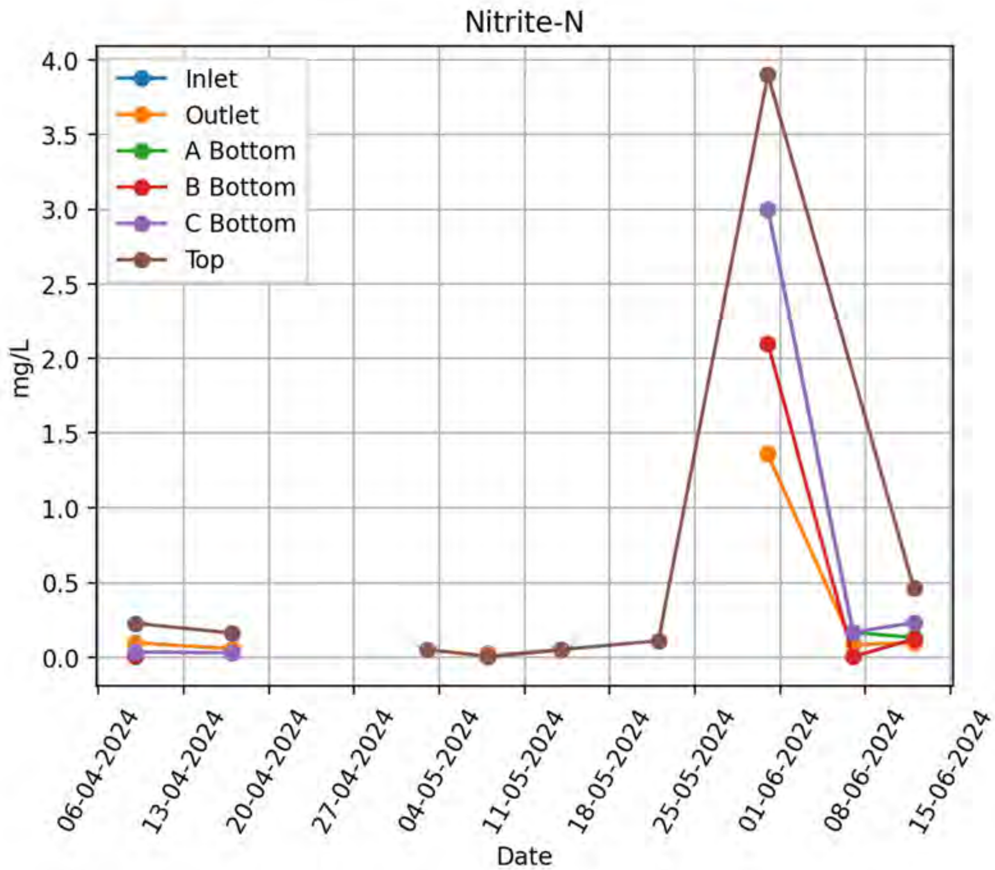
Electrical Conductivity (EC)
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
mS/m
50
100
150
200
250
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

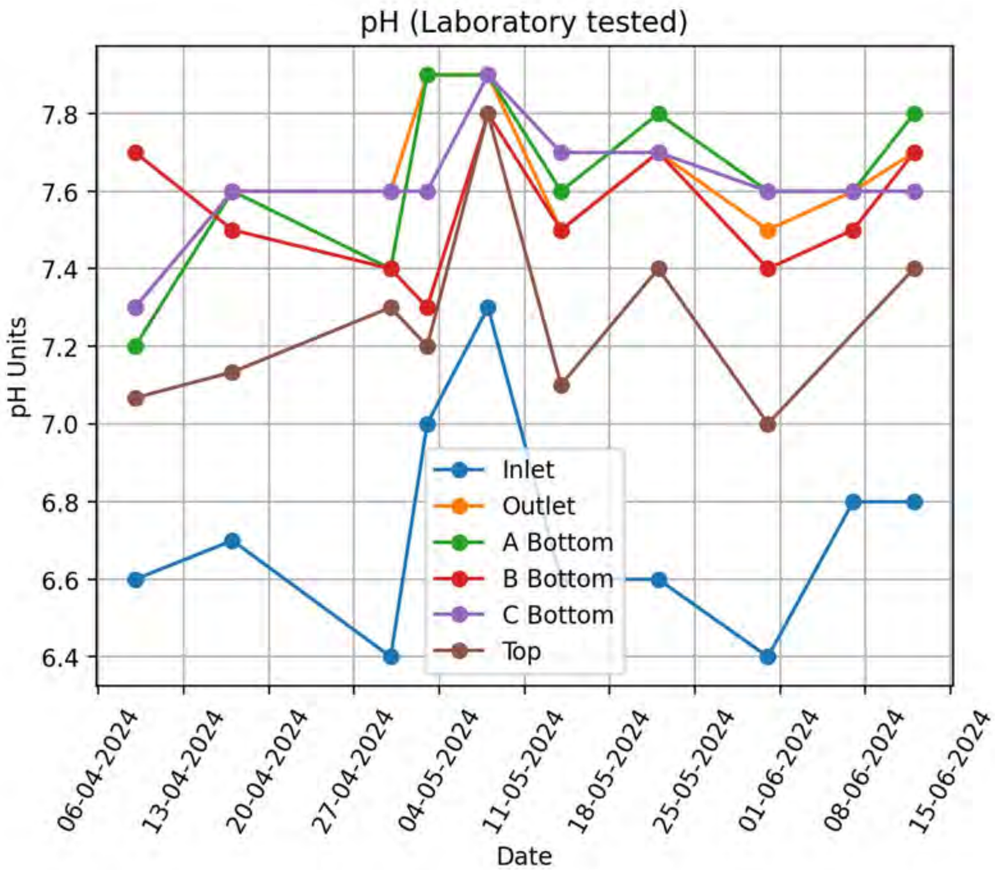

Escherichia coli (cfu / 100mL)
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
cfu / 100mL
0
200
400
600
800
1000
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

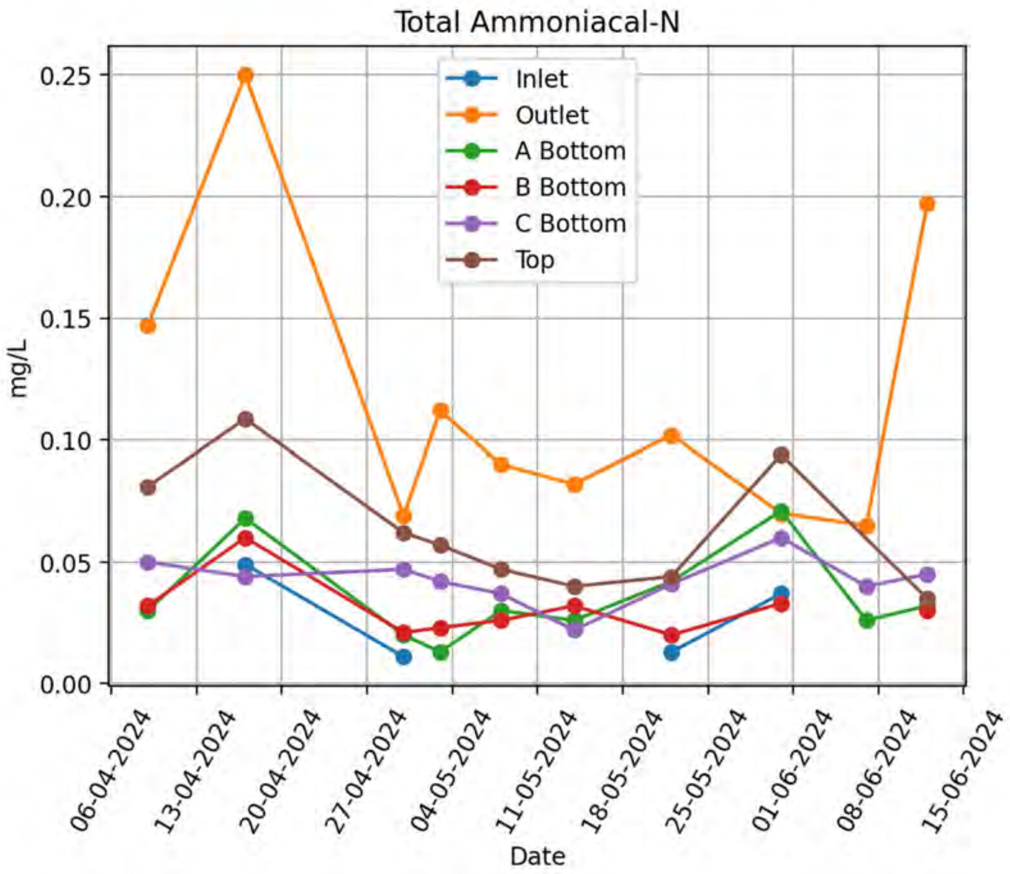

Faecal Coliforms
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
cfu / 100mL
0
200
400
600
800
1000
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

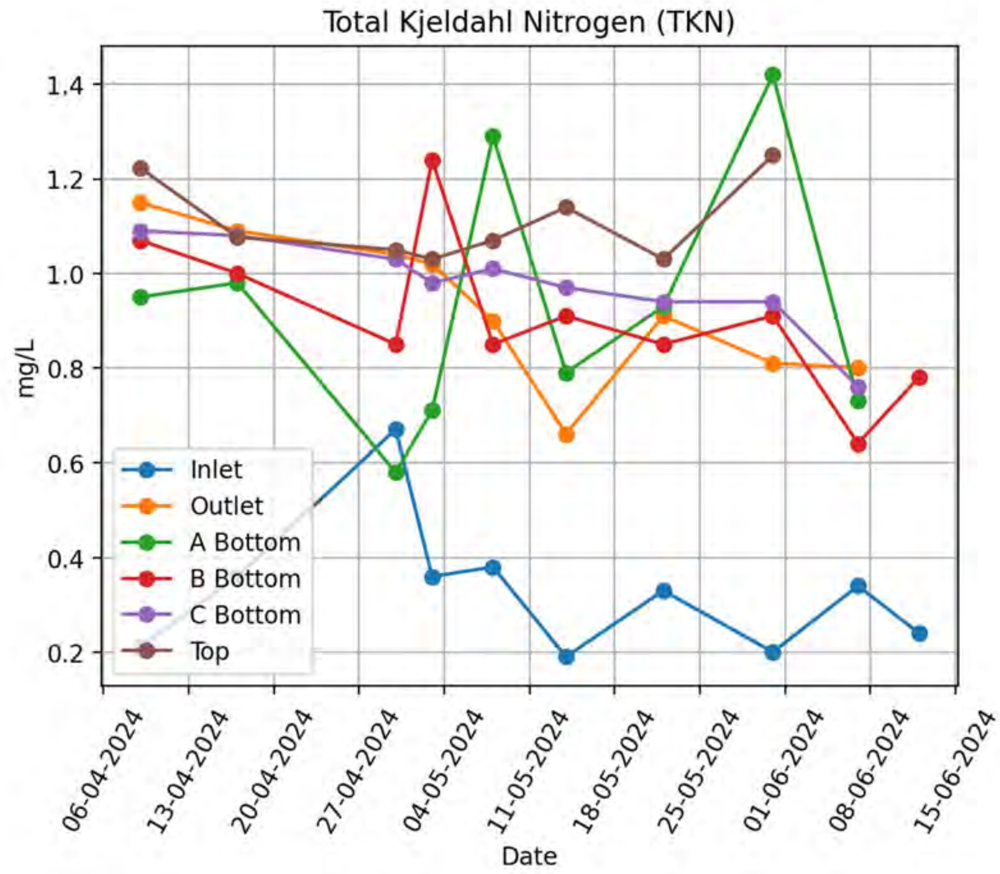

Nitrate-N + Nitrite-N
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
mg/L
0
1
2
3
4
5
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

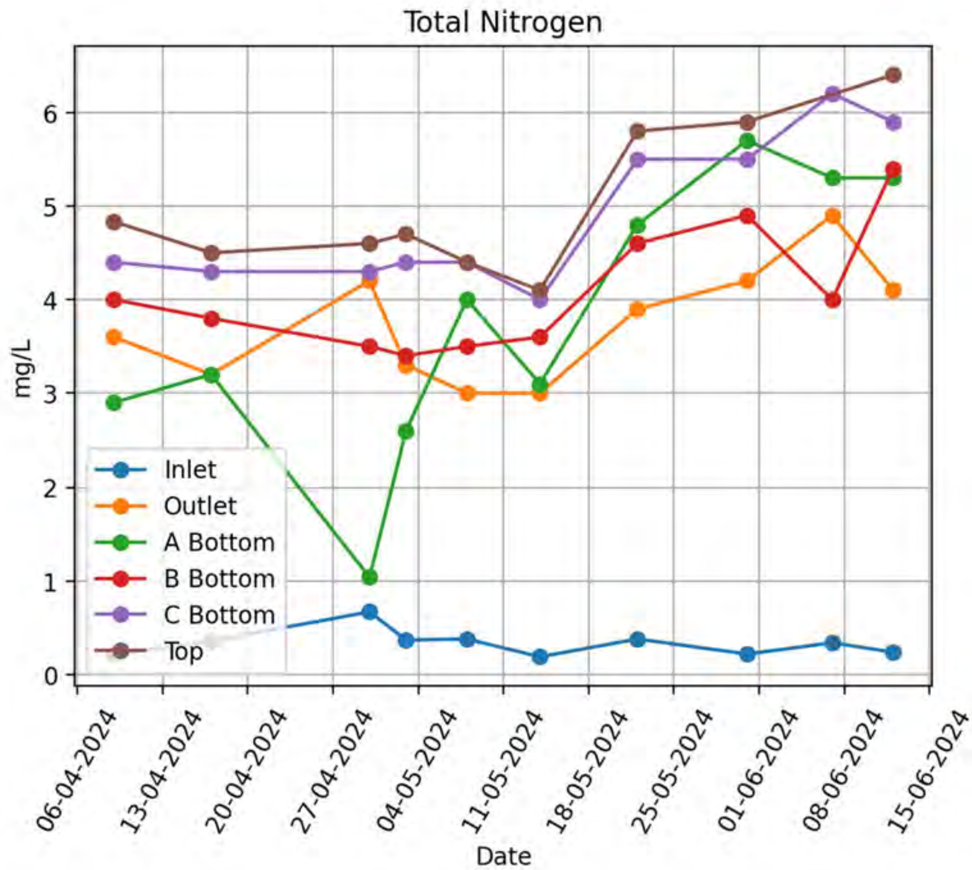

Nitrate-N
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
mg/L
0
1
2
3
4
5
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

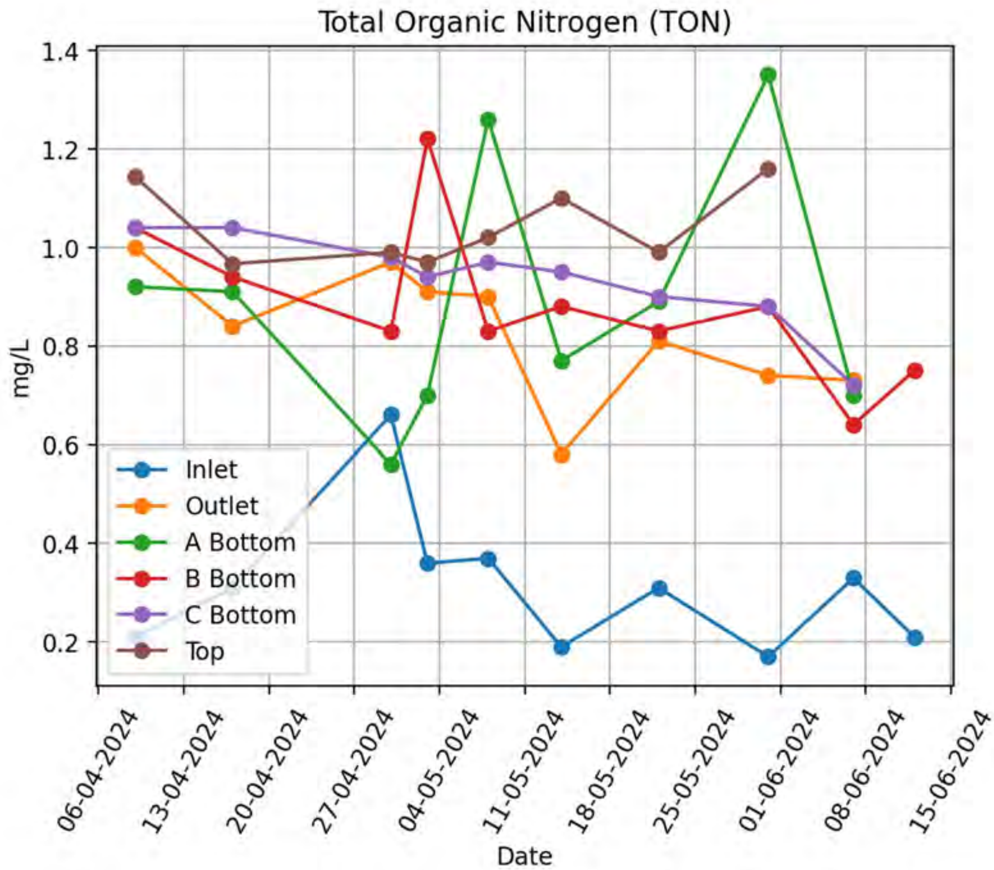

Nitrite-N
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
mg/L
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

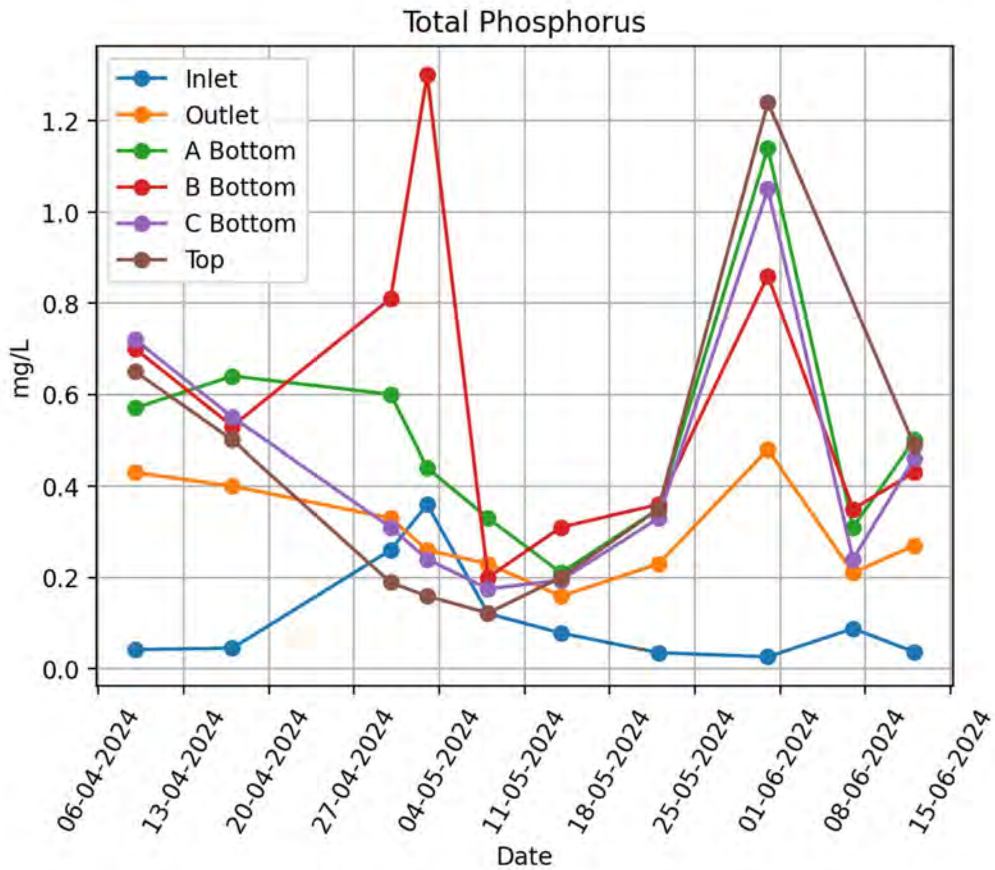

pH (Laboratory tested)
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
pH Units
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date


Total Ammoniacal-N
mg/L
0.25
0.20
0.15
0.10
0.05
0.00
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

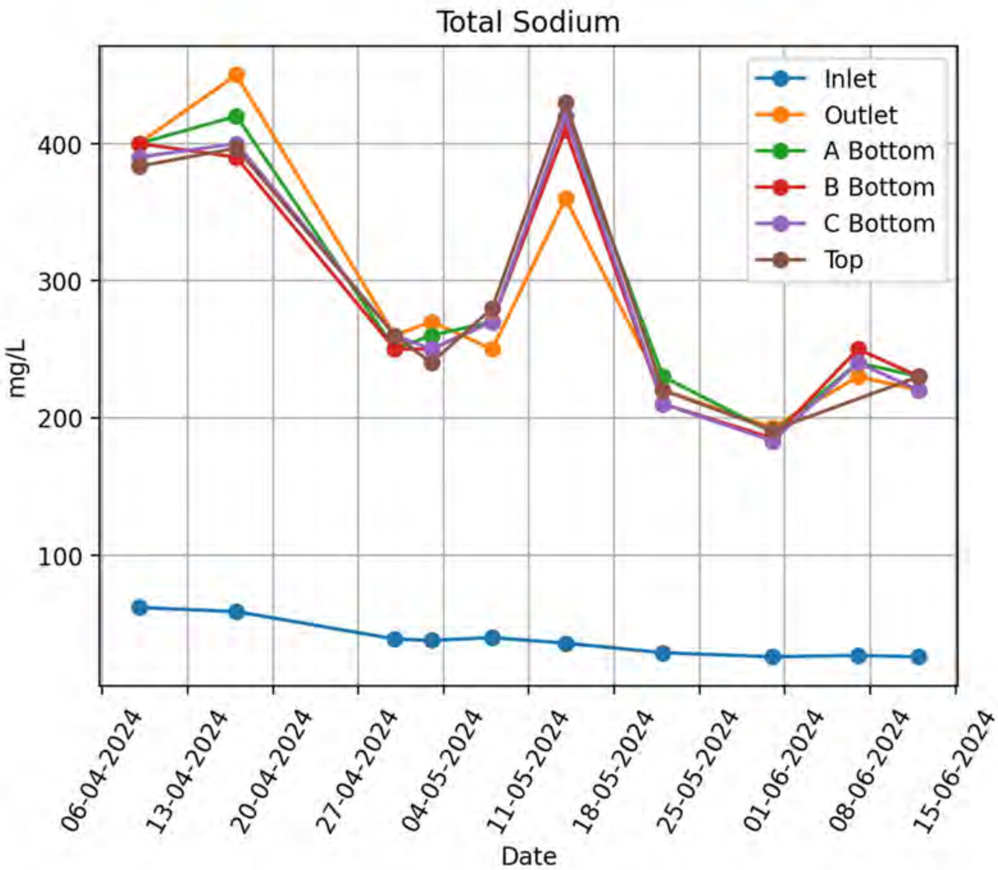

Total Kjeldahl Nitrogen (TKN)
mg/L
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date


Total Nitrogen
mg/L
0
1
2
3
4
5
6
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date


Total Organic Nitrogen (TON)
mg/L
0.2
0.4
0.6
0.8
1.0
1.2
1.4
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date



Total Phosphorus
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
mg/L
0.0
0.2
0.4
0.6
0.8
1.0
1.2
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date



Total Sodium
Inlet
Outlet
A Bottom
B Bottom
C Bottom
Top
mg/L
100
200
300
400
06-04-2024
13-04-2024
20-04-2024
27-04-2024
04-05-2024
11-05-2024
18-05-2024
25-05-2024
01-06-2024
08-06-2024
15-06-2024
Date

Appendix B: Site Photographs

Appendix B: Site Photographs

A Top Sampling Point

B Top Sampling Point

C Top Sampling Point

A Bottom Sampling Point

B Bottom Sampling Point

C Bottom Sampling Point

Pond Inlet Sampling Point

Pond Outlet Sampling Point

Appendix C: Laboratory Result Certificates

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

0508 HILL LAB (44 555 22)
+64 7 858 2000
mail@hill-labs.co.nz
www.hill-labs.co.nz

Certificate of Analysis

SPv1

Client:	Pattle Delamore Partners Limited	**Lab No:**	3538507
Contact:	Oliver Hunt	**Date Received:**	11-Apr-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	23-Apr-2024
	PO Box 389	**Quote No:**	130161
	Christchurch 8140	**Order No:**	
		Client Reference:	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 09-Apr-2024 12:20 pm	Outlet 09-Apr-2024 12:00 pm	A Top 09-Apr-2024 10:00 am	A Top Repeat 09-Apr-2024 10:00 am	A Bottom 09-Apr-2024 10:55 am
Lab Number:		3538507.1	3538507.2	3538507.3	3538507.4	3538507.5
Individual Tests						
Turbidity	NTU	9.7	7.4	1.00	0.93	6.2
pH	pH Units	6.6	7.3	7.1	7.0	7.2
Electrical Conductivity (EC)	mS/m	43.0	238	240	238	242
Total Sodium	g/m^3	62	400	370	400	400
Chloride	g/m^3	110	710	710	630	660
Total Nitrogen	g/m^3	0.21	3.6	4.9	4.9	2.9
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.21	1.15	1.18	1.21	0.95
Total Organic Nitrogen (TON)	g/m^3	0.21	1.00	1.10	1.14	0.92
Total Phosphorus	g/m^3	0.042	0.43	0.66	0.67	0.57
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	2 [#3]	< 2 [#3]	< 2 [#3]	< 2 [#3]	< 2 [#3]
Chlorophyll a	g/m^3	0.005	< 0.003	< 0.003	< 0.003	< 0.003
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	160 [#1]	250 [#2]	< 10 [#1]	< 10 [#1]	320 [#2]
Escherichia coli	cfu / 100mL	150 [#1]	250 [#2]	< 10 [#1]	< 10 [#1]	310 [#2]
Nutrient Profile						
Total Ammoniacal-N	g/m^3	< 0.010	0.147	0.079	0.072	0.030
Nitrite-N	g/m^3	< 0.002	0.096	0.21	0.21	0.004
Nitrate-N	g/m^3	< 0.002	2.4	3.5	3.5	1.95
Nitrate-N + Nitrite-N	g/m^3	< 0.002	2.5	3.7	3.7	1.96
Dissolved Reactive Phosphorus	g/m^3	0.004	0.25	0.59	0.59	0.48

Sample Name:		B Top 09-Apr-2024 9:45 am	B Bottom 09-Apr-2024 11:15 am	C Top 09-Apr-2024 9:10 am	C Bottom 09-Apr-2024 11:30 am
Lab Number:		3538507.6	3538507.7	3538507.8	3538507.9
Individual Tests					
Turbidity	NTU	0.85	9.9	1.09	3.0
pH	pH Units	7.1	7.7	7.0	7.3
Electrical Conductivity (EC)	mS/m	239	240	239	240
Total Sodium	g/m^3	390	400	390	390
Chloride	g/m^3	680	710	700	640
Total Nitrogen	g/m^3	4.8	4.0	4.8	4.4
Total Kjeldahl Nitrogen (TKN)	g/m^3	1.24	1.07	1.25	1.09
Total Organic Nitrogen (TON)	g/m^3	1.16	1.04	1.17	1.04
Total Phosphorus	g/m^3	0.64	0.70	0.65	0.72
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2	< 2	< 2	< 2
Chlorophyll a	g/m^3	< 0.003	< 0.003	< 0.003	< 0.003

Sample Type: Aqueous					
	Sample Name:	B Top 09-Apr-2024 9:45 am	B Bottom 09-Apr-2024 11:15 am	C Top 09-Apr-2024 9:10 am	C Bottom 09-Apr-2024 11:30 am
	Lab Number:	3538507.6	3538507.7	3538507.8	3538507.9
Faecal Coliforms and E. coli profile					
Faecal Coliforms	cfu / 100mL	90 #1	120 #1	40 #1	80 #1
Escherichia coli	cfu / 100mL	50 #1	120 #1	40 #1	70 #1
Nutrient Profile					
Total Ammoniacal-N	g/m³	0.085	0.032	0.079	0.050
Nitrite-N	g/m³	0.23	0.008	0.24	0.034
Nitrate-N	g/m³	3.3	3.0	3.3	3.2
Nitrate-N + Nitrite-N	g/m³	3.5	3.0	3.5	3.3
Dissolved Reactive Phosphorus	g/m³	0.53	0.55	0.50	0.61

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this microbiological result with caution as the sample was > 24 hours old at the time of testing in the laboratory. The sample is required to reach the laboratory with sufficient time to allow testing to commence within 24 hours of sampling.
Please interpret this result with caution as the sample was > 10 °C on receipt at the lab. The sample temperature is recommended by the laboratory's reference methods to be less than 10 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

#2 Please interpret this microbiological result with caution as the sample was > 24 hours old at the time of testing in the laboratory. The sample is required to reach the laboratory with sufficient time to allow testing to commence within 24 hours of sampling.
Please interpret this result with caution as the sample was > 10 °C on receipt at the lab. The sample temperature is recommended by the laboratory's reference methods to be less than 10 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

#3 Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand (cBOD5) analysis on the day that the sample arrived at the laboratory. The analysis was performed, as soon as possible, on the frozen sample.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45μm membrane filter.	-	1-9
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-9
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-9
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-9
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-9
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m³	1-9
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m³	1-9
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m³ is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m³, the Default Detection Limit for Total Nitrogen will be 0.11 g/m³. In-house calculation.	0.05 g/m³	1-9

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-9
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-9
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-9
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-9
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-9
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-9
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-9
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-9
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-9
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-9
Nutrient Profile		0.0010 - 0.010 g/m^3	1-9
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-9
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-9

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 12-Apr-2024 and 23-Apr-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3548288 SPv1
Contact:	Kimberly Murphy C/- Pattle Delamore Partners Limited PO Box 9528 Newmarket Auckland 1149	**Date Received:**	18-Apr-2024
		Date Reported:	29-Apr-2024
		Quote No:	130161
		Order No:	
		Client Reference:	A 028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		A Top 17-Apr-2024 9:15 am	B Top 17-Apr-2024 8:55 am	C Top 17-Apr-2024 8:45 am	A Top Repeat 17-Apr-2024 9:20 am
Lab Number:		3548288.1	3548288.2	3548288.3	3548288.4
Individual Tests					
Turbidity	NTU	0.52	0.66	0.83	0.72
pH	pH Units	7.1	7.2	7.1	7.1
Electrical Conductivity (EC)	mS/m	257	260	262	258
Total Sodium	g/m^3	390	400	400	390
Chloride	g/m^3	750	740	720	740
Total Nitrogen	g/m^3	4.5	4.5	4.5	4.6
Total Kjeldahl Nitrogen (TKN)	g/m^3	1.05	1.10	1.08	1.14
Total Organic Nitrogen (TON)	g/m^3	0.86	1.02	1.02	0.86
Total Phosphorus	g/m^3	0.53	0.49	0.48	0.50
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2	< 2	< 2	< 2
Chlorophyll a	g/m^3	< 0.003	< 0.003	< 0.003	< 0.003
Faecal Coliforms and E. coli profile					
Faecal Coliforms	cfu / 100mL	< 10 #1	20 #1	60 #1	10 #1
Escherichia coli	cfu / 100mL	< 10 #1	20 #1	60 #1	10 #1
Nutrient Profile					
Total Ammoniacal-N	g/m^3	0.187	0.082	0.057	0.29
Nitrite-N	g/m^3	0.130	0.167	0.186	0.132
Nitrate-N	g/m^3	3.3	3.3	3.2	3.3
Nitrate-N + Nitrite-N	g/m^3	3.5	3.4	3.4	3.5
Dissolved Reactive Phosphorus	g/m^3	0.42	0.41	0.39	0.42

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this microbiological result with caution as the sample was > 24 hours old at the time of testing in the laboratory. The sample is required to reach the laboratory with sufficient time to allow testing to commence within 24 hours of sampling.
Please interpret this result with caution as the sample was > 10 °C on receipt at the lab. The sample temperature is recommended by the laboratory's reference methods to be less than 10 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Filtration, Unpreserved	Sample filtration through 0.45μm membrane filter.	-	1-4
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-4
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-4
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-4
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-4
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-4
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-4
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-4
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-4
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-4
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-4
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-4
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-4
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-4
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-4
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-4
Nutrient Profile		0.0010 - 0.010 g/m^3	1-4
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-4
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 19-Apr-2024 and 29-Apr-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Client Services Manager - Environmental

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3548347 SPv1
Contact:	Kimberly Murphy	**Date Received:**	18-Apr-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	29-Apr-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		A Bottom 17-Apr-2024 11:05 am	B Bottom 17-Apr-2024 10:05 am	C Bottom 17-Apr-2024 9:50 am	Inlet 17-Apr-2024 10:35 am	Outlet 17-Apr-2024 10:50 am
Lab Number:		3548347.1	3548347.2	3548347.3	3548347.4	3548347.5
Individual Tests						
Turbidity	NTU	17.6	6.5	3.5	10.0	2.3
pH	pH Units	7.6	7.5	7.6	6.7	7.6
Electrical Conductivity (EC)	mS/m	266	262	260	42.6	286
Total Sodium	g/m^3	420	390	400	59	450
Chloride	g/m^3	730	750	730	111	840
Total Nitrogen	g/m^3	3.2	3.8	4.3	0.36	3.2
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.98	1.00	1.08	0.36	1.09
Total Organic Nitrogen (TON)	g/m^3	0.91	0.94	1.04	0.31	0.84
Total Phosphorus	g/m^3	0.64	0.53	0.55	0.045	0.40
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	< 2	< 2	< 2	< 2	< 2
Chlorophyll a	g/m^3	< 0.003	< 0.003	< 0.003	0.041	< 0.003
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	640 [#1]	440 [#2]	300 [#2]	420 [#2]	130 [#1]
Escherichia coli	cfu / 100mL	630 [#1]	160 [#2]	300 [#2]	420 [#2]	130 [#1]
Nutrient Profile						
Total Ammoniacal-N	g/m^3	0.068	0.060	0.044	0.049	0.25
Nitrite-N	g/m^3	< 0.002	< 0.002	0.029	< 0.002	0.056
Nitrate-N	g/m^3	2.2	2.8	3.2	< 0.002	2.0
Nitrate-N + Nitrite-N	g/m^3	2.2	2.8	3.3	0.002	2.1
Dissolved Reactive Phosphorus	g/m^3	0.38	0.39	0.44	0.008	0.30

Analyst's Comments

[#1] Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this result with caution as the sample was > 10 °C on receipt at the lab. The sample temperature is recommended by the laboratory's reference methods to be less than 10 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

[#2] Please interpret this result with caution as the sample was > 10 °C on receipt at the lab. The sample temperature is recommended by the laboratory's reference methods to be less than 10 °C on receipt at the laboratory (but not frozen). However, it is acknowledged that samples that are transported quickly to the laboratory after sampling, may not have been cooled to this temperature.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-5
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-5
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-5
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-5
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-5
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-5
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-5
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-5
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-5
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-5
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-5
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-5
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-5
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-5
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-5
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-5
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-5
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-5
Nutrient Profile		0.0010 - 0.010 g/m^3	1-5
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-5
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-5

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 19-Apr-2024 and 29-Apr-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Martin Cowell - BSc
Client Services Manager - Environmental

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Certificate of Analysis

SPv1

Client:	Pattle Delamore Partners Limited	**Lab No:**	3565150
Contact:	Kimberly Murphy	**Date Received:**	01-May-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	08-May-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	AO2803001
		Add. Client Ref:	130161
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 30-Apr-2024 8:45 am	Outlet 30-Apr-2024 9:15 am	A bottom 30-Apr-2024 9:40 am	B bottom 30-Apr-2024 10:45 am	C bottom 30-Apr-2024 10:30 am
Lab Number:		3565150.1	3565150.2	3565150.3	3565150.4	3565150.5
Individual Tests						
Turbidity	NTU	33	2.1	25	37	6.2
pH	pH Units	6.4	7.6	7.4	7.4	7.6
Electrical Conductivity (EC)	mS/m	28.6	159.0	157.6	152.4	155.8
Total Sodium	g/m^3	39	260	250	250	260
Chloride	g/m^3	62	380	360	340	360
Total Nitrogen	g/m^3	0.67	4.2	1.04	3.5	4.3
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.67	1.04	0.58	0.85	1.03
Total Organic Nitrogen (TON)	g/m^3	0.66	0.97	0.56	0.83	0.98
Total Phosphorus	g/m^3	0.26	0.33	0.60	0.81	0.31
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	12	< 2	< 2	4	2
Chlorophyll a	g/m^3	0.006	< 0.003	< 0.003	< 0.003	< 0.003
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	< 100 #1	500 #1	400 #1	300 #1	220 #2
Escherichia coli	cfu / 100mL	< 100 #1	500 #1	400 #1	300 #1	160 #2
Nutrient Profile						
Total Ammoniacal-N	g/m^3	0.011	0.069	0.02	0.021	0.047
Nitrite-N	g/m^3	< 0.002	< 0.10	< 0.10	< 0.10	< 0.10
Nitrate-N	g/m^3	< 0.002	3.1	0.45	2.6	3.3
Nitrate-N + Nitrite-N	g/m^3	0.002	3.1	0.45	2.6	3.3
Dissolved Reactive Phosphorus	g/m^3	0.006	0.26	0.47	0.28	0.198

Sample Name:		C top repeat 30-Apr-2024 10:10 am	C top 30-Apr-2024 10:10 am
Lab Number:		3565150.6	3565150.7
Individual Tests			
Turbidity	NTU	0.57	0.62
pH	pH Units	7.3	7.3
Electrical Conductivity (EC)	mS/m	155.4	156.0
Total Sodium	g/m^3	260	260
Chloride	g/m^3	350	350
Total Nitrogen	g/m^3	4.6	4.6
Total Kjeldahl Nitrogen (TKN)	g/m^3	1.10	1.05
Total Organic Nitrogen (TON)	g/m^3	1.05	0.99
Total Phosphorus	g/m^3	0.181	0.189
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2	< 2
Chlorophyll a	g/m^3	< 0.003	< 0.003

Sample Type: Aqueous

		C top repeat 30-Apr-2024 10:10 am	C top 30-Apr-2024 10:10 am
Sample Name:		C top repeat 30-Apr-2024 10:10 am	C top 30-Apr-2024 10:10 am
Lab Number:		3565150.6	3565150.7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	cfu / 100mL	< 10 #3	< 10 #3
Escherichia coli	cfu / 100mL	< 10 #3	< 10 #3
Nutrient Profile			
Total Ammoniacal-N	g/m^3	0.049	0.062
Nitrite-N	g/m^3	< 0.10	< 0.10
Nitrate-N	g/m^3	3.5	3.6
Nitrate-N + Nitrite-N	g/m^3	3.5	3.6
Dissolved Reactive Phosphorus	g/m^3	0.108	0.107

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.

#2 Please interpret this microbiological result with caution as the sample required repeat analysis. Due to incubation times it is not possible to perform a repeat analysis within 24 hours of sampling as required by the method. Repeats are typically due to unexpected analyte levels.

#3 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this microbiological result with caution as the sample required repeat analysis. Due to incubation times it is not possible to perform a repeat analysis within 24 hours of sampling as required by the method. Repeats are typically due to unexpected analyte levels.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-7
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-7
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-7
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-7
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-7
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-7
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-7
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-7
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-7
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-7
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-7
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-7

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-7
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-7
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-7
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-7
Nutrient Profile		0.0010 - 0.010 g/m^3	1-7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-7
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-7

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 02-May-2024 and 08-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Kim Harrison MSc
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3570063	SPv1
Contact:	Kimberly Murphy C/- Pattle Delamore Partners Limited PO Box 9528 Newmarket Auckland 1149	**Date Received:**	04-May-2024	
		Date Reported:	10-May-2024	
		Quote No:	130161	
		Order No:		
		Client Reference:		
		Submitted By:	Kimberly Murphy	

Sample Type: Aqueous

Sample Name:		C Bottom 03-May-2024 9:55 am	C Top 03-May-2024 10:35 am	C Top Repeat 03-May-2024 10:35 am
Lab Number:		3570063.1	3570063.2	3570063.3
Individual Tests				
Turbidity	NTU	5.8	0.62	0.77
pH	pH Units	7.6	7.2	7.3
Electrical Conductivity (EC)	mS/m	156.2	155.6	155.7
Total Sodium	g/m^3	250	240	240
Chloride	g/m^3	370	350	360
Total Nitrogen	g/m^3	4.4	4.7	4.6
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.98	1.03	1.04
Total Organic Nitrogen (TON)	g/m^3	0.94	0.97	0.98
Total Phosphorus	g/m^3	0.24	0.159	0.163
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2	< 2	< 2
Chlorophyll a	g/m^3	< 0.003	< 0.003	< 0.003
Faecal Coliforms and E. coli profile				
Faecal Coliforms	cfu / 100mL	160 #1	180 #1	240 #3
Escherichia coli	cfu / 100mL	160 #1	< 10 #1	< 10 #3
Nutrient Profile				
Total Ammoniacal-N	g/m^3	0.042	0.057	0.061
Nitrite-N	g/m^3	< 0.10	< 0.10 #2	< 0.10
Nitrate-N	g/m^3	3.4	3.7	3.6
Nitrate-N + Nitrite-N	g/m^3	3.5	3.7	3.6
Dissolved Reactive Phosphorus	g/m^3	0.174	0.090	0.091

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this microbiological result with caution as the sample required repeat analysis. Due to incubation times it is not possible to perform a repeat analysis within 24 hours of sampling as required by the method. Repeats are typically due to unexpected analyte levels.

#2 Due to the nature of this sample a dilution was performed prior to analysis, resulting in a detection limit higher than that normally achieved for the NO2N analysis.

#3 Please interpret this microbiological result with caution as the sample required repeat analysis. Due to incubation times it is not possible to perform a repeat analysis within 24 hours of sampling as required by the method. Repeats are typically due to unexpected analyte levels.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-3
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-3
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-3
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-3
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-3
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-3
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-3
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-3
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-3
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-3
Nutrient Profile		0.0010 - 0.010 g/m^3	1-3
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-3
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 06-May-2024 and 10-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

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Client Services Manager - Environmental

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3570064 SPv2
Contact:	Kimberly Murphy C/- Pattle Delamore Partners Limited PO Box 9528 Newmarket Auckland 1149	**Date Received:**	04-May-2024
		Date Reported:	15-May-2024
		Quote No:	130161
		Order No:	
		Client Reference:	
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 03-May-2024 8:35 am	Outlet 03-May-2024 9:00 am	A Bottom 03-May-2024 9:30 am	B Bottom 03-May-2024 10:05 am
Lab Number:		3570064.1	3570064.2	3570064.3	3570064.4
Individual Tests					
Turbidity	NTU	106	2.0	10.7	116
pH	pH Units	7.0	7.9	7.9	7.3
Electrical Conductivity (EC)	mS/m	27.9	177.9	163.1	153.9
Total Sodium	g/m³	38	270	260	250
Chloride	g/m³	64	410	370	360
Total Nitrogen	g/m³	0.37	3.3	2.6	3.4
Total Kjeldahl Nitrogen (TKN)	g/m³	0.36	1.02	0.71	1.24
Total Organic Nitrogen (TON)	g/m³	0.36	0.91	0.70	1.22
Total Phosphorus	g/m³	0.36	0.26	0.44	1.30
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m³	7	< 2	< 2	< 2
Chlorophyll a	g/m³	0.128 #4	< 0.003	< 0.003	< 0.003
Faecal Coliforms and E. coli profile					
Faecal Coliforms	cfu / 100mL	10 #1	150 #1	1,000 #2	280 #3
Escherichia coli	cfu / 100mL	10 #1	100 #1	1,000 #2	260 #3
Nutrient Profile					
Total Ammoniacal-N	g/m³	< 0.010	0.112	0.013	0.023
Nitrite-N	g/m³	< 0.002	< 0.10	< 0.10	< 0.10
Nitrate-N	g/m³	0.006	2.2	1.88	2.1
Nitrate-N + Nitrite-N	g/m³	0.006	2.3	1.88	2.1
Dissolved Reactive Phosphorus	g/m³	< 0.004	0.186	0.31	0.179

Analyst's Comments

[#1] Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this microbiological result with caution as the sample required repeat analysis. Due to incubation times it is not possible to perform a repeat analysis within 24 hours of sampling as required by the method. Repeats are typically due to unexpected analyte levels.

[#2] Statistically estimated count based on the theoretical countable range for the stated method.

[#3] Please interpret this microbiological result with caution as the sample required repeat analysis. Due to incubation times it is not possible to perform a repeat analysis within 24 hours of sampling as required by the method. Repeats are typically due to unexpected analyte levels.

[#4] Due to the nature of the sample it was very difficult to homogenise the sample resulting the different results on the final reading for the Chlorophyll A analysis. The result for this sample should be treated with caution.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-4
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-4
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-4
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-4
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-4
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-4
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-4
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-4
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-4
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-4
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-4
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-4
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-4
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-4
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-4
Chlorophyll a	Acetone extraction. Spectroscopy. APHA 10200 H (modified) : Online Edition.	0.003 g/m^3	1-4
Nutrient Profile		0.0010 - 0.010 g/m^3	1-4
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-4
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 05-May-2024 and 15-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Martin Cowell - BSc
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3574912 SPv1
Contact:	Kimberly Murphy	**Date Received:**	09-May-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	16-May-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 08-May-2024 8:35 am	Outlet 08-May-2024 8:55 am	A Bottom 08-May-2024 9:20 am	C Bottom 08-May-2024 9:40 am
Lab Number:		3574912.1	3574912.2	3574912.3	3574912.4
Individual Tests					
Turbidity	NTU	27	2.6	14.2	4.7
pH	pH Units	7.3	7.9	7.9	7.9
Electrical Conductivity (EC)	mS/m	28.1	155.0	173.2	173.8
Total Sodium	g/m^3	40	250	270	270
Chloride	g/m^3	62	350	390	390
Total Nitrogen	g/m^3	0.38	3.0	4.0	4.4
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.38	0.9	1.29	1.01
Total Organic Nitrogen (TON)	g/m^3	0.37	0.9	1.26	0.97
Total Phosphorus	g/m^3	0.121	0.23	0.33	0.175
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	< 2 #2	< 2 #2	< 2 #2	< 2 #2
Faecal Coliforms and E. coli profile					
Faecal Coliforms	cfu / 100mL	< 1,000 #1	< 1,000 #1	< 1,000 #1	< 1,000 #1
Escherichia coli	cfu / 100mL	< 1,000 #1	< 1,000 #1	< 1,000 #1	< 1,000 #1
Nutrient Profile					
Total Ammoniacal-N	g/m^3	< 0.010	0.090	0.030	0.037
Nitrite-N	g/m^3	< 0.002	0.025	0.003	0.004
Nitrate-N	g/m^3	< 0.002	2.0	2.7	3.4
Nitrate-N + Nitrite-N	g/m^3	< 0.002	2.1	2.7	3.4
Dissolved Reactive Phosphorus	g/m^3	0.008	0.160	0.160	0.106

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.

#2 Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand (cBOD5) analysis on the day that the sample arrived at the laboratory. The analysis was performed, as soon as possible, on the frozen sample.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-4
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-4

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-4
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-4
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-4
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-4
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-4
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-4
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-4
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-4
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-4
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-4
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-4
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-4
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-4
Nutrient Profile		0.0010 - 0.010 g/m^3	1-4
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-4
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 10-May-2024 and 16-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

Ara Heron BSc (Tech)
Client Services Manager - Environmental

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3574922 SPv1
Contact:	Kimberly Murphy	**Date Received:**	09-May-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	16-May-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		B Bottom 08-May-2024 9:50 am	A Top 08-May-2024 10:10 am	A Top Repeat 08-May-2024 10:10 am
Lab Number:		3574922.1	3574922.2	3574922.3
Individual Tests				
Turbidity	NTU	4.1	1.31	1.45
pH	pH Units	7.8	7.8	7.8
Electrical Conductivity (EC)	mS/m	169.8	173.1	174.5
Total Sodium	g/m^3	270	280	290
Chloride	g/m^3	390	400	390
Total Nitrogen	g/m^3	3.5	4.4	4.7
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.85	1.07	1.18
Total Organic Nitrogen (TON)	g/m^3	0.83	1.02	1.14
Total Phosphorus	g/m^3	0.20	0.122	0.126
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2 [#2]	< 2 [#2]	< 2 [#2]
Faecal Coliforms and E. coli profile				
Faecal Coliforms	cfu / 100mL	150 [#1]	20 [#1]	20 [#1]
Escherichia coli	cfu / 100mL	140 [#1]	10 [#1]	20 [#1]
Nutrient Profile				
Total Ammoniacal-N	g/m^3	0.026	0.047	0.043
Nitrite-N	g/m^3	0.002	0.006	0.006
Nitrate-N	g/m^3	2.7	3.4	3.5
Nitrate-N + Nitrite-N	g/m^3	2.7	3.4	3.5
Dissolved Reactive Phosphorus	g/m^3	0.132	0.033	0.040

Analyst's Comments

[#1] Statistically estimated count based on the theoretical countable range for the stated method.

[#2] Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand (cBOD5) analysis on the day that the sample arrived at the laboratory. The analysis was performed, as soon as possible, on the frozen sample.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-3

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-3
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-3
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-3
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-3
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-3
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-3
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-3
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-3
Nutrient Profile		0.0010 - 0.010 g/m^3	1-3
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-3
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 10-May-2024 and 16-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Client Services Manager - Environmental

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Certificate of Analysis

SPv1

Client:	Pattle Delamore Partners Limited	**Lab No:**	3581245
Contact:	Kimberly Murphy	**Date Received:**	15-May-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	23-May-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 14-May-2024 8:50 am	Outlet 14-May-2024 9:10 am	A bottom 14-May-2024 9:30 am	C bottom 14-May-2024 9:50 am	B bottom 14-May-2024 10:00 am
Lab Number:		3581245.1	3581245.2	3581245.3	3581245.4	3581245.5
Individual Tests						
Turbidity	NTU	22	2.1	6.0	4.9	12.1
pH	pH Units	6.6	7.5	7.6	7.7	7.5
Electrical Conductivity (EC)	mS/m	25.3	218	254	257	250
Total Sodium	g/m^3	36	360	420	420	410
Chloride	g/m^3	57	570	670	710	870
Total Nitrogen	g/m^3	0.19	3.0	3.1	4.0	3.6
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.19	0.66	0.79	0.97	0.91
Total Organic Nitrogen (TON)	g/m^3	0.19	0.58	0.77	0.95	0.88
Total Phosphorus	g/m^3	0.078	0.159	0.21	0.194	0.31
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	5	< 2	< 2	< 2	< 2
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	420 #1	300	100 #2	300 #2	270
Escherichia coli	cfu / 100mL	390 #1	300	100 #2	300 #2	260
Nutrient Profile						
Total Ammoniacal-N	g/m^3	< 0.010	0.082	0.026	0.022	0.032
Nitrite-N	g/m^3	< 0.002	< 0.10	< 0.10	< 0.10 #3	< 0.10 #3
Nitrate-N	g/m^3	< 0.002	2.3	2.3	3.0	2.7
Nitrate-N + Nitrite-N	g/m^3	< 0.002	2.4	2.3	3.1	2.7
Dissolved Reactive Phosphorus	g/m^3	0.005	0.099	0.142	0.108	0.122

Sample Name:		B top 14-May-2024 10:15 am	B top repeat 14-May-2024 10:15 am
Lab Number:		3581245.6	3581245.7
Individual Tests			
Turbidity	NTU	1.18	1.21
pH	pH Units	7.1	7.2
Electrical Conductivity (EC)	mS/m	259	258
Total Sodium	g/m^3	430	400
Chloride	g/m^3	950	720
Total Nitrogen	g/m^3	4.1	4.2
Total Kjeldahl Nitrogen (TKN)	g/m^3	1.14	1.21
Total Organic Nitrogen (TON)	g/m^3	1.10	1.17
Total Phosphorus	g/m^3	0.20	0.21
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	< 2	< 2

Sample Type: Aqueous			
	Sample Name:	B top 14-May-2024 10:15 am	B top repeat 14-May-2024 10:15 am
	Lab Number:	3581245.6	3581245.7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	cfu / 100mL	< 100 #2	< 100 #2
Escherichia coli	cfu / 100mL	< 100 #2	< 100 #2
Nutrient Profile			
Total Ammoniacal-N	g/m^3	0.040	0.040
Nitrite-N	g/m^3	< 0.10 #3	< 0.10 #3
Nitrate-N	g/m^3	2.9	3.0
Nitrate-N + Nitrite-N	g/m^3	3.0	3.0
Dissolved Reactive Phosphorus	g/m^3	0.097	0.098

Analyst's Comments

#1 Please interpret this microbiological result with caution as the sample was > 24 hours old at the time of testing in the laboratory. The sample is required to reach the laboratory with sufficient time to allow testing to commence within 24 hours of sampling.

#2 Statistically estimated count based on the theoretical countable range for the stated method.

#3 Due to the nature of this sample a dilution was performed prior to analysis, resulting in a detection limit higher than that normally achieved for the NO2N analysis.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-7
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-7
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-7
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-7
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-7
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-7
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-7
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-7
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-7
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-7
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-7
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-7

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-7
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-7
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-7
Nutrient Profile		0.0010 - 0.010 g/m^3	1-7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-7
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-7

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 16-May-2024 and 23-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3588982 SPv1
Contact:	Kimberly Murphy C/- Pattle Delamore Partners Limited PO Box 9528 Newmarket Auckland 1149	**Date Received:**	23-May-2024
		Date Reported:	31-May-2024
		Quote No:	130161
		Order No:	
		Client Reference:	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 22-May-2024 8:30 am	Outlet 22-May-2024 8:40 am	A Bottom 22-May-2024 9:00 am	B Bottom 22-May-2024 9:30 am	C Bottom 22-May-2024 9:20 am
Lab Number:		3588982.1	3588982.2	3588982.3	3588982.4	3588982.5
Individual Tests						
Turbidity	NTU	8.7	4.9	10.1	7.7	5.6
pH	pH Units	6.6	7.7	7.8	7.7	7.7
Electrical Conductivity (EC)	mS/m	21.5	131.5	134.9	128.8	131.1
Total Sodium	g/m^3	29	220	230	210	210
Chloride	g/m^3	46	300	300	290	300
Total Nitrogen	g/m^3	0.38	3.9	4.8	4.6	5.5
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.33	0.91	0.93	0.85	0.94
Total Organic Nitrogen (TON)	g/m^3	0.31	0.81	0.89	0.83	0.90
Total Phosphorus	g/m^3	0.035	0.23	0.35	0.36	0.33
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2	< 2	< 2	< 2	< 2
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	140 [#1]	460	50 [#1]	30 [#1]	40 [#1]
Escherichia coli	cfu / 100mL	140 [#1]	460	50 [#1]	30 [#1]	30 [#1]
Nutrient Profile						
Total Ammoniacal-N	g/m^3	0.013	0.102	0.042	0.020	0.041
Nitrite-N	g/m^3	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Nitrate-N	g/m^3	< 0.10	3.0	3.8	3.7	4.5
Nitrate-N + Nitrite-N	g/m^3	< 0.10	3.0	3.9	3.8	4.5
Dissolved Reactive Phosphorus	g/m^3	0.006	0.17	0.3	0.24	0.25

Sample Name:		A Top 22-May-2024 9:40 am	A Top Retreat 22-May-2024 9:40 am
Lab Number:		3588982.6	3588982.7
Individual Tests			
Turbidity	NTU	1.14	1.23
pH	pH Units	7.4	7.1
Electrical Conductivity (EC)	mS/m	130.8	130.1
Total Sodium	g/m^3	220	210
Chloride	g/m^3	290	290
Total Nitrogen	g/m^3	5.8	5.9
Total Kjeldahl Nitrogen (TKN)	g/m^3	1.03	1.16
Total Organic Nitrogen (TON)	g/m^3	0.99	1.12
Total Phosphorus	g/m^3	0.35	0.37
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2	< 2

Sample Type: Aqueous			
Sample Name:		A Top 22-May-2024 9:40 am	A Top Retreat 22-May-2024 9:40 am
Lab Number:		3588982.6	3588982.7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	cfu / 100mL	< 10 #1	< 10 #1
Escherichia coli	cfu / 100mL	< 10 #1	< 10 #1
Nutrient Profile			
Total Ammoniacal-N	g/m^3	0.044	0.036
Nitrite-N	g/m^3	0.11	0.11
Nitrate-N	g/m^3	4.7	4.6
Nitrate-N + Nitrite-N	g/m^3	4.8	4.7
Dissolved Reactive Phosphorus	g/m^3	0.23	0.22

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-7
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-7
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-7
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-7
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-7
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-7
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-7
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-7
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-7
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-7
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-7
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-7
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-7
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-7
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-7
Nutrient Profile		0.0010 - 0.010 g/m^3	1-7

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-7
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-7

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 24-May-2024 and 31-May-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3597185	SPv1
Contact:	Kimberly Murphy	**Date Received:**	01-Jun-2024	
	C/- Pattle Delamore Partners Limited	**Date Reported:**	14-Jun-2024	
	PO Box 9528	**Quote No:**	130161	
	Newmarket	**Order No:**		
	Auckland 1149	**Client Reference:**	A02803001	
		Submitted By:	Kimberly Murphy	

Sample Type: Aqueous

Sample Name:		Inlet 31-May-2024 8:35 am	Outlet 31-May-2024 8:50 am	C bottom 31-May-2024 9:30 am	B bottom 31-May-2024 9:45 am	A bottom 31-May-2024 9:10 am
Lab Number:		3597185.1	3597185.2	3597185.3	3597185.4	3597185.5
Individual Tests						
Turbidity	NTU	7.1	4.4	4.1	7.5	10.1
pH	pH Units	6.4	7.5	7.6	7.4	7.6
Electrical Conductivity (EC)	mS/m	20.0	130.9	124.9	124.0	126.5
Total Sodium	g/m^3	26	193	183	185	189
Chloride	g/m^3	42	290	270	280	280
Total Nitrogen	g/m^3	0.22	4.2	5.5	4.9	5.7
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.20	0.81	0.94	0.91	1.42
Total Organic Nitrogen (TON)	g/m^3	0.17	0.74	0.88	0.88	1.35
Total Phosphorus	g/m^3	0.026	0.48	1.05	0.86	1.14
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2 #3	< 2 #3	< 2 #3	< 2 #3	< 2 #3
Faecal Coliforms and E. coli profile						
Faecal Coliforms	cfu / 100mL	60 #1	100 #2	40 #2	110 #2	90 #2
Escherichia coli	cfu / 100mL	60 #1	80 #2	40 #2	110 #2	90 #2
Nutrient Profile						
Total Ammoniacal-N	g/m^3	0.037	0.070	0.060	0.033	0.071
Nitrite-N	g/m^3	< 0.002	1.36	3.0	2.1	3.0
Nitrate-N	g/m^3	0.017	2.0	1.63	1.91	1.21
Nitrate-N + Nitrite-N	g/m^3	0.018	3.4	4.6	4.0	4.2
Dissolved Reactive Phosphorus	g/m^3	0.007	0.39	0.91	0.73	0.90

Sample Name:		A Top 31-May-2024 9:55 am	A Top Repeat 31-May-2024 9:55 am
Lab Number:		3597185.6	3597185.7
Individual Tests			
Turbidity	NTU	1.44	2.0
pH	pH Units	7.0	7.0
Electrical Conductivity (EC)	mS/m	124.8	122.9
Total Sodium	g/m^3	191	181
Chloride	g/m^3	260	270
Total Nitrogen	g/m^3	5.9	5.7
Total Kjeldahl Nitrogen (TKN)	g/m^3	1.25	1.10
Total Organic Nitrogen (TON)	g/m^3	1.16	1.04
Total Phosphorus	g/m^3	1.24	1.26
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2 #3	< 2 #3

Sample Type: Aqueous			
	Sample Name:	A Top 31-May-2024 9:55 am	A Top Repeat 31-May-2024 9:55 am
	Lab Number:	3597185.6	3597185.7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	cfu / 100mL	< 10 #2	< 10 #2
Escherichia coli	cfu / 100mL	< 10 #2	< 10 #2
Nutrient Profile			
Total Ammoniacal-N	g/m^3	0.094	0.064
Nitrite-N	g/m^3	3.9	3.7
Nitrate-N	g/m^3	0.82	0.89
Nitrate-N + Nitrite-N	g/m^3	4.7	4.6
Dissolved Reactive Phosphorus	g/m^3	0.98	0.96

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.
Please interpret this microbiological result with caution as the sample was > 24 hours old at the time of testing in the laboratory. The sample is required to reach the laboratory with sufficient time to allow testing to commence within 24 hours of sampling.

#2 Statistically estimated count based on the theoretical countable range for the stated method.

#3 Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand (cBOD5) analyses on the day that they arrived at the laboratory. The analyses were performed, as soon as possible, on the frozen samples.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request.
Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-7
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-7
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-7
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-7
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-7
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-7
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-7
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-7
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-7
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-7
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-7
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-7
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-7

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-7
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-7
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-7
Nutrient Profile		0.0010 - 0.010 g/m^3	1-7
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-7
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-7

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 02-Jun-2024 and 14-Jun-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

SPv1

Client:	Pattle Delamore Partners Limited	**Lab No:**	3602107
Contact:	Kimberly Murphy	**Date Received:**	08-Jun-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	20-Jun-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

	Sample Name:	Inlet 07-Jun-2024 8:30 am	Outlet 07-Jun-2024 8:45 am	A Bottom 07-Jun-2024 9:00 am
	Lab Number:	3602107.1	3602107.2	3602107.3
Individual Tests				
Turbidity	NTU	36	3.1	11.9
pH	pH Units	6.8	7.6	7.6
Electrical Conductivity (EC)	mS/m	19.8	137.3	145.2
Total Sodium	g/m^3	27	230	240
Chloride	g/m^3	42	310	330
Total Nitrogen	g/m^3	0.34	4.9	5.3
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.34	0.80	0.73
Total Organic Nitrogen (TON)	g/m^3	0.33	0.73	0.70
Total Phosphorus	g/m^3	0.088	0.21	0.31
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	$g\ O_2/m^3$	< 2 #2	< 2 #2	< 2 #2
Faecal Coliforms and E. coli profile				
Faecal Coliforms	cfu / 100mL	20 #1	180 #1	400
Escherichia coli	cfu / 100mL	20 #1	180 #1	400
Nutrient Profile				
Total Ammoniacal-N	g/m^3	< 0.010	0.065	0.026
Nitrite-N	g/m^3	< 0.002	0.083	0.166
Nitrate-N	g/m^3	< 0.002	4.1	4.4
Nitrate-N + Nitrite-N	g/m^3	0.002	4.1	4.5
Dissolved Reactive Phosphorus	g/m^3	0.008	0.152	0.21

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.

#2 Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand (cBOD5) analysis on the day that the sample arrived at the laboratory. The analysis was performed, as soon as possible, on the frozen sample.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-3

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-3
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-3
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-3
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-3
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-3
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-3
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-3
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-3
Nutrient Profile		0.0010 - 0.010 g/m^3	1-3
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-3
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 09-Jun-2024 and 20-Jun-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

Client:	Pattle Delamore Partners Limited	**Lab No:**	3602118 SPv1
Contact:	Kimberly Murphy	**Date Received:**	08-Jun-2024
	C/- Pattle Delamore Partners Limited	**Date Reported:**	20-Jun-2024
	PO Box 9528	**Quote No:**	130161
	Newmarket	**Order No:**	
	Auckland 1149	**Client Reference:**	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		B Bottom 07-Jun-2024 9:30 am	C Bottom 07-Jun-2024 9:20 am
Lab Number:		3602118.1	3602118.2
Individual Tests			
Turbidity	NTU	9.8	3.1
pH	pH Units	7.5	7.6
Electrical Conductivity (EC)	mS/m	144.3	146.3
Total Sodium	g/m^3	250	240
Chloride	g/m^3	330	330
Total Nitrogen	g/m^3	4.0	6.2
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.64	0.76
Total Organic Nitrogen (TON)	g/m^3	0.64	0.72
Total Phosphorus	g/m^3	0.35	0.24
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	< 2 #2	< 2 #2
Faecal Coliforms and E. coli profile			
Faecal Coliforms	cfu / 100mL	40 #1	10 #1
Escherichia coli	cfu / 100mL	40 #1	10 #1
Nutrient Profile			
Total Ammoniacal-N	g/m^3	< 0.010	0.040
Nitrite-N	g/m^3	0.003	0.168
Nitrate-N	g/m^3	3.4	5.3
Nitrate-N + Nitrite-N	g/m^3	3.4	5.4
Dissolved Reactive Phosphorus	g/m^3	0.146	0.181

Analyst's Comments

#1 Statistically estimated count based on the theoretical countable range for the stated method.

#2 Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical Oxygen Demand (cBOD5) analysis on the day that the sample arrived at the laboratory. The analysis was performed, as soon as possible, on the frozen sample.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-2
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-2
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-2

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-2
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-2
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-2
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-2
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-2
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-2
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-2
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-2
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-2
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-2
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-2
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-2
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-2
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-2
Nutrient Profile		0.0010 - 0.010 g/m^3	1-2
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-2
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-2

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 09-Jun-2024 and 20-Jun-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

SPv1

Client:	Pattle Delamore Partners Limited	**Lab No:**	3605132
Contact:	Kimberly Murphy C/- Pattle Delamore Partners Limited PO Box 9528 Newmarket Auckland 1149	**Date Received:**	13-Jun-2024
		Date Reported:	21-Jun-2024
		Quote No:	130161
		Order No:	
		Client Reference:	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		Inlet 12-Jun-2024 8:10 am	Outlet 12-Jun-2024 8:25 am	A Bottom 12-Jun-2024 8:45 am	C Bottom 12-Jun-2024 9:05 am
Lab Number:		3605132.1	3605132.2	3605132.3	3605132.4
Individual Tests					
Turbidity	NTU	9.2	2.6	20	4.7
pH	pH Units	6.8	7.7	7.8	7.6
Electrical Conductivity (EC)	mS/m	19.9	142.8	150.5	153.0
Total Sodium	g/m³	26	220	230	220
Chloride	g/m³	40	310	340	340
Total Nitrogen	g/m³	0.24	4.1	5.3	5.9
Total Kjeldahl Nitrogen (TKN)	g/m³	0.24	< 1.0	< 1.0	< 1.0
Total Organic Nitrogen (TON)	g/m³	0.21	< 1.1	< 1.1	< 1.1
Total Phosphorus	g/m³	0.037	0.27	0.50	0.46
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m³	< 2	< 2	< 2	< 2
Faecal Coliforms and E. coli profile					
Faecal Coliforms	cfu / 100mL	< 100 #1	100 #1	1,000 #1	< 100 #1
Escherichia coli	cfu / 100mL	< 100 #1	100 #1	1,000 #1	< 100 #1
Nutrient Profile					
Total Ammoniacal-N	g/m³	0.031	0.197	0.032	0.045
Nitrite-N	g/m³	< 0.002	0.097	0.131	0.23
Nitrate-N	g/m³	0.004	3.1	4.4	4.9
Nitrate-N + Nitrite-N	g/m³	0.006	3.2	4.5	5.1
Dissolved Reactive Phosphorus	g/m³	0.008	0.181	0.33	0.34

Analyst's Comments

Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical oxygen demand (cBOD5) analyses on the day that they arrived at the laboratory. The analyses were performed, as soon as possible, on the frozen samples.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45μm membrane filter.	-	1-4
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-4
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-4

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-4
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-4
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-4
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-4
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-4
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-4
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-4
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-4
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-4
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-4
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-4
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-4
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-4
Nutrient Profile		0.0010 - 0.010 g/m^3	1-4
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-4
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-4

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 14-Jun-2024 and 21-Jun-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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Certificate of Analysis

SPv1

Client:	Pattle Delamore Partners Limited	**Lab No:**	3605134
Contact:	Kimberly Murphy C/- Pattle Delamore Partners Limited PO Box 9528 Newmarket Auckland 1149	**Date Received:**	13-Jun-2024
		Date Reported:	21-Jun-2024
		Quote No:	130161
		Order No:	
		Client Reference:	A028030001
		Submitted By:	Kimberly Murphy

Sample Type: Aqueous

Sample Name:		B Bottom 12-Jun-2024 9:15 am	A Top 12-Jun-2024 9:50 am	A Top Repeat 12-Jun-2024 9:30 am
Lab Number:		3605134.1	3605134.2	3605134.3
Individual Tests				
Turbidity	NTU	6.9	0.89	1.01
pH	pH Units	7.7	7.4	7.1
Electrical Conductivity (EC)	mS/m	149.8	151.6	153.4
Total Sodium	g/m^3	230	230	230
Chloride	g/m^3	330	340	340
Total Nitrogen	g/m^3	5.4	6.4	6.3
Total Kjeldahl Nitrogen (TKN)	g/m^3	0.78	< 1.0	0.87
Total Organic Nitrogen (TON)	g/m^3	0.75	< 1.1	0.83
Total Phosphorus	g/m^3	0.43	0.49	0.50
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	g O_2/m^3	< 2	< 2	< 2
Faecal Coliforms and E. coli profile				
Faecal Coliforms	cfu / 100mL	170 #1	< 10 #1	< 10 #1
Escherichia coli	cfu / 100mL	160 #1	< 10 #1	< 10 #1
Nutrient Profile				
Total Ammoniacal-N	g/m^3	0.030	0.035	0.038
Nitrite-N	g/m^3	0.121	0.46	0.45
Nitrate-N	g/m^3	4.5	5.1	5.0
Nitrate-N + Nitrite-N	g/m^3	4.7	5.6	5.4
Dissolved Reactive Phosphorus	g/m^3	0.30	0.33	0.32

Analyst's Comments

Due to unexpected sample numbers and limited resources, we were unable to commence the carbonaceous Biochemical oxygen demand (cBOD5) analyses on the day that they arrived at the laboratory. The analyses were performed, as soon as possible, on the frozen samples.

#1 Statistically estimated count based on the theoretical countable range for the stated method.

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Aqueous

Test	**Method Description**	**Default Detection Limit**	**Sample No**
Individual Tests			
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1-3
Total Digestion	Nitric acid digestion. APHA 3030 E (modified) : Online Edition.	-	1-3
Turbidity	Analysis by Turbidity meter. APHA 2130 B (modified) : Online Edition.	0.05 NTU	1-3

Sample Type: Aqueous			
Test	**Method Description**	**Default Detection Limit**	**Sample No**
pH	pH meter. APHA 4500-H^+ B (modified) : Online Edition. Note: It is not possible to achieve the APHA Maximum Storage Recommendation for this test (15 min) when samples are analysed upon receipt at the laboratory, and not in the field. Samples and Standards are analysed at an equivalent laboratory temperature (typically 18 to 22 °C). Temperature compensation is used.	0.1 pH Units	1-3
Electrical Conductivity (EC)	Conductivity meter, 25°C. APHA 2510 B : Online Edition.	0.1 mS/m	1-3
Total Sodium	Nitric acid digestion, ICP-MS, screen level. APHA 3125 B : Online Edition.	0.42 g/m^3	1-3
Chloride	Filtered sample. Ion Chromatography. APHA 4110 B (modified) : Online Edition.	0.5 g/m^3	1-3
Total Nitrogen	Calculation: TKN + Nitrate-N + Nitrite-N. Please note: The Default Detection Limit of 0.05 g/m^3 is only attainable when the TKN has been determined using a trace method utilising duplicate analyses. In cases where the Detection Limit for TKN is 0.10 g/m^3, the Default Detection Limit for Total Nitrogen will be 0.11 g/m^3. In-house calculation.	0.05 g/m^3	1-3
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) : Online Edition.	0.010 g/m^3	1-3
Nitrite-N	Automated Azo dye colorimetry, Flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Nitrate-N	Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N. In-House.	0.0010 g/m^3	1-3
Nitrate-N + Nitrite-N	Total oxidised nitrogen. Automated cadmium reduction, flow injection analyser. APHA 4500-NO_3^- I (modified) : Online Edition.	0.002 g/m^3	1-3
Total Kjeldahl Nitrogen (TKN)	Total Kjeldahl digestion, phenol/hypochlorite colorimetry. Discrete Analyser. APHA 4500-N_{org} D (modified) 4500 NH_3 F (modified) : Online Edition.	0.10 g/m^3	1-3
Total Organic Nitrogen (TON)	Calculation: TKN - NH_4-N. In-house calculation.	0.10 g/m^3	1-3
Dissolved Reactive Phosphorus	Filtered sample. Molybdenum blue colourimetry. Flow injection analyser. APHA 4500-P G (modified) : Online Edition.	0.004 g/m^3	1-3
Total Phosphorus	Total phosphorus digestion, automated ascorbic acid colorimetry. Flow Injection Analyser. APHA 4500-P H (modified) : Online Edition.	0.002 g/m^3	1-3
Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Incubation 5 days, DO meter, nitrification inhibitor added, seeded. APHA 5210 B (modified) : Online Edition.	2 g O_2/m^3	1-3
Nutrient Profile		0.0010 - 0.010 g/m^3	1-3
Faecal Coliforms and E. coli profile			
Faecal Coliforms	Membrane Filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 D (modified) : Online Edition.	1 cfu / 100mL	1-3
Escherichia coli	Membrane filtration, Count on CCA agar, Incubated at 44.5°C for 21-24 hours. APHA 9222 I (modified) : Online Edition.	1 cfu / 100mL	1-3

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 14-Jun-2024 and 21-Jun-2024. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

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ATTACHMENT 24

SECTION 92 RESPONSE
HUMAN HEALTH RISKS FROM EOCS
ATTACHMENT 8

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Attachment 8 - Human health risks from EOCs

Consumption of drinking water or aquatic species containing EOCs are the two main potential sources of human health risk in this case.

Drinking water standards in New Zealand are regulated by Taumata Arowai. These standards contain a multitude of organic determinands (see **Appendix**). Internationally, the World Health Organization (WHO) guidelines for drinking water quality (2022) include a section on chemicals of emerging concern which exclusively covers pharmaceuticals. WHO provide the following statement: *"The concentrations of pharmaceuticals found in drinking-water are typically orders of magnitude less than the lowest therapeutic doses. Therefore, exposure to individual compounds in drinking-water is unlikely to have appreciable adverse impacts on human health. Formal guideline values are therefore not proposed in these Guidelines."* This suggests that pharmaceuticals are not a high-risk class of EOCs in drinking water.

There have been a recent review report in New Zealand on human health effects from untreated wastewater and stormwater (Coxon and Eaton, 2023). Coxon and Eaton (2023) provided an overview of contaminants in municipal wastewater and urban stormwater that have the potential to pose a risk to human health and focused on untreated wastewater and stormwater (hence highest risk). Contaminants were grouped into nine broad classes: microbial pathogens, heavy metals, per- and polyfluoroalkyl substances (PFAS), polycyclic aromatic hydrocarbons (PAHs), pesticides, pharmaceutical and personal care products (PPCPs), endocrine-disrupting compounds (EDCs), brominated flame retardants (BFRs), and microplastics. The authors concluded that, due to significant knowledge gaps, the potential impacts on human health are unclear. This conclusion is consistent with our current understanding.

In terms of human health risks from EOCs through the consumption of aquatic species, bioaccumulation is the key concern. A complication of assessing bioaccumulation of EOCs is that there is even less known about the distribution of EOCs in biota than in water or sediment.

Bioconcentration factors (BCF) may be used to estimate potential bioaccumulation of EOCs in biota. The US EPA define a chemical with a BCF <1000 as having a low bioconcentration potential (US EPA, 2012), while ECHA defines a chemical as fulfilling the bioconcentration criterion when BCF >2000 (European Chemicals Agency, 2017). BCF may be calculated from the physico-chemical properties of any chemical.

References

Coxon, S., Eaton, C., 2023. Review of contaminants of potential human health concern in wastewater and stormwater. Prepared for Ministry of Health. 232 pp.

European Chemicals Agency, 2017. Guidance on Information Requirements and Chemical Safety Assessment Part C: PBT/vPvB assessment Version 3.0 June 2017.

Parliamentary Counsel Office, 2022. Water Services (Drinking Water Standards for New Zealand) Regulations 2022.

US EPA, 2012. Sustainable Futures / P2 Framework Manual 2012 EPA-748-B12-001 5. Estimating Physical / Chemical and Environmental Fate Properties with EPI Suite™.

World Health Organization, 2022. Guidelines for drinking-water quality: fourth edition incorporating the first and second addenda.

Appendix : MAV for pesticides and EOCs in 2018 and 2022 (Parliamentary Counsel Office, 2022).

Table A1. MAV for 2018 and 2022. Changes in MAV between 2018 and 2022 are bolded.

Name	MAV 2018 (mg/L)	MAV 2022 (mg/L)
alachlor	0.02	0.02
aldicarb	0.01	0.01
aldrin + dieldrin	0.00004	0.00004
atrazine	**0.002**	**0.1**
azinphos methyl	**0.004**	**0.1**
bromacil	0.4	0.4
carbofuran	0.008	0.008
chlordane	0.0002	0.0002
chlorotoluron	0.04	0.04
chlorpyriphos	0.04	0.04
cyanazine	0.0007	0.0007
2,4-D	0.04	0.04
2,4-DB	0.1	0.1
DDT + isomers	0.001	0.001
di(2-ethylhexyl)phthalate	0.009	0.009
1,2-dibromo-3-chloropropane	0.001	0.001
1,2-dibromoethane	0.0004	0.0004
1,2-dichloropropane	0.05	0.05
1,3-dichloropropene	0.02	0.02

Name	MAV 2018 (mg/L)	MAV 2022 (mg/L)
dichlorprop	0.1	0.1
dimethoate	0.008	0.008
diuron	0.02	0.02
endrin	0.001	0.001
fenoprop	0.01	0.01
hexazinone	0.4	0.4
isoproturon	0.01	0.01
lindane	0.002	0.002
MCPA	**0.002**	**0.8**
mecoprop	0.01	0.01
metalaxyl	**0.1**	**0.3**
methoxychlor	0.02	0.02
metolachlor	0.01	0.01
metribuzin	0.07	0.07
molinate	0.007	0.007
oryzalin	0.4	0.4
oxadiazon	0.2	0.2
pendimethalin	0.02	0.02
pentachlorophenol	0.009	0.009
PFHxS + PFOS	No value	0.00007
PFOA	No value	0.00056
picloram	0.2	0.2
pirimiphos methyl	0.1	0.1
primisulfuron methyl	0.9	0.9
procymidone	0.7	0.7
propazine	0.07	0.07
pyriproxifen	0.4	0.4
simazine	0.002	0.002
2,4,5-T	0.01	0.01
terbacil	0.04	0.04
terbuthylazine	0.008	0.008
thiabendazole	0.4	0.4
triclopyr	0.1	0.1
trifluralin	0.03	0.03
MFA (1080)	0.0035	0.0035

ATTACHMENT 25

SECTION 92 RESPONSE
PROPOSED CONSENT CONDITIONS
ATTACHMENT 9

Beachlands WWTP Discharge Consent – Proposed Consent Conditions

<u>General Accordance</u>

1. The activities authorised by this consent shall be carried out in general accordance with the plans and information submitted with the application detailed below and all material referenced by the Council as consent number DIS60433803.

   - Application form and Assessment of Environmental Effects report, titled "Beachlands Wastewater Scheme Discharges", prepared by Stantec, dated June 2024.

Report title and Reference	Author	Rev	Dated
Beachlands Wastewater Scheme Resource Consent Project - Alternatives Assessment Report	Stantec	1	June 2024
Beachlands Wastewater Treatment Plant – water quality, ecological and human health effects assessment	Streamlined	4	9 October 2024
Beachlands WWTP: Preliminary assessment of land area requirements for overland flow system explanation – Memorandum 1	Pattle Delamore Partners (PDP)		02 April 2024
Beachlands WWTP: Assessment of Overland Flow System Treatment Performance – Memorandum 2	Pattle Delamore Partners (PDP)		02 April 2024
Beachlands WWTP: Assessment of Overland Flow System Treatment Performance – Memorandum 3 (interim)	Pattle Delamore Partners (PDP)		17 May 2024
Assessment of Potential Effects on Soils and Ecology from Beachlands WWTP Overland Flow System (Memorandum 4)	Pattle Delamore Partners (PDP)		17 May 2024
Beachlands Maraetai WWTP Resource Consent Renewal: Stream Hydraulic Assessment	Pattle Delamore Partners (PDP)		26 March 2024
Beachlands WWTP Discharge: Assessment of microbiological effects and health risk	NIWA		April 2024
Assessment of Proposed Te Puru Stream Discharge	DHI Water & Environment Ltd (DHI)		28 March 2024
Water Quality and Biological Assessment, Te Puru Stream Tributary, Beachlands	Bioresearches		May 2024
Te Puru Stream WWTP Discharge Assessment of Effects on Stream Habitat	Bioresearches		18 April 2024
Beachlands WWTP - Wastewater Discharge Consent Project – Stakeholder Engagement Report	Watercare Services Limited (WSL)		12 June 2024

In the event of any conflict between the documents listed above and the conditions of this consent, the conditions shall prevail.

Definitions

- Annual Average Dry Weather Flow (**ADWF**): Average dry-weather flow means the flow in the wastewater network that would occur during a normal day in a dry weather period (i.e. three consecutive days of less than 5mm rainfall per day), including wastewater, trade waste and an allowance for groundwater infiltration.

  For the purposes of compliance, the annual average dry weather flow shall be calculated every Calendar year based on the average dry weather flow recorded during the past year.

- Peak Wet Weather Flow (**PWWF**): Peak wet weather flow means the peak flow to the wastewater treatment plant that would occur during wet weather.

- **WWTP** – means the Beachlands Wastewater Treatment Plant located at 100 Okaroro Drive, Beachlands.

- **Fortnightly** – This refers to sampling frequency and means the second and the fourth week of the month only (i.e. 24 samples per year).

Term of Consent

2. The discharge permit DIS60433803 shall expire 35 years from the date of commencement, unless it has lapsed, been surrendered or been cancelled at an earlier date pursuant to the Resource Management Act 1991 (**RMA**).

Works

3. Within one month of the completion and commissioning of each of the upgrades to the WWTP identified in Conditions 5, 8 and 11, or of any interim works required to meet treated wastewater quality requirements in this consent, the Consent Holder shall notify Auckland Council in writing that the works have been completed.

Discharge Volume and Standards – Existing WWTP

4. From the date of commencement of this consent until the date the Consent Holder gives written notice to Auckland Council in accordance with Condition 5 that the Short Term Upgrade has been completed and commissioned, clauses (a) – (b) of this condition, and Condition 7 below, apply to the operation of the WWTP:

   (a) The discharge volume from the WWTP to the overland flow system shall not exceed the flow rates outlined in Table 1 below;

   Table 1. Treated Wastewater Discharge Volumes from the Existing Beachlands WWTP.

Parameter	Units	Limit
Annual Average Dry Weather Flow	m^3/day	2,200
Peak Wet Weather Flow	m^3/day	4,500

   (b) The discharge from the WWTP shall be equal to or less than the limit specified for each parameter set out in Table 2 below. The collection of treated wastewater grab samples shall occur **fortnightly** and take place following Ultraviolet treatment and prior to discharge to the overland flow system.

Table 2. Existing WWTP Treated Wastewater Quality Standards.

Parameter	Units	Limit
Biochemical Oxygen Demand (BOD)	**g/m³** at the 90% percentile	15
Total Suspended Solids (TSS)	**g/m³** at the 90% percentile	15
Ammoniacal nitrogen (NH_4-N)	**gN/m³** at the 95th percentile	4.0 (Summer)[1] 5.0 (Winter)
Nitrate plus nitrite nitrogen (NOx-N)	**gN/m³** at the 90th percentile	15
Dissolved Reactive Phosphorus (DRP)	**g/m³** at the 90th percentile	5.0
Faecal coliforms	cfu/100 mL	Better than a median of 14

Note:

1. Summer period is November to April inclusive
2. Ammoniacal nitrogen will be sampled weekly (first, second, third and fourth week of the month) and will be assessed over the respective seasons.
3. Median - no more than 12 samples in any 24 consecutive fortnightly samples shall exceed the specified limit.
4. 90th percentile limits - no more than two samples in any twenty consecutive samples events shall exceed the specified limit.
5. 95th percentile limits - no more than one sample in any twenty consecutive samples events shall exceed the specified limit.

<u>**Discharge Volume and Standards – After Short-term Upgrade to WWTP**</u>

5. Prior to the annual ADWF from the WWTP exceeding 2,200m³ per day, the consent holder must complete and commission the Short-Term Upgrade to the WWTP, as generally described in the Assessment of Environmental Effects, and give written notice of this to Auckland Council.

6. Clauses (a) – (b) of this condition, and Condition 7 below, apply to the operation of the WWTP from the date the consent holder gives notice under Condition 5 until the date that the consent holder gives notice to Auckland Council under Condition 8 that the Beachlands WWTP Long Term Upgrade Stage 1 has been completed and commissioned:

    (a) The discharge volume from the WWTP to the overland flow system shall not exceed the flow rates outlined in Table 3 below;

[1] Summer is November to April inclusive

Table 3. Treated Wastewater Discharge Volumes from the WWTP following completion of the Short Term Upgrade.

Parameter	Units	Limit
Annual Average Dry Weather Flow	m^3/day	3,600
Peak Wet Weather Flow	m^3/day	8,700

(b) The discharge from the WWTP shall be equal to or less than the limit specified for each parameter set out in Table 4 below. The collection of treated wastewater grab samples shall occur fortnightly and take place following Ultraviolet treatment and prior to discharge to the overland flow system.

Table 4. Treated Wastewater Quality Standards following completion of the Short Term Upgrade.

Parameter	Median	95^{th} % ile
Biochemical Oxygen Demand (BOD)	7.0	15
Total Suspended Solids (TSS)	7.0	15
Ammoniacal nitrogen (NH_4-N)	0.6	3.0
Nitrate plus nitrite nitrogen (NO_x-N)	3.5	11
Soluble Inorganic Nitrogen (SIN)	4.1	14
Dissolved Reactive Phosphorus (DRP)	1.0	3.0
Faecal coliforms	<10	100

Note:

1. Median - no more than 12 samples in any 24 consecutive fortnightly samples shall exceed the specified limit.
2. 95th percentile limits - no more than one sample in any twenty consecutive samples events shall exceed the specified limit.

7. Following commencement of the consent and until the commissioning of the Long Term Upgrade, the Consent Holder shall also undertake discharge quality monitoring for the parameters identified in Table 5 below. The collection of treated wastewater grab samples shall take place following Ultraviolet treatment and prior to discharge to the overland flow system.

Table 3. Short-Term Additional Treated Wastewater Monitoring Parameters.

Parameter	Units	Frequency
pH		Monthly
Temperature	°C	Monthly
Conductivity	mS/m	Monthly
Total Suspended Solids	mg/L	Monthly
Faecal Coliforms	cfu/100mL	Monthly
Carbonaceous Biochemical Oxygen Demand	mg/L	Monthly
Ammoniacal-N (NH4-N)	mg/L	Monthly

Nitrate plus Nitrite-N (NOx-N)	mg/L	Monthly
Total Nitrogen (TN)	mg/L	Monthly
Dissolved Reactive Phosphorus (DRP)	mg/L	Monthly
Total Phosphorus (TP)	mg/L	Monthly

Discharge Volume and Standards – After Long Term Stage 1 Upgrade

8. Prior to the annual ADWF from the WWTP exceeding 3,600m^3 per day, the consent holder shall complete and commission sufficient upgrades to the WWTP to meet the Long Term Stage 1 Upgrade volumes and standards specified in Condition 9 and give written notice of this to Auckland Council.

9. Clauses (a) to (b) of this condition apply from the date the consent holder gives notice to Auckland Council under Condition 8 above until the date that the consent holder gives written notice to Auckland Council under Condition 10 that the Beachlands WWTP Long-Term Stage 2 Upgrade has been completed and commissioned.

(a) The discharge volume from the WWTP to the overland flow system shall not exceed the flow rates outlined in Table 6 below;

Table 4. Treated Wastewater Discharge Volumes from the Beachlands WWTP following completion of the Long Term Stage 1 Upgrade.

Parameter	Units	New WWTP - Long Term Stage 1 Upgrade
Annual Average Dry Weather Flow	m^3/day	4,800
Peak Wet Weather Flow	m^3/day	28,900

(b) The discharge from the WWTP shall be equal to or less than the limit specified for each parameter set out in Table 7 below. The collection of treated wastewater grab samples shall take place following Ultraviolet treatment and prior to discharge to the overland flow system.

Table 5. Treated Wastewater Quality Standards following completion of the Long Term Stage 1 Upgrade.

Parameter	Units	Long Term Stage 1	
		Median	95^{th} %ile
Biochemical Oxygen Demand (BOD)	mg/L	5.0	9.0
Total Suspended Solids (TSS)	mg/L	5.0	9.0
Ammoniacal nitrogen (NH_4-N)	mg/L	0.5	3.0
Nitrate plus nitrite nitrogen (NO_x-N)	mg/L	2.0	4.5
Soluble Inorganic Nitrogen (SIN)	mg/L	2.5	7.5
Dissolved Reactive Phosphorus (DRP)	mg/L	0.5	1.0
Faecal coliforms	Cfu/100mL	<10	<100

Note:
1. Median - no more than 12 samples in any 24 consecutive fortnightly samples shall exceed the specified limit.
2. 95th percentile limits - no more than one sample in any twenty consecutive samples events shall exceed the specified limit.

10. Following implementation of the Long-Term Stage 1 upgrade, the Consent Holder shall ensure that a validated (in accordance with USEPA UV Disinfection Guidance Manual 2006 or another suitable method) Ultraviolet (UV) dose of 35 mJ/cm^2 is delivered by the UV disinfection facility for 99% of the time (calculated based on a 15-minute average) over each calendar month.

Discharge Volume and Standards – After Long Term Stage 2 Upgrade

11. Prior to the annual ADWF from the WWTP reaching 4,800m^3 per day, the consent holder shall complete and commission sufficient upgrades to the WWTP to meet the Long Term Stage 2 Upgrade volumes and standards specified in Condition 12 and give written notice of this to Auckland Council.

12. Clauses (a) and (b) of this condition apply from the date that the consent holder gives notice to Auckland Council under Condition 11 above until the term of this consent ends in accordance with Condition 2 above:

    (a) The discharge volume from the WWTP to the overland flow system shall not exceed the flow rates outlined in Table 8 below.

    Table 8. Treated Wastewater Discharge Volumes from the Beachlands WWTP following completion of the Long Term Stage 2 Upgrade.

Parameter	Units	New WWTP - Long Term Stage 2 Upgrade
Annual Average Dry Weather Flow	m^3/day	6,000
Peak Wet Weather Flow	m^3/day	36,200

    (b) The discharge from the WWTP shall be equal to or less than the limit specified for each parameter set out in Table 9 below. The collection of treated wastewater grab samples shall take place following Ultraviolet treatment and prior to discharge to the overland flow system.

    Table 9. Treated Wastewater Quality Standards following completion of the Long Term Stage 2 Upgrade

Parameter	Units	Long Term Stage 2	
		Median	95^{th} %ile
Biochemical Oxygen Demand (BOD)	mg/L	5.0	9.0
Total Suspended Solids (TSS)	mg/L	5.0	9.0
Ammoniacal nitrogen (NH_4-N)	mg/L	0.5	3.0
Nitrate plus nitrite nitrogen (NO_x-N)	mg/L	2.0	4.5
Soluble Inorganic Nitrogen (SIN)	mg/L	2.5	7.5

Dissolved Reactive Phosphorus (DRP)	mg/L	0.5	1.0
Faecal coliforms	Cfu/100mL	10	100

Note:
1. Median - no more than 12 samples in any 24 consecutive fortnightly samples shall exceed the specified limit.
2. 95th percentile limits - no more than one sample in any twenty consecutive samples events shall exceed the specified limit.

13. Following completion of the Long-term upgrade the Consent Holder shall undertake discharge quality monitoring for the parameters identified in Table 10 below. The collection of treated wastewater grab samples shall take place following Ultraviolet treatment and prior to discharge to the overland flow system.

Table 6. Long-Term - Additional Treated Wastewater Monitoring Parameters.

Parameter	Units	Frequency
pH		Monthly
Temperature	°C	Monthly
Conductivity	mS/m	Monthly
Total Suspended Solids	mg/L	Monthly
Faecal Coliforms	cfu/100mL	Monthly
Carbonaceous Biochemical Oxygen Demand	mg/L	Monthly
Ammoniacal-N (NH4-N)	mg/L	Monthly
Nitrate plus Nitrite-N (NOx-N)	mg/L	Monthly
Total Nitrogen (TN)	mg/L	Monthly
Dissolved Reactive Phosphorus (DRP)	mg/L	Monthly
Total Phosphorus (TP)	mg/L	Monthly

<u>General Standards – All Discharges</u>

14. The Consent Holder shall ensure that all chemical analyses and sampling techniques are carried out in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater", APHA AWWA WEF, or other standards approved in writing by the Auckland Council. All wastewater quality analyses shall be undertaken by an IANZ accredited or equivalent laboratory.

15. The Consent Holder shall advise the Auckland Council in writing as soon as practicable if the 95th percentile limit is exceeded in two consecutive fortnightly samples for any parameters shown in Tables 4, 7 and 9 above, an investigation shall also be undertaken into the cause of the exceedance, the significance of the effect of the exceedance on the receiving environment, and the remedial action undertaken (if required) in response to the exceedance and the findings of this investigation report to the Auckland Council within one month of the exceedance occurring.

<u>Flow Volume Monitoring</u>

16. At all times during the term of this consent, the Consent Holder shall maintain flow meters to continuously measure the total daily volume discharged from the WWTP post Ultraviolet treatment. The discharge volume meter must be maintained to ensure an accuracy of plus or minus 5 percent. Records shall be kept of the treated wastewater volumes discharged post Ultraviolet treatment. Recorded data shall be reported in accordance with Condition 29.

Overland Flow Design Plan

17. Within 9 months of the commencement of this consent, the Consent Holder shall:
    a. prepare an Overland Flow Design Plan (**OFDP**) and submit it to Auckland Council for certification against the requirements of condition 18a – 19g;
    b. in partnership with Ngāi Tai ki Tāmaki design and develop the expanded overland flow system for the discharges from the WWTP within the Watercare site.

18. The OFDP shall as a minimum, include:
    a. A review of the design of the existing overland flow system and pond including application rate, residence time, the periodic resting of zones within the overland flow area, and the capacity and potential erosion risk of the culvert at the downstream end of the farm pond.
    b. design plans for the Overland Flow System, including any pond element that is part of the system.
    c. A description of the cultural design input, including in particular from Ngai Tai ki Tamaki, and how this has been incorporated into the final design of the Overland Flow System.
    d. A description of the location and design of the proposed expansion to the overland flow system, including how the Overland Flow System:
        i. Avoids and mitigates potential adverse effects on the ecological values of riparian areas, and aquatic habitats, including application of an effects management hierarchy where appropriate.
        ii. Ensures the future overland flow system has an appropriate area slope and gradient. This includes earthworks, slope length, soil conditions, vegetation cover and erosion control.
        iii. Ensures that future wastewater flows, including wet weather flows, are provided for.
        iv. Aligns with good practice in relation to:
            - dispersal method.
            - wastewater application rate.
            - residence time.
            - periodic resting of zones within the overland flow area(s).
            - management of vegetation, including harvesting where this will contribute to the treatment benefits of the overland flow areas.
    e. A description of the operational management of all overland flow systems for the WWTP.
    f. A description of the ongoing monitoring and maintenance requirements associated with the Overland Flow System.
    g. Where applicable to the overland flow system, a riparian planting plan will be prepared, that describes the location of riparian planting, what plant species will be used and the proposed maintenance measures.

Once certificated the OFDP shall be implemented by the consent holder. Implementation of the matters identified in Condition 18(b)-(g) shall be undertaken in conjunction with the Short-term and Long-term Upgrades to the WWTP.

Receiving Environment Monitoring Plan

19. Within 6 months of the commissioning of the Short-term Upgrade of the WWTP, the Consent Holder shall prepare a Receiving Environment Monitoring Plan (**REMP**) for the receiving environment of the WWTP discharges and submit it to the Auckland Council for certification that it has been prepared in general accordance with the requirements listed in Condition 21. Once

certified by the Council the Consent Holder shall implement the REMP for the duration of the consent.

20. The purpose of the REMP is to provide the monitoring framework for:
    a. Detecting trends in receiving water quality that are attributable to the discharges from the WWTP.
    b. Detecting unanticipated adverse effects on freshwater ecology that are attributable to the discharges from the WWTP.
    c. Detecting relevant changes in sediment quality with the potential to affect benthic ecological health in Te Puru estuary.
    d. Detecting and tracking blooms of nuisance macroalgae that are attributable to the discharges from the WWTP.

21. The REMP shall, as a minimum, include / provide for:
    a. A description of the sampling location/s, frequency and methodology for sampling the effects of treated wastewater discharges on receiving water quality for each parameter set out in Table 11;

Table 7.Minimum receiving environment monitoring parameters.

Parameter	Units
Dissolved Oxygen	mg/L and % saturation
pH	
Temperature	°C
Conductivity	mS/m
Salinity	ppt
Total Suspended Solids	mg/L
Faecal Coliforms	cfu/100mL
Carbonaceous Biochemical Oxygen Demand	mg/L
Ammoniacal-N (NH4-N)	mg/L
Nitrate plus Nitrite-N (NOx-N)	mg/L
Total Nitrogen (TN)	mg/L
Dissolved Reactive Phosphorus (DRP)	mg/L
Total Phosphorus (TP)	mg/L
Chlorophyll a	mg/L

    b. A description of the monitoring location/s, frequency and methodology for ecological monitoring for benthic ecology and macroalgae monitoring.
    c. Sediment quality monitoring will include sediment grain size, total organic carbon, total nitrogen, total phosphorus and heavy metals (cadmium, chromium, copper, lead and zinc) at trace detection levels.
    d. Monitoring of emerging contaminants in water and sediment from an upstream site, farm pond site, site 15 (refer to Figure 3.3 of the AEE), and the estuary.
    e. Monitoring emerging contaminants in the treated wastewater discharge
    f. The procedure for modifying the REMP; and
    g. Reporting and review procedures.

Monitoring design for the above aspects shall include the number of samples, spacing of sample stations in relation to the position of the outfall, frequency of sampling, methodology and reporting including baseline data collection. The REMP shall be designed to deliver environmentally meaningful results and be statistically robust enough to detect potential changes to those matters listed above.

22. Following the second year of reporting under the REMP, and subsequently at five yearly intervals or following the completion and commissioning of each upgrade stage (whichever comes first), the Consent Holder shall engage an independent suitably qualified person to review the REMP to confirm that the sampling provided for is 'fit for purpose'. The review of the REMP shall, as a minimum, consider:
    a. Monitoring results (particularly spatial and temporal patterns used to assess the effects of the outfall);
    b. Whether the parameters measured are appropriate;
    c. The location and number of sampling sites and whether they are spatially appropriate;
    d. Sampling frequencies;
    e. Whether better methods are available for obtaining the information required (e.g. because of technological developments);
    f. The suitability of data analyses; and
    g. The adequacy of reporting.

    The review shall be forwarded to Auckland Council within one month of completion and where the findings of the review identify a need to amend the REMP, this shall be undertaken in accordance with the procedure for modifying the REMP as outlined in the REMP.

<u>Operations Management Plan</u>

23. Within six months of commissioning of the Short-term Upgrade to the WWTP, the Consent Holder shall prepare an Operations Management Plan (**OMP**) and submit it to Auckland Council for certification against the requirements of condition 24. A new OMP shall be prepared for every significant upgrade of the WWTP. The purpose of the OMP is to provide a framework for the operation and management, maintenance, treated wastewater, environmental monitoring and reporting of the WWTP to ensure compliance with conditions of this consent.

24. The OMP, as a minimum, shall include / provide for:
    a. A description of the service area information including population growth.
    b. An overview description of the WWTP and discharge facilities;
    c. A description and schedule of the routine inspection, monitoring and maintenance procedures to be undertaken to ensure operation of the WWTP and discharge facilities complies with this consent;
    d. Details of contingency plans and procedures to address a critical power or equipment failure at the WWTP;
    e. Procedures for recording routine maintenance and all major repairs that are undertaken; and
    f. The Consent Holder's chain of command, responsibility and notification protocols.

25. Once the OMP has been certified by the Auckland Council, the Consent Holder shall implement it for the duration of the consent. All significant updates to the OMP throughout the term of this consent shall be submitted to the Auckland Council for certification that the updated OMP meets the requirements of Condition 24 prior to its implementation.

Emerging Contaminants Risk Assessment

26. Within six months of commissioning of the Short-term Upgrade to the WWTP, the Consent Holder shall engage a suitably qualified person to undertake an Emerging Contaminants Risk Assessment (**ECRA**) of the treated wastewater discharged under this consent. Thereafter, an ECRA shall be prepared at 5 yearly intervals. The ECRA shall as a minimum address:
    a. An assessment of the risks to the environment from all emerging contaminants in the treated wastewater discharge and receiving environment from the upgraded WWTP using the monitoring data collected under condition 21d and 21e of this Consent.
    b. Review of changes in the state of knowledge of emerging contaminants relevant to the WWTP either since the assessment of emerging contaminants included in the Application for these consents or the previous ECRA, whichever is more recent.
    c. Identification of any new emerging contaminants or those for which risk factors have changed resulting in the need for them to be included in an ECRA.

27. The ECRA shall be forwarded to the Auckland Council by 30 September of each year that it is required for certification that it meets the requirements of Condition 26.

Reporting

28. An Annual Monitoring Report shall be submitted to the Auckland Council by September 30 of each year. The report shall include, but not be limited to:
    a. Collate, analyse and interpret all relevant data and information pertaining to this consent for the previous year from 1 July to 30 June;
    b. Report the calculated annual ADWF and PWWF volumes, and the rainfall data for the previous year from 1 July to 30 June, and compare these values with the applicable discharge volume requirements specified in Conditions 4(a), 6(a), 9(a) or 12(a) of this consent;
    c. The monitoring and reporting for flows, treated wastewater quality, other environmental monitoring;
    d. Include comment on Wastewater Treatment Plant performance in relation to the quality of the treated wastewater discharge (including compliance with Ultraviolet dose requirements in accordance with Condition 10 and any trends in changes in the discharge volume and/or the discharge quality over time;
    e. Comment on compliance with each consent condition; and
    f. Identify any actions required and submit a timetable to rectify any non-compliance.

Complaints Reporting and Processes

29. All complaints received by the Consent Holder about the treated wastewater discharge associated with the WWTP shall be logged immediately in the WWTP Complaints Register. The Register shall include:
    a. The date, time, location, duration and nature of the complaint;
    b. Name, phone number and address of the complainant unless the complainant wishes to remain anonymous;
    c. Any remedial action taken by the Consent Holder in response to the complaint and when it was undertaken, and if no remedial action was considered necessary by the Consent Holder, the reasons for taking no remedial action;
    d. The possible cause of the relevant event/ incident that lead to the complaint;

e. The weather conditions at the time of the relevant event/ incident including estimates of wind direction, wind strength, temperature and cloud cover;
f. The date and name of the person making the entry; and.
g. Details of any complaints received shall be provided to the Auckland Council within 24 hours of receipt of the complaint(s) or on the next working day, if the complaint is associated with breaches to the performance standards set out in the above conditions. All other complaints shall be provided in the Annual Report required by Condition 28.

30. All records, monitoring and test results that are required by the conditions of this consent shall, upon request by Auckland Council (being the Consent Compliance Officer or the Team Leader, Compliance Monitoring), be made available by the Consent Holder. All records and results shall be kept for a minimum of two years from the date of each entry.

<u>Monitoring and Technology Reviews</u>

31. The Consent Holder shall engage an independent suitably qualified person to prepare and submit a Monitoring and Technology Review Report (**MTRR**) for the WWTP, its catchment area and its contaminant discharges at five yearly intervals following the commissioning of the Short-term WWTP upgrade. The draft MTRR shall be submitted to the Auckland Council for certification that it has been produced in accordance with the requirements of Condition 32 below, by 30 September of each year that it is required.

32. The MTRR shall as a minimum include:
a. An assessment of ongoing compliance with the requirements of the resource consent particularly in relation to any reported non-compliance with consent conditions.
b. An assessment of compliance/consistency with any relevant national or regional water quality policies, environmental standards or guidelines in effect at the time.
c. An assessment of the results of the Consent Holder's monitoring undertaken in accordance with these consents, including the adequacy and scope of such monitoring.
d. A summary of any residual actual or potential adverse effects of the treated wastewater discharge.
e. A review of the significant technological changes and advances in relation to wastewater treatment and discharge methods relevant to disposal options as they relate to land disposal from the WWTP treated wastewater and other by-products either since the commencement of these consents or the previous MTRR, whichever is more recent.
f. A review of the significant technological changes and advances in relation to wastewater management, inflow and contaminant reduction (including for trade waste management), treatment and discharge that could be of relevance for possible future use in the WWTP and discharge facilities. Specific information shall be included on:
(i) Options the Consent Holder has investigated for wastewater reduction and/or reuse and/or alternative discharge options, including Managed Aquifer Recharge and industrial re-use, and any actions taken as a result of those investigations; and
(ii) Any discharge volume and/or contaminant inflow reduction that has been achieved as a result of those actions, since the commencement of these consents, when assessed on a per domestic connection equivalent basis, as reported by flow volume monitoring required under condition 16.
g. An assessment of whether any newly available technology option/s or combination of options identified through (f) above represent the Best Practicable Option (as defined in the in the RMA) and or any other relevant legislation to minimise the potential and actual

adverse effects of the treated wastewater discharge and whether the Consent Holder intends to incorporate such technologies, and if not, an explanation as to why not.

Community Liaison Group

33. The Consent Holder shall within six months of the commencement of this consent invite stakeholders including but not limited to Ngai Tai ki Tamaki, the Auckland Regional Public Health Service (add others) to establish a Community Liaison Group (**CLG**). A general invitation shall be made by way of public notice in the Pohutukawa Coast Times (where practicable), and on the Consent Holder's website.

34. The purpose of the CLG shall be to provide a forum to:
    a. Facilitate communication and dialogue between the Consent Holder, Auckland Council and the community on issues concerning WWTP operation, performance and upgrade works; and
    b. Facilitate communication and dialogue between the Consent Holder and the community on effects on the community / environment arising from plant operations and on future intentions.

35. The Consent Holder shall use its best endeavours to ensure that formal meetings of the CLG are held at least once annually, and where practicable, within three months of the completion of the Annual Monitoring Report required by Condition 28. The CLG meeting can be cancelled or deferred subject to agreement being obtained from all parties who attended the prior year's CLG meeting or have requested to be invited to all future CLG meetings.

36. The Consent Holder shall provide reasonable organisation and administrative support to facilitate the development and on-going role of this CLG for the duration of the consent.

37. The Consent Holder shall provide an appropriate venue for the CLG meetings a minimum of ten working days prior to the scheduled meeting date and provide the minutes of the CLG meeting to all parties listed above within one month following the CLG meeting.

38. The Consent Holder shall assist the CLG to fulfil its purpose by providing information to the CLG parties on:
    a. Any concerns and complaints of the local community, aspects of non-compliance and remedial actions or proposals;
    b. WWTP performance, including an overview of the most recent annual monitoring report and receiving environment monitoring; and
    c. Updates on issues that have been resolved since the previous CLG meeting.

Review

39. The conditions of this consent may be reviewed by Auckland Council pursuant to section 128 of the Resource Management Act 1991 (RMA), by giving notice pursuant to section 129, on the fifth anniversary of the commencement of these consents and subsequently at intervals of not less than five years thereafter in order to:
    a. To deal with any adverse effects, which are more than minor, on the environment arising from the exercise of the consent, which was not foreseen at the time the application was considered and which is appropriate to deal with at the time of review, including more than minor adverse effects of the treated wastewater discharge on receiving water quality and

benthic ecology as identified through the monitoring undertaken in the Receiving Environment Monitoring Plan under Condition 19; and / or,

b. To alter the monitoring requirements, including requiring further monitoring, or increasing or reducing the frequency of monitoring.

Charges and Access

40. This consent (or any part thereof) shall not commence until such time as the following charges, which are owing at the time Auckland Council's decision is notified have been paid in full:
    a. All fixed charges relating to the receiving, processing and granting of this resource consent under section 36(1) of the RMA;
    b. All additional charges imposed under section 36 of the RMA to enable the Council to recover its actual and reasonable costs in respect of this application; and
    c. All initial consent compliance monitoring charges, plus any further monitoring charges to recover the actual and reasonable costs incurred to ensure compliance with the conditions attached to this consent.

41. The servants or agents of Auckland Council shall be permitted to have access to the relevant parts of the property at all reasonable times for the purpose of carrying out monitoring procedures, inspections, surveys, investigations, tests, measurements or take samples while adhering to the Consent Holder's health and safety policies.

ATTACHMENT 26

SUBMISSIONS

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Tuesday, November 19, 2024 3:00:49 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23187] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Grant Bowring

Organisation name: JWB Group

Contact phone number: 021955642

Email address: grant@jwb.co.nz

Postal address:
204104
Highbrook
East Tamaki 2161

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
Degrading the receiving environment and stream

What are the reasons for your submission?

What decisions and amendments would you like the council to make?
Pipe effluent to Mangere for treatment

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: Yes

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Tuesday, November 19, 2024 3:15:45 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23188] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Grant Bowring

Organisation name: JWB Group

Contact phone number: 021955642

Email address: grant@jwb.co.nz

Postal address:
204104
Highbrook
East Tamaki 2161

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
Degrading the receiving environment

What are the reasons for your submission?

What decisions and amendments would you like the council to make?
Pipe effluent to Mangere for treatment

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: Yes

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Wednesday, November 20, 2024 6:45:20 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23245] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: shane stewart

Organisation name:

Contact phone number: 021841357

Email address: shanestew@gmail.com

Postal address:
14 Alva Glen Place, Pyes Pa,
Pyes pa
Tauranga 3112

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
Discharged to ground water. This is not sustainable or good national practice

What are the reasons for your submission?

What decisions and amendments would you like the council to make?
No discharge to ground water. Treat it properly

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? No

If other people make a similar submission I will consider making a joint case with them at the hearing: No

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Monday, December 2, 2024 9:01:01 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23858] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Catherine Bryant

Organisation name:

Contact phone number: +64275764777

Email address: chocolatebadgers@gmail.com

Postal address:
13 Campbell rd
Maraetai
Auckland 2018

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
Upgrade of treatment plant has been discussed at many watercare community meetings and we have heard once population reaches 10000 it would need to be upgraded. I believe the system should be upgraded prior further large scale subdivision being included (plus Whitford's houses) and by acting promptly we can avoid the compounding negative impacts on public well-being and coastal ecosystems, securing a cleaner, healthier, and more sustainable future for all residents and visitors. Many of our locals and tourists swim at Omana beach and shelly beaches and they will be impacted more than now under the proposed plan. The diagrams show the water quality at beaches will decrease with possibly a medium impact if no treatment upgrades occurs. I think subdivisions should be delayed until traeatment systems are capable to coping with the volume of materials, rather than changing the limits to accept reduced quality and heath of our environment

What are the reasons for your submission?
I value the heath of my family, friends and the area we live. This plan seems to sacrifice all that I hold dear so large large subdivisions can not occur. I strongly believe upgrades should occur prior to subdivision and not retrospectively.

What decisions and amendments would you like the council to make?
I would like the council to take a path of proactive protection of human health and the environment near the immediate dis-charge site. I do not support a treatment plan that worsens water quality, this applies both short term and long term.

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: Yes

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Monday, December 9, 2024 9:45:39 PM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23880] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Dick Bavelaar

Organisation name:

Contact phone number: 021772878

Email address: bavelaars5@gmail.com

Postal address:
13 Te Pene Road
Auckland
Auckland 2018

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
Increased discharge ending up into Te Puru streem

What are the reasons for your submission?
I am a resident of Maraetai for over 25 years. I am a civil engineer. I have detailed knowledge of the current sewage treatment plant, having been in charge as the Manuau Water project manager responsible for delivery of design and construction of the previous capacity increase of the plant. The current plant appears to take good care of biological hazards. However, it is not good at removing the sewage smell from it's discharge. Te Puru stream regularly smells like sewage. I have raised this a few times with Watercare but it is ignored, presumably because the consent does not measure it.
Te Puru stream is already largely composed of treated effluent. The proposed 3-fold plant capacity increase will make the stream basically an open treated effluent channel. Smelly and not a good look, upstream of one of the most well-used beaches in Auckland.

The consultation process was a bit of a farce. The options available for consultation were B-grade and high risk for Maraetai's beaches. Options that included pumping sewage or (partially) treated effluent towards Auckland's main sewer sytem were excluded from the consultation.

The selected option includes overland flow. This is a very high risk solution in this period of climate change with increasing rain intensities. Any failure of this will result in contamintion entering Te Puru stream.

Because of the limited consultation process I am not aware of the evaluated pumped options and why they were discarded. As a professional I believe there are technically feasible and superior solutions available that include pumping all or part of the sewage to the Auckland main sewer system. This could include part treatment and buffering within the current plant footprint prior to pumping it into the Main Auckland sewer system.

What decisions and amendments would you like the council to make?
Not to grant a resource consent for a high risk B-grade solution that increases discharge into Te Puru stream. Send Watercare back to the drawing board and select an A-grade option that pumps the increase or all of the treated effluent discharge into the main Auckland sewage system.

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: No

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Friday, December 13, 2024 4:15:17 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23898] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Robin Miller

Organisation name:

Contact phone number: 0223288466

Email address: rjm.otago@googlemail.com

Postal address:
15 harbourside Court
Beachlands
Auckland 2018

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
Contamination levels in discharge waters into the tributary of the Te Puru Stream

What are the reasons for your submission?
As a user of the beaches and surrounding waters along the coastline of Maraiteai and Beachlands areas, I have noticed significant increases in waste from the treatment plants on our beaches. I have also taken many fish samples in the area, which show a decrease in small nursery fish and invertebrates.

What decisions and amendments would you like the council to make?
No increase at all in toxins levels released into the tributary of the Te Puru Stream.

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: Yes

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Sunday, December 15, 2024 3:15:40 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23906] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Revell Butler

Organisation name: Ngāi Tai ki Tāmaki

Contact phone number: 027 233 6020

Email address: revell@ngaitaitamaki.iwi.nz

Postal address:
PO Box 141
Clevedon
Auckland 2248

Submission details

This submission: is neutral regarding the application in whole or in part

Specify the aspects of the application you are submitting on:
This submission relates to all aspects of the Watercare application to continue to discharge wastewater into Te Puru (Te Puru Stream) and its tributaries, and ultimately to Te Marae o Tai (Maraetai Moana), Tikapakapa Moana (Hauraki Gulf).

What are the reasons for your submission?
Ngāi Tai ki Tāmaki is the iwi taketake (original peoples) of the area, since time immemorial and to this day maintain our mana motuhake as the tāngata whenua, mana whenua, mana moana, Kaitiaki and ahikāroa of Turanga (Whitford), Kahawairahi (Pine Harbour), Kauriwhakiwhaki (Beachlands), Te Motukaraka, Te Hiore, Te Puru, Te Ruatauirohā Ō Manawatere, Pōhaturoa (Maraetai) through to Umupuia and Whakakaiwhara.

Ngāi Tai ki Tāmaki, through our whakapapa and inherent responsibilities, as Kaitiaki has a recognised role in ensuring that activities within te taiao (the natural environment) are managed to ensure that activities do not adversely impact the physical or intrinsic elements of te taiao, the tangible and intangible.

Ngāi Tai ki Tāmaki and Watercare are engaging on this kaupapa however no outcomes have been reached.

What decisions and amendments would you like the council to make?
Ngāi Tai ki Tāmaki will continue to engage with Watercare and provide updates as relevant to Auckland Council on this engagement process.

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: No

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Monday, December 16, 2024 4:31:01 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23933] Submission

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Zaelene Maxwell-Butler

Organisation name:

Contact phone number: 0274877121

Email address: zaelenemaxwellbutler@gmail.com

Postal address:
29 Te Puru Drive
Auckland
Auckland 2018

Submission details

This submission: opposes the application in whole or in part

Specify the aspects of the application you are submitting on:
This submission addresses the comprehensive aspects of the Watercare Wastewater Discharge Application DIS60433803, which seeks to continue and expand the operation of the Beachlands Wastewater Treatment Plant (WWTP). The proposed discharge to groundwater and an overland flow system will flow into a tributary of a wāhi tapu known to my iwi Ngāi Tai ki Tāmaki as Te Puru, or Te Puru Stream and ultimately into Te Marae o Tai (Maraetai Moana) and Tīkapakapa Moana (Hauraki Gulf).

What are the reasons for your submission?
As a resident of Maraetai, a ratepayer, and as local iwi Ngāi Tai ki Tāmaki, I am deeply concerned about the ongoing impacts on Ngāi Tai taonga, our awa (river) Te Puru and moana (ocean) Te Marae o Tai, and the ongoing desecration of our wāhi tapu (sacred place) within Te Puru. My submission seeks to share the Ngāi Tai cultural landscape, as known by me.

I am employed by my iwi in Te Taiao (RMA/Environmental), my submission represents my whānau, my mokopuna and my tūpuna who came before me and underscores the profound culturally insensitive and physical impacts on the CMA and Te Tahua, the coastal marine area along the front of Ōmana Regional Park. Our name Te Tahua speaks to its purpose, a peaceful place, an ātea (courtyard) that was an integral part of the villages of my ancestors. Regarding wāhi tapu, opposite Te Tahua were the ancient burial caves along the base of cliffs, now eroded. Archaeology reports and the kōrero handed down over the generations from our tūpuna show us that the area was once abundant with kaimoana, including kukupara (little blue mussels), tipa (scallop), tuangi (cockle), tio (cockles) and pipi. Te Puru and Te Marae o Tai (moana) lie between two ancient pā sites, Te Hiore (now Leigh Auton Reserve) and Te Ruatauirohā o Manawatere (Ōmana Regional Park). Te Puru Sports Park was once part of the village system, partly forested, waka landing places and temporary dwellings. There are 2 awa in the area, Te Ruangaingai and Te Puru, both names like GPS co-ordinates tell us there are burials within the banks of each awa.

The degradation of Te Puru Stream and the surrounding environment continues to prevent our ability to harvest kaimoana (seafood) and maintain traditional practices, severing a vital connection to our tūpuna (ancestors) and disrupting our role as kaitiaki (guardians) of the whenua and moana. This highlights the urgent need to protect and restore these waters to preserve the cultural heritage and well-being of my whānau for many generations of Ngāi Tai ki Tāmaki to come. The environmental degradation is visibly evident, with noticeable mangrove growth in Te Puru and the CMA (coastal marine area). The cultural harm extends to the mauri (life force) of Tangaroa, Hinemoana, Hinekirikiri, and the many Ngāi Tai tūpuna interred in the area.

I have concern also for the nutrients from recreational/other drug users within the wastewater which cannot be removed by WWT processes and ultimately impact the ecology of the receiving environment.

This causes further harm for swimmers.

What decisions and amendments would you like the council to make?
There is no environmental remediation for the ongoing degradation to Te Puru, for the insult to my tūpuna resting.

Watercare must be encouraged to explore other methods for reuse of the water rather than continue to degrade our waterways.

Climate Change isn't coming, it has always been here but the human race is not listening. Our activities inland continue to place stress on the freshwater and marine areas. Where is it going in an inter-tidal area?

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: No

Supporting information:

From: NotifiedResourceConsentSubmissionOnlineForm@donotreply.aucklandcouncil.govt.nz
Sent on: Monday, December 16, 2024 7:46:01 AM
To: CentralRCSubmissions@aucklandcouncil.govt.nz
CC: Anshita.Jerath@water.co.nz
Subject: DIS60433803 [ID:23937] Submission
Attachments: Submission on behalf of RPG.pdf (692.2 KB)

We have received a submission on the notified resource consent for 100 Okaroro Drive, Beachlands .

Details of submission

Notified resource consent application details

Property address: 100 Okaroro Drive, Beachlands

Application number: DIS60433803

Applicant name: Watercare Services Limited

Applicant email: Anshita.Jerath@water.co.nz

Application description: Watercare Services Limited has applied for a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant to groundwater and an overland flow system, which will then flow into an unnamed tributary of Te Puru Stream. Overall, the application is a discretionary activity.

Submitter contact details

Full name: Russell Property Group

Organisation name: Simpson Grierson

Contact phone number: 0274244617

Email address: rachel.abraham@simpsongrierson.com

Postal address:
Level 27, Shortland and Fort, 88 Shortland Street
Auckland
Auckland 1010

Submission details

This submission: supports the application in whole or in part

Specify the aspects of the application you are submitting on:
See attached submission.

What are the reasons for your submission?
See attached submission.

What decisions and amendments would you like the council to make?
See attached submission.

Are you a trade competitor of the applicant? I am not a trade competitor of the applicant.

Do you want to attend a hearing and speak in support of your submission? Yes

If other people make a similar submission I will consider making a joint case with them at the hearing: Yes

Supporting information:
Submission on behalf of RPG.pdf

Submission on Beachlands Wastewater Treatment Plant (WWTP) discharge consent renewal

Section 95A of the Resource Management Act 1991

To: Auckland Council

Name of Submitter: Russell Property Group (**RPG**)

1. SUBMITTER DETAILS

1.1 This is a submission on the proposed Beachlands Wastewater Treatment Plant (**WWTP**) discharge consent renewal by Watercare Services Limited (DIS60433803, **Application**).

1.2 RPG is the manager of the applicant of Plan Change 88: Beachlands South (**PC88**) to the Auckland Unitary Plan – Operative in Part (**AUP**). PC88 was approved in consent determination issued by the Environment Court on 28 November 2024 and on 10 December 2024 the Council resolved to make PC88 operative. PC88 enables significant housing and business development in Beachlands South.

2. SCOPE OF SUBMISSION

2.1 RPG's submission is on **all aspects** of the Application.

2.2 Without limiting the generality of the above, the specific aspects of the Application that this submission relates to are:

(a) the discharge of treated wastewater from the continued and expanded operation of the Beachlands WWTP; and

(b) the timeframe for implementing each of the four stages of the upgrade process.

2.3 RPG **supports** the Application subject to sufficient wastewater capacity being provided for both the 'live' zoned and Future Urban zone of the Beachlands South precinct and the provision of greater certainty of the timeframes within which each stage of the proposed WWTP upgrades will occur.

3. BACKGROUND

3.1 PC88 is a private plan change to the AUP to rezone approximately 307 hectares of Rural - Countryside Living zoned land with a contiguous boundary to the existing coastal town of Beachlands to a variety of urban zones and to Future Urban zone. PC88 'live' zones the northern portion of the land (159.54 ha) to a mixture of Residential zones (Terrace Housing and Apartment Buildings, Mixed Housing Urban and Large Lot), and Business zones (Local Centre, Mixed Use and Light Industrial). The southern portion of the land (147.5761 ha) is rezoned Future Urban zone.

3.2 PC88 will enable a sustainable and well-functioning community at Beachlands that provides greater residential and business land capacity. The live zone portion of PC88 enables 2,700 dwellings and other uses which could support around 8,000 to 10,000 people. Further growth is envisaged in the Future Urban zone once it is rezoned for urban uses.

3.3 On 28 November 2024, the Environment Court issued a consent determination under section 279(1)(b) of the RMA, resolving three appeals filed against the decision of Auckland Council approving PC88. On 10 December 2024, Auckland Council passed a resolution to approve PC88 and requested staff to complete the necessary statutory processes to make PC88 operative. RPG understands that PC88 will be made operative on 24 January 2025.

3.4 There is significant growth projected for the Beachlands area as a result of PC88. To ensure this growth can be adequately serviced with wastewater, RPG supports the Application to replace the existing consent discharge permit DIS60263339 with a new permit for a term of 35 years, to be implemented in four stages.

4. SUBMISSION AND DECISION SOUGHT

4.1 The Beachlands and Maraetai communities are currently serviced by a wastewater network that connects to the Beachlands WWTP. There are around 3,400 existing wastewater-only connections and no reticulated water supply in Beachlands and Maraetai. Around 2,500 connections are in Beachlands. The discharge volume is nearing the consent limit of 2,800m^3 per day and the condition that restricts the population serviced by the WWTP to 10,000 people is at this limit or potentially exceeded.[1]

4.2 The upgrades provided for in stages 1 and 2 of the Application are therefore important to service the growth that is enabled as a result of PC88. These stages propose to cater for a population of up to 18,000 people and a maximum discharge volume limit of 8,700m^3 / day, and an average daily flow of 3,600m^3.

4.3 The Application includes a broad target range of timing for implementing these short-term upgrades, from December 2026 to December 2031.[2] The Application states that the long-term upgrades (Stages 3 and 4) are population dependent and will only be implemented once population numbers are reached.

4.4 RPG seeks that the Application be **granted** to provide adequate capacity for growth that is enabled by PC88, subject to the following:

(a) That sufficient capacity is provided for all the urban development envisaged in the 'live' zoned part of the Beachlands South precinct and allocated to the Beachlands South Precinct;

(b) That sufficient capacity is provided for all the future urban development envisaged in the Future Urban zoned part of the Beachlands South precinct and is allocated to the Beachlands South Precinct; and

(c) That any required interim wastewater collection and disposal measures are supported by and agreed to by Watercare, should the upgrade to the plant not be completed by the time it is required for development within Beachlands South.

4.5 RPG seeks greater clarity on the timeframes for implementing the short to medium term upgrades to ensure that they align with the timeframes for developing PC88. RPG also seeks

1 Beachlands Wastewater Scheme Resource Consent Project *Alternatives Assessment Report* (June 2024) at page 1.
2 Watercare Services Limited "Executive Summary" Auckland Council < RC 6.16.11 Internal notification memorandum>

clarity that long-term upgrades will occur in advance of (and in anticipation of) population numbers being reached.

Dated: 16 December 2024

Russell Property Group

Address for service of Submitter:

Simpson Grierson
C/- Bill Loutit and Rachel Abraham
Bill.loutit@simpsongrierson.com / Rachel.abraham@simpsongrierson.com

16th December 2024

Auckland Council

RCappeals@aucklandcouncil.govt.nz

Watercare Services Limited

Anshita.Jerath@water.co.nz

Application: DIS60433803

Thank you for the opportunity for National Public Health Service – Northern Region, Health New Zealand I Te Whatu Ora to provide a submission on the resource consent application by Watercare Services Ltd for a discharge consent for upgrades and extension to the Beachlands Wastewater Treatment Plant, 100 Okaroro Drive Beachlands (application DIS60433803).

The National Public Health Service - Northern Region will provide feedback on the council officers' reports and wishes to speak in support of the submission at the hearing.

The primary contact point for this submission is:

Megan Howson

Senior Policy and Equity Advisor

National Public Health Service – Northern Region

Megan.Howson@tewhatuora.govt.nz

Ngā mihi,

David Sinclair

Medical Officer of Health

National Public Health Service - Northern Region

Health New Zealand | Te Whatu Ora

Hayden McRobbie

Regional Director

National Public Health Service - Northern Region

Health New Zealand | Te Whatu Ora

1 General Information

1.1 Submitter Details

This submission is made on behalf of the National Public Health Service – Northern Region (NPH-NR), a directorate within Health New Zealand I Te Whatu Ora. As a crown agency, NPHS - Northern Region has a range of regulatory and no-regulatory roles and functions related to public and environmental health, with the purpose of protecting, improving and promoting public health and wellbeing. NPHS - Northern Region does not have a specific regulatory role in relation to this consent application or the operation or monitoring of the Beachlands Waste Water Treatment Plant (BWWTP).

1.1.1 Trade Competition

NPHS - Northern Region is not a trade competitor of the applicant.

1.2 Prior Consultation

Public health staff from NPHS - Northern Region meet regularly with representatives from Watercare Services on matters related to wastewater and drinking water services and infrastructure plans. The proposed BWWTP upgrades have been discussed a number of times over several years, including discussion of the current state of the BWWTP and the need for upgrade and extension; environmental and public health implications of the BWWTP; options for upgrading the treatment plant; and options for treated effluent discharge. We have discussed the population projections and development proposals in and around the Beachlands and Maraetai area, including the Beachlands South private plan change (PPC 88) and proposed business park.

2 Submission Details

2.1 Te Mana o te Wai

NPHS - Northern Region supports Watercare in applying *Te Mana o te Wai* as set out in the National Policy Statement – Freshwater Management (NPS-FW); and its contribution to Auckland Council's vision for freshwater, *Te Mauri o te Wai*.

In particular, NPHS - Northern Region acknowledges the linkage being developed between Watercare and Ngāi Tai ki Tāmaki and the importance of *Take Taiaomaurikura* , the taiao framework developed by Ngāi Tai ki Tāmaki. The cultural impact assessment being prepared by Ngāi Tai ki Tāmaki needs to be an important factor in the planning and implementation of the upgraded BWWTP.

2.2 Proposed Beachlands Wastewater Treatment Plant

We have reviewed the consent application documents and reports relevant for public health protection, including the Assessment of Environmental Effects (AEE), the Assessment of Microbiological Effects and Health Risk (AMEHR) prepared by NIWA for Watercare, and "Human Health Risks from EOCs – Attachment 8" prepared by ESR.

The proposed four stage redevelopment and expansion of the BWWTP is timely because of the age and state of existing plant and population projections for the Beachlands and Maraetai area. The proposal should be seen in the context of Auckland Council's Future Development Strategy, infrastructure situations and challenges, population projections, climate change adaptation plans, the need for improved environmental performance over time; and the relationship between Council and iwi.

Discharge Options

NPHS - Northern Region agrees with Watercare Services' decision not to develop an ocean outfall, and instead improve the treatment facilities and expand effluent discharge using overland flow with discharge to the tributary of Te Puru stream.

Influent

Most of the Beachlands and Maraetai area relies on individual roof and tank water supplies (there are 2 registered network supplies, for Pine Harbour and around the Beachlands shopping area, totalling about 1100 residents). NPHS - Northern Region is not aware of any proposals for a network drinking water supply, or what water supply is proposed for the PPC 88 development. However, if a networked supply is developed during the proposed consent period (35 years) it is likely to increase the influent load significantly, which would have implications for the BWWTP capacity and performance. This should be considered in the consent assessment process and conditions.

NPHS - Northern Region notes that the proposed redevelopment and expansion of the BWWTP includes wastewater treatment and discharge capacity for the proposed Beachlands South residential development (PPC 88), and business park, rather than having separate WWTPs with separate discharges into potentially sensitive freshwater and coastal environments. In general, NPHS supports having a single public utility WWTP in situations like this because of long term ownership, financial, maintenance, operational and environmental issue. The consent application documents are not clear on whether any final decisions have been made.

Treatment and Effluent Quality

The proposed WWTP is intended to produce the higher quality effluent necessary to deal with higher environmental standards and greater flow. The replacement of secondary clarifier and disc filters with the membrane bioreactor should be beneficial in reducing the Total Suspended Solids (TSS) - particularly as the consent limit (90th percentile) is 15 mg/L whereas the current plant outputs 12mg/L (90th percentile) following UV treatment with current processes. The new processes should enable the BWWTP to produce effluent with lower TSS.

In the report from NIWA on microbiological effects and health risk, the indicator organisms levels for effluent from the current WWTP is low (2CFU/100mL). Following discharge to the overland flow (OLF) system, bottom samples for Zones A, B and C are much higher. The Farm Pond outlet has a median concentration of 250 CFU/100mL. Whilst the risk of the treated effluent presents low microbiological risk, the discharge through the overland flow system

(OLF) could act as an accelerated transport mechanisms for environmental microorganisms (including indicator organisms and potential pathogens) into the farm pond. An expansion of the OLF system needs to be designed and operated so as not to exacerbate the faecal indicator bacteria levels. The microbiological levels are also noted to be higher during summer time due to low rainfall and dilution. Recreational activities and food gathering often occurring more during summer. Watercress and shellfish gathering have been reported at Site A, which is a potential source of illness. Although the latter is noted to be unlikely due to shellfish size, this does not guarantee deterrence for recreational gathering. NPHA-NR recommends improving local awareness and signage at downstream access points on Te Puru stream.

Dissolved inorganic nitrogen (DIN) discharge during current and short-term consent stages at site 15 is expected to be 1.3mg/L which marginally exceeds the eutrophication threshold (1mg/L). This stage is expected to take place for six years, and any cumulative effects should be monitored and management. The AEE states that long-term options are proposed to have negligible effects on dissolved oxygen (DO), but what about the short-term and current stages since DO is already reduced in places?

It is expected that nitrogen removal will be more efficient with the expansion of the discharge field, however it is also noted in the report that silty clay subsoil within the OLF system is better suited for phosphorus removal rather than nitrogen. The ammonical-N concentrations in the farm pond can reach potentially harmful concentrations due to nitrification processes - is this expected to reach harmful concentrations during the current and short-term stages? Noting that max daily discharge will increase from 4500 to 8700 m3/day from the current to short term stage.

The AEE identifies the need to upgrade and expand the overland flow effluent system, which will need to have capacity to cope with uneven flows and the topography of the land around the Farm Pond.

Other aspects of the environmental monitoring programme will need to continue. We note the nitrogen and phosphorous level and impacts on freshwater ecology downstream of the existing plant, and the potential upstream sources of nitrogen and phosphate described in the AEE.

While supportive in principle, the potential capacity constraints and down-stream impacts on hydrology and ecology of the stream from increased flow and nutrient load, as described in the consent application, and the perspective of Ngāi Tai ki Tāmaki need to be high priority for planning, construction, operation and monitoring.

The range of management, mitigation and monitoring proposed by Watercare in the application covers the main topics related to environmental health and sanitation. However, the monitoring framework includes faecal coliforms as the microbiological indicator, rather than E. coli which is the indicator organism for freshwater quality monitoring in the National Policy Statement for Freshwater Management and Water NZ's 2002 guidelines on monitoring municipal wastewater treatment plant performance. NPHS - Northern Region recommends including E. coli in the monitoring programme for the consent conditions.

NPHS - Northern Region notes the design capacity for floods described in the application (in relation to the 2023 Auckland Anniversary weekend storm), which we can expect to be more frequent and more severe during the consent period because of climate disruption.

Overall, the proposed upgrade and expansion of the BWWTP should be able to meet the sanitary and environmental health requirements for wastewater management for the projected population increase and urban development in the Beachlands – Maraetai area.

From:	Faye Barraclough on behalf of rcregulatorysupportcentral2
To:	Premium Submissions
Subject:	FW: Submission FW: DIS60433803 (Beachlands Wastewater Treatment Plant)
Date:	Tuesday, 17 December 2024 7:43:08 am
Attachments:	image001.png 20241216 Beachlands WWTP RC submission.pdf image002.png

Ngā mihi nui,

Faye Barraclough | Regulatory Support officer
Regulatory Support Team Central (2) | Planning and Resource Consents
Auckland Council, Level 6, 135 Albert Street, Auckland
Private Bag 92300, Auckland 1142
Visit our website: www.aucklandcouncil.govt.nz

From: Mae Richardson <mae.richardson@aucklandcouncil.govt.nz> **On Behalf Of** Resource Consent Authority
Sent: Tuesday, 17 December 2024 7:37 am
To: rcregulatorysupportcentral2 <rcregulatorysupportcentral2@aucklandcouncil.govt.nz>
Subject: FW: Submission FW: DIS60433803 (Beachlands Wastewater Treatment Plant)

Hi team, submission for a premium application

Ngā mihi,

Mae Richardson | Senior Regulatory Support Officer
Southern Planning & Resource Consents
Auckland Council, Level 6, Manukau Civic, 31-33 Manukau Station Road, Manukau
DDI: 09 890 2924 |EXT: 46 2924
Website: www.aucklandcouncil.govt.nz

From: Zara Mitchell-Brookes <zara.mitchell-brookes@TeWhatuOra.govt.nz>
Sent: Monday, 16 December 2024 3:00 pm
To: RCappeals <rcappeals@aucklandcouncil.govt.nz>; Anshita Jerath <Anshita.Jerath@water.co.nz>
Cc: Megan Howson <megan.howson@TeWhatuOra.govt.nz>
Subject: DIS60433803 (Beachlands Wastewater Treatment Plant)

Kia ora,

Please find attached the National Public Health Service – Northern Region submission in regard to application DIS60433803 (Beachlands Wastewater Treatment Plant).

We look forward to hearing from you.

Ngā mihi,

Zara Mitchell-Brookes (she/her)
Manager Planning, Policy and Performance
National Public Health Service Northern Region

+64 223455084 | zara.mitchell-brookes@tewhatuora.govt.nz
Building 15, Cornwall Complex Greenlane Clinical Centre

Health New Zealand
Te Whatu Ora

*** My working hours may not be your working hours. Please do not feel obligated to reply outside of your normal work schedule ***

Submission on a Resource Consent Application DIS60433803
Applicant: Watercare Services Limited

To:	Attention: Resource Consents Auckland Council Level 24, 135 Albert Street Private Bag 92300 Auckland 1142 rca@aucklandcouncil.govt.nz
"The Submitters":	Knight Investments Limited ("KIL") & Manukau Quarries Limited Partnership ("MQLP")
Address for Service:	Attn: Doyle Smith doyle@nakhlegroup.co.nz 420 Airfield Road, Takanini

Introduction:

1. This is a submission on a resource consent) lodged by Watercare Services Limited ("WSL") a discharge permit associated with the discharge of treated wastewater from the continued and expanded operation of the Beachlands Wastewater Treatment Plant ("WWTP") to groundwater and an overland flow system, which will then flow into an unnamed tributary of the Te Ruangaingai Stream (formally Te Puru Stream).[1]

2. The Submitters could not gain an advantage in trade competition through this submission.

Interest in Beachlands

3. MQLP operates what is known as the "Beachlands Quarry" which is currently undertaking (simultaneously) quarrying and rehabilitation works at 885 Whitford-Maraetai Road. MQLP is also the owner of 867 Whitford-Maraetai Road.

[1] Stream name has been altered under the Ngāi Tai ki Tāmaki Claims Settlement Act 2018

4. KIL has a commercial agreement with MQLP in respect of developing land at 867 and 885 Whitford Maraetai Road. KIL has already obtained resource consent via the COVID-19 Recovery (Fast-Track Consenting) Act 2020 (FTCA) to construct and operate a business park for light industrial and business uses comprising approximately 22,000m2 of gross floor area, associated roading, hardstands, and services.

5. As part of the FTCA process agreement was reached with WSL for wastewater servicing capacity for the entire landholding inclusive of a future stage of development.

Support/Oppose and Reasons for submission:

6. The Submitters generally supports the application by WSL insofar as:

   (a) The proposal retains the existing capacity to service the KIL landholdings as agreed between WSL and KIL.

   (b) The proposed upgrade plant (technology and treatment capability) is sufficient to enable the industrial and business uses to discharge into the network anticipated for the KIL activities without the need for pre-treatment on the KIL landholding.

   (c) The discharge quality does not negatively impact on the ability of MQLP and KIL to meet their obligations for water quality testing under the respective quarry/rehabilitation and FTC consents.

7. The Submitters consider that (subject to the resolution of the matters above) the proposed WSL discharge consent:

   (a) Promotes the sustainable management of natural and physical resources and is not contrary to Part 2 of the RMA, to the extent that it:

      (i) Ensures that any potential adverse effects are appropriately addressed;

      (ii) Enable the social, economic and cultural well-being of the community in the Auckland Region; and

      (iii) Meet the reasonably foreseeable needs of future generations; and

      (iv) Would enable development of Beachlands urban zoned land and KIL landholdings to continue.

Relief sought:

8. The Submitters seek that the resource consent be approved, subject to the confirmation or resolution of the matters listed in 6(a)-(c).

Hearing:

9. The Submitters wishes to be heard in support of its submission.

10. If others make a similar submission, The Submitters will consider presenting a joint case with them at any hearing.

Doyle Smith (for Knight Investments Limited)

doyle@nakhlegroup.co.nz

Phone: 021 666 220

Address: 420 Airfield Road Ardmore,

16 December 2024

From:	Faye Barraclough on behalf of rcregulatorysupportcentral2
To:	Premium Submissions
Subject:	FW: Submission on DIS60433803
Date:	Tuesday, 17 December 2024 7:43:19 am
Attachments:	KIL & MQLP Submission.pdf image001.png

Ngā mihi nui,

Faye Barraclough | Regulatory Support officer
Regulatory Support Team Central (2) | Planning and Resource Consents
Auckland Council, Level 6, 135 Albert Street, Auckland
Private Bag 92300, Auckland 1142
Visit our website: www.aucklandcouncil.govt.nz

From: Mae Richardson <mae.richardson@aucklandcouncil.govt.nz> **On Behalf Of** Resource Consent Authority
Sent: Tuesday, 17 December 2024 7:40 am
To: rcregulatorysupportcentral2 <rcregulatorysupportcentral2@aucklandcouncil.govt.nz>
Cc: mark@planned.co.nz
Subject: FW: Submission on DIS60433803

Hi team,

Please see another submission for DIS60433803.
Not sure why they are coming to this inbox?

Ngā mihi,

Mae Richardson | Senior Regulatory Support Officer
Southern Planning & Resource Consents
Auckland Council, Level 6, Manukau Civic, 31-33 Manukau Station Road, Manukau
DDI: 09 890 2924 |EXT: 46 2924
Website: www.aucklandcouncil.govt.nz

From: Renee Fraser-Smith <renee@tollemache.co>
Sent: Monday, 16 December 2024 5:21 pm
To: mark@planned.co.nz; Resource Consent Authority <rca@aucklandcouncil.govt.nz>
Cc: Anshita Jerath <Anshita.Jerath@water.co.nz>; doyle@nakhlegroup.co.nz
Subject: Submission on DIS60433803

Hi There

On behalf of Knight Investments Limited & Manukau Quarries Limited Partnership please see attached submission on DIS60433803.

Kind Regards
Renee

renee fraser-smith town planner
027 238 2937 renee@tollemache.co

From: Warwick Pascoe
To: Achini Ranasinghe
Cc: rcregulatorysupportcentral2
Subject: FW: Submission on Resource Consent Application DIS60433803 by Watercare Services Limited
Date: Tuesday, 17 December 2024 8:10:47 am

Morning Achini,

Please see the late submission below.

Mark Ross has one too that he'll send through shortly.

How many others have been received please?

Thanks
Warwick Pascoe | Principal Project Lead
Auckland Council | Premium Resource Consents
Level 6 (North), 135 Albert Street

Mobile (021) 574 402

From: company Impress <impresscompanylimited@gmail.com>
Sent: Tuesday, 17 December 2024 6:34 am
To: Warwick Pascoe <warwick.pascoe@aucklandcouncil.govt.nz>
Subject: Submission on Resource Consent Application DIS60433803 by Watercare Services Limited

To: warwick.pascoe@aucklandcouncil.govt.nz
Regard: Submission on Resource Consent Application DIS60433803 by Watercare Services Limited

Dear Mr. Pascoe,

I hope this email finds you well.

Firstly, I would like to extend my sincere apologies for submitting this response one day past the deadline of **16 December 2024**. Due to an **unexpected scheduling conflict**and an urgent work matter requiring immediate attention, I was unable to finalise our feedback in time. As soon as I became aware of this oversight, I prioritised completing and submitting this response to ensure our concerns are clearly communicated. I kindly ask for your understanding in this matter and appreciate your consideration in reviewing our slightly delayed submission.
We are writing regarding the public notification of Resource Consent Application **DIS60433803** submitted by Watercare Services Limited. While we understand the necessity of upgrading infrastructure to meet growing community

demands, as property owners in close proximity to the Beachlands Wastewater Treatment Plant, we have significant concerns regarding the project's **visual impact** and its broader **economic effects**. These concerns are particularly relevant to our plans for a high-end villa development on our property, which may face considerable challenges in attracting buyers without effective mitigation measures.

To streamline our feedback and focus on actionable aspects within the Council's purview, we have summarised our key requests as follows:

1. **Mitigation of Visual Impact:**
    - **Landscape Enhancement Plan:** We would like to know whether you have plans to mitigate the facility's visual impact on our property through planting trees, establishing green belts, or other methods.
    - **Optimisation of Architectural Design:** We recommend adopting colours and materials in the architectural design that harmonise with the surrounding environment to reduce visual impact.
2. **Environmental and Economic Impact Assessment:**
    - **Environmental Impact Assessment:** We request that you conduct a comprehensive environmental impact assessment, particularly focusing on the visual factors affecting surrounding properties and the community, and share the assessment results with us.
    - **Property Value Analysis:** Please evaluate the potential impact of the expansion project on the value of surrounding properties and provide mitigation strategies to address any negative effects.
3. **Communication and Cooperation:**
    - **Establish Communication Channels:** We hope to establish regular communication mechanisms with you to stay informed about project progress and related measures.
    - **Participation in the Planning Process:** We are willing to actively participate in the planning and discussion of the project to jointly seek solutions that align with community and property owner interests.

By focusing on these critical areas, we believe that practical solutions can be identified to address our concerns and safeguard the well-being and economic interests of both the local community and property owners.

We respectfully request that you consider the above feedback and provide us with a **timeframe** for addressing these specific issues. Through open dialogue and collaboration, we are confident that mutually beneficial outcomes can be achieved.

Thank you for your understanding and for considering our submission despite its slightly delayed timing. Should you wish to discuss this matter further, please do not hesitate to contact me directly.

Yours sincerely,

Andrew KOT
Impress Company Limited
impresscompanylimited@gmail.com